BRING PRACTICALITY INTO THEORY IN OPTIMISING ASSET RENEWALS

Nina Sardareva, Jayanthi Rangamuwa

ABSTRACT (200 WORDS MAXIMUM)

Auckland Council owns a stormwater pipe network of around 6,000 km. These pipe assets are in varying or unknown conditions and are at different standards. Although the network is fairly young, it has started displaying signs of degradation in some areas.

In the context of Auckland Council's aspirations and objectives; to keep the cost of infrastructure low and manage cost to the community, we need to apply smart management techniques. In this regard we need to consider long-term benefits and optimise our renewal strategies accordingly.

This paper will present our approach to optimise renewal strategy:

- utilise asset condition data – in the best possible way and responsibly
- smart/ sophisticated renewal projections - use best tools and theory
- recognise and incorporate actual performance issues – maintenance history and capacity constraints
- apply asset criticality in renewal prioritisation
- apply reality check to identified renewals – use institutional knowledge, field checks, etc
- scoping projects smartly – consider various treatment options, utilise upgrading opportunities
- monitor actual renewals vs forecast and maintenance cost – to understand the reality

Risk and costs are our key drivers!

KEYWORDS

Stormwater network, Management Techniques, Renewal Strategy, Optimisation, Asset Deterioration, Costs, Risks

PRESENTER PROFILE

Nina Sardareva

Nina Sardareva is the Manager Stormwater Asset Management with Auckland Council. She has been working in the area of infrastructure asset management since 2000, when she was appointed a Water Services Asset Management Team Leader with the former North Shore City Council. Nina holds a MSC in Water and Wastewater Engineering and is particularly interested in optimisation of asset management practices.

Jayanthi Rangamuwa

Jayanthi is a professionally qualified civil engineer with extensive experience in planning, design, construction and maintenance of civil infrastructure assets and facilities. She has been involved in NZ asset management for the past 8 years in both – public and private sectors.

1 INTRODUCTION

As of 1st November 2010, Auckland Council became a unitary authority, through the amalgamation of one regional authority and seven territorial authorities. The Auckland Plan, adopted in March 2012, sets out the strategic direction for the council, specifying targets and priorities, to become the world's most livable city in 30 years.

The council provides various services and amenities for communities in the region. Stormwater management – the management and coordination of stormwater across private and public property throughout Auckland to minimise and mitigate the adverse effects of rainfall, is one of them. To provide these services within the context of Auckland Plan objectives, council regulates land use activities and manages a stormwater network consisting of built and natural assets. While the immense value and role of natural asset in managing stormwater is now recognized, we still do not have a systemized approach to their long term management. Built assets are still the main means for managing stormwater across the Auckland region. The built assets have a replacement cost of $4.7 billion and consist of:

- 6,000 km of pipes and culverts
- 350 km open channels
- 150,000 manholes and 17,000 catchpits
- inlets and outlets 27,000
- 360 soakage systems
- 15,000 quality devices
- 400 ponds, detention tanks and treatment structures

Management of an asset portfolio covers acquiring, operating, maintaining, replacing (renewing) and disposing of assets. To provide the agreed stormwater service levels cost effectively, each of these functions requires careful planning and consideration of whole life cycle costs.

Although Auckland stormwater network is fairly young - more than 50% of the network is less than 30 years old – the replacement cost of assets older than 50 years is over half a billion dollars. To maintain sustainable stormwater service at optimised cost and to avoid catastrophic situations, the council needs to understand the behaviors of its assets and to plan asset renewals carefully.

This paper discusses the current approach to stormwater asset renewals including handling the gaps in data and processes; our present goals is to ensure service continuity and optimize, optimizing the cost of risk failure mitigation and understand the long term renewal requirements of the stormwater system. Our focus is on pipe assets, which are the backbone of the stormwater system and determine its overall performance. The pipes in the Auckland region account for more than 80% the total asset replacement cost.

2 DISCUSSION

Determining the level of expenditure and timing of asset renewals is a challenge faced by every asset rich organisation. To plan asset renewal we need to understand the nature and reasons for asset failures (asset failure is defined as inability of the asset to fulfill its purpose). Asset failures affect the delivery of agreed service levels, for example the frequency of blockages and collapsed pipes contribute to flooding events. The total asset failure marks the end of asset life and then renewal is imminent, should the service is to be sustained.

Optimising renewals is about getting the right balance between the level of asset failure risk that council is prepared to accept and the cost of and the asset replacement costs that the community can afford. This section describes the tools and processes that we use to manage this balance.

2.1 ASSET RENEWAL FRAMEWORK

Auckland Council inherited not only assets, but also processes and practices from the legacy councils. Before amalgamation, the approach to asset renewal varied widely - from reactive renewal budgets to be spent when needed to established planned renewal programs based on modeled remaining life. Harmonising these processes and practices into a robust regional framework is a key objective of Auckland Council and its Stormwater Unit.

The asset renewal framework outlined below is the first step towards establishing a foundation for a comprehensive Stormwater Renewal Strategy (identified as a key improvement objective in our current business improvement program):

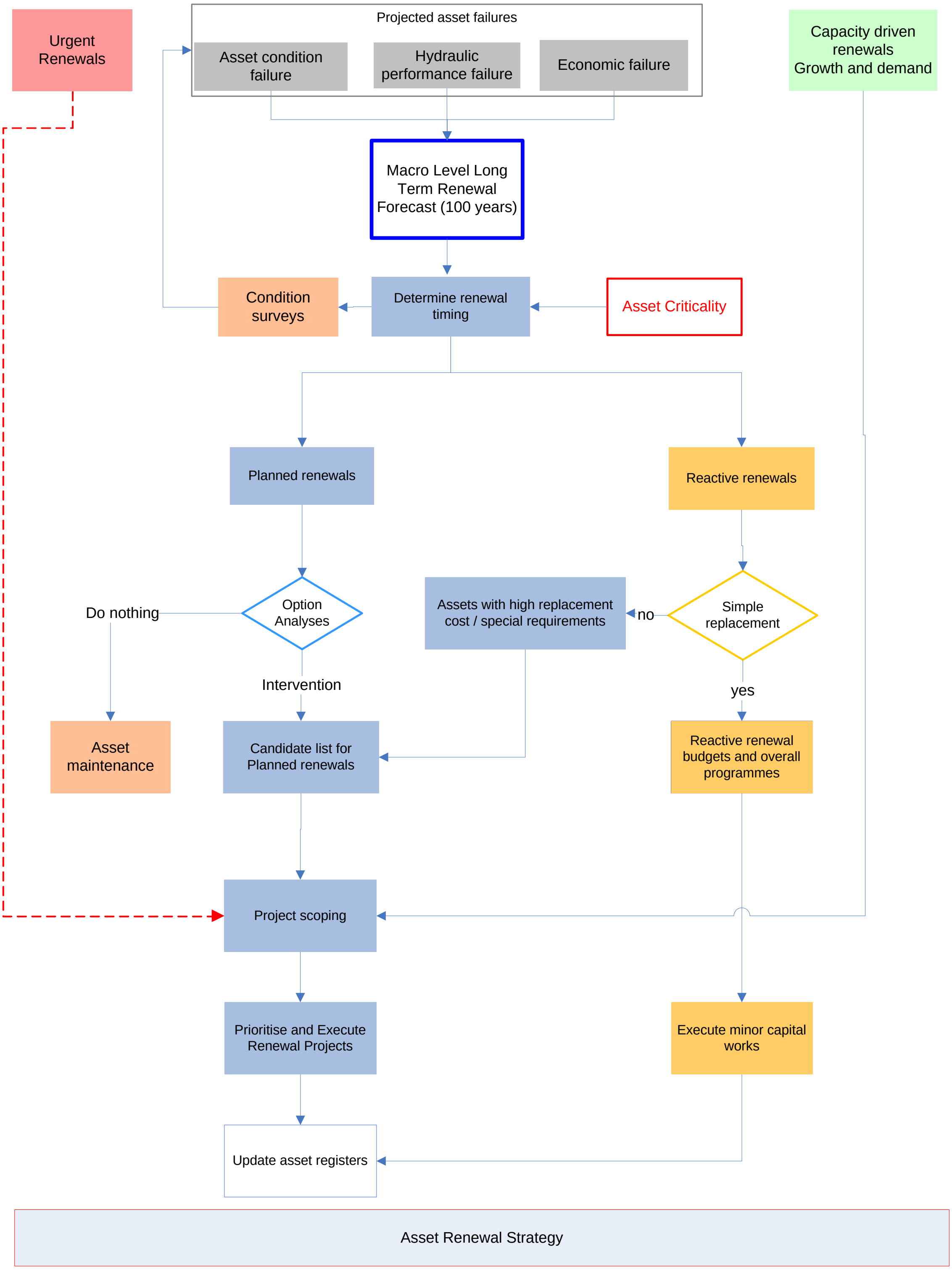

Figure 1: Asset Renewal Framework

Asset failure is the reason for asset renewal. An asset is considered as failed, when it no longer performs as originally designed – for stormwater pipes this is when the pipe no longer can convey and contain the flows. This can be due to:

- Asset condition failure

This can happen due to the structural deterioration over the asset age or due to an external event, such as ground instability, corrosive environments and poor workmanship. Structural deterioration may not be affecting the asset performance until it collapses completely.

- Hydraulic performance failure

The ability of a pipe to convey flows can be impaired by root intrusion, debris or silting. The consequences of hydraulic performance failure can be observed as surcharges or flooding during a storm event.

- Economic failure

The cost of asset maintenance depends on various factors such as asset condition, material type and the surrounding environment. When annual maintenance costs increase steadily and exceed the annualised replacement costs, ongoing maintenance of the asset may not be economical. Definitions and methodologies for determining asset economic failure need to be developed in the context of the particular asset class and service levels (this is an improvement opportunity that will be investigated later)

Unlike assets that support a man-made service - like water supply, the failures of stormwater assets do not necessarily result in visible performance issues. Therefore we need to undertake purposeful condition surveys to understand asset condition and assess the risk of asset failure. And since condition surveys are associated with significant cost, we need to plan them smartly.

Macro Level Long Term Renewal Forecast reflects the renewal profile of the stormwater network over a period of time comparable with its lifespan. It is driven by the renewal requirements of stormwater pipes. Renewal requirements are identified through modeling asset deterioration that utilizes the best available information.

The purpose of the long term renewal forecast is to understand the peaks and troughs in the cumulative renewal needs of the stormwater system and to inform the Asset Management Plan and Council's Long Term Plan.

It is critical to properly determine the timing of asset renewal. Running assets to failure has an effect on the levels of service delivery and - potentially – increases the asset operation cost, while replacing the asset before it fails require early capital investment. Therefore to get the right balance, consequences of asset failure on service delivery need to be considered. The figure below illustrates the dynamic relationship between the service, cost and risk.

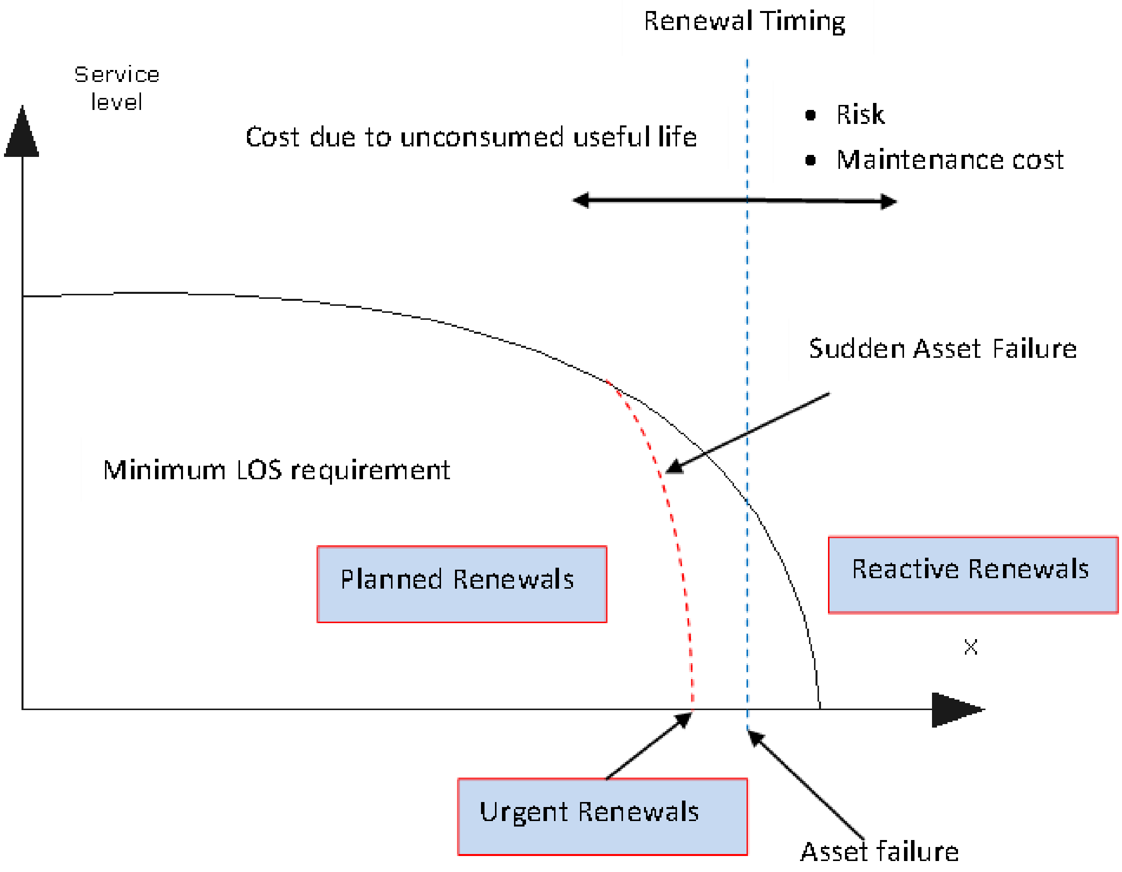

Figure 2: Relationship between service level, cost and risk

The Macro Level Long Term Forecast forms the basis for the three main renewal streams:

Reactive renewals cover assets that can be utilised until failure without major consequences. This also includes assets where monitoring asset behavior and planning renewals is difficult and cost prohibitive, e.g. replacement of stormwater connections, non critical manholes, etc.

Planned renewals aim to replace the asset before if fails. Assets with high failure consequences (critical assets) and short remaining lives are the first candidates for planned renewals. It is recognised that sometimes non critical assets may also need to be included under planned renewals due high replacement costs as well as construction and consenting complexity.

We use **asset criticality** as the key driver for determining the right mix of planned and reactive asset renewals. Asset criticality reflects the consequences of asset failure – the larger the consequence, the higher the criticality, the higher need for renewal planning.

Urgent renewals cover the cases of sudden asset failures, where the risk of non functioning asset is too significant and needs to be addressed immediately. The level of urgent renewals reflect the maturity of the asset renewal strategies of the organization; it is expected that the level of urgent renewals of critical infrastructure will decrease with increasing asset knowledge and optimised renewal planning.

Assets to be included in the planned renewal are subject to treatment option analyses to determine the type of intervention required. Assets that require intervention are included in the **Renewal Candidate List**. This list forms the basis of the future renewal projects.

Project scoping covers organising assets identified for renewals into projects for optimised implementation. Capacity driven renewals that are identified through **Growth and Demand** analyses as well as known **Urgent Renewals** are also considered. The scope of renewal projects is determined by location considerations, other planned capital works, the state and parameters of the stormwater network, etc.

Renewal Projects are prioritised and executed in accordance with the prioritization methodologies of the Stormwater Unit and the capital work implementation process of Auckland Council. The data is returned to the **Asset Registers**, which are used for an input to the renewal forecast process.

2.2 MACRO LEVEL RENEWAL FORECAST

Long-term renewal forecast is developed by considering all asset failure modes. Assets with long useful life such as pipes require a planning horizon of 50 to 100 years.

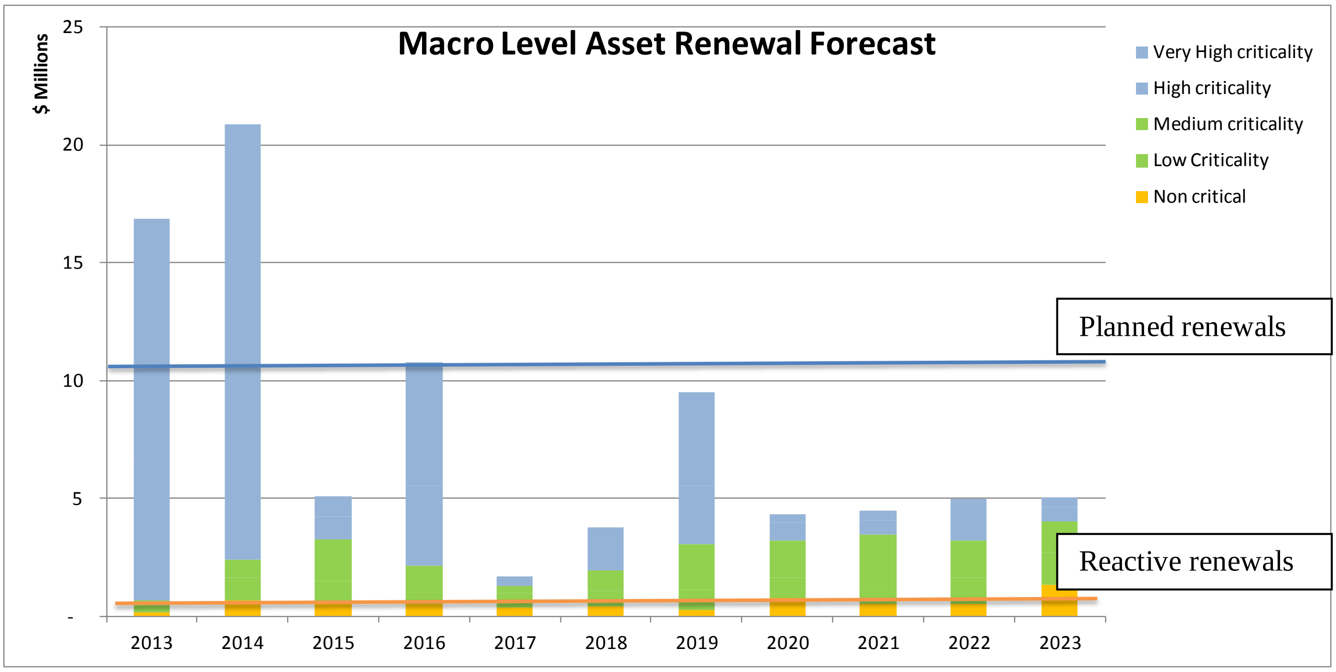

Figure 3: Example of deterioration driven renewal forecast, planned and reactive renewals

2.2.1 MODELING ASSET DETERIORATION

Structural asset deterioration varies with many factors – asset age, material type, size, environmental conditions, maintenance regime, etc. A sophisticated analytical approach which considers all these parameters is essential to determine the time of asset failure (remaining useful time).

Asset deterioration model:

Auckland Council uses SPM Network, a web based analytical model developed by SPM Applications, for predicting stormwater asset renewals. The tool uses an analytical algorithm based on asset deterioration profiles and asset condition to determine the asset remaining life. It has the capability of grouping asset data with like behaviours, which is an essential feature for renewal forecasting of a large and diverse asset base.

The key inputs to deterioration modeling are:

- Asset attributes from asset registers
- Unit replacement costs and base lives
- Condition data (actual and estimated as described above)
- Appropriate selection of an asset deterioration profile

Asset attributes:

Main asset attributes required to import into the forecasting tool are asset id, asset type, material, diameter, installation date and information regarding asset location. These fields are available in the council's asset management systems. Data is sufficiently reliable and complete. Incomplete data values (ie. Installation date, material, pipe size) are filled using general assumptions based on available data patterns.

Unit replacement cost:

Asset unit replacement rates used for the 2012 asset revaluation process are also used for 2012 renewal forecasting. Replacement costs of stormwater pipes are derived from the actual construction cost and institutional knowledge. Replacement costs also vary with other factors such as complexity of construction, ground or soil conditions and location (access issues and traffic management requirements).

Replacement cost estimates based on material type, pipe size and catchment management area are sufficient (and practical) for developing a long-term renewal forecast for a large asset base. Updated cost estimates are developed later in the project scoping stage.

Asset condition:

Condition of stormwater pipes are determined through CCTV surveys. It has to be noted however that only part of the stormwater network – about 14% has reliable condition data. And while this is a reasonably good sample, it is recognized that there are significant gaps and inconsistency in capturing condition data due to various legacy processes.

In 2012, a study was carried out to determine the state and reliability of available condition information for the stormwater pipe network.. To have an understanding of the overall condition of the network, actual condition gradings were extrapolated to assign condition profiles to the rest of the network, while a clear metadata for the source of information was maintained.

Contributing factors for pipe deterioration are pipe material, pipe size, pipe age, design and construction standards, pipe depth, pipe slope and pipe location (soil type, ground water level, presence of tree roots). These factors were considered in grouping assets with similar deterioration rates for this extrapolating exercise.

Our confidence in the extrapolation will improve as we obtain more actual condition information. Auckland Council is in the process of improving our condition survey program to address this.

Deterioration profile:

A study to select appropriate deterioration profiles for different material types, pipe sizes and catchments was carried out in 2009 by North Shore City Council using actual condition data. The appropriateness of the selected deterioration profiles was tested extensively and validated against actual conditions.

The findings of this study were used to determine the deterioration profiles of stormwater pipes regionwide. A review of deterioration profiles of stormwater pipes is included in the draft Asset Renewal Strategy action plan.

Asset Remaining life is the key output of deterioration modeling. It allows us to prioritise renewals not only by the merit and benefits, but also to more accurately allocated projects to years, which is the first step towards renewal optimization.

2.2.2 RENEWALS TRIGGERED BY OTHER FAILURES

The assets with hydraulic performance failures are identified using service request information and maintenance records stored in various systems. Frequently these have health and safety implications and have to be addressed timely.

Asset performance failures are not captured consistently across the region. Auckland Council is developing asset maintenance data standards that will be used for configuring asset management systems and tools.

To get a better understanding of the economic failure of assets, the relationship between asset condition and maintenance requirements need to be analysed. Institutional knowledge and historical maintenance cost are currently used to justify the benefit of replacement over continuing to maintain an asset.

Renewal requirements identified due to these failure modes are incorporated with the deterioration model output.

2.3 IDENTIFYING PLANNED AND REACTIVE RENEWALS

To minimise asset risks at optimal cost we need to understand the drivers and specifics of different renewal streams. The level of planning in asset renewal is driven by the consequences of their failure, which we call asset criticality.

2.3.1 IMPACT OF ASSET CRITICALITY ON RENEWAL TIMING

Assets criticality plays pivotal role in deciding the timing of asset renewal. Assets with high consequences need to be replaced before the end of their life.

Council has developed a GIS based criticality model that assigns criticality rating to all assets in the region. The model considers the consequences of asset failure in the context of the four well-beings - social, cultural, economic and environmental.

The factors use to assess asset criticality include:

- Asset attributes – type, size and depth

- Road classifications – motorways, urban arterial roads
- Geotechnical data – in landfills, etc
- Flood plains
- Critical facilities – within 50m of fire stations, police stations, schools, hospitals, etc
- Building footprints – pipes => 600mm under buildings
- High population areas – In areas with => 50 persons/ha
- District plan zones
- Hot spots – criticality identified by operational / planning staff, specific studies, etc (i.e. Manholes with no safety lids, soakage tunnels, dams)

The model derives the criticality score against each asset component by applying measure rating and criteria weighting. This score is used to group assets into criticality bands – high criticality, critical, low criticality and not critical.

Renewals of critical and highly critical assets are planned in advance to manage the overall risk. Regular inspections of critical assets provide updated condition information to recalculate their remaining life.

A critical asset inspection program is essential for the optimised planning of asset renewals.

2.3.2 RENEWAL TIMING

Very critical assets are scheduled for renewal well before they reach the end of their expected useful life, while non critical assets are generally replaced when they fail (reactive renewals).

And while planned renewals are driven by the asset remaining life, it is equally important to understand the required level of reactive renewals. Failure to understand that may lead to insufficient renewal funds and ultimately can affect the Levels of Service. Determining the level of reactive renewal is inherently difficult due to the uncertainty of actual failures; it is generally based on historical expenditures and is therefore quite conservative. Proper analyses of historical spending on reactive renewals will improve our understanding of reactive renewal needs.

Reactive renewals are carried out as part of our minor capital works programmes, frequently by maintenance contractors.

2.3.3 RENEWAL CANDIDATE LIST

Deterioration modeling of asset remaining life in the context of asset criticality produces a list of assets that need to be addressed in the next five to ten years; we call this our Renewal Candidate List. Since it is a result of modeling it needs further validation using institutional knowledge, detailed information and further inspections.

Reality checks:

It is not realistic to expect that the predicted remaining lives will be 100% accurate. Therefore there is still a probability of replacing an asset too early (impact on cost) or critical assets may run to failure (impact on risk).

This can be minimised by doing some reality checks:

- Review older critical assets of vulnerable materials type, which are not captured by deterioration modelling – use staff knowledge, customer complaints and inspection notes. Condition surveys may be required
- Audit and analyse CCTV observations of selected pipes(peak and mean scores, defects) to determine the treatment option required. Sometime the condition score alone may be misleading and maintenance intervention could be sufficient
- Assets with significant replacement costs or with special requirements (complex designs, access issues, traffic management, consenting issues, etc), also need to be included in the renewal candidate list. They may need to assessed on a case by case using institutional knowledge.

2.4 SCOPING RENEWAL PROJECTS

While it is possible to implement asset renewals straight from the Renewal Candidate List, this may not be an optimal solution. Grouping assets by location and with capital investments from other activities provides much better value.

The confirmed Renewal Candidate List needs to be translated into renewal projects. The process of scoping renewal projects cover

- Determine the extent of the project by analyzing the condition and performance of adjacent assets
- Determine and carry out additional condition inspections if nessecary
- Consider other planning requirements (current capacity issues, future growth requirements, etc) to decide replace/upgrade/downgrade/dispose
- Consider optimal construction extent
- Investigate various treatment options and select the most cost effective one

Renewal projects are recorded in the Stormwater Capital Portfolio database, where the project progress is monitored through to completion.. Renewal projects are further prioritized to ensure that the capital spending achieve maximum benefits. A new Project Prioritisation Methodology for stormwater projects is under implementation.

2.5 ASSET RENEWAL FORECAST REVIEW

The Stormwater Unit is at the start of the long journey to optimize asset renewals. T is expected that the renewal forecast in the next few years will change with our improved understanding of asset behavior. The Macro Long Level Renewal Forecast will be reviewed annually to ensure that the best available information is utilized.

It is important that we continue to analyse renewal forecast against actual expenditures and performance against Service Levels. This will include:

- comparison between renewal requirements and provided budgets
- analysis of renewal mix – planned, reactive and urgent renewals
- impact on reactive maintenance activities
- present the findings in suitable format to communicate with stakeholders and decision makers.

3 CONCLUSIONS

There are three main renewal steams – urgent, planned and reactive renewals. Managing each stream is essential for minimizing asset failure risks.

We have control over how we approach the planned and reactive renewals. Considerable savings can be made if we get the right balance between planned and reactive renewals.

Implementing asset renewals through prioritised renewal projects is a good way to achieve value for money.

Reliable asset deterioration modeling and understanding asset criticality are key to optimizing planned asset renewals. Deterioration modeling depend on condition data, so asset condition strategy together with appropriate processes and tools play very important role. It is important to remember that prediction of asset renewals through estimating their remaining life requires continual verification and adjustment.

Process and tools are our weakest link, but we are working towards improving them. The Stormwater Unit is working to develop a business management framework by the end of June 2013.