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Practical tools and frameworks for freshwater policy development:

Application in the Kaituna-Pongakawa-Waitahanui and Rangitāiki Water Management Areas, Bay of Plenty

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- *the Ministry for the Environment for part-funding this project through the Freshwater Economics Capability Fund, and*
- *staff members who participated in workshops and discussions.*

Contact us for more information

Bay of Plenty Regional council staff, the researcher and consultants involved in this project welcome comments, questions and discussion from regional councils and other parties involved in freshwater management and would be happy to share resources developed as part of this project. Our contact details are listed below.

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Part 1:

Overview

This project was aimed at developing Bay of Plenty Regional Council's (BOPRC's) staff capability to apply tools and frameworks to support freshwater policy development. The tools and frameworks were applied in the Kaituna-Pongakawa-Waitahanui and Rangitāiki Water Management Areas (WMAs), where BOPRC is currently implementing the National Policy Statement for Freshwater Management 2014 (NPS-FM). The capability and lessons developed from this project are applicable to other WMAs in the Bay of Plenty and, indeed, other regions.

Freshwater management is not an easy job. Although this project has certainly introduced tools, frameworks, processes and disciplines that will strengthen the policy process, the task is challenging. BOPRC staff, researchers and consultants involved in this project welcome comments, questions and discussion from regional councils and other parties involved in freshwater management and would be happy to share resources developed as part of this project. Single page A3 poster summaries of each of the sub-projects are included in this report, with the aim of providing a quick reference about what we did and learned for other regional councils or other parties involved in freshwater management. The staff workshops undertaken as part of this project highlighted the importance of having engaged project teams that are clear on the process and that communicate effectively with each other.

Causal loop diagrams were found to be a powerful tool to develop a simple shared understanding of what are complex freshwater systems. BOPRC sees merit in starting NPS-FM implementation processes with a tool like this that would introduce participants to the wide range of factors and relationships involved in freshwater management and identify uncertainties that may warrant further investigation. It is a quick and efficient tool for groups to build an understanding of complex systems based on their own knowledge and experience. The output can be used to introduce the system to a non-technical audience (e.g. relative to reading numerous complex technical reports or waiting for the outputs of catchment modelling). Although causal loop diagrams are not substitutes for technical information, they can inform more detailed technical analysis (e.g. modelling) and in some cases may be the only way to explain certain relationships for which there is very limited information. It also provides an open platform for questions and ideas to be addressed. The diagram developed as part of this project will be a useful tool to keep developing and referring back to as the policy process for the Rangitāiki catchment progresses.

A number of **risks and uncertainties** associated with management of fresh water in the two WMAs were identified and the likely implications of these started to be discussed as part of this project. BOPRC intends to keep developing this thinking and embed the principles of identifying, assessing, reducing, communicating and managing risk and uncertainty in decision-making in each of the work streams. These principles are directly applicable to the bio-physical catchment modelling process and analyses of socio-economic impacts, which will support NPS-FM implementation in the two WMAs. Transparency of assumptions and limitations is critical.

Likewise, the **identification of management options and a proposed framework to assess them** is also directly applicable to the current policy process. The outputs of this sub-project are effectively some of the building blocks of scenarios to be tested through bio-physical catchment modelling and of the evaluation that will be required before a proposed plan change is ready.

But regional plans on their own make no difference to freshwater outcomes. It is the actions of resource users and direct interventions by regional councils that do. While regional plans will guide or direct these actions, they are only a part of the puzzle. Except for the causal loop sub-project, and some very marginal initial input on management options and criteria from community groups, this project was largely aimed at staff. One of the tasks ahead for us is to bring communities, iwi, stakeholders and resource users along with us when applying the tools and frameworks used here; their input will be critical.

Understanding complex relationships in freshwater management through causal loop diagrams

An experimental application in the Rangitāiki Water Management Area, Bay of Plenty

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The aim

The aim of this project was to **develop a shared understanding of the overall freshwater management context** by:

- creating a simplified and accessible overview of the system and the numerous and complex relationships within it,
- helping to define problems or identify areas for further analysis, and
- introducing the participants (10 members of the Rangitāiki Freshwater Futures Community Group) and Bay of Plenty Regional Council staff to a simple and powerful tool that can assist in catchment discussions by reducing complexity and providing an open platform for questions and ideas.

The overarching question that the participants worked through was:

What factors influence, or are influenced by, freshwater quality and quantity in the Rangitāiki Water Management Area?

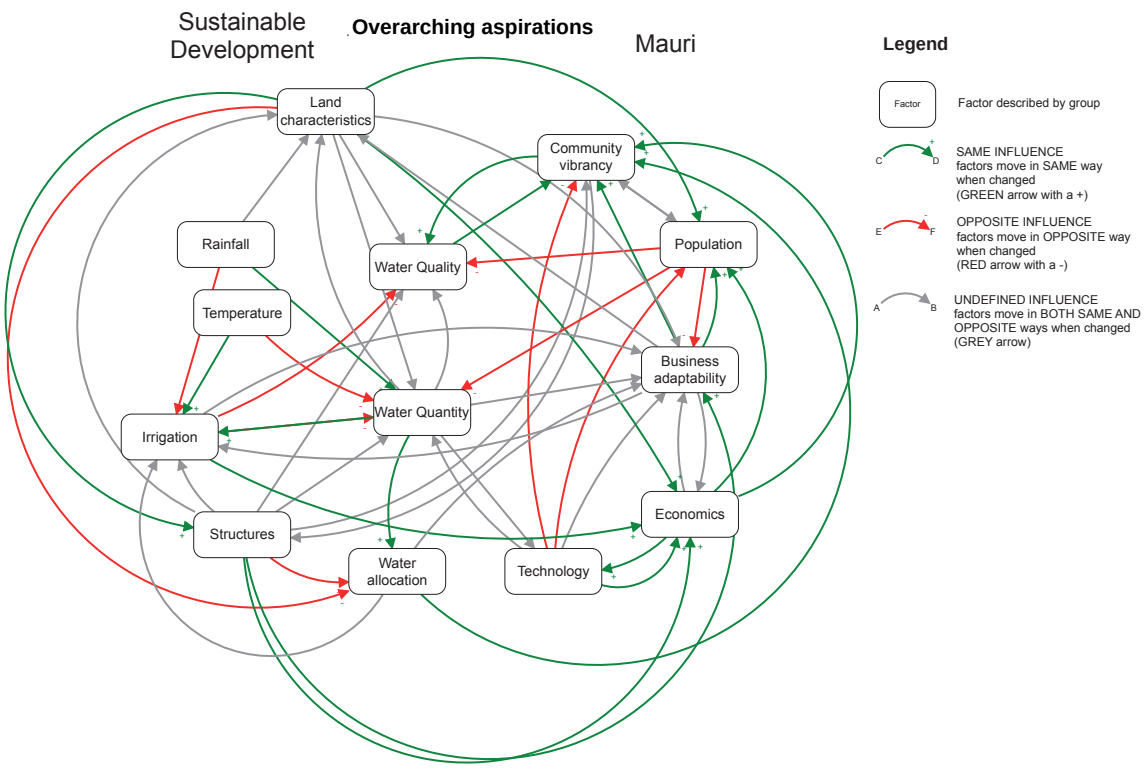
Assisted by an independent and skilled facilitator, participants went through a process of:

- identifying numerous factors,
- grouping and re-grouping the factors down to a number that was manageable but still included key aspects,
- labelling and re-labelling the factors to terms that were intuitive and captured the range of things participants considered were relevant,
- identifying relationships between the factors (and whether these were direct/same/positive or inverse/opposite/negative).

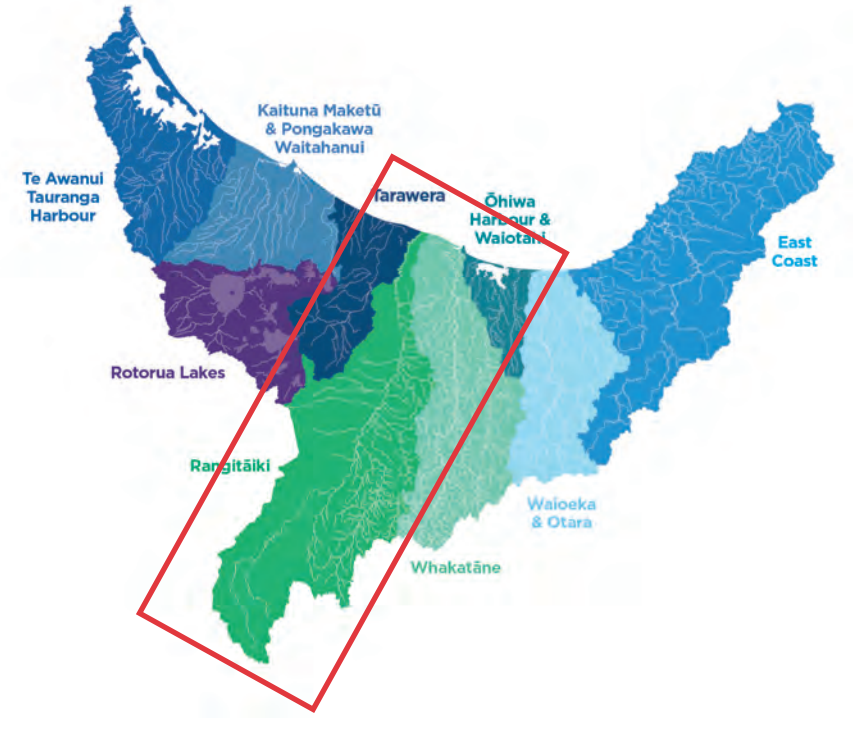
With an initial diagram drawn showing a simple but comprehensive description of the system, the group could more easily identify:

- factors over which there is no, or very little, influence (e.g. land characteristics, rainfall, temperature),
- factors over which there is more influence (e.g. irrigation, water allocation, technology and infrastructure),
- overarching aspirations for the catchment (mauri and sustainable development),
- desired socio-economic outcomes (e.g. community vibrancy),
- possible tensions or conflicting objectives and common patterns like virtuous or vicious cycles or unintended consequences of some actions, and
- relationships that warrant further detail or analysis (e.g. through catchment modelling).

Causal loop diagram for the Rangitāiki Water Management Area



Bay of Plenty Water Management Areas



Managing risk and uncertainty in freshwater management

Application in the Kaituna-Pongakawa-Waitahanui and Rangitāiki Water Management Areas, Bay of Plenty

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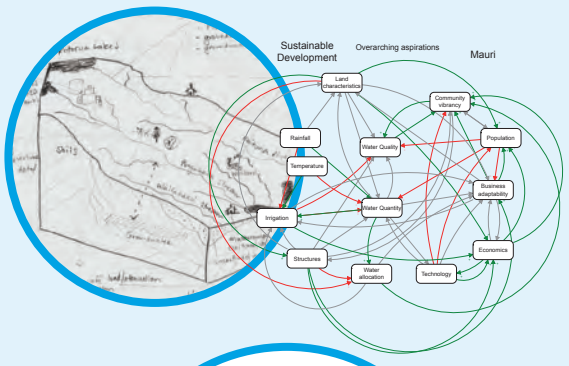
Assess and Reduce Uncertainty

Acknowledge uncertainty is inevitable

Start with a simple exercise (e.g. causal loop or catchment diagrams) to develop a basic shared understanding of how the system works and the process being followed. This may help to highlight key uncertainties.



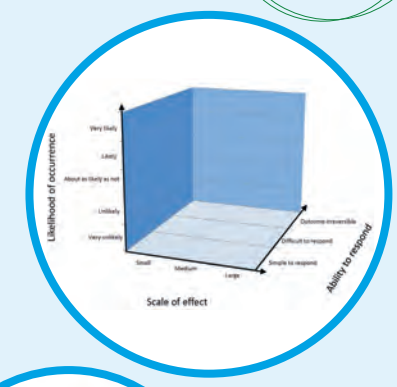
Example of a catchment diagram for the Kaituna-Pongakawa-Waitahanui WMA and causal loop diagram developed by members of the Rangitāiki WMA Freshwater Futures Community Group.

Identify key risks and uncertainties in the system

Are these due to natural variability model/ parameter uncertainty or deep uncertainty?

Assess likelihood and consequence

Start thinking about degree of irreversibility if we get it wrong and our ability to respond in light of new information.



As part of this project, BOPRC staff developed a draft register of natural resource risks and uncertainties which identifies our initial assessment of likelihood, consequence and degree of irreversibility/ability to respond. For example, some impacts from poor water quality on estuaries could be very hard to reverse.

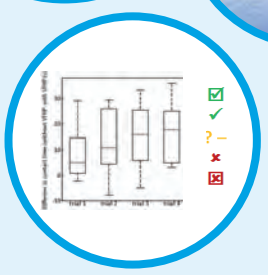
Reduce uncertainty where possible and appropriate

Could we do more monitoring or research? Could we further develop our catchment model? Is it worth it? What additional work should be prioritised?

Additional data, research and monitoring can reduce uncertainty. For example, improved water metering data, flow records, economic impact assessments, relationship between E.coli and pathogens etc.

Quantify, semi-quantity or qualify uncertainty

Where possible, present value ranges, standard deviations, confidence intervals, sample statistics and undertake sensitivity analysis. Where not possible, undertake qualitative assessments.

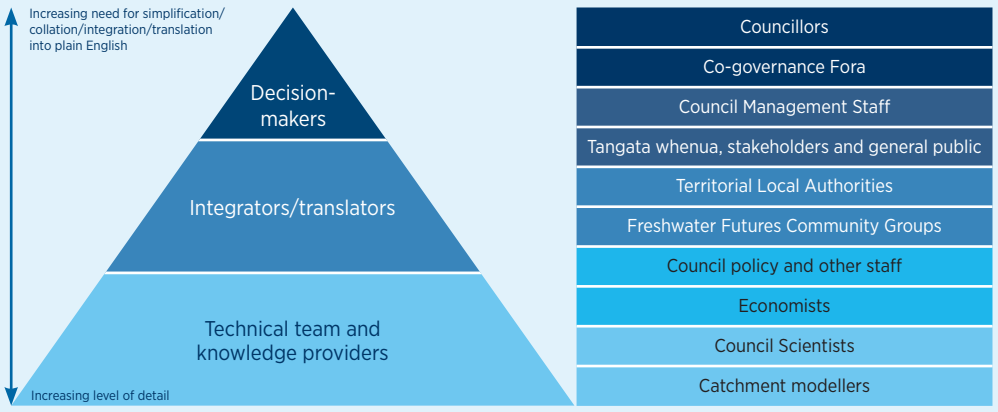


Examples of ways to present uncertainty quantitatively and qualitatively.

Communicate Uncertainty

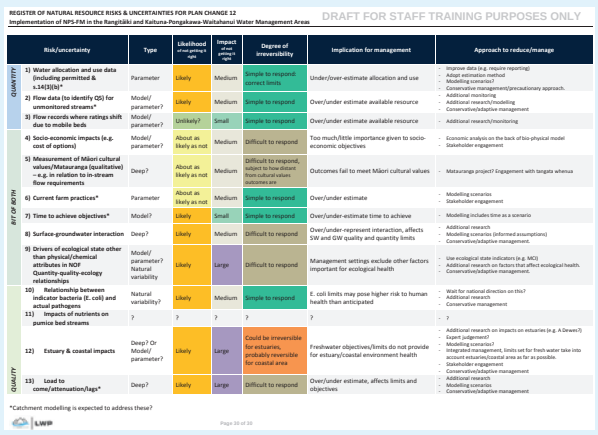
"Share the burden":

- Use a range of tools (tables, graphs, text, maps, diagrams, etc.) and build in repetition.
- Be cognisant of the needs and interests of different audiences and the need to move up and down the pyramid in different circumstances.
- Watch out for biases, be the "honest broker".
- Be open about limitations and uncertainties.



An example of what the 'information pyramid' could look like in the Bay of Plenty.

Incorporate Uncertainty into Decision-Making



REGISTER OF NATURAL RESOURCE RISKS & UNCERTAINTIES FOR PLAN CHANGE 12
Implementation of NPS-FM in the Rangitāiki and Kaituna-Pongakawa-Waitahanui Water Management Areas

DRAFT FOR STAFF TRAINING PURPOSES ONLY

		Risk/uncertainty	Type	Likelihood of not getting it right	Impact of not getting it right	Degree of irreversibility	Implication for management	Approach to reduce/manage
QUANTITY	BIT OF BOTH	1) Water allocation and use data (including permitted & s.14(3)(b)*	Parameter	Likely	Medium	Simple to respond: correct limits.	Under/over-estimate allocation and use	– Improve data (e.g. require reporting) – Adopt estimation method – Modelling scenarios? – Conservative management/precautionary approach.
		2) Flow data (to identify Q5) for unmonitored streams*	Model/ parameter?	Likely	Medium	Simple to respond	Over/under estimate available resource	– Additional monitoring – Additional research/modelling – Conservative/adaptive management
		3) Flow records where ratings shift due to mobile beds	Model/ parameter?	Unlikely?	Small	Simple to respond	Over/under estimate available resource	– Additional research/monitoring
		4) Socio-economic impacts (e.g. cost of options)	Model/ parameter?	About as likely as not	Medium	Difficult to respond	Too much/little importance given to socio-economic objectives	– Economic analysis on the back of bio-physical model – Stakeholder engagement
		5) Measurement of Māori cultural values/Matauranga (qualitative) – e.g. in relation to in-stream flow requirements	Deep?	About as likely as not	Medium	Difficult to respond, subject to how distant from cultural values outcomes are	Outcomes fail to meet Māori cultural values	– Matauranga project? Engagement with tangata whenua
		6) Current farm practices*	Parameter	About as likely as not	Medium	Simple to respond	Over/under estimate	– Modelling scenarios – Stakeholder engagement
		7) Time to achieve objectives*	Model?	Likely	Small	Simple to respond	Over/under-estimate time to achieve	– Modelling includes time as a scenario
		8) Surface-groundwater interaction	Deep?	Likely	Medium	Difficult to respond	Over/under-represent interaction, affects SW and GW quality and quantity limits	– Additional research – Modelling scenarios (informed assumptions) – Conservative/adaptive management.
		9) Drivers of ecological state other than physical/chemical attributes in NOF Quantity-quality-ecology relationships	Model/ parameter? Natural variability	Likely	Large	Difficult to respond	Management settings exclude other factors important for ecological health	– Use ecological state indicators (e.g. MCI) – Additional research on factors that affect ecological health. – Conservative/adaptive management.
QUALITY		10) Relationship between indicator bacteria (E. coli) and actual pathogens	Natural variability?	Likely	Medium	Simple to respond	E. coli limits may pose higher risk to human health than anticipated	– Wait for national direction on this? – Additional research – Conservative management
		11) Impacts of nutrients on pumice bed streams	?	?	?	?	?	– ?
		12) Estuary & coastal impacts	Deep? Or Model/ parameter?	Likely	Large	Could be irreversible for estuaries, probably reversible for coastal area	Freshwater objectives/limits do not provide for estuary/coastal environment health	– Additional research on impacts on estuaries (e.g. A Dewes?) – Expert judgement? – Modelling scenarios? – Integrated management, limits set for fresh water take into account estuaries/coastal area as far as possible. – Stakeholder engagement – Conservative/adaptive management
		13) Load to come/attenuation/lags*	Deep?	Likely	Large	Difficult to respond	Over/under estimate, affects limits and objectives	– Additional research – Modelling scenarios – Conservative/adaptive management

*Catchment modelling is expected to address these?

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Scenarios: exploring possible alternative futures

		A		
A.	'Naturalised' land use			
		Current practice	Mitigation practices:	
			1. Good Management Practice (GMP)	2. GMP plus other mitigations (GMP+)
B.	Current land & water use	B0 (status quo)	B1	B2
Development	C. Land & water use (C)	C0	C1	C2
	D. Land & water use (D)	D0	D1	D2
	E. Land & water use (E)	E0	E1	E2

To effectively incorporate uncertainty into decision-making, BOPRC will continue to work with community groups, including by considering alternative future scenarios. The draft register of natural resource risks and the principles from the Guide will be further developed and applied in subject-specific work streams.

Identifying and assessing management options for fresh water

in the Kaituna-Pongakawa-Waitahanui and Rangitāiki Water Management Areas, Bay of Plenty

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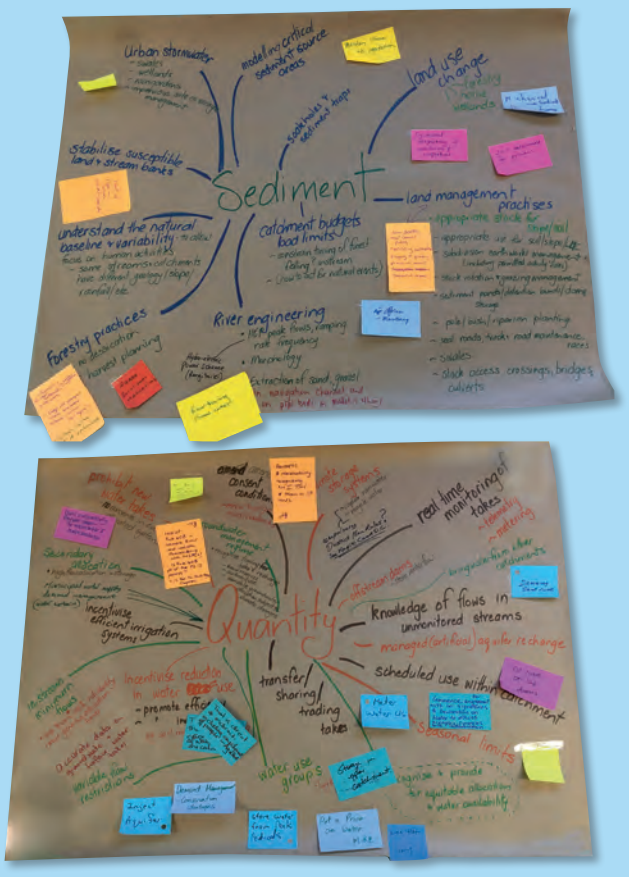
Staff brainstormed potential management options and shared these ideas with community group members, who added theirs...



An initial set of assessment criteria was developed...

...based on a review of literature, other Regional Council's practice, staff workshop, insights from Rangitāiki Causal Loop exercise and a case study of the lower Kaituna Freshwater Management Unit and Maketū Estuary.

1. Effectiveness - environmental outcomes
Does it support environmental limits and objectives?

2. Effectiveness - socio-economic outcomes
Costs, benefits and flow-on implications.
Does it support desired socio-economic outcomes?

3. Distribution of costs and benefits
Who pays, who benefits?

4. Practicality
Can users comply voluntarily?
Is it able to be monitored and enforced?

5. Adaptability
For landowners

6. New entrants, and development by existing users, allowed for
Within environmental constraints.

7. Tangata whenua assessment
Against Iwi Management Plans, Regional Policy Statement.
Are management options culturally acceptable to iwi?

8. Consistency with other initiatives and obligations
Local co-governance documents, Regional Policies and Plans, National Policies and Standards, etc.

9. Resilience to climate change
Does it still work under a different climate scenario?
What is the impact on our resilience to climate change?

10. Administrative/staff resourcing costs

An initial qualitative assessment will help determine which management options are included in scenarios to be tested through catchment modelling.

Scenarios: exploring possible alternative futures

A.	'Naturalised' land use	A		
		Current practice	Mitigation practices:	
			1. Good Management Practice (GMP)	2. GMP plus other mitigations (GMP+)
B.	Current land & water use	B0 (status quo)	B1	B2
Development	C. Land & water use (C)	C0	C1	C2
Development	D. Land & water use (D)	D0	D1	D2
Development	E. Land & water use (E)	E0	E1	E2

Bio-physical catchment modelling

Catchment modelling would primarily help to assess management options' effectiveness to achieve environmental outcomes. Separate analyses and assessments will be required for the other criteria, prior to a Plan Change.

Engagement

The management options and criteria summarised here are initial sets developed as part of this project. Tangata whenua and stakeholder engagement will inform which management options are considered further and whether any additions or changes to this initial set of criteria are warranted.

- **Community Groups**
- **Tangata whenua**
- **Co-governance fora**
- **General public**
- **Territorial Local Authorities**
- **Major resource users/environmental NGOs/industry groups**

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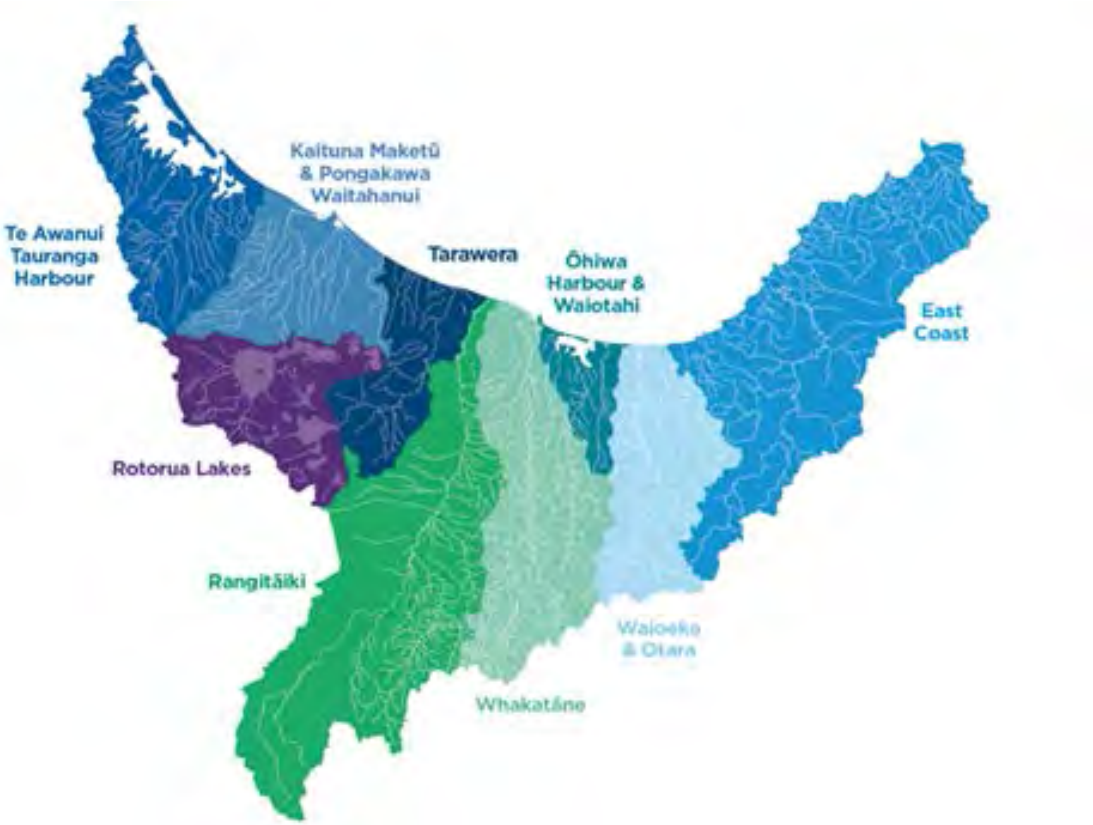
Part 2:

Introduction

Background

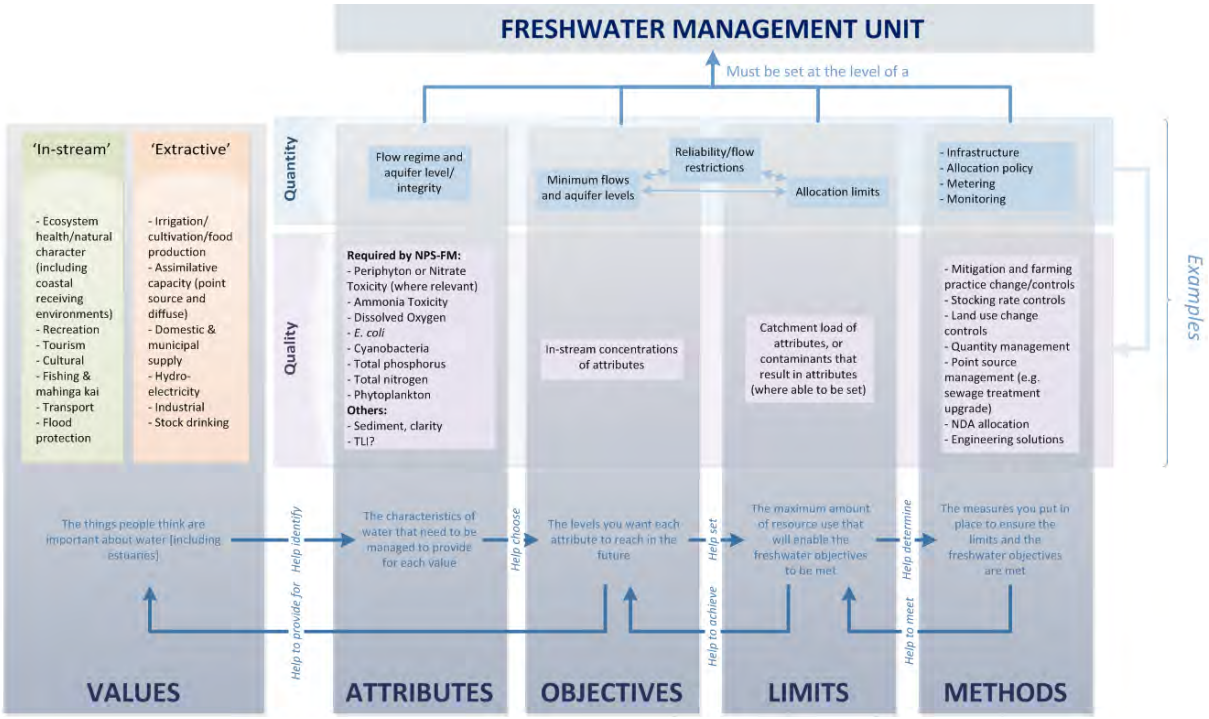
The Bay of Plenty Regional Council (BOPRC) is implementing the National Policy Statement for Freshwater Management 2014 (NPS-FM) in two stages. The first stage is to establish a region-wide water quantity Plan Change, which was notified in late 2016. This Plan Change seeks to confirm default minimum flows and allocation limits, and introduces general measures for the management of freshwater quantity. The second stage is to set specific water quality and quantity provisions consecutively in nine Water Management Areas (WMAs). These WMAs, illustrated in Figure 1, have been defined as geographical areas for managing fresh water in the region. The areas are based on factors including physical surface water catchments, iwi cultural boundaries, Treaty settlement co-governance boundaries, and where people live/local communities.

Figure 1 – Bay of Plenty Water Management Areas.



The first two WMAs in which BOPRC is currently working to set specific water quantity and quality provisions are Rangitāiki and Kaituna-Pongakawa-Waitahanui. The provisions to be set are objectives, limits and methods/rules for freshwater quality and quantity that would support the desired values of fresh water, as illustrated by Figure 2. This work is supported by three catchment community groups (Rangitāiki, Pongakawa-Waitahanui, and Kaituna), two co-governance fora (Rangitāiki River Forum and Te Maru o Kaituna), and engagement with iwi, hapū, stakeholders, Territorial Local Authorities and the general public. Community group members are representative of a range of land use and water interests within the catchments, including iwi, farming, horticulture, hydro-electricity generation, recreational and environmental

Figure 2 – Implementing the NPS-FM (adapted from Ministry for the Environment 2015, [A Guide to the National Policy Statement for Freshwater Management 2014)]



Managing water is complex. Water is a basic need of human life, and has strong social and cultural connections for people. It is a hugely important commercial resource, contributing to the livelihoods of people within and beyond the WMAs and region. Within the lifetime of many New Zealanders fresh water has gone from being perceived as a plentiful and perhaps largely taken for granted resource, to a scarce and degraded resource in some places. There is stronger public and national recognition of the need to understand freshwater values and carefully decide how best to use water while supporting those values. This is reflected in the NPS-FM. In spite of water's value, scientific information is uncertain and incomplete. Without management through good policy, water is subject to the 'tragedy of the commons' issues of open access resources.

Tools and frameworks for freshwater policy development

Economics, in its broadest sense, is about how we make choices about use of scarce resources. This project tests and applies tools, frameworks and processes to improve decision-making about how we use and manage our freshwater resources. The principles and lessons learned from this project are expected to strengthen the policy development process and eventually the evaluation of options and of a Plan Change proposal (e.g. under section 32 of the Resource Management Act 1991). The overall project is aligned with the policy process, and aims to improve the use and integration of economics thinking in the policy development and decision-making process. Although it is aimed at supporting implementation of the NPS-FM in the Kaituna-Pongakawa-Waitahanui and Rangitāiki WMAs specifically, the lessons learned from the application of these tools and frameworks would be relevant to implementation of the NPS-FM in other WMAs in the Bay of Plenty and, indeed, in other regions.

The project is divided into three sub-projects:

1 **Causal loop diagram:** In this sub-project, ten members of the Rangitāiki Freshwater Futures community group, supported by an independent facilitator and BOPRC staff, worked through a process to develop a causal loop diagram for their catchment. They identified factors and relationships that influence, or are influenced by, freshwater quantity and quality. The output is a simple and accessible overview of the system and the numerous and complex relationships within it. It helps to define problems and identify areas for further analysis (e.g. through catchment modelling), and also possible tensions or unintended consequences of some actions. This sub-project was led by Justin Connolly (The University of Waikato), as part of a Master's Thesis on the application of systems thinking to freshwater management.

2 **Risk & uncertainty:** Incomplete information (e.g. no data, poor quality or limited data) is a fundamental concept in economics and a universal reality in freshwater management. Uncertainty and risk can relate to economic, social, cultural and environmental knowledge. It is critical that uncertainty and risk are accounted for transparently in policy making, such that decision-makers understand them in the context of their choice of policy options. This sub-project seeks to apply the principles set out in *A Draft Guide to Communicating and Managing Uncertainty when implementing the National Policy Statement for Freshwater Management 2014* (Ministry for the Environment, 2016) in the context of the two WMAs. It is designed to upskill BOPRC staff to better identify, assess and communicate risk and uncertainty, and to better incorporate them into decisions in the NPS-FM implementation context. This sub-project was supported by Ned Norton (LWP Ltd.), who is one of the authors of the Ministry for the Environment's *Draft Guide*.

3 **Management options and assessment criteria:** Insufficient consideration and assessment of the range of potential policy options to address complex environmental issues can lead to inefficient or sub-optimal outcomes (environmentally, socially, culturally or economically). This sub-project seeks to identify and explore a wide range of feasible policy options, avoiding the tendency to focus on one solution too soon in the policy process. The sub-project takes advantage of the cross-disciplinary skills and experience of BOPRC staff, with some initial input from Freshwater Futures Community Groups, and proposes a comprehensive and transparent process for assessing policy options. This sub-project was supported by Christina Robb (Happen Consulting), who has extensive experience in implementing the Canterbury Water Management Strategy, and the NPS-FM in other regions.

The following sections report on each sub-project. Overall findings and lessons are summarised in the Overview section above.

Part 3:

Understanding complex relationships in freshwater management through causal loop diagrams

Introduction

Freshwater management occurs in a complex context with a range of different social, cultural, economic and environmental aspects. It is often referred to as a “wicked problem”. Many of the relationships between these aspects are often not immediately discernible or understood. Consequently, determining appropriate action to take in freshwater management is likely to be an iterative process requiring broad and deep consideration about the implications of possible choices.

This sub-project is an experimental application of a system dynamics approach, using causal loop diagrams in a group model building process, to identify variables and relationships that influence, or are influenced by, freshwater quality and quantity in the Rangitāiki catchment. Causal loop diagrams help to understand an overview of complex issues without detailed supporting data, while group model building allows them to be developed directly from the knowledge and experience of workshop participants.

Objectives

The aim of this project is to improve BOPRC’s and stakeholder understanding of the overall freshwater context, to support development and setting of freshwater management measures. There is a focus on synthesising the whole context/system rather than on analysing individual parts in detail. The project also seeks to build Council staff and participant capability to use causal loop diagrams.

The project’s specific objectives are to:

1 increase participants’ shared understanding of the system in which freshwater management occurs;

2 assist participants in defining the problems to be addressed by the policy process;

3 support identification of areas for further analysis;

4 provide a non-technical audience an accessible overview of the system;

5 increase participants’ understanding of the causal loop diagram approach and their capability to use it in the future, where appropriate; and

6 provide an insight into how the causal loop diagram might inform catchment bio-physical and/or economic modelling.

Ultimately, it is expected that causal loop diagrams would help to qualify the ramifications of possible decisions, showing how parts are linked, even if the detailed information about each part is not fully understood.

Methodology

Following an initial scoping session with BOPRC staff, the process involved two workshops with 10 members of the Rangitāiki Freshwater Futures Community Group who volunteered to participate.

An initial workshop was held on 15 December 2016. The group went through a process of identifying factors to address the over-arching question:

“What factors influence, or are influenced by, freshwater quality and quantity in the Rangitāiki Water Management Area?”

Factors identified by the participants were shared, clustered and given labels that were more suited for the range of factors, with the aim of using terms that were intuitive and sufficiently specific. This was done twice and resulted in a list of fourteen factors being labelled, seven in the first sort (those considered more important) and seven in a second sort.

Beginning with the first seven factors, the group then identified links or relationships between the different factors. As a sub-sequent step, they also identified if these relationships were direct/same/positive or inverse/opposite/negative. In other words, if an increase in factor A would increase (direct/same/positive) or decrease (inverse/opposite/negative) factor B.

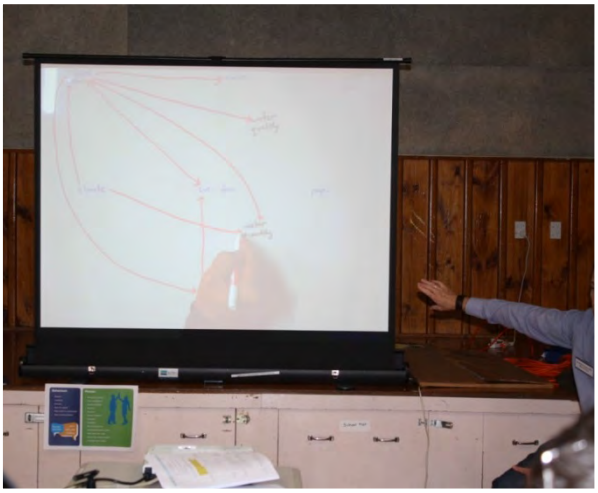
During the workshop some further factors were identified or expanded, while the limited time meant that not all factors on the original list were able to be included.

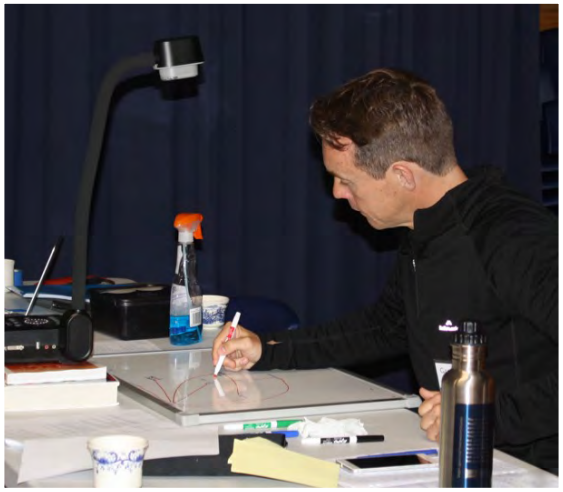
The first workshop involved extensive discussion, post-it notes on the wall (for the ability to re-group, re-arrange and re-label) and an overhead projection of the developing diagram as it was being drawn.

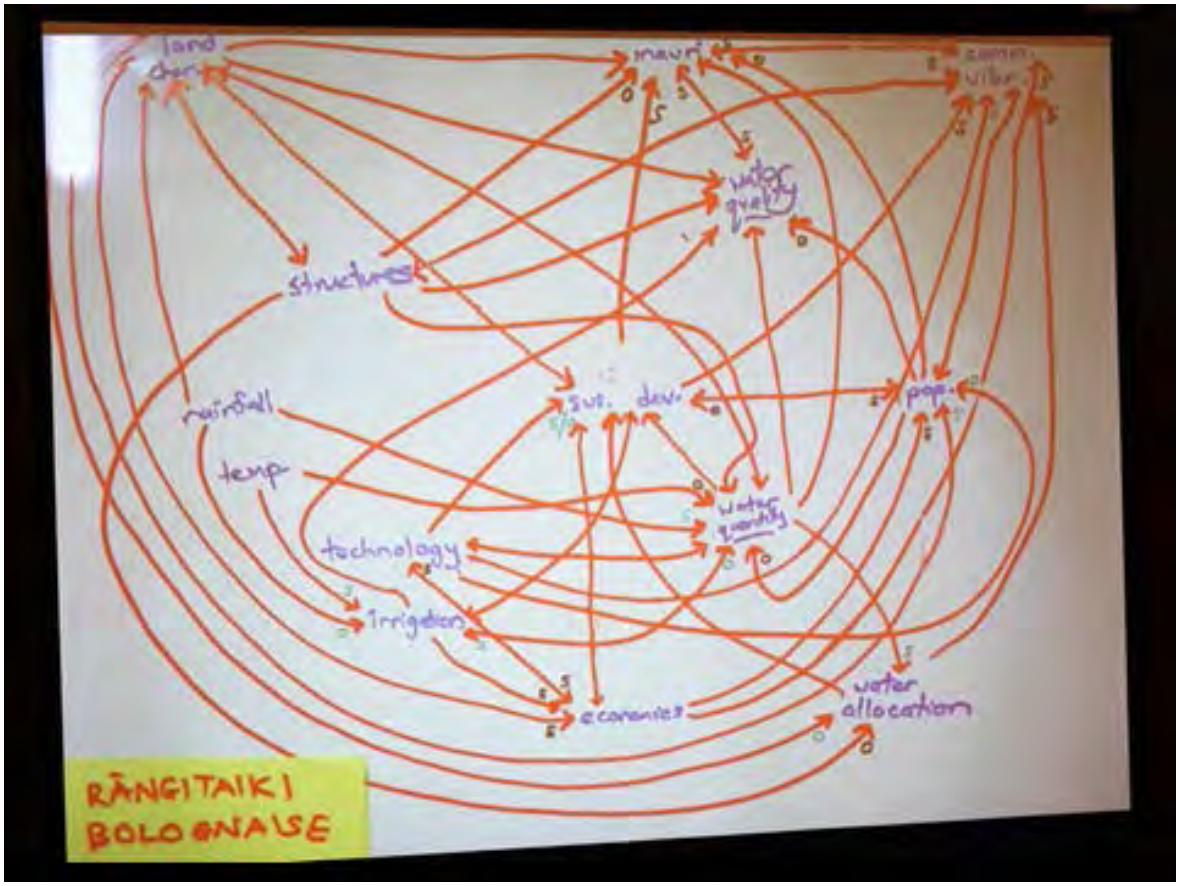
Below are photos from the first workshop.


1985
USA


SOIL TYPE
MAURI
CULTURAL PRACTICES
RESOURCE CONSENT
MONEY
RECREATION
CLIMATE CHANGE
ELECTRICITY







During a second workshop, on 21 February 2017, the researcher presented the output from the first workshop and sought confirmation from participants.

There was an opportunity to re-label some factors and re-assess how some fitted into the wider diagram. There was also an opportunity to discuss different categories of factors and to start identifying possible tensions, conflicting objectives and common patterns like virtuous or vicious cycles or unintended consequences of some actions. The final diagram included eleven factors, excluding the two primary variables of water quality and water quantity, and two additional factors of ‘mauri’ and ‘sustainable development’ that were identified as important over-arching aspirations

Outcomes

Figure 1 below is the final output, after the second workshop. The definitions of the factors are listed in Table 1.

Figure 1 – Causal loop diagram developed by some members of the Rangitāiki Freshwater Futures community group

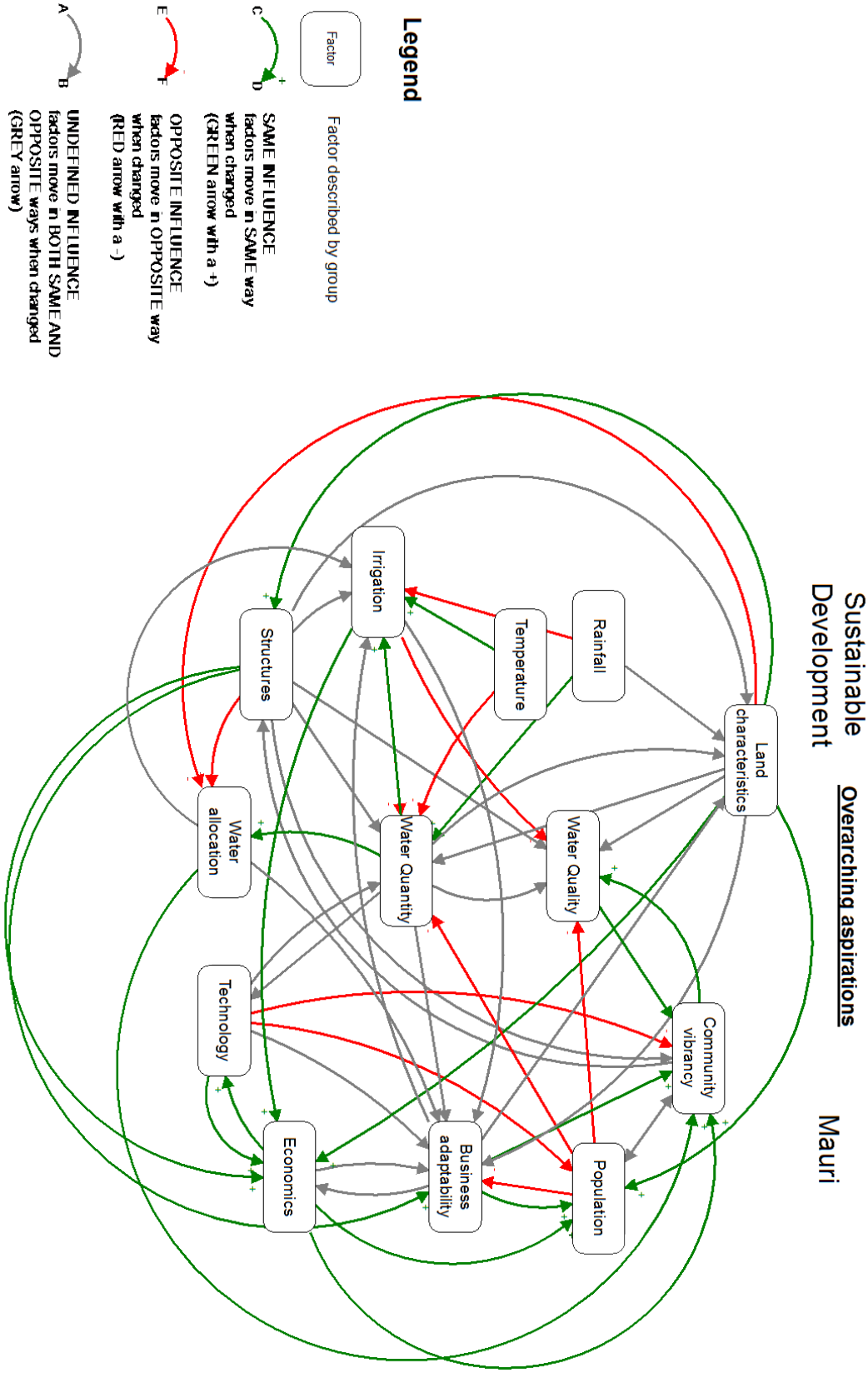


Table 1 – Definition of factors

Factor	Description
Water Quality	The water quality of the Rangitāiki River.
Water Quantity	The water quantity in the Rangitāiki River.
Community Vibrancy	The general social and cultural wellbeing of the community overall.
Financial vibrancy	A broad measure of the financial vibrancy of the community overall. Businesses are profitable and individuals are financially secure.
Adaptable land use	The durability and ability of businesses to adapt and be flexible in response to drivers in the business environment.
Irrigation	Abstracting water and applying it to productive farmland and horticulture.
Population	The *number* of people in the area represented (as opposed to their *vibrancy*.
Structures	All *river related* infrastructure in the WMA. Relates to flood protection, irrigation, electricity generation etc.
Technology	This factor describes advances and/or changes in physical (e.g. mechanical) and economic technology (e.g. contracting methods).
Water Allocation	The act of determining access to, and the distribution of, water amongst users of all types.
Land Characteristics	The natural or modified features and characteristics of the land.
Rainfall	Patterns and levels of rainfall.
Temperature	Patterns and levels of temperature.

From this relatively simple but comprehensive depiction of the system, it was possible to identify:

- factors over which the planning process and resource users have no, or very little, influence such as rainfall, temperature and land characteristics. These are also key inputs into bio-physical catchment modelling,
- a second group of factors over which the planning process and resource users have a greater degree of influence: irrigation, water allocation, technology and infrastructure. This group is also within the scope of the bio-physical catchment modelling,
- over-arching aspirations for the catchment, which related to several other factors and encompassed multiple dimensions: mauri and sustainable development. As a consequence, the group agreed to treat them separately from other factors,
- desired socio-economic outcomes in the planning process (e.g. community vibrancy, business adaptability, etc.), which also came up in the initial set of criteria to assess management options under the third sub-project,
- possible tensions or conflicting objectives which started to become apparent. For example, between improved water quality and economics (or profitability).

The causal loop diagram could be further developed and analysed to explore these insights in more detail. These insights could include common patterns (or 'archetypes') such as virtuous or vicious cycles or unintended consequences of some actions. The group discussed possible common patterns described in literature (e.g. balancing relationships where factors cancel each other out, reinforcing relationships, delays and side-effects).

Lessons for future applications

If the process is led by an external provider, who is unfamiliar with the catchment or stakeholders, an initial scoping session with council staff would be useful to ensure the workshops are pitched at the right level.

Using clear and intuitive terminology that the group agrees with for factor labels and to describe the nature of relationships (e.g. “same” and “opposite”) is essential. For factor labels, the facilitator or supporting staff should encourage the use of single nouns. There may be a tension between using very specific concepts (e.g. one dimensional concepts that can either increase or decrease as a single parameter at one end of the spectrum) and broader concepts that would encompass multiple dimensions (e.g. “sustainable development”, at the other end of the spectrum). In this exercise, the group agreed to lift up the “sustainable development” factor to an over-arching outcome, along with mauri, which also encompasses various aspects.

When defining factors, establishing relationships and identifying common patterns, it is important for the level of detail to be consistent. For example, the factors of “technology” and “structures” could encompass a raft of things. If in the context of a particular catchment those terms can be defined more specifically, then participants could be encouraged to do that. If not, then the relationships between those and other factors are more likely to be undefined, as opposed to same/direct/positive or opposite/inverse/negative given that different types of technology or structures would have different impacts.

Furthermore, it may be helpful to start with a focus question aimed at a more specific problem (e.g. over-allocation of freshwater quantity in the mid-upper catchment) that would allow the factors and relationships to be more specific. However, a level of aggregation is important and assumed in system dynamics applications. In this exercise, the overarching question, encompassing water quality and quantity across a large and diverse catchment, may have lacked a degree of focus.

It is important to keep in mind the catchment context and the purpose of the exercise. If the output diagram is deviating from the reality of the catchment or creating confusion, it may be that more or less detail is required (in terms of specificity of the factors and their relationships).

The role of a skilled independent facilitator to guide the participants through the process was very important and highlighted by participants in debrief interviews. Although it may seem a minor point, the availability of resources that assisted the discussion and the ability for participants to easily move things around and re-label them (e.g. sticky notes, overhead projector, etc.) was also important.

Managing Risk & Uncertainty

Identifying and communicating risk and uncertainty in the Rangitāiki and Kaituna-Pongakawa-Waitahanui Water Management Area planning process (Bay of Plenty Regional Water and Land Plan Change 12)

June 2017

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Executive Summary

The Bay of Plenty Regional Council (BOPRC) is currently running a community engagement process to identify freshwater values, objectives, and associated limits to resource use for the Rangitāiki and Kaituna-Pongakawa-Waitahanui Water Management Areas.

The objective of this sub-project was to provide a practical approach to identifying and expressing risk and uncertainty in the process of identifying freshwater quality and quantity objectives, limits, and other management options.

LWP Limited worked with a BOPRC multi-disciplinary team to run two workshops based on the three stage framework for handling uncertainty described in: *A Draft Guide to Communicating and Managing Uncertainty When Implementing the National Policy Statement for Freshwater Management 2014* (Ministry for the Environment, 2016). The material in the Draft Guide was used to generate discussion on local examples where handling uncertainty is proving a challenge in the BOPRC's current process.

The methods used for the workshops are described, and the agendas, run-sheets, presentations and group exercises are provided in appendices to this report.

Outcomes and learnings from this sub-project include:

- There is considerable value in sharing the "burden" of uncertainty by simply communicating it within multidisciplinary project teams.
- Communication within multidisciplinary project teams would be helped by agreeing on a common language, such as consistent use of the terms uncertainty, risk, likelihood, consequence and reversibility, as well as consistent descriptors of points on a scale of likelihood (e.g., very likely, likely, about as likely as not, unlikely, very unlikely).
- It is useful to systematically identify, acknowledge, assess, reduce and quantify uncertainties and risk, so that sensible project decisions can be made on a suitable level of effort to manage different risks.
- To some extent this approach to handling uncertainty is about developing a useful "mind-set" for each individual to employ continuously in a manner suitable for their particular role. However, there is also value in periodically documenting key uncertainties for the project as a whole, such as the draft "risk register" table produced during this project.
- It is clear that communication of uncertainties is universally important when informing plan development processes, and ultimately for decision-making.
- BOPRC staff already use some of the many available methods for communicating uncertainty. The workshops increased collective capacity amongst participants through sharing ideas and approaches, and considering examples in the Draft Guide. Consistent use of terminology suggested at bullet 2 above would help further.
- It is clear that incorporating uncertainty into decision-making is challenging for many reasons. Running community engagement processes and testing alternative future scenarios both help expose uncertainties and risks to be managed. BOPRC is already doing both of these things. Workshop participants also specifically identified that communicating "reversibility" is useful to inform decision-making.

BOPRC's proposed approach arising out of this sub-project is summarised in Figure 1.

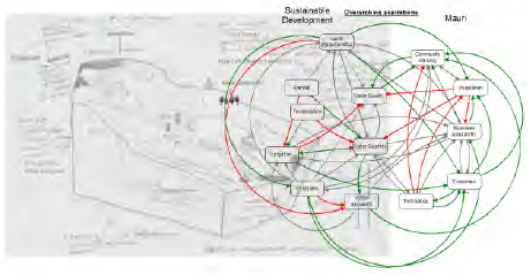
Managing risk & uncertainty in freshwater management

Application in the Kaituna-Pongakawa-Waitahanui and Rangitāiki Water Management Areas, Bay of Plenty

ASSESS & REDUCE UNCERTAINTY

Acknowledge uncertainty is inevitable

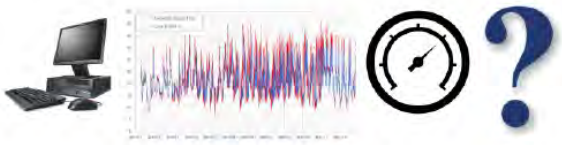
Start with a simple exercise (e.g. causal loop or catchment diagrams) to develop a basic shared understanding of how the system works and the process being followed. This may help to highlight key uncertainties.



Example of a catchment diagram for the Kaituna-Pongakawa-Waitahanui WMA and casual loop diagram developed by members of the Rangitāiki WMA Freshwater Futures Community Group

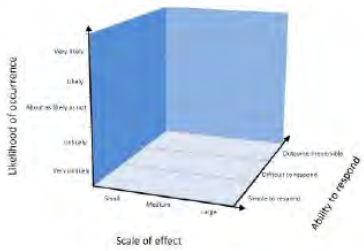
Identify key risks and uncertainties in the system

Are these due to natural variability, model/parameter uncertainty or deep uncertainty?



Assess likelihood and consequence

Start thinking about degree of irreversibility if we get it wrong and our ability to respond in light of new information



As part of this project, BOPRC staff developed a draft register of natural resource risks and uncertainties which identifies our initial assessment of likelihood, consequence and degree of irreversibility/ability to respond. For example, some impacts from poor water quality on estuaries could be very hard to reverse.

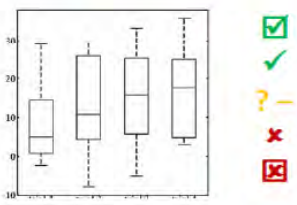
Reduce uncertainty where possible and appropriate

Could we do more monitoring or research? Could we further develop our catchment model? Is it worth it? What additional work should be prioritised?

Additional data, research and monitoring can reduce uncertainty. For example, improved water metering data, flow records, economic impact assessments, relationship between E. coli and pathogens, etc.

Quantify, semi-quantify or qualify uncertainty

Where possible, present value ranges, standard deviations, confidence intervals, sample statistics and undertake sensitivity analysis. Where not possible, undertake qualitative assessments.

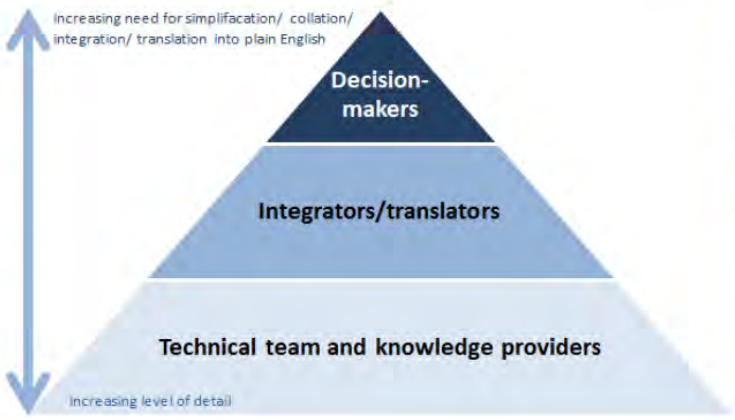


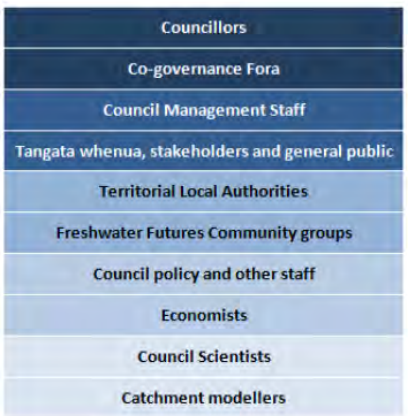
Examples of ways to present uncertainty quantitatively and qualitatively.

COMMUNICATE UNCERTAINTY

"Share the burden":

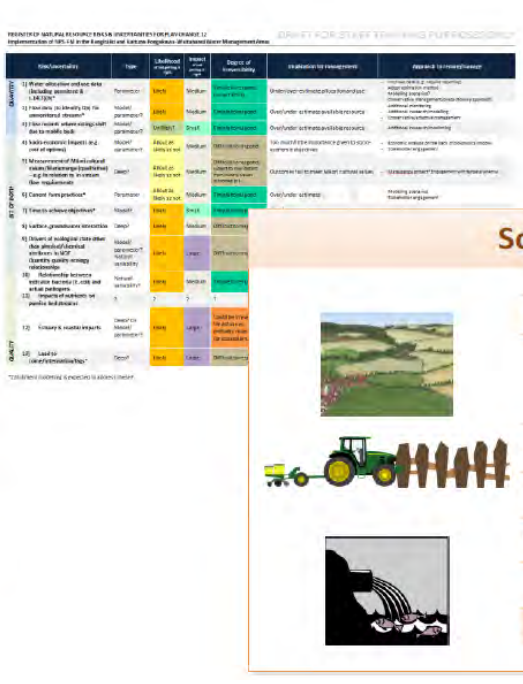
- Use a range of tools (tables, graphs, text, maps, diagrams, etc.) and build in repetition
- Be cognisant of the needs and interests of different audiences and the need to move up and down the pyramid in different circumstances
- Watch out for biases, be the "honest broker"
- Be open about limitations and uncertainties





An example of what the 'information pyramid' could look like in the Bay of Plenty

INCORPORATE UNCERTAINTY INTO DECISION-MAKING



Freshwater Futures Community Groups

To effectively incorporate uncertainty into decision-making, BOPRC will continue to work with community groups, including by considering alternative future scenarios. The draft register of natural resource risks and the principles from the Guide will be further developed and applied in subject-specific work streams.

Scenarios: exploring possible alternative futures

'Natural state' scenario:	A		
	Current farming practice	*Mitigation scenarios:* *Good Management Farming Practice*	*Best Management Farming Practice*
Current land & water use or land use change trend	B1 (status quo scenario)	B2	B3
Development scenarios:			
High intensity land & water use	C1	C2	C3
Low intensity land & water use	D1	D2	D3
Also different climate scenarios, timeframes to achieve objectives and point source management scenarios.			

Figure 1.Summary of BOPRC's approach to managing risk and uncertainty.

1 Introduction

1.1 Background

Bay of Plenty Regional Council (BOPRC) is undertaking regional plan development processes in accordance with the requirements of the National Policy Statement for Freshwater Management (2014) (NPSFM). The BOPRC is currently seeking to establish freshwater objectives for the Rangitāiki and Kaituna-Pongakawa-Waitahanui Water Management Areas, based on a community engagement process to identify freshwater values, objectives and associated limits to resource use. Community group members cover a range of land use and water interests within the catchments, including farming, horticulture, cultural, environmental and recreational.

Once freshwater objectives are developed, BOPRC will identify feasible policy options that may fully or partially achieve the stated objectives, thereby addressing the resource issues identified by the community. BOPRC has identified that incomplete information is inevitable when making policy decisions. While incomplete information creates uncertainty and risk, there are costs to gathering information; these costs may be financial, and they can also involve time – possibly years, and still it will not be possible to know everything or accurately predict the future. Waiting for complete information can increase environmental risk.

This BOPRC sub-project recognises:

(1) risk is inherent in environmental policy;

(2) information is not costless, or not always possible, and the benefits and costs of additional information must be considered; and

(3) policy effectiveness can be jeopardised by failing to identify, assess and communicate policy risk.

This sub-project focuses on uncertainty, and is designed to integrate thinking about risk and uncertainty into the policy process using frameworks for identifying, assessing and communicating risk.

BOPRC recognises that a multi-disciplinary approach is essential to its planning process, and there is a focus on 'learning by doing'. The outputs of this sub-project will feed into the assessment of the effectiveness and efficiency of plan provisions in achieving the objectives, and assessing the risk of acting or not acting if there is uncertain or insufficient information about the subject matter of the provisions[1].

1.2 Objective

The objective of this sub-project was to provide a practical approach to identifying and expressing risk and uncertainty in the process of identifying freshwater quality and quantity objectives, limits, and management options for the Rangitāiki and Kaituna-Pongakawa-Waitahanui Water Management Areas.

[1] i.e., as part of fulfilling BOPRC's functions and duties under section 32(1)(b)(ii) of the RMA.

2 Approach

LWP Limited (LWP) was contracted to provide thought leadership and discussion on assessing and expressing uncertainty and risk, working with the BOPRC multi-disciplinary team in workshops, based on the framework published in: *A Draft Guide to Communicating and Managing Uncertainty When Implementing the National Policy Statement for Freshwater Management 2014* (Ministry for the Environment, 2016)[2] (Figure 2).

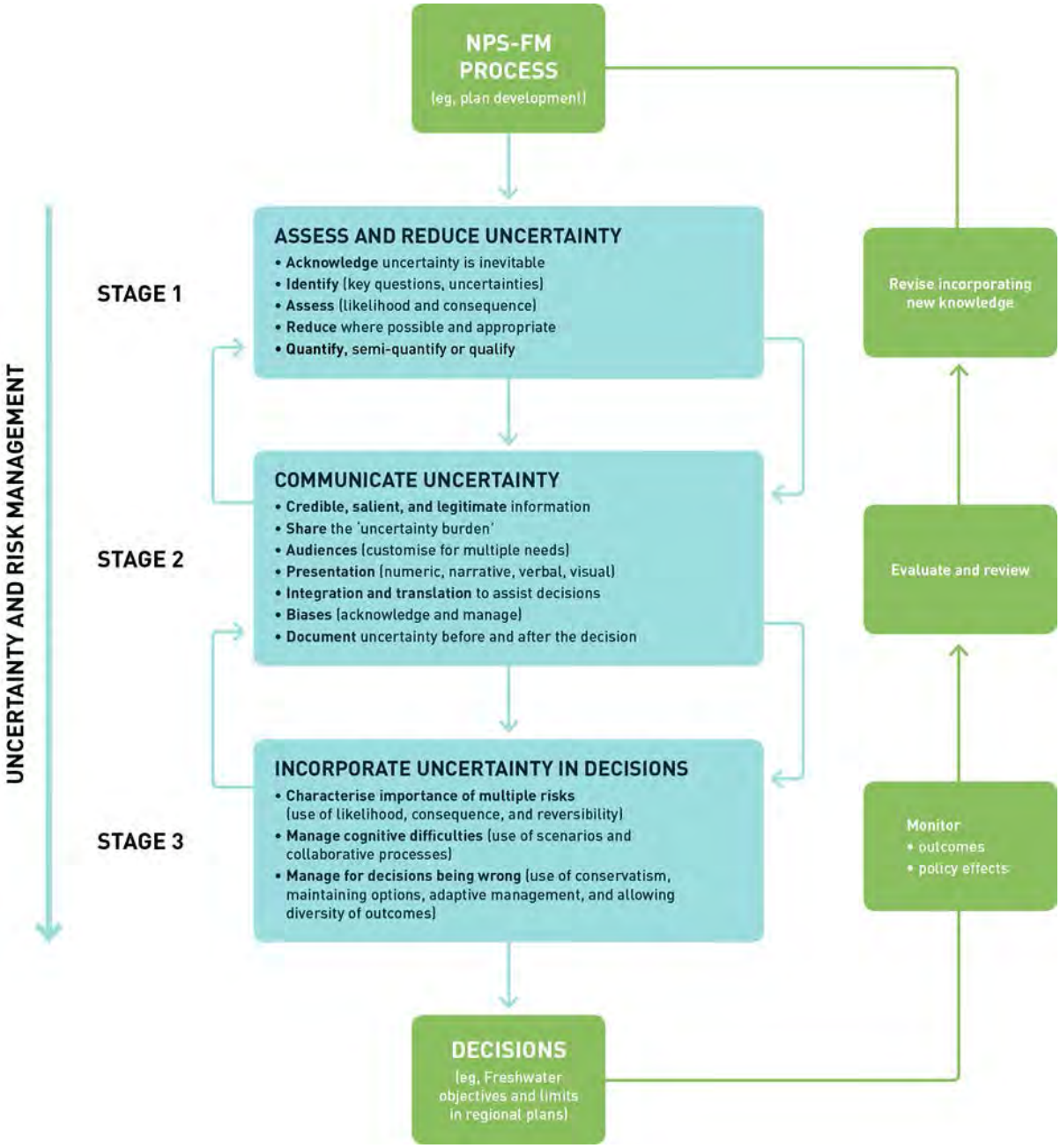


Figure 2. Three stage iterative process to manage uncertainty in NPSFM processes (from Ministry for the Environment, 2016).

[2] Ministry for the Environment. 2016. *A Draft Guide to Communicating and Managing Uncertainty When Implementing the National Policy Statement for Freshwater Management 2014*. Wellington: Ministry for the Environment.

The general approach was to run two workshops based on the three stage framework described in the Draft Uncertainty Guide (Figure 2). Each workshop included presentations of the theory and examples from the Draft Guide, as well as group exercises designed to facilitate discussion, co-learning, and development of locally relevant approaches for the current Rangitāiki and Kaituna-Pongakawa-Waitahanui planning processes. The intent of this approach was to build capacity of knowledge on approaches to handling uncertainty used elsewhere, and to thereby develop with BOPRC staff practical and fit-for-purpose approaches for use in the technical modelling and community engagement projects.

Broadly, the first workshop (in March 2017) covered Stage 1 in the Draft Uncertainty Guide, while the second workshop (in May 2017) covered Stages 2 and 3 (Figure 2). All BOPRC staff who were directly involved in the Rangitāiki and Kaituna-Pongakawa-Waitahanui processes were invited, including technical, planning, community engagement and management staff. As preparation for the workshops all invitees were encouraged to read the Draft Uncertainty Guide and to consider its relevance for their individual roles.

The method and content for each workshop is described in more detail in the following sections.

3 Workshop 1: Assessing & reducing uncertainty

Workshop 1 was held on 9 March 2017 at the BOPRC offices in Whakatāne.

3.1 Agenda and run-sheet

The agenda, run-sheet and resources used for Workshop 1 are provided in Appendix 1. In brief, Workshop 1 involved:

- An introduction to the project and scene-setting by BOPRC staff for the current stage of BOPRC's processes.
- An introductory presentation to some necessary terminology and theory around uncertainty and risk.
- An overview presentation of Stage 1 in the Uncertainty Guide (on "assessing and reducing uncertainty") followed by three group exercises designed to put the three steps of Stage 1 of the Guide into practice with local examples (see below).

3.2 Presentations

The presentations used for Workshop 1 are provided in Appendix 2.

3.3 Group exercises

Three group exercises were designed (see run-sheet in Appendix 1 for detail) to:

- Identify and acknowledge examples of key uncertainties in the Rangitāiki and Kaituna-Pongakawa-Waitahanui projects;
- Consider methods to assess and reduce uncertainties, if appropriate, from the list of identified local examples;
- Consider methods to quantify or semi-quantify the identified local examples of uncertainty

3.4 Participants' reflections

The last exercise of the day was to go around the room asking all participants for their take-home reflections. These are provided as recorded on the day in Appendix 3.

4 Workshop 2: Communicating & incorporating uncertainty in decisions

Workshop 2 was held on 2 May 2017 at the BOPRC offices in Whakatāne.

4.1 Agenda and run-sheet

The agenda, run-sheet and resources used for Workshop 2 are provided in Appendix 4. In brief Workshop 2 involved:

- A progress update by BOPRC staff of the current state of BOPRC's processes, and a reminder of the relevance of handling uncertainty and risk for those processes.
- An overview presentation of Stage 2 in the Uncertainty Guide (on "communicating uncertainty") interspersed with pauses for prompted discussion on examples of communication challenges in the local BOPRC projects.
- An overview presentation of Stage 3 in the Uncertainty Guide (on "informing decision-making"), followed by two group discussion exercises designed to put the elements of Stage 3 of the Guide into practice with local examples (see below).

4.2 Presentations

The presentations used for Workshop 2 are provided in Appendix 5.

4.3 Group exercises

Two group exercises were designed (see run-sheet in Appendix 4 for detail) to:

- Review a list of uncertainties and risks previously identified in Workshop 1 for the Rangitāiki and Kaituna-Pongakawa-Waitahanui projects (i.e., the "risk register" – see Appendix 4) and assess likelihood, impact and degree of irreversibility for each;
- Discuss how the use of scenario testing and stakeholder engagement in collaborative processes can be part of the approach to handling uncertainty and incorporating uncertainty and risk into decision-making.

4.4 Participants' reflections

The last exercise of the day was to go around the room asking all participants for their take-home reflections. These are provided as recorded on the day in Appendix 6.

5 Outcomes and learnings

The authors offer the following reflections on the process of running the workshops, as well as on the project objective to provide a practical approach to identify and express risk and uncertainty during the process of developing regional plans.

5.1 Learnings about the workshop process

- When participants at the first workshop were asked to identify key uncertainties they would have to deal with in their project roles (see group exercise 1 in Appendix 1), they identified a wide range of uncertainties not only about the information needed to inform the plan development process, but also uncertainties around project structure, roles, responsibilities, timelines, and even governance issues. It then took time to narrow the discussion down to the intended focus of the workshops; i.e., developing approaches to handling natural resource uncertainties in informing the plan development process. The other uncertainties around project structure and governance are also obviously important; the discussion was a reminder of the importance of communication between BOPRC staff to improve clarity around these aspects outside the scope of this sub-project (see reflections from Workshop 1 in Appendix 3).

- While the presentation of a certain amount of theoretical material was arguably necessary at the workshops, it was very important to intersperse this with questions and activities to stimulate discussion and sharing of local examples. It was clear that most participants had many local examples of situations involving uncertainties that "struck a chord" with the examples and approach promulgated in the Draft Uncertainty Guide. This was particularly evident by the second workshop where interactive and useful discussion characterised the day.

5.2 Outcomes and learnings about uncertainty in planning processes

- There is considerable value in acknowledging and sharing the challenge of uncertainty within the multidisciplinary project team (i.e., "sharing the uncertainty burden"), as occurred simply by holding the workshops. Participants reflected that acknowledging uncertainties represents "real life" (see Appendix 6).

- Communication within the team could be helped by agreeing on a common language, such as consistent use of the terms uncertainty, risk, likelihood, consequence and reversibility, as well as consistent descriptors of points on a scale of likelihood (e.g., very likely, likely, about as likely as not, unlikely, very unlikely).

- It is useful to spend some effort systematically identifying, acknowledging, assessing, reducing and quantifying uncertainties and risk, so that sensible project decisions can be made on a suitable level of effort to manage different risks. To some extent this is about developing a useful "mind-set" for each individual to employ continuously in a manner suitable for their particular role. There is also value in periodically documenting key uncertainties for the project as a whole, such as the draft "risk register" table produced for discussion at Workshop 2 (see Appendix 4).

- It is clear that communication of uncertainties is universally important when informing plan development processes and ultimately for decision-making. There are many methods for this and BOPRC staff already use some of them. The workshops served to build collective capacity amongst participants through sharing ideas and approaches, and considering examples in the Draft Uncertainty Guide. It seems clear that consistent use of terminology developed within multidisciplinary teams (e.g., as suggested in bullet 2 above) would also be useful for communicating out beyond the project team to the community and decision-makers.

- A summary list of tips for communicating uncertainty was developed as part of preparing the Draft Uncertainty Guide and this list is provided, with permission from the Ministry for the Environment, in Appendix 7.
- It is clear that incorporating uncertainty into decision-making is challenging for many reasons. Workshop participants largely agreed that effective characterisation and communication of uncertainty and risk by BOPRC teams could help decision-making. It was also acknowledged by participants that use of scenarios and community engagement processes are process tools that help expose uncertainties and risks to be handled. In this respect the BORC projects are already on a useful path. Participants specifically also identified the concept of communicating “reversibility” as a useful feature to inform decision-making.

Acknowledgements

The authors of this report gratefully acknowledge the other co-authors of the Draft Uncertainty Guide (Ministry for the Environment 2016), Simon Harris (LWP) and Helen Rouse (NIWA). Also sincere thanks to all of those who provided input to the development of the Draft Guide including the Ministry for the Environment who funded the Draft Uncertainty Guide project and also co-funding the present BOPRC project.

Appendix 1: Workshop 1 agenda, group exercises & resources

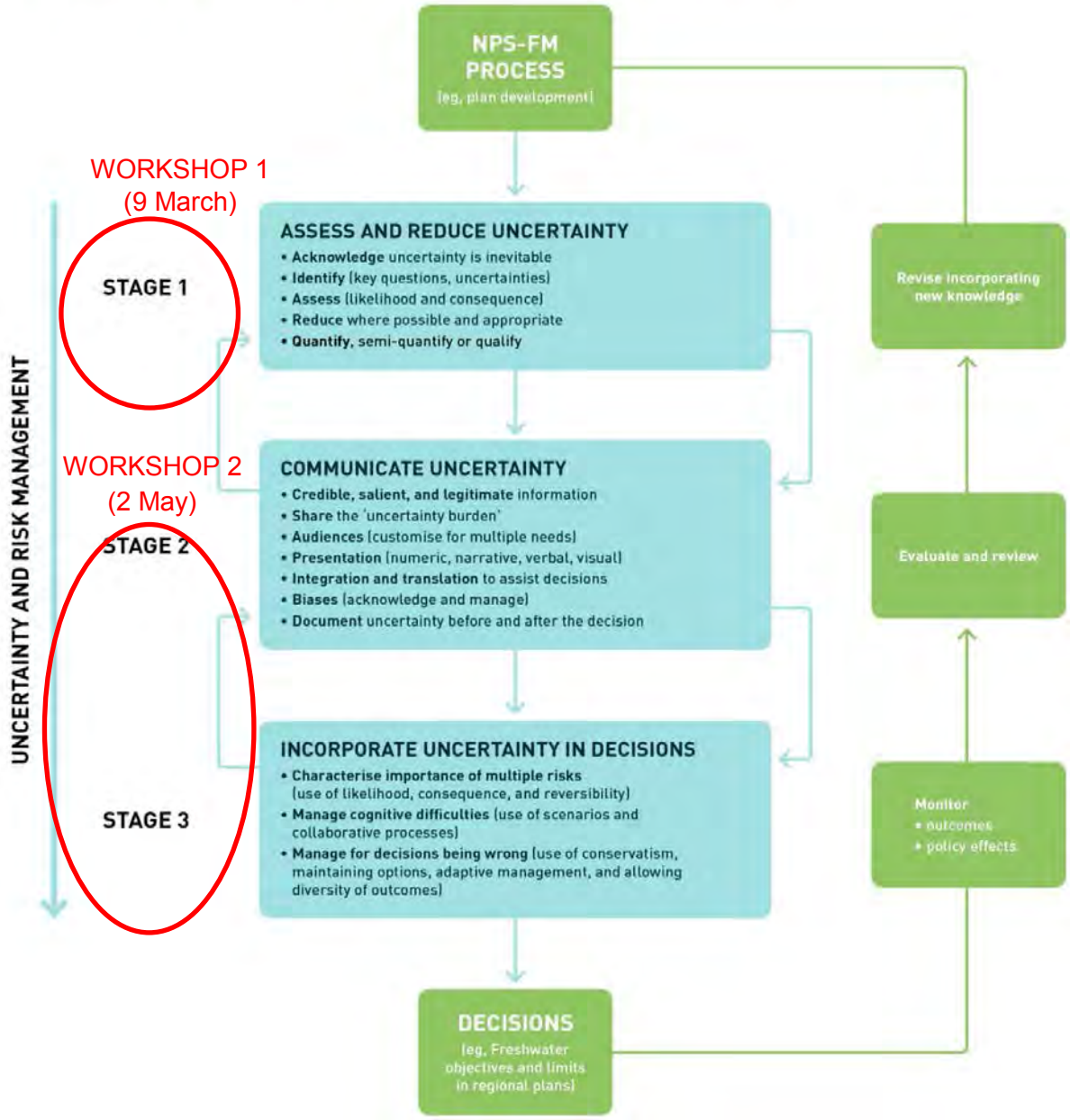
MANAGING RISK & UNCERTAINTY WORKSHOP 1: Run sheet & resources

Thursday 9 March 2017; 9am to 1pm; Pohutukawa Room, BOPRC, Whakatāne

Time	Activity/Resources	Lead
8-9 am	**Set up** (Flip charts, markers, post-it notes, pens, printed agendas, printed exercise sheets, poster with WMA diagram?, A3s with issues table, computer & projector, whiteboard & markers)	**Santiago /Ned/ Toni**
9–9.15am	**Introduction** - Introductions (Santiago, Ned, participants) - Reminder of where we are at in planning process - Relevance of this workshop in that context - Purpose for the day: consistent treatment, etc. - Outline for the day (refer to the agenda)	**Santiago**
9.15-9.55am	**Introduction to risk & uncertainty**	**Ned**
9.55-10.05am	**Morning tea**	
10.05-10.25am	**Overview of Stage 1 in Uncertainty Guide** This covers the three parts in Stage 1 of the Uncertainty Guide and explains how we will look at each of those 3 parts sequentially in the 3 group exercises to follow.	**Ned**
10.25-11.05am	**EXERCISE 1 – Identify and acknowledge uncertainty** (See below)	**Ned/ Santiago**
11.05-11.45pm	**EXERCISE 2 – Assess and reduce uncertainty** (See below)	**Ned**
11.45-12.10pm	**Lunch**	
12.10-12.50pm	**EXERCISE 3 – Quantify or semi-quantify uncertainty** (See below)	**Ned**
12.50-1pm	**Wrap up and next steps** - Key take outs: common language, immediate future applications - Workshop 2	**Santiago /Ned/All**

Diagram from the MfE Uncertainty Guide – showing areas of focus for Workshops 1 and 2

Figure 2: Three stage iterative process to manage uncertainty in NPS-FM processes



GROUP EXERCISES

Exercise 1 (everyone together) – Identify and acknowledge uncertainty (40 minutes)

Introduce the exercise (5 minutes)

Step 1: (15 minutes)
To set the scene, and remind everyone involved in the project, a summary will be provided of: i) our current high level conceptual understanding of the study catchments (Kaituna-Pongakawa-Waitahanui and/or Rangitāiki); and ii) our current understanding of the key land and water resource management issues and pressures in these catchments.

Step 2: (5 minutes)
Everyone spend five minutes, on your own, writing down your top five bullet point uncertainties that are troubling you with regard to the questions you think you will be asked in your role in the project.

Step 3 (10 minutes)
We will go around the room getting everyone to verbally give us your one top troubling uncertainty. We will collect all the written "top fives" - put your name on them.

Step 4: (5 minutes)
We will try to use the uncertainties we hear above to identify three key example project questions, around which there is concern about uncertainty. We will then break the workshop attendees into three groups and give one question to each group for the remaining workshop exercises below.

By way of pre-preparation, based on what we've heard already, we anticipate that choosing three from the following three example questions may suffice:

1. What constraint on nitrogen losses from land uses (e.g., what nitrogen limits) would be necessary in order to meet identified ecological health, mahinga kai, cultural and recreational outcomes desired for the Maketu/Waihi estuaries as well as likely socio-economic outcomes desired for the wider WMA?

2. What constraint on nitrogen losses from land uses (e.g., what nitrogen limits) would be necessary in order to meet identified ecological health, mahinga kai, cultural and recreational outcomes desired for the Rangitāiki River as well as likely socio-economic outcomes desired for the wider WMA?

3. What surface and groundwater allocation limits would be needed in order to achieve outcomes that support ecological, cultural, recreational and socio-economic values in the Kaituna-Pongakawa-Waitahanui WMA and/or Rangitāiki WMA?

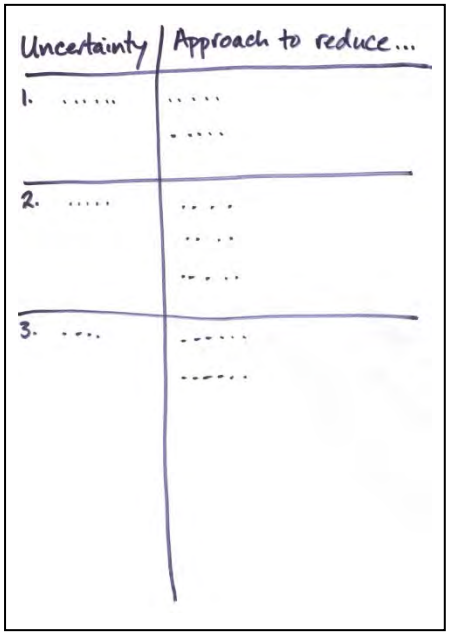
Exercise 2 (small groups) - Assessing and reducing uncertainty, where appropriate (40 minutes)

Introduce the exercise (5 minutes)

Step 1: (20 minutes)
Make a bullet list of uncertainties associated with answering your group's question and, for each bullet on the list, try to assess what would be a cost effective amount of effort to employ to try and reduce that uncertainty. You could use Box 2 from the Guide below to help your discussions. Identify and assess as many uncertainties as you have time for. You will need to make notes against each bullet so that a representative from your group can report back to everyone at the end on what you found.

Step 2: (15 minutes everyone together)
A group representative is to give a verbal summary to everyone – 5 minutes per group.

Your group's note sheet could be organised like this….



Box 2 – Summary of approaches for assessing and reducing uncertainty

- Assess the type and nature of uncertainties and associated risks.
- Assess priorities – which uncertainties justify the effort to reduce?
- Consider the merits and costs of gathering more data.
- Consider the pros and cons of using more sophisticated models.
- Consider more technical expertise, research, and/or peer review.
- Consider multiple parallel methods to produce converging lines of evidence.
- Making cost-effective decisions concerning effort to reduce uncertainty.

Exercise 3 (small groups) – Quantify or semi quantify uncertainty, where possible (40 minutes)

Introduce the exercise (5 minutes)

Step 1: (10 minutes)
Start with the bullet list of uncertainties your Group created in Exercise 2. For each bullet consider what the options are for expressing that uncertainty in terms of likelihood and consequence, and whether this can be done quantitatively (e.g., can likelihood be quantified using a probability from 0 to 1?) or only narratively – perhaps using some sort of likelihood scale like that shown in Table 3 from the Guide below. You could use Box 4 from the Guide below to help your discussions. Record a Q (for quantitative) or N (for narrative) against each uncertainty in your bullet list.

Step 2: (10 minutes)
As a group address the following questions:

- *Do you think by the end of the project you could be able to answer questions put to you in terms of likelihood and consequence? - at the level of very likely, likely, about as likely as not,...etc.?*
- *How do you feel about that? – is narrative expression sufficient? - is it likely to be useful or not?*
- *Is there technical or professional discomfort with using such narrative expression?*
- *Could there be agreement across the team to adopt the same language around likelihood?*
- *Is there an alternative useful way to express uncertainties in a common way across the project?*

Step 3: (15 minutes everyone together)
A group representative is to give a verbal summary to everyone – 5 minutes per group.

Table 3: A simplified narrative scale of likelihood combined with a visual colour code[35]

Narrative descriptor[36]	Probability class	Description[37]	Colour code
Very likely	90–100%	Likely to occur even in extreme conditions	
Likely	67–90%	Expected to occur in normal conditions	
About as likely as not	33–67%	About an equal chance of occurring as not	
Unlikely	10–33%	Not expected to occur in normal conditions	
Very unlikely	0–10%	Not likely to occur even in extreme conditions	

Box 4 – Summary of methods and approaches for quantifying uncertainty

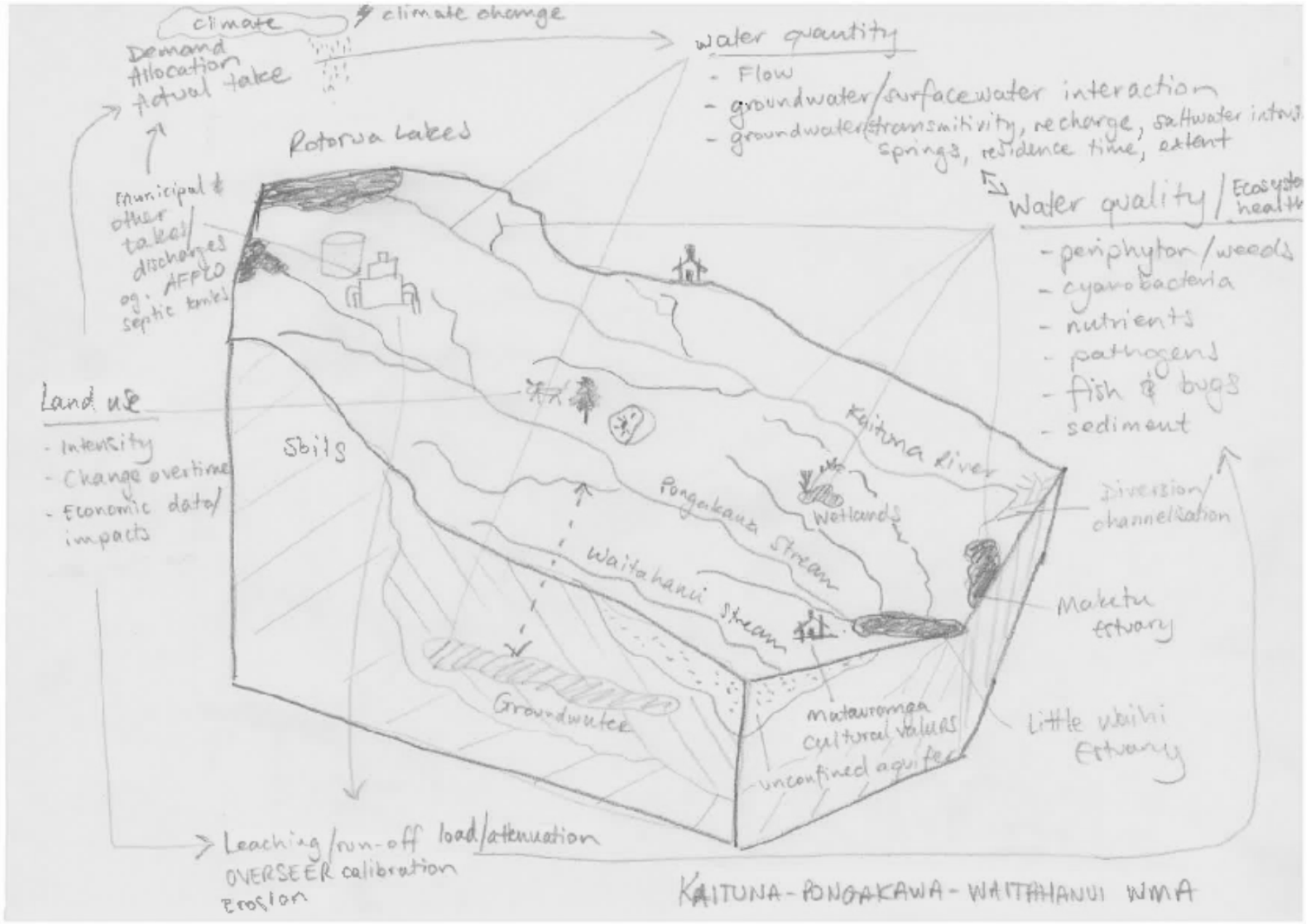
- Consider how much the uncertainty can be quantified.
- Use data ranges, standard errors and confidence intervals to quantify uncertainties associated with sample statistics such as the mean and median, where appropriate.
- Quantify uncertainty associated with model predictions where possible (eg, statistical errors, sensitivity analysis, Monte Carlo and other technical methods).
- Develop semi-quantitative or qualitative methods where full quantification is not possible, and express results using narrative descriptors of likelihood (eg, very likely, likely, about as likely as not, unlikely, very unlikely).
- Acknowledge limitations and ignorance.

Tentative groups

Group 1 – Nitrogen limit in Kaituna-Pongakawa-Waitahanui WMA	
Toni Briggs	Project manager
Pim De Monchy (or delegate)	Relationship and catchment management
Anaru Vercoe	Māori Policy Team Leader
Stephen Park	Coastal scientist
Rochelle Carter	Surface freshwater quality scientist
Janine Barber	Groundwater scientist
Jo Watts	Water Policy
Group 2 – Nitrogen limit in Rangitāiki WMA	
Lisa Baty	Project Coordinator
Simon Stokes (or delegate)	Relationship and catchment management
Sandy Hohepa	Māori Policy
Paul Scholes	Surface freshwater quality scientist and team leader
Kerry Gosling	Community engagement
Michelle Lee	Water Policy
Jo Armstrong	MfE
Group 3 – Water quantity allocation limits in Kaituna-Pongakawa-Waitahanui WMA and/or Rangitāiki WMA	
Sharon Pimlott	Science work project manager. Catchment modelling project manager.
Clarke Koopu	Māori Policy
Raoul Fernandes	Groundwater science and team leader (groundwater-surface water interactions)
Andrew Millar	Water Policy
Alastair Suren	Freshwater ecologist
Nic Conland	Consultant – Catchment Modelling
Janie Stevenson	Community engagement

Issue	Description	Kaituna-Pongakawa-Waitahanui	Rangitāiki
Estuary health	Ecological health, mahinga kai, cultural and recreational values are significantly degraded in Maketū and Waihī estuaries. Nutrient (nitrogen and, to a lesser extent, phosphorus), sediment, and faecal contaminants from the catchment and modified freshwater flows are key stressors. [3]	✓	✗
Nutrient enrichment of HEP dam lakes	The Matahina and Aniwaniwa Hydro-electric power (HEP) Dam Lakes are "human made" receiving water bodies in the Rangitāiki River. Sedimentation, nutrient enrichment and resulting algal/macrophyte growth affects dam operations, ecological health[4] and recreational values.	✗	✓
Rising nitrates and land use intensification	Nitrates are increasing (all monitored river and stream sites in the Kaituna, Pongakawa and Waitahanui catchments[5] and also in upper Rangitāiki). Current and potential land use change and intensification (and historic changes in the last few decades) pose a significant risk that nitrogen levels will continue to increase for some time, potentially affecting ecological health, amenity and recreation values in freshwater bodies.	✓	✓
Increasing water demand	There is increasing water demand for agricultural/horticultural and municipal uses in Kaituna catchment and Waihī Estuary catchment, and this has potential to cause adverse effects on ecological cultural and recreational values. Current allocation significantly exceeds current region-wide water allocation limits in several sub-catchments and in the Kaituna aquifer[6]. There is current and potential future demand for water in the mid-upper Rangitāiki catchment to enable land use intensification and/or change in land use, but surface water and groundwater is fully allocated to currently consenting irrigators and the HEP schemes[3]. There is increasing demand for water in the lower Rangitāiki River catchment and this may affect the upstream extent of the saline wedge, recreational and ecological values. Surface and groundwater are closely connected across the Rangitāiki Plains. Availability and effects are heavily dependent on the HEP scheme managed flow regime.	✓	✓
Risk of phosphorous inputs increasing	Soil phosphorous levels (using Olsen-P) under kiwifruit have increased significantly from 71 to 106 mg/kg between 1999/2000 and 2009 and the risk of runoff to water bodies is high, with potential effects on receiving environment ecological values. Olsen-P levels on dairying soils have also increased. Other soil quality issues include the increasing mineralisable N concentrations in dairying soils with the mean now above the target band, increasing the risk of N leaching, and the high anaerobically mineralisable N on sheep and beef soils. [7]	✓	✓
Sediment loads, particularly in high rainfall events	Sediment monitoring data for high flow events is limited. Community group members expressed significant concern about sediment affecting water quality and river substrate particularly in Waihī Estuary catchment. The majority of this sediment load is likely to be generated in high rainfall events for which there is currently limited data available.	✓	✓
Indigenous fish species habitat and passage	Tuna/eel and other indigenous fish species are heavily impacted by structural changes to/loss of habitat and obstacles to fish passage, and also by water quality, changes to flow regime and possibly harvesting. While this is not primarily caused by water quality and quantity management, this is a key freshwater issue for community members.	✓	✓
Swimming at some locations	Monitoring results available for some recreation sites show E. coli concentrations do not meet the *current* minimum acceptable state for swimming (full immersion) stated in the NPSFM (Pongakawa River at SH2, and Waitahanui River at SH2). Information is being reviewed in light of the proposed amendments in Clean Water 2017. Community group members in the WMAs and nationally are strongly voicing the expectation that all freshwater bodies should be safe to swim in. Some popular swimming spots are not monitored, and State of the Environment monitoring indicates that some of these sites may also not meet the current safe swimming standard. The lower reaches of the Kaituna River are an example of this[8].	✓	✓
Mahinga kai and natural character in lowlands	Mahinga kai and natural character values are significantly impacted by water quality and waterbody modification (drainage schemes) in the lower Rangitāiki, lower Kaituna catchment and lower reaches of rivers draining to Waihī Estuary. Community groups show strong support for restoration of whitebait spawning areas and natural character while acknowledging the need for flood and drainage schemes.	✓	✓
Ecological health in pasture and urban areas	The Macro-invertebrate Community Index (MCI) values are lowest in streams/rivers draining pasture. MCI is relatively stable. In some areas, particularly the upper Pongakawa, indicators show improving trends.	✓	✓

[3] Donald, Rob (2016). Ecological Health of Waihi Estuary. Agenda Report to Bay of Plenty Regional Council's Regional Direction and Delivery Committee, 31 March 2016.
[4] Scholes, P and McKelvey, T (2015). Recreational Waters Surveillance Report 2014/2015. Bay of Plenty Regional Council Environmental Publication 2015/2016. ISSN: 1175 9372 (Print) ISSN: 1179 9471 (Online)
[5] Scholes, P. and Carter, R. (2015). Freshwater in the Bay of Plenty – Comparison against the National Objectives Framework. Bay of Plenty Regional Council, Environmental Publication 2015/04. ISSN: 11750-9372 (Print), 9471 (Online). April 2015.
[6] Kroon, Glenny (2016). Assessment of water availability and estimates of current allocation levels October 2016. Bay of Plenty Regional Council
[7] Carter, R., Suren, A., Fernandes, R., Bloor, M., Barber, J., and Dean, S. (2015). Kaituna-Pongakawa-Waitahanui Water Management Area: Current State and Gap Analysis. Bay of Plenty Regional Council Environmental Publication 2016/01. ISSN: 1175-9372(print),ISSN: 1179-9471 (online). March 2015. http://www.boprc.govt.nz/media/99812/2010_22_soil_quality_in_the_bay_of_plenty_2010_update.pdf (Guinto/BOPRC, 2010)
[8] Scholes, P and McKelvey, T (2015). Recreational Waters Surveillance Report 2014/2015. Bay of Plenty Regional Council Environmental Publication 2015/2016. ISSN: 1175 9372 (Print) ISSN: 1179 9471 (Online)


climate
climate change
Demand
Allocation
Actual take
water quantity
- Flow
- groundwater/surfacewater interaction
- groundwater transmissivity, recharge, saltwater intrus
springs, residence time, extent
Rotorua Lakes
Municipal & other take/ discharges eg. AFFCO septic tanks
Water quality / Ecosyste health
- periphyton / weeds
- cyanobacteria
- nutrients
- pathogens
- fish & bugs
- sediment
Land use
- Intensity
- Change overtime
- Economic data/ impacts
Soils
Kaituna River
Diversion/ channelisation
Wetlands
Pongakawa Stream
Waitahanui Stream
Maketu estuary
Groundwater
Matauranga
Cultural values
unconfined aquifer
Little Waihi Estuary
Leaching/run-off load/attenuation
OVERSEER calibration
Erosion
KAITUNA - PONGAKAWA - WAITAHANUI WMA

Appendix 2: Workshop 1 presentations

Managing risk & uncertainty

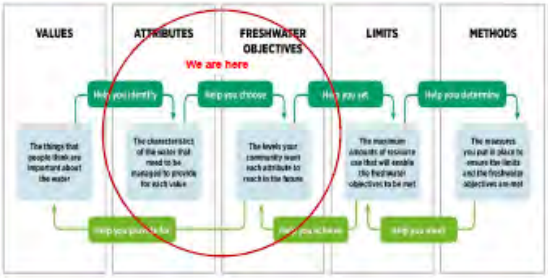
Staff Workshop 1
9 March 2017

Introduction

Relevance & purpose

- Acknowledge we won't have all the answers
- Shared understanding of how we will manage risk & uncertainty in the planning process (and catchment modelling)…
- …so we have a robust approach when we get to hearings, s. 32 report writing, etc.
- Prioritise additional gap filling required?

Planning process for Kaituna-Pongakawa-Waitahanui and Rangitaiki WMAs



Outline

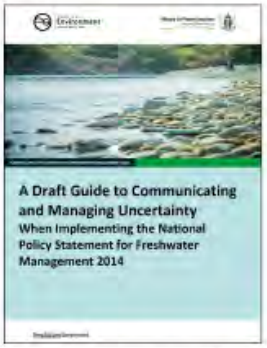
Time	Activity
9–9.15am	Introduction
9.15-9.55am	Introduction to risk & uncertainty
9.55-10.05am	Morning tea
10.05-10.25am	Overview of Stage 1 in Uncertainty Guide
10.25-11.05am	EXERCISE 1 – Identify and acknowledge uncertainty
11.05-11.45pm	EXERCISE 2 – Assess and reduce uncertainty
11.45-12.10pm	Lunch
12.10-12.50pm	EXERCISE 3 – Quantify or semi-quantify uncertainty
12.50-1pm	Wrap up and next steps

Introduction to Risk & Uncertainty

Managing Risk & Uncertainty - Workshop 1
Thursday 9 March 2017
Pohutukawa Room
Bay of Plenty Regional Council
Whakatāne

...in context of...

National Policy Statement for Freshwater Management (NPS-FM)



Ned Norton[1], Simon Harris[1], Helen L. Rouse[2]
[1] LandWaterPeople (LWP)
[2] NIWA

Draft MfE guide: http://www.mfe.govt.nz/publications/fresh-water/draft-guide-communicating-and-managing-uncertainty-when-implementing

Outline

1. What is uncertainty?
2. Types of uncertainty – broadly?
3. What is risk?
4. How does this help in terms of NPS-FM?
   - Events & consequences
   - Likelihood (and probability)
5. Likelihood can be narrative – it's OK!
6. Simple, traditional risk framework is useful
7. Ability to respond (reversibility) also important
8. Summary of key messages

What is uncertainty?

"There are some things that you know to be true, and others that you know to be false; yet, despite this extensive knowledge that you have, there remain many things whose truth or falsity is not known to you. We say that you are uncertain about them. You are uncertain, to varying degrees, about everything in the future; much of the past is hidden from you; and there is a lot of the present about which you do not have full information. Uncertainty is everywhere and you cannot escape from it."

Dennis Lindley in *Understanding Uncertainty* (Lindley 2006).

Types of uncertainty? – really?.....can be overwhelming...

Three broad types of uncertainty?

Natural variability refers to the natural variations in many aspects of the environment that we measure.

Model and parameter uncertainty includes uncertainty due to the limited scientific knowledge about the nature of models that link causes, environmental effects and mitigation actions, as well as about model parameters.

Deep uncertainty is uncertainty about the fundamental processes or assumptions underlying an assessment, which is not likely to be reduced by additional technical work within the project timeframe (i.e. the period in which a decision must be made).

Standard definitions of uncertainty & risk...[1]

Uncertainty is *"the state, even partial, of deficiency of information related to understanding or knowledge of an event, its consequence, or likelihood"*

Risk is *"the effect of uncertainty on objectives"*

Note the terms uncertainty and risk here are inseparable

1 = Joint Australian New Zealand International Standard for Risk Management (AS/NZS ISO 31000:2009)

Furthermore…(& usefully)…

Risk *"is often expressed in terms of a combination of the consequences of an event and the associated likelihood of occurrence"*[1]

… we suggest the standard approach to risk assessment is useful in an NPS-FM context!

1 = Joint Australian New Zealand International Standard for Risk Management (AS/NZS ISO 31000:2009)

How this helps – in terms of NPS-FM?

Events & consequences = Effects on the environment, and;… Attainment (or not) of outcomes

Likelihood = Predictions (probability & likelihood)

Events/Conseq. = Effects/Outcomes

- Assessments of effects on outcomes take many forms – we've all been doing this for a long time in NZ under the RMA. Some outcomes are now defined numerically using NPS-FM "attributes" (thresholds define an acceptable state)
- For now – to make a point – we'll simplify to "small", "medium", "large" effects on outcomes (or low, medium, high thresholds for attributes)

…just hold this thought for a minute while we deal with "likelihood"…

Predicting likelihood & probability

Table 1: Probability scale and alternative narrative scales of likelihood[22]

Probability	Intergovernmental Panel on Climate Change (IPCC) scale[24]	Scale based on legal standards of proof[23]	Environmental Risk Management Authority (ERMA) scale[25]
100%	–	Beyond any doubt	–
>99%	Virtually certain	Beyond a reasonable doubt	Highly likely
90–99%	Very likely	Clear and convincing evidence	Highly likely
80–90%	Likely	Clear showing	Highly likely
67–80%	Likely	Substantial and credible evidence	Likely
50–67%	About as likely as not	Preponderance of evidence	Likely
33–50%	About as likely as not	Clear indication	Unlikely (occasional)
10–33%	Unlikely	Probable cause, reasonable belief	Very unlikely
1–10%	Very unlikely	Reasonable grounds for suspicion	Highly improbable
<1%	Exceptionally unlikely	No reasonable grounds for suspicion	Highly improbable
0%	–	Impossible	–

Quantitative versus narrative expression of likelihood

Simplified scale might be sufficient?

(in context of NPSFM?)

Table 3: A simplified narrative scale of likelihood combined with a visual colour code[27]

Narrative descriptor[28]	Probability class	Description[17]	Colour code
Very likely	90–100%	Likely to occur even in extreme conditions	
Likely	67–90%	Expected to occur in normal conditions	
About as likely as not	33–67%	About an equal chance of occurring as not	
Unlikely	10–33%	Not expected to occur in normal conditions	
Very unlikely	0–10%	Not likely to occur even in extreme conditions	

Narrative expression of likelihood is OK? – even inevitable?

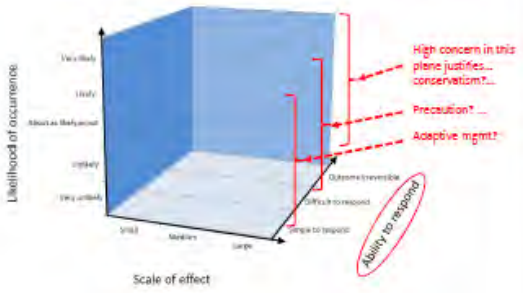
Consistent language across disciplines in a project is useful?

So… the traditional **risk** framework…

(consequence x likelihood)

…is, arguably, useful!

But other things come into it…
(in particular assessing reversibility is also useful)



Key messages…

1. Uncertainty is, at some level, inevitable
2. Risk is the effect of uncertainty on objectives
3. Risk is expressed as likelihood & consequence of events
4. In NPS-FM context - the events we are typically interested in are the effects of resource use and achievement (or failure) of outcomes.
5. It is useful to predict effects and achievement of outcomes in terms of likelihood, and the magnitude and/or significance of the effect or outcome.

and…

…Key messages (continued)

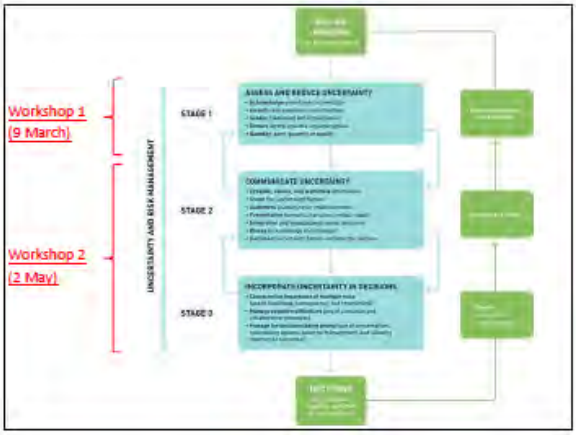
6. Expressing likelihood: is sometimes possible quantitatively (e.g. probabilities) but more often narrative is required (e.g. likely, very likely etc.).
7. It is also useful to describe ability to respond (reversibility), as part of the context of a risk.
8. Communicating on consequences, likelihood and ability to respond ultimately can help decision-making.

Personal observations…

- Awareness of this framework, and constructive use, can be helpful and liberating for information providers.
- For decision-makers it is at first frustrating - they'd rather have certain answers - but ultimately helpful – decisions in the face of uncertainty are tough.
- Some parties may choose to exploit your transparency about uncertainty for advocacy.

…that's the introductory background…

What next?…



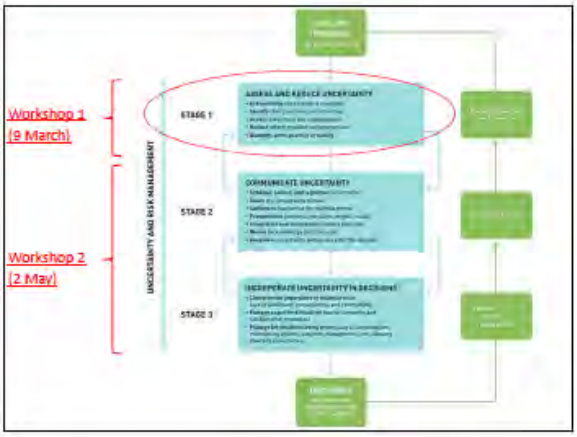
Acknowledgements…

- Ministry for Environment, Guidance Team, Water Directorate
- The Environment Canterbury team
- NIWA
- The MBIE funded Management of Cumulative Effects of Stressors on Aquatic Ecosystems Programme, CO1X1005

Overview of Stage 1 in the Guide

Managing Risk & Uncertainty - Workshop 1

Thursday 9 March 2017
Pohutukawa Room
Bay of Plenty Regional Council
Whakatāne



Stage 1: Assessing & reducing uncertainty

Three parts to this in the Guide…

1. Identify & acknowledge sources of uncertainty
2. Assess & reduce uncertainty
3. Quantify or semi-quantify uncertainty, where possible

- *We will do a workshop exercise on each of these three shortly*
- *I will do quick overview of Stage 1 of the Guide…*

but first…

The Point of this?…

- Is NOT to try and solve every uncertainty today, but to…
- Practice & develop an approach to handling uncertainty by working some examples and sharing ideas, so that…
- Many uncertainties in the project can be subsequently worked through in a way that is as systematic and consistent across the project(s) as possible.

1. Identify & acknowledge uncertainty

- Uncertainty is everywhere, is inevitable, and is normal in natural resource management and planning.
- Identification of uncertainties begins at the outset of a project and should be continually revisited.
- Conceptual diagrams are a useful tool to help frame the key project questions, and to thus identify the knowledge providers needed – these providers (i.e., you) help identify where the uncertainties are.

We will do exercise on this shortly

2. Assess & reduce uncertainty

This involves...

- Identifying whether the uncertainty is around *natural variability*, *model uncertainty* or *deep uncertainty* - because methods to reduce these differ.
- Identifying whether the uncertainty relates to a likelihood or a consequence – because methods to reduce these differ.
- Prioritising the uncertainty's likely importance in the decision.
- Thereby determine how much effort to put into reducing the uncertainty.

...Assess & reduce... (continued)

Typically...

- For attributes that have '*natural variability*' we cannot reduce the variability but we can improve our estimates of the statistics (mean, ranges, std errors) by taking more samples.
- Uncertainties with '*models and their parameters*' can be reduced by employing greater technical effort (e.g. more studies) – but there will be budget and time trade-offs, potentially diminishing returns, and complexity issues to consider.
- '*Deep uncertainties*' by definition cannot be reduced in the project timeframe – acknowledge these transparently

...Assess & reduce - Summary

Box 2 – Summary of approaches for assessing and reducing uncertainty

- Assess the type and nature of uncertainties and associated risks.
- Assess priorities – which uncertainties justify the effort to reduce?
- Consider the merits and costs of gathering more data
- Consider the pros and cons of using more sophisticated models.
- Consider more technical expertise, research, and/or peer review
- Consider multiple parallel methods to produce converging lines of evidence.
- Making cost-effective decisions concerning effort to reduce uncertainty.

3. Quantify or semi-quantify

As a project progresses and uncertainties are reduced as much as possible with the time and resources available, it is useful to characterise the key remaining uncertainties:

- Quantitatively (e.g. numeric probabilities where possible)
- Semi-quantitative or qualitatively (e.g. unlikely, likely, etc)
- By weak descriptions where there is deep uncertainty
- Acknowledging ignorance about unknowns

...Quantify or semi-quantify... (continued)

Typically...

- Uncertainties in estimating attributes that have '*natural variability*' can be shown by describing statistics (mean, ranges, std errors)
- Uncertainties with '*models and their parameters*' may sometimes be shown using a variety of statistical techniques, sensitivity analysis and Monte Carlo analysis, but..
- Often may require expert judgements using narrative expressions
- '*Deep uncertainties*' by definition cannot be quantified in the project timeframe

Narrative expression – as shown previously

Table 3: A simplified narrative scale of likelihood combined with a visual colour code[iv]

Narrative descriptor[iv]	Probability class	Description[iv]	Colour code
Very likely	90–100%	Likely to occur even in extreme conditions	
Likely	67–90%	Expected to occur in normal conditions	
About as likely as not	33–67%	About an equal chance of occurring as not	
Unlikely	10–33%	Not expected to occur in normal conditions	
Very unlikely	0–10%	Not likely to occur even in extreme conditions	

...Quantify/semi-quantify - Summary

Box 4 – Summary of methods and approaches for quantifying uncertainty

- Consider how much the uncertainty can be quantified.
- Use data ranges, standard errors and confidence intervals to quantify uncertainties associated with sample statistics such as the mean and median, where appropriate.
- Quantify uncertainty associated with model predictions where possible (eg, statistical errors, sensitivity analysis, Monte Carlo and other technical methods).
- Develop semi-quantitative or qualitative methods where full quantification is not possible, and express results using narrative descriptors of likelihood (eg, very likely, likely, about as likely as not, unlikely, very unlikely).
- Acknowledge limitations and ignorance.

EXERCISE 1 - Identify and acknowledge uncertainty

Kaituna-Pongakawa-Waitahanui WMA

Our understanding of key issues

- Estuary health (K-P-W)
- Nutrient enrichment of HEP dam lakes (Rangitāiki)
- Rising nitrates and land use intensification
- Increasing water demand/over-allocation
- Risk of phosphorus inputs increasing
- Sediment loads, particularly in high rainfall events

Our understanding of key issues

- Indigenous fish species habitat and passage
- Unsuitability for swimming
- Mahinga kai and natural character in lowlands
- Ecological health in pasture and urban areas
- BUT, also socio-economic values (e.g. "community vibrancy", "financial viability", etc.)

EXERCISE 2 - Assess and reduce uncertainty

EXERCISE 3 -
Quantify or semi-quantify uncertainty
(where possible)

Wrap-up and next steps

- Key take home messages
- Next steps:
  - Communicating uncertainty:
    - » To tangata whenua & stakeholders, Managers, Councillors, Commissioners, etc.
    - » Ways to present it
  - Incorporating uncertainty in decisions

Appendix 3: Workshop 1 – participants' reflections

The last task of the day (9 March 2017) was to go around the room asking all participants for their take-home reflection.

1. Many uncertainties have been raised during the day about the "process" and how the team is operating together.

2. Uncertainty of direction of the group (i.e., the project team)

3. Maybe limits should be a range (maybe the goal is to be somewhere in the A Band or B Band for example) rather than a single number.

4. Important to communicate that we know enough to move forward but don't overstate our confidence.

5. Might need to present our information in terms of ranges

6. Everyone is putting a lot of hope in modelling – but uncertainties in there too and won't provide all the answers.

7. We work with uncertainty every day – this workshop has helped put it in a bit of a context/construct.

8. Two types of uncertainty have come up today – i) operational uncertainty around the project/process; and ii) handling uncertainty in technical assessments. In terms of the latter this workshop has helped by the Guide/workshop – in particular the 3D diagram incorporating reversibility with likelihood and consequence.

9. Increased awareness of uncertainty that others in the project are dealing with – but how do we communicate it together as a team?

10. A challenge is how we are going to communicate all this information – and its uncertainties – together.

11. Our teams need to do this kind of get-together more often. Need to have these conversations – how to have them too with our Māori partners and our Councillors.

12. We can have some confidence in being able to express our level of uncertainty.

13. When we end up on the stand we need to know that others in our team understand the level of certainty we are going to express – need to have pre-discussed these as a team.

14. Communicating all this is a big challenge.

15. Has highlighted the usefulness of getting together as a wider project team – despite how busy we are and that it is hard to find time – every time we do it is worthwhile. We need to keep doing this to become more cohesive in our thinking as a team.

16. BOPRC team need to get together before next Uncertainty Workshop 2 to progress this discussion further.

Appendix 4: Workshop 2 agenda, group exercises & resources

MANAGING RISK & UNCERTAINTY WORKSHOP 2: Run sheet & resources

Tuesday 2 May 2017; 10am to 1.30pm

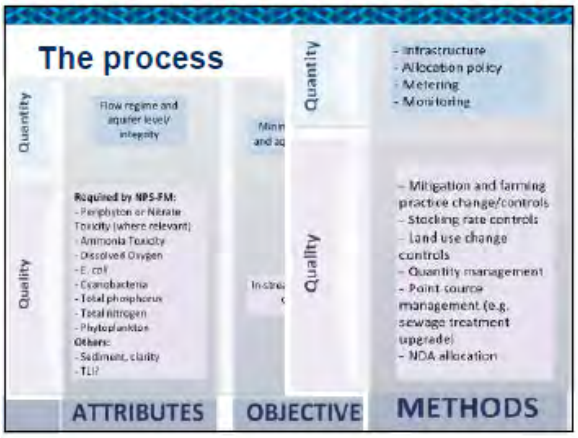
Mānuka Meeting Room (CMR4), Bay of Plenty Regional Council, Whakatāne

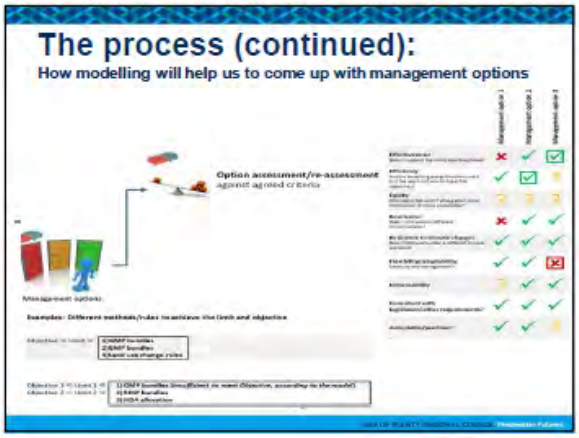
Time	Activity/Resources	Lead
9.30-10 am	**Set up** (Flip charts, markers, post-it notes, pens, printed agendas, printed exercise sheets, computer & projector, whiteboard & markers, coffee!)	**Toni/ Santiago /Ned**
10–10.15am	**Introduction** - Introductions (Santiago, Ned, participants – if any new participants) - FEC projects - Reminder of where we are at in planning process, process diagram - Relevance of this workshop in that context - Reminder of what was covered last time, including internal process uncertainties and purpose of the day - Outline for the day (refer to the agenda)	**Santiago**
10.15-11.15am	**Communicating scenario outputs**	**Ned**
11.15-11.30am	**Morning tea**	
11.30am-12.30pm	**Informing decisions, including Exercises/Discussion Points** EXERCISE 1 – Review of risks' likelihood, impact and degree of irreversibility EXERCISE 2 – Managing risk through scenarios and stakeholder engagement EXERCISE 3 – Implications of getting it wrong	**Ned/ Santiago**
12.30-1pm	**Wrap up and key points**	**Santiago /Ned/All**
1-1.30pm	**Lunch**	

	Risk/uncertainty	Type	Likelihood of not getting it right	Impact of not getting it right	Degree of irreversibility	Implication for management	Approach to reduce/manage
QUANTITY	**1) Water allocation and use data (including permitted & s.14(3)(b)***	Parameter				Under/over-estimate allocation and use	- Improve data (e.g. require reporting) - Adopt estimation method - Modelling scenarios? - Conservative management/precautionary approach.
	2) Flow data (to identify Q5) for unmonitored streams*	Model/ parameter?				Over/under estimate available resource	- Additional monitoring - Additional research/modelling - Conservative/adaptive management
	3) Flow records where ratings shift due to mobile beds	Model/ parameter?				Over/under estimate available resource	- Additional research/monitoring
BIT OF BOTH	**4) Socio-economic impacts (e.g. cost of options)**	Model/ parameter?				Too much/little importance given to socio-economic objectives	- Economic analysis on the back of bio-physical model - Stakeholder engagement
	5) Measurement of Māori cultural values/Matauranga (qualitative) – e.g. in relation to in-stream flow requirements	Deep?				Outcomes fail to meet Māori cultural values	- Matauranga project? Engagement with tangata whenua
	6) Current farm practices*	Parameter				Over/under estimate	- Modelling scenarios - Stakeholder engagement
	7) Time to achieve objectives*	Model?				Over/under-estimate time to achieve	- Modelling includes time as a scenario
	8) Surface-groundwater interaction	Deep?				Over/under-represent interaction, affects SW and GW quality and quantity limits	- Additional research - Modelling scenarios (informed assumptions) - Conservative/adaptive management.
	9) Drivers of ecological state other than physical/chemical attributes in NOF Quantity-quality-ecology relationships	Model/ parameter? Natural variability				Management settings exclude other factors important for ecological health	- Use ecological state indicators (e.g. MCI) - Additional research on factors that affect ecological health. - Conservative/adaptive management.
QUALITY	**10) Relationship between indicator bacteria (E. coli) and actual pathogens**	Natural variability?				E. coli limits may pose higher risk to human health than anticipated	- Wait for national direction on this? - Additional research - Conservative management
	11) Impacts of nutrients on pumice bed streams	?				?	- ?
	12) Estuary & coastal impacts	Deep? Or Model/ parameter?				Freshwater objectives/limits do not provide for estuary/coastal environment health	- Additional research on impacts on estuaries (e.g. A Dewes?) - Expert judgement? - Modelling scenarios? - Integrated management, limits set for fresh water take into account estuaries/coastal area as far as possible. - Stakeholder engagement - Conservative/adaptive management
	13) Load to come/attenuation/lags*	Deep?				Over/under estimate, affects limits and objectives	- Additional research - Modelling scenarios - Conservative/adaptive management

*Catchment modelling is expected to address these?

Appendix 5: Workshop 2 presentations





Communicating Scenario Outputs

Lessons & reflections from practice

Managing Risk & Uncertainty - Workshop 2

Tuesday 2 May 2017
Pohutukawa Room
Bay of Plenty Regional Council
Whakatāne

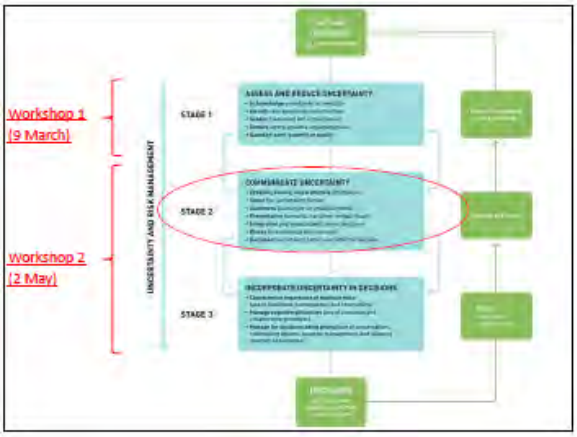
Recent gathering of lessons & ideas from processes to date in here... →

MfE (2016) - draft

...structured around uncertainty... but applies to technical communication generally...

...you're an audience that reads!... so lets assume that....

...and so lets come into this from a different angle....



Outline

1. Establishing a useful mind-set
   - Knowing your role – specifically in "this" process
   - Walking in the communities' shoes
   - Relationships are crucial
   - Listening ears on
2. Applying that mind-set to the task at hand
   - Communication is critical
   - Establish purpose – why scenarios?
   - Identify target audiences
   - Presenting complex information – team members
   - A bit about uncertainty
   - Presenting complex information – integrators
   - Acknowledging and managing biases
   - Managing communication risks

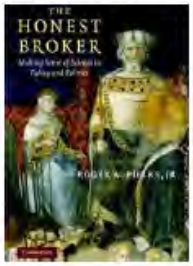
---

1. Establishing a useful mind-set

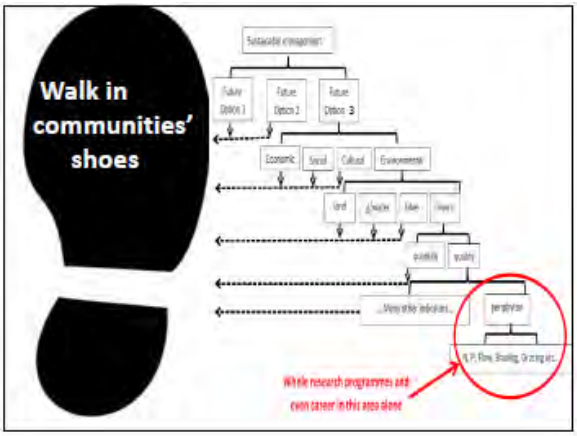
Knowing your role – specifically in "this" process, which is informing policy development

Four idealised roles for scientists in decision-making (Pielke 2007)

Pure Scientist	Issue Advocate
Science Arbiter	Honest Broker of Policy Alternative



"...the preferred position for the professional researcher embedded within the policy process is as an 'honest broker' explaining what is known, what is not known, and thus the implications of the options that emerge." Gluckman (2014) – NZ's PMCSA



Mind-set things…

- Relationships are crucial
- Listening ears on

It helps to think in terms of telling a story

- Helps uptake – open, grounded, logical
- Content (science) is important, but so is..
- Building rapport and trust

2. The task at hand…

"Communicating scenario outputs (& uncertainty) to diverse audiences"

Communication is critical

New Zealand research into what the public thinks about science found that in general:[7]

- "New Zealanders are not inclined to take scientific claims on trust. They are likely to judge research as irrelevant or unconvincing if they do not understand the research methods and/or the meaning of evidence is not immediately apparent."
- "Openness about uncertainty is seen as evidence of honesty on the part of scientists. Open acknowledgement of areas of uncertainty and new questions are preferable to bland assurances of safety or predictability."[7]

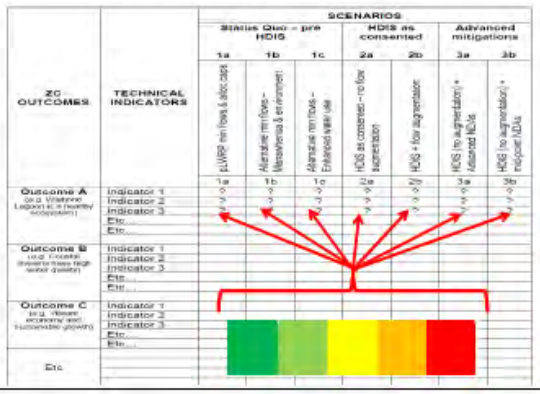
Quote from Parliamentary Commissioner for the Environment (2004)

Establish purpose – why scenarios?

Scenarios enable us to explore what the future might look like – for everyone's values, if we did certain things (including limits in the plan). They make trade-offs and win-wins visible.

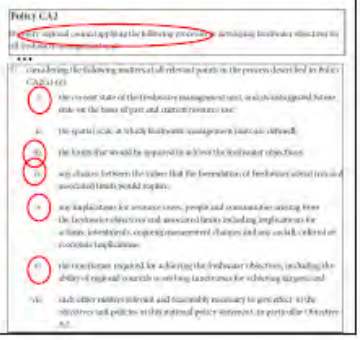
- Must accept best estimates – no crystal ball
- Scenarios are not necessarily options **(but lie within)**
- Scenarios *inform* **choices** *(of limits & other actions)*

How scenarios inform choices?



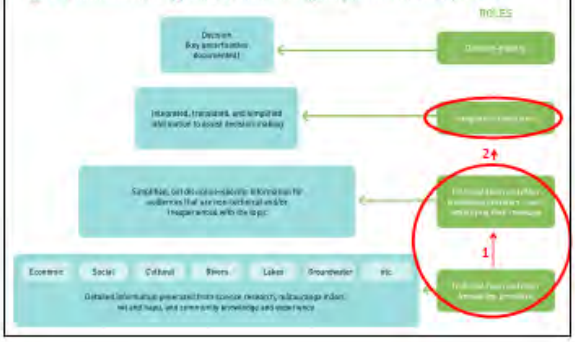
Establish purpose – why scenarios?

- Scenarios also directly assist with delivering the process mapped out in NPSFM Policy CA2(f)



Identify target audiences – multiple!

Figure 5: Illustration of the 'pyramid' of information typically needed in NPS-FM processes



Presenting complex information – tech team members

Pros/cons of numeric, narrative, verbal, visual, graphic etc.

Key messages:
- People differ
- Use as many as possible
- Repetition in diff ways

This bit is old hat really (Table 2 in MfE 2016 guide)

Why uncertainty is important

Box 5 – A key message is: "Communicating uncertainty shares the burden"

- Scientists and other technical contributors to a public policy process have a responsibility to identify and communicate the uncertainties in their work.
- Acknowledging uncertainty can relieve the burden felt by scientists who are often unreasonably expected to have high confidence in their conclusions.
- When uncertainty is communicated its burden is shared amongst technical people, the community, and decision-makers, and decisions can be more transparent.
- Limit-setting decisions require weighing of values and their uncertainties. Communicating uncertainty is therefore critical for good decision-making.

Simplify uncertainty if possible…

An example of numeric, narrative and visual methods of communicating the likelihood of attaining a given outcome (e.g. a freshwater objective)

Table 3: A simplified narrative scale of likelihood combined with a visual colour code[9]

Narrative descriptor[9]	Probability class	Description[9]	Colour code
Very likely	90–100%	Likely to occur even in extreme conditions	
Likely	67–90%	Expected to occur in normal conditions	
About as likely as not	33–67%	About an equal chance of occurring as not	
Unlikely	10–33%	Not expected to occur in normal conditions	
Very unlikely	0–10%	Not likely to occur even in extreme conditions	

Presenting complex information – integrators

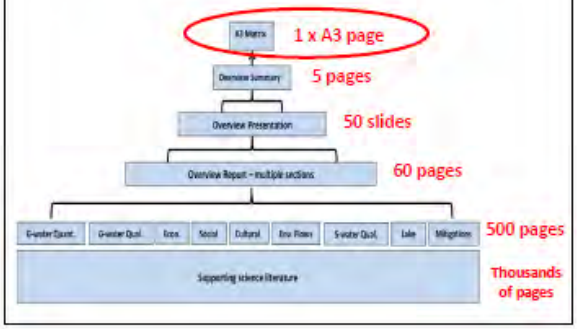
There is a need for some(one) to:
- Integrate
- Translate
- Simplify

Why do we need to integrate!?!

Why do we need to translate & simplify?

Communicating complex info

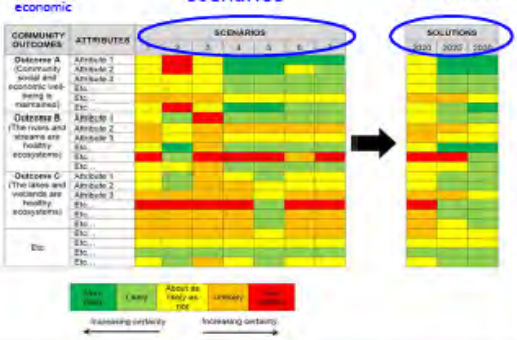
"Pyramid" of information



- ✓ Environmental
- ✓ Social
- ✓ Cultural
- ✓ economic

Exploratory scenarios

Building solutions



Acknowledging & managing biases

There are many biases professionals working in this space should be aware of:

- Availability bias
- Confirmation bias
- Confidence bias
- Group bias
- Framing bias
- Anchoring bias

See Appendix 2 in MfE 2016 guide – also Kahneman (2011) "Thinking, Fast and Slow" is a fascinating read

Managing communication risks

There are many risks including criticism for:

- Not enough information/knowledge (on "my" needs)
- Over-complicating (and then) over-simplifying
- Bias
- Not giving us the answer/decision
- Too fast / too slow / too uncertain

Also, RC experience has shown that open communication of uncertainty may be abused by some who use it for advocacy.

That's life – the first step in managing these is to be aware of them – the tools discussed here can help

Finally…
also try to keep a sight-line thru to…

- Community decision-making needs (see S5 in guide)
- Plan-writing needs (a whole subsequent step)
- Plan decision-makers needs

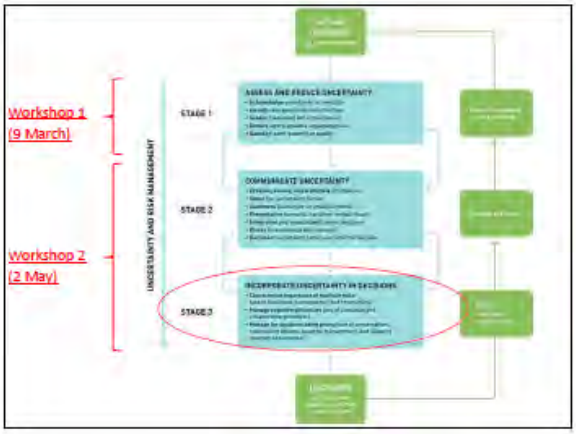
…as well as beyond that to…

- The community that implements it!

End

Informing Decision-Making

Managing Risk & Uncertainty - Workshop 2
Tuesday 2 May 2017
Pohutukawa Room
Bay of Plenty Regional Council
Whakatāne



Three parts to this in the Guide…

1. Characterise the importance of multiple risks
2. Manage cognitive difficulties
3. Manage for decisions being wrong

The Point of this?…

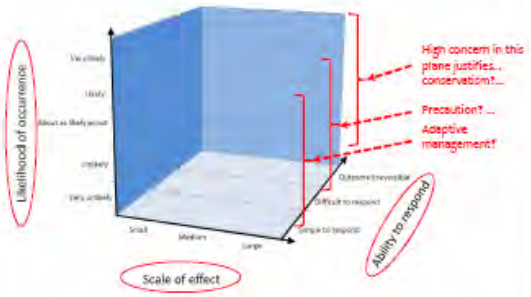
- Is NOT to try and be decision-makers if we are in an informing role, but to…
- Imagine ourselves in their shoes, understand the difficulties they face, and so best assist with our information.

1. Characterise the relative importance of multiple risks

- How can decision-makers grapple with the importance of any particular risk or uncertainty relative to other risks and uncertainties in that decision?
- We can help by describing likelihood and consequence, but also…
- Other contextual things like… reversibility!

However, we should leave the weighting to decision-makers?

Likelihood, Scale of effect, & reversibility



Key messages on the relative importance of multiple risks (Box 8)

- Characterise the nature of risks and uncertainties through the technical informing process. These can be usefully described in terms of the likelihood of occurrence, the scale and significance of the effect or outcome, and reversibility.
- Particular attention should be paid to irreversibility of consequences across the range of values, since this will drive approaches to manage for the situation where the decision turns out, over time, to be wrong (eg, use of precaution, conservatism and adaptive management).

Discussion 1:

- ❑ ***Lets consider some of the risks identified last time, their likelihood, impact and degree of irreversibility…do you agree with how we've categorised them?***
- ❑ ***What is the implication of getting it wrong?***
- ❑ ***How do we manage that?***
- ❑ ***What other major risks should be included in the list?***

2. Manage cognitive difficulties

- Human brains and "heuristics"
- Biases
- Value judgements
- Process tools to help include:
  - Use of scenarios
  - Use of collaborative approaches

Key messages on managing cognitive difficulties (Box 8)

- Cognitive difficulties with making decisions under uncertainty place a considerable burden on decision-makers. Scenarios provide a useful tool for exposing and understanding uncertainties.
- Because NPS-FM decisions on limits involve value judgements, some level of stakeholder engagement is essential. Consensus-based collaborative processes are particularly useful in policy problems where there is uncertainty of knowledge and disagreement over norms and values (ie, in 'wicked' problems), as is typically the case with limit setting under the NPS-FM. Experience suggests collaborative processes also provide assistance with the cognitive difficulties of making decisions under uncertainty.

Discussion 2:

- ***How could testing scenarios through modelling help us to incorporate risk & uncertainty in decision-making?***
- ***What other scenarios could be considered? Are those able to be modelled?***
- ***Do you agree that involving (community groups, tangata whenua, large resource users, others?), rather than consulting, is an additional way of handling difficulties associated with managing risk & uncertainty?***

3. Managing the certainty of being wrong

The future is uncertain. It is certain we will be inaccurate or wrong – by how much we don't know...

This is not a reason for inaction – but measured action?

Precautionary Principle:

- Conservatism
- Consideration of irreversibility
- Adaptive management

Key messages on the certainty of being wrong (Box 8)

- It is useful to start from the premise that decisions will, in time, turn out to be wrong, although we cannot tell how wrong or in what respect. Approaches to managing this situation then become an essential part of the decision, and include conservatism, maintaining options, adaptive management, and allowing for a diversity of outcomes.

End

Appendix 6: Workshop 2 – participants' reflections

The last task of the day (3 May 2017) was to go around the room asking all participants for their take-home reflection.

1. Usefulness of a risk register, with assessed likelihood, consequence, reversibility and response.
2. Value in transparent acknowledgement of past errors or things not handled well – humility in this regard can diffuse tension and rebuild relationships, respect and help progress towards trust.
3. This workshop has been timely for process design.
4. Risk register useful but would be good to progress further.
5. The concept of establishing a useful mind-set is useful.
6. Some good references to follow up on.
7. Risk register useful but need to progress and take care as might be misused by some for advocacy.
8. The hierarchy/pyramid concept is useful.
9. Usefulness of open, honest communication.
10. The value of transparency and objectivity.
11. Remember the value of repetition is useful.
12. Critical importance of relationships and trust.
13. Things useful to apply in local work now are i) to help prioritise information/analysis work needs in the project; ii) consistent use of terminology; iii) increase awareness of the upper and lower levels of the pyramid and the needs and challenges faced by others in the project team operating at those levels.
14. Really like acknowledgement of uncertainty, concepts and the fact there is a guide on it – it is real life.
15. Risk register could be really useful – without prejudice – good start to a useful tool.
16. Honesty/transparency very welcome.
17. Good reminder of usefulness of openness.
18. Risk register good start – maybe could use to help resource planning beyond life of the current project as well.
19. Well done for taking on the topic – usually technical people in the past have been pressured to give certain answers.
20. Need to communicate/signal which numbers/answers might change in the future – and allow or at least be aware of that in plans.
21. Applicable to other projects in the engagement section of the council – not just in water management project – in particular the good general principles about openness/honesty and grass-roots communications.

Appendix 7: Tips for communicating uncertainty

- ***Set the scene*** - uncertainty is common in day-to-day life, but we are not 'paralysed' by it in our daily lives. Uncertainty is not a reason for inaction, and inaction has its own consequences.
- ***Build trust first*** - allow the conversations about uncertainty to come at a point in the process when some degree of trust is already built in the group. Uncertainty discussions may be most useful at dialogue stage - assuming the group may progress through dialogue (what does this mean?), debate (what could we do?) and negotiation (what will we do?) stages during the limit-setting process.
- ***Don't mask the message*** – while you need to be clear about uncertainties, lead with the key message (for example, "the trend is definitely downwards over the next 50 years") before you provide the uncertainty estimates.
- ***Differentiate the three types of uncertainty*** – it might help to explain what can and can't be done to help reduce uncertainties, in which case these 'types' may be useful:
    - '*Variability*' is a natural characteristic of the environment. It can't be reduced but our estimates of current state and trends, and their variability, can be improved with more work if we have the time and resources.
    - '*Model and parameter uncertainty*' can be reduced to some extent by more data, different models and further work.
    - '*Deep uncertainty*' cannot be reduced, at least in the timeframes of the decision at hand, and must be acknowledged and accepted.
- ***Develop common terminology*** – you could borrow some calibrated language (such as the IPCC's language to express likelihood, e.g., very likely, likely, about as likely as not, unlikely, very unlikely etc.), which can help integrate between different disciplines so that everyone has a shared understanding.
- ***Ensure information is (and is seen to be) credible, salient and legitimate*** - i.e., is scientifically accurate and believable, relevant to the decision at hand, and arises from a procedurally unbiased and fair process.
- ***Use analogies*** to equate the management of uncertainty in freshwater management decisions to general day-to-day decision making (what car shall I buy?) or common examples of risk-based action (taking out insurance, abiding by speed limits, wearing seat-belts).
- ***Use story-lines*** - how does the predicted future (i.e., the outcome of decisions to be made) look from certain perspectives – for a farmer, a kayaker, a small business person, iwi and hapū on a marae?
- ***Make it personal*** - use the values identified as important to the community for the freshwater body/river or freshwater management unit (FMU) so that they can better appreciate the impact of the predicted outcomes.
- ***Use photos*** - or maps, which help to ground any discussions in real environments (their river, their farm, etc.).
- ***Use a variety of methods*** – for example use tables, words, or different types of diagrams such as box-and-whisker plots to explain any specific technical uncertainties. Don't worry that this may cause repetition – this will actually reinforce the message and help it to sink in.
- ***Use scenarios*** – to explore different possible futures and the uncertainties with each. Try to ensure that the range of scenarios considered spans (and thus acknowledges) the aspirations of everyone in the community.

- ***Collate, integrate, translate*** – bring together the key messages and their uncertainties, show how they balance out, and most importantly explain in English what effect these uncertainties may have on the decision.
- ***Share the uncertainty burden*** – when uncertainty is communicated the burden is shared amongst council staff (technical and planning), the community and decision-makers, and decisions can be more transparent.
- ***Finally, decisions are normative*** - the decisions at hand are likely to involve value judgements, and the uncertainties you have outlined may or may not fundamentally affect the decision at hand. Make sure the group have the best available information in front of them. The key for the decision becomes, what as a group can they all live with?

HAPPEN CONSULTING

Turning strategy into action

Identifying and assessing management options for fresh water in the Kaituna-Pongakawa-Waitahanui and Rangitāiki Water Management Areas, Bay of Plenty

June 2017

Happen Consulting

For Bay of Plenty Regional Council

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1 Background and Purpose

The Ministry for the Environment is seeking to increase council capacity to undertake economic analysis. This project sought to apply learnings from economic evaluation techniques to the processes councils use to respond to the National Policy Statement for Freshwater Management 2014 (NPS-FM). This project concentrates on the development and assessment of options.

Definition of Economic Evaluation

> *"Economic evaluation has been defined as: the quantitative analysis of the relative desirability to the whole community of investing in alternative projects or programmes where desirability is assessed in terms of both costs and consequences. 'Consequences' is used here as the generic term for the beneficial results of a programme (Only those forms which examine both costs and consequences for two or more alternatives fit the above definition and can be described as full economic evaluation studies. In practice, one of the two alternatives examined may be an existing project/programme (the 'do-nothing' alternative*)". EPC 1998

There are many aspects of options within the freshwater context; options for objectives, then options to achieve objectives with various combinations of statutory and non-statutory actions, options for limits and how they are expressed as well as spatial variation and options with different timeframes. A council's approach must apply both in a community context, a political context and through the formal assessment under section 32 of the Resource Management Act 1991 (RMA).

Section 32 of the RMA requires regional councils, when amending regional plans, to examine the appropriateness, effectiveness and efficiency of the proposed changes. The requirements of regional councils under section 32 were revised under the Resource Management Amendment Act 2013 to improve the quality of evaluations, particularly for the assessment of benefits and costs, including anticipated opportunities for economic growth and employment.

Bay of Plenty Regional Council (BOPRC) is using community engagement to identify freshwater values, uses and objectives in the Rangitāiki and Kaituna-Pongakawa-Waitahanui Water Management Areas (WMAs). As at June 2017, the community advisory groups are close to determining objectives but have yet to determine options. This project therefore worked ahead of, rather than as part of the community process, and sought to test ideas with BOPRC staff prior to use with the community.

This report is one of a suite of three sub-projects. The overall project is aligned with the policy process, and aims to improve the use and integration of economics thinking in the policy development and decision-making process. Although it is aimed at supporting implementation of the NPS-FM in the Kaituna-Pongakawa-Waitahanui and Rangitāiki WMAs specifically, the lessons learned from the application of these tools and frameworks would be relevant to implementation of the NPS-FM in other WMAs in the Bay of Plenty and, indeed, in other regions. The other two projects are:

(1) **Causal loop diagram**. An application of casual loop diagram in the Rangitāiki Water Management Unit. The output is a simple and accessible overview of the system and the numerous and complex relationships within it. This sub-project was led by Justin Connolly (The University of Waikato), as part of a Master's Thesis on the application of systems thinking to freshwater management.

(2) **Risk & uncertainty**. This sub-project seeks to apply the principles set out in *A Draft Guide to Communicating and Managing Uncertainty when implementing the National Policy Statement for Freshwater Management 2014* (Ministry for the Environment, 2016) in the context of the two WMAs. It is designed to upskill BOPRC staff to better identify, assess and communicate risk and

uncertainty, and to better incorporate them into decisions in the NPS-FM implementation context. This sub-project was supported by Ned Norton (LWP Ltd.).

1.1 Purpose of this project – Management actions and assessment criteria

To develop, test and document an approach to the development and evaluation of options for meeting freshwater objectives which is:

- informed by economic evaluation techniques;
- suitable for both s.32 reporting and use in a community process; and
- nationally applicable.

2 Method

The project adopted an iterative process starting with a literature review then a series of workshops/discussions with BOPRC staff to refine test and further refine the approach. The approach will subsequently inform the Freshwater Futures Community Groups, co-governance fora for the Kaituna and Rangitāiki catchment and BOPRC Councillors, and will undergo further refinement.

1. Literature review

   Examples from each of the following were reviewed:

   - Economic evaluation literature.
   - International examples of water project and programme evaluation.
   - New Zealand examples of evaluation of water policies and projects.
   - New Zealand government regulatory impact guidance.
   - Outcomes of the casual loop workshop developed as part of the first sub-project.

2. Workshop with BOPRC to develop potential options and evaluation criteria

   A workshop was held on 9 May 2017 with a BOPRC multidisciplinary project team involved in implementing the NPS-FM in the Rangitāiki and Kaituna-Pongakawa-Waitahanui WMAs to identify potential options and assess potential criteria. Participants included planners, scientists, land management officers, project managers, community engagement advisors, Māori policy and economists.

3. Refining a set of management options

   Following the workshop, a set of six illustrative management options was developed for a specific Freshwater Management Unit and one contaminant using a smaller project team.

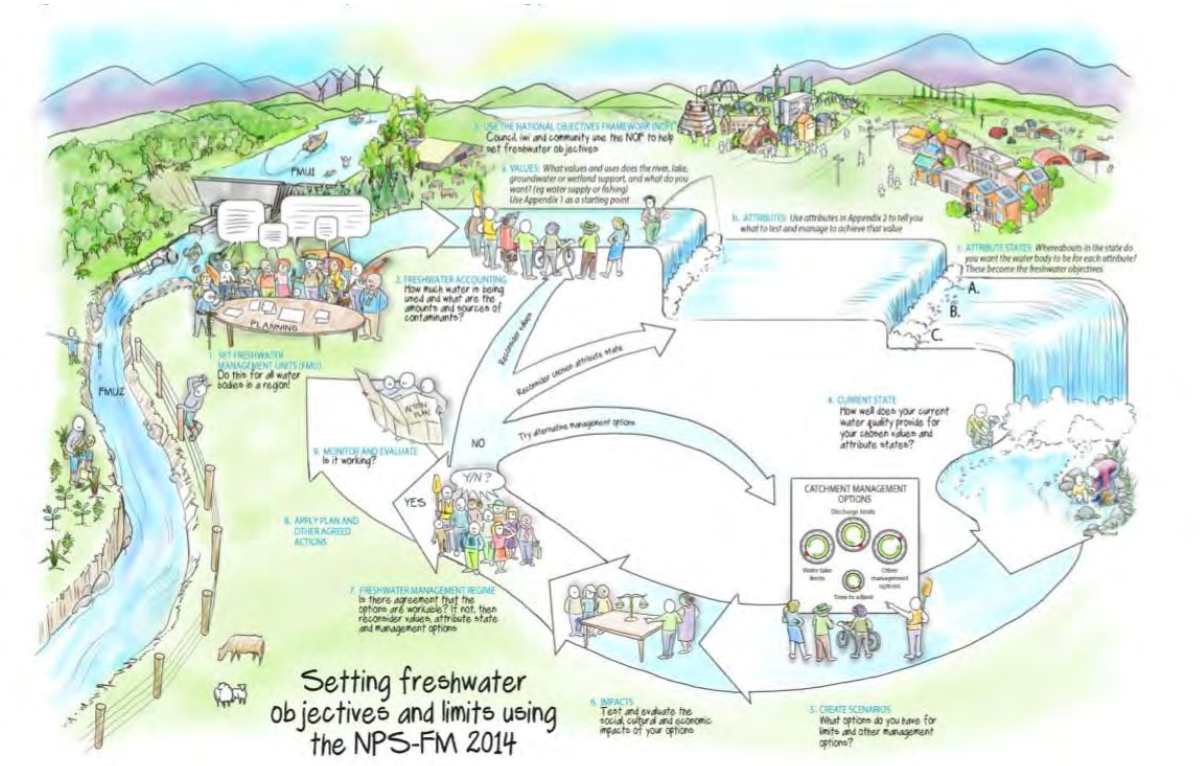
4. Refining and testing of management options and criteria

   A workbook was developed for staff to trial the application of 12 criteria to the six management options. The intent was to assess the usefulness of criteria and potential measures.

3 Management Options and Scenarios

The term "scenarios" is used in New Zealand as part of the limit setting process, as illustrated by Step 5 – Create scenarios – in the diagram from MfE's guidance document[1], replicated in Figure 1.

Figure 1 – Overview of the freshwater and objective limit setting process under the NPS-FM



The review of approaches in Canterbury and Greater Wellington revealed three types of scenarios:

- Exploratory scenarios
- Future scenarios
- Management options.

Exploratory scenarios are used as an understanding tool. The scenarios enabled a community to understand existing conditions, likely future conditions if no change, and explore issues and opportunities. The exploratory scenarios are deliberately designed to align with community expectations and allow exploration around key decision areas for limits. The Hinds/Hekeao Plains Technical Overview (Environment Canterbury (2014)) uses exploratory scenarios.

Future scenarios are used to assess resilience in the face of possible futures with the most common application relating to possible futures given various climate change predictions. This use of scenarios is aligned with the use in economic evaluation literature as per the quote below.

> *Scenario Development: In evaluating the policy options it will be useful to assess how they would perform against possible future conditions. Scenarios reflect a set of future conditions that are combined to form distinctly different futures in which the options may variously prosper or founder.*

[1] Ministry for the Environment. 2015. A Guide to the National Policy Statement for Freshwater Management 2014. Wellington: Ministry for the Environment.

The conditions that may enter into a scenario could be social, economic, political or environmental. For example, one scenario might explore a future where water availability is drastically curtailed. Such a scenario would allow an assessment of the resilience of the chosen water management system in the face of severe drought. (The Nature Conservancy, 2010)

Most commonly the term 'scenario' is being used in New Zealand to describe a management option or choice. This approach is illustrated by the following example from Porirua in Figure 2.[2]

Figure 2 – Proposed scenario framework for Te Awarua-o-Porirua whaitua (9 February 2017)

		Land and water use practice		
		Current	**Improved**	**Water sensitive**
Development area	**Existing growth**	Scenario 1 (BAU 1)	Scenario 5	Scenario 9*
	Identified further growth	Scenario 2 (BAU 2)	Scenario 6	Scenario 10
	Restricting growth extent (denser development)	Scenario 3	Scenario 7	Scenario 11
	Expanding growth extent (spread out development)	Scenario 4	Scenario 8	Scenario 12

At an early stage in this project, the term "management options" was used rather than scenarios. The term "management options" aligns well with the literature on criteria and policy evaluation techniques. In the literature, criteria are described as the means to differentiate between "management options". The term "scenario" is used only for possible future scenarios such as climate change.

Overall the literature is very strong on the benefits of including as many viewpoints, perspectives, and stakeholders as possible in the determination of management options.

One of the most-discussed elements of water management planning and ecological goods and services protection is that of stakeholder engagement and participation. (Koleyak, 2012)

[2] Greater Wellington Regional Council (2017) Proposed scenario framework for Te Awarua-o-Porirua whaitua Prepared for Te Awarua-o-Porirua Whaitua Committee. http://www.gw.govt.nz/assets/Whaitua/Proposed-scenario-framework-for-TAoPWC-09.02.2017.

4 Literature review – evaluation of options

The literature review revealed a large suite of evaluative criteria. These were grouped and compiled into nine themes. The themes are summarised in Table 1 and discussed below. The "effectiveness" criteria are discussed first, followed by efficiency and other criteria. A list of references is provided in Chapter 9 of this report.

Evaluation criteria – grouped into themes
1. **Effectiveness**
• Achieves intended outcomes • Does it achieve objectives? • Does it reach target group? • Diverse array of stakeholders • Highest level of problem resolution • Consequences most closely aligned to goals • Certainty of achieving the "big' or over-arching objective • Any unintended positive or negative effects that can be observed? • Best use of right tools? • Unanticipated or opposing consequences? • Could we do another way
2. **Cost-effectiveness**
• Benefit/Cost ratio • Regulatory cost to Council and others (transaction costs) • Private and public costs • Costs of implementation • Costs of transition
3. Participatory/community building
• Does it allow local control? • Stakeholder ownership of action/implementation? • Does it integrate stakeholder groups? • Is it self-supporting in the long term? • What is the timeframe of commitment from the regulator?
4. **Equity/distribution of costs/benefits**
• Distribution of costs and benefits • Where do the costs lie? • Share of private vs public costs and benefits • Financial burdens to non-participants • Are the burden of rules and enforcement proportional to the benefits?
5. Adaptable/resilience
• Can the approach respond to changing circumstances? • How does the approach perform in different future scenarios – climate change
6. **Opportunity to learn/flexibility in face of new knowledge**
• Does the system allow innovation? • How easily can the approach be adapted overtime? • The need for firms to make long-term investments is taken into account • Feedback systems are included/can be included • Measures can be tested and adjusted as they are implemented • Is it clear how progress will be measured? • Is learning/new science integrated into solution?

7.	**Practicality**
	• Certainty of legal obligations • Can compliance be clearly assessed? • Is it enforceable? • Is the right advice available? • Accountability – is there the means and authority to hold people to account? • Degree of institutional difficulty for delivery • Institutional arrangements needed for implementation • Evidence of effective implementation elsewhere • Is it physically possible? • Is it tried and tested?
8.	**Consistency with broader initiatives**
	• Consistency with other regulatory regimes
9.	**Acceptability**
	• Public health and safety • Social acceptance • Public acceptability

Table 1 – Criteria categories from the literature

4.1 Effectiveness criteria

Effectiveness criteria are essential and possibly the most important criteria, particularly in a community context. Effectiveness describes how well the management options meet the social, cultural, economic and biophysical outcomes or objectives. In many cases, the word criteria is not used – instead the process predicts a set of outcomes for each management option.

In the literature, it is often assumed that the objective is known from the outset, which is not the reality of water management decisions in New Zealand. Questions suggested in the literature include:

- Does it achieve intended outcomes?
- Does it achieve objectives?
- Which provides the highest level of problem resolution?
- For which action are the consequences most closely aligned to goals?

There are multiple ways to report objectives or outcomes, and multiple ways to assess how management choices influence objectives/outcomes. The National Objectives Framework provides measures for ecological health and human health for some contaminants and some waterways. These measures need to be complemented by outcomes and measures for other water bodies (e.g. groundwater and estuaries), and for other values – cultural, economic and social. The measures also need to cover the outcomes from an instream perspective and from the use (water and land use) perspective. Appendix 1 to this report contains a list of economic, social and cultural measures used in New Zealand water examples.

The effectiveness of each management action is assessed using modelling outputs, expert opinion, qualitative evaluation, or panel assessment. Both relative and absolute assessment has been used. Relative measures ask, "how does this management option rate relative to other options". The choice of measures and how to assess is not trivial. There are also aspects of timeframes and certainty of prediction that will need to be included in assessment. The topic of uncertainty and risk are covered in the second sub-project Norton (2016).

<u>Tests for Effectiveness measures</u>

- Measures something that matters to community and/or Council

- Can be assessed (even if only in a relative and qualitative way)
- Differentiates between management options

Overall effectiveness

Many of the examples end up with a large list of outcomes that have been evaluated. The example illustrated in Figure 3, from South Coastal Canterbury Streams[3], shows the evaluation for the social measures for each scenario (management option). Similar tables are provided for economic and ecological measures.

Figure 3 – Evaluation of scenarios/management options for South Canterbury Streams against social indicators

TECHNICAL INDICATORS	SCENARIOS						
	1a	1b	1c	2a	2b	3a	3b
Number of farmers and farm workers engaged in dairy, dairy support, horticulture and arable [R]		↓					
On farm and regional employment [R]							
School rolls [R]							
Individual household income [R]		SCCS area Local					
Engagement in GMP [R]							
Population in SCCS project area [R]							
Services - health, infrastructure and education. Social connectedness [R]							
Drinking water – nitrate in deep groundwater – test MAV [A]							
Drinking water – nitrate in shallow groundwater – test MAV [A]						↑	↓
Drinking water – microorganisms in surface & shallow groundwater – test MAV [A]		↑	↓	↓	↓	↑	↓
Fishing activity in streams and Wainono [R]				↑QN↓QL	↑Wain	↑QN↓QL	↑QN↓QL
Recreational use [R]				↓	↑Wain		↓
Game bird hunting in Wainono [R]							

Notes:
Arrows (↑↓) indicate relative change (more/less likely to deliver an outcome) compared to Scenario 1a but not sufficient change to justify shifting to a new colour class.
↑QN indicates an improvement in terms of water quantity (ecological flows)
↓QL indicates a decline in terms of water quality
↑Wain indicates an improvement in Wainono Lagoon but not in all rivers

Explanation of colours used in Figure 3.

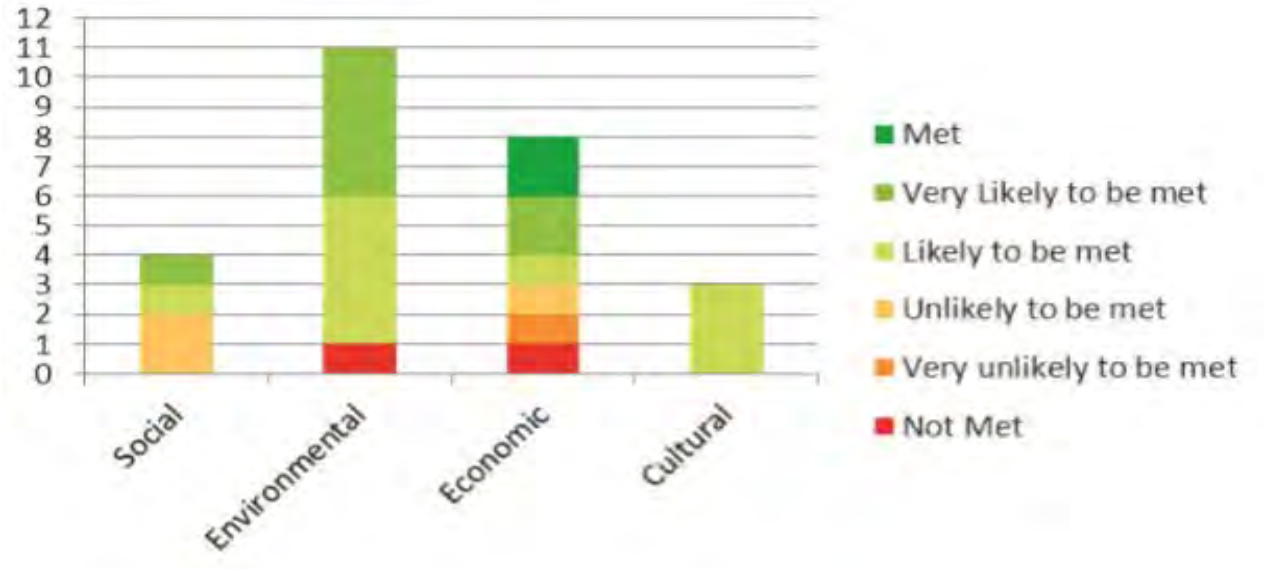
Where there is a clearly defined desired outcome or an absolute (e.g. numeric) indicator to test, an assessment is made of the **likelihood** that the outcome will be achieved… (five-class scale)…	Almost certainly	Probably	Possibly	Unlikely	Highly unlikely
Indicative numeric probability out of 10	9,10	7,8	4,5,6	2,3	0,1

Where there is not a clearly defined desired outcome, or the indicator allows only a relative assessment, the assessment reflects only the ***relative merit*** of each scenario compared to current… (five-class scale)…	Very high (maximum)	High	Medium	Low	Very low (minimum)

[3] Table 3.3 from Environment Canterbury (2015) South Coastal Canterbury Streams (SCCS) limit setting process – Predicting consequences of future scenarios: Overview Report. Report R15/29 ISBN 978-0-478-1541-1

The following example in Figure 4 attempt to bring a range of outcome evaluations into a single graph. The bars show the probability of meeting each of the 26 indicators of social outcomes (4 indicators), environmental outcomes (11 indicators), economic outcomes (8 indicators) and cultural outcomes (3 indicators).

Figure 4A - Summary of outcomes from the exploratory environmental scenario from Hinds/Hekeao Plains Technical Overview (Environment Canterbury (2014))[4]



Another approach used in the literature is to evaluate the options against an over-arching goal. For example, the OECD Development Assessment Criteria include a test against the Millennium Development Goals. kFw Development Banks (2017) elaborates on the application of this concept reference to the OECD Development Assessment Criteria -

> *In addition to a project's direct goals, there is also the overarching developmental impact, the big objectives that are the reason why the decision was made to promote the project in the first place – for example the impact on health in the case of improving the water supply.*

The concept of an "over-arching" goal does not replace the need to predict a suite of specific outcomes; it provides a framework for the overall assessment. There is potential to use documents like the Co-governance documents or Regional Policy Statements in this role.

4.2 Efficiency and other criteria

Section 32 of the RMA requires Councils to examine the efficiency and effectiveness of the proposed provisions at achieving the identified objectives (s. 32(1)(b)(ii)). The discussion in section 4.1 above relates to effectiveness - evaluating options against objectives. This section relates to efficiency and other measures. The literature on measures other than effectiveness shows a broadening of thinking beyond costs of achieving the objective and now includes aspects such as community ownership, allowance for innovation, and stakeholder acceptability.

[4] Figure 5.3 from Environment Canterbury (2014) Hinds/Hekeao Plains Technical Overview – Sub-regional Plan Development Process Report No. R14/79 ISBN 978-1-927314-38-8

Cost effectiveness

Cost effectiveness is frequently used and described as "identifying the most cost-effective option for achieving a pre-set objective". It is a broad concept that can be broken down into implementation costs, ongoing operational costs, transition costs, costs to businesses, etc. The distribution of costs relative to the benefits is also important. Cost to businesses (both those associated with instream outcomes and those derived from use of water and land) can already be included in the effectiveness assessment. We have not pursued a stand-alone cost effectiveness measure in this project. Instead there are criteria related to the distribution of costs and benefits (which will require the costs to be assessed) and transaction costs.

Transaction costs

The literature on cost-effectiveness includes reference to the regulatory cost to Council and others, and the costs of implementation and transition. The concept of transaction costs will be particularly relevant in the regulatory design phase. It seeks to separate out transactional costs from the expenditure that is directly related to improving water quality. A definition of transaction costs:

> *Transaction costs are the costs we incur when we make economic exchanges during the purchase of goods and services. Transaction costs may cover many areas. Some include charges for communication, such as telephones and the Internet, fees charged for legal services, or costs for purchasing and maintaining a car and paying for public transportation. Basically, transaction costs are the costs of playing a part in the market. (Stramm, 2017)*

It is the cost of the system/administration needed to get the approach working. For example, the cost of obtaining a resource consent, the cost of demonstrating compliance, compliance and permitted activity monitoring, and the cost of databases. It differs from the direct costs of (say) fencing.

Participatory and Community Building

The OECD has a principle on water governance to *Promote stakeholder engagement for informed and outcome-oriented contributions to water policy design and implementation, t*hrough ……..*promoting legal and institutional frameworks, organisational structures and responsible authorities that are conducive to stakeholder engagement, taking account of local circumstances, needs and capacities;… (Austrian Development Cooperation, 2009)*

This concept comes through increasingly in the literature as a criterion to differentiate management options such as requiring assessment of how many stakeholder groups are involved in an option, whether the option can be sustained by the community in the long term, and does the an option provide opportunities for interaction among stakeholders.

Equity/distribution of costs/benefits

Some of the criteria relate to equity and fairness. An overview of equity concepts as they relate to freshwater management in New Zealand is provided in Sinner (2016). The Ruamahanga Whaitua group subsequently discussed a set of potential measures for equity (GWRC, 2016).

> *There are many dimensions to equity issues in freshwater management. For some of these, e.g. how a discharge limit should allocated between land users, many approaches have been suggested, and each has implications for both efficiency and equity. Different criteria might be appropriate in different contexts. What one person considers fair or equitable may be considered unfair or inequitable by someone else.*

When applying equity considerations to assess policy, decision-makers should identify which dimensions or aspects of equity are of most concern, and draft a clear statement about the equity objective for each of these. Policy options or scenarios can then be assessed for how well these objectives are likely to be achieved, and conditions or qualifications on the objectives can be introduced if necessary to resolve conflicting objectives. (Sinner, 2016)

Adaptability/resilience

This criterion relates to the assessment of management options against possible futures such as different climate change predictions. The most common application in the water-related literature is climate change which has obvious links to water/land management. It is also used to assess changing economic conditions, pest outbreaks, natural disasters, etc. The criterion makes sure that an option that would lessen resilience is not inadvertently chosen, or put another way, that an option that enhances resilience is deliberately chosen.

Any futures scenarios used in this criterion need to be outside the influence of the current policy question. It is not to assess different outcomes under different water policy approaches, rather it is to assess how different water policy approaches would perform if other factors – beyond the control of the current process - were to change– climate change, world economy etc. The water management process does not assess a full suite of climate change adaptation options. The question to be answered is: *Does this water management option still look like the "best" option under various climate change scenarios? Does it enhance resilience?*

Opportunity to learn/ability to be flexible in the face of new knowledge/Innovation/adaptability of businesses

The literature commonly included a criterion assessing whether regulation can be adapted to changing circumstances and information. Flexibility has been important to the community in previous processes, particularly given the clunky nature of making changes to RMA plans. The usefulness of this criterion may depend on whether it is used to assess regulatory options or to assess mixtures of regulatory and non-statutory interventions. The latter are more easily adapted.

Flexibility criteria can relate to the regulatory system and to businesses. These criteria assess the ability of businesses to adapt within a given planning framework. Future possibilities include new crops, innovative techniques and greater use of technology on farm and in other commercial businesses. While these possibilities may not be known or easily evaluated in economic assessments, the ability of the planning framework to allow these possibilities can be evaluated.

Practicality

This criterion is a reality check on the achievability of the management options. The literature concentrates on both regulatory design - such as the certainty of legal obligations – and the certainty of how a management choice delivers outcomes – such as whether the approach has worked elsewhere. It requires thinking through the implementation of each management option.

Consistency with broader initiatives

This criterion acknowledges that water management decisions are often nested in or pursued in parallel with other initiatives. Options could be assessed against other national instruments such as the National Policy Statement on Renewable Electricity Generation or regional instruments such as Regional Economic Development Strategies.

Acceptability

The literature also refers to a criterion on public or social "acceptability". This criterion seeks to measure the views of the wider population (beyond those directly involved in the assessment). Paneque Salgado, P (2008) used an opinion survey of the wider population to measure this criterion.

The type of criterion can also be used to explicitly acknowledge an issue that has high community profile but is not a direct focus of the NPS-FM. The best example is flooding which can be addressed by a criterion on whether a management option either enhances, reduces or makes no change to flood vulnerability.

5 Workshop on potential management options and criteria

A workshop was held with the BOPRC multidisciplinary project team involved in implementing the NPS-FM in the Rangitāiki and Kaituna-Pongakawa-Waitahanui WMAs to identify potential options for meeting the objectives identified by the community. Participants included planners, scientists, consents officers, land management officers, compliance officers, Māori policy and economists.

Participants were given an overview of the literature on management options/scenarios and criteria (as outlined in the previous chapters of this report). The following diagram (Figure 5) was used to illustrate how the management options and criteria would come together.

Figure 5 – Conceptual diagram showing how management options and criteria come together

5.1 Workshop exercises

There were two exercises at the workshop; the first on management options. Participants were asked:

What management options can help us to achieve limits/objectives for each issue/attribute?

- Nutrients (including algae in hydro dam lakes)
- Bacteria
- Sediment
- Quantity

The second exercise concentrated on criteria. Participants were provided with an initial list and asked:

- Are there any other criteria?
- How should the criteria be defined?
- Would assessment be quantitative or qualitative?
- What information do we need to complete that assessment?
- Have we got or can we get that information?

The initial list of criteria was:

- Social, cultural, ecological and economic outcomes
- Least cost way of getting to the outcomes/objective
- Equity/distribution of costs/benefits
- Adaptable/resilient
- Resilience to climate change as a separate criteria
- Community cohesion, involvement, self-sustaining
- Opportunity to learn/flexibility in face of new knowledge
- Practicality/Certainty of legal obligations
- Consistency with broader initiatives
    - Regional
    - National
- Acceptability
    - Other aspects such as flooding

5.2 Workshop outputs

The full notes from the workshop are included in Appendix 2.

A large list of management options was developed. BOPRC staff identified potential options. The lists were later shared with the Freshwater Futures Community Groups, who added their own ideas, and feedback was generally positive.

Because the list of options was too large to progress criteria, the workshop suggested **focusing on a specific area and a specific attribute,** to identify more specific management options and undertake a more applied assessment against the criteria.

A concept that came from the workshop was **the use of values to report effectiveness**. For example, shell fish gathering – how often, where, and in which seasons – could that value be achieved? This approach could ensure the report back to the community uses their own terminology and provide a way to consolidate predictions on a range of outcomes.

The **importance of the river co-governance documents** was highlighted. Like the OECD approach of assessing all proposals against the Millennium Development Goals, the workshop considered that the river documents could provide a similar role for BOPRC Freshwater Futures.

There was a discussion about **the use of the term "equity**". Like the approach used by Greater Wellington for Porirua, the concept of equity and/or fairness was broken down into component parts that are capable of a more objective evaluation. The criteria on distribution of costs and benefits obviously relates to equity but **two further aspects were added at the workshop – opportunities for new entrants/development by existing users, and incentivising (or rewarding) the right behaviour.**

Opportunities for new entrants/development by existing users

This criterion addresses those who have reasonable expectations of being able to start and run viable businesses. Examples included development of Māori forestry land and ability to use land cleared of gorse. It is different from the regional economic growth aspects and relates to existing expectations.

Incentivising

This criterion seeks to recognise that regulatory regime should consider means to incentivise and/or reward those who are doing the "right" thing. The "right" thing needs to be defined.

A further criterion – tangata whenua assessment - was added. It reflects recognition of kaitiakitanga and recognises that tangata whenua may have views on how objectives/outcomes are achieved. While Tangata whenua values will be part of the effectiveness assessment, this criterion would seek a tangata whenua view on "how" objectives were met. The assessment can only be made by tangata whenua. It may be assessed through Council's ongoing partnership and engagement with tangata whenua or it may need a separate process.

BOPRC has already set out Appendix F to the Regional Policy Statement - Criteria for Māori culture and traditions in the User Guide to the Bay of Plenty Regional Policy Statement (Change No. 1) June 2008. A fundamental principle of the criteria is that *Only Māori people that have a relationship with the affected area can identify their relationship and that of their culture and traditions with their ancestral lands, water sites, waahi tapu and other taonga.* The measure is therefore an assessment by iwi and hapū.

5.3 Initial set of evaluation criteria

The following list of criteria will be used as an initial test.

1	Effectiveness at providing for biophysical/ecological, cultural and social instream values
2	Effectiveness of providing for social and economic land and water use values
3	Promotion of community vibrancy
4	Adaptability
5	Incentivising the right actions?
6	Practicality
7	Distribution of costs and benefits
8	New entrants allowed for?
9	Tangata whenua assessment
10	Resilience to climate change
11	Consistency with river co-governance documents
12	Compatibility with broader initiatives
13	Administrative/staff resourcing costs

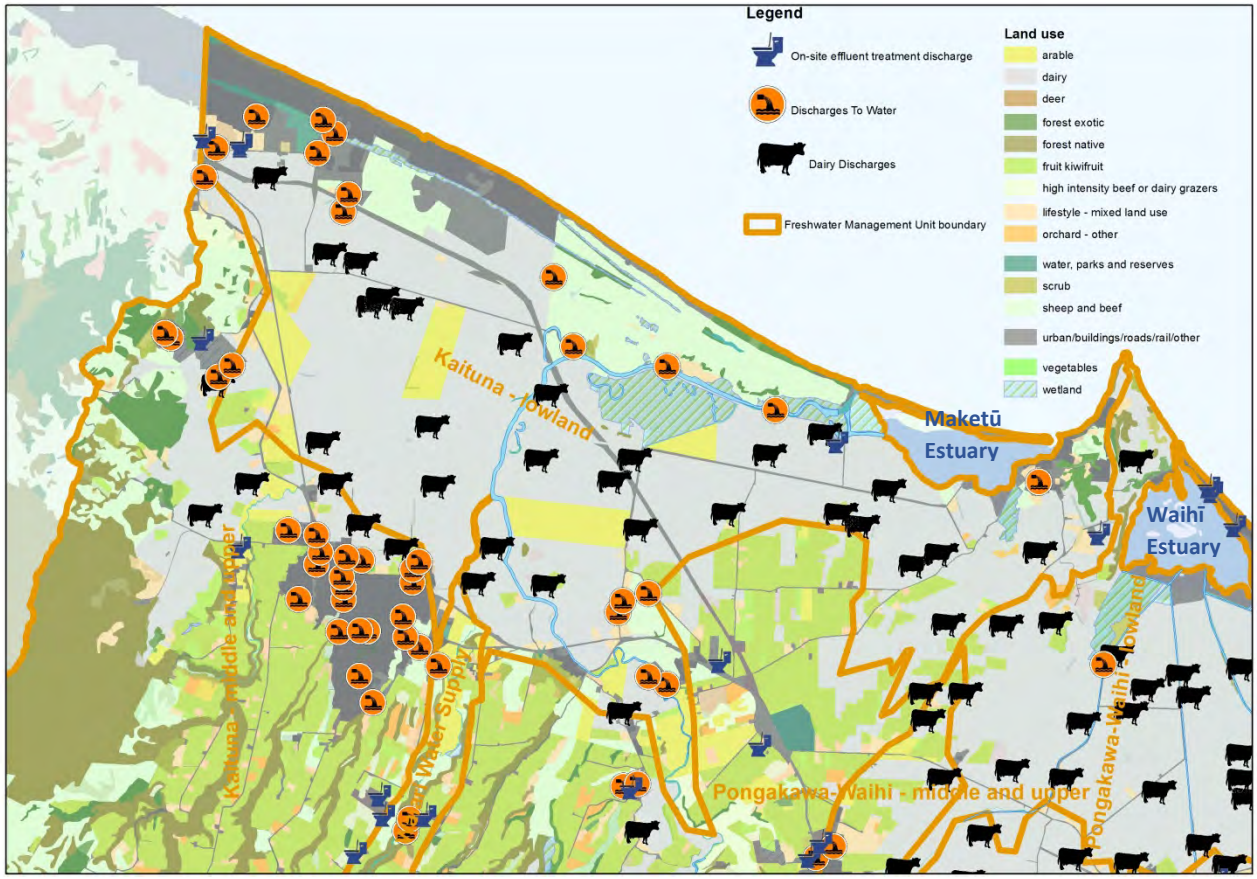
Table 2 – Refined list of criteria following May workshop with BOPRC staff

6 Development of illustrative management options for testing approach

The next step was to develop a set of illustrative management options through focussing on a single attribute in a specific location. These options could then be used to further refine the criteria. This approach was suggested at the 9 May workshop.

This exercise focused on the lower Kaituna Freshwater Management Unit/Maketū estuary, illustrated in Figure 6, and *E. coli*/bacteria/pathogens. The community group had expressed their desired state for the lower Kaituna and estuary in relation to that (i.e. water will be suitable for swimming and shellfish from the estuary will be safe to eat).

Figure 6 – Lower Kaituna Freshwater Management Unit



A small group of scientists, policy, compliance and catchment management staff familiar with the lower Kaituna/Maketū were asked to come up with some (between 3 and 6) management options to meet the desired state for the lower Kaituna and estuary.

The group were asked to concentrate on the 'big' options. For example, use of buffer zone or use of property scale limits. It was recognised that there are likely to be a few 'big' options to address the problem/meet the objective and several smaller ancillary options (e.g. the scale of riparian planting). For example, a riparian planting requirement for a 3 metre buffer and one for a 5 metre buffer is not enough differentiation between options at this stage.

The group developed the following illustrative management options:

1. Property based *E.coli* discharge limits – measured at one or more reference locations on property
2. Dairy shed effluent and farm drain discharge treatment prior to discharge[5]
3. Create a buffer – no intensive land use/*E. coli* generating land use within a buffer zone
4. Purchase of land - retirement from productive use and revegetate
5. Stocking rate or herd size limits
6. Point source discharge limit (with allowed variability) – real time sensors

The development of a final list of management actions is expected to occur with the community and to combine all contaminants.

[5] See for example: www.forsi.co.nz

7 Criteria testing and refinement

The final stage in the process was to assess the illustrative management options against an initial set of criteria. Given the stage that BOPRC is at in its process (i.e. no catchment modelling or economic analysis results are available yet), it was acknowledged that this could only be a qualitative and/or relative assessment between different options at this point.

A workbook was provided to BOPRC staff and two one-hour sessions used to get feedback on the criteria. The workbook is attached as Appendix 3 to this report.

The workbook included a table for scoring options – on a scale of 1 to 5 - against the criteria, and feedback was sought from staff on the criteria, possible measures and information requirements. The workbook also contained information on the criteria from the literature review and the 9 May 2017 workshop.

The sessions with BOPRC staff illustrated that the measures were too generic for an initial assessment. Staff did not score the management options against the measures, but instead referred to the measures to better understand the criteria. It became obvious that measures such as regional GDP or population were too generic and could be replaced with more targeted measures such as farm profitability and diversity or the number of jobs in the rural sector. Population and GDP are influenced by factors beyond water management, particularly given the potential for urban expansion into the Kaituna catchment.

Some criteria were refined or dropped from the assessment. The criterion on community cohesion was dropped because it was considered to be covered by the effectiveness measures on diversity of jobs/population. The criteria on adaptability was confined to assessing the ability of landowners to determine and adapt practices. BOPRC staff did not believe it was useful to assess how adaptable the planning framework could be given the current inability to easily change plans under the RMA.

There was discussion about the need for liaison with modellers building the bio-physical catchment model and those conducting the economic assessment to assess whether the criteria could be modelled/assessed. The refinement of management options and criteria could usefully guide the technical analyses.

In summary, the workshop developed a set of criteria and measures that could be used in an initial assessment of management options. A revised set of measures are included in Table 3 below.

7.1 Recommended set of criteria and measures

	Criteria	**Measures**
1	Effectiveness at providing for biophysical/ecological, cultural and social instream values	Still to be determined with catchment modellers
2	Effectiveness of providing for social and economic land and water use values	Farm profitability Population diversity or job diversity in the rural sector
3	Adaptability	Ability of landowners to adapt within limits
4	Incentivising the right actions?	Incentivising the right outcome (link back to effectiveness measure)
5	Practicality	Ability to monitor/enforce Scientific feasibility – proven elsewhere?
6	Distribution of costs and benefits	Economic assessment/analysis needed
7	Opportunities for new entrants	Need to be a specific opportunity identified if it is to be used as a criterion
8	Tangata whenua assessment	Iwi management plans, engagement

9	Resilience to climate change	Impact on effectiveness criteria and Reduce or enhance resilience
10	Consistency with co-governance documents	Ongoing reporting and feedback to co-governance fora
11	Compatibility with broader initiatives	Policy analysis
12	Administrative/resourcing costs	Cost of consents, monitoring, modelling and information systems

Table 3 Recommended set of criteria and measures

8 Lessons and next steps

8.1 Lessons

The use of "scenarios" is varied in New Zealand and the international literature. For the BOPRC Freshwater Futures process, the term "management options" more accurately reflects that the process is describing choices available to Council, whereas the term scenario will be used within criteria to evaluate the resilience of management options given possible future climate change predictions.

BOPRC staff were able to come up with a large list of **possible management options**. A small list of "big" management choices was possible by focussing on a single contaminant in a specific location. The early identification of a set of illustrative management options provided a useful focus for the subsequent discussion of criteria.

A literature review of developing and evaluating options provided **a suite of evaluation criteria** applicable to New Zealand's freshwater management. The criteria were developed iteratively, and were refined by testing against illustrative management options.

Effectiveness criteria measure how well a management options meets social, economic, ecological and cultural objectives/outcomes. The effectiveness criteria are to some extent provided by the NPS-FM but complemented by other measures that cover all waterbodies, and social, economic and cultural outcomes. Criteria can be evaluated qualitatively and assessed relative to each other. Some examples in the literature have used over 60 outcomes. BOPRC staff would prefer to target a smaller set of measures and methods. This streamlining will require careful design in close liaison with modellers/economists, other experts, and the community groups. **The refinement of management options and criteria could usefully guide the technical analyses**. It may be possible to describe effectiveness at meeting instream values by reference to values such as swimmability and shell-fish gathering.

Measures for effectiveness criteria are very specific to the issue at hand and to location. It became obvious that measures such as regional GDP, or population were too generic and could be replaced with more targeted measures such as farm profitability and diversity of jobs in the rural sector. Staff recognised that population and GDP are influenced by factors beyond water management, particularly given the potential for urban expansion into the Kaituna catchment.

The **use of criteria in the literature is broader** than that required under the RMA. The RMA requires Councils to examine the effectiveness and efficiency of proposed plan provisions. The literature on measures other than effectiveness shows a broadening of thinking beyond costs of achieving the objective (efficiency) and now includes aspects such as community ownership, allowance for innovation, and stakeholder acceptability.

The BOPRC initial set of criteria did not include **criteria called "efficiency" or "equity",** rather these concepts were included by using a combination of other criteria that are more easily understood and/or assessed. Efficiency criteria include the distribution of costs and benefits and transaction costs. Equity is assessed by criteria on the distribution of costs and benefits, opportunities for new entrants, and whether the management option incentivises the right action.

The **iterative process** of discussing criteria from the literature, developing illustrative management options, then refining criteria proved **a useful approach** to develop management options and criteria. Importantly, the process **involved many parts of Council** – science, policy, consent/compliance and catchment management staff – all of whom provided perspectives that could be incorporated and will need to be involved in the next round of assessments. The rigour of using criteria drove a focussed discussion.

The use of criteria can also drive refinement of options. For example, the criteria on distribution or costs and benefits could lead to a consideration of re-distributing costs and benefits to make a management option more acceptable on this criterion.

The **use of a formal scale of measures** -1 to 5 – for each criterion **may not be necessary**. Some criteria such as "compatibility with other initiatives" might be a policy report or seek a comment on management options from (say) the group overseeing the Regional Economic Development Strategy.

8.2 Next steps

The next stage for BOPRC will be to apply the criteria at a coarse level (e.g. a qualitative assessment using ticks, crosses and question marks rather than a measurement scale). A refined set of management options and criteria will then be taken to the Freshwater Futures Community Groups, tangata whenua and stakeholders for assessment and further refinement. The final stage is likely to be a full analysis of a smaller suite of criteria on a smaller set of management options. The number of criteria and options at each stage should get smaller so that modelling/analysis, evaluation effort and decisions can focus on the critical choices.

The analysis in this report was based on a single contaminant. Management options will need to address all contaminants – nutrients, sediment and micro-biological – as well as water quantity. Ideally, management choices could address multiple contaminants simultaneously. It seems sensible that the full evaluation is of management choices and occurs once the contaminants have been combined. That approach will highlight complementarity between contaminants and instream objectives.

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Appendix 1 – Social, Economic and Cultural Outcome measures

Social, economic and cultural measures used in New Zealand examples

Business scale economics

- Cash farm surplus (reduces volatility) and the equivalent for other industry
- Farm return on capital
- Number of days of irrigation restrictions
- Change in and economic value of hydropower in FMU
- Change in and economic value of agricultural production in FMU
- Change in and economic value of aquaculture in FMU
- Change in and economic value of tourism in FMU
- On farm economic impacts (revenue, farm working expenses, variable expenses and earnings before income and tax [EBIT])
- Economic valuation for commercial fishery

Regional catchment economics

- Economic output per cubic metre water used/ EBIT per cubic metre water used
- Farm expenditure with urban businesses within/outside of catchment
- Regional economic impacts including GDP, earned household income, rates and taxes
- Sustainable diverse and productive land use
- Providing for Maori economic development

Population, income and jobs

- Population
- Number of jobs
- Average household income
- Median income
- Change in salary distribution
- Number of farmers and farm workers engaged in sheep, beef, deer, dairy, dairy support, horticulture and arable
- Number of people working in aquaculture, hydro, tourism and conservation management
- Unemployment

Cultural health

- Number of people who have/use pepeha/whakapapa
- Availability and suitability of weaving products (raranga)
- Change in number of sites able to be used for cultural purposes and recreation
- Confidence to use waterways
- Stories are passed on
- State of mahinga kai species
- Likely satisfaction of mahinga kai gathering experience
- Access to important sites
- Satisfaction that seasonal runs and migrations of taonga species observed
- Iwi satisfaction quantity, catch effort and condition of kai/cultural materials collected of species, age and seasonality, gathering consistent with tikanga
- Customary fish stocks

- Cultural assessment of Mahinga kai and Wahi Tapu sites
- Wāhi tapu and wāhi taonga are protected and access enhanced.
- Mahinga kai is protected and enhanced.

Recreational use

- Fishing activity in streams and estuaries
- Game bird hunting

Social connectedness and cohesion

- Farm ownership, types and size of holding
- Average age of farmers
- Qualifications of farmers and involvement in agricultural extension activities
- Ethnicity, age structure, perceptions of safety, leadership, participation in community, level of social conflict
- School rolls
- Local Engagement in GMP
- Services - health, infrastructure and education.
- Number of educational programmes operating covering river ecosystems, including Māori perspectives
- Community, Sense of belonging, peace, informal traditions
- Housing (housing affordability, rent to income ratio)
- Trust (level of trust in policy makers and other actors involved in policy process)
- Enhanced social wellbeing of rural communities.
- Safety and security (crime rates, perceptions of safety)

Drinking water

- Percentage of population who have access to potable water - in regards to drinking water standard
- Drinking water – nitrate in deep groundwater
- Drinking water – nitrate in shallow groundwater
- Drinking water – microorganisms in surface & shallow groundwater
- Drinking water wells and domestic supplies now and in the future at least meet national drinking water standard for *E.coli* and nitrate.
- Enhanced recreational opportunities on waterways (e.g. fishing, picnicking, tourism).

Broader

- Intergenerational use
- Access / Accessibility, including number of legal campsites
- Quality of connection
- Pride in waterways
- Connection
- Awareness
- Sense of belonging (who you are etc.)

Drain and flood infrastructure

- Maintain existing flood control to protect small communities and farmland.
- Protect current water availability, including for smaller landowners.
- Drain flows provide for abstractive use.
- Drain flows provide for flood conveyance.

Appendix 2 – Notes from Workshop 9 May 2017

Kaituna-Pongakawa-Waitahanui & Rangitāiki Water Management Areas

Management option assessment BOPRC staff workshop, 9 May 2017
Group Exercise outputs

Management Options

Issue/ Attribute	Management Options

Sediment	• Land use change (forestry, native, wetlands)
	• Land management practice:
	  o appropriate stock for slope/soil
	  o appropriate use for soil/slope/LUC
	  o subdivision and & earthworks management (including permitted activity rules)
	  o stock rotation and grazing management
	  o sediment ponds, detention bunds, dams, storage
	  o pole planting, bush planting
	  o Riparian planting (grass and buffer strips
	  o Seal roads, track & road maintenance, races
	  o Swales
	  o Stock access crossings, bridges, culverts
	• *Catchment budgets/load limits* (e.g. could constrain timing of forest felling instream, *how to act for natural events*).
	• River engineering:
	  o HEP peak flows, ramping rate frequency
	  o Morphology
	  o Extraction of sand, gravel
	• *Understand the natural baseline & variability to allow focus on human activities, some streams & catchments have different geology/slope/rainfall, etc.*
	• Stabilise susceptible land and stream banks
	• Urban storm water swales, wetlands, rain gardens, impervious site coverage management
	• Forestry practices (no desiccation, harvest planning).
	• *Modelling critical sediment source areas*
	• Soak holes & sediment traps

Quantity	- Real-time monitoring of takes (telemetry, metering) - *Knowledge of flows in unmonitored streams* - Scheduled use within catchment - Transfer/trading/sharing takes - Incentivise reduction in water use, promote efficiency/innovation (e.g. soil moisture monitoring) - Incentivise efficient irrigation systems - Prohibit new water take consents in over-allocated systems.

Issue/ Attribute	Management Options
	- Amend consent conditions as they are renewed to align with limits/clawback. - Seasonal limits - Promote storage systems (e.g. capture rainwater, recycle water) - Managed (Artificial) Aquifer Recharge - Off-stream dams to store winter flow - Variable flow restrictions, less than 100% reliability and more generous allocation limits. - Bring water from other catchments - *In-stream minimum flows* - Groundwater management regime recognising timing for take and recharge (e.g. knowing reserves, continent use, variable groundwater allocation subject to climatic changes). - Allocation based on natural capital (e.g. LUC) - *Recognise and provide for equitable allocation, water availability* - Water use groups (e.g. Twyford) - Secondary allocation – high flow allocation for storage
Bacteria/ pathogens	- Gate & trough location & feeding - Managed stock crossings and bridges - Riparian management (grass, fencing, stock exclusion) - Stock water reticulation - *Stocking numbers – herd/paddock management (particularly on peat soils) - Wastewater management – point of discharge, on-site treatment capability - Storm water management – infrastructure problems - *Manure management – races and tracks - WWTPs lined effluent ponds for dairy - Wetlands - *Non-high [or Low] intensity pasture around sensitive environments - Avoid land use activities where land is incapable of carrying them - Waterfowl control for bacterial reduction only! - Land use change - Hydrology: pumped drains, water quantity (dilution), changing drainage network - 'Companion' activities: support each other on land while minimising water use and discharge (e.g. ginseng and pines) *Relates to LUC/natural capital *Key decisions:* - *Pathogen longevity and soil processes* - *Use of indicator bacteria for pathogen risk* - *Risk vs. reality, what's acceptable*
Nutrients	- Establish prohibited activities in sensitive areas (e.g. no dairy around estuaries or limited stock). - Nutrient fertiliser loading rates (application of irrigation/fertiliser) - Incentivise management practices (i.e. loading rates, land use practices, pasture management) - Nutrient Management Plans/Budgets for all farms

Issue/ Attribute	Management Options
	- Farm-level Nutrient Discharge Allowances – root zone level losses - Land use capability/natural capital mapping and planning around what soil/land block. - Catchment/sub-catchment user groups - *Cultivating a rationalised within an area where community groups can manage a common attribute (e.g. Lake Rerewhakaaitu)* - Avoid consenting activities in areas where the land is incapable of carrying the land use without significant volumes of water being available (assumes adding water will release nutrients?) - *Catchment/stream limit, load and concentration* - WWTP, industrial point source controls - Land use change (forestry) – coordinated catchment approach - Better effluent treatment, disposal or reuse. - Wetlands - Aeration in lakes - Alum dosing in lakes (although only addressing symptom) - Weed harvesting in lakes (although only addressing symptom) - Remove gorse (nitrogen) - Critical source areas and prioritise management options - Otago RC approach: point source type monitoring at each property, let landowners figure out how to comply - Storm water best-practice, LIDs [low impact design?] - On (drained) farms, use of treatment wetlands in all but flood flows - Riparian management for P and N - Cropping controls, e.g. maize has huge loss rates. What about other crops like kiwifruit and other crops? - Timing of fertiliser and cultivation - Basic soil health (combine with soil carbon management) - WWTP standards and load controls *Main issue, monitoring & enforceability.*

Feedback on Criteria

Criteria	Definition	Information requirements	Assessment type
Equity	- Distribution of right/resource/pain/cost - Fairness - Equal future opportunity - New entrants provided for - Inter/intra-generational	- Current distribution, consent timeframes - *Future scenarios* - *Ongoing flexibility*	Quantitative and qualitative
Suitability to local conditions	Physical, biology, future climate, land	LUC, soils, biophysical, etc. …	Quantitative
Consistency with/give effect to Treaty obligations	Reflect/acknowledge/recognise content of relevant documents. E.g. Iwi Management Plans, River documents, etc.	Assessment of options relative to relevant documents	Both, subject to relevant document content
Sustainability	Could solution carry on/continue forever? Is it reversible? Does it lead to adverse cumulative impacts? Degree of 'organic-ness', naturalness.	Biophysical, economic, social/cultural data	Both
Cultural acceptability	Wastewater in waterways Waterway mixing Significant sites	Tangata whenua knowledge Cultural impact assessment Iwi management Plans	Qualitative
Cultural outcomes	Community recreation Cultural values (e.g. mahinga kai) Specific events Historical uses return Community engagement	Map of use (past, present, future) – location, type Community Management Plan Matauranga Māori Co-governance River documents Iwi Management Plans Recreational clubs	Both
Environmental Outcomes	NOF GW levels Minimum flows Loads Fishery	Banding choices Load levels Targets Objectives TLI and SPI	Both

Criteria	Definition	Information requirements	Assessment type
	Shellfish Erosion Narrative Forms Riparian Wetlands	Wetland health indicator	
Economic Outcomes	TLA costs (rates & services) Ability to start a new venture Iwi development programmes Reliability No cost off-setting to environment Adaptability of business Schools and commercial districts	Property values Lenders (banks) Iwi engagement Crop sensitivity RC applications Farm economic data Allocation framework Chamber of commerce Formation of community groups	Both
Equity (fairness)	Equal opportunity? Volumes? Rights? Are we starting from the same baseline? E.g. not all land has the same legal structure/ownership – Māori-freehold land. Can we be equitable in distribution of costs & benefits?		Both
Least cost way of achieving outcome	(Note there may be a tension with equity) Social, cultural, economic, political, environmental		
Consistency with broader initiatives – E.g. RPS Appendix F and G, Value set 4, IW2B(b)			Both
Practicality/certainty of legal obligations			
Effectiveness	Whether the management option will achieve the freshwater quality and quantity	Clear objectives (including targets, banding, etc.) Value descriptions (qualitative)	Quantitative Potentially qualitative

Criteria	Definition	Information requirements	Assessment type
	desired, values-based objectives and over what time	How the management option changes attribute relationships Modelling	for some methods (e.g. inform or educate)
Efficiency	Sum of benefits gained compared to costs and timing, including non-target costs and benefits and timeframes. Rates implications. Administrative/staff resourcing implications	Range of costs incurred and benefits gained directly in relation to meeting objective (or broader)	Both
Equity	Who incurs the costs & benefits compared to who contributes to the problems. Are there mechanisms to spread costs fairly? Inter/intra-generational New entrants	Same as above	Both
Practicality/Enforceability	Is it affordable? Is it physically possible? Tried & tested? Unanticipated or opposing consequences? Can we practically make/ensure it happens?	Cost Evidence of effective implementation elsewhere	
Enable innovation?	Do the policies allow flexibility for innovative new approaches? E.g. set nutrient discharge requirement vs. set an action that must be taken.		Quantitative?
Compatibility with broader policy objectives	Are there any consequences that would be contrary to broader policies (e.g. in the RPS, animal welfare, etc.) – are these acceptable? How far to go with this?		
Social outcomes/values		Current/past, use of river, number of users, etc.	
Cultural value			
Does the policy address externalised environmental cost of <u>all</u> potential activities?			
Does it incentivise <u>good</u> behaviour?			
Ability to start a new business?			

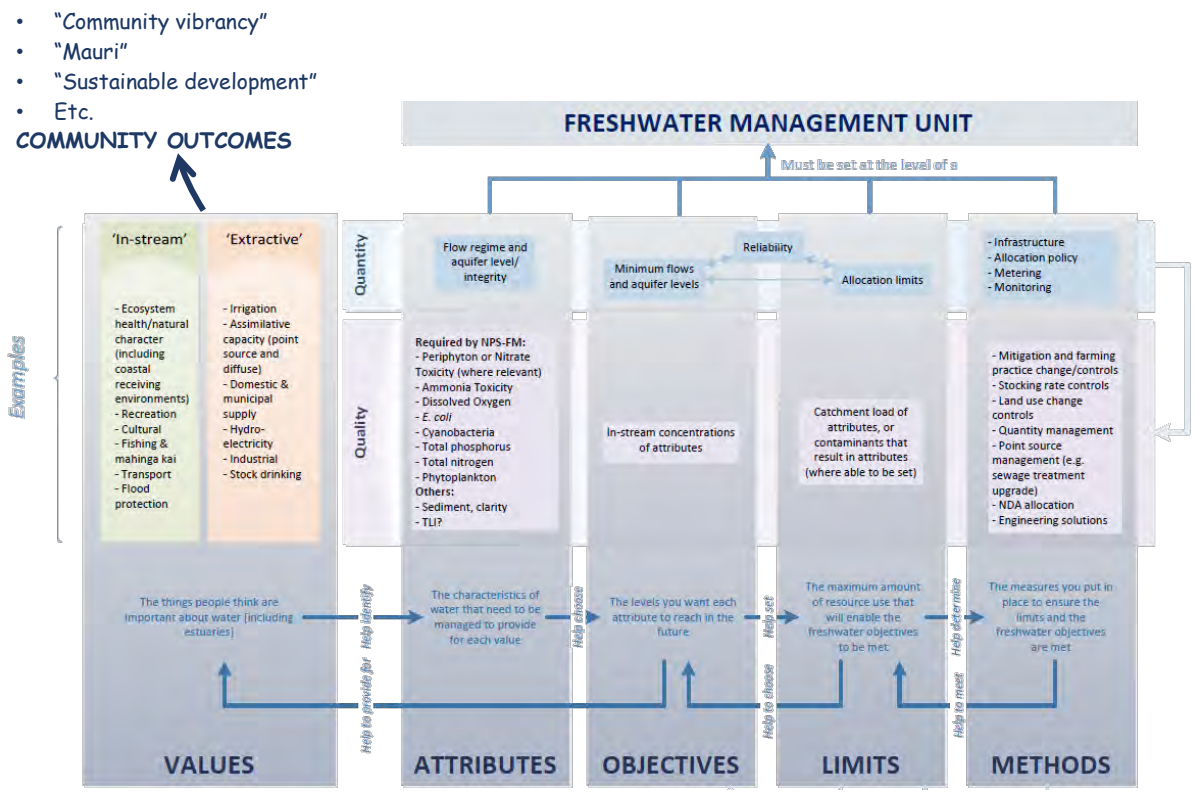
Appendix 3 – Workbook for refinement of criteria for assessing freshwater management options

June 2017

Background

The Bay of Plenty Regional Council is running a small internal project to come up with an initial set of management options and assessment criteria for Plan Change 12 (implementation of the National Policy Statement for Freshwater Management 2014 [NPS-FM] in the Rangitāiki and Kaituna-Pongakawa-Waitahanui Water Management Areas). As illustrated in Figure 1 below, management options (or methods) should give effect to freshwater limits and objectives to provide for community values and outcomes.

Figure 1 – Implementation of the NPS-FM



A staff workshop was held on 9 May 2017, where an initial brainstorm of management options (to address nutrient, sediment, bacteria/pathogens and water quantity problems) and assessment criteria were produced. These initial ideas were shared with the Kaituna and Pongakawa Freshwater Futures Community Groups during May 2017 and feedback was generally positive.

As a next step, a smaller group of staff looked at the Lower Kaituna and Maketū Estuary Freshwater Management Unit (FMU), and selected a narrower set of possible (potentially credible) management options to meet the desired community outcomes for the FMU. These are for water to be suitable for swimming and food-gathering, in relation to the *E. coli* attribute.

The management options identified were:

1. Property based E.coli discharge limits – measured at one or more reference locations on property
2. Dairy shed effluent and farm drain discharge treatment prior to discharge
3. Create a buffer – no intensive land use/E. coli generating land use within a buffer zone
4. Purchase of land - retirement from productive use and revegetate
5. Stocking rate or herd size limits
6. Point source discharge limit (with allowed variability) – real time sensors

Explaining the Workbook

This workbook is intended to test draft criteria so that a refined set can be used in community processes, using options for reducing *E. coli* in the Lower Kaituna as a working example.

Notes from Christina - I have split the criteria into groups as to who would make the assessment. This may well prove wrong.

- Criteria 1 and 2 assess effectiveness and ability to provide for values. They will definitely be informed by modelling and analysis (*You will have to do a best guess at this stage)*
- Criteria 3 to 8 are criteria I think the community groups could assess – with some expert input needed.
- Criterion 9 is specific to iwi/hapu.
- Criteria 10 to 13 may be more suited to Council evaluation.

Criteria			
Effectiveness			
1	Effectiveness at providing for biophysical/ecological, cultural and social instream values		
2	Effectiveness of providing for social and economic land and water use values		
Community group assessment			
3	Promotion of Community vibrancy		
4	Adaptability		
5	Incentivising the right actions?		
6	Practicality		
7	Distribution of costs and benefits		
8	New entrants allowed for?		
Iwi/hap assessment			
9	Tangata whenua assessment		
Council assessment			
10	Resilience to climate change		
11	Consistency with river co-governance documents		
12	Compatibility with broader initiatives		
13	Administrative/staff resourcing costs		

The workbook has a table for scoring the options against the criteria with lots of room for you to comment on criteria and measures. For the purposes of testing the criteria I have only used Options 1, 2, 3 and 6. I have put in a question as to whether time is important in assessing each criterion.

On the facing page are the notes I have from four sources:

- the literature review,
- looking at other NZ case studies,
- information from the casual loops workshop and
- feedback from the BOPRC workshop on 9 May.

THERE ARE NO RULES to filling in the workbook – you can reject, rewrite, redo any bit of the criteria as well as suggesting that it is perhaps addressed another way – e.g. policy analysis or just by asking for views from (say) governance groups – or make notes as to how it should be used and by whom

Criterion 1: Effectiveness at providing for biophysical/ecological, cultural and social "instream" outcomes

This is perhaps the most important criterion. Its ultimate assessment will involve the use of biophysical models. There are also aspects of timeframes and certainty of prediction that will need to be included in assessment somehow – ideas welcome.

I have based the measures on whether the options achieve the values. Other Councils have used a set of outcomes (examples below). You could split the biophysical, cultural, social, etc. into separate criteria but using values somehow seems to bring those aspects together.

If a value (or groundwater system) doesn't have an attribute in the NOF then you will need to determine indicator and range.

Literature – effectiveness is a necessary criterion (not optional)

- Achieves intended outcomes
- Does it achieve objectives?
- Highest level of problem resolution
- Consequences most closely aligned to goals

Comments from BOPRC workshop

- Clear objectives (including targets, banding, etc.)
- Value descriptions (qualitative)
- How the management option changes attribute relationships
- Whether the management option will achieve the freshwater quality and quantity desired, values-based objectives and over what time

Suggested Outcomes/Information from literature - BOPRC and other NZ examples

• NOF bands • GW levels • Minimum flows • Loads • Fishery • Shellfish • Erosion • Narrative Forms • Riparian • Wetlands	• Banding choices • Load levels • Targets • Objectives • TLI and SPI • Wetland health indicator	• Change in number of sites able to be used for cultural purposes and recreation • Drinking water • 'Swimmability' • Enhanced recreational opportunities • Fishing activities in rivers/streams/estuaries • Community recreation • Specific events • Historical uses return • Community Map of use (past, present, future) – location, type • Community Management Plan • Current/past, use of river, number of users, etc. • Recreational clubs engagement	• Satisfaction of mahinga kai gathering experience • Number of people who have/use papeda/whakapapa • Confidence to use waterways • Availability and suitability of weaving productions • Wahi tapu and wahi taonga – state and access • Taonga species – seasonal runs and migrations • Cultural values (e.g. mahinga kai) • Matauranga Māori • Co-governance River documents • Iwi Management Plans

Assessment Table for Criterion 1

Criterion – Effectiveness - biophysical/ecological, cultural and social instream values

Suggested measures: Very likely to be informed by output from biophysical model

- NOF band
- Water quality - Suitability for values

Without understanding the science, I don't know whether the key difference between options is in the outcome, or in how much of the estuary is (say) swimmable or is it frequency so feel free to adjust measure

Comments on measure and scoring

Score: *E. Coli*	NOF Band D	NOF Band C	NOF Band B	NOF Band A
Option 1	☐	☐	☐	☐
Option 2	☐	☐	☐	☐
Option 3	☐	☐	☐	☐
Option 6	☐	☐	☐	☐

Score: Suitability for Values	Swimming at limited times	Swimming during summer	Swimming year round	Swimming year round - sometimes shellfish	Swimming and shellfish gathering year round
Option 1	☐	☐	☐	☐	☐
Option 2	☐	☐	☐	☐	☐
Option 3	☐	☐	☐	☐	☐
Option 6	☐	☐	☐	☐	☐

Would timeframes make any difference to your assessment? How could certainty of predictions/ uncertainty be included?

Comments on criterion:

- Is there too much information in one criterion? Could be broken down into more outcomes and measures? If so, how would you give an overall assessment?

Criterion 2: Effectiveness at providing for economic and social outcomes from use of land and water

Other Councils have included social and economic modelling (or expert opinion) alongside their biophysical models. I suspect you will have some quantitative information on some aspects of effects on business (such as lost farm production) but most of the assessment for this criterion will be qualitative and probably relative.

Consistent with the approach for Criterion 1, I suggest using a values approach with one value about social factors and another about economic factors. I have listed outcomes used by other councils and those suggested at the BOPRC workshop below.

There are links to a latter criterion on community cohesion (Criterion 3) which assesses how the options promote or discourage community cohesion (divisiveness being the opposite). Community cohesion could be combined into this criterion. I have kept them separate because this one feels like an expert assessment, whereas community cohesion is much more subjective and I think can be assessed by the community groups.

As with the instream effectiveness there will be aspects of time and certainty that will need to be woven in.

Suggested outcomes from literature and BOPRC workshop

Social outcomes	**Economic outcomes**
Literature (other councils) • Population • Jobs • Income • Ethnicity, age structure, leadership, participation in community, level of social conflict • Health infrastructure and education (e.g. school rolls) • Population in catchment *Number of jobs in aquaculture, hydro-electricity, tourism, conservation, farming* BOPRC • Adaptability of business • Schools and commercial districts • Ability to start a new business • Iwi engagement • Formation of community groups • No cost off-setting to environment	Literature (other councils) • Regional economic outcomes • Business scale economics o Change in and economic value of hydropower in FMU o Change in and economic value of agricultural production in FMU o Change in and economic value of tourism in FMU • Regional catchment economics o GDP, earned household income, rates and taxes o Sustainable diverse and productive land use • Maori regional economic development • The need for firms to make long-term investments BOPRC • TLA costs (rates & services) • Ability to start a new venture • Iwi development programmes • Reliability (of water supply) • Property values • Lenders (banks) • Crop sensitivity • Resource Consent applications • Farm economic data • Allocation framework • Chamber of commerce

Assessment Table for Criterion 2

Criterion – Effectiveness - biophysical/ecological, cultural and social instream values

Suggested measures: Very likely to be informed by output from biophysical model and associated social/economic analysis

- Catchment GDP (change due to implementation of option)
- Catchment population (change due to implementation of option)

Am not sure that 5% is the right division between scores – that will need to be determined once you have some numbers

Comments on measure and scoring

Score: Catchment GDP	Decrease in GDP (>5%)	Some decrease in GPD (<5% decr)	No change in catchment GDP	Some increase in GDP (<5%)	GDP increase (>5% incr)
Option 1	☐	☐	☐	☐	☐
Option 2	☐	☐	☐	☐	☐
Option 3	☐	☐	☐	☐	☐
Option 6	☐	☐	☐	☐	☐
Score: Population	Decrease in population (>5% decr)	Some decrease in population (<5% decr)	No change in catchment population	Some increase in population(<5%)	Population increase (>5% incr)
Option 1	☐	☐	☐	☐	☐
Option 2	☐	☐	☐	☐	☐
Option 3	☐	☐	☐	☐	☐
Option 6	☐	☐	☐	☐	☐

Would timeframes make any difference to your assessment? How could certainty of predictions/ uncertainty be included?

Comments on criterion:

- Is there too much information in one criterion? Could be broken down into more outcomes and measures? If so, how would you give an overall assessment?

Criterion 3: Promotion of community vibrancy

This factor comes through strongly in the literature and in the casual loop work. It was not discussed in detail at the BOPRC workshop. The literature definition uses a tighter definition - community cohesion. It could also be described as community wellbeing - an RMA reference

I have suggested it is something that the community groups can assess. It relates very strongly to social and cultural values. Does it need to be assessed separately?

Literature references

Community connectedness/cohesion

- Does the option allow local control?
- Is there local engagement in action?
- Does it encourage stakeholder ownership of action/implementation?
- Does it integrate stakeholder groups?

Casual Loop references

This factor describes and captures the social components of the wider community in relation to the system and evolved from a discussion around social wellbeing and cultural practices. The broad connections here were 'people' and their wellbeing.

This is a very broad factor that incorporates many considerations. After some initial discussion about whether 'cultural' and 'social' needed to be kept separate, they were all included in this factor to reflect the connectedness and overlap of these elements within the wider community.
** This factor was the subject of sustained discussion and much is considered to be involved in this high level factor.*

Assessment Table for Criterion 3

<table>
<tr><td colspan="7">Criterion - Community vibrancy</td></tr>
<tr><td colspan="6">Suggested measure:

Qualitative assessment by the consultative group on whether the proposed option will enhance their community or be divisive.</td><td>Comments on measure</td></tr>
<tr><td colspan="6">Score:</td><td rowspan="5">Comments on scoring:</td></tr>
<tr><td></td><td>Consultative group – all agree it will be divisive</td><td>Consultative group consider it will be divisive for some parts of community</td><td>Consultative group – mixed opinions or good for some, bad for other parts of community</td><td>Consultative group consider is will enhance some parts of community</td><td>Consultative group – all agree option will enhance community</td></tr>
<tr><td>Option 1</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 2</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 3</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 6</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td colspan="7">Would timeframes make any difference to your assessment?</td></tr>
<tr><td colspan="7">Comments on criterion:
Necessary / helpful?
Links to other criteria – could it be combined into another?
Information that would make it easier to assess</td></tr>
</table>

Criterion 4: Adaptability

This criterion seeks to measure whether the proposed option can respond to new information and innovation. It's a future looking criterion. Adaptation/resilience has been very important to community in previous processes, particularly given the clunky nature of making changes to RMA plans. As suggested, it combines both ability to adapt to new information and to innovation – does this make it too clunky?

Community process has identified future possibilities such as new crops, innovative farming techniques including low impact, manuka forestry and greater use of technology on farm and in other commercial businesses

Literature references

- Can we respond to changing circumstances?
- Allows innovation
- Feedback systems are included/can be included, measures can be tested and adjusted as they are implemented
- Can we track progress?
- Is learning/new science integrated into solution
- Ease of adapting approach overtime (OECD)

BOPRC workshop

Do the policies allow flexibility for innovative new approaches? E.g. set nutrient discharge requirement vs. set an action that must be taken

Casual Loop notes

<u>Technology</u>

- This factor describes advances and/or changes in physical and economic technology.
- Physical technology is mechanical advances, automation, etc. This may include elements of water related technology or not - for example, it might refer to the automation of a milking practice on a dairy farm, or the development of more water efficient irrigation technology for some kind of land use.
- ** This factor was added to the CLD during discussion to identify all the links between factors and was not one of the originally identified factors.*

<u>Sustainable development</u>

- Sustainable development was a term used to capture a wide range of elements that originated from elements of *land use*, *land use flexibility* and *business sustainability* that were suggested by members of the group. The original discussion relating to this factor centered round the durability of businesses to be adaptable and flexible in response to drivers in the business environment. The group described this as the cultural drivers underpinning business practices in the area.

Assessment Table for Criterion 4

<table>
<tr><td colspan="7">Criterion - Adaptability - ability to respond to new information and innovation</td></tr>
<tr><td colspan="6">Suggested measure:
Assessment by the consultative group
Will probably need some definition of likely areas for new information and innovation to do assessment in a consistent way</td><td>Comments on measure</td></tr>
<tr><td colspan="6">Score:</td><td rowspan="5">Comments on scoring: Is it too clunky to combine new knowledge and innovation?</td></tr>
<tr><td></td><td>Option does not allow for innovation or new information</td><td>Option could only respond through a plan change</td><td>Option could respond to new information and/or to innovative practice but would be a bit clunky</td><td>Option has mechanisms to respond to monitoring results and/or innovation</td><td>Option encourages new information and innovative practice</td></tr>
<tr><td>Option 1</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 2</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 3</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 6</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td colspan="7">Would timeframes make any difference to your assessment?</td></tr>
<tr><td colspan="7">Comments on criterion:
Necessary / helpful?
Links to other criteria – could it be combined into another?
Information that would make it easier to assess</td></tr>
</table>

Criterion 5: Incentivise the right behaviour

This criterion came from the BOPRC workshop.

It could relate to these two criteria that came from the literature review

- Is it self-supporting in the long term?
- What is the timeframe of commitment from the regulator?

It's an important concept in solution and regulatory design. In my experience, it is often talked about by the community and matters a lot to them. In Canterbury, the community also talked about rewarding those who take up initiatives voluntarily. I haven't seen it taken forward into regulatory design very often.

I have left it in at this point because I think it will resonate with the community. It may be an important concept that doesn't need its own criterion as it will be picked up in other criteria?? - ideas/views are welcome.

It is probably part of the broad concept of equity.

Assessment Table for Criterion 5

<table>
<tr><td colspan="6">Criterion – Incentivising the right behaviour</td></tr>
<tr><td colspan="5">Suggested measure:
Assessment by consultative group</td><td>Comments on measure</td></tr>
<tr><td colspan="5">Score:</td><td rowspan="5">Comments on scoring:</td></tr>
<tr><td></td><td>There are clear disincentives to the right behaviour</td><td></td><td>The option neither incentivises or discourages the right behaviour</td><td></td><td>There are clear incentives in place for the right behaviour</td></tr>
<tr><td>Option 1</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 2</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 3</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 6</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td colspan="6">Would timeframes make any difference to your assessment?</td></tr>
<tr><td colspan="6">Comments on criterion:
• Necessary / helpful?
• Links to other criteria – could it be combined into another?
• Information that would make it easier to assess</td></tr>
</table>

Criterion 6: Practicality

Literature review

- Is compliance clearly assessed?
- Enforceability
- Accountability – means and authority to hold people to account
- Degree of institutional difficulty for delivery
- Suitability to local conditions Physical, biology, future climate, land LUC, soils, biophysical, etc.
- Institutional arrangements needed for implementation

BOPRC workshop

- Is it affordable?
- Is it physically possible?
- Tried & tested?
- Unanticipated or opposing consequences?
- Can we practically make/ensure it happens?

Measures

- Cost
- Evidence of effective implementation elsewhere

Assessment Table for Criterion 6

<table>
<tr><td colspan="7">Criterion – Practicality</td></tr>
<tr><td colspan="6">Suggested measure:
An assessment by the community group and by BOPRC consents/compliance and catchment teams.</td><td>Comments on measure</td></tr>
<tr><td colspan="6">Score:</td><td rowspan="5">Comments on scoring:</td></tr>
<tr><td></td><td>Community and staff dubious of practicality</td><td>Some fishhooks identified but majority of approach considered practical</td><td>Unproven implementation but broad agreement that it could work</td><td>Confidence from community and staff that it can be implemented with some aspects proven</td><td>Relies on proven implementation approaches</td></tr>
<tr><td>Option 1</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 2</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 3</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 6</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td colspan="7">Would timeframes make any difference to your assessment?</td></tr>
<tr><td colspan="7">Comments on criterion:
• Necessary / helpful?
• Links to other criteria – could it be combined into another?
• Information that would make it easier to assess</td></tr>
</table>

Criterion 7: Distribution of costs and benefits

This criterion relates to equity. Communities often talk about fairness. I have moved away from the use of the terms – fairness and equity as it has proven problematic in a community/stakeholder process when used as a term in itself – a view that was echoed at the BOPRC workshop. It is better broken into component parts that are more objective. There are two criteria – this one and the following one about allowance for new entrants – which could both be described as part of equity.

It relates to the tests for Councils under the Local Government Act when deciding financial policies – polluter pays and beneficiary pays – usually a political call. I considered whether this was a criterion assessed by consultative group or more aligned to a Council evaluation. In the end, I put it with community group because equity comes up so much in discussions.

I suspect this criterion will need some expert analysis to provide a consistent view on costs/benefits and where they lie.

Literature review

- Distribution of costs and benefits
- Share of private vs public costs and benefits
- Financial burdens to non-participants
- Burden of rules and enforcement proportional to the benefits
- Where do the costs lie?
- Links to LGA tests – beneficiary pays, exacerbator pays
- Qualitative assessment once the costs are known
- Distribution of right/resource/pain/cost
- Fairness
- Does the policy address externalised environmental cost of <u>all</u> potential activities?

BOPRC

- Inter/intra-generational
- Equal opportunity? Volumes? Rights?
- *Ongoing flexibility*
- Can we be equitable in distribution of costs & benefits?
- Are we starting from the same baseline? E.g. not all land has the same legal structure/ownership – Māori-freehold land.
- Who incurs the costs & benefits compared to who contributes to the problems. Are there mechanisms to spread costs fairly?

Measures

- Current distribution, consent timeframes
- *Future scenarios*
- Quantitative and qualitative
- Sum of benefits gained compared to costs and timing, including non-target costs and benefits and timeframes.
- Rates implications.
- Administrative/staff resourcing implications
- Range of costs incurred and benefits gained directly in relation to meeting objective (or broader)

Assessment Table for Criterion 7

<table>
<tr><td colspan="7">Criterion – Distribution of costs and benefits</td></tr>
<tr><td colspan="6">Suggested measure:

Assessment by community group. Some quantitative analysis would be useful and provided to community group before they make assessment</td><td>Comments on measure</td></tr>
<tr><td colspan="6">Score:</td><td rowspan="6">Comments on scoring:</td></tr>
<tr><td></td><td>Consultative group – uncomfortable with distribution of costs and benefits</td><td>Consultative group concerned about some major aspects of distribution</td><td>Consultative group neutral/undecided on whether costs and benefits are distributed well</td><td>Consultative group concerned about some minor aspects of distribution but understand rationale and support overall</td><td>Consultative group – comfortable with distribution of costs/benefits</td></tr>
<tr><td>Option 1</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 2</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 3</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 6</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td colspan="7">Would timeframes make any difference to your assessment?</td></tr>
<tr><td colspan="7">Comments on criterion:
Necessary / helpful?
Links to other criteria – could it be combined into another?
Information that would make it easier to assess</td></tr>
</table>

Criterion 8: New entrants and development by existing users allowed for?

This is a criterion suggested at the BOPRC workshop. It's about the ability to start and run viable businesses, but relates to those who have reasonable expectations of being able to do so rather than wider economic growth considerations. It is definitely part of equity/fairness considerations. It relates to ongoing flexibility (Criterion 4) and possibly to Criterion 2 (depending on economic development options) including opportunities for Māori economic development.

At the BOPRC workshop this criterion was only used in relation to new entrants. I wonder if the term "new entrants" is a bit limiting. For example, in many of the Canterbury discussions a hot topic was the ability of dryland farmers to continue to gradually intensify given that there are N limits in place (and they are such low N emitters).

The suggested measures are a bit broad as I suspect the ultimate assessment will identify a specific development opportunity, and depend on existing and potential land uses within a given WMU.

Literature review

- Equal future opportunity

BOPRC

- New entrants provided for

Casual Loop work

- "Business adaptability", "sustainable development" and "community vibrancy" concepts cover aspects of this criterion.

Assessment Table for Criterion 8

Criterion - New entrants allowed for?

Suggested measure:
Qualitative assessment by consultative group with advice from staff on opportunities
I suspect this will be hard to evaluate in the absence of a clear statement as to what future opportunities/new entrants to allow for? Development scenarios may help with this

Comments on measure

Score:

Comments on scoring:

	No opportunity	Very limited opportunities	Opportunities for new entrants but only in negotiation with existing users	Some opportunities available to all	Obvious opportunities with clear entry path
Option 1	☐	☐	☐	☐	☐
Option 2	☐	☐	☐	☐	☐
Option 3	☐	☐	☐	☐	☐
Option 6	☐	☐	☐	☐	☐

Would timeframes make any difference to your assessment?

Comments on criterion:

- Necessary / helpful?
- Links to other criteria – could it be combined into another?
- Information that would make it easier to assess

Criterion 9: Tangata whenua assessment

BOPRC has already set out Appendix F to the Regional Policy Statement - Criteria for Maori culture and traditions in the User Guide to the Bay of Plenty Regional Policy Statement (Change No. 1) June 2008.

A fundamental principle of the criteria is that *Only Maori people that have a relationship with the affected area can identify their relationship and that of their culture and traditions with their ancestral lands, water sites, waahi tapu and other taonga.* The measure is therefore an assessment by iwi and hapū.

Policy 5.3.2. (b) v and vi of the RPS

> *To assess the relationships of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga, in relation to section 6(e) of the Act, by the extent to which criteria not inconsistent with those in Appendix F*
>
> *To use criteria no inconsistent with those in Appendix F when preparing provisions relating to the relationships of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga, in relation to section 6(e) of the Act <u>for inclusion in regional and district plans</u> for the purpose of part V of the Act.*

The criteria are: Mauri, Waahi tapu, Korero Tuturu/Historical and Rawa Tuturu/Customary resources, Hiahiatanga Tuturu/Customary Needs, Whakaaronui o te Wai/ Contemporary esteem.

BOPRC

- Consistency with/give effect to Treaty obligations
- Reflect/acknowledge/recognise content of relevant documents. E.g. Iwi Management Plans, River documents, etc.
- Wastewater in waterways
- Waterway mixing
- Significant sites Tangata whenua knowledge

Measures

- Cultural impact assessment
- Iwi management Plans
- Consistency with broader initiatives, national and regional obligations – E.g. RPS Appendix F and G, Value set 4, IW2B(b)

Assessment Table for Criterion 9

<table>
<tr><td colspan="7">Criterion – Tangata whenua assessment</td></tr>
<tr><td colspan="6">Suggested measure: Assessment by iwi hapū of the option against 5 criteria in Appendix F of the RPS
• Mauri, Waahi tapu,
• Korero Tuturu/Historical
• Rawa Tuturu/Customary resources,
• Hiahiatanga Tuturu/Customary Needs,
• Whakaaronui o te Wai/ Contemporary esteem.
The use of measures may not work and instead could be replaced by a statement from iwi/hapū</td><td>Comments on measure</td></tr>
<tr><td colspan="6">Score:</td><td rowspan="6">Comments on scoring:</td></tr>
<tr><td></td><td>Iwi/hapū have concerns over at least one RPS criteria</td><td>Iwi/hapū consider the option is neutral in terms of RPS criteria</td><td>Iwi/hapū consider the option improves 1 or 2 RPS criteria</td><td>Iwi/hapū consider the options enhances at least RPS 3 of the 5 criteria</td><td>Iwi/hapū consider the option enhances all criteria</td></tr>
<tr><td>Option 1</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 2</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 3</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Option 6</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td colspan="7">Would timeframes make any difference to your assessment?</td></tr>
<tr><td colspan="7">Comments on criterion:
• Necessary / helpful?
• Links to other criteria – could it be combined into another?
• Information that would make it easier to assess</td></tr>
</table>

Criterion 10: Resilience to climate change

This aspect of resilience has been separated out of Criterion 4 because of there is a high level of interest and climate change has obvious links to water/land management. However, discussions need to be clear that this water management process is not testing the full suite of climate change adaptation options.

The question to be answered is *Does the proposal still look like the "best" option under various climate change proposals?*

The criterion makes sure that we are not inadvertently choosing an option that would lessen resilience, or put another way choosing an option that enhances our resilience.

I understand BOPRC has access to NIWA data on various climate change scenarios and will be able to model the effects on instream objectives of various climate change scenarios.

Assessment Table for Criterion 10

Criterion – Resilience to climate change						
Suggested measure: Ability to meet instream objectives) and maintain social economic outcomes (as per base case) under different climate scenarios (quantitative assessment using models) Ability to enhance resilience to climate change (qualitative assessment) experts *The Percentages given in the measures may need to be adjusted once the models run*						**Comments on measure and scoring**
Score: Instream objective IO	IOs not met in 80% of scenarios – at least one severely affected	IOs not met in 80% of climate scenarios	IOs still met in 50% of climate scenarios	IOs are still met under 80% of climate scenarios	IOs all still met and option enhances resilience	
Option 1	☐	☐	☐	☐	☐	
Option 2	☐	☐	☐	☐	☐	
Option 3	☐	☐	☐	☐	☐	
Option 6	☐	☐	☐	☐	☐	
Score: Social economic outcomes SEO	SEOs not met in 80% of scenarios – at least one severely affected	SEOs not met in 80% of climate scenarios	SEOs still met in 50% of climate scenarios	SEOs are still met under 80% of climate scenarios	SEOs all still met and option enhances resilience	
Option 1	☐	☐	☐	☐	☐	
Option 2	☐	☐	☐	☐	☐	
Option 3	☐	☐	☐	☐	☐	
Option 6	☐	☐	☐	☐	☐	
Comments on Criteria: Would timeframes make any difference to your assessment? How could certainty of predictions/ uncertainty be included? • Necessary / helpful? Links to other criteria – could it be combined into another? • Information that would make it easier to assess						

Criterion 11: Consistency with river co-governance documents

This criterion has strong links to Criteria 12 – Linkages to other initiatives. However, because these river documents are also about water I have elevated their consideration above the other documents listed in Criteria 12.

The OECD has a recommended evaluation criteria that relates to achieving the "big" or overarching goals. For the OECD, it is usually the Millennium Development Goals. These are different from the specific objectives of a project.

At the BOPRC workshop it was suggested that the river documents – the co-governance documents are the equivalent.

I have suggested that the co-governance group makes the assessment.

Assessment Table for Criterion 11

Criterion – Consistency with River Documents						
Suggested measure: Assessment by co-governance committee *The use of measures may not work and instead could be replaced by a statement from the co-governance group*						**Comments on measure**
Score:						**Comments on scoring:**
	Co-governance group has some reservations	Co-governance group has mixed views	More than half the co-governance group believes it is consistent	Co-governance group agrees that it is generally consistent	Co-governance group consider it is very well aligned	
Option 1	☐	☐	☐	☐	☐	
Option 2	☐	☐	☐	☐	☐	
Option 3	☐	☐	☐	☐	☐	
Option 6	☐	☐	☐	☐	☐	
Would timeframes make any difference to your assessment?						
Comments on criterion: • Necessary / helpful? • Links to other criteria – could it be combined into another? • Information that would make it easier to assess						

Criterion 12: Compatibility with broader initiatives and obligations

A check to test how the proposal aligns with other initiatives.

- Alignment with other NPSs – renewables and urban form
- Drinking water NES??
- Alignment with Regional Economic Development Strategy for Bay of Plenty Alignment with co-governance documents is covered in Criterion 11
- Flood risk

I suspect these will have to be assessed separately and probably qualitatively by an appropriate expert or group. *Is there a steering group for the Regional Economic Strategy?*

Literature review

Consistency with other regulatory regimes

Feedback from co-governors on proposal

Feedback from who? on regional economic development?

Any other initiatives to test?

BOPRC workshop

Are there any consequences that would be contrary to broader policies (e.g. in the RPS, animal welfare, etc.) – are these acceptable?

How far to go with this?

Assessment Table for Criterion 12

Criterion - Compatibility with broader initiatives and obligations

Suggested measure:
Assessment of alignment for each individual initiative or obligation
List the initiatives/obligations you think should be included and choose one to score

Comments on measure

Score: NAME OF INITIATIVE -

Comments on scoring:

	Some areas of conflict	No effect on other initiative	Some areas of alignment	Alignment for most aspects	High alignment
Option 1	☐	☐	☐	☐	☐
Option 2	☐	☐	☐	☐	☐
Option 3	☐	☐	☐	☐	☐
Option 6	☐	☐	☐	☐	☐

Would timeframes make any difference to your assessment?

Comments on criterion:

- Necessary / helpful?
- Links to other criteria – could it be combined into another?
- Information that would make it easier to assess

Criterion 13: Transaction costs

This criterion will be particularly relevant in the regulatory design phase. It seeks to separate out transactional costs from the expenditure that is directly related to improving water quality.

> **Literature definition**
>
> Transaction costs are the costs we incur when we make economic exchanges during the purchase of goods and services. Transaction costs may cover many areas. Some include charges for communication, such as telephones and the Internet, fees charged for legal services, or costs for purchasing and maintaining a car and paying for public transportation. Basically, transaction costs are the costs of playing a part in the market.

It is the cost of the system/administration needed to get the approach working. For example, the cost of obtaining a resource consent, the cost of compliance monitoring, the cost of databases etc. etc.

It differs from the direct costs of (say) fencing.

Perhaps this is more a Council consideration than community but there is no point the community recommending a whole lot of expenditure by Council (rates, user pays or use of other Council income) if that is politically unrealistic.

I suspect that time will have a strong influence here.

I have suggested that the % increase in rates and/or fees (user pays but charged by Council) is a reasonable measure. Are there other transactional costs that could be considered?

Literature review

- Regulatory cost to Council and others
- Private and public costs
- Costs of implementation
- Costs of transition

Assessment Table for Criterion 13

<table>
<tr><td colspan="7">Criterion – Transaction costs - Administrative/staff resourcing costs</td></tr>
<tr><td colspan="6">Suggested measure:

The rates and/or fees increase
Fees are assumed to be those paid to Council via consents and compliance user pays</td><td>Comments on measure
Are there other transaction costs than those which go through Council’s books?</td></tr>
<tr><td colspan="6">Score:</td><td rowspan="2">Comments on scoring:</td></tr>
<tr><td></td><td>Rates decrease</td><td>No rates increase</td><td>Up to 3% rates increase</td><td>Up to 3% rates and/or fees increase</td><td>Over 3% rates and/or fees increase</td></tr>
<tr><td>Option 1</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Option 2</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Option 3</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Option 6</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td colspan="7">Would timeframes make any difference to your assessment?</td></tr>
<tr><td colspan="7">Comments on criterion:
Necessary / helpful?
Links to other criteria – could it be combined into another?
Information that would make it easier to assess</td></tr>
</table>

Appendix 4 – Feedback on Criteria

Notes from BOPRC sessions on criteria and measures 20 and 21 June 2017

		Option 1: Property level E. coli limits	Option 2: On-site dairy shed and drain	Option 3: Buffer zone around sensitive environments	Option 6: [Stricter] point source discharge limits	Source of information to assess	Comments
CRITERIA	**1. Effectiveness to achieve in-stream objectives**					Catchment modelling	▪ Note *E. coli* would be the indicator for freshwater; enterococci for the estuary (can we model enterococci?) ▪ Use of a discharge standard does provide certainty on the limit (provided it can be measured and achieved) ▪ Time element is included in proposed changes to E. coli attribute table
	2. Effectiveness to achieve socio-economic outcomes				Associated costs, one-off investment by industry Alternative disposal options	Economic analysis	▪ Jobs rather than population? ▪ Job related only to water (not other drivers) ▪ Job diversity ▪ Ave on-farm/orchard cost, operating profit (/ha/yr, as % of land value?) or EBITD instead of catchment GDP ▪ Quantify in-river values/co-benefits (e.g. reserves in buffer)
	3. Community vibrancy					Community qualitative assessment	▪ Ability of community to take up projects ▪ Diversification of land use ▪ Community vibrancy driven by other than water ▪ Covered by distribution, effectiveness, etc. May be unneccessary on its own?
	4. Adaptability					Community, Council qualitative assessment	▪ Council adaptability is hamstrung by RMA. Focus on landowner adaptability.

	Option 1: Property level E. coli limits	Option 2: On-site dairy shed and drain	Option 3: Buffer zone around sensitive environments	Option 6: [Stricter] point source discharge limits	Source of information to assess	Comments
5. Inventivices "right" behaviour					Community, Council qualitative assessment	▪ What is the "right" behaviour? ▪ Closely linked to adaptability ▪ Right behaviour or the right outcome? ▪ Does not reward wrong behaviour/unintended consequences.
6. Practicality	Could be tricky to monitor Done in Otago Rely on real-time monitoring rather than models				Community, Council (enforcement, Catchment Managers, Scientists) qualitative assessment	▪ Ability to monitor/enforce ▪ Devil in detail of requirements ▪ Is existing land use still viable or unachievable under rules? Covered under effectiveness socio-econ? ▪ Needs to stand up in court ▪ Rule as conditions of permitted activity or otherwise (e.g. consent condition)? ▪ Effects vs. input-based rules! ▪ Resourcing affects practicality
7. Distribution of costs and benefits					Qualitative assessment supported by economic analysis	▪ Can be re-distributed to compensate ▪ Polluter pays or beneficiary?
8. New entrants, and development by existing users, allowed for					Qualitative assessment supported by economic analysis	▪ E.g. development of Māori-owned land and low intensity land users, ex-gorse land in Rotorua, CNI ▪ Need to be specific about each type of land/user ▪ Urban a "new entrant"?
9. Tangata whenua					Iwi Management Plan analysis	Cultural acceptability of management option itself (e.g. mixing waters, diversions, etc.)

		Option 1: Property level E. coli limits	Option 2: On-site dairy shed and drain	Option 3: Buffer zone around sensitive environments	Option 6: [Stricter] point source discharge limits	Source of information to assess	Comments
	assessment					Iwi/technical cultural assessment Against RPS, IMPs, indicators from engagement	Need to check if indicators from are still relevant/important
	10. Resilience to climate change					Catchment modelling, second stage Qualitative assessment on general impact of options on climate change resilience	Impact on effectiveness criteria Enhancing or otherwise climate change resilience (e.g. do any options reduce our resilience to climate change, such as reduced flood control capacity, etc.). Would it just be a seasonal lack of resilience or long term? Devil in detail of climate scenario modelling. Sensitivity analysis of effectiveness criteria for 2040 and 2090
	11. Consistency with co-governance documents					Assessment by co-governance fora	Would this only apply at objective setting or management options also? These are 'high-level' documents, although they do have some specific detail.
	12. Compatibility with broader initiatives					Council assessment of alignment with other initiatives	LTP is the cart not the horse; tail not the dog. (flood control, NPSs [Urban, Renewable Energy, etc.], NESs, biodiversity strategy, Coastal Plan, etc.).
	13. Administrative /staff resourcing costs	Potentially huge for compliance,	Minor for compliance		Very minor for compliance	Cost-recovered from consent holder Cost borne by Council from general rates base	Cost of consenting/compliance monitoring Monitoring and modelling costs

		Option 1: Property level E. coli limits	Option 2: On-site dairy shed and drain	Option 3: Buffer zone around sensitive environments	Option 6: [Stricter] point source discharge limits	Source of information to assess	Comments
		science monitoring					
	14.GENERAL						For some criteria there may just be questions rather than formal assessment. Or combo of both. Need to take into account complementarity of options when bundling them. Packages of measures rather than individual options. Need to think about weighting different criteria (here is where politicians could have a say) Initial rough assessment to influence what management options go into modelling scenarios, with community groups/iwi. Management options for all attributes, could be a long exercise. Narrow down by issues in different parts of WMA/FMU. Detailed assessment later on.