WASTEWATER INFRASTRUCTURE PLANNING – COMBINING RENEWALS AND CATCHMENT MODELING STUDIES

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ABSTRACT

Wastewater infrastructure expenditure is often planned through wastewater Catchment Modeling Studies and Renewals Programming. Catchment Modeling Studies are focused on meeting level of service criteria and providing for predicted growth, while renewals focus on maintaining reliability and operability of an ageing network.

Catchment Modeling Studies and renewals are often considered in relative isolation; however there is significant advantage to coupling the two processes and maintaining both programs as live documents. The results of continued investigations and condition assessments can have a major impact on the priority of planned projects along with directly impacting the preferred upgrade option and resulting cost. Running the two processes in parallel ensures that upgrade projects fully utilise the useful life of existing infrastructure while ensuring that upgrades to meet level of service requirements. This also resolves areas identified as being of high risk as much as possible. This can result in significantly different results from the Catchment Modeling Studies that if capacity and growth requirements are considered in isolation.

The following paper uses case studies to demonstrate the effect of this holistic approach.

KEYWORDS

Master Planning, Renewals, Optimisation

1 INTRODUCTION

With an aging infrastructure and growing population, asset management is increasingly needing to balance level of service improvements, increased wastewater demand, risk management and renewals requirements. There is a need for continued long-term investment in wastewater assets in order to ensure sound custodianship of assets and to prevent maintenance and renewals costs being lumped on to future generations.

This paper investigates the different processes involved in growth planning, renewals planning and risk assessment within wastewater networks and identifies how these processes work together to result in a live management process that optimizes network investment to achieve three separate goals.

2 BACKGROUND

There are multiple objectives that are taken into account in the management of wastewater infrastructure, these objectives can broadly be categorized into level of service targets, future growth provisions, proactive network renewals and risk based objectives. Some of the key objectives associated with these management categories are outlined in the table below.

Table 1

Level of Service	**Future Growth**	**Proactive Renewals**	**Risk Management**
Achieve regulatory requirements for wet weather overflows	Ensure sufficient capacity is available to receive growth as it occurs	Ensure the overall condition of the network is maintained from one planning period to the next	Manage the risk of asset failure and consequential environmental and social damage
	Ensure environmental, social and cultural performance indicators are maintained or improved	Ensure the cost of asset investment and replacement is spread across the generations that will benefit from it	Identify the safest method of providing network upgrade and renewals projects
Maintain service to customers through in effective renewals program	Ensure capital upgrade projects are optimized for the best outcome for the whole network	Reduce risk of exposure to high level of reactive renewals projects	Minimize financial risk through well managed works program
	Ensure development occurs in an appropriate manor that can be serviced in a cost effective manor	Assist in maintaining service level to customers	Remodel the network at pre determined timeframes to highlight all risk areas

Many of the objectives described above apply to multiple management categories and also have an impact on how projects are serviced and prioritized.

Level of service projects are typically focused around network improvement projects to address existing failures to meet regulatory requirements for network performance and also reacting to network failures as they occur. Factors such as growth and risk management will often be taken into account in these projects, however the primary information used in determining these projects is often historical analysis relating to issues in the past. The primary data inputs to planning and prioritizing these projects is typically historical failure records, GIS network records including network age and material and CCTV investigations.

Proactive renewals are aimed at ensuring the overall condition of the network is maintained from one planning period to the next. This requires an understanding of the rate of deterioration of the sewer network assets. Understanding the life expectancy of assets through sewer deterioration modelling allows an investment strategy to be developed that ensures the capital investment matches the asset deterioration. This will ensure a long-term stable asset base which is capable of continuing to provide the required level of service to the customer. Data inputs to this analysis are primarily historical in nature and will often be used to identify further information requirements such as Inflow and Infiltration (I&I) investigations and focusing CCTV investigations.

Future growth provisions is primarily assessed through hydraulic modelling tools. This allows the forecast wastewater flows to be tested against the existing assets to identify areas where capacity constraints are likely to occur. Hydraulic models allow detailed assessments of the system performance to be completed and offer an important tool for optimizing both level of service and future growth projects to provide the best use of capital investment. Future growth assessments and system performance investigations focus primarily on the available capacity in the network and does not typically consider network condition beyond the initial calibration parameters. Hydraulic models are also a useful tool for considering how network upgrades and expansion will impact on the performance given different flow and growth scenarios.

Risk based assessment has a significant influence on the prioritization of projects and can also influence the options and methodology reviewed for construction. Risk based assessment takes into account the criticality of an asset along with the parameters utilized in renewals programming to determine both the likely risk of failure and the associated consequence. Another dimension to risk analysis is the utilization of methods such as safety in design. While this does not influence the prioritization of a project, it can significantly influence the preferred options for delivering the project and should be considered at the earliest stages in planning. The ability to safely construct and operate a project for the contractor, operator and public can be heavily influenced by the route selection, the method of providing the level of service and the construction methodology.

3 SIMILARITIES IN ASSESSMENTS

3.1 LINKING THE PROCESS

Level of service planning, growth planning and renewals planning all rely on certain inputs, with different priorities and outcomes depending on the objectives. The information gathered in order to develop one area of planning will always influence other areas as well. There is therefore a strong need for network management to be a live, linked process so that opportunities to achieve objectives outside of a specific planning envelope are not missed.

The figure below shows the traditional inputs that are considered for each stage of planning. As information is gathered for one particular planning area, this information also needs to be included in the other plans to ensure appropriate project identification and prioritization is maintained. For example, if a section of network is identified as being under capacity through system performance investigations, there may be an opportunity to upgrade the network. This should be done in such a way that the highest risk pipelines from a renewals perspective are incorporated into the project such that both plans derive a net benefit from the project. While system performance outcomes are not specifically on input into renewals programming, it can have an influence on the preferred option and the prioritization of a project. Conversely, if a section of network has been identified as being in poor condition with a high failure rate, this may have a direct impact on the timing of a growth related project.

Figure 1 below presents how level of service, gorwth planning and preactive renewals can br linked through the network planning process.

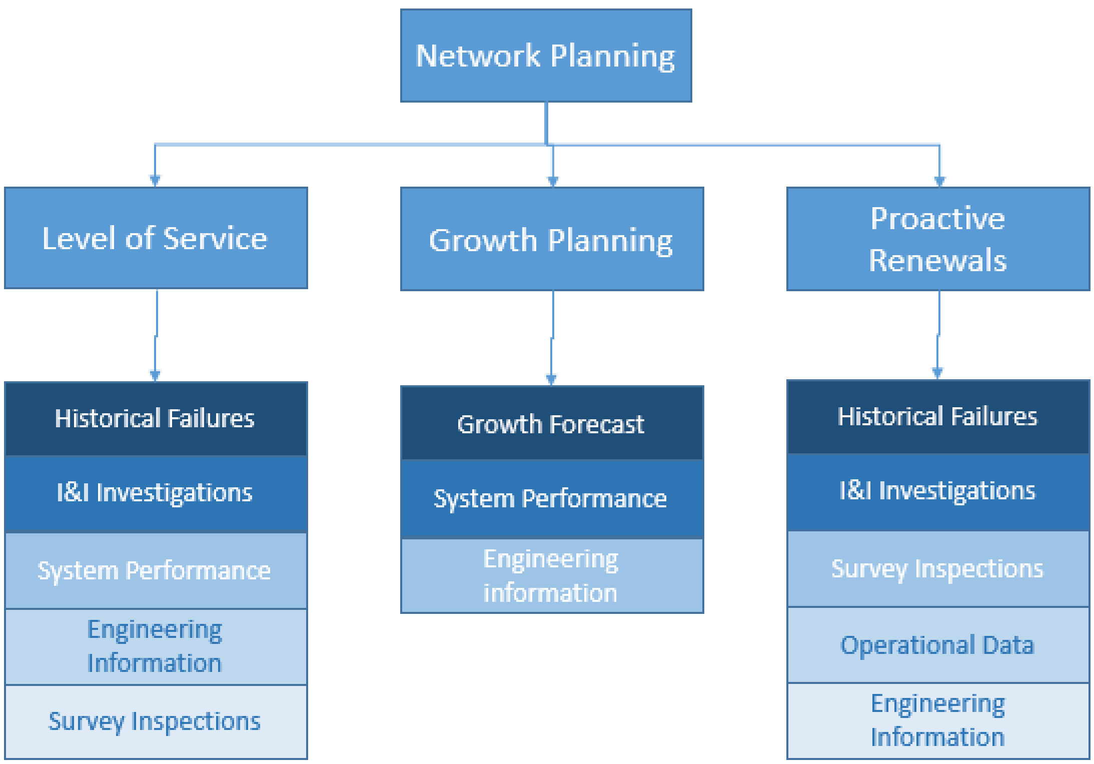

Figure 1

Network upgrade programs and renewals programs should be generated in parallel, with both documents being maintained as live documents and updated at regular intervals. Both programs will identify locations where further information is required and the results of these additional investigation should be fed into both programs as the information is unlikely to influence only one program. With the network upgrade plan and renewals plan being developed together, the overall output represents a complete Master Plan in which risk is appropriately managed across the network.

The flow chart (figure2) below shows how hydraulic modelling outputs and deterioration modelling outputs should both be used in identifying projects and determining priorities. This process ensures that all network information is considered in both the hydraulic and deterioration modelling. Project identification will result in a series of projects that can be level of service related, renewals related or both. Projects can be classified as either upgrade related or renewals related at this stage if necessary for budgeting purposes. Merging the project identification stage of network planning will maximize the opportunity to achieve multiple network objectives with a single project, minimizing the total scope of works required in the long term.

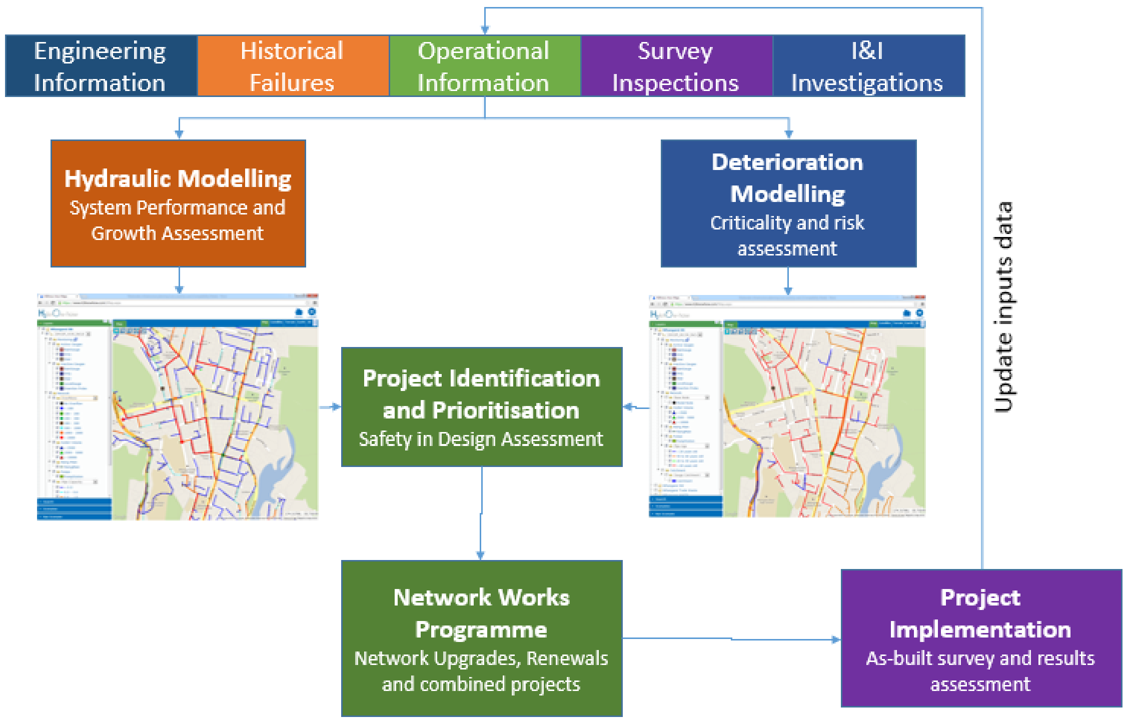

Figure 2

Ensuring safety in design is considered in this early planning and project scoping stage provides a significant opportunity to ensure the preferred option taken forward into design minimizes the safety risk to contractors, operators and the public. Upgrade and replacement methodologies, along with route selections and construction techniques have a large influence on the ability to complete a project safely and opportunities to achieve this can become significantly reduced as the project progresses.

3.2 EXAMPLE OF DIFFERENT OUTCOMES

The Whangarei Wastewater Master Plan identified an area of the network where there were significant capacity issues, resulting in predicted overflows in both current and future wet weather scenarios. The catchment is served by 2 sewer mains, the trunk running down Lupton and a local main running down Kamo Rd as shown in the figure 3 below.

Kamo Rd is a main highlighting through Whangarei (SH1), which has a significant number of other services within the carriageway and a high number of lateral connections to the sewer. The 150mm sewer pipeline down Kamo Rd has recently been investigated using CCTV footage and was identified as being in poor condition, with significant damage in some places. Less information is available on the trunk main serving the area, however the majority of the network in this catchment is known to be over 60 years old. The following discussion runs through the different options that would have been preferred if different network planning methodologies were considered in isolation. The eventual preferred option that was selected when level of service, provision for growth, renewals and risk were all taken into account.

Level of Service and Growth provision

The initial system performance assessment identified capacity issues along both the Kamo Rd and Lupton Ave pipelines. The assessment aimed to upgrade the existing network in order to remove capacity constraints and achieve the target level of service for wet weather overflows. The recommended upgrades when solely considering capacity constraints would be to upgrade the Kamo Rd sewer to a 300mm pipeline and provide a diversion from the Lupton Ave sewer to and adjacent trunk main that has available capacity. This option would achieve level of service targets, however construction of a new 300mm pipeline along Kamo Rd would result in significant disruption to the community and significant safety risks during construction due to deep excavations, constrained site and the high number of other services. The project would meet renewals objectives for the Kamo Rd sewer, however the Lupton Ave trunk would continue to be a high risk asset and may require further investment in the foreseeable future.

3.3 LEVEL OF SERVICE, GROWTH PROVISION AND RENEWALS

When the age of the existing infrastructure is taken into account and the requirement to complete proactive renewals is incorporated into the options, more comprehensive replacement of existing infrastructure becomes favored over a simple diversion. The preferred option for Kamo Rd would still be to replace the existing pipeline with a 300mm diameter trunk main, however the preferred option for Lupton Ave include replacement of the trunk main upstream of the proposed diversion. This incurs a larger cost to the project now, however will ensure the network continues to meet the level of service requirements and reduces the risk of significant, reactive renewals being required.

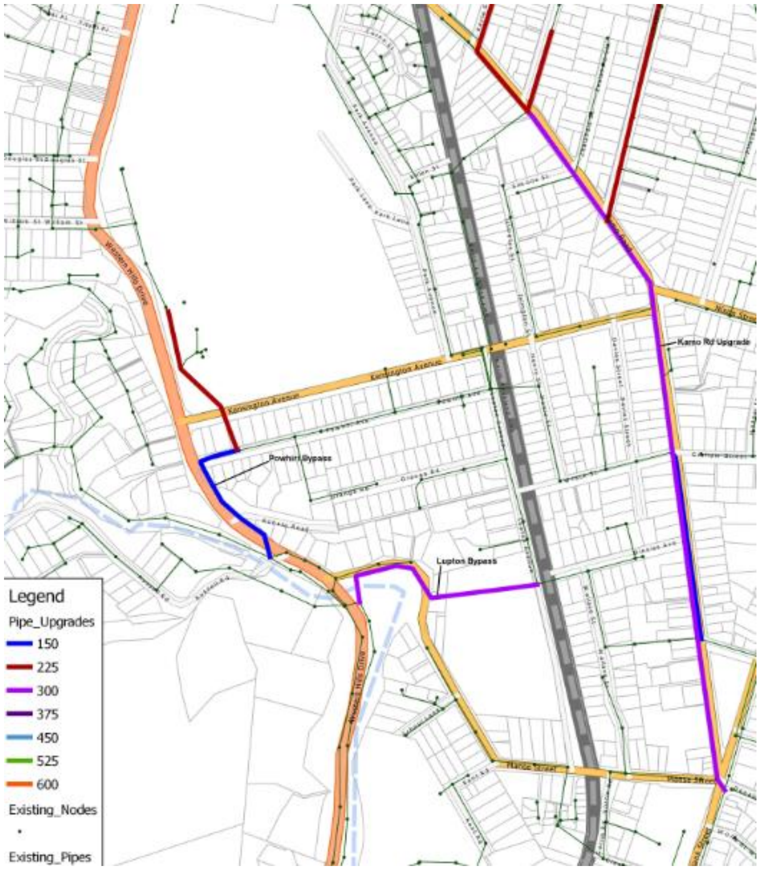

Figure 3

3.4 LEVEL OF SERVICE, GROWTH PROVISION, RENEWALS AND RISK

When risk is included in the analysis, the upgrade of the Kamo Rd sewer raises significant concern due to the difficult construction condition. The sewer is known to be over 4m deep in places, with heavy road traffic and a congested services corridor above. Replacing the pipeline through directional drilling or pipe bursting would reduce the overall trenching required, however due to the significant number of lateral connections, there would still be a very high level of excavation and disruption required.

An alternative option that may be available is to construct a new, large diameter trunk main along Lupton Ave, which has a wide berm and has a lower traffic load, divert a significant amount of flow from Kamo Rd to the new Lupton Ave sewer and rehabilitate the existing 150mm pipeline using techniques that allow reconnection of laterals without the need for excavation. This option provides for capacity upgrades and pipeline renewals and also removes a significant amount of safety risk from the project. This option does however require further specialist investigation to ensure the existing 150mm pipeline is suitable for rehabilitation technologies.

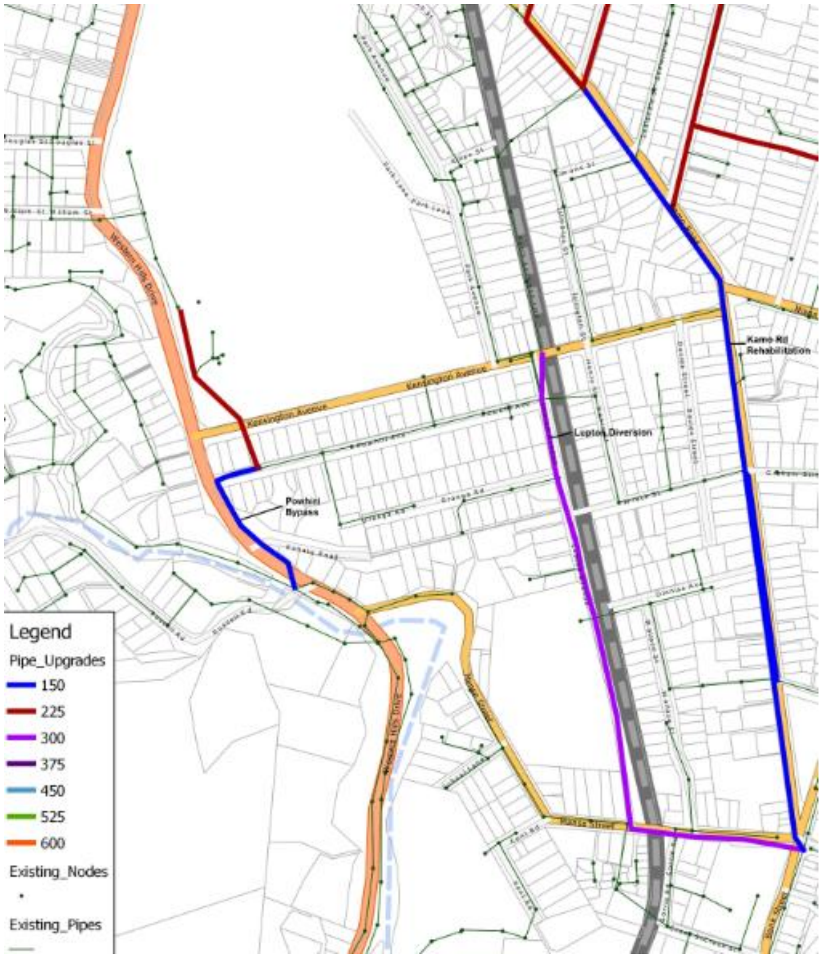

Figure 4

4 CONCLUSIONS

Network renewals and catchment growth and level of service planning are often considered in relative isolation. Significant benefit can be achieved through combining the outcomes of network modelling assessments and deterioration modelling at the project identification stage. This will enable projects to be scoped such that they maximize opportunities to achieve multiple network objectives with a single project. A safety in design assessment at this stage may assist in identifying methods of delivering the project that minimize the health and safety risk to the contractor, operators and the public.

As additional information is gathered about the network such as survey and CCTV data, this should be incorporated into both the hydraulic modeling and deterioration modelling and any consequence this information has on the outcomes should be reviewed against the network plan. This will ensure any effect on projects scopes or prioritization is identified. This also applies to as-built information as projects are completed. It is then imperative to ensure the Network Works program is kept up to date and is operational as a live document.