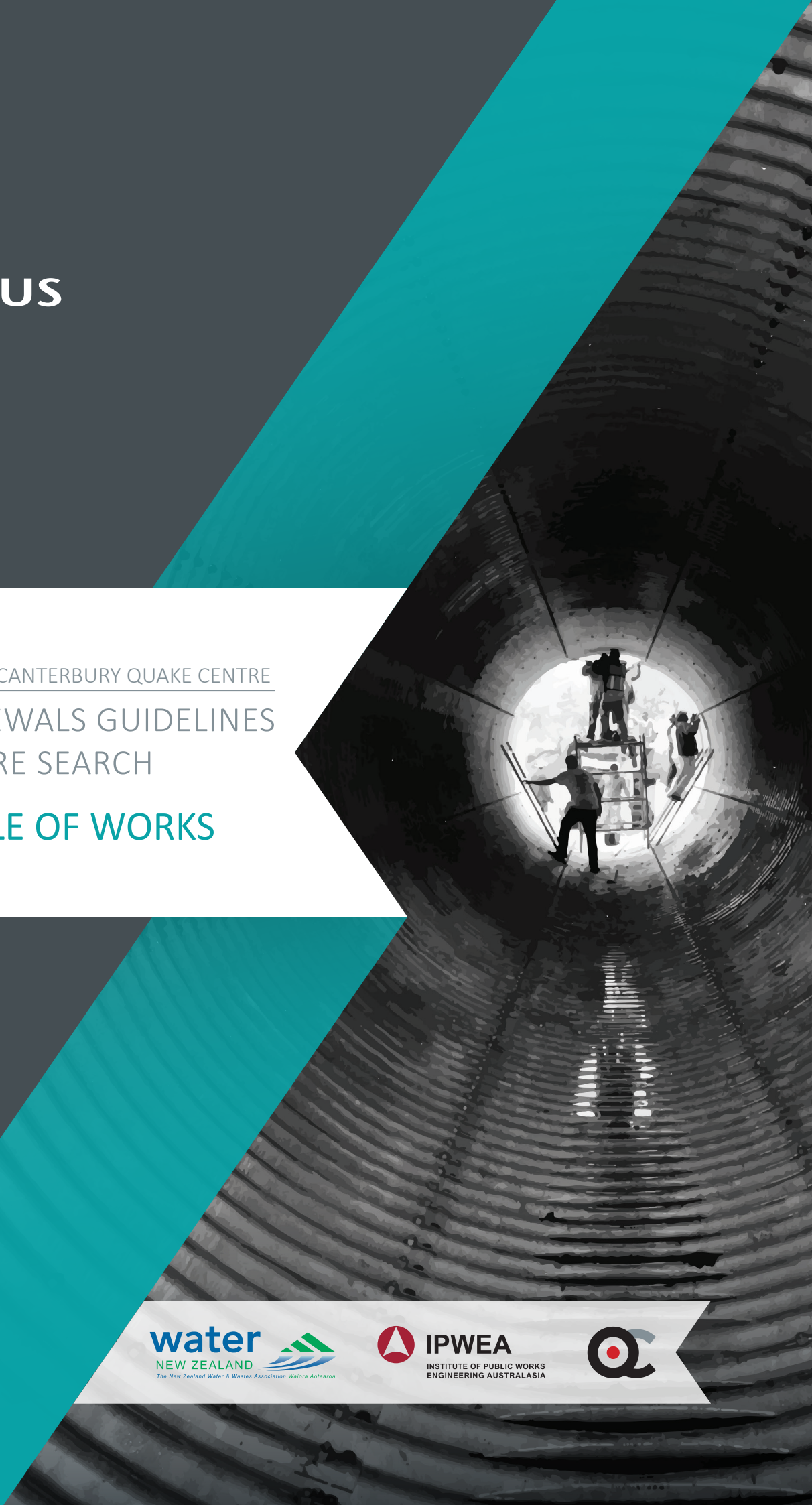
OPUS

UNIVERSITY OF CANTERBURY QUAKE CENTRE

PIPE RENEWALS GUIDELINES LITERATURE SEARCH

SCHEDULE OF WORKS



water NEW ZEALAND
The New Zealand Water & Wastes Association Waiora Aotearoa

IPWEA
INSTITUTE OF PUBLIC WORKS ENGINEERING AUSTRALASIA

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Executive Summary

The Pipe Renewals Guidelines Programme initiated by UC Quake Centre, IPWEA and Water New Zealand (Water NZ) will develop guidance documents and tools to enable New Zealand's water organisations to make evidence based decisions. The programme covers inspection, maintenance and renewal strategies for pipework in potable water, wastewater and stormwater systems.

The tools and guidance documents will form a framework that can be used in conjunction with the International Infrastructure Management Manual (IIMM) and the New Zealand Metadata to implement advanced asset management processes that produce investment strategies that optimise cost, risk and level of service. Organisations will be able to assess the implications of adopting alternative investment strategies and select the strategy that best suits the needs of their community.

UC Quake Centre hosted an initial workshop on 2 February 2016 which was attended by representatives from water organisations, contractors, consultants, suppliers and researchers. The attendees identified ten themes that provide a framework for the creation of guidance materials and tools. The 10 themes comprise of:

1. Strategy and Planning for Capacity and Growth (both positive and negative)
2. Levels of Service, Risk and Resilience
3. Pipe Criticality
4. Pipe Vulnerability
5. Pipe Inspection and Condition
6. Forecasting Remaining Pipe Life
7. Business Processes
8. Data management
9. Building Standards and Constructability
10. Life-cycle Cost of Pipes

Under this commission a stocktake of existing knowledge and practices has been prepared for each of these themes.

46 initiatives have been determined that could be completed over the next three years to close gaps in knowledge or practice. A description of each initiative is provided outlining what is required, why it is necessary and the recommended approach for developing the initiative.

A budget estimate has been prepared for each initiative. It is estimated that that the full framework will cost in the order of $4 mil to develop.

The framework developed through the Pipe Renewals Guidelines Programme will help organisations assess and manage future liabilities. Lessons learnt will be shared through the framework and specific research undertaken to improve the accuracy of forecasts.

If even a small percentage of the possible renewals cost can be saved by a better understanding of the renewals process, this would amount to many millions of dollars that may be invested more productively

Introduction

Pipe Renewals Guidelines Programme

The Pipe Renewals Guidelines Programme initiated by UC Quake Centre, IPWEA and Water New Zealand (Water NZ) will develop guidance documents and tools to enable New Zealand's water organisations to make evidence based decisions. The programme covers inspection, maintenance and renewal strategies for pipework in potable water, wastewater and stormwater systems.

The tools and guidance documents will form a framework that can be used in conjunction with the International Infrastructure Management Manual (IIMM) to implement advanced asset management processes that produce investment strategies that optimise cost, risk and level of service. Organisations will be able to assess the implications of adopting alternative investment strategies and select the strategy that best suits the needs of their community.

The framework will help organisations assess and manage future liabilities. Lessons learnt will be shared through the framework and specific research undertaken to improve the accuracy of forecasts.

The programme will initially focus on pipework assets as they make up the largest proportion of water systems, but it is intended that over time the scope will be extended to other assets.

The programme is adopting the following key principles:

- Develop a common framework and analysis methods that can be applied consistently across New Zealand, but allow organisations to adopt different investment strategies to suit the differing needs of their communities.
- Do not reinvent the wheel. Use existing guidance documents wherever possible.

Framework themes

Quake Centre hosted an initial workshop on 2 February 2016 which was attended by representatives from water organisations, contractors, consultants, suppliers and researchers. Appendix A includes a summary of the workshop findings. The attendees identified ten themes that provide a framework for the creation of guidance materials and tools. The 10 themes comprise of:

1. Strategy and Planning for Capacity and Growth (both positive and negative)
2. Levels of Service, Risk and Resilience
3. Pipe Criticality
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This Work Package

This work package provides an initial roadmap for the development of the framework for the Pipe Renewal Guidelines. This will help shape discussion on the best way to deliver the framework. The outputs from this work package will form the basis of a business case for the development of the Pipe Renewals Guidelines.

This work package will provide the following specific outputs:

- An inventory of relevant New Zealand and overseas literature that can be used to inform the development of the NZ Pipe Renewals Guidelines
- Mapping the available literature to the framework developed at the Pipe Renewals workshop
- An estimate of the hours needed to develop the individual guidance documents
- Identification of areas that will need further research before guidance can be developed.
- Identification of any other resources, projects or research activity that may be applicable to the Renewals project.

Background

The Need and Context

New Zealand's water, wastewater and stormwater networks play a major role in shaping our communities. The National Infrastructure Unit (New Zealand Government, 2011) notes that these networks "contribute to healthy and safe communities, promote the social, economic, environmental and cultural well-being of those communities, and provide a competitive advantage for New Zealand's primary producers and industries".

In 2014, the total replacement value of the 3 waters assets in New Zealand was estimated to be about NZ$45.2 billion. The wastewater network had the highest replacement value at around NZ$17.8 billion, followed by drinking water assets at NZ$16.2 billion and storm water at NZ$11.2 billion. Many of these assets are nearing the end of their design lives and might need to be replaced in the next couple of decades.

There is a disconnect between renewals expenditure and the amount that local authorities are depreciating. The Auditor General identified (Office of the Auditor-General, 2014) that during the period between 2007 to 2013, local authorities consistently spent less than they intended on capital works (3waters and roading) , including on asset renewals. If actual spending trends continue to match those forecast, they estimate that, by 2022, the gap between asset renewals expenditure and depreciation for the local government sector could be between $6 billion and $7 billion.

This raises the question are New Zealand communities going to be faced with significant liabilities in future to renew assets or currently are water assets being over depreciated.

In addition population changes will affect demand for, and the affordability of, the services provided by infrastructure assets (Office of the Auditor-General, 2014).

If even a small percentage of the possible renewals cost can be saved by a better understanding of the renewals process, this would amount to many millions of dollars that may be invested more productively elsewhere.

It is the Auditor General's view that, "the evidence base for good decision-making and learning is not consistently available. However, it needs to be. Local authorities need to build their capability to use their information and systems to get the best performance from their asset networks. They need to understand how assets perform throughout their lives to know the points at which and whether to maintain, renew, or replace individual asset parts."

Local Government New Zealand highlighted (Castalia Strategic Advisors, 2014) that Councils are investing significant resources in trying to address this challenge – each operating in independent silos and not taking advantage of a shared approach. Whilst there are a number of guidance documents available such as the International Infrastructure Management Manual these outline generic management approaches. There is a need for guidance and tools specifically developed for water assets that move the discussion from general process to implementation.

Although local authorities tend to have a lot of data, they do not necessarily use it well, or use the best data, to support decision-making. Good information is built from data that:

- has consistent definitions and metadata, and is high quality;
- is used to look at trends and to compare organisations and jurisdictions; and
- is studied alongside other sets of information to identify wider implications and needs. (Office of the Auditor-General, 2014)

A significant amount of data is available from SCIRT on the Christchurch water systems. This is currently being analysed to gain learnings on how to improve the seismic resilience of water systems, but it can also provide valuable learnings on business as usual renewal requirements.

A combination of the following is required to enable available data to be used for evidence based decision making to improve the management of our 3Waters networks, refer Figure 1:

- Metadata standards to provide data consistency so that data can be shared, aggregated and analysed to identify trends.
- Data analytics to predict future conditions and to assess various intervention strategies.
- Asset management processes that provide a decision making framework that links assets and investment decisions with the provision of community outcomes.

The Pipe Renewals Guidelines Programme will concentrate on the analysis of data to improve the understanding of the behaviour of pipelines, the development of analytics to predict future situations and the development of an asset management framework specifically tailored to water pipelines.

The programme will integrate with the LINZ Metadata programme which is outlined below and existing asset management practices such as the International Infrastructure Management Manual and ISO55000.

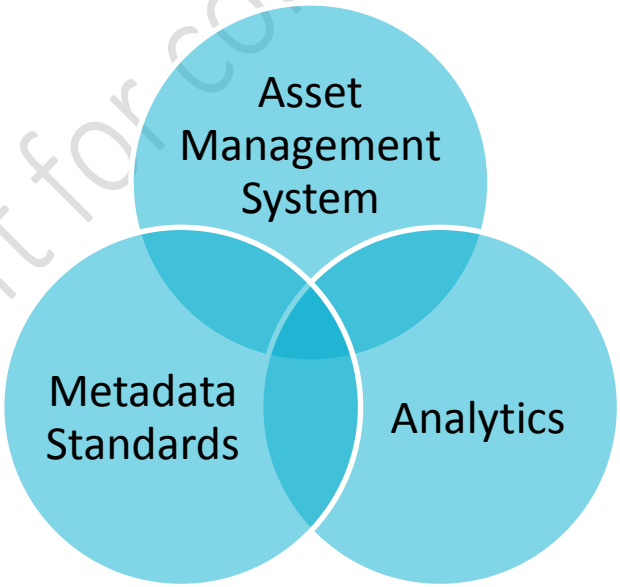

Figure 1 Requirements for Improved Management of 3Waters Networks

Metadata Standards Project

MBIE & LINZ are implementing a project to explore the implementation of shared data standards (Metadata Standards) for water infrastructure and built assets (buildings). This is linked to a separate roading initiative.

Metadata standards will provide data consistency. They will enable data to be shared, aggregated and analysed in more detail than is currently possible.

Figure 2 shows the global metadata schemata and how the standards sit in context with the wider asset management framework. Each layer has a role in the development of an integrated, learning asset management environment as described below. Volumes 1 & 2 are being drafted under the Metadata project. The Pipeline Renewals Programme will contribute to Volumes 3, 4 & 5.

As-constructed / As-built Asset Metadata Standard (Volume 1)

This standard describes the data to be captured on the creation of a new asset, at an assetID (component) level. The data at this level has three attributes that define the characteristics of the asset:

- physical (for example, material or diameter)
- metadata (for example, date of construction or builder)
- asset management (for example, condition of the asset). These are summary attributes the full schemas for each attribute are defined within the Asset Management Metadata Standard (Volume 2).

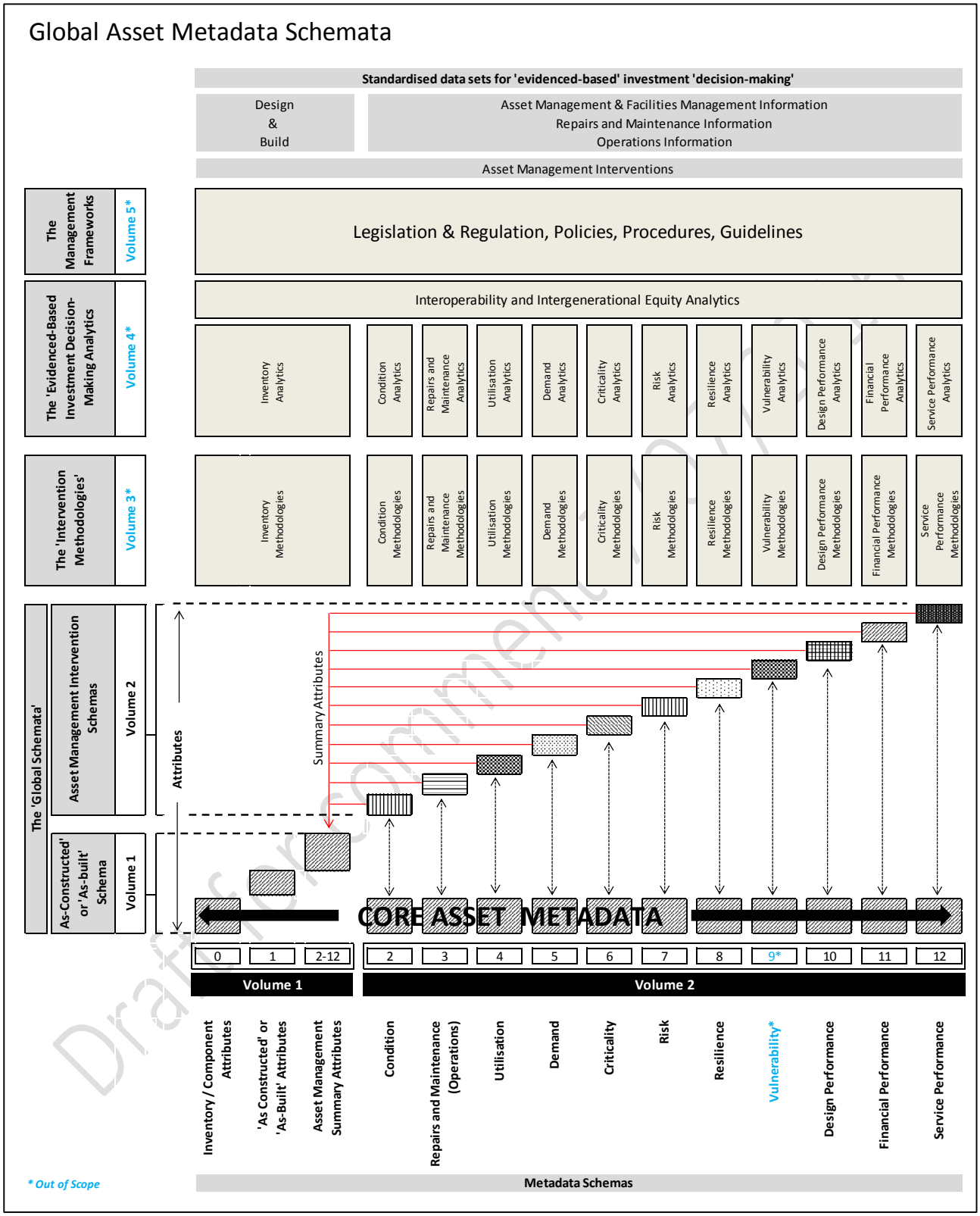

Figure 2 Global Asset metadata Schemata

Asset Management Metadata Standard (Volume 2)

This standard describes the decision elements required for making evidenced-based investment decisions. The elements are defined as:

- condition: the physical state of the asset, which may or may not affect its ability to deliver the service designed to perform
- repairs, maintenance and operations: activities undertaken to ensure the asset continues to deliver its intended design performance
- utilisation: the proportion of an asset's available capacity being used
- demand: the call on an asset's capacity at any given time
- criticality: the significance of the removal of any individual component or asset on the ability of any part of a network or portfolio to deliver the service it was designed to perform
- risk: the potential to gain or lose something of value, that is, the probability or threat of quantifiable damage, injury, liability, loss, or any other negative occurrence caused by external or internal vulnerabilities, and that may be avoided through pre-emptive action
- resilience: the potential disruption of an asset to deliver the service as intended in the design
- vulnerability
- design performance: an asset's ability to deliver the service within the functional limits as intended in the design
- financial performance: an asset's ability to deliver the service within the financial limits as intended in the design
- service performance: an asset's ability to deliver the service within the levels of service limits as intended in the design.

Each element is required to inform investment decisions in public sector assets – whether for operational investment (for example, prioritising a work programme for condition assessments) or a capital investment programme for renewals (for example, the replacement of water main pipes).

Intervention Methodologies (Volume 3)

This volume will describe intervention methodologies to determine the current state and performance of assets. For example Volume 3 will describe methodologies for determining the condition of pipelines.

Evidenced-based Investment Decision-making Analytics (Volume 4)

This volume will include analytical methods to predict the condition and performance of assets, to determine when and where to undertake the interventions described in Volume 3 and to assess the implications of adopting alternative investment strategies with regard to cost, risk and level of service.

Alignment of Framework Themes with Metadata Standard Schema

Figure 3 shows how the framework themes for the Pipeline Renewals Guidelines align with the Metadata Standards schema.

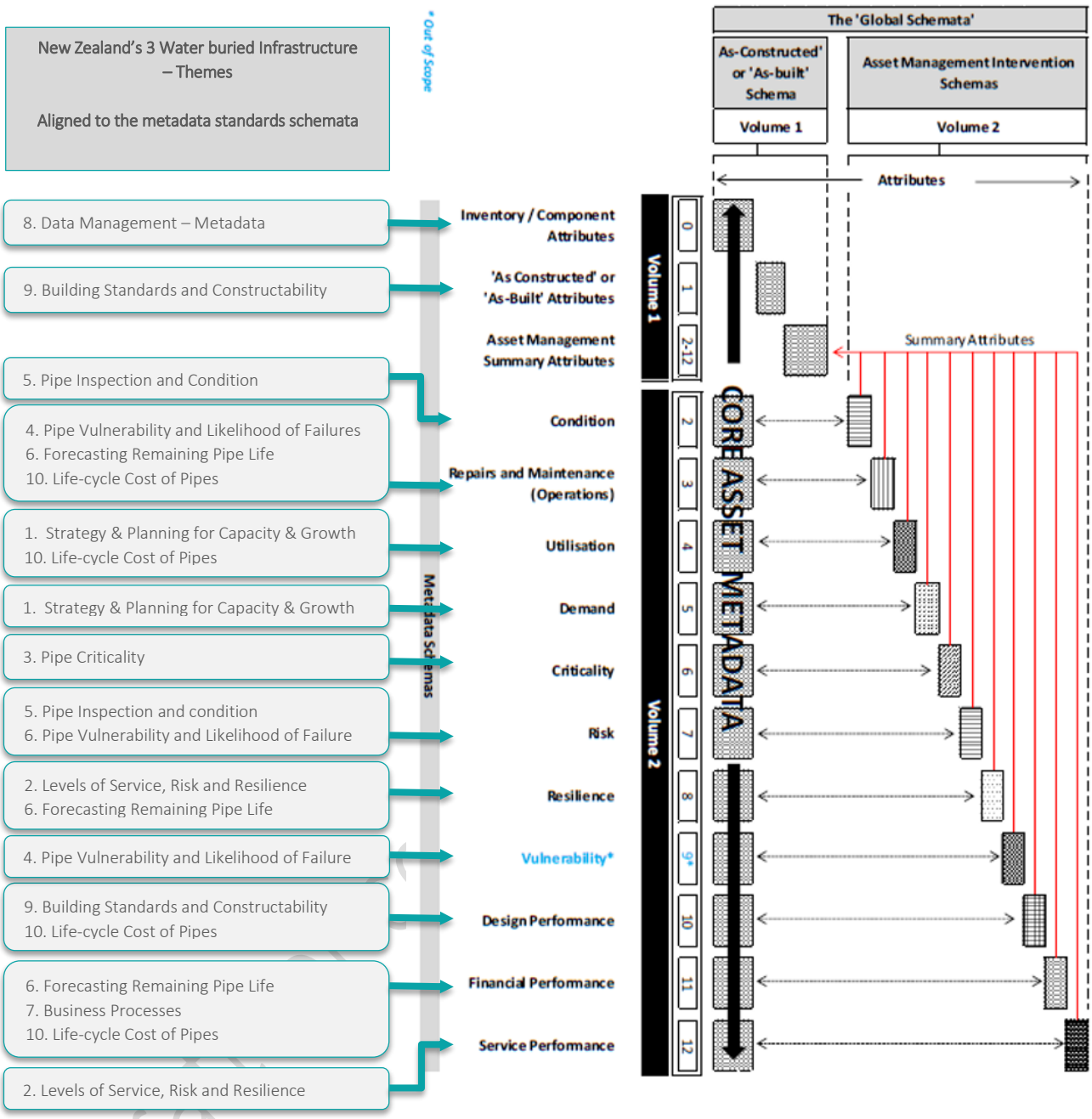

Figure 3 Alignment of Framework Themes with Metadata Standard Schema

Remaining asset life

A key component of the Pipe Renewals Guidelines will be providing tools and guidance to predict of the optimum time to replace assets.

Conceptually the optimum time to replace an asset is when it fails to meet one of following tests:

1. End of physical life - When the asset is physically derelict, i.e. the asset has failed to the extent it can no longer meet its intended purpose and repair is not practical.
2. End of economic life - The cost of retaining the asset in service is no longer cheaper than replacing the asset. Lost revenue should be considered when determining cost e.g. lost revenue from under recording water meters. System costs should also be considered e.g. on a watermain, the cost of producing water lost through leakage should considered as well as repair cost.
3. End of service life - When at least one of the following conditions apply:
    - Asset does not provide required level of service
    - Risk of failure is above tolerable levels
    - Demand on the asset exceeds capacity, i.e. utilisation exceeds 100%
    - Asset becomes obsolete, e.g. a pipeline needs to be replaced due to road reprofiling.

The Implementation Plan

Stocktake of Existing Knowledge & Practice

A stocktake of existing knowledge and practices has been completed. Reports on each of the framework themes are contained in Appendix B. The reports summarise:

- Current knowledge – the reports record policies, guidelines and other tools that are available in New Zealand, Australia and elsewhere in the world
- Experts and leading practitioners in New Zealand
- Gaps in knowledge and practices
- Activities required to close these gaps and why it is important to do so.

Innitiatives Already Underway

The following initiatives that will add to existing knowledge and practice are already underway:

1. Seismic Response of Buried Utilities being prepared by Opus Research. The guidelines being prepared as part of this research project will enable asset managers to:
    - Identify the sections of networks that are vulnerable to damage, to assess the amount of damage likely to occur and estimate the level of service expected after an earthquake
    - Identify measures to improve resilience of existing networks. This includes the development of response plans and capital works to improve the robustness and redundancy of the system and to make it easier to restore service after an event. Direction is given on how to incorporate these activities into asset management planning
    - Determine how to restore a network following an earthquake and to assess the long-term implications of the damage sustained
    - Design and install new utilities that provide an acceptable level of resilience

2. Update of the National Asbestos Cement Pressure Pipe Manual, being prepared by Opus International Consultants. These guidelines will assist asset managers with understanding the likely condition and remaining life of asbestos cement pressure pipes. The guidelines also specify methodologies for pipe sampling and condition assessment. Use of these methodologies will ensure that assessments are consistent and repeatable. This will enable the information collected to aggregated so that national trends can be identified.
3. Update of the New Zealand Pipe Inspection Manual, being prepared by ProjectMax Ltd. This manual will update practices for assessing the condition of gravity pipelines using CCTV and other inspection manuals. The scoring system for assigning condition grades will be updated so that the grades are aligned with those defined in the Metadata Standards.

Further Improvements

Figure 4 sets out a roadmap for implementing the improvements in knowledge and practice identified from the stocktakes in Appendix B. 46 initiatives have been identified that could be completed over the next three years. These initiatives have been prioritised and the linkages and dependencies between the initiatives are shown.

A budget estimate has been prepared for each initiative. It is estimated that that the full framework will cost in the order of $4 mil to develop.

A description of each initiative is also provided in the section after the budget estimate. The descriptions outline what is required, why it is necessary and the recommended approach for developing the initiative.

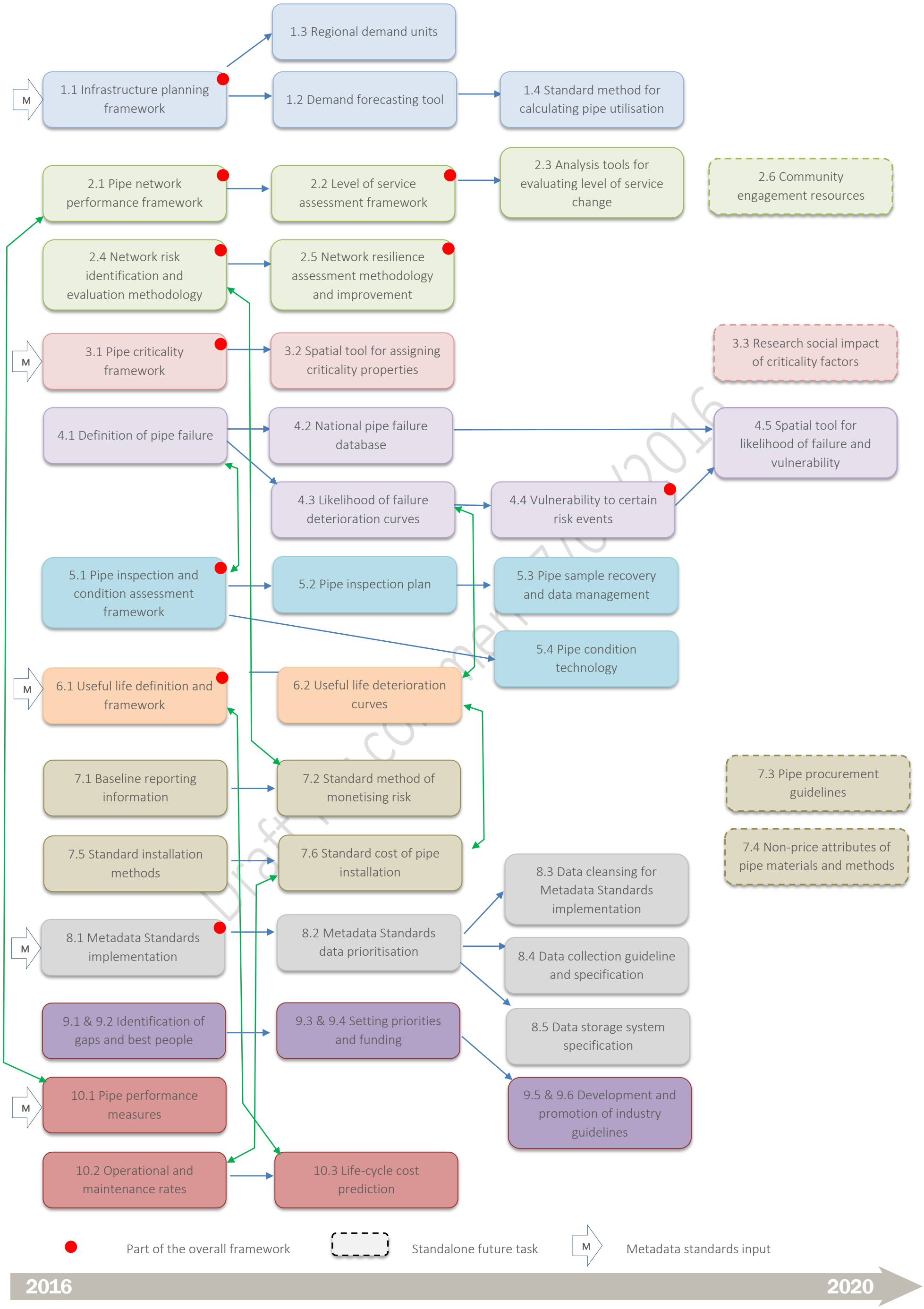

Figure 4 Implementation Roadmap

Budget Estimate

Implementation Cost $ (,000)	
Year 1 (2016-17)	**1,140**
Year 2 (2017-18)	**2,430**
Year 3 (2018-19)	**320**
Year 4 (2019-20)	**135**
Total Plan	**4,025**

PROJECT NO.	THEME	TITLE	RELATED TASKS		WHO	TIMING		YEAR	PRIORITY	FEE ESTIMATE $ (,000)
			INPUT	FUTURE		DURATION	START-DATE			
1.1	*Strategy & Planning*	*Infrastructure Planning Framework*	*Metadata*		*Consultant*	*6 mths+*	*Sep-16*	*1*		*150*
1.2	*Strategy & Planning*	*Demand Forecasting Tool*	*1.1*	*1.3, 1.4*	*Consultant*	*12 mths*	*Sep-16*	*2*		*150*
1.3	*Strategy & Planning*	*Regional Demand Units*	*1.1, 1.2, 1.4*	*1.1, 1.2*	*Research*	*18 mths*		*2*		*250*
1.4	*Strategy & Planning*	*Standard Method for Calculating Current and Future Pipe Utilisation*	*1.1, 1.2*		*Consultant - Opus*			*2*		*35*
2.1	*Level of Service*	*Pipe Network Performance Framework*		*2.2, 2.3, 2.6*		*3 months*		*1*		*50*
2.2	*Level of Service*	*Level of Service Assessment Framework*	*2.1, 2.4, 2.5*	*2.3, 2.6*		*12 months*		*2*		*100*
2.3	*Level of Service*	*Analysis Tool for Evaluating Level of Service Change*	*2.2*	*2.6*		*12 months*		*3*		*100*
2.4	*Level of Service*	*Network Risk Identification and Evaluation Methodology*		*2.2*		*3 months*		*1*		*50*
2.5	*Level of Service*	*Network Resilience Assessment Methodology and Improvement Opportunities*		*2.2*		*6 months*		*2*		*100*
2.6	*Level of Service*	*Community Engagement Resources*	*2.1, 2.2, 2.3 2.4, 2.5*			*6 months*		*4*		*75*
3.1	*Criticality*	*Criticality definition review*	*Metadata*	*Criticality/Risk*	*Consultant*	*1 mths*	*Sep-16*	*1*		*5*
3.2	*Criticality*	*Methodology for applying criticality*	*Metadata*	*Criticality/Risk*	*Consultant*	*3 mths*	*Nov-16*	*2*		*30*
3.3	*Criticality*	*Spatial tool for assigning criticality properties*	*3.2*		*Consultant*	*6 mths*	*Feb-17*	*2*		*60*
3.4	*Criticality*	*Research criticality factors with respect to social impacts*	*Criticality*	*Criticality/LoS*	*Research*	*12 mths*	*Feb-17*	*3*		*100*
4.1	*Pipe Vulnerability*	*Definition of pipe failure*	*Metadata, industry*	*Vulnerability*	*Consultant*	*2 mths*	*Sep-16*	*1*		*10*

4.2	*Pipe Vulnerability*	*National pipe failure database*	*Metadata, Vulnerability*	*Vulnerability, Risk, Useful life*	*Industry (Water NZ?), ICT Consultant*	*12 mths*	*Sep-16*	*2*		*120*
4.3	*Pipe Vulnerability*	*Likelihood of failure deterioration curves*	*Useful life, Life-cycle costing of pipes*	*Useful life, Life-cycle costing*	*Consultant*	*12 mths*	*Feb-17*	*2*		*150*
4.4	*Pipe Vulnerability*	*Vulnerability to certain risk events*	*Risk, Condition*	*Likelihood of failure*	*Research*	*12 mths*	*Feb-17*	*3*		*120*
4.5	*Pipe Vulnerability*	*Spatial tool for assigning vulnerability and likelihood of failure*	*4.3, 4.4*		*Consultant*	*6 mths*	*Sep-17*	*4*		*60*
5.1	*Pipe Inspection & Condition*	*Pipe Inspection and Condition Assessment Framework*		*5.2*	*Consultant – Opus, ProjectMax*	*6 mths*	*Oct-16*	*1*		*75*
5.2	*Pipe Inspection & Condition*	*Pipe Inspection Plan*	*5.1, 5.2*	*5.3*	*Consultant - Opus*	*4 mths*	*Feb-17*	*2*		*40*
5.3	*Pipe Inspection & Condition*	*Pipe Sample Recovery and Data Management*	*5.1, 5.2 , 5.3*		*Consultant - Opus*	*5 mths*	*Nov-16*	*2*		*65*
5.4	*Pipe Inspection & Condition*	*Pipe Condition Technology*	*5.1, 5.2*	*5.1*	*Consultant – Opus, ProjectMax, Industry – Detection Services, Research*	*9 mths*	*Feb-17*	*2*		*60*
6.1	*Forecasting Remaining Useful Life*	*Definition of useful life*	*Metadata, industry*	*Useful life*	*Consultant*	*2 mths*	*Feb-17*	*1*		*10*
6.2	*Forecasting Remaining Useful Life*	*Standard framework for application of remaining useful life*	*6.1*	*Useful life*	*Financial/ asset management research*	*9 mths*	*Apr-17*	*1*		*60*
6.3	*Forecasting Remaining Useful Life*	*Useful life deterioration curves*	*Likelihood of failure, Life-cycle costing of pipes*	*Useful life, Life-cycle costing*	*Consultant*	*12 mths*	*Feb-17*	*2*		*150*
7.1	*Business Processes*	*Baseline reporting information*	*Industry*		*Industry*	*4 mths*	*Feb-17*	*1*		*30*
7.2	*Business Processes*	*Standard method of monetising risk*	*Useful life, Metadata standards*		*Research*	*9 mths*	*Apr-17*	*2*		*60*
7.3	*Business Processes*	*Pipe procurement guidelines*			*Industry*	*6 mths*	*Sep-16*	*1*		*60*

7.4	*Business Processes*	*Non-price attributes of pipe materials and methods*			*Industry*	*6 mths*	*Sep-17*	*1*		*60*
7.5	*Business Processes*	*Standard installation methods*			*Consultant, Industry*	*6 mths*	*Sep-16*	*1*		*60*
7.6	*Business Processes*	*Standard cost of pipe installation*	*7.5*		*Consultant, Industry*	*6 mths*	*Apr-17*	*2*		*60*
8.1	*Data Management*	*Metadata Standards Implementation*	*Metadata, 8.2*	*8.3, 8.4*	*Consultant - Opus*	*6 mths*	*Sep-16*	*1*		*150*
8.2	*Data Management*	*Metadata Data Prioritisation*			*Consultant - Opus*	*4 mth*		*2*		*40*
8.3	*Data Management*	*Data Cleansing for Metadata Implementation*			*Consultant - Opus*	*24+ mths*	*Jun-17*	*2*		*600*
8.4	*Data Management*	*Data Collection Guideline (s) and Specification (s)*			*Consultant*			*2*		*60*
8.5	*Data Management*	*Data Storage System Specification (s)*	*8.1, 8.2, 8.3, 8.4*		*Consultant*	*9mths*	*Jul-17*	*2*		*100*
9.1	*Building Standards & Constructability*	*Identification of Best People*			*Consultant*	*1 mths*	*Sep-16*	*1*		*15*
9.2	*Building Standards & Constructability*	*Identification of Gaps*			*Consultant*	*1 mths*	*Oct-16*	*1*		*30*
9.3	*Building Standards & Constructability*	*Setting Priorities*			*Consultant*	*1 mths*	*Nov-16*	*1*		*30*
9.4	*Building Standards & Constructability*	*Gain Funding for Identified Actions*			*Consultant*	*1 mths*	*Dec-16*	*1*		*20*
9.5	*Building Standards & Constructability*	*Development of Draft Industry Guidelines*			*Consultant*	*3 mths*	*Jan-17*	*1*		*150*
9.6	*Building Standards & Constructability*	*Development and Promotion of Industry Guidelines*			*Consultant*	*9 mths*	*Apr-17*	*1*		*50*
10.1	*Life-Cycle Cost of Pipes*	*Pipe Performance Measures*			*Consultant*	*4 mths*	*Oct-16*	*1*		*75*
10.2	*Life-Cycle Cost of Pipes*	*Operational and Maintence Rates*	*10.1*	*10.3*	*Research*	*12 mths*	*Jan-17*	*2*		*100*
10.3	*Life-Cycle Cost of Pipes*	*Life-Cycle Cost Prediction*	*10.1, 10.2*	*10.2*	*Consultant*	*9mths*	*Sep-17*	*2*		*100*

Task Plans

Strategy and Planning (1)

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
1.1	*Infrastructure Planning Framework*	Metadata		Consultant	6 mths+	Sep-16	100-150k
What	The development of an overarching framework for the planning of three waters services. The framework will map out a consistent approach to manging three waters pipes with guidance on tools available, when and how these should be applied. The primary purpose of the framework is to facilitate strategic thinking in the planning process and to ensure these services are appropriately managed. The framework will be a live document that will be updated as projects are delivered.						
Why	Properly managed three water services are essential for the protection of public health and ensuring the well-being of communities, as well as safeguarding the environment. An Infrastructure Planning Framework is required to ensure implementation of best practice and to minimise risk, it will support the implementation of the Metadata Standards Project Volume 1.						
Approach	• Outline the requirements of an Infrastructure Planning Framework; what should this look like, what do we currently do, what information is currently available within New Zealand and internationally (refer to documents identified as part of literature search), gap assessment – where do we want to be versus where we are now • Develop a framework to: ○ Identify service needs in the short and long term in order to deliver service standards, social, environmental and financial outcomes ○ Evaluate options for delivering defined outcomes ○ Establish the optimal strategy that delivers the defined outcomes for the community ○ Provides a clear and robust outcome of the planning process to key stakeholders						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
1.2	*Demand Forecasting Tool*	1.1	1.3, 1.4	Consultant	12 mths	Sep-16	150
What	The development of a demand forecasting tool to support informed infrastructure and financial planning. The tool will provide a consistent approach to land based development (bottom-up) and future growth predications (top-down) with the use of standard demand profiles and peaking factors to accurately predict future demand. The tool will consider factors which influence demand and how these can be applied as variables for different regions and drivers i.e. climate change – demand management approaches, environmental regulation/policy regional						
Why	The implications of demand and strategies to manage demand must be considered, notably in the equitable allocation of supplies between future and current users, between current social groups, and the needs of the environment. To provide a consistent approach to managing the impact of (±) demand on communities, providing accurate robust demand forecasts that supports the timely investment of new infrastructure.						
Approach	• Set out the requirements/functions for a demand forecasting tool; how will it remain live/ updated, agreement on future population forecasts – method (national/local) • Identify and review demand forecasting tools/approaches used within the New Zealand market and internationally • Adopt a spatial approach with GIS /spatial tools with current and future customer points represented • Identify what land use types are required for planning and develop standard demand profiles/hydrograph for land use type and design peaking factors for different demand scenarios						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$

	• The demand forecasting tool should:
	  ○ Consider an integrated method of land use planning with demand forecasting at a spatial level
	  ○ Account for factors that influence demand particularly within different regions and demand management strategies
	  ○ Forecast uncertainty to quantify risks
	• Tool to include; testing, documentation, training, maintenance/updating						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
1.3	*Regional Demand Units*	1.1, 1.2, 1.4	1.1, 1.2	Research	18 mths		250k
What	Research water and wastewater usage for different land use types determining the sensitivity, weighting of different land use categories for regions of New Zealand. Develop localised demand conversion rates for all land use categories to improve the prediction for local regions that will better inform infrastructure and financial planning.						
Why	Improve the accuracy of demand predictions that represent local conditions and factors to make better infrastructure and financial decisions						
Approach	• Test and review demand forecasting tool (1.2) • Review type of land use categories and establish a standard reference system (SIC Code) for land use i.e. Hotels – ID:1234 • Collate and evaluate raw demand/flow/water meter readings for determining standard/regional profiles – New Zealand wide • Generate diurnal profiles for different land use categories i.e. residential, commercial, Industrial, rural , etc.. This could be regional, urban/rural based. Consider, rainfall, temperature, climate changes etc. • Determine method to calculate future peak day demand (outdoor use) based on region, considering building/property size and use, soil type (moisture index?) • Generate standard water and sewerage demand conversion rates to calculate water supply demand and sewerage discharge loads for different land use categories i.e. motel versus hotel						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
1.4	*Standard Method for Calculating Current and Future Pipe Utilisation*	1.1, 1.2		Consultant - Opus			35k
What	Develop a standard method to calculating pipe utilisation with the application of hydraulic models. The standard will include a specification to ensure hydraulic models are appropriate and fit for purpose with a consistent approach to master (infrastructure) planning.						
Why	Provides a standard approach to assessing the capacity of a pipe which feeds into the determination of remaining life, providing guidance for replacement or measures to reduce demand.						
Approach	• Define what is meant by utilisation and how this should be measured – Reference Metadata Standards • Review current methods for estimating pipe utilisation; what methods, accuracy, frequency applied (updated)						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$

	• Define key demand planning parameters and peaking factors
	• Review and update the 3Water NZ modelling guidelines in respect to:
	  ○ Specification – Model build, demand and calibration, model maintenance, application of model
	  ○ Infrastructure (Master) Planning – Demand modelling (Current/future (30-50+yrs), planning horizons
	• Develop a standard to set the rules and reporting method to calculate pipe utilisation for current and future demand						

Level of Service, Risk and Resilience (2)

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
2.1	*Pipe Network Performance Framework*		2.2, 2.3, 2.6		3 months		$50k
What	Establish a framework of customer facing performance measures that will reflect pipe network investment decisions						
Why	To provide a common platform for establishing performance objectives, reporting current performance, guiding investment planning (to address performance shortfalls) and reviewing objectives (to align with budgetary constraints						
Approach	• Review existing performance measures used in the NZ (and international) water industry and establish a suite of proposed measures for development and adoption. Consider inclusion of network resilience (requires definition) as a performance measure. • Research relationships between pipe network condition, performance and criticality factors and service delivery performance • Identify mechanisms by which pipe network investment decisions influence different aspects of performance and select a group of the more significant measures (noting that this • Revise, refine and consult on the measures with respect to industry acceptance and customer relevance						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
2.2	*Level of Service Assessment Framework*	2.1, 2.4, 2.5	2.3, 2.6		12 months		$100k
What	Establish measurement scales (eg 1 to 5) and descriptors for each of the adopted aspects of performance (2.1)						
Why	To provide a clear and consistent approach for communicating with customers on their needs and wants, and reporting of actual and forecast performance						
Approach	• Engage with customer groups and review previous community consultation to understand customer perspective and needs to inform a spectrum of possible performance levels for each aspect of performance • Consider legislative requirements that may establish bottom line levels of service (eg Drinking Water Standards and water quality) • Utilise risk approaches in describing the various levels of services, (eg water restrictions imposed in 2% probability drought event)						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
	• Test proposed scales/descriptors with customer groups and refine as necessary • Develop corresponding methodologies and standards for performance measurement • Pilot study/trial						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
2.3	*Analysis Tool for Evaluating Level of Service Change*	2.2	2.6		12 months		$100k
What	Develop a methodology or analysis tool that uses asset data, condition, performance and criticality data to model level of service outcomes						
Why	To assist in the evaluation of pipe network investment decisions and strategies such that customer based impact can be analysed and communicated in a consistent and meaningful way						
Approach	• Research relationships and correlations between pipe network condition, performance and criticality factors and service delivery performance • Define and cost a range of typical intervention strategies • Research social and economic aspects of changes to provided level of service and risk profiles • Develop a simple predictive tool that can be integrated with the asset database (linkage with metadata standards) • Trial tool with range of intervention strategies and cost inputs to model level of service changes and associated social and economic impacts.						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
2.4	*Network Risk Identification and Evaluation Methodology*		2.2		3 months		$50k
What	Develop a methodology for identifying and evaluating risks (likelihood and consequence) associated with pipe network operations						
Why	To promote robust and consistent risk identification and evaluation, prompting identification of existing and desired control measures, and allowing the risk of network investment or deferral strategies to be understood and communicated with decision makers.						
Approach	• Research and review existing work, bringing together examples of best practice • Develop risk methodology and guidance, prepare pro-forma documentation • Document typical range of potential hazards and impacts that ought to be considered • Document potential control measures/strategies for consideration • Prepare worked example						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
2.5	*Network Resilience Assessment Methodology and Improvement Opportunities*		2.2		6 months		$100k
What	Develop a methodology for assessing the degree of resilience of a pipe network and identifying potential improvements along with associated costs and benefits						
Why	To promote wider understanding of network resilience and the costs and benefits of potential strategies for improving the resilience of pipe networks, to inform pipe network intervention strategies						
Approach	• Define 'resilience' in the context of three waters services • Research and engage with communities to understand expectations around network resilience and service delivery • Identify key factors underlying the provision of resilient pipe network infrastructure • Establish and test assessment methodologies that can be used to provide a measure of network resilience • Research and identify current strategies for improving pipe asset resilience and evaluate potential costs and benefits						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
2.6	*Community Engagement Resources*	2.1, 2.2, 2.3 2.4, 2.5			6 months		$75k
What	Develop a suite of information and engagement resources aligned with the Performance Framework						
Why	To facilitate strong community engagement for the setting of service level objectives that meet the needs of the local community with an associated understanding of the social and economic impacts of these decisions						
Approach	• Prepare information material (printed/web) in simple, non-technical language • Prepare case studies comparing a variety of investment strategies and their outcomes • Align with analysis tool for assessing level of service change • Include communication of risk and resilience considerations						

Pipe Criticality (3)

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
3.1	*Criticality definition review*	Metadata	Criticality/Risk	Consultant	1 mths	Sep-16	5k
What	A review of the criticality definition provided by the metadata standards to determine if it is usable to the 3 waters industry "as is" or whether there needs to be additional support						
Why	To provide a common understanding for criticality so that there is consistency						
Approach	• Review metadata standards to determine if additional definition is required for 3 waters criticality • Provide additional definition and guidance						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
3.2	*Methodology for applying criticality*	Metadata	Criticality/Risk	Consultant	3 mths	Nov-16	30k
What	A standard application of criticality for each of the 3 waters. A step by step guide for how criticality can be determined and an explanation for how it is used within the overall decision making framework						
Why	To provide a common application for criticality so that there is consistency in how criticality is used in each of the 3 waters and under the associated schemas						
Approach	• Develop a methodology for assigning criticality • Develop a set of tables where criticality for a single pipe can be determined from a list of contributing factors and categories • Demonstrate how criticality is used in the overall decision making framework (and ensure criticality definition and assignment fits its' purpose)						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
3.3	*Spatial tool for assigning criticality properties*	3.2		Consultant	6 mths	Feb-17	60k
What	Developing a spatial tool to assign criticality (based on the earlier definition and methodology) to pipes based on spatial features such as; number of users, proximity to healthcare facilities, high sensitivity users, transportation routes etc.						
Why	A spatial tool allows criticality to be assigned automatically and provides efficiencies particularly for large networks						
Approach	• Determine the factors that will be linked to criticality in the spatial tool • Develop the tool and test over a number of different networks						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE $
		INPUT	FUTURE		DURATION	START-DATE	
3.4	*Research criticality factors with respect to social impacts*	Criticality	Criticality/LoS	Research	12 mths	Feb-17	100k
What	Further research to determine the appropriateness of the developed method and assignment of criticality. The research will examine what are the real social impacts of varius criticality classes to inform the ongoing use of the criticality and update the developed methodologies and definitions						
Why	To provide further knowledge on the assignment of criticality and deeper understanding of the social impacts. Further research will provide additional accuracy and sophistication in the assignment of criticality						
Approach	• Scope the required research and determine which levels of criticality provide the most impact and therefor should be the focus of the study • Social research on the how service levels impact society to determine where different criticality thresholds should be set • Update existing definitions and methodologies based on the research findings						

Pipe Vulnerability (4)

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE $
		INPUT	FUTURE		DURATION	START-DATE	
4.1	*Definition of pipe failure*	Metadata, industry	Vulnerability	Consultant	2 mths	Sep-16	10k
What	Develop a definition of pipe failure for each of the 3 waters to account for different mechanisms that each constitute “failure” e.g. pipe break, collapse, blockage						
Why	To provide a common understanding for pipe failure so that subsequent tasks are founded on the same definitions						
Approach	• Review international literature and practices relevant to pipe failure definitions • Develop a definition of pipe failure that is complete for all failure modes and for each of the 3 waters						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE $
		INPUT	FUTURE		DURATION	START-DATE	
4.2	*National pipe failure database*	Metadata, Vulnerability	Vulnerability, Risk, Useful life	Industry (Water NZ?), ICT Consultant	12 mths	Sep-16	120k
What	A single source database for storing pipe failure information for all New Zealand pipe network authorities						
Why	To provide a common database where pipe failure rates and trends can be investigating using data from all of New Zealand. The database will allow pipe failure rates to be analysed for pipes of varying physical states and will inform analytics within other related schemas. Provides a common standard for reporting and describing failures.						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE $
		INPUT	FUTURE		DURATION	START-DATE	
Approach	• Create a database for NZ wide failure reporting • Pilot test database through importing legacy failure records where available • Develop a standard method for reporting and describing failures • Roll out to pipe network authorities with supporting software						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE $
		INPUT	FUTURE		DURATION	START-DATE	
4.3	*Likelihood of failure deterioration curves*	Useful life, Life-cycle costing of pipes	Useful life, Life-cycle costing	Consultant	12 mths	Feb-17	150k
What	Creation of deterioration curves that predict the likelihood of various pipe failures. This work is closely related to deterioration curves of other tasks that predict remaining useful life, physical pipe performance, financial performance, and level of service performance						
Why	Knowledge of pipe failure likelihood will inform all predictive analysis and planning for pipe renewals						
Approach	• Create a set of curves to be used and tested in the first instance based on available international literature and practice • Determine the most influential factors that affect the likelihood of pipe failure • Further research into the relationships to determine relationships between the most influential factors and pipe failure rates • Update curves based on the further research findings						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE $
		INPUT	FUTURE		DURATION	START-DATE	
4.4	*Vulnerability to certain risk events*	Risk, Condition	Likelihood of failure	Research	12 mths	Feb-17	120k
What	Determine how vulnerable pipes of varying conditions are to a range of expected risk events						
Why	This research provides the key link between condition and performance for a range of events as defined under the Metadata standards risk schema						
Approach	• Determine which events are most important to investigation, e.g. earthquake, rain events • Develop a number of relationships between condition and performance for each of the events in the first instance based on available international literature and practice • Further NZ specific research into the relationships to determine relationships between events and pipe failure rates • Provide equations/tables/methods to determine vulnerability rates for each of the events researched						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
4.5	*Spatial tool for assigning vulnerability and likelihood of failure*	4.3, 4.4		Consultant	6 mths	Sept-17	60k
What	Developing a spatial tool to assign vulnerability and likelihood of failure to pipes based on spatial features						
Why	A spatial tool allows vulnerability and likelihood to be assigned automatically and provides efficiencies particularly for large networks						
Approach	• Determine the factors that will be linked to vulnerability and likelihood in the spatial tool • Develop the tool and test over a number of different networks						

Pipe Inspection and Condition (5)

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
5.1	*Pipe Inspection and Condition Assessment Framework*		5.2	Consultant – Opus, ProjectMax			
What	A framework to outline the recommended pipe inspection methods for assessing condition / remaining useful life with basic principles and guidance on setting condition parameters for different pipe material and genre. The framework will clearly set-out pipe inspection techniques used for different pipe materials (advantages, limitations and sensitivity), where best to apply them and how to interpret the results and allocate a condition grade in accordance with the Metadata Standards definitions.						
Why	Enables the asset owner to make an informed decision on the preferred method of pipe condition assessment for piped asset(s) and understand the level of the results likely to be achieved (e.g. specific to a pipe sample or an average for a pipeline etc.). Supports implementation of the metadata standards project.						
Approach	• Literature search and review of available research to verify and validate current pipe inspection/ condition assessment techniques, advantages, limitations and outputs/results • Develop a national guideline for the application of pipe inspection methods across different pipe materials detailing where and how to apply them • Guide for assigning pipe condition rating in accordance with metadata standard definitions, based on inspection method and the interpreting of results.						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE $
		INPUT	FUTURE		DURATION	START-DATE	
5.2	*Pipe Inspection Plan*	5.1, 5.2	5.3	Consultant - Opus			
What	Guidelines on the development and implementation of a pipe inspection and test planning process and quantities. Includes typical inspection test plans for small, medium and large pipe networks.						
Why	Enables the asset owner understand the advantages, limitations and costs of the two methods, opportunistic and planned pipe inspections. To better understand the type and quality of pipe data likely to be generated for the different pipe materials and where best to use each method within their network (for both condition assessment and pipe data improvement).						
Approach	• Procedure for establishing a pipe inspection programme based on network type size and materials • Set our rules / guidance for number of samples based on network type/size considering performance/risk/criticality/vulnerability/etc. • Provide costs for type of condition assessment i.e. $/m to allow financial budgets to be set						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE $
		INPUT	FUTURE		DURATION	START-DATE	
5.3	*Pipe Sample Recovery and Data Management*	5.1, 5.2 , 5.3		Consultant - Opus			
What	A standard procedure to be followed for the removal of pipe samples and soil samples associated with pipe networks. The procedure is to be used by those involved in either opportunistic removal of pipe samples or removal of selected pipe samples in support of a renewal programme.						
Why	The aim of the procedure is to standardise the requirements of the pipe sample removal and data capture process throughout to ensure that a consistent system of controlling and managing the data is developed and maintained.						
Approach	• Data cleansing tools – standard cohorts table for all material types • Identify areas for data collection for improved confidence for decision making activities • Procedures and work instructions for pipe sample recovery method to Define planned and opportunistic pipe data collection processes include: o Health and Safety procedures / Permit to work o Cutting and removing pipe samples (i.e. AC Pipe Watermain Manual) o Wrapping and tagging • A standard for the recording of Operational and Management fault data, including the collection, storage (Asset Management Information Systems) and reporting to allow estimates to be made of future expenditure that will be required to maintain and upgrade the asset condition						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE $
		INPUT	FUTURE		DURATION	START-DATE	
5.4	*Pipe Condition Technology*	5.1, 5.2	5.1	Consultant – Opus, ProjectMax, Industry – Detection Services Research -	6mths+ Ongoing		60
What	Register of pipe inspection methods to capture existing and new technology, detailing level of confidence, accuracy and recommended use i.e. pipe material						
Why	To ensure new technology is captured and regulated to ensure users are informed of the what is approved technology and its capabilities						
Approach	• Establish a New Zealand Technical Committee responsible for managing new technology and innovation • Establish links and work with other organisations to share experience with technology and innovation i.e. Universities, AWWA, UKWIR • Set up a Water NZ site listing recommended technology – status approved, not approved, not tested etc. • List of recommended contractors and suppliers that can provide pipe condition assessment						

Forecasting Remaining Pipe Life (6)

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE $
		INPUT	FUTURE		DURATION	START-DATE	
6.1	*Definition of useful life*	Metadata, industry	Useful life	Consultant	2 mths	Feb-17	10k
What	Develop a definition of useful life for each of the 3 waters to account for the financial impact of operating a pipe with poor performance vs the cost of renewal or rehabilitation. Also to take into account risk profiles						
Why	To provide a common understanding of useful life that subsequent tasks are founded on the same definitions						
Approach	• Review international literature and practices relevant to useful asset life, especially for pipes • Develop a definition of useful pipe life that is complete and relevant for 3 waters pipes						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE $
		INPUT	FUTURE		DURATION	START-DATE	
6.2	*Standard framework for application of remaining useful life*	6.1	Useful life	Financial/ asset management research	9 mths	Apr-17	60k
What	A standard process for how pipe network authorities should plan activities based on useful life pipe data. The development of guidelines that recommend intervention points (eg when to inspect, budget for replacement and take action) for pipes depending on remaining useful life and cost/benefit scenarios						
Why	To provide a financially sound process for intervention points that are evidence based and associated with remaining pipe useful life						
Approach	• Develop a theoretical framework for intervention points based on international literature and practice • Financial research into best practice and standard methods for monetising pipe risk profiles • Financial research project on the cost benefit of intervention points for 3 waters pipes to determine optimal timing • Update framework based on financial research						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE $
		INPUT	FUTURE		DURATION	START-DATE	
6.3	*Useful life deterioration curves*	Likelihood of failure, Life-cycle costing of pipes	Useful life, Life-cycle costing	Consultant	12 mths	Feb-17	150k
What	Creation of deterioration curves that predict the useful life of various pipe failures. This work is closely related to deterioration curves of other tasks that predict likelihood of failure, physical pipe performance, financial performance, and level of service performance						
Why	Knowledge of pipe useful life will inform all predictive analysis and planning for pipe renewals						
Approach	• Create a set of curves to be used and tested in the first instance based on available international literature and practice • Determine the most influential factors that affect pipe useful life • Further research into the relationships to determine relationships between the most influential factors and pipe useful life • Update curves based on the further research findings						

Business Processes (7)

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
7.1	*Baseline reporting information*	Industry		Industry	4 mths	Feb-17	30k
What	Develop a minimum baseline of reporting information to be shared between network authorities, government, and insurers (eg useful asset life and cost of replacement)						
Why	To provide a common understanding of asset valuation and risk between all stakeholder parties						
Approach	• Review current practice • Develop a minimum baseline • Submit to stakeholders for feedback • Publish document with minimum baseline standards and roll out to network authorities						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
7.2	*Standard method of monetising risk*	Useful life, Metadata standards		Research	9 mths	Apr-17	60k
What	Develop a standard method of monetising risk (and in combination with the common definition of useful asset life) to support better business cases for 3 waters pipes						
Why	To provide a financially sound process for monetising asset risk profiles for 3 waters pipes so that business cases can be examined more quantitatively						
Approach	• Financial research into best practice and standard methods for monetising pipe risk profiles • Publish standard document for monetising pipe risk profiles						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
7.3	*Pipe procurement guidelines*			Industry	6 mths	Sep-16	60k
What	Production of a guideline on different procurement methods with commentary on when and why to use each different method						
Why	To provide a single source of wisdom for pipe procurement methods to give opportunities for different procurement models to be adopted where appropriate so that efficiencies can be achieved						
Approach	• Research of international literature and practices for different pipe procurement models to determine which models may be appropriate for NZ • Further research into the benefits and issues with the possible procurement models						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
	• Publish a guideline document available to industry that sets out the benefits, issues and appropriateness of various procurement models (as well as presenting findings to industry groups, councils, conferences etc)						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
7.4	*Non-price attributes of pipe materials and methods*			Industry	6 mths	Sep-17	60k
What	Research the economic impact of choosing different pipe materials or construction methods in comparison to the lowest conforming price materials and method						
Why	To quantify the economic benefit of using materials and methods that may not be the lowest outturn cost or are less common						
Approach	• Research of life cycle costing between alternative materials and methods • Publish a guideline document available to industry that sets out the benefits, issues and appropriateness of various alternative materials and methods						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
7.5	*Standard installation methods*			Consultant, Industry	6 mths	Sep-16	60k
What	Provide a standard pipe installation method for various pipe materials and ground conditions						
Why	Seeking efficiencies by standardising construction methods. Improves quality assurance of installation methods by standardising approaches.						
Approach	• Research current methods of installation • Publish a pipe installation standard document to industry						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
7.6	*Standard cost of pipe installation*	7.5		Consultant, Industry	6 mths	Apr-17	60k
What	Provide a standard costing regime for pipe installation						
Why	Reduce variance in pipe installation costs. Reduce variance in the calculation of replacement costs of pipes.						
Approach	• Research current methods of pipe costing • Publish a pipe installation costing guideline document to industry						

Data Management (8)

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
8.1	*Metadata Standards Implementation*	Metadata 8.2	8.3, 8.4	Consultant - Opus	6 mths	Sep-16	150k
What	Metadata standards will provide data consistency. They will enable data to be shared, aggregated and analysed in more detail than is currently possible.						
Why	Provides a consistent approach to managing asset data that allows informed decisions to be made with confidence						
Approach	• Conduct a stocktake on legacy asset data and compare against metadata standards - what data is available, it's form, what are the gaps • Prioritise actions for data cleansing and develop tools to support delivery for 3Water Assets • Develop standards for capturing new asset information i.e. standard As-Builts • Guidance on data structure to be captured						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
8.2	*Metadata Data Prioritisation*			Consultant - Opus	4 mth		40k
What	Develop a programme for the rollout for metadata standards implementation						
Why	Focus on the data that will provide greatest value in the short-term						
Approach	• Literature search to better understand the factors which impact on performance • Pick up from existing Opus work done by Phil McFarlane						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
8.3	*Data Cleansing for Metadata Implementation*			Consultant - Opus	24+ mths	June-17	500-900k
What	New Zealand programme to convert legacy data to the new metadata standard following prioritisation recommendations (project 8.2)						
Why	To allow smarter decisions to be made based on metadata standards project						
Approach	• Identify pilot areas (Small, medium networks) to run data cleansing tools and evaluate outputs • Develop a data cleansing programme to convert legacy data • Rollout data cleansing programme						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE $
		INPUT	FUTURE		DURATION	START-DATE	
8.4	*Data Collection Guideline (s) and Specification (s)*			Consultant			
What	Develop a guideline for pipe data collection						
Why	Ensure a consistent approach is being adopted throughout New Zealand to retain data confidence and overall knowledge of the asset, supporting future decision making						
Approach	• Identify type of data collection practices and specifications required • Review available data collection practices and supporting documentation for managing QA, H&S and work practices (work instructions) • Develop a quality plan (specification) for undertaking data collection to provide consistency • Develop a guideline detailing data collection methods and when to use with supporting information						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE $
		INPUT	FUTURE		DURATION	START-DATE	
8.5	*Data Storage System Specification (s)*	8.1, 8.2, 8.3, 8.4		Consultant	9mths	Jul-17	100k
What	Specification for data management and recommendation of appropriate software						
Why	To ensure investment is made in the right storage systems and that critical data is available and secure						
Approach	• Identify what system requirements are required and available data management systems for collating and managing pipe asset data. • Review and test types of systems and how this will need to integrate with other systems • Specification will outline quality assurance, data maintenance and checking, off-site access, back-up of critical data i.e. Cloud base						

Building Standards and Constructability (9)

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
9.1	*Identification of Best People*			Consultant	1 mths	Sep-16	15k
What	Identification of best people within the water industry in New Zealand to contribute						
Why	Ensuring that the best people are involved adds value to the process						
Approach	• Using known contacts and with assistance from Water NZ, identify those who can contribute to project • Approach individuals to ascertain interest and areas of expertise						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
9.2	*Identification of Gaps*			Consultant	1 mths	Oct-16	30k
What	Prepare a brief of sub-project objectives and questions, then circulate and collate submissions						
Why	Ensuring that best questions have been identified adds value to the process						
Approach	• Prepare a brief of project objectives and questions about issues/gaps for circulation • Seek feedback from agreed contributors • Collate information received						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
9.3	*Setting Priorities*			Consultant	1 mths	Nov-16	30k
What	Prepare a priority plan for gap filling						
Why	Identify quick wins and medium term programme						
Approach	• Develop a draft priority plan • Gain agreement on priorities • Draft initial programme • Put time and cost estimates against items						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE $
		INPUT	FUTURE		DURATION	START-DATE	
9.4	*Gain Funding for Identified Actions*			Consultant	1 mths	Dec-16	? k
What	Gain funding for identified gap – filling actions						
Why	Without industry funding the work cannot progress						
Approach	• Prepare a case for submission to industry • Seek approvals and funding						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE $
		INPUT	FUTURE		DURATION	START-DATE	
9.5	*Development of Draft Industry Guidelines*			Consultant	3 mths	Jan-17	150k
What	Prepare draft guidelines and circulate for comment						
Why	Guidelines needed to improve industry standards						
Approach	• Prepare guidelines						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE $
		INPUT	FUTURE		DURATION	START-DATE	
9.6	*Development and Promotion of Industry Guidelines*			Consultant	9 mths	Apr-17	50k
What	Prepare guidelines and promote						
Why	Guidelines needed to improve industry standards						
Approach	• Prepare guidelines • Prepare promotional material • Promote guidelines through presentations at conferences and workshops						

Life-Cycle Cost of Pipes (10)

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
10.1	*Pipe Performance Measures*			Consultant	4 mths	Oct-16	75k
What	A specification that sets out pipe performance measures and how they should be applied and used to provide justification for investment decisions						
Why	Optimised total expenditure by providing the appropriate actions at the right time						
Approach	• Review pipe failures data within New Zealand and Internationally to identify key indicators for assessing performance with a LoS/Community and financial focus • Develop a specification for key performance indicators (KPIs) and parameter definitions (Condition Type – burst frequency, blockages) (Performance Type – Water quality failures, customer complaints, environmental impact) • Provide provisional weightings for each parameter and test i.e. burst frequency (15%), blockages (30%), Overflows (50%) • Develop a pipe performance grading system as a measure of the performance of the asset and its ability to maintain adequate levels of service						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
10.2	*Operational and Maintence Rates*	10.1	10.3	Research	12 mths	Jan-17	100
What	Unit rate guide for operational and maintenance actions and capital expenditure for pipe renewals and rehabilitation methods.						
Why	To provide robust and quality data for whole life cycle costing						
Approach	• Review OPEX and CAPEX methods and cost rates across New Zealand • Develop a standard rate for typical O&M procedures (jobs) • Develop cost rate for intervention options consisting of opex and capex solutions						

PROJECT NO.	TITLE	RELATED TASKS		WHO	TIMING		FEE ESTIMATE
		INPUT	FUTURE		DURATION	START-DATE	$
10.3	*Life-Cycle Cost Prediction*	10.1, 10.2	10.2	Consultant	9mths	Sep-17	???
What	A procedure which seeks to identify the most appropriate solution to network problems by considering various types of intervention options mainly consisting of opex and capex solutions.						
Why	Cost effective approaches can be utilised to determine the most appropriate least whole life cost option						
Approach	• Literature search to identify what tools/approaches are available for assessing expenditure based on intervention methods i.e. IDS approach • Develop financial tool to predict opex /capex methods						

Summary

A stocktake of existing knowledge and practices for the management of pipework in potable water, wastewater and stormwater systems has been completed. Gaps in knowledge have been identified. 46 initiatives have been identified to assist water organisations to make evidence based decisions regarding the inspection, maintenance and renewal of pipelines.

A roadmap for developing these initiatives over the next 3 years has been prepared. It is estimated that these initiatives will cost in the order of $4 mil to develop.

The tools and guidance documents developed through these initiatives will form a framework that can be used in conjunction with the International Infrastructure Management Manual (IIMM) and the New Zealand Metadata project to implement advanced asset management processes to produce investment strategies that optimise cost, risk and level of service. They will enable organisations to assess the implications of adopting alternative investment strategies and select the strategy that best suits the needs of their community.

Through this process New Zealand communities should gain confidence that they are neither going to be faced with significant liabilities in the future to renew pipeline assets nor are they currently over depreciating water assets.

If even a small percentage of the possible renewals cost can be saved by a better understanding of the renewals process, this would amount to many millions of dollars that may be invested more productively elsewhere.

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New Zealand Government. (2011). *National Infrastructure Plan 2011.*

Office of the Auditor-General. (2014). *Water and Roads: Funding and Management Challenges.*

APPENDIX A

SUMMARY OF THE FINDINGS FROM THE WORKSHOP HELD ON 2 FEBRUARY 2016

Pipe Renewals Guidelines Literature Search Schedule

Opus internal workshop – 28-4-2016

Present:

Greg Preston UC Quake Center
Philip McFarlane Opus
Dan Johnson Opus
Paul Carran Opus
Liam Foster Opus
Adam Wheeldon Opus
Hock Yeo Opus
James Thorne Opus

The purpose of these notes is to record the agreed steps, directions and commitments under each of the ten theme areas. General discussions have been noted under "General"

General

- WaterNZ and IPWEA key stakeholders for this project.
- Aim to lift the game for NZ inc in how we do pipeline renewals and planning
- Smart tools that asset managers will actually use
- Want to bridge the gap between asset management theory (principles of IIMM) and practise (do better than 3 pipe breaks and then replace)
- Provide evidence based tools to allow more informed decision making
- The primary driver is economic – optimising the renewals process

Two concurrent projects that are linked to this work:
- Metadata standards
- The update of the NZ Pipe Inspection Manual – ProjectMax

The deliverables of this current phase of the project:
- Task plans for each identified package of work within the ten theme areas.

The task plans will:
- summarise current knowledge and practise
- identify gaps
- describe what could be done to enhance current practise including
- scope of the cost and programme for these enhancements
- present the business case for potential benefits

Theme 0: Strategy for guidance use and presentation
The overall process and framework of presenting, connecting and using the various resources that come out of the ten themes research areas.
UK would be a good example because there is a high degree of standardisation across the water companies and that they all report to the same authority.

Action: Phil to provide a first cut of the overall plan and how things fit together.

Theme 1: Strategy and planning for capacity and growth
Global examples: UK SRM sewer rehabilitation manual
Is IIMM OK? Or how should we go further or rearrange things in IIMM?

Can we actually develop tools for this theme or is it a big picture checklist and that's as deep as we go? eg have you considered future demand scenarios, have you considered current vs future capacity, political growth areas, climate change,
Ideas: common sense prompt/flowchart/checklist
Might need an agreed definition of _Strategy_Planning_Capacity_Growth_

Laterals: Phil has something. Could explore various lateral ownership scenarios

Graph: demand v capacity

Themes 2: Levels of service, risk and resilience
And
Theme 3: Criticality

Definition of "criticality" coming from Metadata standards

The use of criticality needs to fit in with the other themes and how they interpret/use criticality

Get a clear idea of what outputs within these themes are coming out of the Metadata standards

Liam's resource: National Science Challenge – Economic impacts/criticality

Perhaps a two step progression of criticality/LoS/risk where we get some "interim" definitions that come out of Metadata standards. And then refine over time with further research, testing and testing the true community impacts.

EG Metadata standards -> interim definitions -> and then refinement ….

>road testing (customer feedback, stakeholder engagement)
>economic, social science research
>future research

… and then with feedback definitions can be altered over time to become more accurate and useful.

Theme 4: Pipe vulnerability and likelihood of failure

Adam has some data/resources on his desk already (which needs to be refreshed) – Adam's pipe cohort table

What are the NZ option for adopting international documents for failure modes? Especially UK?

"Failure" should really be "performance failure"

Create a national database of performance failure
    Pipe failure quality assurance:
    >data verification
    >standard processes / recording
    > what do we need to give us confidence in this database

Pipe installation is a significant contributor on performance failures – so quality assurance for pipe laying is incredibly important. -> Out of the scope of this study

Standard useful life: Phil has a watercare study with mean useful life

In future need a likelihood of failure depending on time since installation -> not yet done, needs further research

Problems: not all pipes sharing the same classification are equal E.G. early plastic vs modern plastic.

Theme 5: Pipe inspection and condition

Develop a standard rationale for when/where to inspect:

Eg a) to gather data to populate your pipe databse, and inform your analytics
b) forcasting analytics has identified a pipe as "risky" and you want to confirm if repair/replacement is required

Planned and opportunistic collection strategies.

Provide guidance on the use of:

- Visual eg CCTV (this is expected to be covered under the updated Pipe Inspection Manual (ProjectMax)
- Non destructive testing (may be in Project Max work)
- Visual scanning
- Leak detection
- Profile inspection/level survey

Guidance could be in the form of an industry group who can provide:
When/why should I use this method?
How good are these methods, are they available?

The industry group could be a working party at a national level that can vet new methods and provide objective feedback on behalf of NZ asset owners.

Phil has an example with Auckland Council gravity pipes

Collect condition curves from around the world

Steve Symmonds – detection services

Graph: condition vs time

Theme 6: Forecasting remaining pipe life

The goal is to generate / adopt a number of graphs that can be used to approximate likelihood of failure vs time.

Tackle this is two parts:

1) adopt a number of curves to begin with – either from what is used overseas or come up with a simple set of curves to begin with
2) commission future research to more fully develop the set of curves over time to be more accurate, useful (and NZ specific?)

Theme 7: Business processes

More input is required in this theme from TA's and contractors.

Risk allocation and procurement models: we need to understand the alternative methods/models that are available and used overseas.

Literature review to list the possible models and their benefits and disadvantages.
Work with ACENZ and LGANZ. Advice from Productivity Commission, and Infrastructure Australia.

Pipe material selection: could be more based on whole of life cost modelling (eg more expensive option giving future O&M and benefits.)
The selection process could also include vulnerability, installation, sustainability, carbon costs.

Produce a tool that gives recommendation based on the costs AS WELL as intangibles.

Asset inheritance:
1) developers handover to TA's
2) amalgamation / shared services

Develop national guidance (rather than each TA having a different approach).

Standard handover process and checklist. Lessons learnt could come from SCIRT->CCC, Banks Pen -> CCC, Watercare, Wellington Water.

Standard national design standards rather than each TA having their own way of doing things. Try a different approach to NZS4404 where the standard is only used for TAs that don't have their own design standards. Instead have a national standard that takes precedence and can be used across all TAs where each TA will only need to have their own addendums individually where required.

Theme 8: Data management

Consistency required.

Metadata standards is the key element which will encompass the necessary improvements in this theme.

Theme 9: Building standards and constructability

Standard specifications for trenchless technology – could use the SCIRT spec as starting point.

International guidance – standard testing regime for trenchless methods compliance quality assurance.

We need a national doorway for new methods and innovations. Set up a central national repository for trenchless technology guidance. Responsibilities include a assessing and monitoring methods and innovations. (Example how CCC do their approvals a certain way).

A standard single installation spec for the pipe materials.

Aspects of this theme could be led by industry and contractors.

Standardise elements of construction – procurement, specifications, pathways for innovation

Standardise cost of installation – get manufacturers on board
Common installation for pvc pipe, conc pipe,
Humes/Hynds/Iplex keen to be involved

Theme 10: Life-cycle cost of pipes

Aspects of this this theme have been covered elsewhere. Metadata standards could help here.

Financial planning – three breaks and replace, run till failure,

Optimal time for intervention and spending money.

Documents mentioned:
International Infrastructure Management Manual – NAMS
SRM Sewage Rehabilitation Manual – UK
SIMPLE – WERF (US)
CSRO – smart inspection technology
UK Water Industry Research
Critical Pipes – Australia
Management and Prediction of Pipe Bursts – Mon Ash
Canada - NRC
UK - Water Research Foundation
US - Water Foundation
US – Army Corp of Engineers
Europe – P aware
Japan – Resilience
NAMS – Optimised Decision Making Guidelines (James has a copy)
AC pipe condition assessment manual
UK- National Science Challenge – Economic impacts and criticality
Procurement models – Productivity Commission /Infrastructure Australia

APPENDIX B

LITERATURE RESEARCH SUMMARY

Theme: Strategy and Planning	**Theme ID:** PR1 (Pipe Renewals 1)
Definition (What is it)	**Purpose** (What will it provide / How will it be beneficial)
▪ Strategy encompasses how factors other than pipe condition/performance interact with pipe renewals to get the best outcomes in line with the organisations greater objectives. ▪ The planning element encompasses the effect of service supply, demand, utilisation of existing assets and growth and how that influences the pipe renewal decisions.	▪ Strategic prioritisation of repair or renewal based on greater organisational objectives ▪ A common approach gives asset owners confidence in the method and promotes alignment ▪ Forecasting demand allows for greater efficiency and effectiveness for renewal expenditure in the right places

Current Knowledge (What do we know – policy, guidelines, tools, research)		NZ / Australia		International	
New Zealand / Australia		**Reference** (Where, Type – Policy /Guideline / Research)			
Ref. ID	**Detail**	**Organisation**	**Region**	**Type**	
P1_1	Long-Term Plans, Infrastructure Strategy, Asset Management Plan	LGNZ	NZ	Regulatory	
P1_2	Institute of Public Works Engineering Australasia	IPWEA	Aus/NZ	Industry group	
P1_3	Planning Guidelines for Water Supply and Sewerage (2014)	Dep of Energy and Water Supply – QLD,	Aus	International Guidance	
International		**Reference** (Where, Type – Policy /Guideline / Research)			
Ref. ID	**Detail**	**Organisation**	**Country**	**Type**	
P1_4	Water Services Infrastructure Guide – A Planning Framework	UK Water Authorities	UK	Framework	
P1_5	Capital Maintenance Planning, A Common Framework	UKWIR	UK	Framework	
P1_6	Assessment and Renewal of Water Distribution Systems	AWWA	USA	Guideline	

Experts / Leading Practitioners		
Name	**Subject Area**	**Company**

Theme Gaps (Identify what is missing, why it is important, and what does it look like)		
Gap (What is missing)	**Value** (Why is it important)	**Objective** (What does it look like i.e. National Database)
A common national approach	To standardise the national approach and support individual stakeholders who are wanting to optimise renewal decision making with overarching organisational objectives	A guide to establish a set of overarching planning and delivery principles for 3waters (Pipe) infrastructure
A demand forecasting tool that is used as standard	To support the national approach by providing a tool that is specific to the application of pipe renewals and can be run under various future scenarios	Develop a demand forecasting tool and roll out to asset owners for them to incorporate into the pipe renewal decision making and is consistent with the overarching approach
A standard method for calculating current and future pipe utilisation	To calculate and report pipe utilisation in a standard way to support the understanding of how existing assets meet the requirements of future demand scenarios	Define utilisation and its measurements, define key parameters and develop a standard approach and set of guidelines for application of utilisation

OBJECTIVE – WORK BREAKDOWN STRUCTURE (Packages for future development)

Ref.	Objective	Tasks	Priority	Period	Who	Cost (Hours /$)
	A guide to establish a set of overarching planning and delivery principles for 3waters (Pipe) infrastructure:	• Establish strategic planning approach for pipe renewals in New Zealand, what should this look • Identify and review available strategic planning literature/ documentation, this may include but not limited to: o Long-Term Plans, Infrastructure Strategy, Asset Management Plan (LGNZ) o Institute of Public Works Engineering Australia (IPENZ) o Planning Guidelines for Water Supply and Sewerage (Dep of Energy and Water Supply – QLD, 2014) o Water Services Infrastructure Guide – A Planning Framework (UK Water Authorities) o Capital Maintenance Planning, A Common Framework (UKWIR, 002) o Assessment and Renewal of Water Distribution Systems (AWWA, 2004) • Gap assessment – Where do want to be versus where are we now and what's available • Set out simple guidelines / process chart to clearly map out the approaches for best practice strategic planning • Develop a strategic planning guide for 3waters (Pipe) infrastructure • Role of a Regional Development Plan (Canterbury) and Local Development Plans				

	The development of a 'Demand Forcasting Tool' that includes factors which influence demand i.e. climate change:	• Set out the requirements/functions for a demand forecasting tool; how will it remain live/ updated • Review current approaches (30yr Infrastructure Plans, LTPs) to forecasting demand; what data is used, how it is applied (census, land based) • Agreement on future population forcasts – method (national/local) • Establish factors which influence demand and how these can be applied as variables for different regions and drivers i.e. climate change – demand management approaches, environmental regulation/policy • Identify and review demand forecasting tools/approaches used within the New Zealand market and internationally. • Define a consistent approach/method for measuring current and future demand; o Adopt a spatial approach with GIS /spatial tools with current and future customer points represented o Identify what land use types are required for planning; residential, commerical, industrial, rural, restrictor (residential/agricultural) o Collate and evaluate raw demand/flow/water meter readings for determing standard profiles – New Zealand wide o Generate diurnal profiles for different land use categories i.e. residential, commercial, Industrial, rural , etc.. This could be region, urban/rural based. Need to also consider, rainfall, temperature, climate changes etc... o Determine method to calculate future peak day use based on region, considering building/property size and use, soil type (moisture index?) o Generate standard water and sewerage demand conversion rates to calculate water supply demand and sewerage discharge loads for different land use categories i.e. motel versus hotel (Referece City of Gold Coast – Water and Sewerage Demand Table) • Recommend approach to the dveelopment of a demand forecasting tools, this may include the enhancement of existing tools to suit New Zeland requirements or the full develoipment of a new tool/software • Develop demand forecasting tool to include; testing, documentation, training, maintenance/updating				

	Standard Method for Calculating Current and Future Pipe Utilisation:	• Define what is meant by utilisation and how this should be measured – Reference Metadata Standards • Review current methods for estimating pipe utilisation; what methods, accuracy, frequency applied (updated) • Define key planning parameters i.e. Peak Day Demand (PD), Peak Hour (PH, Non-Revenue Water (NRW) (NZ Water: Water Loss Guidelines), peaking factors • Develop a standard approach for the use of hydraulic models: o Specification – Model build, demand and calibration, model maintenance, application of model o Infrastructure (Master) Planning – Demand modelling (Current/future (30-50+yrs), planing horizons • Develop a guideline to set the rules and reporting method to calculate pipe utilisation for current and future demand				

Theme: Level of Service	**Theme ID:** PR2 (Pipe Renewals 2)
Definition (What is it)	**Purpose** (What will it provide / How will it be beneficial)
This theme explores the relationship between pipe renewals and the delivery of services (to the customer and the environment) that meet the needs/expectations of a community. ▪ Pipelines are a key component of a group of assets used to provide water services to customers. ▪ Different aspects of service performance may be improved, maintained or degraded by adoption of different pipe renewals (or capital maintenance) strategies. ▪ Performance considerations must also include risk (probability and consequence of asset failure), resilience (ability to recover and resume service following adverse event) and economics (whole of life costs). ▪ Aspects of performance will be similar across all communities, but the desired level of service will vary according to community needs, aspirations, and resources. ▪ Resource constraints may limit the ability to deliver the desired levels of service though constraining renewals programmes. ▪ Communities require sufficient information to understand the cost implications of their level of service expectations, and the potential service level implications of reduced/increased expenditure.	Improved understanding in this area will allow: ▪ The opportunity to refine or optimise renewals interventions to better match community needs and expectations. ▪ Projection of service level change for proposed renewal strategy adjustments. ▪ Improved communication with communities of the costs associated with maintaining or improving service levels, including varying levels of risk and degrees of resilience provision. Improved knowledge of how asset condition, performance and criticality impact on the delivery of customer services will create opportunities to model service level change in response to pipe renewal strategies and funding constraints. Improved information will facilitate more meaningful engagement with customers and stakeholders about the cost of providing for their aspiration needs and the service experience that can be delivered if resources are constrained.

Current Knowledge (What do we know – policy, guidelines, tools, research)

New Zealand / Australia		**Reference** (What, Where, Type – Policy / Guideline / Research)		
Ref. ID	Detail	Source	Region	Type
P2_1	*Non-Financial Performance Measures Rules 2013*	Dept Internal Affairs	NZ	Rules

	Establishes a set of mandatory performance measures for local authorities to use when reporting to their communities. Comment (PC) Measures adopted for reporting may not be complete/or appropriate for use in the context of assessing investment decisions with respect to community outcomes and level of service.			
P2_2	*National Performance Review* Annual performance review and benchmarking of local authority delivery of 3 waters services. Aligned with *Non-Financial Performance Measures Rules 2013*	Water New Zealand	NZ	Review
P2_3	*International Infrastructure Management Manual* A foundation document for asset management practice as generally adopted/promoted in NZ. Section 2.2 Covers Establishing Levels of Service and includes case studies. Comment (PC) Takes more of a 'what to do' then 'how to do' approach.	IPWEA	NZ/Aust	Guidance
P2_4	*Developing Levels of Service & Performance Management Guide*	NAMS	NZ	Guidance

P2_5	*Practice Note 8: Levels of Service & Community Engagement* Levels of Service are the building blocks for infrastructure asset management. Proper understanding about the levels of service is a basic requirement to effectively provide services from infrastructure. The best results are when the community understands their infrastructure needs, delivered at affordable levels. The organisation providing the services from infrastructure must effectively engage their communities for proper mutual understanding. This Level of Service and Community Engagement Practice Note has been prepared for practitioners in organisations with responsibility for service delivery from infrastructure. These organisations have to manage assets with long but finite lives. It has particular application for local government councils. The Practice Note will assist these organisations prepare for, consult and engage with their communities on the Levels of Service to be provided by the organisation and financed by the community. The Practice Note looks in detail at: The purpose of Community Engagement with 3 levels of engagement Developing Levels of Service and service options Developing a Community Engagement Plan and engaging with the community Determining affordable and acceptable Service Levels Delivering agreed services Case studies with examples from councils in Australia, NZ and Canada.	IPWEA (2014)	NZ	Guidence

International (Country of Origin)		**Reference** (What, Where, Type – Policy / Guideline / Research)		
Ref. ID	Detail	Source	Region	Type
P2_10	*WRMP 2019 Methods – Risk Based Planning* Includes risk based planning with communication of risk clearly structured so that it is visible and understandable to stakeholders. Risk are described in a Level of Service Statement (expected frequency of restrictions) and in a Drought Resilience Statement (severity of	UKWIR (2016) Report Ref No 16/WR/02/11	UK	Guidance

	drought that can be managed). Allow for clearer consultation on issues such as customer preferences for risk and resilience. Comment (PC) – this document focuses on water supply and drought management, more on the infrastructure planning side rather than renewals, but may offer some useful approaches around communication of risk.			
P2_11	*Contaminant Risk Management Communications Strategy and Tools* Develops a risk communication strategy and set of communication tools for use in relation to contamination of drinking water supplies. Comment (PC) – does not appear to be strongly aligned with this theme.	Water Research Foundation and Drinking Water Inspectorate (2010)	USA	Research
P2_12	*How Risk Management Impacts Asset Management Decisions* Identifies steps for developing a risk management process. Comment (PC) - High level, fairly standard ideas around risk management, does not appear to be strongly aligned with this theme.	Water Research Foundation	USA	Fact Sheet
P2_13	*ESW Procedure – Risk Assessment* This document describes a procedure for the analysis of risk as it relates to potable water mains. Quantification of risk informs decision making regarding extent and timing of investments to maintain levels of service. Comment (PC) some relevance around categorising operational impacts but more focussed on Risks than LoS	East of Scotland Water Authority (2001) Procedure P0946_1	UK	Procedure

P2_14	*Work Procedure, Level 1 Investigations, Preliminary Investigations and Ranking* Defines the basis of the inputs and outputs required for ranking zones for the subsequent level 2 and level 3 investigations required to identify rehabilitation needs. The level 1 assessment will provide information through a first pass of corporate information systems and also where conditions/performance issues have given rise to unsatisfactory levels of service. Comment (PC) Presents KPI and Category definitions for condition and performance that may be of interest in context of LoS	Scottish Water (2005) DOM-WI-PRC-00000101	UK	Procedure
	Non-Financial Performance Measures Rules 2013 Establishes a set of mandatory performance measures for local authorities to use when reporting to their communities. Comment (PC) Measures adopted for reporting may not be complete/or appropriate for use in the context of assessing investment decisions with respect to community outcomes and level of service.	Dept Internal Affairs	NZ	Rules
	National Performance Review Annual performance review and benchmarking of local authority delivery of 3 waters services. Aligned with *Non-Financial Performance Measures Rules 2013*	Water New Zealand	NZ	Review
	International Infrastructure Management Manual A foundation document for asset management practice as generally adopted/promoted in NZ. Section 2.2 Covers Establishing Levels of Service and includes case studies. Comment (PC) Takes more of a 'what to do' then 'how to do' approach.	IPWEA	NZ/Aust	Guidance
	Developing Levels of Service & Performance Management Guide	NAMS	NZ	Guidence

	Practice Note 8: Levels of Service & Community Engagement Levels of Service are the building blocks for infrastructure asset management. Proper understanding about the levels of service is a basic requirement to effectively provide services from infrastructure. The best results are when the community understands their infrastructure needs, delivered at affordable levels. The organisation providing the services from infrastructure must effectively engage their communities for proper mutual understanding. This Level of Service and Community Engagement Practice Note has been prepared for practitioners in organisations with responsibility for service delivery from infrastructure. These organisations have to manage assets with long but finite lives. It has particular application for local government councils. The Practice Note will assist these organisations prepare for, consult and engage with their communities on the Levels of Service to be provided by the organisation and financed by the community. The Practice Note looks in detail at: The purpose of Community Engagement with 3 levels of engagement Developing Levels of Service and service options Developing a Community Engagement Plan and engaging with the community Determining affordable and acceptable Service Levels Delivering agreed services Case studies with examples from councils in Australia, NZ and Canada.	IPWEA (2014)	NZ	Guidence
	Customer Acceptance of Water Main Structural Reliability The stated objective of this project was to develop an evaluation approach for utilities to use to assess customer perceptions, attitudes, and expectations for water system reliability; their tolerance to service disruptions and construction impacts; and their willingness to pay (WTP) for expected levels of service. In this research project, we accomplished this by developing • A practical method for assessing customers' perceptions, attitudes, and expectations in terms of infrastructure reliability • The costs of infrastructure strategies	AWWA (2005)	USA	Research

	ranging from repair to rehabilitation to replacement, including internal and external costs • An approach to incorporate external costs into existing utility decisions on infrastructure renewal • A plan to communicate to customers what the utility intends to do and why. Comment (PC) includes survey data about customer LoS expectations in regard to supply interruption duration and frequency etc. Considers external (customer) costs of pipe failure and renewal			
	Large Diameter Trunk Main Failures Investigation of historic trunk mains breaks. Statistical methodology for predicting trunk main failures. Development of a modelling tool to support effective capital maintenance planning.	UKWIR (£600)	UK	Research and Tool
	Asset Data Templates These Microsoft Word documents include a generic asset hierarchy list, performance indicators for drinking water assets, performance indicators for wastewater assets, and a glossary related to key drinking water and wastewater system assets, including above and below ground assets.	WRF	USA	Tool

Experts / Leading Practitioners

Name	Subject Area	Company

Theme Gaps (Identify what is missing, why it is important, and what does it look like)		
Gap (What is missing)	**Value** (Why is it important)	**Objective** (What does it look like i.e. National Database)
Understanding which aspects of (customer facing) performance can be influenced by pipe renewals decisions? Which are most significant? & Understanding the influence that pipe renewal decisions have on service delivery risks (likelihood and consequence of pipe asset failure). & Understanding the influence that pipe renewal decisions have on service delivery resilience (ability to maintain or resume service following adverse event).	To enable the development of appropriate performance measures and associated levels of service within each measure that will reflect the varying outcomes of different pipe renewal strategies.	Research on the relationship between pipe condition/performance/criticality factors and service delivery performance from a customer perspective.
Define standard performance measures related to pipe renewals and formalise measurement methodologies. Include measures reflecting risk and resilience. Establish the accompanying level of service scale for each measure, both in terms of the actual measurement and the corresponding customer experience.	To allow for consistent measurement of performance with ability to benchmark between service providers. To allow communities to select a target level of service that will meet their needs.	Documented suite of standardised performance measures and level of service scales that can be adopted nationally, with opportunity for local communities to determine where their unique service level objectives fit on the standardised scale.
Analysis tools for evaluating and comparing different renewals strategies in terms of predicted performance/level of service delivery, cost, risk and resilience.	To facilitate optimisation of pipe renewal strategies and allow quantification of cost impact of increasing/decreasing level of service objectives, and likewise the level of service impact of increasing or decreasing pipe renewals budgets.	Analysis tool integrated with asset database that utilises condition, performance and risk (criticality?) data to predict level of service outcomes.

What is the acceptability of changing the level of service provided to customers?	To understand customer thresholds for potential level of service changes to inform optimisation of pipe renewal strategies.	Research into the social and economic aspects of changes in levels of service and acceptability of risk.
Communication tools for engaging with communities.	To inform communities in a meaningful way about the options that they have in regard to differing level of service provision, what these means in terms of customer experience, and the differing cost and risk profiles associated with these.	Information material (printed/web) in simple, non-technical language, presenting levels of service, what these mean for customers and how community choice can influence the cost of service provision.

OBJECTIVE – WORK BREAKDOWN STRUCTURE (Packages for future development)

Ref.	Objective	Tasks	Priority	Period	Who	Cost (Hours /$)
	Pipe Network Performance Framework	Establish measurement scales (eg 1 to 5) and descriptors for each of the adopted aspects of performance (2.1) To provide a clear and consistent approach for communicating with customers on their needs and wants, and reporting of actual and forecast performance • Engage with customer groups and review previous community consultation to understand customer perspective and needs to inform a spectrum of possible performance levels for each aspect of performance • Consider legislative requirements that may establish bottom line levels of service (eg Drinking Water Standards and water quality) • Utilise risk approaches in describing the various levels of services, (eg water restrictions imposed in 2% probability drought event) • Test proposed scales/descriptors with customer groups and refine as necessary • Develop corresponding methodologies and standards for performance measurement • Pilot study/trial				

	Analysis Tool for Evaluating Level of Service Change	Develop a methodology or analysis tool that uses asset data, condition, performance and criticality data to model level of service outcomes To assist in the evaluation of pipe network investment decisions and strategies such that customer based impact can be analysed and communicated in a consistent and meaningfull way • Research relationships and correlations between pipe network condition, performance and criticality factors and service delivery performance • Define and cost a range of typical intevention strategies • Research social and economic aspects of changes to provided level of service and risk profiles • Develop a simple predicitive tool that can be integrated with the asset database (linkage with metadata standards) • Trial tool with range of intervention strategies and cost inputs to model level of service changes and assocaited social and economic impacts.				
	Network Risk Identification and Evaluation Methodology	Develop a methodology for identifying and evaluating risks (likelihood and consequence) associated with pipe network operations To promote robust and consistent risk identification and evaluation, prompting identification of existing and desired control measures, and allowing the risk of network investment or deferral strategies to be understood and communicated with decision makers. • Research and review existing work, bringing together examples of best practice • Develop risk methodology and guidance, prepare pro-forma documentation • Document typical range of potential hazards and impacts that ought to be considered • Document potential control measures/strategies for consideration • Prepare worked example				

	Network Resilience Assessment Methodology and Improvement Opportunities	Develop a methodology for assessing the degree of resilience of a pipe network and identifying potential improvements along with associated costs and benefits To promote wider understanding of network resilience and the costs and benefits of potential strategies for improving the resilience of pipe networks, to inform pipe network intervention strategies • Define 'resilience' in the context of three waters services • Research and engage with communities to understand expectations around network resilience and service delivery • Identify key factors underlying the provision of resilient pipe network infrastructure • Establish and test assessment methodologies that can be used to provide a measure of network resilience • Research and identify current strategies for improving pipe asset resilience and evaluate potential costs and benefits				
	Community Engagement Resources	Develop a suite of information and engagement resources aligned with the Performance Framework To facilitate strong community engagement for the setting of service level objectives that meet the needs of the local community with an associated understanding of the social and economic impacts of these decisions • Prepare information material (printed/web) in simple, non-technical language • Prepare case studies comparing a variety of investment strategies and their outcomes • Align with analysis tool for assessing level of service change • Include communication of risk and resilience considerations				

Theme: Pipe Criticality	**Theme ID:** PR3 (Pipe Renewals 3)
Definition (What is it)	**Purpose** (What will it provide / How will it be beneficial)
▪ Pipe criticality represents of the consequences to the owner/stakeholders of a pipe being in a certain condition and/or failing ▪ Criticality can mean different things to different people and a consistent definition and application is needed ▪ Criticality informs the "consequence" aspect of the standard risk management framework	▪ Strategic prioritisation of repair or renewal based on the criticality ▪ Pre-emptive action can be taken to reduce risks to critical pipes ▪ A common approach gives asset owners confidence in the method and reduces wasted or repeated effort

Current Knowledge (What do we know – policy, guidelines, tools, research)		NZ / Australia		International	
New Zealand / Australia		**Reference** (Where, Type – Policy / Guideline / Research)			
Ref. ID	**Detail**	**Organisation**	**Region**	**Type**	
P3_1	**NZ Metadata standards** These will provide a definition for criticality. It is important that this definition in congruent with the overall objectives of this theme	Opus/Metadata standards project	NZ	Standard	
P3_2	**SCIRT Guideline / CERA Design Guideline 43B** Provides a risk based methodology for pipe renewal and rehabilitation decision making	SCIRT / CERA	NZ	Decision making guideline	
P3_3	**International Infrastructure Management Manual 2015: 3.2.4** Explains the use of identifying critical assets to identify priorities. Provides a very basic example of assigning criticality	IPWEA	Aus/NZ	International Guidance Manual	
P3_3	**Critical Pipes: Advanced Condition Assessment & Pipe Failure Prediction Project (Australia)**	Criticalpipes.com	Australia	Research	
International		**Reference** (Where, Type – Policy / Guideline / Research)			

Ref. ID	Detail	Organisation	Country	Type
P3_6	**US Army Technical Manual: Failure Modes, Effects and Criticality Analyses (FMECA)** Provides quantitative and qualitative methods for assigning and assessing criticality	Headquarters, Department of the Army	USA	Technical Manual No. 5-698-4
P3_7	**Critical Infrastructure and Key Assets: Definition and Identification** Explains the difficulty on setting criticality definitions at a national level	US Congress	USA	Congressional Report
P3_8	**Sewerage Rehabilitation Manual (SRM)** Complete guidance for management of sewerage assets	UK Water Research Centre	UK	Manual
P3_9	**Asset Management: Elements & Background** Overview and list of references for water sector asset management practise	Water Research Foundation	UK	Overview

Experts / Leading Practitioners

Name	Subject Area	Company

Theme Gaps (Identify what is missing, why it is important, and what does it look like)

Gap (What is missing)	Value (Why is it important)	Objective (What does it look like i.e. National Database)
A common definition of criticality	To standardise the national approach and support individual stakeholders who are assessing criticality	National guideline Basic table of criticality and impact factors commonly used for water/wastewater/stormwater disciplines
A means for determining a criticality score based on common definition	To standardise the national approach and support individual stakeholders who are assessing criticality	A standard for determining criticality and a tool for supporting the use within GIS

A study of the true stakeholder consequences of critical pipe performance failure – including social and economic impacts	To refine the weighting and priority given to critical assets based on scientific analysis of the technical, social and economic impacts.	Cross discipline research project

OBJECTIVE – WORK BREAKDOWN STRUCTURE (Packages for future development)

Ref.	Objective	Tasks	Priority	Period	Who	Cost (Hours /$)
	Develop a standard national approach	1) Definition of "criticality" from Metadata standards project	High	12 mths	Metadata standards/or others if further scope is required	
		2) Tables of criticality and impact factors to classify and score criticality	Medium	12 mths	Consultant	
		3) Provide the decision making framework for using the criticality and impact factors	Medium	12 mths		
	Tool for plotting criticality	1) Create a GIS based tool where criticality and impact factors can be input for risk based methods	Low	12 mths		
	Long term study of true stakeholder consequences of pipe performance failure	1) Confirm criticality and impact factor tables using economic/social /technical research methods	Medium	5 years	Research	

Theme: Pipe Vulnerability & Likelihood of Failure	**Theme ID:** PR4 (Pipe Renewals 4)
Definition (What is it)	**Purpose** (What will it provide / How will it be beneficial)
▪ Pipe vulnerability and likelihood of failure correspond to the risk assessment aspects of the Metadata Standards. The definition will be governed by the Metadata Standards ▪ This theme effectively looks at the risk profile of a pipe pertaining to a number of different events that may cause performance failure. ▪ Events may be low probability like earthquake damage causing pipe failure, or higher probability such as failure due to age related deterioration	▪ Formalise how pipe vulnerability and likelihood of failure is assessed ▪ Standard methods will allow alignment between organisations and different stakeholders who are exposed to the various risk profiles: eg central government, local councils and insurers ▪ A common approach to defining, assessing and monetising risk relating to vulnerability and likelihood of failure will support the other themes in the overall pipe renewal framework

Current Knowledge (What do we know – policy, guidelines, tools, research) — NZ / Australia | International

New Zealand / Australia

Reference (Where, Type – Policy / Guideline / Research)

Ref. ID	Detail	Organisation	Region	Type
P4_1	**NZ Metadata standards** These will provide a definition for vulnerability and likelihood of failure. It is important that this definition in congruent with the overall objectives of this theme	Opus/Metadata standards project	NZ	Standard
P4_2	Earthquake Damage to Pipelines – A Christchurch Perspective	Opus	NZ	White paper
P4_3	International Infrastructure Management Manual 2015	IPWEA	Aus/NZ	International Guidance Manual

International

Reference (Where, Type – Policy / Guideline / Research)

Ref. ID	Detail	Organisation	Country	Type
P4_4	Pipe Renewal Methods – AWWA Manual	AWWA	USA	Technical Manual

				30028
P4_5	Development of Wastewater Pipe Performance Index and Performance Prediction Model	Virginia Polytechnic Ins and State University	USA	PHD Dissertation
P4_6	UKWIR National Mains Failure Database	UK Water Industry Research Ltd	UK	Database
P4_7	Water Mains Break Rates In the USA and Canada	Utah State University	USA	Research report

Experts / Leading Practitioners

Name	Subject Area	Company

Theme Gaps (Identify what is missing, why it is important, and what does it look like)

Gap (What is missing)	**Value** (Why is it important)	**Objective** (What does it look like i.e. National Database)
A common definition of pipe failure, likelihood (across all 3 waters and event types), and vulnerability	To standardise the national approach and support individual stakeholders who are assessing risk profiles	National guideline Basic charts of vulnerability and failure likelihoods
A common understanding of where these factors fit into the risk assessment procedure and the overall decision framework	To standardise the national approach and support individual stakeholders who are assessing risk profiles	A standard for determining risk quantification relating to pipe failures
A study of evidence based failure rates for NZ	To standardise the national approach and support individual stakeholders who are assessing risk profiles	A standard for determining risk quantification relating to pipe failures. A national database for pipe failures will build the necessary dataset for evidence-based risk assessment.
A standard method for monetising risk under this framework	To standardise the national approach where risks need to be compared across different decision scenarios using a standard quantification: money.	Cross discipline research project

OBJECTIVE – WORK BREAKDOWN STRUCTURE (Packages for future development)

Ref.	Objective	Tasks	Priority	Period	Who	Cost (Hours /$)
	Definition of pipe failure	Develop a definition of pipe failure for each of the 3 waters to account for different mechanisms that each constitute "failure" e.g. pipe break, collapse, blockage To provide a common understanding for pipe failure so that subsequent tasks are founded on the same definitions • Review international literature and practices relevant to pipe failure definitions • Develop a definition of pipe failure that is complete for all failure modes and for each of the 3 waters				
	National pipe failure database	A single source database for storing pipe failure information for all New Zealand pipe network authorities To provide a common database where pipe failure rates and trends can be investigating using data from all of New Zealand. The database will allow pipe failure rates to be analysed for pipes of varying physical states and will inform analytics within other related schemas. Provides a common standard for reporting and describing failures. • Create a database for NZ wide failure reporting • Pilot test database through importing legacy failure records where available • Develop a standard method for reporting and describing failures • Roll out to pipe network authorities with supporting software				

	Likelihood of failure deterioration curves	Creation of deterioration curves that predict the likelihood of various pipe failures. This work is closely related to deterioration curves of other tasks that predict remaining useful life, physical pipe performance, financial performance, and level of service performance Knowledge of pipe failure likelihood will inform all predictive analysis and planning for pipe renewals • Create a set of curves to be used and tested in the first instance based on available international literature and practice • Determine the most influential factors that affect the likelihood of pipe failure • Further research into the relationships to determine relationships between the most influential factors and pipe failure rates • Update curves based on the further research findings				
	Vulnerability to certain risk events	Determine how vulnerable pipes of varying conditions are to a range of expected risk events This research provides the key link between condition and performance for a range of events as defined under the Metadata standards risk schema • Determine which events are most important to investigation, e.g. earthquake, rain events • Develop a number of relationships between condition and performance for each of the events in the first instance based on available international literature and practice • Further NZ specific research into the relationships to determine relationships between events and pipe failure rates • Provide equations/tables/methods to determine vulnerability rates for each of the events researched				
	Spatial tool for assigning vulnerability and likelihood of failure	Developing a spatial tool to assign vulnerability and likelihood of failure to pipes based on spatial features A spatial tool allows vulnerability and likelihood to be assigned automatically and provides efficiencies particularly for large networks • Determine the factors that will be linked to vulnerability and likelihood in the spatial tool • Develop the tool and test over a number of different networks				

Theme: Pipe Inspection and Condition (*All Pipe Materials*)	**Theme ID:** PR5 (Pipe Renewals 5)
Definition (What is it)	**Purpose** (What will it provide / How will it be beneficial)
▪ The condition of a pipe as it relates to its deteriorated state to infer likelihood of performance failure (structural and service) ▪ Inspection / pipe sampling techniques for gathering information relating to pipe condition and assessment ▪ The use of pipe condition data, predicted remaining lifetime and condition grading	▪ Pipe condition as an indicator of performance failure likelihood ▪ For pipe deterioration profiles (linear and / or curves) ▪ Used to assist financial planning and renewal investigation ▪ Justify repair/renewal action or no action ▪ Used to improve confidence in pipe data ▪ Guidance on various inspection techniques (non-destructive and destructive), sampling strategies will help optimise inspection budgets

Current Knowledge (What do we know – policy, guidelines, tools, research)		**NZ/AS Knowledge Rating (H / M / L)**		
New Zealand / Australia		**Reference** (What, Where, Type – Policy (Pol) / Guideline (GL) / Research (Res)		
Ref. ID	**Detail**	**Source**	**Region**	**Type**
PR5-1	Water NZ – Pipe Inspection Manual	Water NZ	NZ	GL
PR5-2	Water NZ – Asbestos Cement Watermain Manual (Currently being revised)	Water NZ	NZ	GL
PR5-3	Water NZ – Visual Assessment of Utility Assets	Water NZ	NZ	GL
PR5-4	Water NZ – New Zealand Infrastructure Asset Grading Guidelines	Water NZ	NZ	GL
PR5-5	Asbestos Cement Pipe Condition Assessment Guidelines	Opus	NZ	GL
PR5-6	Inspection and Test Plan Preparation for Condition Assessment of Pipelines	Opus	NZ	GL
PR5-7	Crush Testing Pipes for Condition Assessment Purposes	Opus	NZ	GL
PR5-8	Water and Wastewater Pipe Bridge Visual Inspections 2012-2014	Opus	NZ	GL

Current Knowledge (What do we know – policy, guidelines, tools, research)				
New Zealand / Australia		**Reference (What, Where, Type – Policy (Pol) / Guideline (GL) / Research (Res)**		
PR5-9	Dunedin City Council Pipe Material Cohort Tables	Opus / DCC	NZ	Pol / GL
PR5-10	DCC Policy Statement	Opus	NZ	Pol
PR5-11	Wellington Water Inspection Test Plan	Opus	NZ	GL
PR5-12	Mackenzie District Council & Clutha District Council Condition Assessment and Inspection Test Plan	Opus	NZ	GL
PR5-13	Auckland Council gravity pipes?			
PR5-14	Condition Assessment Guidelines Stage 1 & 2 ($$$)	WSAA, CSIRO, WERF, WRf	Australia (lead)	GL
PR5-15	Water Pipe Failure Prediction ($$$)	CSIRO	Australia	GL / Res
PR5-16	Sewer Rising Main & Risk Management Manual ($$$)	CSIRO	Australia	GL
PR5-17	Asbestos Cement Pipes Stage 1 & 2 ($$$)	CSIRO	Australia	GL

International (Country of Origin)		Reference (What, Where, Type – Policy (Pol) / Guideline (GL) / Research (Res)		
Ref. ID	**Detail**	**Source**	**Region**	**Type**
PR5-18	Condition Assessment of Wastewater Collection Systems (White Paper) [free]	USEPA	USA	GL / Res
PR5-19	Condition Assessment of Ferrous Water Transmission and Distribution Systems (State of Technology Review Report) [Free]	USEPA	USA	GL
PR5-20	Condition Assessment of Underground Pipes [Free]	USEPA	USA	Res
PR5-21	Asset Management Condition Assessment Techniques	Saskatchewan Ministry of Municipal Affairs	USA	Res
PR5-22	Condition Assessment Strategies and Protocols for Water and Wastewater Utility Assets – 3048	Water Research Foundation	USA	GL
PR5-23	Condition Assessment of Water Pipes ($$$)	National Research Council	Canada	GL
PR5-24	Manual of Sewer Condition Classification 5th Edition (£38)	Water Research Council	UK	GL
PR5-25	Guidance Manual for the Structural Condition Assessment of Trunk Mains (£55)	Water Research Council	UK	GL

Experts / Leading Practitioners / Independent Assessors		
Name	**Subject Area**	**Company**
John Black / Adam Wheeldon	CT Scanning of AC, Concrete, PE and PVC pipe samples	Opus
	p-CAT Pipe wall condition assessment	Detection Services
	p-CAT-AC Pipe wall condition assessment	Detection Services
	smart-CAT Pipe wall condition assessment	Detection Services
	inSCAN-Internal inspection	Detection Services
	Vid-CAT Internal inspection	Detection Services
	PipeDiver® Internal inspection, Condition Assessment	Pure Technologies
	Sahara Pipeline Inspections - Condition Inspection of Gravity Sewers and Culverts	Pure Technologies
	The Sahara® - Pipeline Inspection System Gross Metal Loss Inspection	Pure Technologies
	The Sahara® - Pipeline Inspection System Sonar Profile Surveys	Pure Technologies

Theme Gaps (Identify what is missing, why it is important, and what does it look like)		
Gap (What is missing)	**Value** (Why is it important)	**Objective** (What does it look like i.e. National Database)
TG5-1 Identify primary, secondary and tertiary pipe materials in NZ	Focus on the most commonly installed pipe materials (past and present), to help prioritise the investigations, effort, research, development of process etc.	Likely a spreadsheet identify the pipe materials and may include quantities on a national basis. Could be split water, wastewater and stormwater or compiled purely on material.
TG5-2 Pipe data cleansing process'	Enables the asset owner to develop a better understanding and confidence in their data. Provides support to pipeline renewal programmes when no / limited condition of the pipeline is unknown (medium to long term planning support).	Development of data-strings to be applied to GIS data. Provides a level of confidence in the known information and allows risk to be applied to any decision making *(Document / Data-String Examples)*.
TG5-3 National deterioration profiles (linear / curved) for most pipe materials, including weightings.	To provide more certainty around generic pipe material base life's to assist in risk profiling, expected intervention and renewal planning.	Develop deterioration profiles for various pipe materials *(Document / Deterioration Profiles [graphs])*.
TG5-4 National guidance, acceptance and advice regarding the advantages and limitations of pipe inspection techniques and technologies currently available.	To provide a consistent understanding of the various inspection techniques and technologies and the type of outcomes each provide. This will support the asset owner in determining the most appropriate techniques and technologies to address the individual requirements.	National approach to better understand the advantages and limitations of each of the techniques and technologies and the practicality of application and interpretation of the results. *(Guidelines / Flow Chart / Advantages-Limitation Tables)*. Develop a national focus group to provide independent appraisals as new / refined techniques and technologies are developed *(Custodian)*

Theme Gaps (Identify what is missing, why it is important, and what does it look like)		
Gap (What is missing)	**Value** (Why is it important)	**Objective** (What does it look like i.e. National Database)
TG5-5 A standardised pipe condition assessment process	Provide a practical, pragmatic and defendable approach for the asset owner. Justifies the financial investment with a sustainable approach. This would provide a consistent approach across the industry, while allowing the uniqueness of each asset owner's network to be allowed for.	Develop guidelines to enable the asset owner to improve they knowledge and understanding of the condition of their piped network, limitations and provide confidence and renewal decision making to be auditable and defendable *(Document / Policy / Flow Chart)*. A national approach to allow consistency to be applied across the industry. *(How To Document / Flow Charts / Templates)*.

OBJECTIVE – WORK BREAKDOWN STRUCTURE (Packages for future development)

Ref.	Objective	Tasks	Priority (H / M / L)	Period (Months)	Who	Cost (Hours /$)
PR5-1	Determine this is good practical nationally Provide gap analysis	• Review of existing manual • Review revised manual • Identify gaps	M	5-8	Project Max / Phil McFarlane	? 20hrs
PR5-2		• Review of existing manual • Revised manual • Identify gaps	M	5-8	John Black / Adam Wheeldon	5hrs 5hrs
PR5-3	Determine this is good practical nationally Provide gap analysis	• Review of manual • Understand application for buried structures	L	9-12	James Thorne / Liam Foster	20hrs 20hrs
PR5-4		• Review of manual • Understand application for buried structures	L	9-12	James Thorne / Liam Foster	20hrs 20hrs
PR5-5	Are the guidelines demonstrating good practice? Suitable for national use	• Review guidelines • Determine if there is a national application • Can processes / templates be developed	L	9-12	John Black / Jonathan Morris	15hrs 15hrs
PR5-6		• Review document • Assess process • Assess practical application • Can templates be developed to support a national approach	M	5-8	Adam Wheeldon Jonathan Morris	25hrs 25hrs
PR5-7	Suitable document to base national approach on	• Review process • Assess if guidelines are required • Determine how / if this can support other national processes & assessments	M	5-8	John Black / Adam Wheeldon	15hrs 15hrs

PR5-8	Is the methodology suitable for national application	• Review reports • Understand process (inspections – data collection – reporting) • Determine if a practical and pragmatic methodology for national application could be developed / needs to be developed	L	9-12	Adam Wheeldon Dan Johnson	20hrs 10hrs
PR5-9	Is the approach suitable to build a template(s) for national application	• Review documents • Determine quantum of updates required	M	5-8	Adam Wheeldon Dan Johnson	20hrs 10hrs
PR5-10	Is the approach suitable to build a template(s) for national application	• Review document • Understand scope and drivers • Determine if it can be used to develop (part or full) a methodology for national application	L	9-12	Dan Johnson / Phil McFarlane	40hrs 20hrs
PR5-11	Is the approach suitable to build a template(s) for national application	• Review document • Understand limitations • Compare to other approaches • Determine of a national approach would be beneficial	M	5-8	Adam Wheeldon Jonathan Morris	20hrs 20hrs
PR5-12	Is the approach suitable to build a template(s) for national application	• Review document • Understand limitations • Compare to other approaches • Determine of a national approach would be beneficial	L	9-12	Adam Wheeldon Dan Johnson	25hrs 25hrs

PR5-13	Is this suitable to build a template / process for national application	• Review document • Understand limitations • Compare to other approaches • Determine of a national approach would be beneficial	L	9-12	Phil McFarlane	40hrs
PR5-14	Determine use in NZ / Determine adaptability for NZ use.	• Review and compare to local / national practice. • Identify good work practice / processes • Determine what (if any) practices could benefit NZ practice / policies	H	1-4	Adam Wheeldon John Black James Thorne	30hrs 30hrs 30hrs
PR5-15	Determine use in NZ / Determine adaptability for NZ use.	• Review and compare to local / national practice. • Identify good work practice / processes • Determine what (if any) practices could benefit NZ practice / policies	H	1-4	John Black Jonathan Morris	30hrs 30hrs
PR5-16	Determine use in NZ / Determine adaptability for NZ use.	• Review and compare to local / national practice. • Identify good work practice / processes • Determine what (if any) practices could benefit NZ practice / policies	H	1-4	Adam Wheeldon	30hrs
PR5-17	Determine use in NZ / Determine adaptability to support NZ practice	• Review and compare to local / national practice. • Identify good work practice / processes • Determine what (if any) practices could benefit NZ practice / policies	M	5-8	Adam Wheeldon John Black	20hrs 20hrs
PR5-18	Is this good practice / can it be adopted / modified for NZ use	• Review and compare to local / national practice. • Identify good work practice / processes • Determine what (if any) practices could benefit NZ practice / policies	M	5-8	Adam Wheeldon John Crawford	10hrs 40hrs

PR5-19	Is this good practice Would it benefit NZ practices and conditions	• Review and compare to local / national practice. • Identify good work practice / processes • Determine what (if any) practices could benefit NZ practice / policies	M	5-8	Willie Mandeno Jonathan Morris	30hrs 30hrs
PR5-20	Is this good practice Would it benefit NZ practices and conditions	• Review and compare to local / national practice. • Identify good work practice / processes • Determine what (if any) practices could benefit NZ practice / policies	M	5-8	Willie Mandeno / John Black	25hrs 25hrs
PR5-21	Is this good practice Would it benefit NZ practices and conditions	• Review and compare to local / national practice. • Identify good work practice / processes • Determine what (if any) practices could benefit NZ practice / policies	H	1-4	Paul Carran	30hrs
PR5-22	Is this good practice Would it benefit NZ practices and conditions	• Review and compare to local / national practice. • Identify good work practice / processes • Determine what (if any) practices could benefit NZ practice / policies	H	1-4	Adam Wheeldon / John Black	30hrs 30hrs
PR5-23	Is this good practice Would it benefit NZ practices and conditions	• Review and compare to local / national practice. • Identify good work practice / processes • Determine what (if any) practices could benefit NZ practice / policies	H	1-4	John Black / Jonathan Morris	25hrs 25hrs
PR5-24	Is this good practice Would it benefit NZ practices and conditions	• Review and compare to local / national practice. • Identify good work practice / processes • Determine what (if any) practices could benefit NZ practice / policies	L	9-12	Adam Wheeldon	40hrs

PR5-25	Is this good practice Would it benefit NZ practices and conditions	• Review and compare to local / national practice. • Identify good work practice / processes • Determine what (if any) practices could benefit NZ practice / policies	M	5-8	Adam Wheeldon / John Black	25hrs 25hrs
TG5-1	Develop an understanding of pipe materials, quantities at a national level	• Define pipe materials used by TLA's • Develop a primary, secondary and tertiary list of pipe materials • Develop process to better understand material / age / quantities • Set foundation for focused / prioritised pipe inspection and condition process	H	1-4	Adam Wheeldon Simon Dellis Sam Millar	30hrs 30hrs 40hrs
TG5-2	Develop an understanding and promote the importance of pipe data confidence	• Better understand the quality of pipe data • Identify potential developments to determine data validity (desk top) • Identify approach / process for national application	H	1-4	Adam Wheeldon Dan Johnson Simon Dellis Sam Millar	30hrs 20hrs 40hrs 40hrs
TG5-3	Determine the primary, secondary and tertiary pipe materials for deterioration profiles	• Determine good practice to develop deterioration profiles for pipe materials • Identify conservatism and sensitivity values to enable asset owners to refine deterioration profiles to suit their local conditions	L	9-12	Adam Wheeldon John Black Phil McFarlane Simon Dellis Sam Millar	25hrs 25hrs 25hrs 40hrs 40hrs
TG5-4	To be able to produce clear guidelines to assist asset owners on technologies available	• Review theoretical studies and outcomes • Review case studies • Discuss advantages / limitations with owners of the technologies • Discuss results generated with asset owners who have used the technologies	M	5-8	Adam Wheeldon John Black Jonathan Morris Phil McFarlane	20hrs 40hrs 40hrs 40hrs

TG5-5	Understand the value and necessity for a national process for pipe condition assessment	• Determine what processes and technologies ideally suit the primary pipe materials, followed by secondary and tertiary pipe materials • Develop a pragmatic and practical approach (from identifies which pipes, where, how, when etc.).	M	5-8	Adam Wheeldon John Black Jonathan Morris Phil McFarlane	40hrs 40hrs 20hrs 20hrs

Theme: Forecasting Remaining Pipe Life	Theme ID: PR6 (Pipe Renewals 6)
Definition (What is it)	**Purpose** (What will it provide / How will it be beneficial)
▪ Remaining pipe life examines the situation where the benefit of renewing a pipe outweighs the benefit of maintaining an existing pipe in financial terms ▪ A firm definition of useful life is not yet developed and requires further research and understanding of where this aspect fits into the overall decision making framework	▪ The purpose of useful asset life provides is to provide the quantified justification for renewing, taking action (or no action) on pipe. ▪ Development of this theme is needed to standardise how useful life is calculated and applied within the overall pipe renewal framework. ▪ Useful life is a financial assessment that will optimise spending to get the maximum utility from existing and new assets

Current Knowledge (What do we know – policy, guidelines, tools, research)		NZ / Australia		International	
New Zealand / Australia		**Reference** (Where, Type – Policy / Guideline / Research)			
Ref. ID	**Detail**	**Organisation**	**Region**	**Type**	
P6_1	**NZ Metadata standards** These will provide the necessary definitions surrounding the development of a pipe-renewal-specific definition and application of "useful life". It is important that this definition in congruent with the overall objectives of this theme	Opus/Metadata standards project	NZ	Standard	
P6_2	**dTIMS (Deighton Total Infrastructure Management System)** Tool for deterioration modelling and life-cycle cost analyses of infrastructure assets	IPWEA/IDS	NZ/International	Modelling tool	
International		**Reference** (Where, Type – Policy / Guideline / Research)			
Ref. ID	**Detail**	**Organisation**	**Country**	**Type**	
P6_3	**Degradation of Polyethylene Pipes**	Affinity Water Ltd, Hatfield, UK.	UK	White paper	
P6_4	**Condition Assessment of Underground Pipes**	US EPA	USA	Technical guidance	

Experts / Leading Practitioners		
Name	**Subject Area**	**Company**

Theme Gaps (Identify what is missing, why it is important, and what does it look like)		
Gap (What is missing)	**Value** (Why is it important)	**Objective** (What does it look like i.e. National Database)
A common definition of useful life. The definition needs a common understanding of the financial reasoning behind determining useful life	To standardise the national approach and support individual stakeholders who are assessing useful life	National guideline that fits in with the overarching pipe renewal framework
A means for apply useful life consistently into the decision making processes within the overarching pipe renewal framework	To standardise the national approach and support individual stakeholders who are assessing useful life	A standard application for how to derive useful life and how to use the information as part of the overarching pipe renewal framework
A set of graphs and relationships to be used in the prediction of remaining useful life. The deterioration/modelling curves need to be consistent with the application of useful life for pipe renewal	To provide evidence-based predictive tools to allow renewal scenarios and decision making to be accurate and efficient.	Cross discipline research project to produce a set of relationships and curves depicting useful life and how it is impacted by various factors

OBJECTIVE – WORK BREAKDOWN STRUCTURE (Packages for future development)

Ref.	Objective	Tasks	Priority	Period	Who	Cost (Hours /$)
	Definition of useful life	Develop a definition of useful life for each of the 3 waters to account for the financial impact of operating a pipe with poor performance vs the cost of renewal or rehabilitation. Also to take into account risk profiles To provide a common understanding of useful life that subsequent tasks are founded on the same definitions • Review international literature and practices relevant to useful asset life, especially for pipes • Develop a definition of useful pipe life that is complete and relevant for 3 waters pipes				
	Standard framework for application of remaining useful life	A standard process for how pipe network authorities should plan activities based on useful life pipe data. The development of guidelines that recommend intervention points (eg when to inspect, budget for replacement and take action) for pipes depending on remaining useful life and cost/benefit scenarios To provide a financially sound process for intervention points that are evidence based and associated with remaining pipe useful life • Develop a theoretical framework for intervention points based on international literature and practice • Financial research into best practice and standard methods for monetising pipe risk profiles • Financial research project on the cost benefit of intervention points for 3 waters pipes to determine optimal timing • Update framework based on financial research				

	Useful life deterioration curves	Creation of deterioration curves that predict the useful life of various pipe failures. This work is closely related to deterioration curves of other tasks that predict likelihood of failure, physical pipe performance, financial performance, and level of service performance Knowledge of pipe useful life will inform all predictive analysis and planning for pipe renewals • Create a set of curves to be used and tested in the first instance based on available international literature and practice • Determine the most influential factors that affect pipe useful life • Further research into the relationships to determine relationships between the most influential factors and pipe useful life • Update curves based on the further research findings				

Theme: Business Processes	Theme ID: PR7 (Pipe Renewals 7)
Definition (What is it)	**Purpose** (What will it provide / How will it be beneficial)
▪ This is a wider ranging theme that looks at a number of surrounding business processes that could be enhanced to allow the renewal and asset management of pipe networks to be more clear, consistent and effective ▪ Subcategories within the business processes theme include: better business cases for 3waters, allocation of risks, procurement standards, whole of life cost modelling, and inheritance issues	▪ Each task proposed in this section provides an opportunity to enhance the renewal and asset management processes for pipe networks to be more clear, consistent and effective ▪ Clear delegations of risk and responsibility for pipe networks (particularly the apportionment of risks between central government/local council/insurers in extreme events eg Christchurch earthquakes) ▪ Pathways for new and innovative processes to be adopted into the national approach to pipe renewal

Current Knowledge (What do we know – policy, guidelines, tools, research)	NZ / Australia		International	
New Zealand / Australia	**Reference** (Where, Type – Policy / Guideline / Research)			
Ref. ID	**Detail**	**Organisation**	**Region**	**Type**
P7_1	Local Government Funding Agency (LGFA)	LGFA	NZ	Industry agency
P7_2	Local Government Efficiency Expert Advisory Group	LGNZ	NZ	Report
P7_3	Water Study Waikato: Business Case Analysis for Water Services	Hamilton, Waipa and Waikato Councils	NZ	Consultant Report
International	**Reference** (Where, Type – Policy / Guideline / Research)			
Ref. ID	**Detail**	**Organisation**	**Country**	**Type**
P7_4	Consultation on the future management of private water supply pipes	UK Govt	UK	Consultation document
P7_5	Reforming procurement practices for underground water infrastructure	SUMMIT journal	Canada	Industry article

Experts / Leading Practitioners		
Name	**Subject Area**	**Company**

Theme Gaps (Identify what is missing, why it is important, and what does it look like)		
Gap (What is missing)	**Value** (Why is it important)	**Objective** (What does it look like i.e. National Database)
Standards for information reporting and benchmarking	To standardise information reporting and access. Improvements in this area will give better visibility of the state of 3water infrastructure and the risk profiles and ownership.	National reporting standards. This will partly be covered by the Metadata Standards
A means for monetising risk and pipe renewal and maintenance expenditure to build better business cases.	The financial impact of asset management decisions will be better known once established methods of monetising elements such as risk and future spending are developed	A standard method for monetising risk, and standard cost parameters for pipe renewal and maintenance
A pathway for new business practises such as pipe procurement and non-price attributes for pipe materials to become adopted in the industry	New models for doing business in the 3 water pipe infrastructure sector provide potential benefit but uptake can be impeded by the more institutionalised business methods	Pipe procurement guidelines and non-price attributes of pipe materials and methods

OBJECTIVE – WORK BREAKDOWN STRUCTURE (Packages for future development)

Ref.	Objective	Tasks	Priority	Period	Who	Cost (Hours /$)
	Baseline reporting information	Develop a minimum baseline of reporting information to be shared between network authorities, government, and insurers (eg useful asset life and cost of replacement) To provide a common understanding of asset valuation and risk between all stakeholder parties • Review current practice • Develop a minimum baseline • Submit to stakeholders for feedback • Publish document with minimum baseline standards and roll out to network authorities				
	Standard method of monetising risk	Develop a standard method of monetising risk (and in combination with the common definition of useful asset life) to support better business cases for 3 waters pipes To provide a financially sound process for monetising asset risk profiles for 3 waters pipes so that business cases can be examined more quantitatively • Financial research into best practice and standard methods for monetising pipe risk profiles • Publish standard document for monetising pipe risk profiles				
	Pipe procurement guidelines	Production of a guideline on different procurement methods with commentary on when and why to use each different method To provide a single source of wisdom for pipe procurement methods to give opportunities for different procurement models to be adopted where appropriate so that efficiencies can be achieved • Research of international literature and practices for different pipe procurement models to determine which models may be appropriate for NZ • Further research into the benefits and issues with the possible procurement models • Publish a guideline document available to industry that sets out the benefits, issues and appropriateness of various procurement models (as well as presenting findings to industry groups, councils, conferences etc)				

	Non-price attributes of pipe materials and methods	Research the economic impact of choosing different pipe materials or construction methods in comparison to the lowest conforming price materials and method To quantify the economic benefit of using materials and methods that may not be the lowest outturn cost or are less common • Research of life cycle costing between alternative materials and methods • Publish a guideline document available to industry that sets out the benefits, issues and appropriateness of various alternative materials and methods				
	Standard installation methods	Provide a standard pipe installation method for various pipe materials and ground conditions Seeking efficiencies by standardising construction methods. Improves quality assurance of installation methods by standardising approaches. • Research current methods of installation • Publish a pipe installation standard document to industry				
	Standard cost of pipe installation	Provide a standard costing regime for pipe installation Reduce variance in pipe installation costs. Reduce variance in the calculation of replacement costs of pipes. • Research current methods of pipe costing • Publish a pipe installation costing guideline document to industry				

Theme: Data Management	Theme ID: PR8 (Pipe Renewals 8)
Definition (What is it)	**Purpose** (What will it provide / How will it be beneficial)
▪ The data management systems for 3 waters to support the implementation of the Metadata Standards	▪ The Metadata standards provides a "step change" in the national management of infrastructure systems. The purpose of this theme is to provide the necessary supporting guidelines so that the Metadata Standards gets maximum uptake and utility within the 3 waters industry sector. To support the common data standards a further set of standard practices will be required.

Current Knowledge (What do we know – policy, guidelines, tools, research) — NZ / Australia | International

New Zealand / Australia — **Reference** (Where, Type – Policy / Guideline / Research)

Ref. ID	Detail	Organisation	Region	Type
P8_1	**NZ Metadata standards** These will provide the framework and specification for standardising data. All tasks within this theme have the purpose of supporting the implementation of the Metadata Standards	Opus/Metadata standards project	NZ	Standard
P8_2	The Thirty Year New Zealand Infrastructure Plan	NZ Govt	NZ	National Plan
P8_3	D-SPEC Digital Data Specifications (Drainage)	A Spec (Australia)	Aus	Data specification

International — **Reference** (Where, Type – Policy / Guideline / Research)

Ref. ID	Detail	Organisation	Country	Type

Experts / Leading Practitioners

Name	Subject Area	Company
Philip McFarlane	Water asset management	Opus
Haydn Read	NZ Metadata Standards	LINZ

Theme Gaps (Identify what is missing, why it is important, and what does it look like)		
Gap (What is missing)	**Value** (Why is it important)	**Objective** (What does it look like i.e. National Database)
The NZ Metadata Standards provides a "step change" in the national management of infrastructure systems. A number of new additional standard systems will be required to successfully implement the Metadata Standards	To support the investment in NZ Metadata Standards to ensure successful implementation	Further standards and specifications for implementing the Metadata Standards

OBJECTIVE – WORK BREAKDOWN STRUCTURE (Packages for future development)

Ref.	Objective	Tasks	Priority	Period	Who	Cost (Hours /$)
	Metadata Standards Implementation	Metadata standards will provide data consistency. They will enable data to be shared, aggregated and analysed in more detail than is currently possible. Provides a consistent approach to managing asset data that allows informed decisions to be made with confidence • Conduct a stocktake on legacy asset data and compare against metadata standards - what data is available, it's form, what are the gaps • Prioritise actions for data cleansing and develop tools to support delivery for 3Water Assets • Develop standards for capturing new asset information i.e. standard As-Builts • Guidance on data structure to be captured				
	Metadata Data Prioritisation	Develop a programme for the rollout for metadata standards implementation Focus on the data that will provide greatest value in the short-term • Literature search to better understand the factors which impact on performance				

	Data Cleansing for Metadata Implementation	New Zealand programme to convert legacy data to the new metadata standard following prioritisation recommendations (project 8.2) To allow smarter decisions to be made based on metadata standards project • Identify pilot areas (Small, medium networks) to run data cleansing tools and evaluate outputs • Develop a data cleansing programme to convert legacy data • Rollout data cleansing programme				
	Data Collection Guideline (s) and Specification (s)	Develop a guideline for pipe data collection Ensure a consistent approach is being adopted throughout New Zealand to retain data confidence and overall knowledge of the asset, supporting future decision making • Identify type of data collection practices and specifications required • Review available data collection practices and supporting documentation for managing QA, H&S and work practices (work instructions) • Develop a quality plan (specification) for undertaking data collection to provide consistency • Develop a guideline detailing data collection methods and when to use with supporting information				
	Data Storage System Specification (s)	Specification for data management and recommendation of appropriate software To ensure investment is made in the right storage systems and that critical data is available and secure • Identify what system requirements are required and available data management systems for collating and managing pipe asset data. Identify what • Review and test types of systems and how this will need to integrate with other systems • Specification will outline quality assurance, data maintenance and checking, off-site access, back-up of critical data i.e Cloud base				

Theme: Building standards and constructability	**Theme ID:** PR9 (Pipe Renewals 9)
Definition (What is it)	**Purpose** (What will it provide / How will it be beneficial)
▪ Improve pipeline asset life and performance by lifting standards of pipeline construction by e.g. providing better information on elements of the construction process ▪ Provide guidance for use of new technologies where guidance is not readily accessible e.g. trenchless technology and innovative methods	▪ Better understanding, and where useful standardisation, allows for more efficiency and certainty ▪ A central source for guidance will support individual TAs ▪ A formal pathway for new methods to be accepted into the NZ industry increases opportunity for innovation and improved outcomes

Current Knowledge (What do we know – policy, guidelines, tools, research)

New Zealand / Australia		**Reference** (What, Where, Type – Policy / Guideline / Research)		
Ref. ID	Detail	Source	Region	Type
P9_1	Approved Code of Practice for Excavations and Shafts for Foundations	Worksafe NZ	NZ	Guideline
P9_2	SCIRT Dewatering Guideline	SCIRT	NZ	Guideline
P9_3	SCIRT pipelining specification	SCIRT	NZ	Guideline
P9_4	AS/NZS Pipe installation standards including but not limited to: 2566 Buried flexible pipes 3725 Design and installation of buried concrete pipes 2032 Installation of PVC pipe systems 2033 installation of polyethylene pipe systems 3690 Installation of ABS pipe systems 2041 Buried corrugated metal structures NZS 7643 Code of practice for the installation of unplasticized PVC pipe systems	Relevant Standards organisations	AU, NZ	Guideline
	AS/NZS 3500 Plumbing and drainage	"	AU, NZ	Guideline
	Standards for materials	"	AU, NZ, World	Guideline
	Standards for couplings	"	AU, NZ, World	Guideline

	Standards for other components e.g. couplings, covers etc	"	AU, NZ, World	Guideline
	NZ Building Code Handbook	MBIE	NZ	Guideline
	National Code of Practice for Utility Operators' Access to Transport Corridors	NZUAG	NZ	Guideline
	(others)			

International (Country of Origin)		**Reference** (What, Where, Type – Policy / Guideline / Research)		
Ref. ID	**Detail**	**Source**	**Region**	**Type**
P9_5	Multiple country-specific standards covering the same items as above. Most (western) countries have codes that cover these.	Standards organisations	World	Guideline
P9_6	ISO standards covering the same items as above.	Standards organisations	World	Guideline

Experts / Leading Practitioners		
Name	**Subject Area**	**Company**
(Individuals to be sourced in consultation with Water NZ)		
John Black	Pipe materials	Opus
Jonathan Morris	Pipe materials	Opus
	Concrete pipe	Hynds/Humes/CPAA
	Plastic pipe industry	
	Geotechnical	
	Hydrogeological	
Tony Gordon	Pipeline design	Opus
	Pipeline design	Stds Committee members
	Risk practitioner	

Maurice Lubbock	Pipe rehabilitation specialist	GHD
Philip McFarlane	Pipe rehabilitation specialist	Opus
	Trenchless technology specialist	ASTT

Theme Gaps (Identify what is missing, why it is important, and what does it look like)

Gap (What is missing)	**Value** (Why is it important)	**Objective** (What does it look like i.e. National Database)
Lack of understanding of influencing factors	Poor material section and poor installation shorten life of pipe assets and other impacted assets (e.g. road carriageways)	Best Practice Guideline(s) for material selection, pipeline design, trench excavation, dewatering, pipe installation, restoration. Awareness workshops
Poor understanding of risk factors	Too conservative design practice stifles innovative design and best-value approach	Include in Best Practice Guideline(s) (need to recognise acceptable risk profiles vary so Guideline needs to cover a range of options)
Age of Standards mean sometimes they do not capture current best practice	Best value opportunities lost	Forum of best practice practitioners to provide interim updates to Standards
Funding for Standards updates not available	Best value opportunities lost	More regular Standards updates
Pathway for innovative methods to be adopted nationally	Best value opportunities lost	National panel for innovative methods

OBJECTIVE – WORK BREAKDOWN STRUCTURE (Packages for future development)						
Ref.	**Objective**	**Tasks**	**Priority**	**Period**	**Who**	**Cost (Hours /$)**
	Understand current state of understanding on issues	1. Ask Water NZ and libraries for information 2. Collate information	Short-term	2 months	Opus	
	Ensure best people are consulted	1. Using known contacts and with assistance from WaterNZ identify others who can contribute 2. Approach individuals to ascertain interest and areas of expertise 3. Seek comment on other perceived gaps	Short-term	2 months (concurrent)	Opus	
	Further identify gaps	1. Collate information 2. Identify gaps		2 months		
	Prioritise gap filling	1. Develop a priority plan 2. Gain agreement on priorities 3. Put time and cost estimates on items		2 months		
	Develop guidelines	1. Gain agreement/funding for development 2. Develop guideline(s)		6 months		
	Promote guidelines	1. Prepare presentation material 2. Workshop material				
	Improve Standards update process	1. Discuss with WaterNZ and MBIE what existing process is and ways of improving it	Short-term		Opus	
	Determine best method of providing guidance on new technology	1. Discuss with WaterNZ and other industry players	Short-term		Opus	

Theme: Life-cycle cost of pipes	Theme ID: PR10 (Pipe Renewals 10)
Definition (What is it)	**Purpose** (What will it provide / How will it be beneficial)
▪ The economic analysis of life-cycle costing of pipes taking into account the pipe capex, maintenance cost, residual risks and economic effects of the pipe performance.	▪ Optimised total expenditure by providing the appropriate actions at the right time ▪ Justification for investment decisions

Current Knowledge (What do we know – policy, guidelines, tools, research)

New Zealand / Australia

Ref. ID	Detail	Reference (What, Where, Type – Policy / Guideline / Research) Source	Region	Type
P10_1	Gold Coast Water – Unit rates review 2008	Gold Coast City Council	Aus	Consultant report
P10_2	Life Cycle Analysis of Water Networks	CSIRO	Aus	Research paper
P10_3	Water Utility Service Performance and Benchmarking	Opus	NZ	Report

International (Country of Origin)

Ref. ID	Detail	Reference (What, Where, Type – Policy / Guideline / Research) Source	Region	Type
P10_4	LCCA of wastewater pipeline network in Oslo	International Conference on Urban Drainage	Scotland, UK	Conference paper

Experts / Leading Practitioners

Name	Subject Area	Company

Theme Gaps (Identify what is missing, why it is important, and what does it look like)		
Gap (What is missing)	**Value** (Why is it important)	**Objective** (What does it look like i.e. National Database)
Specific research into the economic life cycle cost of different 3 waters pipelines	Cost effective approaches can be utilised to determine the most appropriate least whole life cost option. To provide robust and quality data for whole life cycle costing	Pipe performance measures referenced in terms of life-cycle costing. Standard operational and maintenance rates
Agreed best practice points of intervention for optimal return on infrastructure investment	Optimised total expenditure by providing the appropriate actions at the right time.	A procedure for finding and documenting the optimal intervention points

OBJECTIVE – WORK BREAKDOWN STRUCTURE (Packages for future development)

Ref.	Objective	Tasks	Priority	Period	Who	Cost (Hours /$)
	Pipe Performance Measures	A specification that sets out pipe performance measures and how they should be applied and used to provide justification for investment decisions Optimised total expenditure by providing the appropriate actions at the right time • Review pipe failures data within New Zealand and Internationally to identify key indicators for assessing performance with a LoS/Community and financial focus • Develop a specification for key performance indicators (KPIs) and parameter definitions (Condition Type – burst frequency, blockages) (Performance Type – Water quality failures, customer complaints, environmental impact) • Provide provisional weightings for each parameter and test i.e. burst frequency (15%), blockages (30%), Overflows (50%) • Develop a pipe performance grading system as a measure of the performance of the asset and its ability to maintain adequate levels of service				

	Operational and Maintenance Rates	Unit rate guide for operational and maintenance actions and capital expenditure for pipe renewals and rehabilitation methods. To provide robust and quality data for whole life cycle costing • Review OPEX and CAPEX methods and cost rates across New Zealand • Develop a standard rate for typical O&M procedures (jobs) • Develop cost rate for intervention options consisting of opex and capex solutions				
	Life-Cycle Cost Prediction	A procedure which seeks to identify the most appropriate solution to network problems by considering various types of intervention options mainly consisting of opex and capex solutions. Cost effective approaches can be utilised to determine the most appropriate least whole life cost option • Literature search to identify what tools/approaches are available for assessing expenditure based on intervention methods i.e. IDS approach? • Develop financial tool to predict opex /capex methods				

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