REPORT

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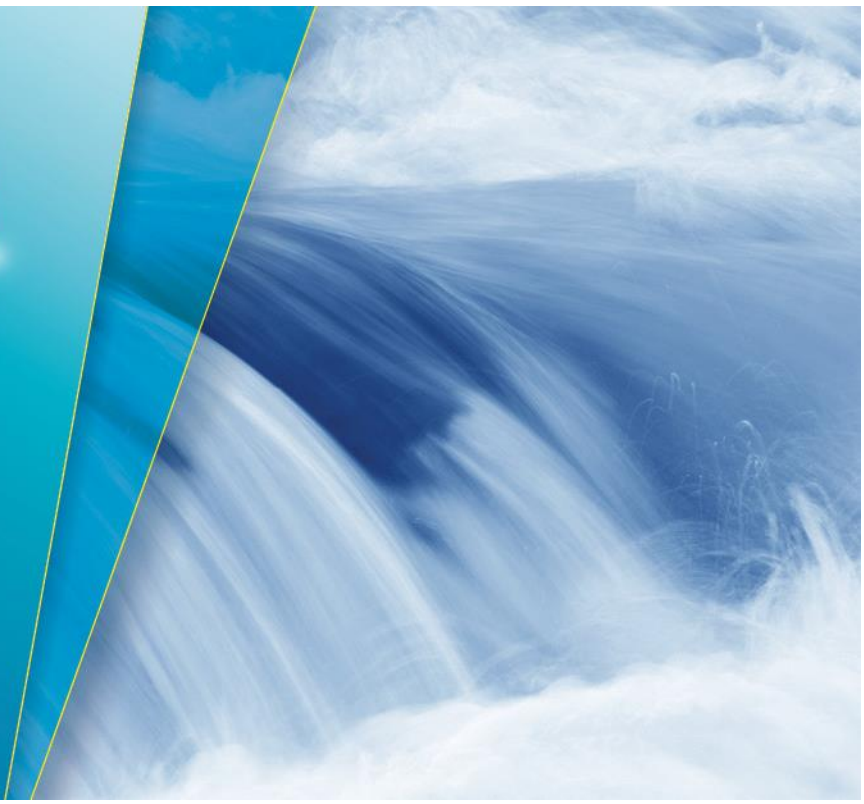

Hiding in plain sight

An overview of current practices, national benefits and future challenges of our flood protection, river control and land drainage schemes

Prepared for
River Managers' Special Interest Group
Prepared by
Tonkin & Taylor Ltd
Date
April 2018
Job Number
62067.v1.1

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Document Control

Title: Hiding in plain sight					
Date	**Version**	**Description**	**Prepared by:**	**Reviewed by:**	**Authorised by:**
March 2018	1.0	Final version for release	C Giberson	P Cochrane	P Cochrane
April 2018	1.1	Opex costs added to Appendix A	C Giberson	P Cochrane	P Cochrane

Distribution:

River Managers' Special Interest Group	electronic copy
Tonkin & Taylor Ltd (FILE)	electronic copy

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Executive summary

Water management has become a pressing concern for many New Zealanders from grassroots level through to our national political dialogue.

In recent years, conversations about water management have tended towards how our communities can be better provisioned by resilient 'three waters' services, and the limits of our regulatory approaches on maintaining an acceptable amount and quality of water within our lakes, streams and rivers.

Flooding is the most common natural hazard that New Zealanders face. The role that a low profile and separate layer of infrastructure – the vast network of critical flood protection, river control and land drainage schemes – plays within water management has generally been absent from these conversations.

Over 100 towns and cities across the country have been built alongside rivers or on flood plains. Between the 1930s and 1980s, billions of dollars were spent building stopbanks, pump stations and related assets to protect our citizens and lifeline infrastructure, and enable regional economic stability by preventing regular flooding of our communities and productive land.

New Zealand has come to rely on the protection provided by over 350 flood protection, river control and land drainage systems. The effectiveness of these systems combined with the low frequency, high impact nature of flooding keeps public awareness of flood risk to life, property, livelihoods and the economy low – until there's a failure – and flood risk is expected to increase as society anticipates more extreme weather events and sea level rise.

This has prompted New Zealand's river managers – the stewards of these critical assets – to stop and think about how well their current practices will serve future generations of New Zealanders.

Environmental engineers, Tonkin + Taylor, and resource economists, Covec, were commissioned to conduct this national assessment of current practices, quantify benefits at a national level and identify future challenges associated with the flood protection, river control and land drainage schemes managed by regional councils.

This national assessment is intended to raise the profile of this hidden infrastructure and its importance. It has not been possible to fully explore all of the issues and challenges identified in this report. It is expected that this report will serve as a starting point for more detailed assessments of these issues.

Takeaway messages

This national assessment has found that, regional councils appear to have, overall, adopted an appropriate level of asset management, renewal and upgrade processes. However, the methods used by councils to understand, interpret and approach both technical and non-technical river management issues are inconsistent, and this variability may unknowingly expose some New Zealand communities to a greater likelihood of asset failure and its consequences.

These infrastructure assets are vital in protecting and supporting New Zealand communities and economic development. These assets protect around 1.5 million hectares of land – including highly productive primary production land, and many urban areas. This report does not cover the effect that historic and current land use practices have had on our water ways, which undoubtedly have a place in water management conversations.

All of these assets have a combined capital and operational value of $3.6 billion, and in aggregate for every dollar of invested there is some $55 of avoided losses on average. These assets provide $13 billion in benefits to New Zealand every year.

Many technical and non-technical challenges face the sector tasked with managing our river management infrastructure. This river management sector is relatively small, with limited capacity and capability to address these challenges. Therefore the sector will need to work together across organisational boundaries, and in collaboration with external parties to adequately face these challenges and serve future generations of New Zealanders.

Key findings

Survey data. Data for this assessment was gathered from over 350 flood protection, river control and land drainage schemes managed by regional councils throughout New Zealand. These schemes directly protect some 1.5 million hectares of land which comprises about 5.5% of New Zealand's land mass, and includes highly productive primary production land, and both small and large urban areas.

Scheme funding. Funding is generally provided through targeted rates on rateable land that either directly or indirectly benefits from the schemes. The schemes also protect or provide a benefit to non-rateable land (Crown estate), regionally significant public utilities – such as three waters infrastructure – and nationally significant infrastructure such as roading and rail networks, and energy and telecommunication links. Current funding practices impact on how councils manage and deliver flood protection, river control and land drainage infrastructure and services.

Scheme management. Indicators of how well the schemes are being managed include infrastructure asset condition, criticality, and performance. Our assessment of asset condition scores for river management infrastructure indicates that, on the whole, regional councils appear to have adopted appropriate levels of asset management, renewal and upgrade processes for various asset types. However, documented asset management practices are variable between councils, and do not generally describe asset criticality and asset performance.

Asset value. The infrastructure assets comprising the schemes – stopbanks, dams, river structures, flood gates, drains, pump stations, and the like – have a collective replacement value of $2.3 billion. In comparison to other publically owned infrastructure, the national value of this infrastructure is small.

Cost benefits. The schemes included in our assessment provide an estimated Net Present Benefit of $198 billion ($NZD at 2016), over $11 billion each year. These benefits includes the wider social and economic benefits of the schemes. The Net Present Cost to operate, maintain and rebuild the schemes total an estimated $3.6 billion ($NZD at 2016).

Consistency. Variability in how councils understand, interpret and approach both technical and non-technical flood protection and land drainage issues was found throughout this assessment. Nationally consistent methodologies in how flood protection and land drainage infrastructure are managed and delivered would assist in ensuring an appropriate level of investment in this infrastructure and associated services to New Zealand communities. We would also expect this to deliver financial efficiencies for ratepayers.

Communication. Many councils describe large flood events to their stakeholders in terms of occurrence probabilities, which has limitations due to the uncertainties associated with estimating these probabilities. It would be useful for the river management sector to reframe these community discussions with a primary focus on event consequences with less emphasis on event probabilities. This is in line with the risk based approach now prescribed in the Resource Management Act. These discussions may be most effective when they include data and illustrative scenarios which convey the consequences and residual risks of events, and community and scheme vulnerabilities.

Technical and non-technical challenges. Many technical and non-technical challenges face the river management sector. These challenges include understanding the impact of more frequent extreme rainfall events, involving much wider stakeholder groups in decision making, scheme funding and affordability, and how environmental, social and cultural values are considered in river management

activities. Many of the challenge themes are similar to those that councils face in the delivery of other infrastructure and services, but the specific challenges facing the river management sector and how it may respond to them are unique.

Given the relatively small and distributed nature of the asset base managed by the sector, a coordinated response from river managers and collaboration with external parties is required to address these challenges. For this to happen effectively, there needs to be further standardisation of whole-of-life asset management and resilience planning methodologies across councils, and development of an enabling environment which supports knowledge sharing and knowledge transfer. Inter-organisational transfers and collective staff training would help staff to work effectively across organisational boundaries. Consideration should be given to how these types of cross-organisational activities are collectively funded.

We've identified a number of areas for further work which will help the river management sector to better address issues and challenges that it faces. **Our recommendations** are to work across the following themes:

Working together across the sector

a Provide resources to river managers to enable and support a step change in professional collaboration and development across regional council river managers and with external organisations, so that the sector as a whole can proactively respond to the challenges identified in this national assessment.

Communication and enabling environment

b Communicate as 'one voice' the state of the river management sector and the outstanding value the schemes provide to New Zealand as identified in this assessment.

c Proactively engage as 'one voice' in discussions about potential changes to the regulatory environment (for example, managing natural hazards under the RMA, development of National Disaster Resilience Strategy, other RMA reforms, etc) so the views of the river management sector are understood by central government.

d Develop methodologies and programmes to enable river managers to effectively engage with stakeholders on the schemes, and their benefits, including how the schemes work and help manage flood risk.

Quality people

e Increase the capacity and capability of the sector to deliver future-focused, successful community outcomes, which may include formal graduate intake and professional development programmes.

f Partner with tangata whenua to bring new skills, networks, and views into the river management sector.

Practices, methodologies and standards

g Benchmark each regional council against key metrics including staffing levels, service levels, funding levels, and the like.

h Prepare nationally consistent asset management methodologies, metadata standards, targeted asset management maturity levels, funding and payment metrics, reporting frameworks (e.g. AMPs), and level of service standards.

i Assess on a scheme by scheme basis asset criticality and performance against asset condition, to better understand how well infrastructure assets are being managed including how river structures integrate with flood protection schemes, and identify where key vulnerabilities lie.

j Compile a technical body of knowledge to establish best practice, and identify knowledge gaps or uncertainties, and research needs (e.g. water quality, risk communication, climate change, river geomorphology).

k Carry out an assessment of cultural and environmental values of the schemes and take them into account when assessing the schemes' benefits and costs.

l Develop a river management resilience framework and supporting decision making tools to enable regional councils to better inform and position communities so they respond to shocks and stressors with minimum disruption, and to formally include environmental, social, cultural and economic values into projects.

m Understand the financial viability of the schemes and common funding issues (asset revaluation, depreciation and renewal expenditure, borrowing, etc) on a national scale and their implications on future affordability of the schemes, and what the impacts of removing protection or decreasing a level of protection may be.

n Investigate alternative funding rationales and strategies, for example, to avoid a higher proportion of scheme costs sitting with fewer ratepayers and to recognise the wider benefits of the schemes.

1 Introduction

In conjunction with Tonkin + Taylor and Covec, regional councils have combined forces to carry out a national assessment of river control, flood protection and land drainage schemes (collectively, 'the schemes', or 'river management activities') that are managed by regional councils. The River Managers' Special Interest Group, which reports to the Regional Council CEO Special Interest Group, has overseen this project. Specifically through this project we have sought to identify at a national level:

- The location and state of the schemes' infrastructure assets
- The benefit they provide in protecting and developing communities and economies
- The quality of asset management and ability to deliver community agreed service levels
- The present and future opportunities and challenges associated with river control, flood protection and land drainage

The outcomes from the project will enable the river management sector to:

- Understand the current state of the schemes in New Zealand
- Communicate the nation's reliance on and value of investment in river control, flood protection and drainage schemes
- Quantify the investment in the schemes' infrastructure by regional councils and their predecessors
- Quantify annual maintenance/renewal expenditure in maintaining agreed levels of service defined in asset management plans
- Quantify the benefits of these schemes to the community
- Understand the extent to which work or plans are in place to meet increasing expectations of communities which benefit from them, including the predicted implications of climate change on the schemes
- Identify strengths and weaknesses in current institutional performance of the river management sector

1.1 Background

Regional councils have been responsible for the construction, maintenance and improvement of river control, flood protection and land drainage scheme infrastructure since 1989. This is when the powers of catchment boards under the Soil Conservation and Rivers Control Act 1941 Act were vested in regional councils and unitary authorities. Prior to 1989 this infrastructure was developed and managed by catchment authorities — often working in partnership with central government who helped fund this infrastructure.

In the absence of seeing this infrastructure tested in significant rainfall or flood events, communities may well forget the purpose, and therefore the importance and value, of this infrastructure. By its very nature, over time this infrastructure simply becomes part of the landscape.

The lack of widespread awareness of the role, state and value of this infrastructure to New Zealand may have contributed to its general omission from the National Infrastructure Unit's *Thirty Year New Zealand Infrastructure Plan 2015*.

1.2 Methodology

Tonkin + Taylor conducted a review of spatial (GIS-based) information provided by regional councils of their river control, flood protection, and drainage schemes to identify the areas that benefit from the schemes' infrastructure assets.

With this spatial information we undertook a high level analysis of the economic benefit afforded by the schemes. The cost benefit analysis was carried out by our project partner Covec, a company specialising in natural resource economics. In carrying out this analysis, Covec undertook an international literature review of flood protection economic evaluation methods to inform their analysis.

We also received detailed responses from the river manager at each regional council in the form of a written questionnaire. Questions and responses covered factors that influence how river management services are delivered. Topics were categorised under the broad headings of People, Equipment, Environment, Processes, Organisation, and External (PEEPOE framework). The questionnaire is included in Appendix C.

The matters raised by river managers, and the outcomes of our analyses were discussed with the river managers' project steering group in three workshops held throughout the course of this project.

Our research covered the way councils manage delivery of other infrastructure assets in NZ, the difference between delivery of river management infrastructure to other infrastructure, and how the history of river management in NZ has influenced the sector we have today. Where appropriate, we've drawn on our knowledge and experience of working within the river management sector.

1.3 Limitations

This project has relied on information provided to us by river managers and regional councils. Most of this information was provided via Asset Management Plans, councils' GIS and ratings databases, and through responses by river managers to the PEEPOE questionnaire. Data was also gathered through follow up questions and workshops with the river managers' project steering group.

Information provided to us has been taken at face value, with data anomalies queried and checked with relevant river managers. A detailed review of all information provided is outside the scope of the project. Based on our experience and understanding, we consider that the results of our analysis represent a reasonable overview of NZ's state of management of river control, drainage and flood control schemes, and their value. Limitations include:

- Data was provided by all regional councils and unitary authorities with the exception of Nelson and Marlborough
- Data provided by Otago Regional Council had some gaps in asset value that could not be resolved within the constraints of this project
- Schemes managed by territorial local authorities — such as Christchurch City Council — are outside the scope of this project[1]
- The economic assessment and cost benefit analysis are based on 2016 costs
- The cost benefit analysis does not attempt to fully account for all environmental, social, and cultural benefits and costs of the schemes as discussed in Section 5.3 Exclusions on page 19.

[1] The scope of this survey included regional councils and the regional council functions of unitary authorities.

2 The nature of river management and land drainage activities

River control and flood protection activities exist to reduce the severity of impacts on communities from low frequency, large flooding events. Land drainage activities allow the use of low lying land predominantly for agricultural production or improve the productivity of agricultural land. These activities provide communities with greater security from substantially mitigated flooding risks and confidence from better knowledge of how frequently their land may be inundated. This has enabled economic growth through increased productivity of land.

Ironically, the success of these schemes, particularly in reducing the impacts of flooding, has resulted in a low awareness of these activities amongst the wider community. Failure of this infrastructure to provide a particular level of service – or even recognition that the infrastructure exists – is often not immediately apparent.

The relatively infrequent nature of these events stands in contrast to other infrastructure assets — for example, the wastewater, stormwater, or transport links that are utilised on a near daily basis. While many of those assets, such as underground pipes, are unseen and taken for granted by the general public, it quickly becomes apparent when a council doesn't deliver these services to the standard expected by the community. Feedback to councils and agencies responsible for managing these assets is often immediate and very clear. However, similar feedback is infrequently available for river management activities because a scheme's performance may only be tested once or twice within a generation.

A combination of event infrequency and subsequent lack of performance feedback presents many challenges to the river management sector. Not least, are communities' engagement and understanding of their infrastructure needs, and the ability of managers to secure and maintain funding for scheme assets. These challenges are discussed further in this report.

3 Brief history of river management and land drainage in New Zealand

The economic, social, and cultural development of New Zealand is intricately linked with human interventions to manage the direction of rivers to protect people and property from flooding, and to drain low-lying land for productive use.

Settlement in New Zealand has primarily occurred on and around the coastal alluvial flats near rivers and streams. In locating settlements on flat land adjacent to rivers and surrounding land, Maori and European settlers were able to use the rivers to their advantage. Fertile soils, drinking water, and transportation links were afforded by these waterways. Conversely, this also exposed them to the hazards of flooding, erosion and sedimentation, and water borne diseases.

Early activities and legislation (1850s-1900s)

By the mid-19th century, settlers had initiated various river management and land drainage works on an ad hoc basis in an attempt to guard against the hazards posed by the rivers. Although various pieces of legislation were enacted to formalise river management and land drainage activities (notably the River Boards and Land Drainage Acts of 1908), a fairly piecemeal and localised approach to these activities continued until the late 1930s. By this time soil erosion and its impact on waterways had become prevalent issues in catchments nationwide. These issues, and the Esk Valley floods of 1938, prompted a response from central government that resulted in the passing of the Soil Conservation and Rivers Control Act 1941.

Formation of the Soil Conservation and Rivers Control Council (1941)

The 1941 Act established the Soil Conservation and Rivers Control Council (SCRCC), which centralised soil conservation, river management and land drainage activities under the Ministry of Works and Development, and gave rise to a formal, interventionist approach to river management and land drainage activities. During this time central government subsidised capital river management works of between 30% and 87.5% of the capital cost of the works. Higher subsidies were provided for larger, nationally important schemes, and lower subsidies provided for smaller, locally important schemes. Although most of the works were subsidised in the order of 70% to 75%, the local funding contribution engendered a sense of ownership among communities that benefitted from the works.

The 1941 Act also established Catchment Boards (or Commissions) and made them responsible for river functions and objectives. These included controlling or regulating water flows into and out of watercourses, preventing or lessening the likelihood of overflow and associated damage from watercourses, preventing or lessening erosion, and promoting soil conservation.

To achieve these objectives Catchment Boards were given powers to compulsorily acquire land, make by-laws, control land use, undertake river management and land drainage activities, and recover their costs from communities. However instead of acting unilaterally with these powers, the Catchment Boards endeavoured to take a collaborative approach with communities, who in many instances were financially assisted to undertake works at the direction of Catchment Board staff.

It was under this regulatory regime, with some later amendments[2], that most of the country's now existing river control, flood protection, and land drainage infrastructure was planned, designed and constructed.

[2] Notably the Water Pollution Act 1953, the Water and Soil Conservation Act 1967 (which also created the National Water and Soil Conservation Authority), the Town and Country Planning Acts of 1953 and 1977, and the Local Government Act 1974.

The rise of environmental awareness and an understanding of the interconnection between land use and water quality in the 1960s and 1970s led to a raft of regulatory changes. Most notable was the Water and Soil Conservation Act 1967. This created the National Water and Soil Conservation Authority (NWASCA) and generally resulted in the morphing of catchment boards and commissions into regional water boards. Boards were charged with responsibility for regulating any significant uses of water through a water rights system.

Local government reforms (1980s-current)

The major state sector and local government reforms[3] of the 1980s essentially completed the transition of river management and associated soil conservation functions to regional authorities. These reforms included the dissolution of NWASCA and the allocation of its responsibilities and those of the Catchment Boards to regional councils. Central government retained a limited transfer policy and monitoring role through the Ministry for the Environment.

These reforms also eliminated central government funding of capital and maintenance works for river control, flood protection, and land drainage activities. Prior to NWASCA's abolition, central government's servicing department (the Ministry of Works and Development) typically applied a funding vote of more than $40 million per annum to support these functions. These are now largely paid for through rates levied by regional councils.

Transitioning from a position of very substantial Government funding support to total reliance on local and regional funding sources posed many political and technical challenges. In general, however, that transition has been successfully made, albeit with some community-negotiated changes to protection service levels, both upwards and downwards.

Regional councils are now the organisations primarily responsible for soil conservation, maintenance and enhancement of water quality, water quantity, aquatic ecosystems, and the avoidance or mitigation of natural hazards. But whereas the primary consideration of most river management infrastructure built during the mid-20th century was safety and economic growth – social, cultural, and environmental values of water resources are now prominent policy and activity drivers. This can be seen in the start of freshwater co-management with tangata whenua, more collaborative engagement on freshwater issues from statutory and industry organisations, and the National Policy Statement for Freshwater Management.

River management activities supporting safety and economic growth still remain vitally important to the communities and primary industry sector that directly benefit from them, as well as their supporting infrastructure, such as the nationally important transport and telecommunications links that underpin the functioning of modern society.

[3] Including the Local Government Act 1989 and the Resource Management Act 1991.

4 An overview of New Zealand schemes

So what do New Zealand flood protection and land drainage schemes look like? This section provides a snapshot of river control, flood protection, and land drainage schemes. It covers what's included and excluded from a scheme, the extent and quantity of the schemes nationally, and the state of the infrastructure assets within schemes.

Figure 4.1: Stopbanks protected Palmerston North from inundation during the 2004 Manawatu River flood event. Source: teara.govt.nz

4.1 Schemes – what's in and what's out?

The river management activities undertaken by regional councils generally deal with the management of rainfall runoff on a catchment scale, and are broadly classed into four scheme types based on the nature of their benefit as follows:

- Land drainage – getting water off the land into a stream or river
- Flood protection – keeping water in the river and off land
- River management – keeping the river where it is
- Tidal inundation – keeping sea water off land

Each regional council classifies schemes and their infrastructure assets into these four broad types. This publically available information has been used in this assessment.

What is not covered under these schemes and is excluded from this assessment is the management of stormwater runoff in urban or semi-urban settings by city and district councils. The management of some flood control and coastal protection schemes by city and district councils such and the Avon-Heathcote River in Christchurch or the Maitai River in Nelson is also excluded[4].

Figure 4.2: Surface flooding on productive land served by land drainage scheme, Waikato 2008. Source: Waikato Regional Council.

Additionally, regional councils undertake soil conservation activities to reduce soil erosion and in some instances these are key elements of flood protection schemes. Although these soil conservation activities are important to water quality and overall catchment health, assessing the state and value of them is beyond the scope of this assessment.

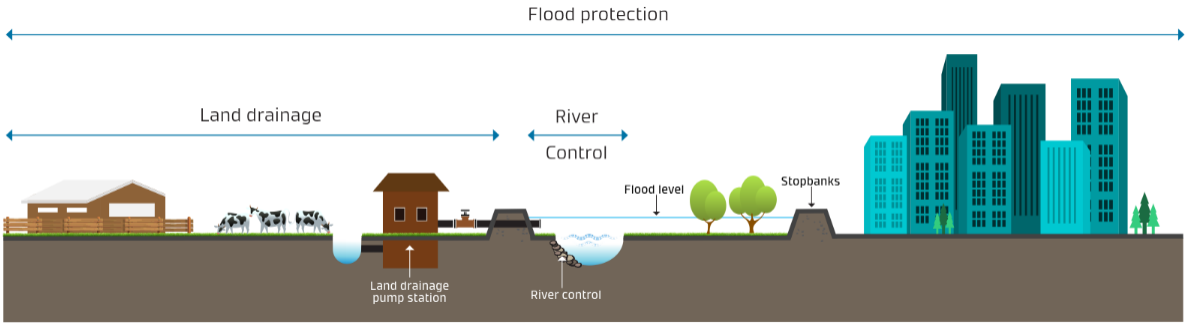

Figure 4.3: Schematic of flood protection, river control and land drainage services

4.2 Scheme extents

The geographic coverage of river control, flood protection and land drainage schemes can be described as follows:

- **Infrastructure assets** – physical structures which protect land from being inundated by water, for example, stopbanks, flood gates, pump stations, and river training works

Capital and operational expenditure associated with these assets are generally funded by rates from the following areas:

- **Direct benefit areas** – areas of land which are immediately protected from flooding by infrastructure assets and would otherwise be subject to flooding during storm events up to and including the size of a design event
- **Indirect benefit areas** – areas of land which sit outside the direct benefit area and receive a 'community good' from protection afforded by the infrastructure assets

[4] The scope of this survey included regional councils and the regional council functions of unitary authorities.

- **Exacerbator areas** – upper areas of land in a catchment that contribute runoff to low-lying portions of a catchment and contribute to drainage or flooding issues experienced in these lower lying areas

The direct benefit areas for all scheme types across New Zealand is shown in Figure 4.4, below.

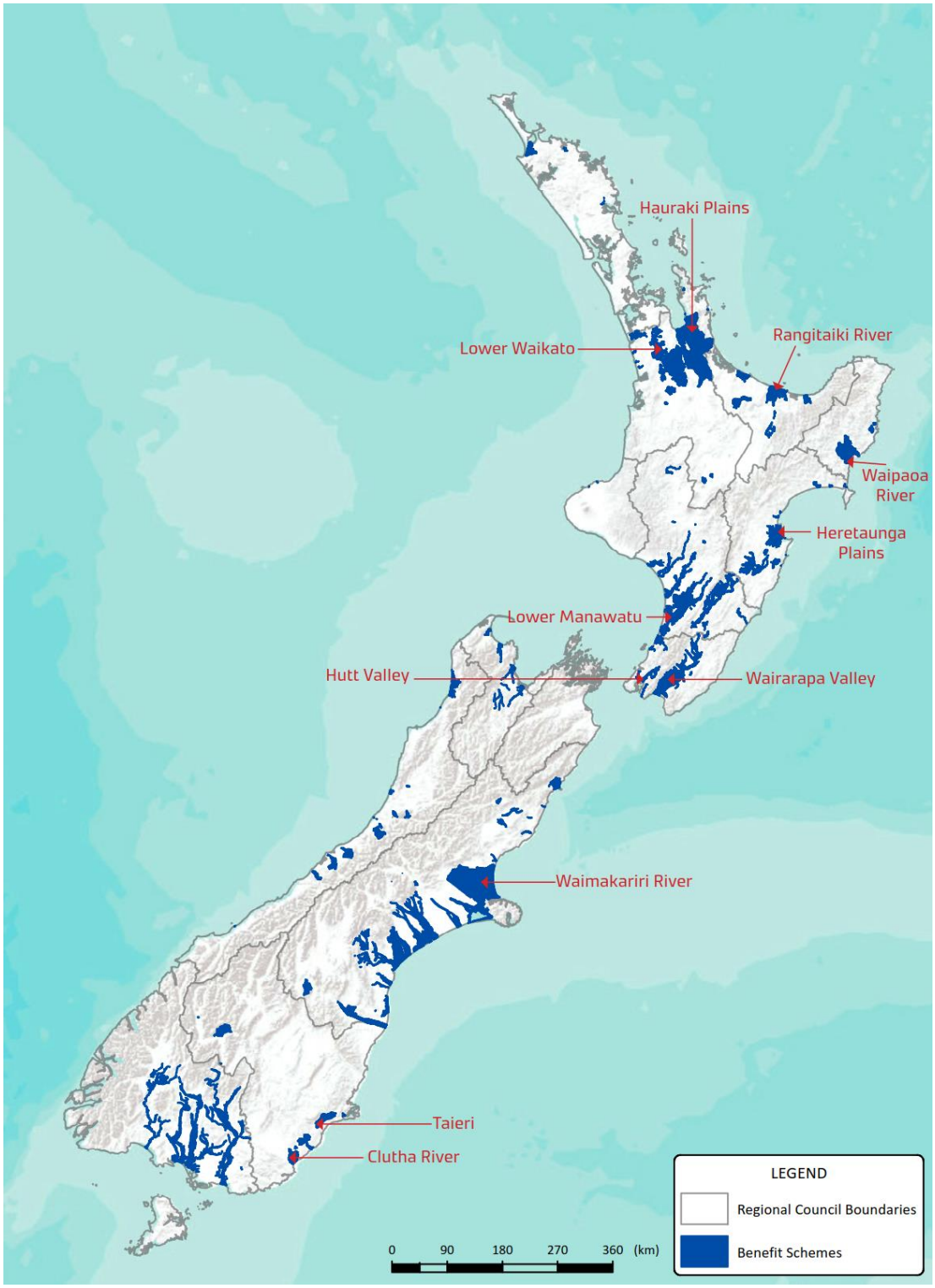

Figure 4.4: Extent of direct benefit areas

4.3 Number of schemes

There are around 364 river control, flood protection, and land drainage schemes administered by regional councils across New Zealand that have been included in this assessment.

A breakdown of the number of scheme types by region is given in Table 4.1 below. We found that how the nature of scheme benefit is described varies depending on the scheme. Specifically, some schemes provide a single benefit type only, while other schemes provide multiple benefits. For those schemes that provide multiple benefit types, the available data was insufficient to understand the proportion of benefit type.

For example, there are a large number of schemes in the Waikato that are identified as only providing drainage benefit. This is contrasted with the Kaituna scheme in the Bay of Plenty that provides flood protection for an event having a 1% Annual Exceedance Probability (AEP) and drainage protection for events up to 20% AEP.

Schemes with multiple benefit types were most common for regional councils in the Bay of Plenty, Hawkes Bay, Manawatu, and West Coast. Future data analysis would be made easier if the schemes or their constituent parts were able to be classed under a single benefit, though we recognise this may be difficult.

Table 4.1: Number of scheme types by region

Council	Benefit Type Flood	Drainage	River Management	Tidal	Mixed Benefit	Total Schemes
Northland	2	0	0	0	1	3
Auckland[1]	-	-	-	-	-	-
Waikato[2]	3	86	0	0	5	94
Bay of Plenty	0	1	0	0	4	5
Gisborne DC	2	17	0	0	0	19
Hawkes Bay	2	0	2	0	21	25
Taranaki	0	0	0	0	2	2
Manawatu	7	6	6	0	15	34
Wellington	51	15	0	0	0	66
Marlborough DC	-	-	-	-	-	-
Nelson CC	-	-	-	-	-	-
Tasman DC	0	0	16	0	6	22
West Coast	3	1	2	1	13	20
Canterbury	15	13	28	0	4	60
Otago	3	3	1	0	1	8
Southland	6	0	0	0	0	6
Grand Total	**94**	**142**	**55**	**1**	**72**	**364**

Notes:

1. Council reported it does not have any relevant schemes under management.
2. No data was provided for schemes protecting urban settlements in Taupo and Thames – Coromandel Districts.

4.4 What schemes protect

The 364 schemes for which data is available provide direct benefit to some 1.5 million hectares of land (about 5.6% of New Zealand's land area). As noted previously, schemes provide benefit beyond the areas of direct benefit. Regional councils recognise this through the identification of indirect benefit areas and exacerbator areas for the purposes of striking a rate to fund the schemes.

In addition to the rateable areas of benefit that schemes protect — or otherwise provide a 'community good' — schemes also protect non-rateable land and regionally and nationally significant infrastructure, including transportation, energy and telecommunication links. For example, State Highway 1, the North Island Main Trunk Line, and a trunk fibre optic cable are protected by the Lower Waikato scheme. Social and cultural infrastructure, for example, the Hutt Hospital and numerous schools, marae, libraries and churches, are protected by the Hutt Valley scheme.

The available scheme rating databases from each region were combined to prepare Figure 4.5, below. This figure shows the four benefit types relative to each other for rateable land area, rateable land value, and rateable capital improvements (capital value less land value).

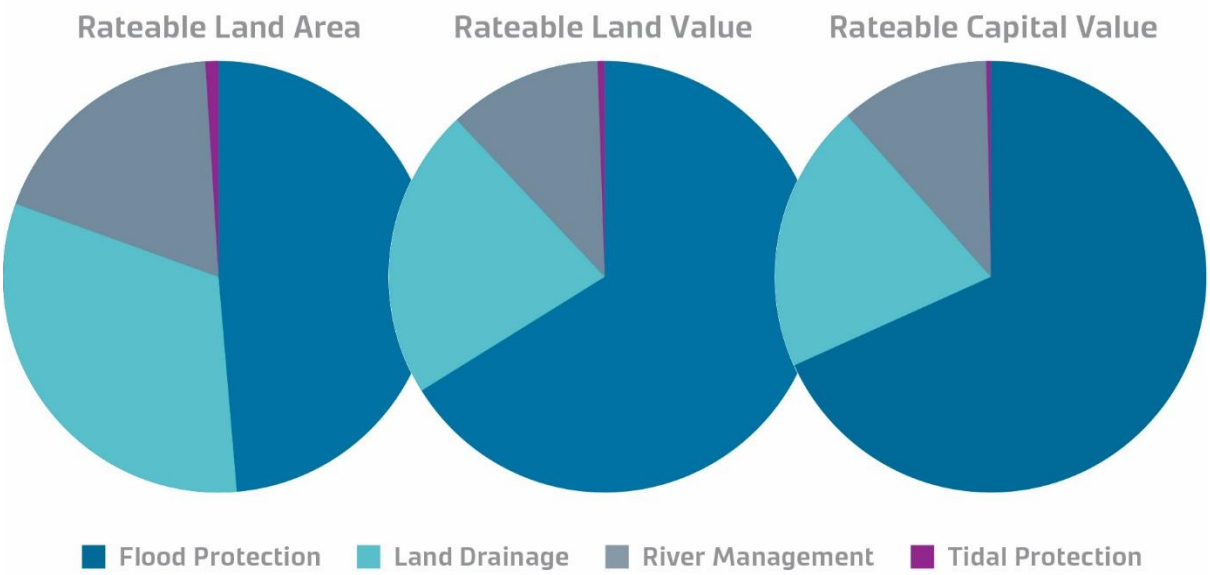

Figure 4.5: Comparison of benefit proportions for rateable area, land value, and improvements value by scheme type based on available data

4.4.1 Discussion

As illustrated in the pie charts, flood protection schemes protect an increasingly greater proportion of rateable land area, land value and capital value compared to other scheme types. This indicates that flood schemes may protect a greater portion of urban land — with capital improvements —than other scheme types.

Land drainage schemes comprise approximately half of the total number of schemes in this assessment. However, they protect a disproportionately small amount of rateable land area, and a diminishing proportion of rateable land value and capital improvements. This is indicative of the more rural nature (primary industry production) of land protected by these schemes.

The same diminishing proportion of rateable land area, value, and capital improvements are observed for tidal protection schemes. Again this is indicative of the rural nature (primary industry production) of land protected by these schemes. For example, the area protected from tidal

inundation in lower Piako River is the largest area of tidal protection benefit, as this scheme covers an extended area of low-lying farmland near or below sea level.

A diminishing proportion of rateable land area, value, and capital improvements is also observed for river management structures. However, these structures are often integral to flood protection schemes. The data does not clearly illustrate a linkage between these structures and the type of land they benefit. Further work would be required to demonstrate this link at a national or regional level.

4.5 Infrastructure assets

4.5.1 Asset value

The total replacement value[5] of river control, flood protection and land drainage infrastructure assets is approximately $2.3 billion. This is about 4.5% of the estimated $45 billion replacement value of assets for three waters infrastructure (drinking water, waste water, and stormwater) as stated in Treasury's Thirty Year NZ Infrastructure Plan 2015-45.

The total replacement value of infrastructure assets (about $2.3 billion) is broken out by asset type in Figure 4.6, below.

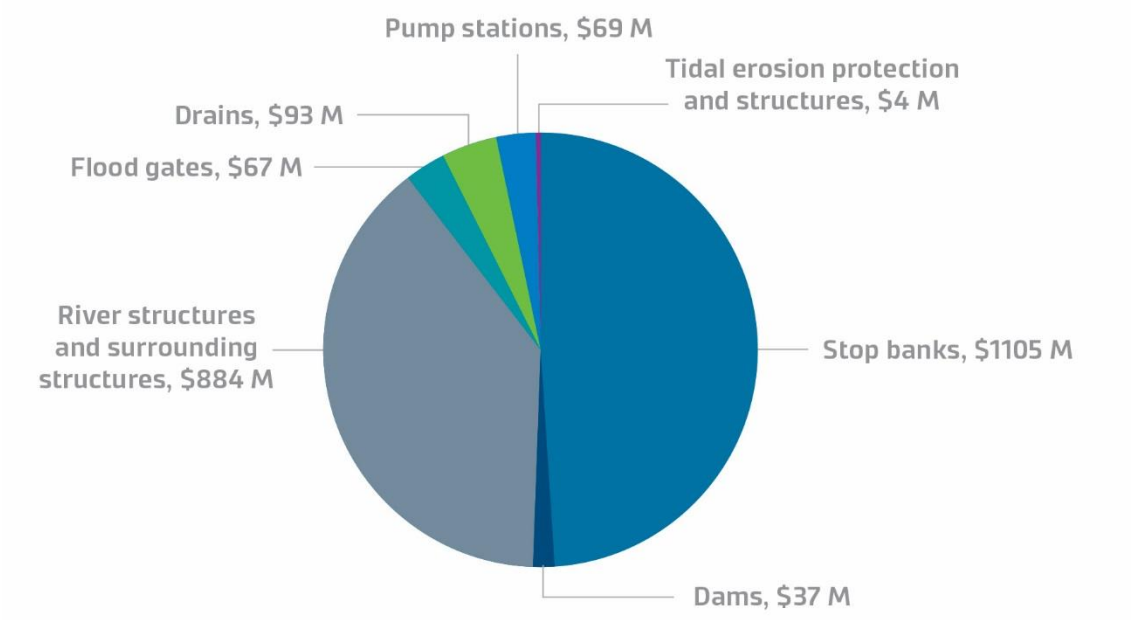

Figure 4.6: Summary of total replacement value by asset type for provided data

Flood protection is generally provided by stopbanks and dams. Across the assessed councils, these assets make up about half of the capital investment but provide almost three quarters of the capital value protected. In other words the capital value of land protected by stopbanks and dams is disproportionally higher than the asset value.

The same pattern can be seen for assets including pump stations, floodgates and drains which provide land drainage. These assets make up about a tenth of the total capital investment and from this provide benefit to around a fifth of the capital value protected.

River structures, such as groynes, rockwork and other armouring, training banks, weirs, and trees/vegetation, are associated with both flood protection and river management as noted above.

[5] Total replacement value of the infrastructure assets is based on the valuations published in the asset management plans available for this assessment.

However, based on the data provided it is difficult to apportion value of these assets to those benefit types. We note that river structures are often capital intensive and integral to flood protection schemes, and the river structures themselves may not directly relate to a large area of benefit.

Further work is needed to better understand how river structures integrate with flood protection schemes, and how the river structure capital and economic values could be apportioned to discrete benefit types.

4.5.2 Asset condition

A fundamental aspect of asset management is the systematic inspection and recording of asset condition. The International Infrastructure Management Manual (IIMM) 2015[6] uses a five point scale for asset management scoring. For the purposes of this assessment we have used the IIMM qualitative descriptors (Excellent/Good/Average/Poor/Failed) instead of a one to five scale.

Based on the data available for this assessment, it appears all regional councils use the NAMS scale. However, there is little, if any, asset condition assessment standardisation across the councils or even within a council. In our experience, the way asset condition is assessed can vary depending on who undertakes the assessment and when the assessment is carried out. For example, staff who are very familiar with an asset can become complacent with its condition and overlook some shortcomings. Additionally, in absence of condition scoring guidance staff departures can result in new staff using a different reference point to score asset condition.

The sector has recognised that standardisation in asset condition scoring is important, and has recently developed a stopbank condition assessment framework that all councils should adopt. Development of further assessment frameworks for assets such as for pump stations, floodgates and the like, is beneficial and should be considered by river managers.

The overall condition of river control, flood protection and land drainage infrastructure assets is summarised in Table 4.2, below. Data is based on conditions published in the asset management plans made available for this assessment.

Table 4.2: Asset condition summary

Infrastructure asset type	Condition (qualitative descriptor)
Stopbanks	Average or better
Floodgates	Average or better
Drains	Good or better, some Average
Dams	Average or better
Pump stations	Average to Good, some Poor
River structures	Good, some Poor to Average

At an overview level, the asset condition scores suggest regional councils have adopted an appropriate level of asset management, renewal and upgrade according to asset type. Scores also reflect councils' general asset management approach of maintaining stopbanks in perpetuity while river and mechanical structures are worn and then replaced, hence the latter group having a wider range of condition. A summary of regional asset condition by type is included in Appendix A.

The condition of an infrastructure asset does not tell the whole story of how well that asset is being managed. Asset condition needs to be assessed in conjunction with asset criticality and performance

[6] The IIMM 2015 is identified by the New Zealand Asset Management Support Organisation as best practice in asset management.

to understand if and when maintenance or renewal work needs to be carried out. Asset criticality and performance are generally not well documented by regional councils, and an assessment of these criteria is beyond the scope of this report. Further work to assess these factors against asset condition would require a more in depth scheme by scheme review.

4.6 Regional breakdown

A regional breakdown of the number of schemes by type is given in Figure 4.7, below. There is significant variation between councils in terms of the size and make up of schemes. Figure 4.7 is ordered by total value of each councils' scheme assets with two cohorts emerging. One is a cohort of councils — Canterbury, Manawatu, Waikato, Greater Wellington, Bay of Plenty and Hawkes Bay — covering a significant overall proportion of asset value. The other, a cohort of councils collectively making up a smaller proportion of the asset value.

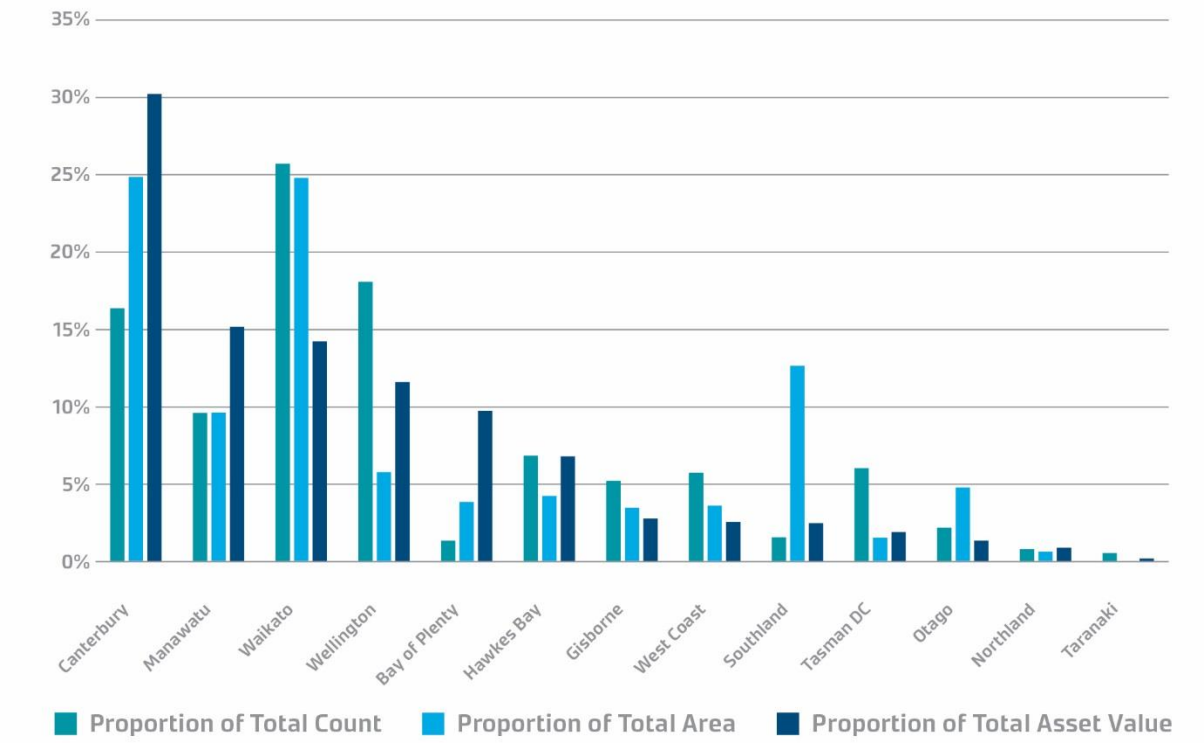

Figure 4.7: Scheme attributes as proportion of assessed total

5 Economic value of the schemes to New Zealand

A cost benefit analysis was undertaken by economic consultants, Covec, to help define the total economic value of the schemes included in this assessment. Covec's report is attached in Appendix E and its analysis is summarised in this section.

Covec estimates that the river control, flood protection, and land drainage schemes included in this assessment provide a Net Present Benefit of $198 billion ($NZD at 2016). Using the sum of the regional councils' published infrastructure asset replacement values and operational expenditure of $3.6 billion ($NZD at 2016), the average Benefit Cost Ratio (BCR) of these schemes to New Zealand is approximately 55:1. For comparison, large infrastructure projects in New Zealand, such as those for the NZ Transport Agency, are considered economically viable if the BCR is greater than 1:1[7]. As such, with an average BCR of 55:1, these schemes provide outstanding value for money to New Zealand.

5.1 Methodology

A cost benefit analysis (CBA) of the schemes was undertaken by adding all of the estimated benefits of the schemes and subtracting estimated operational and maintenance costs. To undertake CBA, two scenarios were assessed:

- The factual case – that is the overall benefit to the community with the schemes in place, and
- A counterfactual case – that is the overall benefit to the community where there are no schemes in place

Covec considered three different situations for the counterfactual case, and evaluated situations in terms of the assumptions needed to define them, the analytical problems arising from these approaches, and whether and to what degree any approach adopted is consistent with best practice for CBA.

The counterfactual approach that was used for this analysis assumes that to continue to receive the current scheme benefits, the community is willing to pay an amount equal to value of assets and land currently protected by the schemes. This assumption, which is further described in Covec's report attached in Appendix E, is made on the basis that the owner of the scheme could otherwise remove these assets.

The approach used to evaluate the benefits to the community was predominantly based on the value of damage to residential and other buildings, and the valuation of various land use types that are protected by the schemes. These are described in detail by Covec, and summarised in Table 5.1.

[7] Economic evaluation manual, New Zealand Transport Agency, January 2016.

Table 5.1: Valuation approach by land use and scheme type (Covec 2017)

Land use/ land type	Flood protection	Tidal protection	Drainage	River management
Built-up areas (residential and other buildings	NPV of avoided damage	Value of improvements plus difference in value of land uses	Value of improvements plus difference in value of land uses	Value of improvements plus difference in value of land uses
Other land uses	Greater of NPV of avoided damage or Difference in value of land uses possible with/ without flood protection	Difference in value of land uses possible with/without tidal protection	Difference in value of land uses possible with/ without drainage	Difference in value of land uses possible with/ without river management

For flood protection, the Net Present Value of avoided damage was estimated through the development of flood risk density curves, whereby the annual average damage for an area of land can be determined with and without a scheme in place, as shown in Figure 5.1 below. For the purposes of estimating annual average damages, data from the NZ Insurance Council for floods between 1976 and 2016 was used.

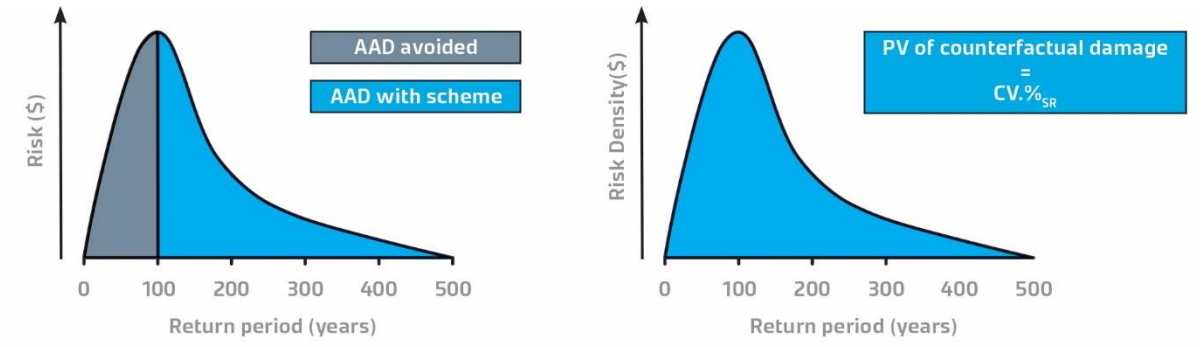

Figure 5.1: Annual Average Flood Damage (AAD), and Average Annual Damage avoided with a flood control scheme in place that has a 100 year return period level of service. The counterfactual is also shown.

Finally, the level of flood damage avoided was modified based on each scheme's benefit rating, as set out in their relevant asset management plans.

For differences in land use, Covec used the difference in value of land based on the current use, and counterfactual use assuming that no scheme was in place.

Covec reviewed potential non-market values such as insurance costs, emergency cost multipliers and health impacts on the community. Based on work carried out for the Greater Wellington Regional Council, Covec adopted a value of 100% of direct damage costs to take account of a range of non-market costs associated with flooding in urban areas. This cost was allocated on a pro rata basis for non-urban areas based on average population densities for rural areas in NZ.

The data used by Covec for this analysis is outlined in their report. It included:

- The flood level of service for the schemes used in this assessment
- The capital value of land within the scheme's benefit area
- The land value within the scheme's benefit area

- The level of benefit provided (low, medium, high)
- Land cover descriptions.

5.2 Results

The results are presented across all schemes assessed and separated into scheme types, and are summarised in Table 5.2 below.

Overall the benefits of the schemes are significant with a Net Present Benefit of approximately $198 billion ($NZD at 2016) at an average Benefit Cost Ratio (BCR) of 55:1. The highest benefits come from flood control, drainage, and mixed benefit schemes followed by tidal and river control schemes.

The annual benefit of over $11 billion provided by the schemes is nearly five times their published infrastructure replacement value. .

Due to the project steering group's concerns of the significantly large difference in benefit calculated for Canterbury region compared with other regions, we reviewed the input data for Canterbury and Wellington regions and performed a few sensitivity checks. In this review we found some differences in how these regions supplied their data and rate their schemes.

However, the differences between Canterbury and Wellington appear to be overshadowed by the relatively large areas of direct benefit, and population within these areas. Using the latest census meshblock information Canterbury has about 350,000 normally resident population in direct benefit areas compared to 75,000 for Wellington's Hutt Valley.

Table 5.2: Estimated benefit (2016 $ million) of flood control, drainage, river management, tidal and multiple schemes

Protection type	Land type	Estimated benefit (PV) ($m)	Annual benefit (at 6% Discount Rate) ($m)
Flood control	Built-up area	$134,601	$7,619
	Other land use type	$12,553	$711
	Total	$147,154	$8,329
Drainage	Built-up area	$12,796	$724
	Other land use type	$629	$36
	Total	$13,424	$760
River Management	Built-up area	$2,167	$123
	Other land use type	$83	$5
	Total	$2,250	$127
Multiple types	Built-up area	$34,631	$1,960
	Other land use type	$895	$51
	Total	$35,526	$2,011
Total		$198,354	$11,228

It should be evident that built-up areas that are protected by these schemes represent the greatest benefit, which together represent over $184 billion NPV or over $10 billion of annual benefit, compared with over $14 billion NPV or an annual benefit nearly $1 billion for other land use types protected by these schemes.

While not all councils are represented in this analysis we consider that the information is sufficient for an evaluation of the benefits of the schemes to be made at a national level. It is expected that inclusion of schemes not included in our analysis would return a similar, outstanding BCR.

Figure 5.2 depicts the cost and benefit of the schemes for each region in our assessment.

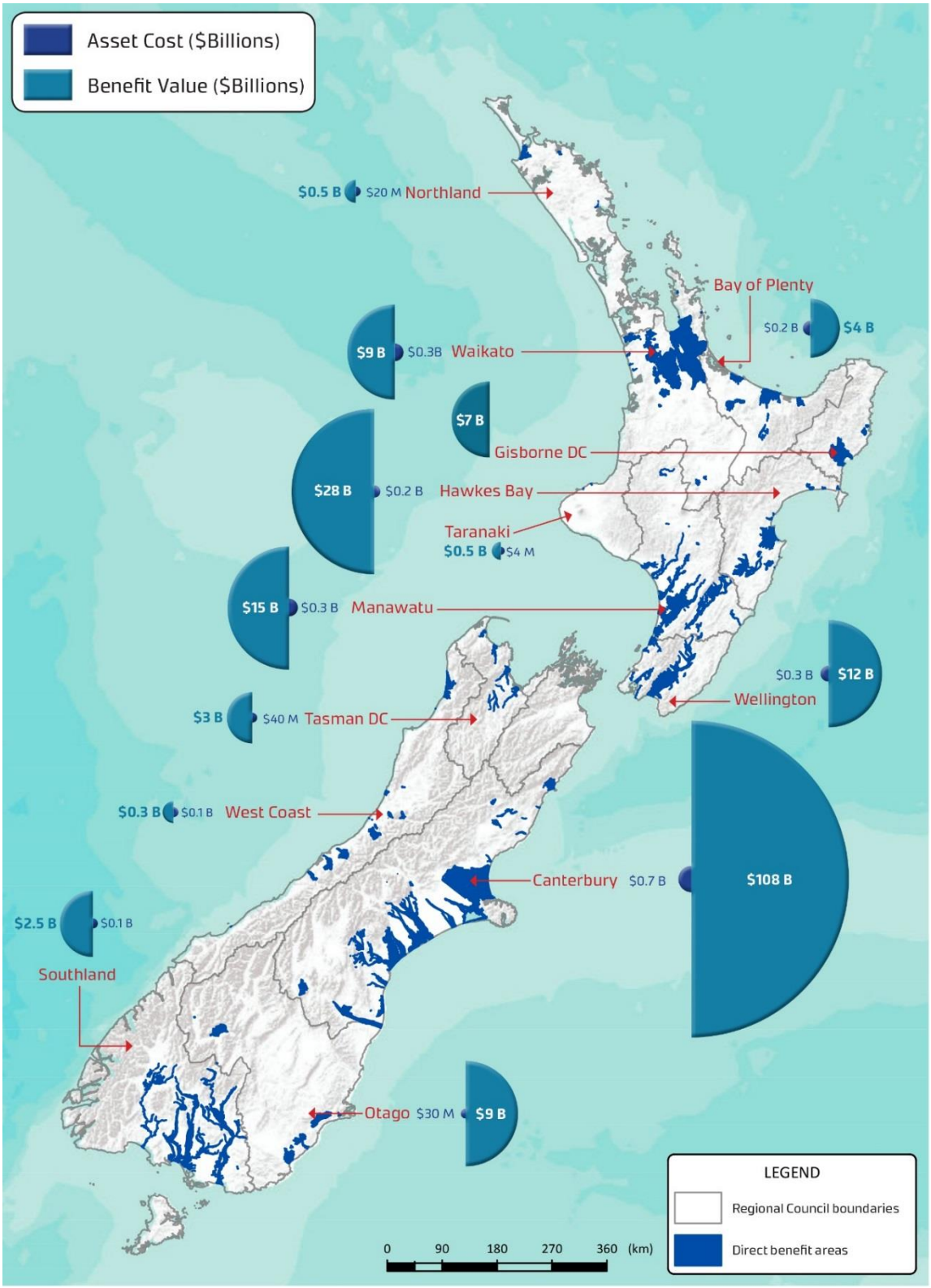

Figure 5.2: NPV of scheme benefits and capex + opex costs by region (values indicated where available, subject to rounding)

Figure 5.3 below shows the combined benefit and the benefit cost ratio for each region. This clearly shows the significant benefit derived from the protection provided in various locations throughout New Zealand, at various scales, and with different land use types being protected.

Figure 5.3 shows that the Canterbury region has a very high BCR. This is because virtually all of the Christchurch urban area receives flood protection benefit from the Waimakariri Flood Protection Scheme. We note that parts of Christchurch are protected by Christchurch City Council's flood protection schemes. The costs of these schemes have not been incorporated into our analysis and if incorporated would reduce the BCR for the Canterbury Region. However, given the small scale of the city's schemes relative to the direct benefit area for all of the Canterbury schemes, we would expect little change to our overall findings, i.e. flood protection schemes in Canterbury provide outstanding value for money.

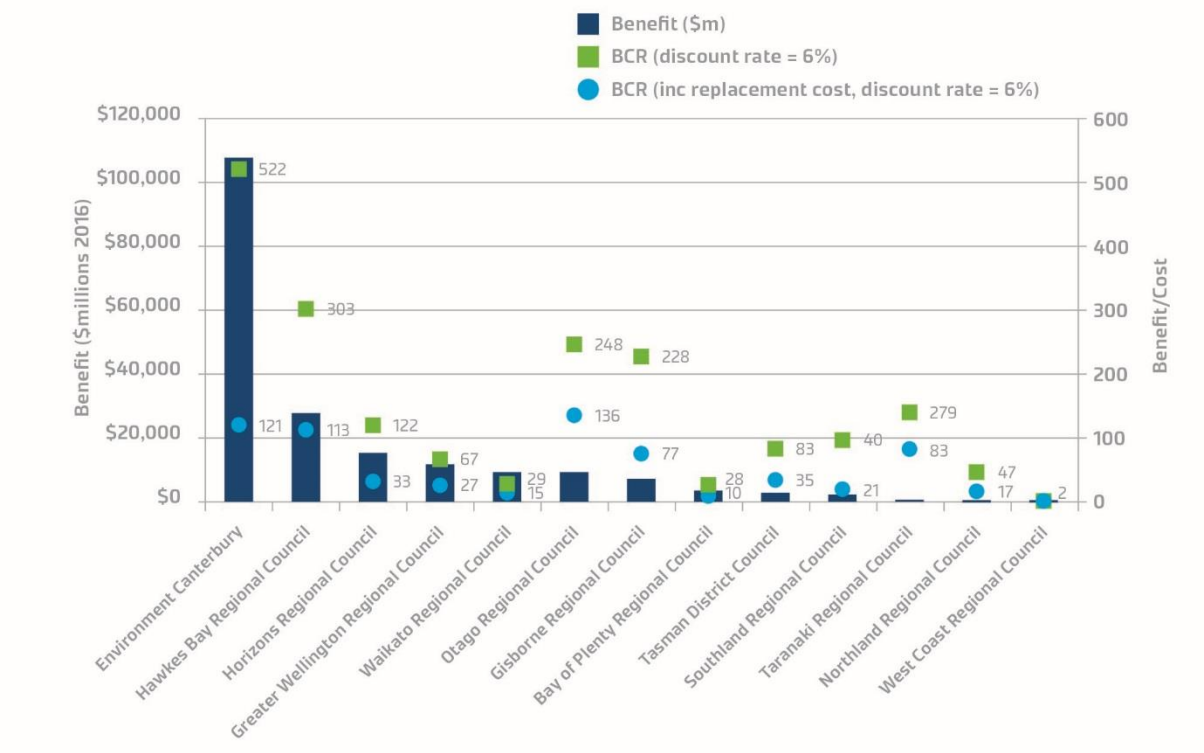

Figure 5.3: Benefit, costs and benefit cost ratios for schemes included in this assessment

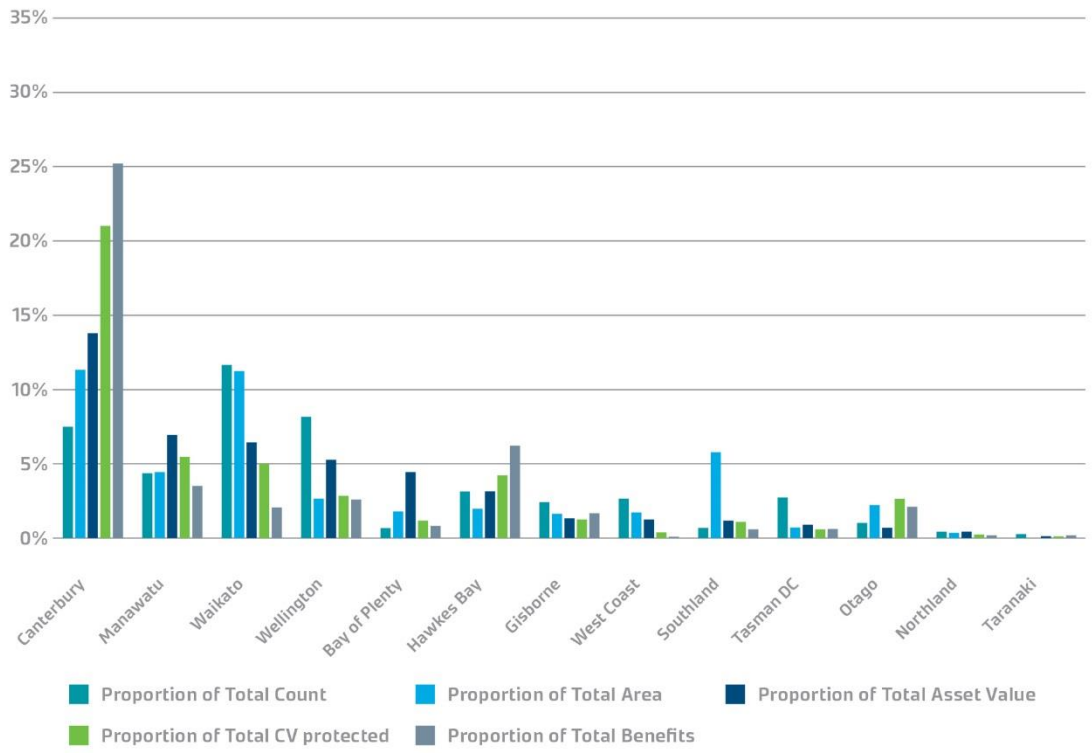

Figure 5.4: Scheme attributes as proportion of national total including economic information

5.3 Exclusions

The economic assessment included in this assessment represents a snapshot of economic benefits and costs as at 2016. A longitudinal study of how these benefits and costs have changed historically and might change in the future was excluded from the scope of this review. We would expect that given the increase in New Zealand GDP and land prices over the past two decades the benefit provided by the schemes is likely to have increased over this period as a result. However, we are less certain on how scheme costs and their cost benefit ratios may have changed over that period. Special care would need to be taken in selecting time periods for such a longitudinal assessment so the results are not overly influenced by selection bias.

The economic assessment included in this assessment is traditional in that a factor was applied to the economic analysis to account for wider social and economic benefits of the schemes. This analysis excluded a formal assessment of the cultural and environmental costs and benefits given its overview nature and the complexities associated with assessing these values on such a large scale. We would expect that the calculated BCR would change if these values were included in a cost benefit analysis. We would also expect that if these values were included, the schemes overall would still provide a net benefit to New Zealand given the large economic BCR calculated in this assessment. Further detailed analyses of individual schemes or portions of schemes may reveal that some are not economic.

Further work would be required to address these exclusions as well as understand infrastructure asset valuation practices and outcomes, and forecast how the benefits and costs of the schemes might change in the future.

6 Management of the schemes

6.1 Asset management maturity

Asset management plans (AMPs) are the central documents for describing the purpose and performance of a scheme and outlining how the scheme is managed.

Councils are required to prepare AMPs for flood protection assets under s101B of the Local Government Act 2002. AMPs are optional for assets that deliver benefits to other areas — for example, drainage, river management, and tidal protection.

We assessed the maturity of the asset management plans provided by regional councils using the Asset Management Maturity Methodology published by Treasury[8]. Assessment was based on an evaluation of a small selection of AMPs from each council. Treasury's framework and our asset management maturity assessment is included in Appendix B.

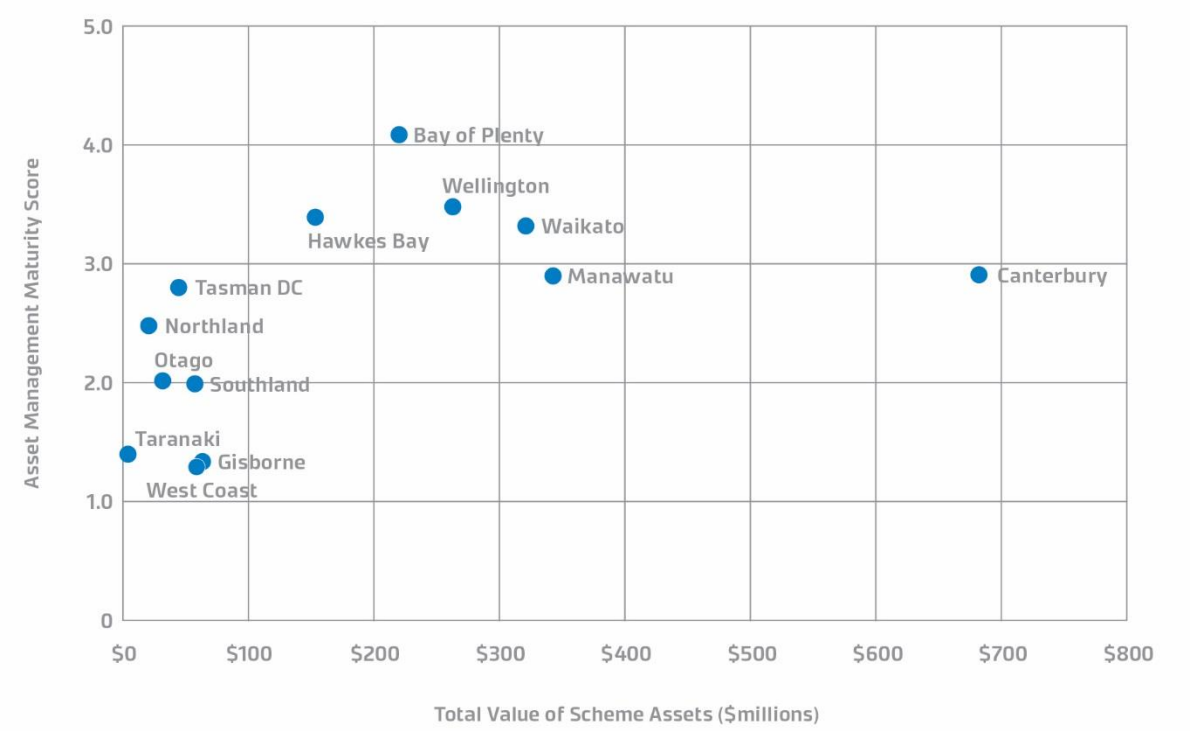

Figure 6.1: Asset management maturity by council

As seen in Figure 6.1 there is some variation in asset management maturity amongst the cohort of councils managing a larger asset base (greater than $150M replacement value). Although all were assessed as meeting or nearly meeting a 'core' level of overall asset management maturity (an asset management maturity score of three). Canterbury and Manawatu fell just short of reaching a 'core' level, indicating that some aspects of asset management weren't well described in the AMPs reviewed.

Amongst the cohort of councils managing smaller asset bases (less than $100M replacement value) asset management maturity scores varied more widely, with Tasman being the only council to nearly achieve a 'core' rating. We expect this is due to their broader asset management responsibilities for

[8] http://www.treasury.govt.nz/statesector/investmentmanagement/review/icr/information/assetmgmt, accessed 27 May 2017

areas such as three waters and transport, which has helped them develop a stronger internal capability to document their activities in AMPs.

It should be noted that AMPs may not reflect actual management practice. This is because some river managers reported that they carried out the necessary asset management activities but did not document it in their AMPs. This feedback predominantly came from managers of smaller schemes.

Asset management maturity at district councils

Although asset management maturity scores that district councils target vary depending on the asset class, a 'core' level of maturity is considered the minimum acceptable score.

Some asset classes — for example, roading — have higher minimum acceptable scores. NZ Transport Agency funding for roads drives better asset management practices in the transport sector and an 'intermediate' level of maturity is required.

It is our view that regional councils should agree on a nationally consistent minimum level of asset management maturity. We would expect that at a minimum, regional councils should target a score of 'core', though a higher level of maturity may be desired.

6.2 Providing a level of service

One of the fundamental metrics across all of the schemes is the level of service that the schemes deliver to their benefit areas. Using a broad sample of asset management plans provided, we reviewed the approach regional councils have taken and the levels of protection offered by schemes[9].

6.2.1 Ways of measuring the level of service

We found that councils generally adopted one of three methods for determining the level of service provided by a scheme:

- Agreeing on a scope of physical works with the community without reference to a target capacity or return period
- Providing physical works with a level of performance provided in terms of a target capacity — for example, stating a maximum channel flow
- Providing physical works with a level of performance in terms of a target return period — for example, referring to a 1 in 100 year event

The proportion of these three levels of service methods across the schemes in this assessment is shown in Figure 6.2.

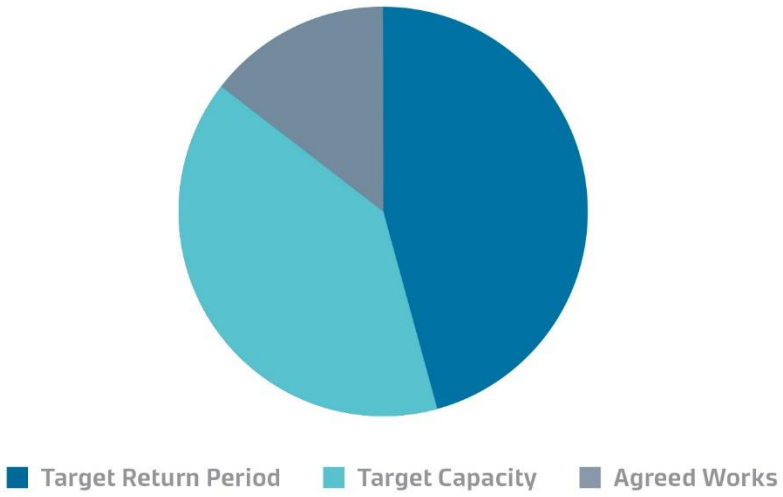

Figure 6.2: Proportions of level of service methods weighted by asset value

[9] The terms level of protection, level of service, and service level are used interchangeably in this document.

6.2.1.1 Agreed works

The level of service provided by 'agreed works' schemes is defined by their performance during past flood or rainfall events. For many of these schemes, both council staff and the community agree that the scheme size does not justify the cost of detailed analysis. However, there are some documented instances where council staff recommended technical analysis that did not proceed due to community resistance to cost. With the scheme performance undefined, councils are only able to track their service delivery through measures around maintenance works programmes or a general description of channel condition.

6.2.1.2 Target capacity

The level of service provided by 'target capacity' was most common in mid-sized schemes. An example of 'target capacity' flood scheme channel capacity with a flowrate of 900 m^3/s or a pumping rate in a drainage scheme of 7 mm/day. This type of service level provision focuses on managing the natural processes and asset lifecycle issues that reduce the capacity below the target, and the integrity of the scheme over time. Meaningful comparisons and conclusions between schemes and councils with 'target capacity' levels of service cannot be made as their service level is specific to each scheme.

Many of New Zealand's hydraulic and hydrologic record lengths are relatively short – in the vicinity of 40 to 60 years. As time passes and these record lengths increase, the frequency that a scheme's 'target capacity' occurs will change. This phenomenon, combined with climate change will likely cause the 'target capacity' of a scheme to be exceeded more frequently in the future. Climate change is widely acknowledged to likely lead to more frequent high intensity storms and may result in increased flood damages and poorer community outcomes if left unmanaged.

6.2.1.3 Target return period

The larger schemes have a level of service based on a 'target return period' or 'target AEP', for example protection from events up to a 50 year return period or 2% AEP. For flood schemes, rural return periods ranged from 5 years (20% AEP) to 100 years (1% AEP), with the return periods for urban schemes ranging from 100 years (1% AEP) to 500 years (0.2% AEP).

Under a 'target return period' level of service, the notional level of service – say 2% AEP – will stay the same over a given period until the agreed level of service is changed. However, the actual size of the design event, such as flow and water level, will vary as the length of hydrologic record grows. In addition, as environmental changes — ranging from land use change within the catchment, sea level rise, and increased frequency of high intensity rainfall events to river channel aggradation or degradation — take place, the frequency of a flood of a particular size will vary.

Given this, schemes that use a 'target return period' rather than a 'target capacity' to set the level of service for a scheme need regular and detailed technical analysis to quantify the size of the design event. Also, these schemes may require physical works to ensure the agreed level of service is maintained. Schemes using a 'target capacity' approach will also require periodic technical analysis, though on the face of it this should be more straightforward than that carried out for a 'target return period' approach.

6.2.1.4 Discussion

Each of the three methods for determining the level of service currently in use may be suitable for a given scheme, provided that information about event likelihood, scheme and property vulnerability, potential consequences, and residual risk to the community are well understood and communicated. Each of the three methods may also be suitable for a class of schemes. For example, the 'agreed

works' method may be suitable for low risk schemes, the 'target capacity' method for medium risk schemes, and the 'target return period' method for high risk schemes.

In addition, a 'target return period' may be more effectively communicated in terms of cumulative probability rather than a return period or annual probability. For example, what is commonly known as a 100 year flood is technically an event having a 1% probability of exceedance annually. People regularly dismiss this risk believing there is a low probability of it occurring in their lifetime.

But statistically, a 1% AEP event has a 26% chance of occurring during the life of a 30 year mortgage, and a 39% chance of occurring during a 50 year design life of a standard building[10].

Providing this and other contextual information may assist in increasing the public's understanding of a 'target return period' level of protection.

This approach, however, does not consider the uncertainty associated with event likelihood given New Zealand's relatively short record periods. These short record periods mean that any estimate of rainfall or flood events larger than one having a 10 to 20 year average recurrence interval (or a 10% to 5% annual exceedance probability) is potentially unreliable. A summary of the length of historical record required to reliably estimate return period events is presented in Table 6.1.

Table 6.1: Length of historical record required to reliably estimate return period events

Average recurrence interval (ARI, years)	Annual exceedance probability (AEP which is the inverse of ARI, %)	Length of record required to reliably estimate return period events (years)	
		95% reliable estimate	80% reliable estimate
2.33	43%	40	25
10	10%	90	38
25	4%	105	75
50	2%	110	90
100	1%	115	100

Source: *Landslide risk assessment*, Lee E.M. and Jones, D.K.C., Thomas Telford, 2004.

6.3 Changing the level of service

Changes to a scheme's targeted levels of service typically do not happen very often. As noted above, schemes using the 'target return period' and 'target capacity' methods of providing a level of service will require periodic technical analysis to quantify the size of the design event, and possibly physical works upgrades to ensure a scheme continues to provide the target level of service. There is not the same need to review the underlying technical analysis of schemes where the 'agreed works' approach is adopted.

Even though most schemes would benefit from a level of service review, the scale of investment required to improve service levels and the longevity of the associated infrastructure assets mean there are long periods between planned reviews. By not having a regular programme of level of service reviews, there is a risk that a scheme may not actually deliver on the community's expectations of performance.

[10] Rather than using event AEP as a design basis, the New Zealand structural loadings code uses cumulative probability language such as "an event having a 10% chance of occurring over 50 years". This equates to a 475 year return period, and approximately a 0.2% AEP.

For example, the Heretaunga Plains Flood Control Scheme was 30 years old before undergoing its first level of service review. Events that exceed a targeted level of service, for example the Whanganui River floods of 2015, may also trigger a service review. However, these large scale events are infrequent and any review is therefore on an ad hoc basis.

Regional councils generally undertake incremental reviews of scheme performance on an ongoing or revolving basis. For example, the Waikato Regional Council has a programme of works to update each of their hydraulic models on a 10 year rolling basis. The way this works is that a proportion of their models are updated each year so that by the end of a 10 year period all models have been updated. These reviews may identify changes in actual performance, for example, a reduction in channel capacity. Or, they may identify changes in the understanding of actual performance, for example, from an improved scheme model. These incremental reviews may produce updated works programmes requiring consultation with the community.

Further work is required to standardise the timing and frequency of a level of service review across the sector. This could be undertaken as part of the package of work described above to provide a framework for determining the level of service by scheme class, and how risk is understood and communicated.

6.3.1 Adequacy of existing levels of service

A comparison of the large economic BCR of the schemes and the relatively low performance standards of schemes when compared with other hazards[11], suggests that, on the whole, the schemes may be under-designed for what they protect and enable. Further work would be required to understand if the existing levels of service are appropriate and sufficiently in line with best practice.

We would expect this conversation to be informed by a better understanding and communication of flood risk information. This includes data on probability and likelihoods, scheme vulnerability and that of protected properties, consequences, and residual risks, as well as the physical works and associated costs required to provide a higher level of service. In our experience, the magnitude of a 200 year flood event is not twice that of a 100 year flood event even though the former is statistically twice as rare as the latter. Further, we would expect the marginal cost of providing protection from a 200 year event to be less than the cost of providing protection from a 100 year event. Nonetheless, current pressures on scheme funding and affordability would need to be considered in opting for a higher level of service. These pressures are further discussed in Section 6.6 of this report.

6.4 Community consultation

The requirements, processes, and techniques for effective community consultation on river management activities can largely be classed into routine and non-routine matters.

6.4.1 Existing practices

Consultation on routine operational and maintenance matters including annual renewal programmes, annual plans and the like are reported by river managers to be generally relatively easy and straightforward to carry out. Consultation is reported by river managers to be effective for smaller schemes and where stakeholders are direct beneficiaries.

[11] The Reserve Bank of New Zealand's solvency standards require insurers to be solvent after a 0.1% AEP (1 in 1,000 year) earthquake, and after other events (e.g. storms and floods) with an AEP of 0.4% (1 in 250 year). The New Zealand structural loadings code is designed to provide buildings that do not endanger human life during a 0.2% AEP equivalent (1 in 475 year) earthquake, while many flood protection schemes are designed to protect from events up to 1% AEP (1 in 100 year).

A summary of consultation methods used by councils is given in Table 6.2, below. All councils report using liaison committees which are comprised of stakeholders, although on some very small schemes, the number of stakeholders is so small that the council deals directly with ratepayers.

Table 6.2: Consultation methods employed by councils

Council	Consultation methods				
	Long term plan	Liaison committee	Direct consultation (ie no committee)	Annual ratepayer meeting	Survey
Canterbury	✓	✓			
Manawatu	✓	✓	✓	✓	
Waikato	✓	✓			
Wellington	✓	✓			
Bay of Plenty	✓	✓			
Hawkes Bay	✓	✓	✓		✓
West Coast	✓	✓	✓		
Southland	✓	✓			
Tasman DC	✓	✓			✓
Otago	✓	✓	✓	✓	
Northland	✓	✓			
Taranaki	✓	✓			
Gisborne DC	✓	✓			

Consultation on non-routine matters is generally more difficult as these matters represent a significant change to scheme operation or level of service. For these issues, a unique consultation strategy is required for each change or issue. This typically requires educating various stakeholders about an issue, then gathering key stakeholders around a table to develop a consultation strategy before finally consulting more widely. This process is reported to generally provide a better chance of successful consultation on a major issue but doesn't guarantee its outcome.

6.4.2 Willingness to pay

River managers also reported that communities are generally more willing to pay for tangible measures of protection, such as stopbanks rather than soft responses – for example, land use controls or managed retreat. Also, that communities often opt for a larger capital outlay in the near term rather than an adaptive response carried out over many decades. These two incidences were reported by Greater Wellington as results of their public consultation regarding the recent Hutt Valley scheme upgrade for a future state of 2115.

6.4.3 Effective engagement

The ability to conduct effective stakeholder communications will be vital if communities are to understand the rationale for, and gain the potential benefits — such as cost savings and improved quality — from soft or adaptive approaches to flood hazard management. Especially as these approaches are often controversial. For example, managed retreat may be the best long term option for some communities. But this approach will require greater collaboration, and a willingness to consider alternative strategies that provide a similar outcome to physical works – such as providing safety and security from flooding.

Given the uncertain level of impact surrounding many of the sector challenges outlined in Section 7, river managers will need to be collaborative and engage early with stakeholders to deliver successful outcomes for the community. This early engagement process may challenge river managers who the community potentially perceives as having a vested interest in the ongoing maintenance of a particular intervention. It may also challenge asset managers to consider whether and how the community may respond to an event – such as flooding— and to then tailor their communication appropriately at an early stage.

6.4.4 Risk communication

The importance of how well risk information — probability or likelihood, vulnerability, consequences, and residual risk — is communicated to stakeholders cannot be emphasised enough[12]. Reframing by the river management sector of the risk discussion to one of consequences first and cumulative probability and uncertainty second may be a good first step towards better risk communication with stakeholders.

Understanding and building a national picture of flood risk vulnerability and consequences, underpinned by development of a nationally consistent methodology for understanding and documenting asset criticality, performance, and level of service, would be a useful foundation for communicating this risk to communities and stakeholders.

6.5 Council staffing

Recruiting, retaining, and developing great staff is fundamental to the success of any organisation. Current river management staffing levels are just sufficient to carry out day to day activities, and staff often have a narrow technical skill set or limited understanding of river management in a New Zealand context. Staffing issues that inhibit regional councils from producing successful river management activities and community outcomes include:

- A chronic shortage of versatile, multi-faceted engineers with an understanding of the broader non–engineering aspects of river management activities
- A lack of visibility of a professional river management career by university students
- No formal, sector-wide graduate engineer intake or development programme
- Lack of awareness of the regional council business by the wider public, and a lack of positive news stories about regional council activities in the mainstream media

[12] This approach is effected through a risk-based approach to natural hazards under the 2017 amendment to the Resource Management Act, see http://www.mfe.govt.nz/publications/rma/resource-legislation-amendments-2017-fact-sheet-series, Fact Sheet 10, accessed 27 May 2017.

- Unstructured in-house and sector professional development programmes that are geared towards future issues facing the sector
- A lack of sophisticated employee transfer arrangements between councils and with other organisations

Addressing these staffing challenges is critical, and the ability of river managers to resolve them individually is constrained by several factors, including the current level of funding at each council, and level of coordination amongst regional councils.

Partnership and collaboration is essential to addressing staff and resource challenges successfully. This could take the form of working with an existing organisation (e.g. IPENZ or LGNZ) or the formation of a new pan-sector partnership to promote the river engineering sector. Activities by this group of sector professionals could include:

- Guest lecturing at engineering schools in New Zealand universities
- Establishing a chair in river engineering and management at a New Zealand university
- Developing a formal graduate intake and development process
- Creating a river management continuing education framework and supporting coursework
- Facilitating movement of staff within and among regional councils, and with similar organisations overseas

Case study – Development of River Management Asset Performance Assessment Code of Practice

New Zealand's river managers have already recognised the importance of greater consistency in assessing the condition and performance of river management infrastructure. Development of a guidance document for this purpose was recently developed by Greater Wellington RC, and endorsed by other river managers.

However, we understand that uptake of the Code of Practice has not been uniform across the regional councils. We would expect that implementation of the methodologies outlined in the document would require each river manager to affect change within their council. Achieving this in a timely manner across all regional councils may be difficult depending on the priorities of each council.

Additionally, development of this document by a single regional council in the current working environment raises some questions about how it may be revised and updated. We could see each council using the document as a starting point, with individual councils modifying it to suit their context in isolation from others.

Clearly this is not what was intended when the document was developed, though it appears a real possibility given the current working environment within NZ's river management sector.

6.6 Scheme funding

As noted in Section 2, schemes were heavily subsidised via central government between 1941 when the SCRCC was formed and 1987 when NWASCA was disbanded. The Local Government Act 2002 now provides councils with tools for fair and equitable allocation of rates according to benefit received.

6.6.1 Funding sources

All regional councils generally use targeted rates as the primary funding source for the schemes[13]. These rates are typically banded into benefit levels to reflect spatial variation in the benefit received from a scheme. For example, a property on the second terrace of a flood plain will not receive the same benefit from a flood control scheme as a property lower down and immediately adjacent to the river.

[13] A notable exception to this is Greater Wellington's move towards funding schemes on the Kapiti Coast through a general rate on properties in that sub-region.

Some councils incorporate all relevant benefits into a single targeted rate, where others separate out different costs and benefits as separate rating bases. In one instance 11 different targeted rates overlapped. Obviously councils need to balance transparency, administrative practicality and efficiency, fairness and accuracy when funding these schemes.

Some councils also use either a targeted or uniform rate for indirect benefit to provide part funding of scheme costs by the wider community. This is restricted to schemes that are large enough to have a clear benefit for the wider (or entire) region – either as an individual scheme or the cumulative benefit from a number of schemes.

Overall, we found that each of the rating schemes was developed in its own context and provenance, so even among schemes with simple rating areas it is difficult to use the rating information as a basis for compiling and comparing scheme funding data. Future national data analysis would be enabled by a consistent rating methodology and regional councils should consider if this would be valuable and achievable.

6.6.2 Funding issues

Funding affects many aspects of a regional council's river management business including:

- The future affordability of the schemes and their renewal programmes
- Whether a scheme's level of service can be maintained, upgraded or may need to be downgraded
- The ability of councils to employ, retain and develop, appropriately trained people to effectively deliver work programmes
- The ability of councils to share information and experiences with other river managers
- Their success in educating the community about the value of schemes, what they protect and the residual risks that the communities face

In our assessment we found a number of issues relating to funding and operational expenditure pressures on river management activities including:

- Desire of some communities to control rate increases at the expense of infrastructure asset investment or renewal
- The general expectation to do more for less
- Changing community expectations, the widening of stakeholder groups, and how environmental, social and cultural values manifest themselves in river management activities, including but not limited to:
  - National Policy Statement for Freshwater Management 2014
  - Health and Safety at Work Act 2015
  - Co-governance commitments through Treaty of Waitangi settlements
- A greater incidence of non-rateable properties (and corresponding decline in rating base) within areas of benefit from the schemes — for example through construction of new state highways
- How asset condition is measured (discussed in Section 4.5.2 above), and how this informs asset revaluation practices
- An increase in actual costs to renew or replace infrastructure above the planned expenditure and / or asset book value. This can result from a variety of factors including poor financial and asset management planning, a change in community expectations or legislative environment, and construction costs increasing faster than general inflation

- The way operational and maintenance activities are funded. For example, depreciating asset book value and renewal expenditure, borrowing, and the resulting balance of payments

These issues and downward pressures on funding levels for river management activities discourage best practice, and force staff to 'make do' by cutting expenditure elsewhere. This is particularly relevant for unplanned additional expenditures. For example, on a recent capital works project on the Lower Waikato scheme, the Waikato Regional Council decided to use more costly mechanical components to provide better environmental outcomes while still providing the same level of service, and had to trim budgets elsewhere to accommodate this unplanned expenditure.

Many of these issues are common across the regional councils, though how councils record, report and manage them varies considerably. Further work would be required, for example, to better understand the balance of operational payments on a national scale and its implications on future affordability of the schemes. Standardisation in operational expenditure reporting would make this assessment easier. As with other challenges, this appears to be one that would benefit from greater cross-council collaboration.

As previously discussed, property rates paid to regional councils are the backbone of funding river management activities. Ratepayers, however, are generally unable to offset a property rates increase through increased productivity (i.e. income generation) from their land, and cannot release their property's capital value until it is sold. This creates a challenging situation where communities may not be willing to pay for river management infrastructure upgrades and renewals despite professional advice from river management experts. It is our view that alternative funding strategies should be explored so that regional councils can deliver a better river management service to their communities.

Willingness to pay – a West Coast Regional Council case study

The West Coast Regional Council (WCRC) has low population growth and GDP per resident close to the national average. Many of the flood protection schemes WCRC is responsible for benefit, and are funded by, a small local community.

Council staff sought to better understand changes to the risk posed by the Matanui Creek through a flood study. When council staff approached the community to gauge support for this work, the community declined to spend the money, preferring to leave the current performance of the scheme unknown.

6.6.3 Environmental, social and cultural context of scheme funding

It is our view that to meet changing community expectations and make investment decisions transparently, developing a framework that formally accounts for environmental, social, cultural, and economic outcomes of council projects and schemes would be beneficial. We expect that this framework would be supplemented by a decision support tool, such as that recently developed for NZ Transport Agency[14]. This would enable councils to be more proactive in responding to or adapting to stressors or shocks on their infrastructure assets within a timeframe and to a cost that is acceptable to the community.

In April 2017, the International Public Sector Accounting Standards Board (IPSASB) published a consultation paper on Financial Reporting for Heritage in the Public Sector. In this context 'heritage' includes 'natural heritage', that is, the environment. NZ takes its accounting standards from the IPSASB and the inclusion of environmental outcomes into this formal financial framework represents a significant change in public sector accounting.

This may require regional councils to quantify in their financial reports the natural environment as assets, and costs associated with maintaining the environment as liabilities. Further professional

[14] *Establishing the value of resilience*, New Zealand Transport Agency research report 614, Money C. et al, 2017.

advice would be required to understand how the consultation paper and subsequent standards may affect the river management sector.

6.7 Regulatory environment

The regulatory environment relevant to river management in New Zealand is in a state of flux with changes to the Resource Management Act (RMA), and the National Policy Statement for Freshwater Management, the development of a National Policy Statement for Natural Hazards, funding of emergency response / recovery under the Guide to the National CDEM Plan – Section 33 Government Financial Support, and development of a National Disaster Resilience Strategy.

In addition to the overarching national legislation and guidance, each river manager negotiates a different regional regulatory environment, which has been developed in response to their communities' needs and desires and their own physical settings.

The following subsections outlined details of legislation as relevant to river management activities.

6.7.1 Soil Conservation and Rivers Control Act 1941

The 1941 Soil Conservation and Rivers Control Act (SCRCA) was a key piece of legislation that enabled construction of many of the flood protection, river control, and land drainage schemes in New Zealand. Key elements of this Act that continue to enable river mangers to carry out their work include:

- Section 2 - The breadth of the definition of "defence against water"
- Section 10 - Objectives of the Act (c) the prevention of damage by floods and (d) the utilisation of lands in such a manner as will tend towards the attainment of the said objects
- Part 7 Powers and Duties of (Catchment) Boards
  - Section 126 (2) - General powers to construct, reconstruct, alter, repair and maintain works and do other acts to fulfil function to minimise and prevent damage. These powers are important to carry out river management activities. However, given their breadth and reasonably unfettered nature, we note they could be subject to challenge in a legislative review process
  - Section 131 - Public Works Act 1981 to apply to construction works. This power is also conferred to regional councils under the Local Government Act 2002
  - Section 132 - Powers to enter for assessment and investigation
  - Section 133 - Maintenance and improvement of watercourses and defences against water
  - Section 135 - Incidental powers, including the ability to acquire land under the Public Works Act, enter & use land to take materials, access and load/unload materials and establish work areas
  - Section 137 - Notice in respect of works on private land. This could be subject to challenge in a legislative review process
  - Section 138 - Apportioning costs of works with owners of land
  - Section 139 - Land can be purchased on system of time payment
  - Section 140 - Leasing powers
  - Section 143 - Supervision of drainage works and river works
  - Section 146 & 147 - Ability of Board to pay for private works and purchase land injuriously affected
  - Section 148 - Liability for damages arising from neglect

The objectives of the Act are indirectly encompassed in the purpose and principles of the RMA, with some powers under the Act included in the Local Government Act 2002. Should any repeal of the Act, or parts of it, be proposed river managers should carefully consider how these changes may affect the functions and powers they currently have to enable their river management activities.

To access and maintain their assets some councils rely on good relationships with private landowners and the provisions of the SCRCA. This, however, is variable as some councils own many of their assets, or at least maintain easements over private land.

The ability of regional councils to own the land beneath their assets, or at least maintain an easement across private land would remove some of the concerns river mangers have around getting to and protecting their scheme assets. It must be noted that requiring regional councils to buy land or negotiate easements would substantially increase their costs.

Many of the aspects of the Soil Conservation and Rivers Control Act (SCRCA), along with other pertinent legislation have been repealed. A broad based, blues skies review covering key pieces of legislation, including *inter alia* the Resource Management Act 1991 (RMA) and Local Government Act 2002, has been suggested by several organisations including Local Government New Zealand and the Productivity Commission. Should such a review occur, there is a potential threat to regional councils that the remaining residual provisions of the SCRCA, which enable river management activities and are described above, could be inadvertently repealed.

Repeal of these remaining provisions would affect the ability for regional councils to develop new schemes, manage and maintain existing schemes and, potentially, to upgrade schemes to respond to the effects of climate change. Should a blue skies legislative review occur, how these activities are enabled needs to be considered. Not only in the context of the way that these schemes have been historically developed, but in light of current and likely future environmental and societal expectations. This represents a significant challenge, not only to ensure that legislation allows regional councils to effectively fulfil their obligations, but also to understand how those obligations may change.

Additionally, there is a potential for significant additional cost on communities should these powers be inadvertently removed. Costs could arise from:

- Councils being unable to maintain schemes if access is denied by land owners
- Legal costs associated with maintaining access rights
- Costs of land or easement purchase.

6.7.2 Resource Management Act 1991

The RMA affects river management and land drainage activities, which means river managers can be both applicants and potentially affected parties under the Act. The way in which river managers undertake their works and activities, and the ease of doing so, largely comes down to how the effects of these activities are provided for through regional and other plans.

Provisions in Regional Plans are variable across the regional councils. Some plans have policies that explicitly recognise some scheme structures as natural and physical resources and have specific provisions that enable river managers to undertake a range of activities. For example in Hawkes Bay and Taranaki a range of river management tasks can be undertaken as permitted activities (subject to terms and conditions in the plan), or in some instances compliance with a Code of Practice or similar document. Other regional plans, such as Greater Wellington Regional Council's, are much more restrictive and require resource consents to be obtained for nearly all works and activities that river managers may need to undertake.

Some plans and council practices identify scheme asset managers as potentially affected parties, enabling them to be consulted on resource consent applications that may affect them – other plans and council practices don't. Those managers have reported they have little influence on decisions that may impact on their infrastructure or their ability to deliver services to their communities.

Some regional councils use river management staff as experts in the evaluation of consent applications — which raises potential conflict of interest issues — whereas others would tend to use people from other parts of the organisation or commission this advice from an independent expert.

How these elements play out in any regional council — along with the size or value of assets under management by a regional council — may affect the ability of councils to meet their obligations to the community effectively and efficiently. In some circumstances these elements may affect the councils' ability to retain river management staff.

The river management sector could benefit significantly from a nationally consistent approach to managing the effects of their schemes under the RMA. This approach would allow for more effective collaboration and sharing of resources across councils because staff wouldn't have to learn how to work in a new regulatory setting. This would likely have a wide ranging and significant impact, including providing further consistency in the delivery of services across the sector, normalising compliance costs, expediting processes, and standardising expected outcomes.

6.7.3 Local Government Act 2002

River managers report that the Local Government Act 2002 generally enables and supports their activities, and identified the following provisions as notably important to their activities:

- Ability to have targeted rates
- Use of the special consultative procedure
- Development of infrastructure management strategy
- Use of long term and annual planning processes to implement their infrastructure strategies.

6.7.4 Civil Defence and Emergency Management Act 2002

River managers also have a good connection to the Civil Defence and Emergency Management Act 2002 and see this as integral to their activities. Specifically in areas of emergency management planning, providing advice to emergency controllers, and managing residual risk to communities.

The Ministry of Civil Defence and Emergency Management is currently developing a new National Disaster Resilience Strategy that will replace the current National Civil Defence Emergency Management Strategy[15].

The Ministry has prioritised the following areas for improvement:

- Understanding disaster risk
- Strengthening disaster risk governance to manage disaster risk
- Investing in disaster risk reduction for resilience

[15] This is in response to international best practice that suggests a shift in focus from 'managing disasters' to 'managing risk' will improve the resilience of our communities. New Zealand is also signatory to the Sendai Framework which seeks: *a substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries*.

- Enhancing disaster preparedness for effective response, and to “Build Back Better” in recovery, rehabilitation and reconstruction.

6.7.5 Summary

The regulatory environment relevant to river management in New Zealand is complex and varies from region to region. Key powers given to river managers under legislation such as the SCRCA may inadvertently be removed under a ‘blue skies’ legislative review. As these potential issues affect the sector as a whole, the sector would benefit from better collaboration to create ‘one voice’ and assist in the development of policy and law on these issues.

7 Resilience challenges for river management

Many of the challenges facing river management activities have been outlined in the preceding sections and in this section we describe the concept of resilience. Many organisations understand resilience in the context of natural hazards, however it also relates to other technical and non-technical challenges. Many challenges facing the river management sector fit within the resilience concept.

7.1 Resilience – in concept and practice

The concept of resilience is often simply thought of in terms of how a community responds to a large earthquake or other natural disaster – how quickly will the community return to normal? Resilience is much more than that.

Definitions and themes of resilience include understanding, communicating, and managing risk though lenses as diverse as governance and leadership; health, wellbeing, stability and security for individuals, families and communities; and the built and natural environment.

Central government and many of its agencies recognise the value that adopting a multi-faceted resilience framework brings to their ability to deliver successful outcomes to their communities. As noted above in Section 6.7, the Ministry of Civil Defence and Emergency Management is developing a new National Disaster Resilience Strategy in line with the Sendai Framework for Disaster Risk Reduction, of which New Zealand is a signatory. The NZ Transport Agency has a national resilience programme and recently proposed a definition[16] of resilience as: ***the ability of systems (including infrastructure, government, business and communities) to proactively resist, absorb, recover from, or adapt to, disruption within a timeframe which is tolerable from a social, economic, cultural and environmental perspective*.**

In practical terms, if river management activities among regional councils were resilient one would see a sector that, among other things:

- Values business continuity, and performs effectively in a crisis
- Is resourced in terms of capability and capacity to respond to known and unknown changes relevant to the sector —including climate change or funding pressures
- Understands and effectively communicates risk information — event probability or likelihood, vulnerability, consequences and residual risk
- Proactively engages with diverse stakeholder groups, and has the ability to measure the environmental, social, cultural, and economic value of the services it provides
- Builds and maintains infrastructure assets that are robust and have spare capacity to accommodate disruption and uncertainty
- Can adopt alternative strategies to continue to provide an agreed outcome — including safety and security from flooding — to the community

Some regional councils are carrying out aspects of resilience without the benefit of working within a systematic framework. In this assessment we've found that some councils may be better than others at some aspects of resilience. These practices are not widely adopted, however, and are carried out on an *ad hoc* basis without a vision or strategy of making our communities more resilient. Cross-sector collaboration is needed to develop a river management resilience framework and associated decision making tools to enable all regional councils to respond to their common challenges with minimum disruption to their communities.

[16] Money C. et al, 2017.

7.2 Challenges as shocks and stressors

The challenges facing river management in New Zealand threaten the ability of regional councils to effectively deliver their agreed services to the communities they protect. Challenges can be classed as either shocks or stressors, depending on their nature. Shocks occur suddenly, often without warning, test an organisation's resilience, and can precipitate a crisis. Stressors are issues that persist over a long time or recur frequently, and inhibit the capacity and capability of an organisation to deliver its service or respond effectively during a crisis.

7.2.1 Potential shocks

The findings of this assessment indicate the main potential shocks facing the river management sector include:

- Large flooding events, including infrastructure asset failure during a design event and over design events
- Earthquakes, which can damage infrastructure assets and deplete council and/or insurance reserves
- Future changes to how central government financially supports local authorities during emergencies
- Changes to the regulatory framework that enables river management activities
- Implementation of new policies or standards that may make it difficult for river managers to meet their consent compliance obligations. Refer Appendix D for a discussion on national metadata standards.

Due to the complex systems and environments where river management is practiced in New Zealand, the occurrence of a potential shock can have an impact far beyond the immediate community that receives direct benefit from the scheme. Examples include:

- The March 2016 flooding of the Franz Josef township and closure of State Highway 6. This highlighted that the failure of flood protection in a small settlement on the West Coast can have a disproportionately large impact on national and economically important tourism opportunities and connectivity
- The September 2010 Darfield earthquake, which severely damaged infrastructure assets in Canterbury's Waimakariri scheme. Urgent and timely repairs were undertaken and completed just days before the December 2010 flood event in the Waimakariri River thereby protecting the surrounding community from flooding
- Insurance claims from Christchurch City and Waimakariri District Councils to cover infrastructure damage from the September 2010 and February 2011 Canterbury earthquake sequence. Claims exhausted the reserves of the Local Authority Protection Programme Disaster Fund, which placed other participating councils at risk of not having insurance coverage for their infrastructure assets.

Insuring for Maximum Probable Loss

Following insurance claims resulting from the 2010-11 Canterbury Earthquake Sequence, the reserves in the Local Authority Protection Programme Disaster Fund were depleted.

As a result of this, and other changes to disaster recovery funding for councils, many councils are considering alternative insurance mechanisms. As part of this, councils estimate their Maximum Probable Loss during a natural hazard event, then seek insurance for this amount.

There are a few consultancies operating in the New Zealand loss estimation marketplace, each with their own estimation methodology. Hawkes Bay RC and Greater Wellington RC are two regional councils known to have carried out this exercise, and each have used a different consultant / methodology.

Regional councils should consider carrying out this beneficial exercise for each of their portfolios. Before doing so it would be prudent to compare the usefulness of methodologies available, and consider whether a consistent methodology across the councils is preferred.

7.2.2 Potential stressors

The findings of this assessment indicate the main potential stressors and their implications facing the river management sector include:

- A lack of effective collaboration prevents regional councils from presenting themselves as 'one voice'
- Inconsistent data gathering and reporting prevents regional councils from easily identifying issues common to the sector
- Different regional regulatory environments which result in inconsistent outcomes across the regions and inhibits collaboration between councils

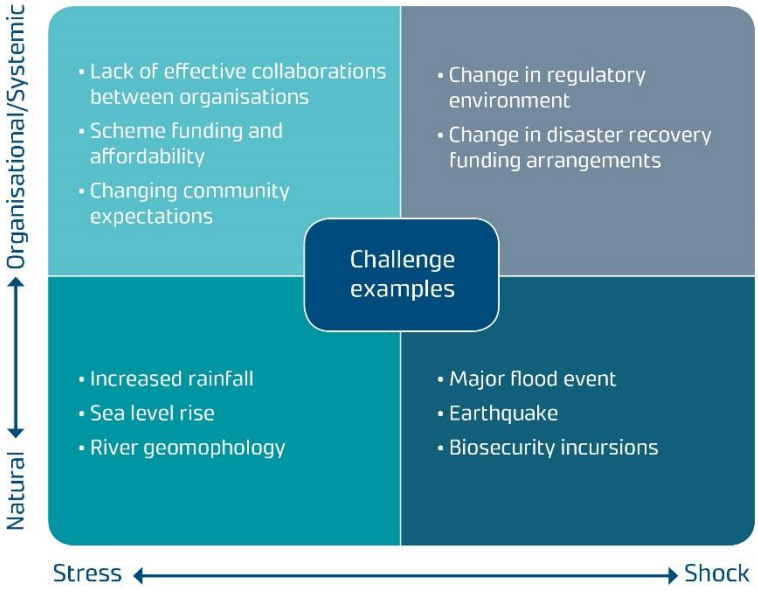

Figure 7.1: Example challenges facing river management sector as shocks and stressors

- A varied understanding of flood risk information —probability or likelihood, vulnerability, consequences, and residual risk — which inhibits effective communication with the community on these key concepts
- Staffing issues as discussed in Section 6.5 which inhibit regional councils from producing successful river management activities and community outcomes
- Funding and scheme affordability issues as discussed in Section 6.6 activities which discourage best practice river management practices, and force staff to 'make do' by cutting expenditure elsewhere
- The rate of change in current policies and procedures which are not keeping up with changing community expectations, the implications of wider stakeholder groups, and how environmental, social and cultural values manifest themselves in river management activities
- Land use change (increased urbanisation) may lead to increased consequences of infrastructure asset failure during an event or of larger-than-design events
- Climate change which may result in:
  - More frequent high intensity rainfall events
  - Higher peak river flows during large rainfall events
  - Increased erosion and sediment discharge into watercourses leading to changes in river geomorphology
  - Increased instances of flood flows transitioning to debris flow (as at Matata, Bay of Plenty, 2005)
  - Increased likelihood of existing infrastructure not meeting agreed levels of service
  - More frequent drought periods, and lower low flows in river channels leading to changes in river geomorphology as low flow channels are infilled by sediment

  - Increased likelihood of existing infrastructure assets not meeting agreed levels of service if low flow channels infilled or river course changed
  - Sea level rise, causing an increase in water levels during flood events in tidally affected areas; and an increased likelihood of existing infrastructure assets not meeting agreed levels of service
- Active river geomorphology may require an increased width of river management corridors that will likely encroach on what is currently private land, and a change in river management philosophy, including type and location of river controls
- Biosecurity incursions —for example, the willow sawfly in 1999 and giant willow aphid identified in 2013 resulted in destruction of some river management structures leading to in increased risk of river alignment changes during more routine flood events
- Peat settlement, which can cause existing infrastructure assets to become redundant when ground levels shrink, and a lowering of the level of service provided by the asset

7.3 Responding to challenges – mitigation or adaptation

Understanding the implications of each of the above shocks and stressors is a significant gap in the current New Zealand river management body of knowledge. Closing this gap and development of appropriate response strategies will be important for river managers and is a large piece of work in its own right.

Once implications of shocks and stressors are well understood a response strategy can be developed. Response strategies are either one of mitigation – finding ways to reduce the impact – or adaptation – the process of preparing for and adjusting to new conditions to minimise disruption and take advantage of opportunities that these new conditions provide.

In developing these strategies, regional councils would benefit from a coordinated approach that is flexible enough to accommodate the diverse scale, range, and criticality of river control, flood protection and land drainage schemes. These strategies can include controls from one of more of the types listed in Figure 7.2.

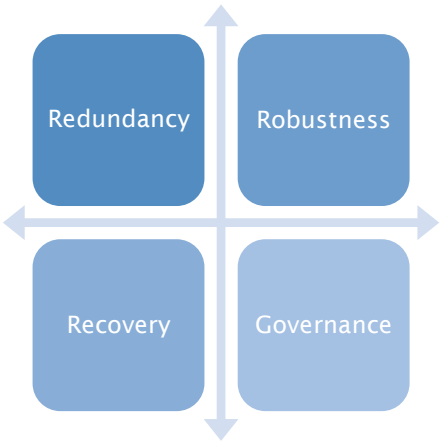

Figure 7.2: Control types to increase resilience of response strategies

Response strategy – adaptation to climate change

An example of an adaptation response to climate change is Greater Wellington Regional Council's policy decision to make allowances for sea level rise and an increased flow in its rivers over a 100 year planning horizon when infrastructure assets are designed or a design review is undertaken.

This response required leadership and governance by policy makers, and accounts for uncertainty through robust design assumption. This response is a good start to building resilient infrastructure, and could be further improved by creating design features to manage uncertainty, and improving the ability of a community to recover after a catastrophic flood event.

8 Delivery of infrastructure in New Zealand

In recent years a considerable amount of work has been done by central government agencies and some sector organisations to improve the delivery of infrastructure services in New Zealand. This has involved work by the Department of Internal Affairs, the National Infrastructure Unit (NIU) of Treasury, the Office of the Auditor General and Local Government NZ. This section presents a broad review of the work that these agencies have carried out.

8.1 Department of Internal Affairs

The Department of Internal Affairs (DIA) is responsible for implementation of the Better Local Government programme announced by Government in 2012. This broad improvement programme included improvement in infrastructure delivery and asset management practices in local government. Among other things, the local government improvement programme:

- Placed greater emphasis on quality asset management planning
- Instituted mandatory timeframes for a review on the cost effectiveness of infrastructure service delivery
- Directed the development of thirty-year infrastructure strategies
- Introduced an expectation that councils should actively seek to collaborate and cooperate to improve effectiveness and efficiency

8.2 National Infrastructure Unit of Treasury

Central to much of the work to improve delivery of infrastructure services is the development of the Thirty Year New Zealand Infrastructure Plan by the NIU, which comprised a critical assessment of New Zealand infrastructural needs, including the provision of water, wastewater, and stormwater services and infrastructure. Within this context the management of flooding is recognised fleetingly in the context of urban stormwater, and there is no comment on the provision of flood control and land drainage infrastructure or services in NZ.

Despite this, several themes have emerged from NIU that are common to the provision of river management infrastructure. These have been recognised in this assessment and the most notable among them include:

- Networks continue to operate without widespread service failures, but concerns about aging infrastructure and asset deterioration are increasing
- Larger authorities with capacity and capability generally better manage their infrastructure, while small provincial councils with static or declining populations and ratings bases face potentially significant servicing issues
- There is no national data framework, standards or benchmarks to understand how infrastructure is being managed nationally
- Councils have generally poor information regarding the condition of their infrastructure assets
- In general, three waters infrastructure is generally less well managed than other council assets (such as roads)

The NIU identified key challenges facing the infrastructure sector as:

- Aging infrastructure, and the corresponding need to invest in renewals and replacement
- Infrastructure affordability in the face of demographic changes

- The role of technology in the provision of infrastructure services
- Climate change, and how this may affect infrastructure assets

8.3 Office of the Auditor General

In response to the development of Long Term Plans by local authorities as required under the Local Government Act, the Office of the Auditor General (OAG) summarised the issues and matters arising from its review of councils' 2015-25 Long Term Plans.

The OAG found that although councils were planning to look after their major assets, there has been a recent shift towards meeting additional demand, renewals and replacement of assets at the expense of improving the level of service.

The OAG identified a close match between depreciation and renewal and replacement expenditure for road and footpath assets, and found that replacement and renewal expenditure of water, wastewater and stormwater assets is well below the level of depreciation. Depreciation on flood protection assets is significantly lower than other assets, which the OAG considers is a result of flood protection expenditure being on land that is not depreciating.

The OAG was unable to draw conclusions about whether the level of infrastructure funding will be sufficient, or that depreciation has been adequately addressed. The generally low level of planned expenditure across the three water assets could indicate a similarly low level of expenditure on flood control and drainage assets. The OAG also noted a decrease in spending to improve levels of service and a corresponding increase in spending on renewal and replacing existing assets.

The OAG noted that almost half of the local authorities identified the need to collect better information about their assets, and a smaller number were actually putting in place programmes to capture better data. While most councils had reasonable information regarding their aboveground assets, they understood less about the condition of underground assets. Additionally, there was little discussion on the risks and implications associated with a lack of reliable asset information.

Finally, the OAG reported that many councils did not adequately address financial sustainability and affordability of expenditure throughout the full life-cycle of infrastructure assets.

8.4 Response by Local Government New Zealand

In response to these concerns, Local Government New Zealand (LGNZ) has put in place a programme to improve New Zealand's water, wastewater and stormwater sector. LGNZ acknowledges the challenges associated with increased levels of infrastructure reliability, quality, and resilience while maintaining its affordability.

As part of this programme, LGNZ identified the priority outcomes for the three waters sector as:

- Performance transparency and performance improvement over time
- High quality asset information which improves asset management practices
- Resolving competing interests during decision making processes

Additionally, LGNZ recognised the characteristics of a strong sector performance as:

- Understanding customer needs and expectations
- Effectively managing and investing in physical assets
- Effectively recovering costs
- Promoting efficient use
- Continuing to learn and grow

To achieve these outcomes LGNZ considered three ways to effect change. These include minor modifications to existing practices, a strong, sector-led approach, and economic regulation. LGNZ identified the preferred way forward as a strong, sector-led approach.

8.5 Comparison with river management sector

Our assessment of New Zealand's flood protection, river control and land drainage activities managed by regional councils has identified many of the same issues raised by several government agencies in relation to infrastructure delivered by district councils, unitary authorities and utility providers. This should not be surprising given the overall regulatory context, demographic changes and their impact on infrastructure funding, and historic infrastructure investment patterns.

However, there is a real concern that given the relatively small size of the river management sector, the needs of river managers could be overlooked through any programme of reform. We believe there is a real need for the river management sector to speak as a united voice to communicate the challenges and opportunities, and ensure the sector is identified as a key stakeholder and recognised as an expert advisor in any reform process.

9 Conclusions and recommendations

This national assessment of river control, flood protection and land drainage schemes was carried out at a high level across the river management sector of New Zealand's regional councils. Overall we have found that NZ's flood protection, river control and land drainage schemes deliver significant benefits and effective, widespread communication of these benefits should be a priority. Our conclusions are outlined below, followed by recommendations for areas and actions that will address specific challenges and opportunities in the river management sector.

9.1 State of the schemes

Approximately 364 river control, flood protection, and land drainage schemes for which regional councils are responsible were included in this assessment. These 'schemes' directly protect some 1.5 million hectares of land (about 5.5% of New Zealand's land mass), including highly productive primary production land and both small and large urban centres. The 'schemes' also protect or otherwise provide a benefit to non-rateable land (Crown estate) and nationally significant infrastructure including roading and rail networks, and energy and telecommunication links. Funding for the schemes is generally provided through targeted rates on rateable land that either directly or indirectly benefits from the schemes.

9.2 Economic value of the schemes

The schemes included in this assessment provide an estimated Net Present Benefit of $198 billion ($NZD at 2016). This Net Present Benefit includes the wider social and economic benefits of the schemes by way of applying a factor to the calculated direct economic benefit. Costs for the schemes if they were constructed today are given by the sum of the regional councils' published infrastructure asset replacement values and capitalised annual operational expenditure, and provide an estimated Net Present Cost of $3.6 billion ($NZD at 2016). Thus the average Benefit Cost Ratio (BCR) of the schemes to New Zealand is approximately 55:1.

Costs and benefits will obviously vary from scheme to scheme and a more detailed analysis of individual schemes or their elements may find that some are uneconomic. Further work is required to include cultural and environmental capitals of the schemes into a broader cost benefit analysis. One of the most compelling findings of this assessment was the annual benefit of over $11 billion provided by the schemes is nearly five times their published infrastructure replacement value.

9.3 Management of the schemes

Scheme management is informed by the state of infrastructure asset condition, criticality, and performance. Our assessment of asset condition scores for river management infrastructure indicates that, on the whole, regional councils appear to have adopted an appropriate level of asset management, renewal and upgrade processes for various asset types. However, documented asset management practices are variable between councils, and do not generally describe asset criticality and asset performance.

9.4 Challenges facing the river management sector

Various challenges face those responsible for river management. Challenges facing the sector come from both external and internal sources and can be classed as natural or systemic stressors and shocks. Given the distributed nature of the asset base managed by a relatively small sector, a coordinated response from river managers and collaboration across regional councils and with external parties will be required to address these challenges efficiently and comprehensively in the future.

To deal with some of the internal challenges that the sector faces, an enabling environment will need to be created to support further standardisation across councils. A formal process or Memorandum of Understanding should be developed to support council staff working across organisational boundaries. This would also position the river management sector to effectively address external challenges. Consideration should be given to how these cross-organisational activities are collectively funded.

9.5 Recommendations

This assessment has identified a number of areas that need further work to better understand and address issues and challenges. We recommend the river management sector work on areas that encompass the following themes: cross sector collaboration, practices and standards, people, and environment.

Working together across the sector

a Provide resources to river managers to enable and support a step change in professional collaboration and development across regional council river managers and with external organisations, so that the sector as a whole can proactively respond to the challenges identified in this national assessment.

Communication and enabling environment

b Communicate as 'one voice' the state of the river management sector and the outstanding value the schemes provide to New Zealand as identified in this assessment.

c Proactively engage as 'one voice' in discussions about potential changes to the regulatory environment (for example, managing natural hazards under the RMA, development of National Disaster Resilience Strategy, other RMA reforms, etc) so the views of the river management sector are understood by central government.

d Develop methodologies and programmes to enable river managers to effectively engage with stakeholders on the schemes, and their benefits, including how the schemes work and help manage flood risk.

Quality people

e Increase the capacity and capability of the sector to deliver future-focused, successful community outcomes, which may include formal graduate intake and professional development programmes.

f Partner with tangata whenua to bring new skills, networks, and views into the river management sector.

Practices, methodologies and standards

g Benchmark each regional council against key metrics including staffing levels, service levels, funding levels, and the like.

h Prepare nationally consistent asset management methodologies, metadata standards, targeted asset management maturity levels, funding and payment metrics, reporting frameworks (e.g. AMPs), and level of service standards.

i Assess on a scheme by scheme basis asset criticality and performance against asset condition, to better understand how well infrastructure assets are being managed including how river structures integrate with flood protection schemes, and identify where key vulnerabilities lie.

j Compile a technical body of knowledge to establish best practice, and identify knowledge gaps or uncertainties, and research needs (e.g. water quality, risk communication, climate change, river geomorphology).

k Carry out an assessment of cultural and environmental values of the schemes and take them into account when assessing the schemes' benefits and costs.

l Develop a river management resilience framework and supporting decision making tools to enable regional councils to better inform and position communities so they respond to shocks and stressors with minimum disruption, and to formally include environmental, social, cultural and economic values into projects.

m Understand the financial viability of the schemes and common funding issues (asset revaluation, depreciation and renewal expenditure, borrowing, etc) on a national scale and their implications on future affordability of the schemes, and what the impacts of removing protection or decreasing a level of protection may be.

n Investigate alternative funding rationales and strategies, for example, to avoid a higher proportion of scheme costs sitting with fewer ratepayers and to recognise the wider benefits of the schemes.

10 Applicability

This report has been prepared for the exclusive use of our client River Managers' Special Interest Group, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
.....	.....
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Project Manager	Project Director

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Appendix A: Regional Scheme Information

- **Regional asset replacement costs by asset group**
- **Regional asset condition by asset group**
- **Regional total benefit areas by benefit type, and combined total area**
- **Regional total protected rateable capital value by benefit type, and combined total**
- **Regional opex budgets**

Appendix B: Asset Management Maturity Framework and Results

- **IIMM2011 Asset Maturity Framework**
- **Assessment results by Council**

Appendix C: River Manager Survey

- **Survey Questionnaire**
- **Survey Results**

Appendix D: Data Standards

- **Discussion of national metadata standards**

Data standards

Land Information New Zealand, in conjunction with the Ministry of Building Innovation and Employment and Treasury, are currently developing metadata standards (how data should be captured, described and stored) for the three waters sector. It is our view that development of similar standards would benefit the river management sector, and lead to improved asset management practices.

The National Environmental Monitoring Standards (NEMS) are a suite of non-regulatory technical documents prescribing technical standards, methods and other requirements associated with the continuous monitoring, recording and processing of environmental parameters (e.g. water level, rainfall, open channel flow, ratings, etc) that were first published in June 2013. Since then, a number of these documents have been reviewed and rereleased, and many others are planned or under development. Whilst they are entitled 'standards', they are considered best practice and not ascribed a formal status in this regard by Standards New Zealand or our legislative environment.

The NEMS documents set out a generic framework ascribing a level of data quality. This is developed based on a range of factors including but not limited to:

- Whether and how the data are processed
- If an empirical relationship is used to derive the data
- The equipment used for data collection, including processes around its selection, installation, verification and calibration

The generic NEMS quality framework is included here as Figure D.1.

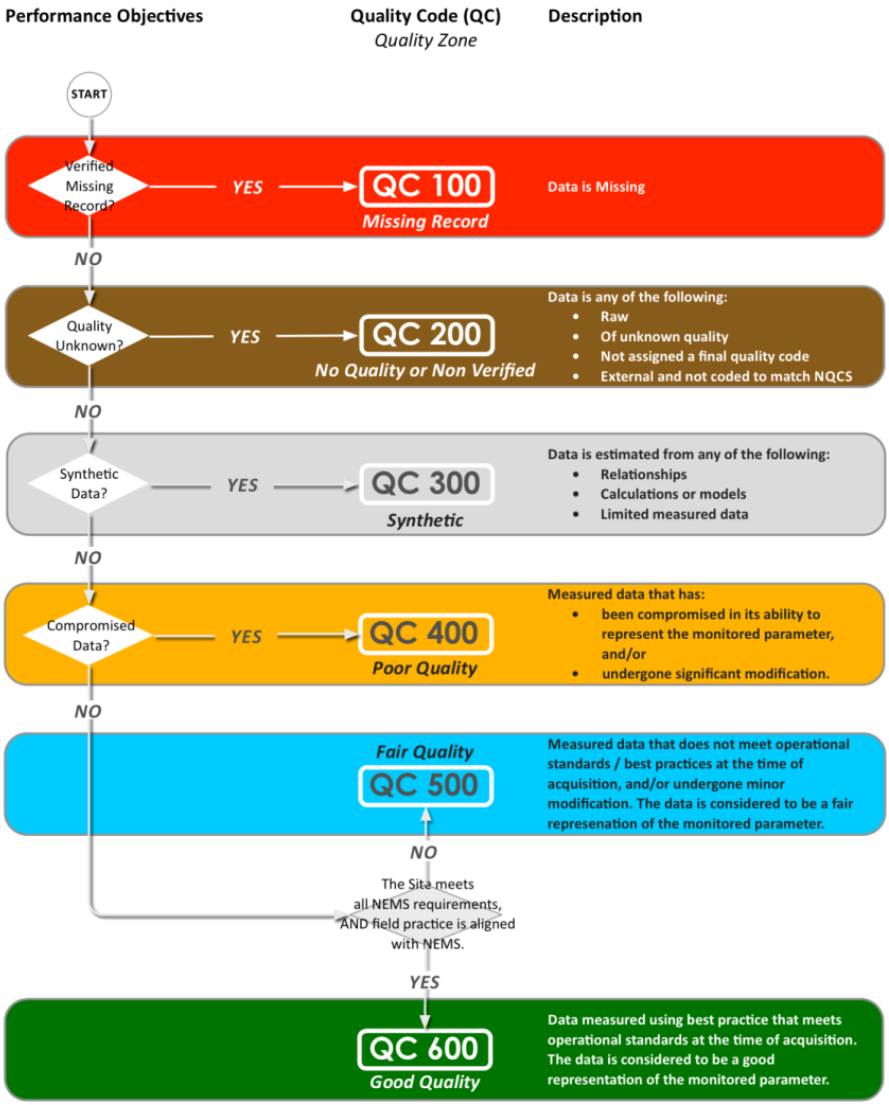

Figure D.1: NEMS generic quality flow chart

In our experience, data of 'fair' quality (QC 500) appears to be a reasonable balance between data accuracy and price tag – 'good' quality (QC 600) data is often associated with expensive installations which may be unaffordable if deployed *en masse*. We would expect that 'fair' quality (QC 500) data would provide enough confidence for regional councils to engage with the National Policy Statement on Freshwater Management and other regulatory processes.

A review of council data acquisition and management processes was outside the scope of this assessment. Further work is required to confirm to which NEMS quality code the river management sector should target, understand each regional council's current data quality codes and what, if any, changes to existing data acquisition and management processes are needed to meet the agreed target NEMS quality code.

Appendix E: Economic Analysis

- **Full report on the analysis of economic benefits**

Appendix F: Regional Benefit Tables

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