IPART
New South Wales

Independent Pricing and Regulatory Tribunal

Audit of Sydney Water Corporation's Asset Management Systems

Report to the Minister

Water — Compliance Report
July 2008

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The Tribunal members for this review are:

Dr Michael Keating, AC, Chairman

Mr James Cox, Chief Executive Officer and Full Time Member

Ms Sibylle Krieger, Part Time Member

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Contents

1 Introduction and Overview

The Independent Pricing and Regulatory Tribunal of New South Wales (IPART) has completed its review of Sydney Water Corporation's (Sydney Water's) Asset Management Systems in accordance with the Operating Licence requirements. IPART engaged Halcrow Pacific Pty Ltd to undertake the audit of Sydney Water's compliance with the relevant Operating Licence clauses.

1.1 Background

Sydney Water is a State Owned Corporation, wholly owned by the NSW Government. Its primary role is to manage potable water supply, sewage treatment and some stormwater drainage services to protect public health and the environment for the benefit of Sydney, Blue Mountains and Illawarra regions. These roles and responsibilities are derived from the *Sydney Water Act 1994* and the Operating Licence issued to Sydney Water pursuant to Part 5 of the Act.

Under Clause 4.10 of the Operating Licence IPART may conduct, during the term of this Licence and at a time it determines, an audit of Sydney Water's compliance with the Asset Management provisions contained in clauses 4.8 and 4.9, and report the findings to the Minister.

The purpose of this report is to inform the Minister for Water Utilities of the audit findings and any forward actions arising from these findings.

1.2 Audit Process

The auditor reviewed key documents, held discussions with the relevant asset management personnel, asked supplementary questions and compared Sydney Water's approach to Asset Management with current Australian and international best practice.

In particular, the auditor looked to assess the robustness of Sydney Water's risk-based approach, the use of whole-of-life costing, and the quality and quantity of the underlying data and information used to predict asset life-cycle behaviour.

The auditor provided Sydney Water with drafts of the audit report, giving Sydney Water an opportunity to comment on the documents and to provide additional information where required. The auditor considered the comments provided before finalising the report.

1.3 Audit Scope

The auditor assessed Sydney Water's compliance with the Asset Management obligations included in the Operating Licence. Specifically, this review assessed Sydney Water's:

- Asset Management Systems to ensure that Sydney Water is managing its assets consistent with clause 4.8(a) to 4.8(d) of the Operating Licence; and
- State of the Assets Report to ensure that it complies with the Operating Licence.

A summary of the auditor's findings are listed below. Further details of the assessment of Sydney Water's Asset Management performance are provided in the auditor's report which is included in Appendix A.

2 Auditor's Findings and IPART's comments

The audit outcome is positive. Sydney Water has defined asset management as follows:

> A business discipline for managing the life cycle of assets to achieve a desired level of service and financial return within an acceptable risk framework.

This is a powerful definition. It clearly shows that Sydney Water aims to be a leading asset management company.

Sydney Water has identified asset management as an integral and essential element of its business planning process, raising its profile and importance. Sydney Water's asset management processes are described as being top-down (strategic) and bottom-up (tactical), underpinned by a financial awareness at all stages. This integrated approach to planning is in line with best practice.

The auditor made the following key conclusions:

1. Sydney Water is committed to an asset management strategy as a basis for underpinning their investment planning process. This is subject to ongoing improvement and exhibits the use of a risk-based approach. Nonetheless, there is scope for improvement, some of which will be dependent on the availability of more specific asset condition and deterioration data.
2. Sydney Water is complying with the Operating Licence conditions with respect to the quality and content of the State of the Assets reporting.
3. Sydney Water's strategic framework for asset management is integrated between strategic business planning and tactical service delivery. This is a good practice approach.
4. Sydney Water needs to ensure that the planned enhancements to its approach (specifically the development of area plans, system plans and asset plans) are well coordinated and the interactions and overlaps are well understood.

5. Sydney Water exhibits many characteristics of a leading water asset management company and this is underpinned by the use of risk-based planning. Nonetheless, there is scope for improving some aspects of the budget setting methodology, so that it aligns closely with the capital program approvals process.
6. The use of the KANEW[1] asset-life model detracts from the risk-based asset management planning methodology and its future use needs careful consideration.
7. The use of risk assessment and whole-life costing is evident in the process used for developing specific business cases that support the capital program. This process is illustrative of good practice and is considered to be robust.
8. Sydney Water has suitable systems, processes and tools and an improving body of data with which to support the asset management process.
9. The Failure Modes and Effects Analysis methodology used for asset maintenance planning is a best practice strategy.

The auditor identified a number of strengths and weaknesses of Sydney Water's asset management approach, and has made a number of recommendations to address these needs. The alignment of the needs and the corresponding recommendations is summarised in Table 2.1 below.

1 KANEW is a software tool that Sydney Water currently uses to assess water mains renewals expenditure for the strategic budget estimation.

Table 2.1 Alignment of needs and recommendations

Needs / weaknesses	Auditor's Recommendations
1) Need to ensure that strategic business drivers are identified, quantified and appropriately weighted and connected to the investment planning process	- That Sydney Water adopt a current best practice approach and undertake the optimisation across the asset base and all of the various investment drivers. This should be achieved using a mathematical calculation engine based on generic algorithms or equivalent.
2) Need to ensure that the budget setting process, business case development, area plans, system plans etc are properly integrated and documented.	- That Sydney Water clarify the interactions between asset plans and service plans. Specifically, the potential overlaps between these plans need to be agreed.
3) Need clarity on inputs to the strategic budget from the business cases that are used to develop the detailed capital program.	- In order for Sydney Water to be able to closely link investment requirements to improvements in levels of service, asset data and tracking of service trends need to be improved and deterioration models developed.
4) Need to address formally the issue of uncertainty in data.	- That if Sydney Water continues to apply the KANEW model for strategic budget estimation, it develop statistically valid asset life models, and that the analysis is undertaken at a finer level of cohort detail.
5) Need clarity on how risk thresholds are set for determining strategies and options.	- That Sydney Water move towards a monetary based risk assessment and consideration of externalities and indirect costs to strengthen the risk based approach and improve risk management potential.

IPART believes that Sydney Water should consider the auditor's recommendations and use them to guide its efforts to manage the risks associated with its assets and endeavour to identify the most cost-effective options for managing the risks.

3 IPART's Recommendations

IPART notes that the auditor has made a number of recommendations. It agrees with Sydney Water that the auditor's recommendations are not easily set to a timetable. Sydney Water has already considered or initiated improvement actions towards addressing each of the issues raised in the auditor's recommendations, and had indicated that all recommendations are expected to be completed during the next IPART price determination period (from 1 July 2008 to 30 June 2012). Recognising this, IPART recommends that the Minister request Sydney Water to provide IPART with a progress report every two years, commencing on 1 September 2010.

Recommendations

That the Minister request Sydney Water to report progress to IPART every two years, commencing with a report on 1 September 2010, on what improvement actions have been undertaken to address each of the issues listed below:

1) Sydney Water needs to ensure that strategic business drivers are identified, quantified and appropriately weighted and connected to the investment planning process.
2) Sydney Water needs to ensure that the budget setting process, business case development, area plans, asset plans, system plans etc are properly integrated and documented.
3) Sydney Water's asset management approach needs clarity on inputs to the strategic budget from the business cases that are used to develop the detailed capital program.
4) Sydney Water needs to formally address the issue of uncertainty in data; this includes:
   - develop statistically valid asset life data to inform the KANEW model, if it continued to be used for strategic budget estimation, and
   - improve asset data and tracking of service trends and develop deterioration models to better link investment requirements to improvements in levels of service.
5) Sydney Water's asset management approach needs clarity on how risk thresholds are set for determining strategies and options. There will be benefit in developing a quantitative measure of risk and thereby expressing externalities and service impacts in common terms. This will support the development of a cost-benefit approach and is in line with best practice investment planning.

Sydney Water may choose to draw on the auditor's recommendations in addressing the above issues.

IPART will monitor Sydney Water's progress in implementing improvement actions in relation to the matters discussed above.

Appendices

A Halcrow Pacific Pty Ltd – Review of Sydney Water Corporation's Asset Management Systems

Halcrow Pacific Pty Ltd

February 2008

Independent Pricing and Regulatory Tribunal (IPART) of New South Wales

Review of Sydney Water Corporation's Asset Management Systems

Final Report

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Halcrow Pacific Pty Ltd

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Review of Sydney Water Corporation's Asset Management Systems

Final Report

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Independent Pricing and Regulatory Tribunal (IPART) of New South Wales

Review of Sydney Water Corporation's Asset Management Systems

Final Report

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Prepared by	Checked by	Authorised by
1	A	Preliminary Draft	02 November 2007	PJC	WDW	
1	B	Preliminary Draft	07 November 2007	PJC	WDW	
1	0	Draft	08 November 2007	PJC	WDW/JOS	JOS
1	1	Final Report including SWC & IPART comments	07 February 2008	PJC	DF/JOS	JOS

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Contents

Table of Figures

1 Executive Summary

This review is an assessment of the effectiveness of Sydney Water Corporation's (Sydney Water) asset management strategy in terms of its ability to ensure that capital and operational investment is prudent and will deliver the right balance of service and value for money. We have looked to see whether or not Sydney Water understands the risks associated with its assets and has endeavoured to identify the most cost-effective options for managing the risks. Specifically, we have undertaken an assessment of Sydney Water's:

- Asset Management Systems to ensure that Sydney Water is managing is assets consistent with clause 4.8(a) – 4.8(d) of the Operating Licence; and
- State of the Assets Report to ensure that it complies with the Operating Licence.

To achieve, this we have reviewed documentation and held discussions with Sydney Water personnel. We have looked for evidence that Sydney Water applies a risk-based decision making approach and that this is suitably supported by people, processes and tools.

We have made the following key conclusions:

1. Sydney Water is committed to an asset management strategy as a basis for underpinning their investment planning process. This is subject to ongoing improvement and exhibits the use of a risk based approach. Nonetheless, we believe there is scope for improvement, some of which will be dependent on the availability of more specific asset condition and deterioration data.

2. Sydney Water is complying with the Operating Licence conditions with respect to the quality and content of the State of the Assets reporting.

3. Sydney Water's strategic framework for asset management is integrated between strategic business planning and tactical service delivery. This is a good practice approach.

4. Sydney Water needs to ensure that the planned enhancements to its approach (specifically, the development of area plans, system plans and asset plans) is well coordinated and the interactions and overlaps are well understood.

5. Sydney Water exhibits many characteristics of a leading water asset management company and this is underpinned by the use of risk-based planning. Nonetheless, we feel there is scope for improving some aspects of the budget setting methodology, so that it aligns closely with the capital program approvals process.

6. The use of the KANEW asset-life model detracts from the risk-based asset management planning methodology and its future use needs careful consideration.

7. The use of risk assessment and whole-life costing is evident, clearly, in the process used for developing specific business cases that support the capital program. This process is illustrative of good practice and we consider it to be robust.

8. Sydney Water has suitable systems, processes and tools and an improving body of data with which to support the asset management process.

9. The FMEA methodology used for asset maintenance planning is a best practice strategy.

2 Introduction

2.1 Background

Sydney Water Corporation (Sydney Water) provides drinking water, recycled water, wastewater services and some stormwater services to more than four million people in Sydney, Illawarra and the Blue Mountains, an area covering some 13000 square kilometres.

Drinking water is sourced from a network of dams managed by the Sydney Catchment Authority. More than 1.4 billion litres of water are treated and distributed to over 1.7 million homes and businesses each day by Sydney Water. Sydney Water collects and treats more than 1.2 billion litres of wastewater from homes and businesses each day, of which some 36 million litres is recycled. The sewerage network services around 1.6 million homes and businesses in the Greater Sydney region.

With more than 3,000 staff, Sydney Water has assets with a replacement value of approximately $20 billion and a planned capital expenditure program in excess of $1 billion in 2007-08.

It is imperative that Sydney Water understands its asset base, the service levels they provide, the risks and how best to invest to offset the effects of aging and meet future needs.

2.2 Scope

The term asset management has a wide range of working definitions. The definition used by Sydney Water is a powerful one:

"A business discipline for managing the life cycle of assets to achieve a desired level of service and financial return within an acceptable risk framework"

Our review is an assessment of Sydney Water's ability to implement this approach across its asset stock and to demonstrate effective management of risk in order to deliver good value to customers and stakeholders. Specifically our review focussed on the systems, procedures and tools being applied by Sydney Water and concentrated on ensuring that the strategic budget and individual schemes have a robust foundation in the management of risk.

2.3 Terms of Reference

The objective of this report is to review Sydney Water's asset management systems and undertake an assessment of performance in complying with asset management obligations contained in Sydney Water's Operating Licence. IPART needs assurance that that Sydney Water is adequately managing its assets.

For this review Halcrow is specifically required to audit Sydney Water's:

- Asset Management Systems to ensure that Sydney Water is managing is assets consistent with clause 4.8(a) – 4.8(d) of the Operating Licence; and
- State of the Assets Report to ensure that it complies with the Operating Licence.

2.4 Approach to Review

Our approach to assessing the strength of the asset management methodology is straightforward. We have reviewed key documents, held discussions with key asset management personnel, asked supplementary questions and compared the approach against out knowledge of current Australian and international best practice.

In particular, we have looked to assess the robustness of Sydney Water's risk-based approach, the use of whole of life costing, and the quality and quantity of the underlying data and information used to predict asset life-cycle behaviour.

In our review we have considered:

- overall suitability of the asset management approach;
- areas of concern that affect long term service delivery capacity;
- confidence in proposed expenditure on assets included in the capital expenditure program; and
- compliance with relevant obligations outlined in the Operating Licence.

3 Review of Sydney Water Corporation's General Methodology, Procedures and Systems

3.1 Introduction

This Section describes and assesses the Sydney Water Strategic Asset Management framework.

An asset management framework is, essentially, a set of building blocks (linked by an asset management process) that must be 'assembled' efficiently in order to develop the asset management plan. A typical[1] set of framework building blocks can include:

1. *Objective setting* – what is the overall approach and how will it be achieved.
2. *Service indicators* – developing a set of performance indicators that will be used for assessing performance and risk.
3. *Asset information* – asset data used to develop a picture of asset failure probability and the consequences.
4. *Forecasting* – predicting future levels of performance and service.
5. *Risk mitigation* – identification of the rehabilitation, maintenance, new construction options, etc. for managing risk.
6. *Optimisation* – selection of the most cost beneficial, or cost effective options, thereby defining the investment program.

The asset management process defines how the framework is implemented. This needs to be supported by definition of responsibilities, organisation and flows of information.

The asset management plan is a document that details the asset specific risks and the work that needs to be done to the assets in order to deliver the appropriate level of service. Asset (management) planning is the analysis and risk

[1] This list is based on typical UK practice, which is influenced by the UKWIR Capital Maintenance Common Framework

quantification carried out in order to support the development of the asset management plan.

Asset management planning is supported by analysis of asset data and application of tools and models. This can include:

1. Asset inspection and condition assessment (what state are the assets in?).
2. Failure modes and effects analysis (how do assets fail and what will happen?).
3. Failure probability analysis (when or how likely is the asset to fail?).
4. Risk ranking (what is the overall probability and consequence of failure?).
5. Cost benefit analysis (what is the best course of action, based on appreciation of whole life costs and benefits?).

A good asset management framework will detail the specific building blocks and the associated processes, systems and tools that underpin them.

It is important that this framework is structured correctly and that it contains all the necessary components to enable efficient, informed decision making. The framework both underpins the importance and identifies the key stages of asset management.

In our review we have looked for evidence that the framework is fully integrated into Sydney Water's business planning and 'business as usual' processes and is supported by robust procedures and asset management capabilities, ie that asset management is part of the 'day to day' business as well as the overarching business strategy. We have also looked to establish whether or not Sydney Water's asset management building blocks, tools and models align with those described above and will enable a robust and efficient assessment of opex and capex investment needs.

3.2 Strategic Framework for Asset Management

3.2.1 *Reference sources*

In compiling this review of the strategic asset management framework we have drawn upon the following sources of information:

- *Sydney Water Strategic Framework for Asset Management; Version 1*, A Merlino, 15 September 2004;
- *State of the Assets; Report on Asset Management Capability; Processes, Practices and Plans; Issue 01*, G Kane, October 2006;

- *Efficiency Review Supporting Document, Asset Management Capability and Improvement Program,* Greg Kane, 31 August 2007; and
- Presentations and interviews with Greg Kane and Paul Freeman of Sydney Water's Asset Management division.

3.2.2 Overview

Sydney Water has made asset management an integral and high profile component of its overall business planning framework (**Figure 3.1**). This is encouraging, because it demonstrates a strong company commitment and gives confidence that solid asset management foundations exist, from which to build the capital program and support continuous improvement.

A detailed assessment of Sydney Water's asset planning approach confirms that key asset management building blocks and tools exist and are used and that ongoing initiatives to extend the use of risk-based planning, optimisation and integration of planning methodologies with strengthen this framework further.

It is apparent that Sydney Water aims to deliver an asset management strategy that delivers service requirements at minimum costs. This is cognisant of risk throughout the asset life cycle (planning, creation, operation, maintenance, rehabilitation, and disposal). These asset management aspirations are identified clearly in Sydney Water's core documentation.

A previous independent review[2] concluded that Sydney Water's asset management approach is that of a leading company. Specific recommendations for improvement were produced, including a recommendation to extend the risk-based approach across the asset base. Sydney Water responded with a three year improvement program.

We agree that Sydney Water exhibits many characteristics of a leading water asset management company, for example, the use of risk-based planning. Nonetheless, we feel there is still scope for improving some aspects of the budget setting methodology (eg the KANEW methodology currently used for water distribution mains, which is not risk-based), developing the tools used and achieving close alignment with the capital program approvals process.

[2] IPART Capex, Asset Management and Opex Review, Atkins, 2005,

In follow-up discussions, Sydney Water confirmed that it recognised these limitations and is appraising the use of alternative tools that will improve confidence in the budget estimation in future. These tools will also enable more effective justification of schemes proposed in the capital program.

3.2.3 *Asset management as part of the business planning framework*

Asset management processes are described as being an integral component of the business planning process and support preparation of the Corporate Plan (company wide requirements) and budget. Furthermore, they are described as being top-down (strategic) and bottom-up (tactical) and underpinned by a financial awareness at all stages. We consider this integrated approach to planning to be in line with best practice. Specific evidence of this is seen in the detailed asset management plans for each asset group and in the business cases that are prepared.

The role of asset management in the overall business planning process is shown in **Figure 3.1** where the asset management activities are shown in the second (large, yellow) box from the left (create, operate, maintain, renew, dispose of assets). Each activity had an underpinning process, supported by appropriate tools and data that is risk-based and uses a whole life costing methodology in order to determine the best asset management option.

This is the asset planning process, the key output being the asset plans (asset management plans).

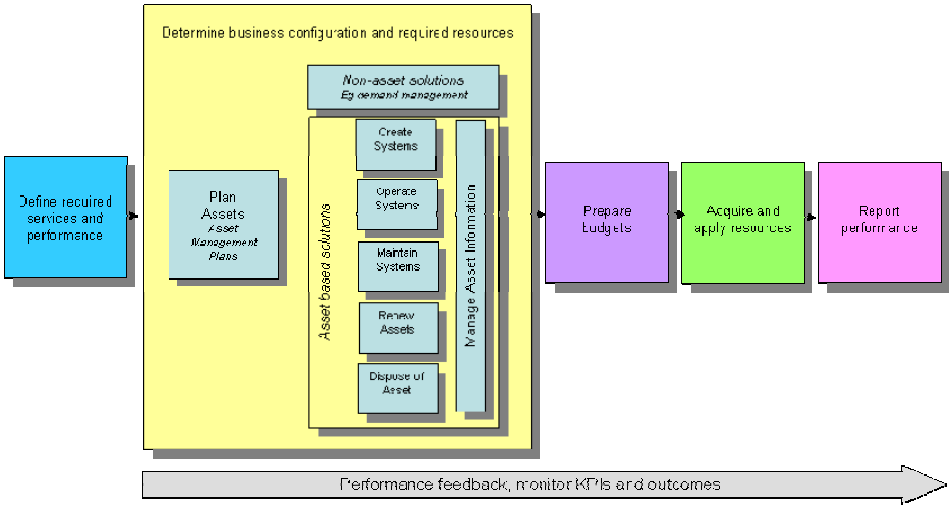

Figure 3.1 Asset management planning within business planning (source: Sydney Water)

The asset (management) plans provide a detailed understanding of:

- the state and condition of existing assets;
- the ability to meet future service needs; and
- the areas requiring remedial action.

The investment needs identified are then fed into the corporate plan on an annual basis. The asset management plans are considered to be a 'bottom-up' appraisal of the asset base, ie a detailed, asset-specific analysis of need. In parallel, there are a series of strategic level (top-down) planning processes and outputs which include the budget and capital program. Note that the capital program takes into account investment drivers such as growth, demand and supply, not just asset reliability and this is why it is described as top down.

There are also two other types of plan that are currently under development as part of the ongoing improvements to Sydney Water's asset management approach. These are (Area) servicing plans, which will contain a 5 to 30 year view of the service delivery strategy to meet customer needs and System Plans which will assess the impacts of drivers such as growth on the system and set out least cost investments over a 20 year horizon. The various plans are reviewed and updated on an annual basis.

We found some of these definitions confusing. Whilst the existence of these various plans is evidence that Sydney Water has an integrated approach that is applied at the strategic and tactical levels and across functional and geographic boundaries, it is essential that the overlap and interactions between these plans is understood and well documented. Consequently, we requested clarification as to how these plans integrate and how are the overlaps quantified and managed.

In simple terms, the asset plans focus on the life-cycle of the existing assets, and the need for renewals and maintenance; the area plans focus on a specific geographic area and issues such as growth and customer need; the system plan looks at how the asset base will deliver service to specific areas in the future. It was apparent that Sydney Water has considered the issues of overlaps and integration. Asset planning has overall responsibility for developing the most effective solutions to meeting the overall needs. It was also recognised that the development of the area plans and system plans is ongoing with the first area plans having just been delivered.

We recommend that asset plan, area plan and system plan overlaps are documented in a single asset management plan overview that defines clearly the nature of the overlaps, the implications for optimisation of the capital program and any efficiency that will be achieved. This integration document will need to demonstrate and justify how the most cost effective strategy has been determined.

3.2.4 Service and performance definition

Sydney Water has declared that understanding stakeholder expectations and converting these into service performance parameters is a key initial step in the strategic asset management process. These service parameters are the basis for assessing risk and for optimising investment in the asset base.

The identified factors that define stakeholder expectations and shape investment strategy are:

- Formal regulation;
- Government policy;
- Customer expectations; and
- Shareholder expectations.

There are potential conflicts and overlaps between these drivers. Customer expectation is one of the most challenging to quantify. Sydney Water states that it relies on a range of methods for determining the needs of its customers. For example, Sydney Water undertakes regular and project based stakeholder and customer and community research. This is used to obtain qualitative and quantitative information on potential future service expectations including issues such as changing demographic trends and water supply issues.

It is also reasonable to assume that customer interests are reflected in the various licences, contracts and conditions under which Sydney Water operates, ie:

- Sydney Water's Operating Licence;
- Sydney Water's Customer Contract;
- Statement of Corporate Intent (SCI);
- Australian Drinking Water Guidelines 1996 (ADWG); and
- Environment Protection Licences.

Customer consultation would be expected of a modern, professional water company. We recommend that Sydney Water could consider, further, the use of willingness to pay as a basis for quantifying the value that customers place on service levels (we note that Sydney Water has looked at this in the past; however, we believe that there is merit in revisiting this approach).

When considering investments that affect a number of drivers, or trying to prioritise between drivers, it is important that service performance parameters are weighted, fairly. A systematic, transparent process must exist to achieve this, so that investment needs can be appraised on an equitable basis.

This process of weighting, or striking the right balance, is not clear in the framework documents that we have reviewed. We asked Sydney Water to demonstrate how these drivers are converted into service parameters and how these are used in the investment decision making process.

At present, seven (7) corporate drivers are used to assess the impact of investment and these are evaluated as part of the business case process that is used to define schemes for the capital program. The drivers are asset renewals, asset reliability, growth, mandatory standards, discretionary standards, government programs and efficiency. For each business case scheme, the expenditure is allocated across these as appropriate, eg:

Asset Renewals	Asset reliability	Growth	Mandatory Standards	Discretionary Standards	Government Programs	Efficiency
100%						

At present, that weighting and preferences of drivers is not used to prioritise the investment within the overall capital program. However, a new optimisation tool is currently being implemented by Sydney Water that will enable this type of trade-off and balancing. We consider that this tool will enable program efficiencies and is an example of good practice investment program planning.

3.2.5 Asset planning process

Asset planning is the process used to ensure that assets and their servicing strategy are capable of meeting service delivery requirements, now and in the future. The primary output from the asset planning process is the asset management plan for each asset group. The process for generating these plans is summarised in **Figure 3.2**.

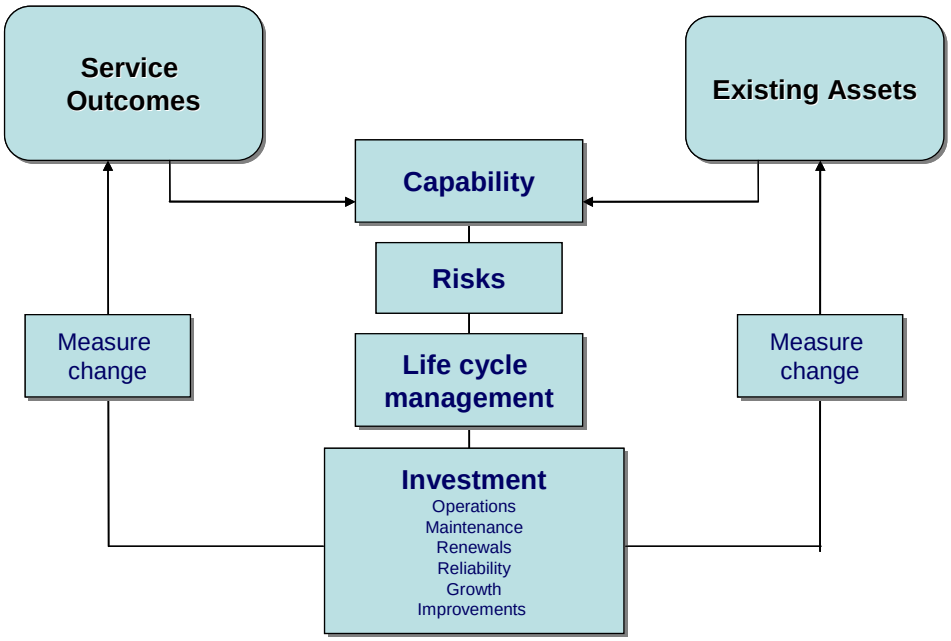

Figure 3.2 Schematic of asset planning process

The planning process covers asset maintenance, renewal/rehabilitation, creation, upgrading and disposal and identifies investment needs accordingly. This is determined by assessing the service requirements, risk and asset 'condition', then identifying the most cost-effective option for managing the risk. The most cost effective option is that which has the lowest total whole life cost and enables the target level of risk to be achieved.

The process allows a systematic appraisal of asset specific investment need and supports the development of a detailed business case.

The process starts with an asset specific review of the necessary service outcomes. This includes consideration of growth and the impact of this with respect to the capacity of existing assets.

The existing assets and asset systems' capabilities are appraised against the service requirements and shortfalls assessed. Asset performance, failure trends and condition are appraised as a basis for quantifying the extent of the potential shortfalls in current and future service delivery. This 'shortfall' in the asset capability to deliver is a measure of asset risk.

A risk-assessment methodology is applied by Sydney Water to prioritise the significance of the shortfalls in service delivery. The risk score, or rather, the position on the risk grid then determines whether or not risk management options should be considered. An asset with low consequence and low probability of failure is 'accepted', ie it is managed reactively (this is referred to as the 'do nothing different' approach). As the consequence or likelihood increases, then a variety of risk mitigation strategies are considered. These include asset creation, maintenance, operational optimisation, renewals, etc.

Preferred risk mitigation options are identified based on a range of decision metrics. These include consideration of the balance of risk and cost over whole of life (direct and indirect) and the technical feasibility. A detailed business case is prepared for the preferred option, the purpose of which is to confirm the business case against a set of criteria. This includes undertaking a robust analysis of life-cycle cost and establishing priority against other potential projects.

When the preferred options are input to the business planning process and developed into a program of work, a 30 year cash flow analysis is developed and entered into the capital investment program. A needs specification is then developed. The detailed business case process is reviewed elsewhere in this report, our main conclusion being that the process is rigorous.

The final step in the asset planning process is to monitor the effects of the changes made to the system assets and to update information accordingly. Acting on feedback is a powerful indicator of good management practice. We established that Sydney Water has regular review meetings and lessons learnt are carried forward to enable continued improvement.

The asset management plan is a record of the asset management process thus described.

We consider the overall approach to be consistent with expected good practice.

The detailed methodology and the associated data uncertainties determine the effectiveness and accuracy of the risk assessment. Data uncertainty is a major issue and it is important that Sydney Water addresses this as part of the risk assessment and risk management cycle.

It is noted that Sydney Water utilises sophisticated uncertainty modelling tools to look at cost uncertainties when developing the capital program and this is commended. It would be prudent to extend the use of these techniques to look at the impact potential of other data uncertainties on the program e.g. asset failure

probabilities, deterioration rates, growth projections. This will give a better understanding of the risk potential 'envelopes' and support development of a more robust capital program.

3.2.6 *Asset life cycle*

The risk-based, asset management approach adopted by Sydney Water is implemented throughout the key phases in the life cycle of the individual assets. These key phases include:

- Asset creation;
- Asset operation;
- Asset maintenance;
- Asset replacement; and
- Asset disposal.

Asset creation is the process of acquiring a new asset, identified as the most effective means of addressing a service performance shortfall under the asset planning process. Once approved, the new asset project moves to a delivery phase and is put onto the capital investment program (unless constructed as part of a BOO package or acquired from developers as a requirement to service growth).

Asset delivery is the responsibility of the Assets Solutions Division, operating in accordance with defined management systems and standards and employing best practice procurement and project management strategies.

Schemes appear to be commissioned with due regard to relevant environmental, safety management and commissioning/acceptance procedures and after the satisfactory completion of the work the fixed asset register is updated.

Monitoring and review is an integral part of the asset creation process. Quarterly reviews are held to help ensure progress and expenditure are controlled and a post project review is undertaken to evaluate delivery and outcomes. It is essential that the actual/final scheme costs are examined so that lessons learned can be built back into the procurement and delivery of capital projects. Sydney Water follows this approach and was able to demonstrate that such lessons learnt were acted on.

Asset operation is the process by which Sydney Water manages existing assets to optimise performance and to monitor and report on the system. Strategic operations sits within the asset management division and reports to the asset owner. Strategic operations are responsible for service optimisation and also for responding to abnormal operation events. Routine operational support has been out-sourced.

Work management and event monitoring is facilitated using the WAMS and MAXIMO systems. These systems are interrogated to identify instances of recurrent asset failure and used to inform decisions about whether to change the operation or maintenance approach or renew the asset. Review of failure data to identify problems and trends is deemed good practice.

In addition to procedures and processes for dealing with day to day reactive maintenance and failures, Sydney Water also has an Emergency Risk Management policy and process to deal with exceptional risks.

Asset maintenance refers to the routine and planned maintenance activities aimed at preserving the reliability and availability of the asset. This is distinct from the renewals or replacement activities that restore the original condition of the asset. Maintenance is the responsibility of the Asset Management division.

Maintenance can be cleaning, making repairs, replacing or servicing minor components in order to prolong the life or improve the efficiency of the assets operation. To optimise the maintenance strategy a number of risk based tools are used such as RCM (reliability centred maintenance) and FMEA (failure modes and effects analysis).

We consider the use of these approaches to be best practice and that their use will help Sydney Water ensure a robust and cost effective basis for managing the asset maintenance program and will enable a risk based prioritisation of investment.

A feedback process is in place to determine the effectiveness of the adopted strategies and to support a continual improvement process.

Asset replacement and rehabilitation become necessary when assets have deteriorated to the point where even prudent maintenance cannot prolong the service life of the asset, ie the asset has become uneconomic to maintain or the reliability has fallen below a critical threshold.

Asset properties that may trigger the investigation to determine suitability for replacement include:

- condition;
- failure rates;
- cost of maintenance; and
- cost of failure.

This is an effective approach, although we would recommend that the 'cost of failure' (or potential failure) should include consideration of externalities and societal impact costs as well as the direct and immediate costs. We recognise that externalities can be difficult to quantify. However, Sydney Water is developing and testing a new economic model that is being appraised for trunk mains investment planning. This will aim to quantify the cost of failure on the community and environment and is a leading edge example of consequence cost modelling.

Asset disposal is the final option for assets that cannot be renewed or have become obsolete. A corporate decommissioning procedure covers this element of the asset lifecycle and after the process is complete the old asset is removed from the asset register.

3.2.7 *Business support*

There are a number of systems that underpin the application of the asset management planning process. These asset information systems enable the asset management process and provide the essential asset and performance data to support decision making.

Asset information systems used by include works and asset management systems (WAMS, MAXIMO) and GIS (Hydra). These are typical systems used in the water industry and they appear to be used effectively by Sydney Water.

Sydney Water also deploys a variety of models for examining the hydraulic properties and capacity of their networks, the results of which are fed into the asset management plans. We consider the use of these approaches to be in line with current good practice.

3.2.8 *Funding programs*

A detailed business case is developed for all significant projects that enter the capital program.

This process appears robust and is described elsewhere.

3.2.9 *Performance monitoring and improvement*

Performance monitoring and continuous improvement are an important element of Sydney Water's asset management philosophy. Benchmarking studies[3] have highlighted Sydney Water's leading edge position in water asset management.

[3] WSAA asset management process benchmarking framework, 2004

3.2.10 *Recent Developments in the Asset Management Framework*

Sydney Water has an ongoing asset management improvement process in place. The previously described asset management process and systems have been subject to a program of revisions and developments, as Sydney Water acts on advice from third party reviews and in line with changing corporate objectives. This process will continue until 2008. These developments include:

- Focussing the organisational structure of the Asset Management division to underpin the asset owner model.
- Development of State of the Assets reports, underpinned by asset plans and integrated into the annual rolling business cycle. These will be complemented by area plans which will integrate asset plans with strategies for growth and service level enhancement[4].
- The Financial Planning and Review Committee has been created to oversee investment planning and approval and this has become an established and effective process.
- Business cases cover the 2007-08 program and much of the future years program giving confidence in the planned capital program.
- The risk framework has been strengthened and is being deployed for all asset types. Expression of risk as a financial equivalent is being trialled. This development is specifically commended and we consider this approach is a key step for developing a comprehensive quantitative cost benefit analysis.
- A number of external[5] and internal reviews of best practice have been undertaken and these activities are to be encouraged. Findings have tended to be positive.
- Condition based asset valuation (first full cycle) has been completed, which has improved confidence in awareness of asset condition and this has been included in the latest asset renewal forecasting models.
- Planning tool improvements have been made and this is improving the ability to prioritise and plan work.

Future improvements that are planned include further benchmarking activities, review and monitoring of continual improvement and continued enhancement of the State of the Assets reports.

[4] These may be required because of a new directive or shortfall in existing service levels

[5] WSAA asset management process benchmarking framework, 2004

3.2.11 *Strengths and needs*

It is clear that Sydney Water aims to be a leading asset management company and is keen to implement appropriate asset management tools and systems.

The current framework and ongoing initiatives provide a robust framework for asset management planning. The following is a summary of the strengths and weaknesses of Sydney Water's asset management approach:

- ***Strengths:***
  - asset management is embedded in the business planning process;
  - asset management is identified as an integral and essential element of the business planning process, raising its profile and importance;
  - the approach is transparent and well documented; and
  - asset management planning provides both strategic and tactical inputs (strategic budget and project detail).
- ***Needs:***
  - need to ensure that strategic business drivers are identified, quantified and appropriately weighted and connected to the investment planning process;
  - need clarity on inputs to the strategic budget from the business cases that used to develop the detailed the capital program;
  - need to ensure that the budget setting process, business case development, area plans, asset plans, system plans etc. are properly integrated and documented;
  - need to address formally the issue of uncertainty in data; and
  - need clarity on how risk thresholds are set for determining strategies and options.

3.2.12 *Implications for investment planning*

The framework provides a well documented and consistent strategic framework for asset management planning. Investment is likely to be well defined and have a robust justification against key business drivers.

3.2.13 *Recommendations*

We recommend that Sydney Water continues to develop their understanding of asset risk. There will be benefit to developing a quantitative measure of risk (eg expressing all risks as a cost impact) and thereby expressing externalities and service impacts in common terms. This will support the development of a cost-benefit approach and this is in line with best practice investment planning.

The cost benefit approach is an evolution of Sydney Water's current cost-effective approach. Cost benefit analysis is aimed at identifying the most cost beneficial

option, not just that which is the lowest cost for achieving a pre-defined level of service/risk. The economic option (the most cost beneficial) is the strategy (this can be scheme specific or system wide) that delivers the greatest net benefit, or in layman's terms, best overall value for money (for further explanation, see **Appendix C**).

3.3 Review of Asset Management Plans

A review of asset management plans is detailed in **Appendix A**.

The asset management plans produced by Sydney Water provide the evidence that supports the future asset investment need. Sydney Water has a process for developing the strategic budget and for building up the capital program from individual schemes. For specific pipeline assets, an asset life estimation model (KANEW) has been used to estimate the budget envelopes. Having identified these budget envelopes, detailed business cases are developed, which use risk assessment and whole life costing to justify specific schemes. Assets such as trunk mains and strategic sewers are subject to condition inspection and this information informs the risk assessment.

Treatment and pumping assets are evaluated using failure modes and effects analysis (FMEA), which is informed by condition inspection. FMEA is a well recognised risk-based approach.

We conclude that the general approach for sewer pipes is acceptable; however, we challenged the business cases for the 'avoid fail' SWSOOS strategic sewer program, because we had not seen sufficient evidence that the sewers were in immediate need of rehabilitation. Having reviewed Sydney Water's detailed condition assessment reports we are now satisfied that the need is justified.

We do not feel that the KANEW model is appropriate for budget setting for high risk assets and recommend that detailed survey approaches are used to define the budget requirement. For water distribution pipes, either KANEW needs to be calibrated to give more confidence in the asset life assumptions, or more detailed statistical models should be implemented (we note that Sydney Water acknowledge this and are currently limited by available asset data).

The use of FMEA and inspection for treatment assets is good practice.

3.4 Developing the Capital Program and Project Approval Procedures

3.4.1 *Reference sources*

In compiling this review of the capital program approval framework we have drawn upon the following sources of information:

- *Project approval procedures; Issue A, Revision 3*, May 2007.
- Independent review of business cases (guide to the pink slip process), March 2006
- *Business case guidelines; Issue A, Revision 2*, January 2007
- ENVON V7 guide and tool.

3.4.2 *The approval process*

Sydney Water has adopted a rigorous process for developing the capital program, based on peer review and challenge. It also requires risk and cost based justification of the schemes that are proposed.

Figure 3.3 is an illustration of how projects and schemes are taken from the asset plans and into the capital program.

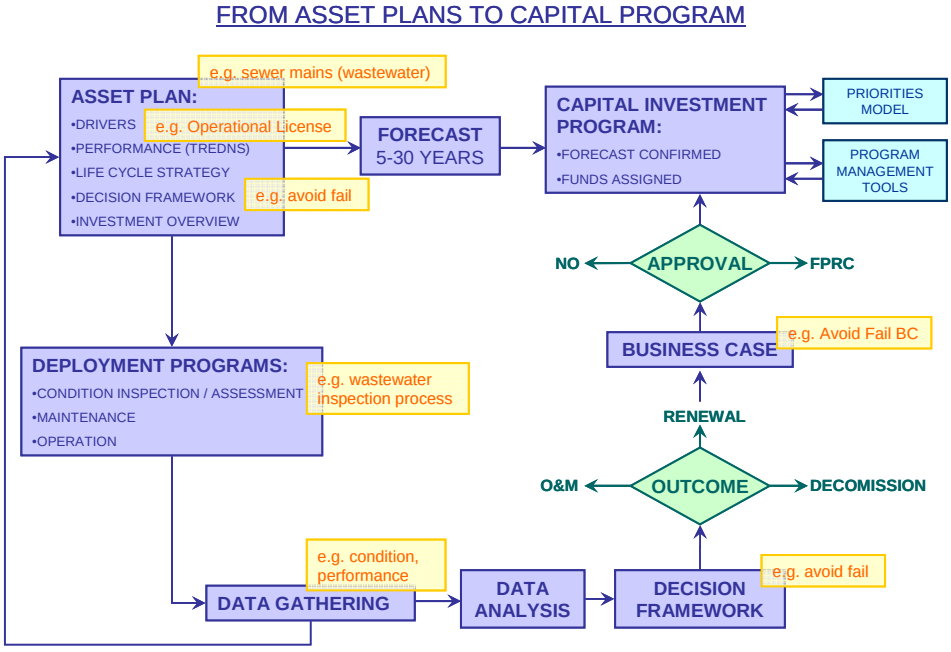

Figure 3.3 Developing the capital program from the asset plans

Asset investment needs may be identified via a number of routes. A key route is via the asset plan for each asset group. The plans are based on developing an understanding of the asset performance and life cycle characteristics. Investment need is typically derived from observations of asset performance and condition

and the application of models that enable forecasting of future service performance shortfalls and remaining life.

Potential projects and schemes need to pass through a series of checks and approvals (the business case approval shown in **Figure 3.3** is iterative) before they are actually passed through to the capital program. This necessitates definition and quantification of risk, cost and benefits of each major scheme. Templates need to be completed and these are used to provide the information for the business case and the independent audit.

In the above example, it is seen that the asset planning process supports development of the long term budget forecast. It also initiates asset specific investigations that will inform the needs and priorities for specific schemes that will need to be delivered as part of the capital program.

The business case process has a number of checks and balances and there is an escalation of approval authority depending on the likely size of the project. As well as approval stages (gateways) there is an audit process (pink slip process) which constitutes an independent review at each key stage.

The approval gateways cover initiation, options, procurement and delivery.

We have reviewed the relevant documentation that details the approval process and examined a number of business cases to determine the consistency with which the process is applied.

We conclude that the process is rigorous. It is well documented, transparent and includes an assessment of compliance with business drivers, risk and cost. It is underpinned by delivery of the required level of service at least whole life cost and is supported by appropriate tools (ENCONV7a).

Note that in our evaluation of the asset management obligations under the Sydney Water Operating Licence (Section 4), risk and cost are assessed further in terms of their basis for investment decision making.

3.4.3 Scoring of budget setting approach

We have scored the asset planning and budget setting approach using questions applied by Ofwat (the water services economic regulator for England and Wales). Whilst care needs to be taken is applying these criterion, these questions are sufficiently generic to provide a useful indication of Sydney Water's asset management position. The analysis is presented in **Appendix B**.

Sydney Water's overall asset management performance is good, with class leading scores in several areas including use of whole life costing, research and benchmarking to improve performance, use of sound data sources and deployment of a bottom up/business as usual process.

Areas to consider for potential strengthening are the offsetting of uplifts (comparing scheme risks and deferring lesser risks to help level peaks in capital investment), use of sensitivity analysis and assessment of integrated interventions (looking at all the drivers and needs and ensuring that the option is appropriate and efficient). Sydney Water is developing area plans and system plans and provided that they are used effectively, then this issue will be addressed.

Use of mathematical optimisation tools may enable additional integration efficiencies to be achieved. We note that Sydney Water is implementing the use of a risk optimisation tool that will facilitate prioritising investment and 'levelling' of the capital investment program.

3.5 Conclusions

In general, we are confident that Sydney Water has a robust general methodology for asset management and this is supported by appropriate procedures and systems.

Sydney Water has a risk based investment planning strategy in place and has demonstrated a commitment to continuous improvement.

With regard to key building blocks that support the asset management process, we see clear evidence of objective setting, defining the asset management approach, identifying appropriate asset data, risk management and going forwards, improved forecasting and optimisation. This is supported by appropriate tools for risk assessment and risk management.

Where issues have been identified, there is generally a strategy in place that will address the issues in the future. For example, the asset life based budget setting model, KANEW, is not risk based and less than ideal for determining investment budgets for 'avoid fail' pipes. To address this, Sydney Water is appraising new statistical models for assessing reticulation assets and continuing to develop a condition inspection based methodology for trunk mains and strategic sewers.

It is also of note that Sydney Water is introducing tools for optimisation, based on an improved risk assessment approach that will be applied consistently across the asset groups.

4 Compliance with Asset Management Obligations under the Operating Licence

4.1 Introduction

Sydney Water's asset management obligations are defined in the Sydney Water Operating Licence, as follows:

- Asset management obligation (Clause 4.8):

  Sydney Water must ensure that its assets are managed consistent with:

  (a) the terms and conditions in this Licence, and its obligations under the Customer Contract and all applicable laws with which Sydney Water must comply;

  (b) subject to (a) above, the lowest life cycle cost and acceptable risk of the Assets;

  (c) the whole of life of the Assets; and

  (d) its assessment of the risk of loss of the Assets, and capacity to respond to a potential failure or reduced performance of the Assets.

- Reporting on the asset management system (Clause 4.9):

  At least once during this Licence at a time agreed with IPART, Sydney Water must report to IPART on the state of each group of assets managed by Sydney Water.

  The report must include the following matters:

  (a) a description of the processes, practices, systems and plans Sydney Water uses in managing the Assets;

  (b) a description of each group of Assets;

  (c) an assessment of the expected capability of the Assets to deliver the Services and meet the existing obligations consistent with this Licence, the Customer Contract and all applicable laws with which Sydney Water must comply;

  (d) an assessment of the major issues or constraints on current and future performance of the Assets;

  (e) the strategies and expected costs of future investment in Assets;

  (f) progress in implementing the management of Sydney Water's Assets and any recommended improvements in processes, practices, systems and plans for the management of the Assets; and

  (g) such other matters reasonably required by IPART.

Compliance with these obligations is discussed in the **Sections 4.2** and **4.3** respectively.

4.2 Compliance with Clause 4.8

4.2.1 *(a) the terms and conditions in this Licence, and its obligations under the Customer Contract and all applicable laws with which Sydney Water must comply;*

As stated in the *Water Mains Asset Management Plan 2007/08*, "Sydney Water's performance across all parameters (of Operating Licence and a Customer Contract) is within regulatory requirements, except for the response to breaks and leaks requirements in 2005/06". External requirements include the following issues:

- *Water continuity:* the "Operating Licence minimum system performance requirement for continuity for the whole delivery system has been met each year since 1995." However, there are issues with high break rates and discontinuity consequences at a local level.
- *Water pressure:* the "delivery system, as a whole, has easily met the Operating Licence minimum system performance requirements each year since 1994/95".
- *Water quality:* "water quality continues to comply with Australian Drinking Water Guidelines".
- *Demand Management:* Sydney Water implements a Water Conservation Strategy to meet target demand of 329 litres per capita per day by 2011 (current estimate is 341 litres per capita per day in June 2006) and target water leakage of 105 ML/day by June 2009 (current estimate is 123 ML/day in 2005/06).

In the Sewers Asset Management Plan, Sydney Water states that, for dry weather, it "currently meets the Operating Licence conditions, although the numbers have been close to the prescribed maximum for properties affected, and there is an unacceptable upward trend in the total five (5) year rolling average choke rate per 100km/year."

In conclusion, Sydney Water can be considered to meet the requirement to manage the assets in accordance with regulatory requirements. Provided that Sydney Water's investment is based on sound cost-effectiveness principles, then over-performance is not an issue. It is not possible to assess whether the level of over-performance reflects an excessive investment program, or simply an efficient and well targeted program. The robust capital investment planning process gives confidence that the investment is efficient and not over indulgent.

4.2.2 *(b) subject to (a) above, the lowest life cycle cost ….*

"Sydney Water aims to operate its systems at the lowest long run cost and at an acceptable level of risk".

One of the criteria for renewing or replacing existing Sydney Water assets is when total life cycle costing justifies replacement of the asset (based on a commercial decision where the expected cost of maintenance over the expected working life of the asset exceeds the expected cost of replacement).

For existing assets planning, traditional life cycle costing analysis is possible and applied when enough data on operation and maintenance cost is available, otherwise a risk management approach is applied, which includes consideration of risk matrix of consequences and probability parameters.

Lack of failure history data makes accurate analysis of long-term trends in mains performance and particularly life-cycle costing problematic, although the current performance data are stored and managed efficiently using WAMS since 1990.

Within the asset planning process, business cases are prepared for each of the asset management options and include a whole of life approach using Sydney Water's Discount Cash Flow model ECONV7a. Options are selected based on the set of criteria including minimum life cycle cost of the asset. We see this model as a powerful planning tool.

For sewers, the least cost option is considered for the wet weather strategy, and in the business case for avoid-fail sewers. The business case undertakes an NPV analysis to get the most cost effective option.

Whilst the ECONV7a whole life costing tool is very powerful, we were concerned that the analysis, to identify the most cost-effective option, was focussed too much on tangible, direct costs, eg cost of repairing the pipe. When trunk mains and strategic sewers fail, there are many less tangible cost impacts, eg damage to the environment, traffic disruption, loss of business, loss of service. Taking these costs into account would tend to make mains rehabilitation more favourable compared to the 'fix on failure' approach. It would also enable a better evaluation of the consequential risk and enable better prioritisation.

We are pleased to note that Sydney Water is trialling an improved econometric model that will help to quantify these indirect cost impacts and support better decision making.

4.2.3 *…. and acceptable risk of the Assets;*

The last IPART efficiency review (2004) concluded that Sydney Water's asset management "methodologies include risk assessments to support current replacement proposals."

Since then there were improvements in the risk based approach in the number of areas, such as asset planning, investment planning and approval, and the corporate risk framework.

Business Case Guidelines indicate consideration of the risk during all project stages (project need, preferred option, procurement strategy, and project implementation) as an indicator of good and robust business cases.

We consider that a risk based approach is implemented in all asset life cycle phases in order to ensure the most appropriate application of resources and specifically:

- *Asset Planning:* Risk Management Framework using 'likelihood-severity' matrix approach in relation to the possible failure and underperformance of assets.
- *Asset Creation:* desktop risk assessment is carried out to asset consequences of asset failure.
- *Asset Operation:* risk-based approach is applied for the asset security, where "risk being a function of 'consequences' and 'probability' of security breach on any asset".
- *Asset Maintenance:* risk based methodology is based on the severity and likelihood of asset failure (Failure Mode Effects Criticality Analysis (FMECA) or tools similar to Reliability Centred Maintenance (RCM)).
- *Asset Replacement and Rehabilitation.*
- *Asset Disposal:* risk analysis is carried out prior to disposal.

For water networks, pro-active risk-based management and three-stage risk management are proposed: "risk identification, risk assessment & ranking, and risk control". At the moment, risk is estimated through grouping assets into critical and non-critical and life cycle cost or risk-based analysis, as shown in **Figure 4.1**.

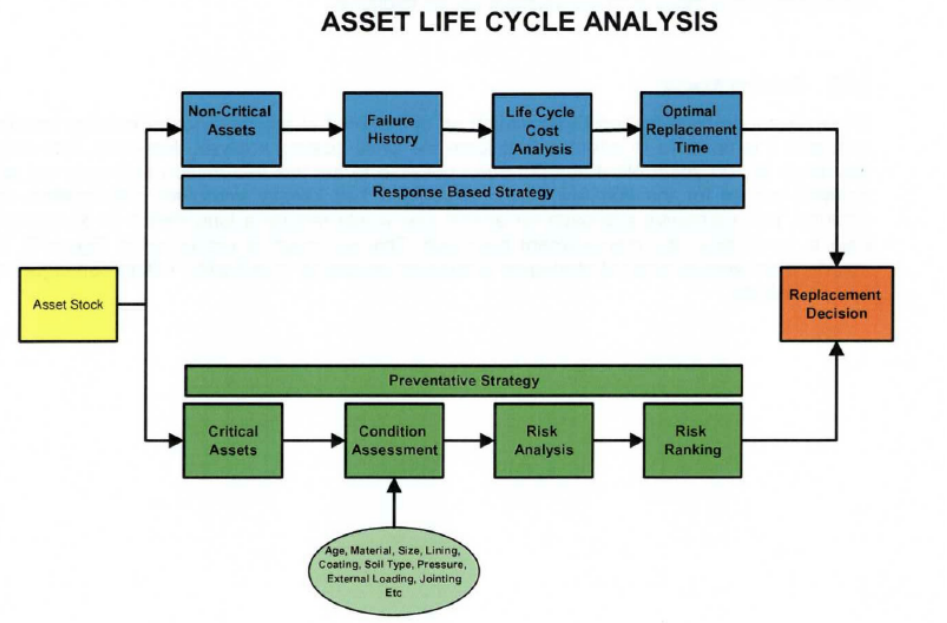

Figure 4.1 Water mains replacement decision process (source: Sydney Water)

As discussed in **Section 4.2.2**, the development of more comprehensive models for analysis of life-cycle cost is required (to include the indirect costs of failure). Whilst the quantification of indirect costs is challenging and introduces uncertainties, the benefit is that the improved quantification of risk becomes feasible, enabling a more effective investment strategy.

Sydney Water also proposes a more robust risk-based approach as indicated in **Figure 4.2** and some of the work on assets classification and model development has already been completed.

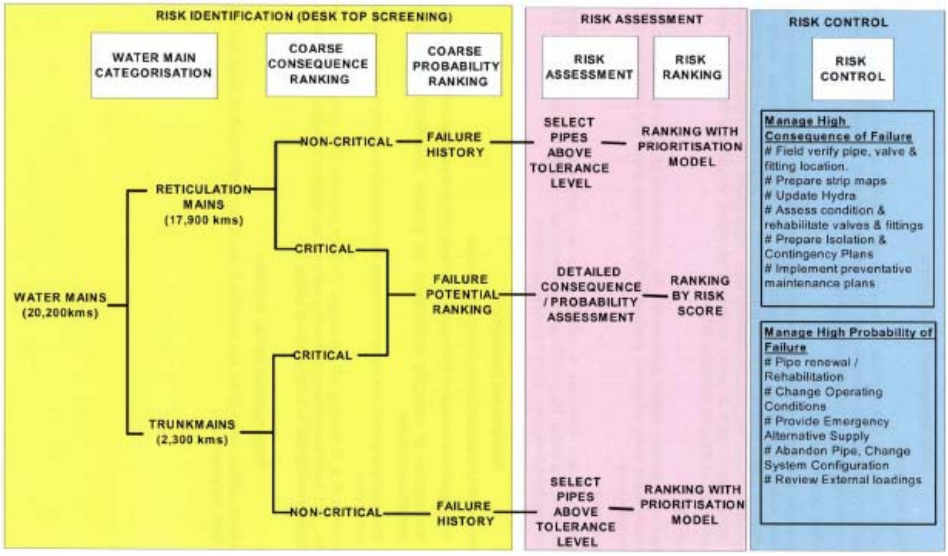

Figure 4.2 Proposed risk assessment framework

For wastewater pipes a risk-based approach is adopted for classification and management, leading to two major classifications:

- **Plan-To-Repair assets** (because the risks are relatively low, it is economic to allow a certain number of failures. Note that as the failure rate increases as the asset ages and deteriorates, there comes a point where it is more economical to replace the asset; and
- **Avoid-Failure assets** (these tend to be large assets whose failure would cause severe disruption and damage. The strategy would be to pro-actively assess failure probability and multiply this by the consequences to give a risk measure. If the extent of the risk outweighs the cost of asset replacement, then the asset should be replaced pro-actively).

The first classification tends to be for Low risk assets, while the second classification tends to be for Medium and High risk assets. Different strategies are given to deal with the three levels of risks. A risk prioritisation matrix is prepared, and assets are put into this matrix to determine whether they are high, medium or low risks. The matrix is based on consequence (measured by cost of rehabilitation) and probability (measured by years-to-end-of-service).

There is also a Wastewater Pipes Renewal Strategy (refer **Figure 4.3**), which considers Risk Analysis and Risk Ranking for Avoid-Fail assets, and a Life Cycle Cost Analysis for Plan-to-Repair assets, before Business Cases are prepared. The former is based on a Preventative Strategy, while the latter is based on a Response Based Strategy.

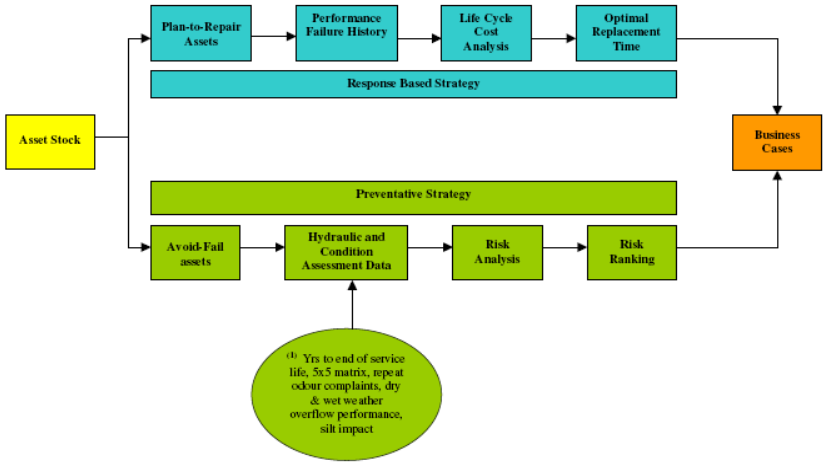

Figure 4.3 Wastewater renewals decision process

This is a parallel process and similar to that applied to water pipes.

Currently, however, for budget setting Sydney Water uses a model called KANEW, which is not risk based, neither is it asset specific (Section 3.4). KANEW is a statistical macro model used in the financial planning of setting up the annual expenditures over 30 years. It does not include a risk- based approach at cohort level and therefore does not identify the specific pipes to be replaced.

We have concluded previously that Sydney Water needs to review the use of the KANEW model and would be better served by deploying a more specific statistical model that enables pipe deterioration to be quantified.

4.2.4 *(c) the whole of life of the Assets; and*

Integration of asset management with corporate strategy and business planning ensures that life-cycle costs and risk are considered through the key phases in the asset life cycle:

- Defining required services and performance;
- Asset planning;
- Asset creation;
- Asset operation;
- Asset maintenance;
- Asset replacement and rehabilitation; and
- Asset disposal.

The following are examples of where Sydney Water adopts a whole of life approach:

1. Asset class plans outline Sydney Water's whole of life approach to these classes of assets. They identify gaps, quantify risks and incorporate risk management strategies and describe the approach for life cycle management of assets each class of assets.

2. Sydney Water's control and monitoring systems provide a key input into asset operational and maintenance planning processes aimed at optimising asset life-cycle management.

3. The Sewers Asset Management plan also discusses the whole of the life of the asset, or life cycle management, and follows the same steps as that of water mains.

4. At the planning phase, Sydney Water states that its "*approach seeks to find a balance between operation, maintenance and capital works whilst minimising life cycle costs*". It is at the planning stage that they prioritise the assets based on the risk matrix, as discussed above.

5. At the maintenance phase, Sydney Water uses a risk approach, based on asset condition, and 'End-of-Service-Life' is the trigger for decision-making. It identifies the risks and prioritises the assets, in order to address the highest risks.

6. The decision to renew/rehabilitate is also assessed on the consequences of end-of-service-life.

In addition, Sydney Water has proposed improvements for its approach to life cycle management, including:

- *Operation and maintenance:* cost efficiencies and better models for analysis of life cycle cost.
- *Renewal/replacement/rehabilitation:* three-stages to risk management, ie "risk identification, risk assessment & ranking, and risk control".

These developments are logical and will enable more effective life cycle management of the assets. The benefits of developing the life cycle cost model have been discussed and can be summarised as enabling a more quantitative assessment of asset risk. The three-stage risk management strategy is a standard approach and will provide a sound structure for risk-based asset management.

We conclude that Sydney Water complies with this condition of the Operating Licence.

4.2.5 *(d) its assessment of the risk of loss of the Assets, and capacity to respond to a potential failure or reduced performance of the Assets.*

To meet internal requirements of Asset Reliability and Contingency Planning, water mains control options are defined for each of three risk categories (high, medium and low risks), which depend on the combination of probability and consequences of failure.

For critical water mains with high consequence of failure a quick response plan is available in the form of System Operation Manuals and contingency plans.

Sydney Water has a system for immediate notification of water quality events or incidents to NSW Health so they can assess any potential public health risk.

For sewers, to meet the Licence conditions for dry weather overflow, Sydney Water "*initiates a response when a system failure occurs, depending on the severity of the failure*". They also deploy standard contingency responses, with each major trunk system having a regularly updated contingency plan. There is also an incident response for sewage overflows that may have entered waterways, which includes monitoring nearby waterways for sewage indicators.

It is our opinion that Sydney Water has complied with Clause 4.8.

4.3 Compliance with Clause 4.9

Compliance with the requirements of Sections (a) and (f) of Clause 4.9 is covered in *State of the Assets: Asset Management Capability - Processes, Practices and Plans*, 2006 which describes generic issues of asset management processes, practices and plans, their implementation and required improvements.

Compliance with the requirements of Sections (b) to (e) of Clause 4.9 is covered in the State of the Assets reports for specific asset classes which were produced for the first time in 2006 to meet the requirement from IPART under the Operating Licence.

The *State of the Assets: Asset Management Capability - Processes, Practices and Plans, 2006* provides a sound description of the asset management framework including the process and how it integrates into the business planning process. Asset management is effectively defined in terms if managing the asset life cycle costs and risks so as to deliver the optimum balance of service, financial return and risk.

Area Plans are to be developed to complement the asset plans. They aim to develop a sustainable approach for servicing future growth in conjunction with Sydney Water's stakeholders and communities and are likely to cover multiple asset classes (water, wastewater, recycled and storm water). We see this as an important integration initiative.

Several recommendations to improve the processes, practices and plans are provided in "State of the Assets – Processes, Practices and Plans", in five key categories: critical data inputs, robustness of decision making processes, procurement of resources, performance monitoring and review, and maintenance. These are identified as priorities for the next two years to 2008.

State of the Assets reports for each of the asset classes include relevant information on Sections (b) to (e) and comprise reporting on asset performance, conditions and investment:

- *State of the Assets; Report on Wastewater Assets, 2006*;
- *State of the Assets; Report on Water Assets, 2006*;
- *State of the Assets; Report on Stormwater Assets, 2006*; and
- *State of the Assets; Report on Asset Management Support Systems, 2006*.

The following **Sections 4.4** to **4.7** outline how the requirements of Sections (b) to (e) of Clause 4.9 have been addressed for each of the asset classes.

4.4 State of the Assets – Wastewater Assets

4.4.1 Asset base

The assets covered by the *State of the Assets; Report on Wastewater Assets* include:

- Sewer mains;
- Sewage pumping stations; and
- Sewage treatment plants.

4.4.2 Description of assets

The *State of the Assets; Report on Wastewater Assets, 2006* provides a description of the assets, including the asset age and condition for each of the key classes of wastewater assets. As at January 2006, Sydney Water's wastewater assets included 30 sewage treatment plants, 3 deep ocean outfalls, 23,500km of sewers and 659 pumping stations. The key classes are sewer mains, pumping stations and sewerage treatment plants. Sydney Water divides its assets into 'avoid fail' or 'plan to repair' based on a risk assessment.

Asset condition is classified on a scale of very good to very poor, which is based on the estimated remaining service life. The condition of the majority of the sewer mains are classified as very good, while the pumping stations are either very good or good. The treatment plants are split between very good, good and fair. The condition is generally assessed on a five year cycle.

4.4.3 *Capability of assets*

Section 3 of the *State of the Assets; Report on Wastewater Assets*, which looks at the capability and performance of the assets, provides an assessment of the expected capability of the assets to deliver the services and meet the existing obligations consistent with the Operating Licence.

The report notes that Sydney Water has incident management and contingency plans in place ready for any incidents that may cause overflows to waterways, and quick responses are available to handle blockages to pipes. They also note that their maintenance and renewals programs keep the pumping stations and treatment plants performing to a high level of performance.

All wastewater systems are consistently meeting Operating Licence conditions. The major conditions of the Department of Environment and Conservation's (DEC's) licences are being met. There are some non-critical non-compliances with the DEC licences. The ongoing compliance with current dry weather overflow targets (relating to chokes) and wet weather overflow targets offer the greatest challenge. The scope and timing of future wet weather overflow targets remains the biggest risk area.

4.4.4 *Major issues and constraints*

During our discussions with Sydney Water staff on the current performance of the assets in the State of the Assets report, commentary was given on issues such as complaints from customers on odour and repeat overflows.

Population growth could be a potential constraint on future performance of the assets, as demand for water and generation of waste will increase. Sydney Water has noted this, and has prepared servicing strategies for growth, which are documented in their Area Plans. Another major challenge, which Sydney Water has taken into consideration in their Area Plans, is the application of the new Building Sustainability Index (BASIX) and the Government's announcement in respect to the Western Sydney Recycled Water Initiative, which aims to maximise the beneficial use of recycled water for residential use in major land releases.

4.4.5 *Strategies and expected cost of future investment in Assets*

The State of the Assets report provides figures on 10-year capital investment programs by wastewater asset class, including for asset renewal and rehabilitation, as well as reliability and growth.

We consider this to be an acceptable projection, though there would be merit in extending this to, say, 20 years. Growth projects would carry significant uncertainty.

The report also specifies key programs that it has for servicing the growth of new urban development expected in the coming five years. They are also looking at ways to improve the long-term forecasts of growth, through their system and area plans, which will "describe sustainable integrated servicing strategies for growth".

4.5 State of the Assets – Water Assets

4.5.1 *Asset base*

The assets covered by the *State of the Assets; Report on Water Assets* include:

- Potable water mains;
- Potable water reservoirs;
- Potable pumping stations;
- Water filtration plants; and
- Recycled water infrastructure.

4.5.2 *Description of assets*

The *State of the Assets; Report on Water Assets* describes all asset stock mentioned above and its changes since 2005/06.

Water Asset stock consists of two networks: potable and recycled water distribution. There are 2,416km of trunk mains and 18,336 km of reticulation mains (plus 309km within recycle water network), serving 1,706,217 customers with potable water and 16,128 with recycled water. Sydney Water owns 151 pumping stations, 257 reservoirs, 9 water filtration plans and 1 recycled water treatment plant.

The condition of water facilities is generally good, with some improvement projects targeted towards mechanical/electrical equipment in pumping stations and water filtration plants, SCADA (supervisory control and data acquisition) systems in water filtration plants and major periodic maintenance refurbishment (corrosion protection) of service reservoirs.

4.5.3 *Capability of assets*

The *State of the Assets; Report on Water Assets* describes the capability of water assets to meet performance requirements in terms of water quality, demand management, adequate pressure and peak demand.

The report indicates that water quality requirements are met for both potable and recycled water supply. There is no evidence of a future deterioration in water quality performance but the main potential risks, for which contingency and emergency plans were prepared, are as follows:

- the management of varying water quality from dam storages as they deplete in the drought and/or fill rapidly in a major wet weather event; and
- the management of algal blooms from storages supplying the Blue Mountains and extracted from the Hawkesbury River.

Sydney Water has meet water continuity and pressure requirements stated in Operating Licence since 1995.

The performance of Sydney Water's mains has generally seen an improving trend since 1997/98 and there no evidence of declining serviceability. The Critical Water Main Program aims to ensure that "all critical main assets continue to operate to an acceptable performance level in delivering water to customers and avoiding impact on the community and environment through failures" (*State of the Assets; Report on Water Assets, 2006*). It is noted that critical mains tend to have low failure rates (they are typically large assets, thick walled and less prone to failure) and it will be difficult to prove, statistically, that this is the case.

Sydney Water implements a Water Conservation Strategy to meet target demand of 329 litres per capita per day by 2011 (current estimate is 341 litres per capita per day in June 2006) and target water leakage of 105ML/day by June 2009 (current estimate is 123ML/day in 2005/06). The strategy incorporates demand management, recycling and leak reduction programs (details can be found in the *2006-07 Water Conservation and Recycling Implementation Report*).

Water supply facilities (pumping stations, reservoirs and water filtration plants) are managed through redundancy of equipment, 24/7 skilled response capability, critical spare parts and failure contingency plans.

There was non-compliance in 2005/06 in regard to response times for break and leaks under the new 2005-2010 Operating Licence requirements. This non-compliance has been the subject of discussions with the Regulator over the

need to develop and implement a range of resourcing and management system changes.

Population growth is addressed through Development Servicing Plans, new Area Plans and the System plans, which outline required servicing over a 20 year horizon.

We have reviewed these plans and conclude that they provide a robust basis for assessing needs to address growth. The 20 year horizon is acceptable, though a 25-30 year projection would be preferred.

4.5.4 *Major issues and constraints*

Major issues and constraints identified in respect to water assets include:

- implementing water main renewals to ensure old pipes are replaced before they become a problem;
- assessment of the criticality of the vulnerable components of water mains (eg above ground pipes, aqueducts, valves and fittings), to ensure contingency plans are available, to reduce the probability of security breaches and to monitor asset security;
- assessment of the condition of critical valves and to minimise problems during shutdowns under emergency conditions;
- achievement of the Operating Licence target of not exceeding 105ML/d water leakage by June 2009 and support of drought and long term water saving measures;
- undertaking Active Leakage Detection, where the system is acoustically scanned for leaks (18,000km/year);
- improving the speed and quality of leak repairs;
- adjusting system pressures to reduce high-pressure areas that cause greater cumulative leakage and additional main breaks; and
- improved flow metering to better identify areas where higher leakage rates are occurring.

4.5.5 *Strategies and expected cost of future investment in Assets*

The *State of the Assets; Report on Water Assets* presents investment requirements for asset renewal and rehabilitation, customer meters fitting and renewals, assets and service reliability, growth, water pressure management, business efficiency and recycling programs.

To address the increasing age profile of the water main asset stock and predicted asset performance levels, a renewal program is planned which equates to an

average of the total length of 0.4 to 0.5% each year and will rise progressively to 0.8% by 2030.

We can comment that these levels are consistent with our experiences.

The proposed investment program includes measures to improve the management of leakage. The overall leakage program includes the inspection of 18,000 kilometres of water mains for hidden leaks each year, implementing pressure management in areas that experience excessive water pressure, developing a comprehensive network of flow measurement devices to assist with pinpointing areas with high leakage, renewing water mains and improving response times to visible leaks and breaks.

These are all deemed typical and appropriate leakage management strategies.

4.6 State of the Assets – Stormwater Assets

4.6.1 *Asset base*

The assets covered by the *State of the Assets; Report on Stormwater Assets* include:

- Stormwater pipes, channels and floodways;
- Stormwater pumps; and
- Stormwater treatment and storage.

4.6.2 *Description of assets*

The *State of the Assets; Report on Stormwater Assets, 2006* provides a description of the assets, including the asset age and condition for each of the key classes of stormwater assets, which are comprised of pipes, channels, floodways, pumps, treatment and storage assets.

The report mentions that the condition of pipes, pumps, channels and floodways is in general good, however, open channels are showing signs of deterioration. Drainage pumping stations are in good condition. Inspections of the condition of the assets are carried out either every five or every ten years.

4.6.3 *Capability of assets*

Section 6 of the *State of the Assets; Report on Stormwater Assets*, which looks at the capability and performance of the assets, provides an assessment of the expected capability of the assets to deliver the services and meet the existing obligations consistent with the Operating Licence.

The Operating Licence requires Sydney Water to report on volumes of litter and sediment removed from the stormwater system through Stormwater Quality Improvement Devices (SQIDs). In 2005/06, Sydney Water removed 1800 cubic metres of litter and 3,000 tonnes of sediment from SQIDs. A further 4,000 tonnes of sediment was removed from stormwater channels. The volume of sediment removed from channels has reduced from previous years following a review of drivers and the decision framework for sediment removal. We cannot comment further on the robustness of this decision as we do not have a detailed knowledge of the decision parameters.

We can also report that a new risk-based methodology has been developed and is due to be 'rolled out' in December 2007. This will enable improved investment decision making for Stormwater assets.

4.6.4 *Major issuers and constrains*

As with wastewater, a major constraint on future performance is population growth. To cope with this, Sydney Water undertook some early planning during the 1980s and 1990s, and produced Capacity Assessments, System Plans and Flood Studies. Sydney Water is also developing Council Flood Risk Management Plans and contributing to a Metropolitan Strategy. Their future response to servicing growth will be carried out through the new Area Plans and System Plans, which cover a 20 year horizon.

4.6.5 *Strategies and expected cost of future investment in Assets*

The $19.4 million Stormwater Environment Improvement Program was completed in 2005/06.

There has been no new investment in capacity for growth, although Sydney Water has committed to spending $3.1 million on improvements to stormwater quality discharging to the Alexandra Canal.

4.7 State of the Assets – Asset Support Systems

4.7.1 *Description of assets*

The assets covered by *State of the Assets; Report on Asset Support Systems* include:

- Management Systems;
- Information Systems; and
- Monitoring and Control Systems.

The management systems are robust and well structured, and are in a stable state. They cover two main levels of the Water Management Systems Framework: organisational (regulatory, environmental, health & safety and emergency risk management) and product/processes (wastewater, water product, water services deliver, capital project, monitoring process and commercial & industrial customer services quality management).

Information Management Systems are used to record and manage information on Sydney Water's assets and related items. They consist of Geographical Information System HYDRA, Asset and Maintenance Management Systems WAMS and FMX, and plan management systems and analysis tools OACIS and WATSYS.

Monitoring and control systems allow for the remote monitoring of Sydney Water's water and wastewater networks and treatment plants, the supply of products and services to customers, and facilitate compliance to external and internal requirements. These systems also store asset operation data for long term strategic planning and optimising life-cycle management of hydraulic assets. Sydney Water's monitoring and control systems include the IICATS telemetry system, the treatment plants SCADA System, and various instrumentation assets.

4.7.2 *Capability of assets*

Management and Monitoring and Control Systems are in good conditions and meet performance standards.

Some of Information Systems meet performance criteria, but some are at operational and maintenance risk and high cost (HYDRA, WAMS and FMX). Information management by those systems is difficult due to their previously uncoordinated development.

4.7.3 *Major issues and constraints*

The biggest concern is in respect to the Information Management Systems, because they contain essential data which underpins most of the asset management processes within the company. These systems are quite complex and their uncontrolled development led to high operational risks and maintenance cost. More efficient and integrated information management is needed along with version upgrades to reduce costs and support risk.

Most of the support systems require their strategic upgrade to ensure reliability in the future and compatibility with the current technologies. This should be done in the most integrated way across the company.

4.7.4 *Strategies and expected cost of future investment in assets*

Most of the investment requirements are related to Information Systems with lesser expected spend on Monitoring and Control Systems. Investment into Management Systems consists mostly of internal labour and management focus.

4.8 Conclusion

We consider that the various *State of the Assets* reports provide the necessary information to satisfy the Operating Licence requirement to produce such documents.

The summary extracts contained in our review demonstrate that key criteria specified in the obligations have been reported on. The documents provide a robust summary of asset management issues and the nature of the assets.

Key investment needs are summarised by driver.

Sydney Water has undertaken to update these documents on an annual basis and this will provide a good summary view of the 'health' of the asset stock.

It is our opinion that the stormwater assets renewal case is weak, being based on historical levels of investment and lacking a detailed risk assessment. We note, however, that Sydney Water has developed a new risk-based methodology which is due to be 'rolled out' in December 2007. This will enable improved investment decision making in respect to stormwater asset renewals.

5 Conclusions

- Sydney Water has an effective strategic framework for asset management that integrates strategic business planning and tactical service delivery.
- This is supported by well documented processes that enable transparency and support consistency.
- Sydney Water has recently adopted the asset owner/asset operator model and this has enabled the successful application of their asset management strategy. This structure will help facilitate future improvements.
- Sydney Water has been proactive in developing their asset management approach and has acted on numerous suggestions for improvements, highlighted by various reviews of their processes and procedures.
- This improvement process is ongoing and whilst the integrated approach to planning is commendable, Sydney Water should be careful not to over complicate the various plans (asset specific, investment driver specific and geographic). The overlap between these plans and their specific uses needs to be clear and we acknowledge that Sydney Water has already considered this issue.
- We recognise that Sydney Water's use of risk based planning is in line with current good practice.
- We recognise that Sydney Water's use of whole of life costing is in line with current good practice.
- Sydney Water has a rigorous investment planning process and formal, consistent procedures exist for capital planning approvals. This process (if not the tools in all cases) is commended.
- Specifically, we feel that the application of the KANEW model to water infrastructure budget setting can be improved and we acknowledge that Sydney Water has already commenced appraising new statistical models for this purpose.
- We feel that at present, the link between expenditure and subsequent improvements in the levels of service is not transparent enough. This needs to be quantified and fed into future investment prioritisation through monitoring of investments and trending levels of service over time. We acknowledge that Sydney Water is currently undertaking similar analysis for IPART for overflows and water continuity service levels.

- .We note that Sydney Water is currently developing an optimisation capability and this is commended.
- Distribution pipe renewal rates appear appropriate at 0.5% per year. This rate of renewal is consistent with rates applied elsewhere. However, if this rate is maintained indefinitely, this would suggest an assumed asset life of 200 years. This is long and the rate will probably need to increase. Sydney Water needs to develop statistical deterioration models to determine the most appropriate rate. We acknowledge that Sydney Water understands the requirement for further statistical models/analysis and is assessing options.
- The State of Assets reports meet the Operating Licence requirements.

6 Recommendations

- It is recommended that in the development of its investment optimisation capability, Sydney Water adopts a current best practice approach and undertake the optimisation across the asset base and all of the various investment drivers. This should be achieved using a mathematical calculation engine based on, for example, genetic algorithms or equivalent. We acknowledge that Sydney Water is already developing a capital investment program optimisation tool.
- We recommend that Sydney Water, in the development of its asset management planning approach, clarify the interactions between asset plans, area plans and service plans. Specifically the potential overlaps between these plans needs to be agreed and we acknowledge that Sydney Water has already considered this issue.
- We recommend that if Sydney Water continues to apply the KANEW model for strategic budget estimation, they develop statistically valid asset life models and that the analysis is undertaken at a finer level of cohort detail. We acknowledge that Sydney Water is reviewing its use of the KANEW model but are also undertaking work to increase the cohort detail.
- Move towards a 'monetary' based risk assessment and consideration of externalities and indirect costs to strengthen the risk based approach and improve risk management potential. We acknowledge that Sydney Water is currently trialling an improved econometric model specifically for trunk water mains.
- In order for Sydney Water to be able to closely link investment requirements to improvements in levels of service, asset data and service trends need to be improved and deterioration models developed. We acknowledge that Sydney Water is currently undertaking similar analysis for IPART for overflows and water continuity service levels.

Appendix A Audit of Asset Management Technical Approach

A.1 Introduction

The purpose of this review is to evaluate the technical asset management approach applied to each asset group. We have looked for evidence of a forward-looking, risk based approach, underpinned by an effective cost-benefit analysis of options.

We have examined the basis for investment planning at a detailed level and considered the data used for the analysis, the robustness of the process and outputs in terms of their confidence.

The review considers three major classes of asset: water mains, sewer mains and sewage treatment plants. The review highlights apparent strengths and weaknesses of the approach and then examines the methodologies against best practice.

Conclusions are made with respect to confidence in the methodology and potential suitability for accurate quantification of the strategic budget. Recommendations are proposed where it is considered that the approach can be strengthened.

A.2 Reference Sources

In compiling this review of the technical asset management approach we have evaluated the following documents:

- *Project approval procedures; Issue A, Revision 3*, May 2007.
- Independent review of business cases (guide to the pink slip process), March 2006
- *Business case guidelines; Issue A, Revision 2*, January 2007
- ENVON V7 guide and tool.

A.3 Approach

The technical approaches have been assessed in terms of the level of decision making that they support, the relationship to the asset plan, and the confidence in their ability to define asset investment.

We have considered the needs of the asset group and the method of needs assessment; approaches to performance and condition assessment; validity of approach; quality of results, and; an overall assessment of rigour.

For each asset group (and sub-group) the technical methodology for evaluating need, rigour, ability to prioritise and optimise the balance between drivers and deliver efficiencies has been considered.

A.4 Water Mains

A.4.1 Investment by drivers

Typically, key drivers for water mains relate to the quality of delivered water, the reliability of the supply and the ability to meet future demands.

The key uncertainty in terms of modelling needs and availability of effective tools relates to the issue of deterioration of the existing asset and the need to renew these assets to offset the effect of the asset deterioration.

We therefore focus on the asset renewals process for water infrastructure.

A.4.2 Options development

Sydney Water has defined an extensive list of options for managing the service delivery of the water infrastructure assets. These risk mitigation options are described as control options and their selection is based on evaluation of the scheme/project drivers, risks, costs and benefits.

As well as activities such as pipe replacement to address reliability and lining to address water quality impacts associated with deteriorating pipes, damage limitation options are identified to deal with unplanned discharges.

The options list is reasonably comprehensive. Sydney Water has linked choice of option to the asset, or group of assets, level of risk. This is an example of good practice, however, before consideration of the options it is necessary to quantify the need for investment such as pipe renewals.

The overall approach to investment decision making is influenced by asset type, behaviour and the associated criticality of the asset. The proposed approach is summarised in **Figure A.1**.

This three step process is a typical risk management strategy and is therefore indicative of sound risk management practice.

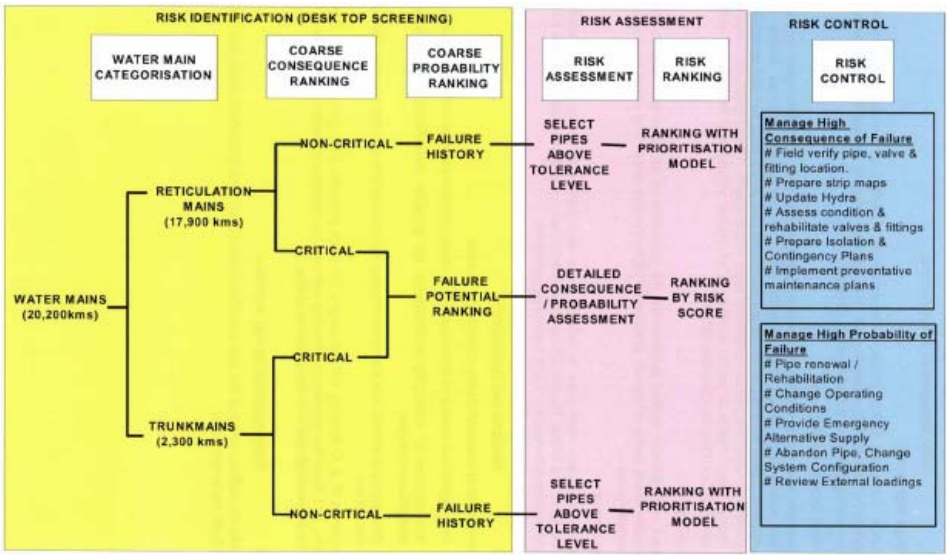

Figure A.1 Risk assessment process – Water infrastructure

We note that the risk for non-critical reticulation mains is driven by the direct cost of failures (burst costs). It has been estimated by Sydney Water that failure rates above a threshold (currently 6 bursts per km/year) make a non-critical reticulation main financially uneconomic over a whole of life accounting period; mains that exhibit this level of failure are targeted for detailed business case evaluation before entering the capital programme. This threshold rate is quite high compared with similar UK utilities that typically use burst rates of 2-3 bursts per km/year as the threshold for triggering investment. It is recognised however that the selection of this rate is dependant on Sydney Water specific economic factors. It should be noted that the threshold for bursts is specific to Sydney Water's current costs and may change over time.

High consequence of failure mains (critical mains) are appraised in terms of the wider social and disruption impacts they are likely to cause if they fail.

We need to look in more detail at the technical approaches in order to determine the robustness of the investment case for trunk mains and distribution mains (reticulation). These two asset classes are discussed below.

Reticulation assets:

Sydney Water has effective asset management systems in terms of the GIS and job management system that enable assets to be targeted and a reasonable history of asset data to be compiled for analysis.

It is our understanding that the main tool for assessing renewals expenditure at the strategic budget level is a software called KANEW.

This is a relatively well known tool and has been used by a number of water and gas utilities internationally. Many usages have been by municipalities and by companies whose asset data is limited. It is based on 'mapping' the pipeline stock by length, installation year (approximate) and material type. The stock can be split further if desired. An estimated residual life profile[6] is assigned to each pipe cohort. The model then predicts the length of each pipe cohort coming to the end of its life in any future period.

We believe that there are risks and uncertainties attached to using this model for quantification of the investment budget envelope.

At worst, the survival functions are based on operator estimates and can be widely inaccurate; however, if the estimates are based on sound data, then the tool can be effective.

The problem is that pipes are repairable assets; to set and determine the pipe life parameters, the user would need to consider asset condition, performance and risk and endeavour to derive a weighted average life that reflected all these influences on actual asset life. The other weakness with KANEW is the lack of specificity. It does not tell the user where the problem is, ie it does not target the individual problem pipe, nor does it consider local risk factors.

This is not, however, necessarily a problem for Sydney Water. Having determined the strategic budget envelope, a detailed risk and whole life costing methodology is applied at the pipe level to establish specific priorities.

In the case of a distribution pipe, the end of life of the pipe is based on whole of life costs and a failure rate of 6 breaks/km/year is the current threshold where the pipe is deemed to be potentially financially uneconomic.

If we assume that the envelope of investment that is identified in the price submission is based primarily on KANEW, then it is important that the life estimates are robust.

[6] This is a statistical distribution, known as the Hertz distribution

It is reported that the life estimates are in fact underpinned by knowledge of the asset condition and performance. However, deterioration models do not exist and this means that future failure rates are not based on burst trends. This suggests that more needs to be done to improve the KANEW asset life estimates for distribution mains. To be confident, we would want to see a statistical analysis of the relationship between pipe cohort characteristics, age, condition and failure probability.

It is recommended that Sydney Water should explore the further calibration of the KANEW model, using more 'granular' cohorts, ie at a greater level of detail and, preferably, the more specific deterioration modelling options that are being applied elsewhere for distribution pipe investment planning.

On the other hand, if the budget envelope is also fully justified on whole of life cost grounds, then this would be deemed a sound asset management approach.

In summary, the issue with KANEW is that it is not specific, not risk based and to work effectively needs a very robust justification of the asset lives used in the model. It may be over or underestimating the replacement need.

It is noteworthy that the short-term rate of renewal for reticulation mains indicated by KANEW is 0.4%, rising to double this by 2030. This rate is relatively low compared to a number of water utilities.

It is our opinion, irrespective of some of the concerns or recommendations for improving the budget setting approach that this rate of renewals is acceptable and reducing it further would potentially result in burst rate increases.

Trunk assets:

The approach for determining trunk mains investment is shown in **Figure A.2**. This appears to integrate the strategic KANEW model with a detailed risk assessment at the pipe level.

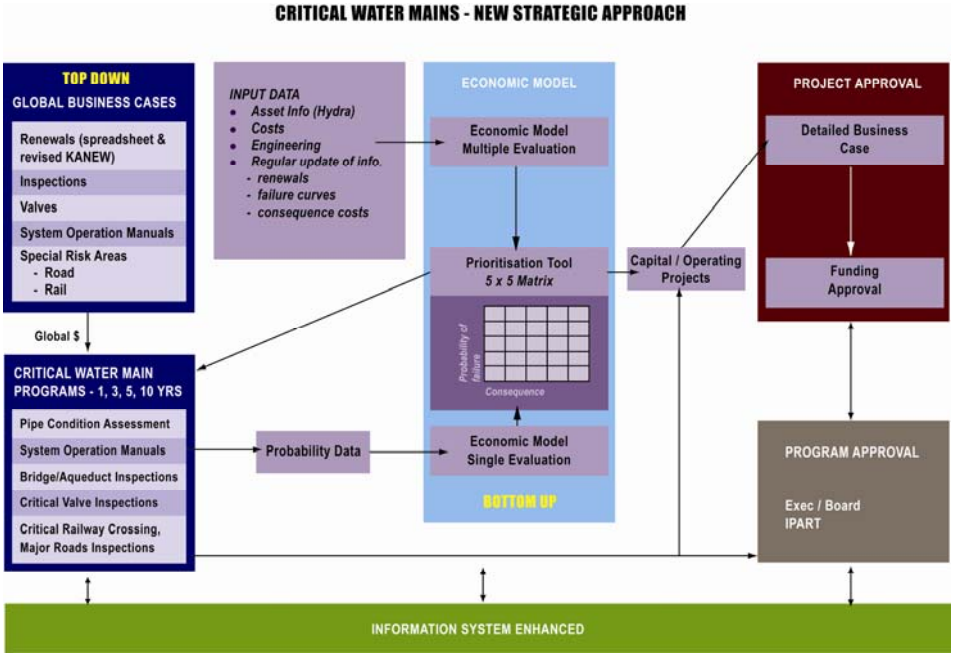

Figure A.2 Planning investment for critical water mains

It is noted that trunk mains are difficult to analyse in terms of risk quantification because they are usually managed to avoid failure and they have very low rates of failures, making statistical analysis difficult. They are considered to be 'avoid failure' assets due to the fact that they have a high consequence of failure and they are therefore critical assets. In developing an investment programme for these assets it is important that they are effectively prioritised for rehabilitation in a way that ensures the right level of investment at the right time.

Sydney Water is using knowledge of asset condition and criticality to inform the investment program. We consider this to be a best practice approach. The challenge is in setting a threshold for risk that can be used to determine when a critical trunk main needs replacement (when do whole life risk costs outweigh the replacement cost?).

We examined business cases for trunk mains and established that failure probability was determined by condition assessment and consequence of failure was being appraised using a new whole life costing model that takes into account the intangible costs of failure.

We consider that KANEW is not a good tool for trunk mains as it works at a strategic level to set an overall budget, based on an estimate of the useful remaining life of pipes. Unlike smaller pipes, asset failure data is not available to enable a reasonable estimate of life end. Also, trunk mains end of life is so

influenced by specific factors and consequences that this is another reason not to use a non-risk based model for budget estimation.

In summary, we would not recommend KANEW for trunk mains budget envelope setting. The budget envelope should be built up on the same case by case basis as the capital program, which is a risk-based methodology In other words, use the same risk-based methodology for the budget setting and developing the capital program.

A.4.3 Conclusions

Asset Management Tools:

Sydney Water is using effective risk and whole life cost methodologies. We feel this good practice is diminished slightly by reliance on KANEW, which we would recommend primarily as a support/estimation tool and a basis for running sensitivity analysis.

For distribution mains, validated statistical models showing deterioration trends would be a better basis for estimating end of life. It is acknowledged that Sydney Water is making best endeavours to gather the data that will support this type of analysis. We also recommend that failure is connected more strongly to customer impacts (eg interruptions) such that the risk can be expressed in terms of customer impact as well as failure costs.

For trunk mains, we consider that the use of a risk matrix to identify high risk pipes and then detailed assessment of specific pipes is the most appropriate means of evaluating the investment need.

In our experience, the specific risks and the costs of rehabilitation are very site specific for large diameter pipes. A detailed business case including cost estimation would be needed to build an accurate estimate of investment need.

Sydney Water is taking this approach, evaluating each trunk main scheme to estimate the required budgets. Due to the high variability of costs, caused by site specific factors, there is significant cost uncertainty with regard to these schemes and this needs to be planned for. Over time, a better understanding of the costs of these schemes and factors that most affect these costs can be achieved so that the budget estimating process can be improved.

Rate of Renewals:

The renewals rate for small diameter mains is reasonable. It is not overstated and in our view possibly on the low side (this is a subjective judgement). The future failure rate needs to be monitored closely to ensure that the rate is sufficient. Sydney Water suggests that the rate will need to increase steadily over the long term. We would not disagree, however, the optimum rate will not be clear until robust deterioration models have been developed.

We find it difficult to comment on the rate of renewals for trunk mains (0.42%). This amounts to approximately 15 km/year of replacement. This does seem a slightly high figure for a relatively young network, however, we acknowledge that local factors can result in high rates of deterioration. Provided that the trunk program is justified with detailed business cases, then this would be reasonable. Sydney Water is compiling data on consequential impacts and categorising mains condition by soil type. Sydney Water states that this is used to inform the risk and underpins the need to rehabilitate the pipe.

Asset Life:

The KANEW model is 'fed' with asset life data. If this is accurate, then the model will give accurate outputs.

The difficulty is that pipes have environment specific lives; they are usually repairable and physically this can be for an indefinite period. The end of life for a specific pipe is unique and circumstance specific. As a statistical population, it is possible, if sufficient data is available, to estimate the average life. We do not feel that Sydney Water currently has this data and even when they do, it would be better used in a detailed pipe level statistical model.

Sydney Water is undertaking ongoing studies to further improve their understanding of condition and performance and will use this to recalibrate the asset lives. The current asset lives used in the model are shown in **Figure A.3**.

We consider that the estimates in aggressive soils and very aggressive soils are not unreasonable for the metallic distribution mains. We have seen examples of severe deterioration and short life where pipes have been installed in similar situations.

We would also advise that the failure rate and lives of a 75mm iron pipe will be very different to that of a 375mm iron pipe in the same exposure environment, but they are treated the same in the KANEW model.

Estimation of life Span in years

MAJOR TRANSFER MAINS (Size: DN 750 and above)						
635kms	112kms		303kms		219kms	
Material	Non- Aggressiv		Aggressive		ighly Aggressiv	
	Lower	Upper	Lower	Upper	Lower	Upper
AC						
Not Applicable						
CICL						
100%	95	115	90	100	50	70
50%	140	152	110	130	80	100
10%	200	220	150	180	100	130
DICLA						
100%	100	120	90	100	70	80
50%	150	150	110	130	90	100
10%	200	220	150	190	130	150
DICLA (Post 1988) - commenced Insulation of service tap						
Not Applicable						
GRP						
100%	40	50	40	50	40	50
50%	80	90	80	90	80	90
10%	110	120	110	120	110	120
PE						
Not Applicable						
PVC						
Not Applicable						
SCL						
100%	95	115	90	100	50	70
50%	140	150	110	130	80	100
10%	200	220	150	190	100	130
SCLA (Post 1986) (SS the same) _ Commenced sintacoa						
100%	90	110	90	110	90	110
50%	130	140	130	140	130	140
10%	180	200	180	200	180	200

TRUNK DISTIBUTION MAINS (SIZE: DN 375 to DN600)						
1626 kms	268kms		753kms		604kms	
Material	Non- aggressive		Aggressive		Highly Aggressive	
	Lower	Upper	Lower	Upper	Lower	Upper
AC						
Not Applicable						
CICL						
100%	90	110	80	90	40	60
50%	130	140	100	120	70	90
10%	180	200	140	170	90	120
DICLA						
100%	90	110	80	90	60	70
50%	130	140	100	120	80	90
10%	180	200	140	180	120	130
DICLA (Post 1988) - commenced Insulation of service tappings						
Not Applicable						
GRP						
100%	40	50	40	50	40	50
50%	80	90	80	90	80	90
10%	110	120	110	120	110	120
PE						
100%	40	50	40	50	40	50
50%	80	90	80	90	80	90
10%	110	120	110	120	110	120
PVC						
Not Applicable						
SCL						
100%	90	110	80	90	40	60
50%	130	140	100	120	70	90
10%	180	200	140	180	90	120
SCLA (Post 1986) (SS the same) _ Commenced sintacoating of pipe barr						
100%	90	110	90	110	90	110
50%	130	140	130	140	130	140
10%	180	200	180	200	180	200

RETICULATION (Less than DN375)						
17989kms	3142kms		8063kms		6785kms	
Material	Non- aggressive		Aggressive		Highly Aggressive	
	Lower	Upper	Lower	Upper	Lower	Upper
AC						
100%	25	40	25	40	25	40
50%	30	50	30	50	30	50
10%	40	70	40	70	40	70
CICL						
100%	90	110	80	90	40	40
50%	110	140	100	120	50	70
10%	180	200	140	170	70	90
DICLA						
100%	80	110	80	90	30	60
50%	130	140	100	12	70	90
10%	180	200	140	180	90	120
DICLA (Post 1988) - commenced Insulation of service tappings						
100%	90	110	90	110	90	50
50%	130	140	130	140	130	90
10%	180	200	180	200	180	120
GRP						
100%	40	50	40	50	40	110
50%	80	90	80	90	80	140
10%	110	120	110	120	110	200
PE						
100%	40	50	40	50	40	50
50%	80	90	80	90	80	90
10%	110	120	110	120	110	120
PVC						
100%	40	50	40	50	40	50
50%	80	90	80	90	80	90
10%	110	120	110	120	110	120
SCL						
100%	90	110	80	90	40	60
50%	130	140	100	120	70	90
10%	180	200	140	180	90	120
SCLA (Post 1988) * Commenced sintacoating of pipe barrels)						
100%	90	110	90	110	90	110
50%	130	140	130	140	130	140
10%	180	200	180	200	180	200

Figure A.3 Asset lives used for KANEW model

We believe that the life of the large diameter pipes in non-aggressive soils can exceed 200 years. We would speculate that the 50 percentile (time to 'death' of half the pipe population) could exceed 200 years. Previous UK studies of corrosion rates of Victorian cast iron mains has put lives well in excess of 300 years in benign soils. A sensitivity analysis is recommended to asses the impact of the asset life estimates on replacement profiles. The most 'sensitive' cohorts should be identified and a detailed condition analysis carried out. It is likely that this will be addressed by Sydney Water's future investigation aimed at improving the model. The improvements will include evaluating the importance of a range of factors including soil type/aggresivity, temperature, humidity and how they influence deterioration rates in different geographical areas.

A.5 Sewer Mains

A.5.1 Investment by drivers

As for water mains, the key drivers for sewer main investment are the need to maintain levels of customer service, meet the requirements of the Environmental Protection Licences, and to cater for growth.

A.5.2 Options development

Sydney Water adopts a risk based approach to the management of sewer mains, and classifies sewers as either 'Plan to Repair', or 'Avoid Failure' assets.

The Sewer Asset Management Plan defines these assets as follows:

- *Plan-to-Repair assets* – apply a 'Response' based strategy and allow these assets (pipes less than 375mm diameter – generally reticulation networks, and all pressure mains) to reach their end of service life before rehabilitation; and
- *Avoid-Failure assets* – apply a 'Preventative Strategy' so these assets (pipes 375mm diameter and above – generally branch and trunk sewers) do not fail.

Sydney Water uses Sewerage Catchment Area Management Plans (SCAMPs) and Sewerage Trunk Asset Management Plans (STAMPs) to understand system capability and current performance. Performance is measured on the following criteria:

- Asset performance;
- Environmental impact; and
- Customer impact.

Assets are then prioritised using a risk based 5x5 matrix (refer **Figure A.4**). Sydney Water's priorities are (in order):

- Maintain service to the customer through a hydraulically capable and structurally sound system;
- Elimination of repeat overflows inside homes and on properties;
- Cater for growth; and
- Meet licence conditions.

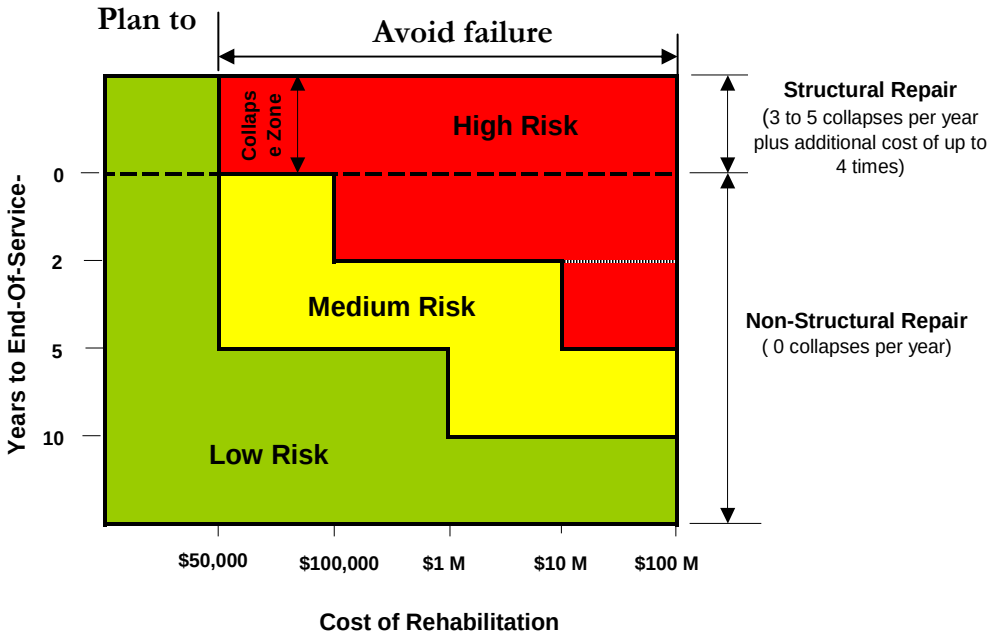

Figure A.4 Risk Prioritisation Matrix

Sewer main renewals are identified through an inspection program and a risk based assessment of condition. Condition is assessed using CCTV survey and graded on a scale of 1 to 5 (1 – Very Poor, 5 – Very Good).

The need to investigate a renewal option for Plan-to-Repair sewers is triggered when:

- tree root chokes repeat, 3 in 5 years or more frequently;
- wet weather flow is causing overflow inside homes;
- repeat dry or wet weather overflows on private property causes customer outrage;
- there is a high frequency wet weather overflow that reaches a waterway; or
- leakage from a pressure main is detected.

For Avoid-Fail sewers, the need to renew/rehabilitate is triggered when 'years to end of service life' <2 years (Grade 5), or when 'years to end of service life' is 2-5 years' and cost is > $1.0m (Grade 4).

It should be noted that Sydney Water is currently completing the rehabilitation of the SWSOOS, which we classified as being in Grade 3 condition.

Sydney Water states in the Sewer Asset Management Plan that "*the condition of pressure mains has been assumed as being the same as gravity mains of the same diameter*", and that pressure mains are classified as "Plan-to-Repair".

We challenged Sydney Water as to why pressure mains are assumed to have the same asset life as sewers with the same material. Sydney Water responded; *"pressure mains are mostly CICL/DICL, with a small amount of plastic pipe in recent years. The main failure mode for iron pressure mains is corrosion from the outside, which is dependant on the soil conditions. This is the same as for the gravity iron mains. The failure rates for pressure/ gravity iron mains are similar. This is the basis of the assumption that service life of pressure mains is the same as the gravity sewers. In recent years, there were 3 failures on gravity iron mains immediately downstream of the pressure section. The failure mode was hydrogen sulphide corrosion from the inside. These sections are a relatively small percentage of the total length of iron mains and the life was not reduced for this type of failure".*

We would expect Sydney Water to continue to monitor failures due to hydrogen sulphide attack and in future, modify as appropriate the assumed asset lives for those pressure mains affected

Although Sydney Water pressure mains are not currently classified into these groups and are managed as Plan-To-Repair sewers, plans are being developed to manage them on a risk based approach and it is recommended that a risk based classification should be carried out in a similar way to the process that has been applied to water mains.

A.5.3 Conclusions

We consider that the process used by Sydney Water to identify and prioritise sewer main capital works based on risk is consistent with established best practice.

A.6 Wastewater Treatment Plants

A.6.1 Investment drivers

The main driver for capital investment is growth in the sewage catchments. Other investment drivers are renewals and compliance with environmental legislation.

A.6.2 Options development

The Sewage Treatment Plant Asset Class Plan states that *"Sydney Water has adopted a Reliability Centred Maintenance Philosophy and uses analysis methods including Failure Mode Effects Criticality Analysis (FMECA) and root cause analysis"* to assess asset reliability.

Risks of failure are assessed using a risk management framework based on a 'likelihood-severity' matrix approach. Risks are then prioritised for mitigation actions such as maintenance and renewals. Sydney Water divides its assets into 'Avoid Fail' and 'Plan to Repair' based on the risk assessment. For 'Plan to Repair' assets age and failure records are used to develop maintenance and renewal programs. 'Avoid Fail' assets have a condition assessment program.

The process for asset creation includes:

- a detailed option study to identify possible options;
- preparation of the Environmental Impact assessment;
- preparation of needs specification for the facility;
- a Value Engineering Study to identify areas for increasing value; and
- a Value Management Study to ensure that the project meets the identified needs for the project.

A.7 Integration issues

We can see that the detailed project approval process considers integration across drivers, but what about at strategic budget stage? For example, the Common Framework methodology used in the UK calls for post project appraisal to establish overlaps.

The integration approach is not sufficiently clear and needs clarification.

A.8 Comparison with other Technical Approaches

A.8.1 Introduction

There is a fundamental asset management question:

For a given level of risk, how much do we need to spend?

Answering this requires knowledge of the asset condition, performance and service. It also requires knowledge of costs and consequences. We consider the extent to which Sydney Water addresses these issues with reference to known international practice.

A.8.2 Condition

Pipeline condition data is valuable for determining the reason why pipes fail and helps identify the most appropriate rehabilitation strategy. Condition data is expensive to collect and subject to significant variation along even a single pipe length. Therefore condition assessment needs to be well targeted and sufficient carried out to pick up the full range of condition grades experienced by each cohort of trunk mains.

Condition data is useful for assessing the remaining life of trunk mains. It is often pipe specific and difficult to extrapolate (large variations are typical) without major sampling.

Sydney Water is exploring a variety of condition assessment options and is focussing on high risk trunk mains. This is considered appropriate.

Condition assessment, based on camera survey and visual inspection, is used by Sydney Water to appraise high risk sewers and above ground assets. This is typical best practice.

A.8.3 *Performance and service*

Many companies are using performance (eg burst trends, blockage rates) to assess distribution pipe renewals. Many statistical models are used internationally and are dependent on a reasonable history of consistent data. As a guide, a 10 year time series provides a sound basis for modelling deterioration trends.

Sydney Water plans on implementing these approaches once sufficient history of data has been collected.

Current best practice is to consider also the effects of the asset failure on serviceability and to correlate these statistically.

A.8.4 *Risk*

Sydney Water has a sound understanding of risk based planning approaches.

Companies using a full CBA methodology have expressed all risk parameters (including loss of service to customers) as a monetary equivalent.

Whilst Sydney Water does not monetarise (express impacts as a cost) all factors it is, nonetheless, continuing to refine its methodology and this is to be commended.

A.8.5 *Whole life costing and cost benefit*

Whole life costing is a best practice approach used by a limited number of leading edge water companies to optimise the 'repair or replace' decision. Sydney Water uses such an approach.

A.8.6 *Optimisation*

The optimisation is to maximise benefit and minimise cost. This is minimisation of net risk over whole of life.

This is inherent in the risk based approach underpinned by whole of life cost analysis.

However, current best practice is to optimise across assets and drivers and typically optimisation is achieved using mathematical calculation engines based on genetic algorithms.

Sydney Water can consider the use of such technologies to support the investment planning exercise.

Appendix B Scoring of Budget Setting Approach

B.1 Introduction

The overall approach to asset management has been scored using a series of questions. We have separated the detailed and the strategic budget setting. These questions were applied by Ofwat for PR04 and are sufficiently generic to provide a useful indication of Sydney Water's asset management position.

B.2 Results

Score results are presented in **Table B.1**. The maximum score given is '5', considered to be indicative of best practice. A score of '1' suggests that significant improvement is feasible. A score of '3' indicates a satisfactory methodology that presents some opportunities for improvement.

Table B.1 Asset Management Planning Performance Scores

Criteria	Parameter	Score (1-5)	Evidence
1	Data acquisitions: Is there evidence of data acquisition effort, eg zonal studies	5	Asset plans detail condition and performance measurement.
2	Availability/Format: How available/in what format are data	5	GIS and job management systems enable key decision data to be utilised.
3	Confidence grades: What confidence grades are attached to the data	N/A	Data not scored. However, data is based on sound records and reasonable history.
4	Reliance on expert judgement: How much reliance is there on expert judgement	3	Judgement used for asset lives **but** underpinned by asset condition/performance information and subject to ongoing improvement.
5	Risk-based or age/condition: Is the approach risk-based or more about age and condition	3.5	Both. Age/condition being linked to risk and move to wards improved risk based planning. Risk used to prioritise/define capital program. Age/condition strategic budget envelope (see asset plans).
6	Degree of risk quantification: What degree of risk quantification is there	4	Risk ranking is used to prioritise the capital program. Some moves towards financial equivalence modelling are being made (see project approval guidance docs).
7	Sub-threshold indicators: Has the company developed its own sub-threshold serviceability indicators to support its case	4	Yes, measures of condition and performance are used by the company to inform failure probability and reliability.

Criteria	Parameter	Score (1-5)	Evidence
8	Top-down/bottom up: Whether a bottom-up understanding of asset service risk has been attempted or not?	5	The asset plans and specific business cases demonstrate a bottom up methodology.
9	Reporter involvement: To what degree has the Reporter been involved during the development of the approach	N/A	Not relevant; however, Sydney Water has been pro-active in seeking opportunities for benchmarking and independent review.
10	Evidence of R&D/best practice: What evidence is there of seeking and applying good practice	5	Innovative asset renewals and leak detection options are being investigated. Numerous benchmarking activities and support for R&D initiatives.
11	Corporate systems or stand alone: To what degree is the process built on business as usual corporate systems	5	Asset management and job management tools provide decision making data. Recognised that these are in need of refreshing. Nonetheless, AM plans developed from corporate system data.
12	Process validation/sensitivity steps: Whether appropriate validation and sensitivity checks have been carried out?	2	Sensitivity done in asset plans wrt capex. Sensitivity checks recommended in business case process. More formal sensitivity and uncertainty modelling is recommended around key input variables to enable better appreciation of risk.
13	Links to company policy: Evidence that selection of optimal interventions is based on stated company risk policies	4	Solutions must be formally justified in terms of service performance (service risks) and delivered at least cost (see project business cases).
14	WLC Approaches: Are interventions costed on whole life basis	5	Projects are justified using the WLC tool EnconsV7.
15	Offset uplifts: Uplifts in investment where risks are intolerable offset against risks that are manageable	2	Not yet convinced that Sydney Water has considered measures to smooth the planned investment profile such as deferring investment in distribution mains renewals, thereby reducing the impact on price rises of major investment such as the desalination plant.
16	Efficiency Integration: Has the company explored the scope for potential efficiencies	4	Efficiency savings are identified and have been delivered (see business plan efficiency performance).
17	Overlap: Have integrated interventions been reflected in efficiencies and overlaps with enhancements	2	This is not apparent in the asset plan and merits further examination.
18	Outputs: Well structured case: Is the case well-structured and integrated with other parts of the Business Plan	3	The individual asset plans are well structured. An overall integrated area and company plan would be welcomed and Sydney Water appears to be moving in this direction.

B.3 Conclusions

The performance is summarised in the following diagram (**Figure B.1**):

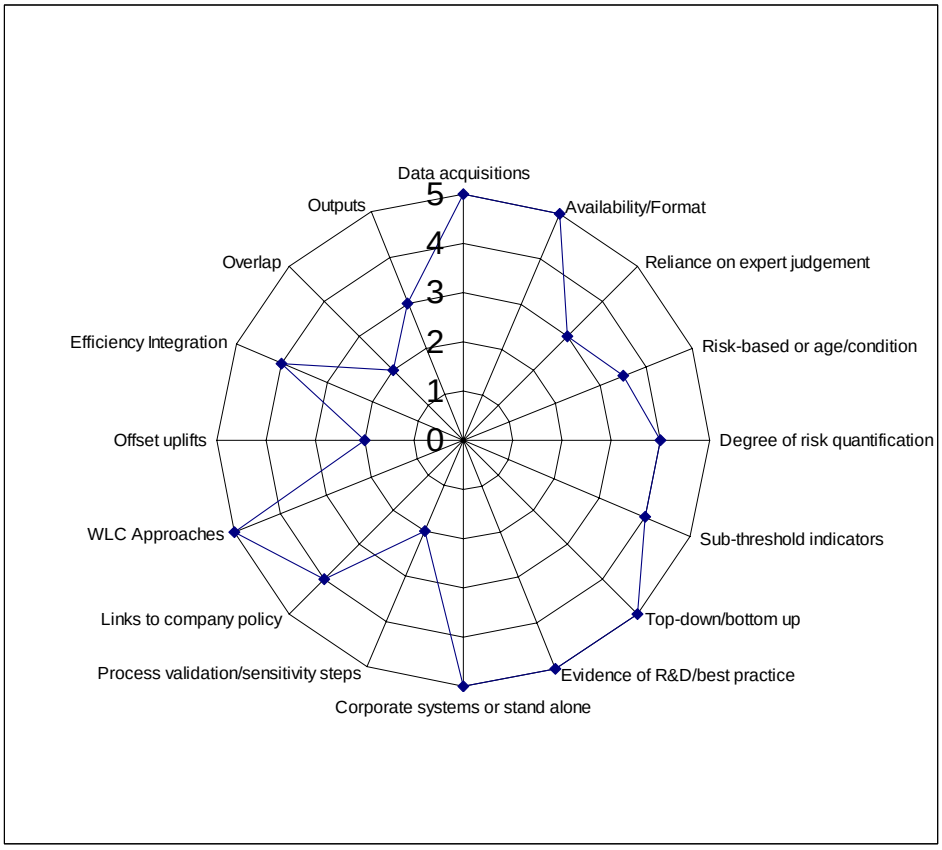

Figure B.1 Asset management performance scores

Sydney Water's overall asset management performance is good, with class leading scores in several areas including use of WLC, R&D and benchmarking to improve performance; use of sound data sources, and; deployment of a bottom up/business as usual process.

Areas to consider for potential strengthening are the offsetting of uplifts, use of sensitivity analysis and assessment of integrated interventions.

Use of mathematical optimisation tools may enable additional integration efficiencies to be achieved.

Appendix C Explanation of cost benefit analysis

Figure C.1 illustrates the application of a cost benefit approach and the scheme that delivers the maximum net benefit is deemed to be the most economic and would be the one selected.

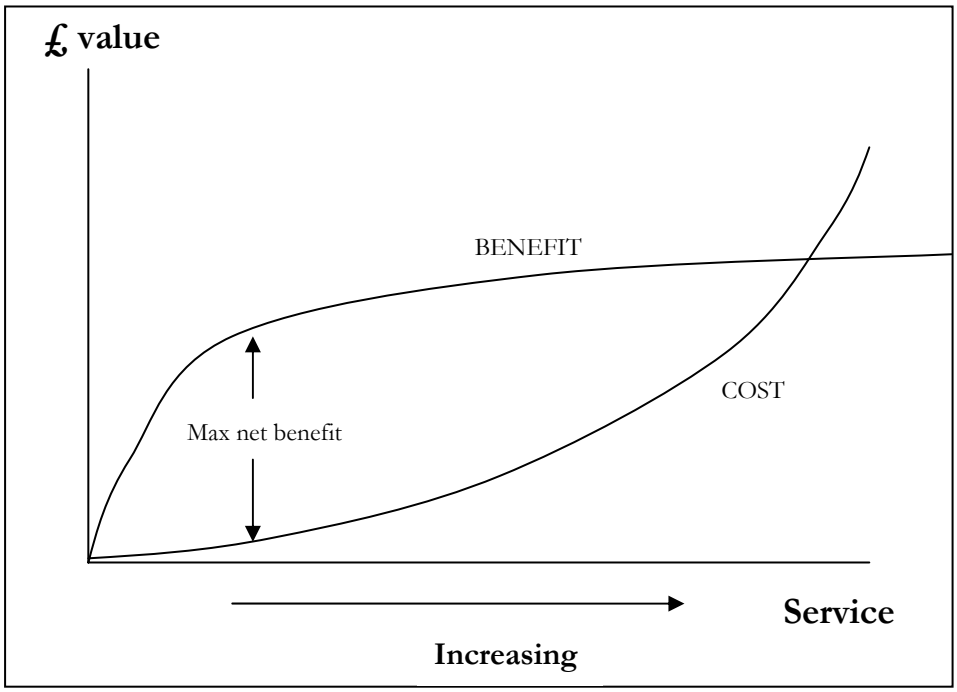

Figure C.1 Identifying the most cost beneficial (economic) option

The underlying concept is that costs of delivering service tend to accelerate so that each unit increase in service has a diminishing return. Furthermore, the benefit associated with each unit increase in service that is perceived by the consumer decreases. For example, the cost of water purification increases for each unit improvement in absolute quality. In addition, the average customer tends to stop valuing the incremental improvement (benefit) once the water has become fit for purpose (safe to drink).

The point where the rate of increase in benefit equals the rate of increase in cost is the point of maximum net benefit. This is referred to the point where the marginal cost equals the marginal benefit.

Cost benefit based investment planning is challenging. In practice, Sydney Water may not have a smooth continuum of options with which to build up the cost benefit curves. There are also many regulatory constraints placed upon a regulated water company that may prevent a purely economic investment strategy.

Achieving a regulatory standard for, say, water quality, should be done by looking at the whole life costs of options then identifying the one that has the lowest whole life cost. This is described as being cost efficient. It may be economic to improve the quality beyond the regulatory standard; however, this will require knowledge of how the customers value the water quality service and their willingness to pay.

It is also conceivable that the regulator has set a standard which is above the economic optimum; this could be challenged if the water company has suitable willingness to pay data. However, it must be remembered that the regulator may also be considering other stakeholder values and may be considering non-economic criterion, such 'fairness', or taking into account health issues and wider economic parameters that are difficult for the layman to appraise.

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