KĀPITI COAST CRITICALITY - A FRAMEWORK FOR FIRST THINGS FIRST

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ABSTRACT

With the next round of Local Authority asset management plan updates underway, there is an ever increasing focus on the financial prudence and robustness of decision making processes used to develop future budgets.

As an industry, we make decisions about prioritising every day. Historically we used previous experience and judgment to establish and prioritise by balancing a complex range of variables. Today we have a wealth of geo-spatial information with powerful processing capabilities which we can use to inform our decision making.

This criticality framework provides a consistent approach to assessing the comparative impacts on people and the environment caused by the failure of an asset and loss of its function.

The framework has being applied to the water supply, wastewater and stormwater assets in Kāpiti. It will be used to prioritise inspections and investigations, refine operation, maintenance and renewal strategies, identify high risk information gaps and increase confidence in programming of works.

This paper is for anyone who is interested in improving the confidence in and precision of their expenditure prioritization and programming.

KEYWORDS

Criticality, prioritization, framework, infrastructure, Kāpiti Coast District Council water supply, storm water, wastewater.

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1 INTRODUCTION

With aging assets, ever tightening budgets and a greater awareness on service the challenge today is to make operational and capital investment decisions with increasing confidence. Now more than ever applying a communities finite resources in the right place at the right time is under scrutiny and we must improve our decision making confidence.

A structured framework is required to be able to analyse the increasing complexity and scale of the networks required to serve our communities' needs. It is easy to determine the comparative criticality of two assets when only one variable is changed between them. Now multiply that by tens of thousands of assets in infinitely variable situations and you have a prioritization challenge beyond simple comparisons between two assets.

The council's three waters criticality framework provides the structure and processes to develop an asset criticality model that can be, and is, used to improve the confidence and precision of expenditure prioritization and programming. It is applicable to other services, in addition to the Three Waters and has the capability of being progressively improved by incremental refinement of the component processes.

This paper is divided into four further sections

- Section 2 What's really critical
    - Asks the question what is really critical and sets out the criticality framework and the processes used to establish initial criticality scorings.
- Section 3 doing first things first
    - Looks at the application of critically and how it is used in day to day operations and in capital planning to improve expenditure and investment decisions.
- Section 4 Kaizen – Continuous improvement
    - Asks the question how can we do this better. Taking the initial framework and incrementally improving on it through industry collaboration.
- Section 5 Conclusions
    - Provides discussion and conclusions about the framework and the processes used to develop it.

2 WHATS REALLY CRITICAL

2.1 STARTING WITH THE END IN MIND

In the development of the council's three water criticality framework there was a unanimous view that service to "people" must come first. Intrinsic in this view is also the protection of the natural and built environment within which we live and work. Three waters infrastructure exists to serve our people and communities and to enhance and protect the environment. So the critically framework must collectively evaluate the consequences of asset failure on the service provided.

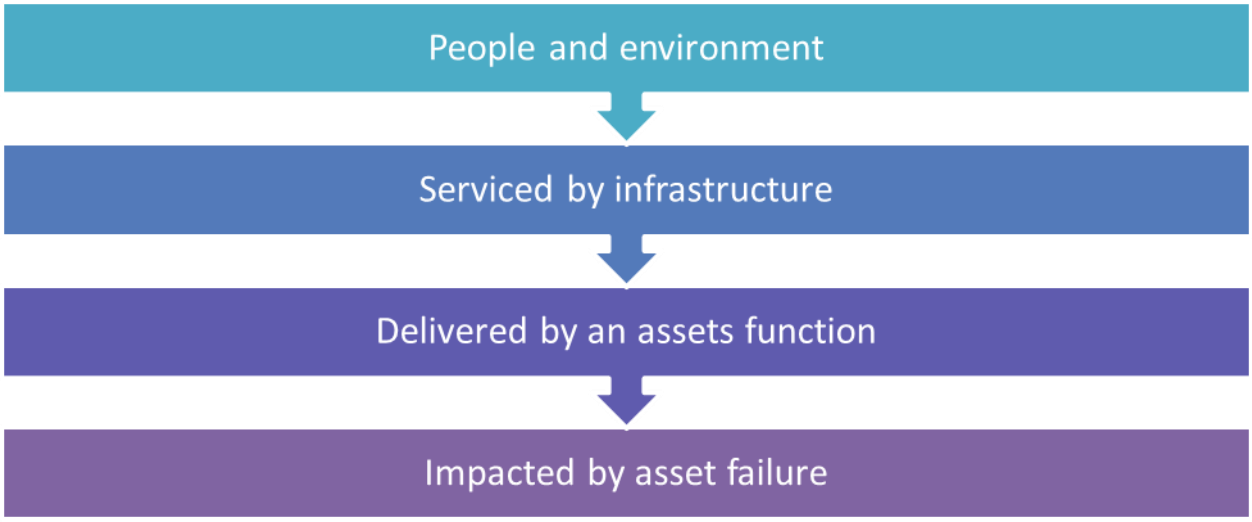
2.2 A FRAMEWORK FOR CRITICALITY

Criticality = impact to a person or receiving environment * no people affected

The framework establishes the criticality of each asset based of the definition set out above. It calculates the impact on people and the environment of an assets failure to deliver its function and

derives comparative criticality score from the collective impacts of that failure. Figure 1 shows the connection of people and environment to assets.

Figure 1 Connecting people to assets – the linkages



2.2.1 SERVICES PROVIDED AND ASSETS FUNCTION

The three services provided to the communities of Kāpiti by the three waters infrastructure are:

WATER SUPPLY

Water supply infrastructure covers the treatment, bulk transmission, storage, distribution of water to the communities in Kapiti. The council is responsible for the provision and management of four water schemes at Ōtaki, Waikanae / Paraparaumu / Raumati (WPR), Hautere / Te Horo and Paekākāriki. The water schemes contain a mix of assets including intakes, bores, treatment plants, pump stations, reservoirs, trunk mains, mains, service lines and resource consents.

The four schemes supply over 7,300,000 m^3 of water per year to c.21,000 properties through 462 kms of pipes and have a replacement cost in excess of $125 million.

WASTE WATER

Wastewater infrastructure covers the collection, reticulation and pumping, treatment and discharge of waste water for the communities in Kapiti. The council is responsible for the provision and management of the two wastewater schemes at Ōtaki and Waikanae / Paraparaumu/ Raumati. These schemes contain a mix of assets including wastewater treatment plants, pump stations, pipes, manholes, service connections, resource consents.

The two schemes treat c.4,200,000 m^3 of wastewater per year for c.21,400 properties collected through 328 kms of pipes and have a replacement cost in excess of $129 million.

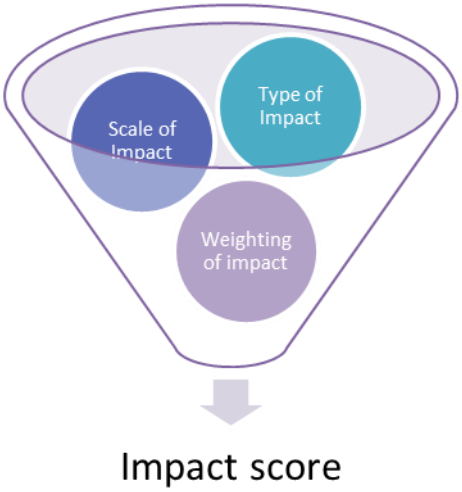
STORMWATER

The Council manages a network of natural streams, open drains, pipes, retention ponds bridges and culverts in the main urban areas of the District. The districts storm water assets include pipes, manholes, inlet and outlet structures, floodways, stopbanks, retention ponds, streams/open drains and soak pits not associated with direct road runoff.

There are c.211 kms of pipe serving the district with a replacement cost for storm water assets in excess of $72 million.

2.2.2 MEASURING THE IMPACT OF ASSET FAILURE

The impact score for an asset is made up of the type, scale and weighting of the various impacts associated with that asset.



In developing the impacts of asset failures the following assumptions were made:

- There may be multiple impacts from an asset failure.
- Relative impacts type weightings should be allocated based on the communities perception of the importance of these impacts because one or more impacts may occur.
- That environmental damage impacts the entire community because of the need for the entire community to bear responsibility for damage to the environment.

IMPACT TYPES

A spectrum approach was adopted for the assessment of the impacts of asset failure on people and the environment. Impact types were adopted to cover the broad range of potential impacts from individual failure events. These are aligned with corporate risk types such as economic and financial, political and reputation, Environmental, Public Health and Safety and can be integrated into broader risk management approaches based on AS/NZS ISO 31000:2009 Risk Management.

The impact types adopted for the framework include:

IMPACT SCALE AND DESCRIPTION

The level of impacts for each of the three waters were graded between 1 being minor and 5 being extreme and descriptions grades 1,3 and 5 developed as per the example for sewerage services

Impact Level	Impact Score	Impact					
		Sickness/Death	Property Damage	Nuisance	Loss of Income	Social Disruption	Environmental Harm
Extreme	5	Potential exposure to waterborne disease or toxins resulting in sickness that can lead to death or permanent organ damage in final treated wastewater effluent that is continuously discharged to water known to be used for recreational purposes and food collection. Complete lack of treatment barriers that remove or inactivate any contaminant known to be present at unacceptable levels in the effluent.	Permanent destruction of significant percentage of property or expenditure >$100,000.	Persistent complaints from consumer about ongoing exposure to noise, odour or appearance (includes corrosion)	Business disrupted for more than 1 week or income stopped for more than 1 week	Deny consumer access to wastewater that is used to maintain lifestyle and access to culture and recreation facilities	Permanent destruction of ecosystem and natural habitats that are of regional significance
	4						
Moderate	3	Intermittent discharge to watercourses or land of effluent that contains organisms or toxins that can result in sickness and even lead to death but at unacceptable levels. Partially effective treatment processes to lower level of contaminants	Damage to property that requires repairs or expenditure > $20,000	Persistent complaints from consumer about intermittent but frequent exposure to noise, odour or appearance (includes corrosion)	Business disrupted for more than 1 day	Limit/restrict consumer lifestyle and access to culture and recreation	Permanent destruction of ecosystems or habitat that is locally significant or partial destruction of ecosystem and natural habitats that are of regional significance
	2						
Minor	1	Full treatment provision to remove potential exposure to waterborne illness or toxic contamination at levels of health significance	Damage to property that results in repairs to small part of property (<$1000). Includes flooding of land that requires clean up expenditure from blocked sewers	Complaints about noise, odour, smell or appearance picked up through customer survey or complaints received as one-off issues	Business disrupted for up to 2 hours per day	Force changes/alternatives to maintain normal consumer lifestyle and access to culture and recreation.	Temporary or partial destruction of eco-system - habitat, vegetation that can be restored

Impact Scale Sewerage Services

below.

IMPACT WEIGHTINGS

Not all impact types are equal and therefore establishing a relative weighting between them is required. Ideally the weightings should be established through engagement with the community as it the communities values that should direct Council expenditure.

For the purposes of developing the initial framework weightings were established at the workshop and are shown in Table 1. They can be corroborated against other studies (such as Power and Water Corporation, Darwin) and other communities of interest where available.

Table 1 Impact type weightings – relative weightings based on initial internal assessment.

Impact	Kāpiti weighting	Comparative weighting Other studies
Public health and safety	1	1
Property damage	0.6	0.5
Nuisance	0.3	0.2
Loss of income	0.9	0.8
Social disruption	0.5	0.3

Environmental harm	0.2	0.2

2.2.3 Exposure weightings

Exposure refers to the population that is affected by an impact resulting from a service failure. Table 2 shows the exposure scale that was used for all impacts **other than environmental harm**. The resulting score is a function of the population affected and the percentage of the community that the affected population represents.

In considering environmental harm and its exposure we are interested in the "non-use" benefits to the community that arise from preventing environmental harm as opposed to the "use-benefits". The loss of use-benefits is covered under other impacts, namely loss of income and social disruption. A maximum exposure score can be applied to environmental impacts

Table 2 Exposure weighting matrix – showing the weighting for various populations and proportion of communities impacted

Population Affected	**Percentage of Community Affected**				
	5%	10%	30%	60%	100%
< 50	1	1.5	2	2.5	3
50 – 1,000	1.5	2	2.5	3	3.5
1,000 – 5,000	2	2.5	3	3.5	4
5,000 - 20,000	n/a	n/a	3.5	4	4.5
> 20,000	n/a	n/a	4	4.5	5

2.2.4 Criticality scoring process

Scoring the impacts and exposure for every individual asset one by one is clearly not practical. So assets were grouped and each impact type assessed using physical attributes as proxies. Examples of the scoring of water network assets for environmental damage and loss of income are shown in Figure 2 and Figure 3 on the following page.

An initial sanity check of the comparative scorings for various asset types was undertaken and a couple of examples are given below:

- Waikanae WTP clarifier 70.5
- Trunk main Waikanae WTP- Paraparaumu Reservoir 600mm 43.0
- Quadrant Heights service main 150mm 15.8
- Alexander Rd service main 100mm 10.5

Figure 2 Loss of income criticality scoring for water supply network assets

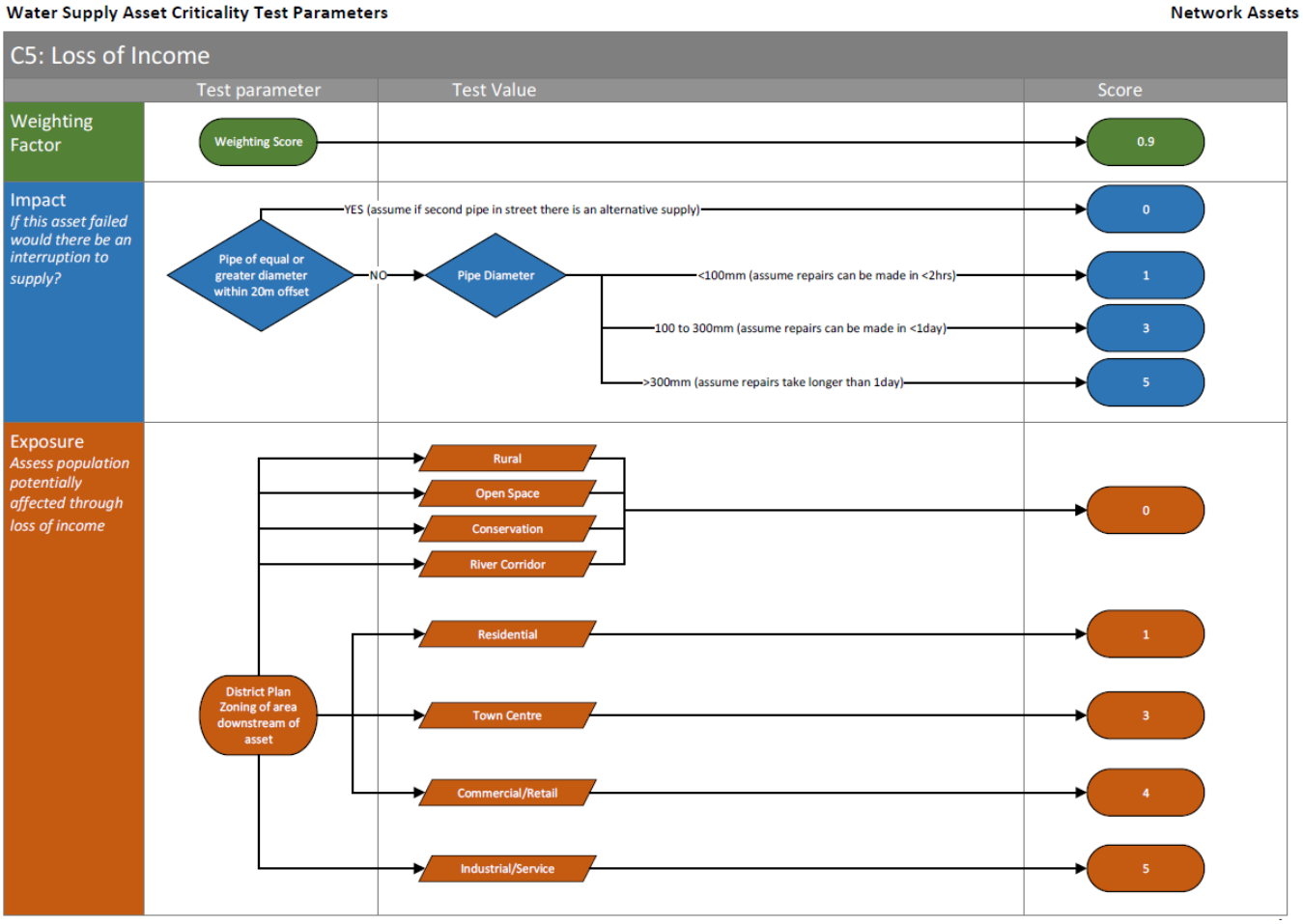
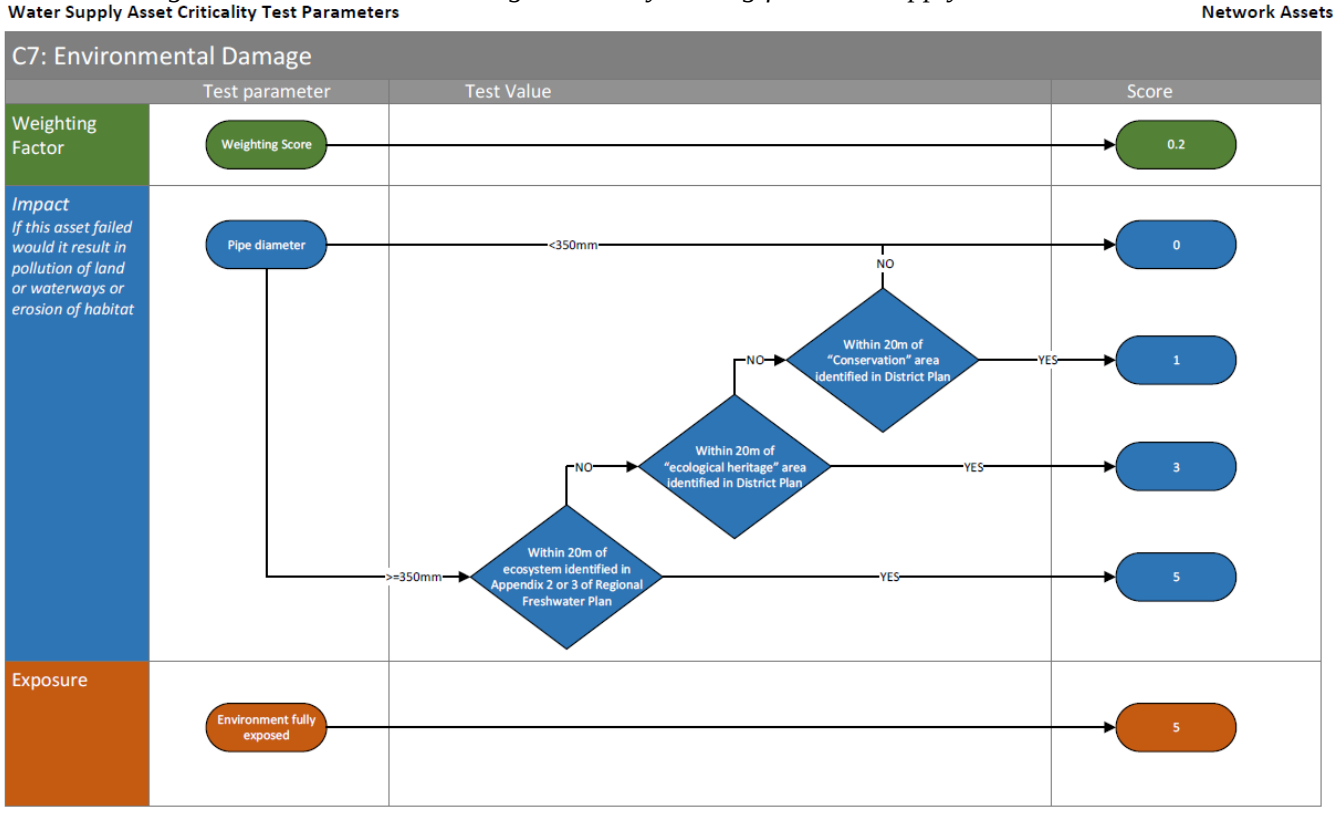
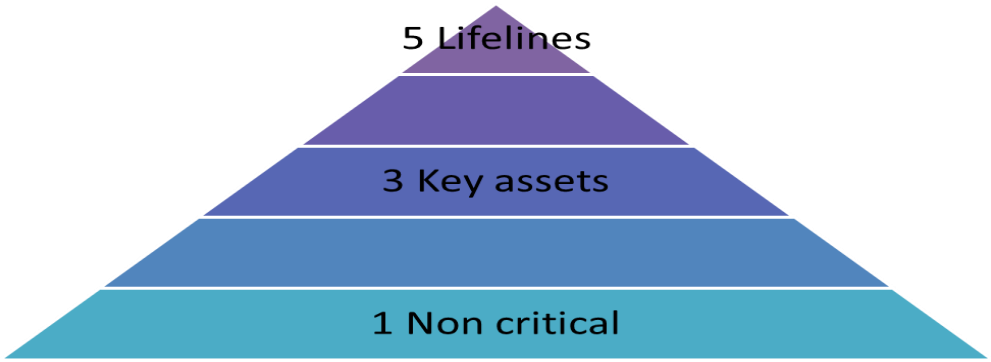


Figure 3 Environmental damage criticality scoring for water supply network assets



Scores are then normalised and classified from 5 to 1 with 5 being most critical lifeline assets and 1 non critical as shown in Figure 4.

Figure 4 Asset criticality classifications



2.3 THE PROCESS OF BUILDING A CRITICALITY FRAMEWORK

The criticality framework was developed through a combination of :

- a facilitated workshop
- initial criteria development and weighting exercises
- draft criticality scale and impact descriptor development and review
- the development and trialing of structured asset assessment guides
- the mapping and trialing of the test parameters.

2.3.1 THE WORKSHOP – DEFINING THE SCOPE

At the outset a workshop was held with the council's infrastructure staff facilitated by Rob Blakemore of Opus Consultants International. Staff responsible for delivering the three waters services from operations, asset planning and treatment were represented. The workshop was used to:

- share, clarify and align the meaning of criticality
- explore the potential applications of assigning criticality to assets
- agree on the definition of criticality
- agree on draft criticality impact descriptors
- discuss weightings for different impacts that determine criticality of an asset.

A discussion about what were viewed as critical assets gave examples such as:

- large wastewater pumping stations such as Mazengarb that delivers 25% of Parapapaumu wastewater to the treatment plant
- treatment plants (water and wastewater)
- trunk mains and rising mains (water and wastewater)
- Wharemaku stream that transports stormwater under SH1 and Coastlands shopping mall

Assets considered low criticality included :

- Leinster Ave wastewater pumping station that services two or three streets
- open stormwater drain through farmland
- water treatment sludge thickner.

2.3.2 CRITERIA DEVELOPMENT AND WEIGHTING EXERCISES

IMPACT WEIGHTINGS

The weighting of the various impact types is important in order to develop criticalities that reflect the underlying values of the community.

To develop initial weightings a facilitated exercise was conducted with the staff present at the workshop. The exercise set a hypothetical scenario which required participants to rank then apportion personal discretionary money to items that mitigated the various impact types in the framework.

The facilitation of the exercise required each participant to consider

- What they would choose as their priority to mitigate and how much would you be prepared to spend on it.
- How they would rank the remaining measures to avoid the various impacts
- How much they would be prepared to spend on each?

The averaged scorings came out consistent with the weighting of other utilities that have undertaken this exercise.

IMPACT SCALE AND DESCRIPTION

A draft of the impact scales and descriptors for water supply was prepared ahead of the workshop. The initial views of its structure and content were discussed to provide feedback prior to the development of drafts for all three waters. The draft scales were provided for review and feedback before the impact scoring guides were developed.

IMPACT SCORING GUIDES

The asset scoring was initially developed using asset assessment guides which were trialed on individual assets with an asset group. They provided a valuable understanding of how specific asset impacts could be scored and assisted with scoping the asset attributes that were used as proxies for the criticality tests. They also were used for a sanity check of the results against the “intuitive” assets criticalities identified in the workshop.

Following the initial scoring the test parameter diagrams were prepared as shown in Figure 2and Figure 3 to assist with structuring the GIS queries and asset criticality analysis.

3 DOING FIRST THINGS FIRST

The classification of an assets criticality is nothing new. The use of a systematic approach to assessing criticality provides consistency across all assets.

It is relatively easy to intuitively assess the comparative criticality of two assets against each other where only one or two variables are different.

A 150mm diameter water pipe supplying a purely residential area versus the same pipe supplying a residential area and small commercial centre.

Now introduce the fact that the first pipe is the sole feed to that community (higher exposure weighting) and its failure would have moderate effect on an ecological heritage area (increased environmental impact) while the second would cause flooding of homes and moderate damage (increased property damage impact).

The assessment becomes less intuitively clear cut as you consider the relative impacts of each variable and their cumulative criticality based on exposure. Personal bias begins to be introduced in the weighting and exposure components of the assessment.

The framework allows consistency in the application of the organisations values through the weightings and scale of the impacts through the exposure.

How does criticality assist us in delivering the service to the community and managing the risks? Each type of asset, from lifeline, key through to non-critical can be considered separately and different strategies applied to their operation, maintenance and management.

3.1 CRITICALITY CLASSIFICATIONS

3.1.1 LIFE LINES ASSETS (CRITICALITY GRADE 5)

These are the highest criticality assets that if they fail will cause the greatest impact to our community. They are fundamental to the service provided and are critical to the mitigation of impacts on the community. They warrant comprehensive management of all aspects of their lifecycle.

3.1.2 KEY ASSETS (CRITICALITY GRADE 4-3)

These assets are key to the service provided to the community. While not the highest criticality their failure would no doubt cause significant impact in our community. As a group they warrant specific management.

3.1.3 NON CRITICAL ASSETS (CRITICALITY GRADE 2-1)

These assets provide a function in the delivery of the service to the community. Their failure will have an impact in the community that is not insignificant. They should be included generally in considerations.

3.2 ASSET STRATEGIES

A summary of the various operation, maintenance and management strategies based on asset criticality are set out in Table 3. These are reflected in the asset management planning for future works programs.

Table 3 A summary of criticality based operational, maintenance and management strategies

Strategy	Lifeline	Key Assets	Non Critical
Performance data	Comprehensively understood	Well understood	Recorded as identified
Condition data	Comprehensively understood	Asset group representative	From information available
Monitoring and Inspections	High frequency	Scheduled periodically	Routine
Maintenance	Preventative regimes	Preventative routines	As required
Renewals	Advanced	Planned	Just in time

3.2.1 PERFORMANCE AND CONDITION DATA

The understanding of an assets performance against its requirements provides confidence that potentially significant impacts of their failure are being mitigated.

The understanding of an assets condition will allow the assessment of its ability to continue to deliver its function, the likelihood and mechanism of failure. The condition data may indicate an asset will fail catastrophically causing the full impact immediately or progressively leading to a decline in function over a period of time.

LIFELINE ASSETS

The performance of a lifeline asset should be comprehensively understood. A high degree of confidence is required in its ability to deliver its function and any specific deficiencies are identified and addressed. Where its performance is not well established it should be assessed as a matter of high priority.

A lifeline assets condition should be comprehensively understood as it may be at the point of failure or have many more years of reliable service left. Where the condition of a lifeline asset is unknown, not well known or understood then it should be assessed as a matter of high priority.

KEY ASSETS

The performance of key assets should be well understood to confirm their ability to deliver the required function and to identify any deficiencies that need to be addressed. Where their performance is not established it should be assessed as a matter of priority. An assessment of the key assets performance should be undertaken to establish any deficiencies against the duty requirements.

A representative of key assets condition will allow their general ability to continue to deliver their function, the likelihood and mechanism of failure to be assessed. Where the understanding of key asset condition is not representative then it should be assessed as a matter of priority.

NON CRITICAL ASSETS

Performance deficiencies reported should be recorded, investigated and resolved on a case by case basis. Where patterns of failures to perform are identified the history of adjacent assets performance should also be considered to determine if there is a wider issue.

In addition to opportunistic condition information captured during repairs and renewals lifeline and key asset condition information should be used to inform the assessment of non-critical asset condition.

3.2.2 MONITORING AND MAINTENANCE

Monitoring provides opportunities to confirm an assets operation and/or identify any faults or potential failures. The more frequent the monitoring the less the risk of a fault or failure going un-noticed and causing an impact. Monitoring can include performance metrics, inspections, testing and analysis.

Maintenance prevents and corrects faults and failures and maintains the operation of the asset. Preventative maintenance is proactive and maintains the correct operating conditions for an asset while corrective is typically reactive addressing the faults and failures that can cause loss of performance.

LIFELINE ASSETS

High levels of monitoring, inspection frequency set by performance reliability and preventative maintenance regimes should be established for Lifeline assets.

KEY ASSETS

Key assets should be monitored and inspection frequency scheduled and preventative maintenance routines.

NON CRITICAL ASSETS

Non critical assets should have routine inspections with preventative and corrective maintenance performed as required.

3.2.3 RENEWALS PLANNING

Renewals re-establish the performance and condition of an asset. Renewal can be considered where continued preventative maintenance is not appropriate or cost effective or operational performance is compromised by repeated corrective maintenance.

LIFELINE ASSETS

Lifeline assets are targeted for advanced renewal to maintain operational performance and minimize disruption to service during the renewal. Inspections provide information risks of performance deterioration in advance of asset fault or failure.

KEY ASSETS

Key asset renewals are scheduled based on the understanding of their performance and condition. This is reconfirmed closer to estimated renewal. This planned approach is used so optimal value of the assets life is achieved while reducing impact risk.

NON CRITICAL ASSETS

Non critical asset renewals are budgeted for using performance and condition understanding from gained from lifeline asset and key asset monitoring and opportunistic samples. Renewal timing is reviewed using operational records and failure information. This just in time approach is used so maximum value of the assets life is achieved.

4 KAIZEN – CONTINUOUS IMPROVEMENT

The framework identifies the linkages between the impacts and the attribute proxies used. It has the capability of being progressively improved by incremental refinement of the component processes. It is clear that assessing criticality is not something new to the water industry and local authorities apply some form process whenever considering expenditure prioritization. These maybe formal or informal, documented or not. This paper tables the work done in Kapiti on a criticality framework and invites others to use and contribute to this work to improve the outcome for the communities we service.

Criticality is only one half of the risk equation with likelihood representing the other. The development of an asset vulnerability framework presents the next step in improving prioritization processes.

4.1 AREAS IDENTIFIED FOR IMPROVEMENT

During the development of this framework a number of improvements were observed including:

- **Impact weightings** - To better understand and represent the communities values in the criticality process. Explore ways to engage the community on the development of impact weightings
- **Exposure weightings** - Sanity check exposure weightings against the geospatial population distribution
- **Impact scale descriptions** - Provide increased consistency with the organizational risk scale. Review and alignment of the impact scale descriptions with the councils risk framework and significance policy
- **Asset attribute proxies** - Improve the accuracy of the criticality scores. Review asset attributes used and scope data improvements and attribute proxy refinements
- **Automation -** Embed criticality in the asset management processes. Scope integration with asset management systems
- **Improving industry outcomes** - Reduce the cost and time of improvements by drawing on national experience. Share learnings with other local authorities

5 CONCLUSIONS

The Kāpiti Three Waters criticality framework provides a consistent approach to assessing the comparative impacts on people and the environment caused by the failure of an asset and loss of its function.

It provides a starting point for those that have not yet formalised their thinking on criticality and a framework for others that have to discuss, contribute to and build on. It has the structure and processes needed to develop an asset criticality model that can be used to improve the confidence and precision of expenditure prioritization and programming.

The use of facilitated workshops was particularly beneficial in the development of the framework as they provided opportunity to form a common understanding of framework terms and principles and find consensus in the setting and application of impact scales and weightings.

The framework will be used to prioritise inspections and investigations, refine maintenance and renewal strategies, identify high risk information gaps and increase confidence in timing and scale of capital expenditure.

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- Jamal Rautao, Engineering Cadet, Kapiti Coast District Council

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