Rangitāiki River Forum

NOTICE IS GIVEN

that the next meeting of the **Rangitāiki River Forum** will be held in the **Council Chambers, Whakatāne District Council, Civic Centre, Commerce Street, Whakatāne** on:

Friday, 8 June 2018 commencing at 10.00 am.

Mary-Anne Macleod
Chief Executive
Bay of Plenty Regional Council Toi Moana

1 June 2018

The Rangitāiki River Forum is a permanent joint committee made up of representatives from:

Rangitāiki River Forum
Terms of Reference

Interpretation

"Rangitāiki River" means the Rangitāiki River and its catchment, including the:

- Rangitāiki River
- Whirinaki River
- Wheao River
- Horomanga River

The scope and delegation of this Forum covers the geographical area of the Rangitāiki River catchment as shown in the attached map.

Purpose

The purpose of the Forum is as set out in Ngāti Manawa Claims Settlement Act 2012 and the Ngāti Whare Claims Settlement Act 2012:

The purpose of the Forum is the protection and enhancement of the environmental, cultural, and spiritual health and wellbeing of the Rangitāiki River and its resources for the benefit of present and future generations.

Despite the composition of the Forum as described in section 108, the Forum is a joint committee of the Bay of Plenty Regional Council and the Whakatāne District Council within the meaning of clause 30(1)(b) of Schedule 7 of the Local Government Act 2002.

Despite Schedule 7 of the Local Government Act 2002, the Forum—

(a) is a permanent committee; and

(b) must not be discharged unless all appointers agree to the Forum being discharged.

The members of the Forum must act in a manner so as to achieve the purpose of the Forum.

Functions

The principle function of the Forum is to achieve its purpose. Other functions of the forum are to:

- Prepare and approve the Rangitāiki River Document for eventual recognition by the Regional Policy Statement, Regional Plans and District Plans. See Figure 1 Rangitāiki River Document Recognition Process for RPS.
- Promote the integrated and coordinated management of the Rangitāiki River
- Engage with, and provide advice to:
- Local Authorities on statutory and non-statutory processes that affect the Rangitāiki River, including under the Resource Management Act 1991.
- Crown agencies that exercise functions in relation to the Rangitāiki River.
- Monitor the extent to which the purpose of the Rangitāiki River Forum is being achieved including the implementation and effectiveness of the Rangitāiki River Document.
- Gather information, disseminate information and hold meetings
- Take any other action that is related to achieving the purpose of the Forum.

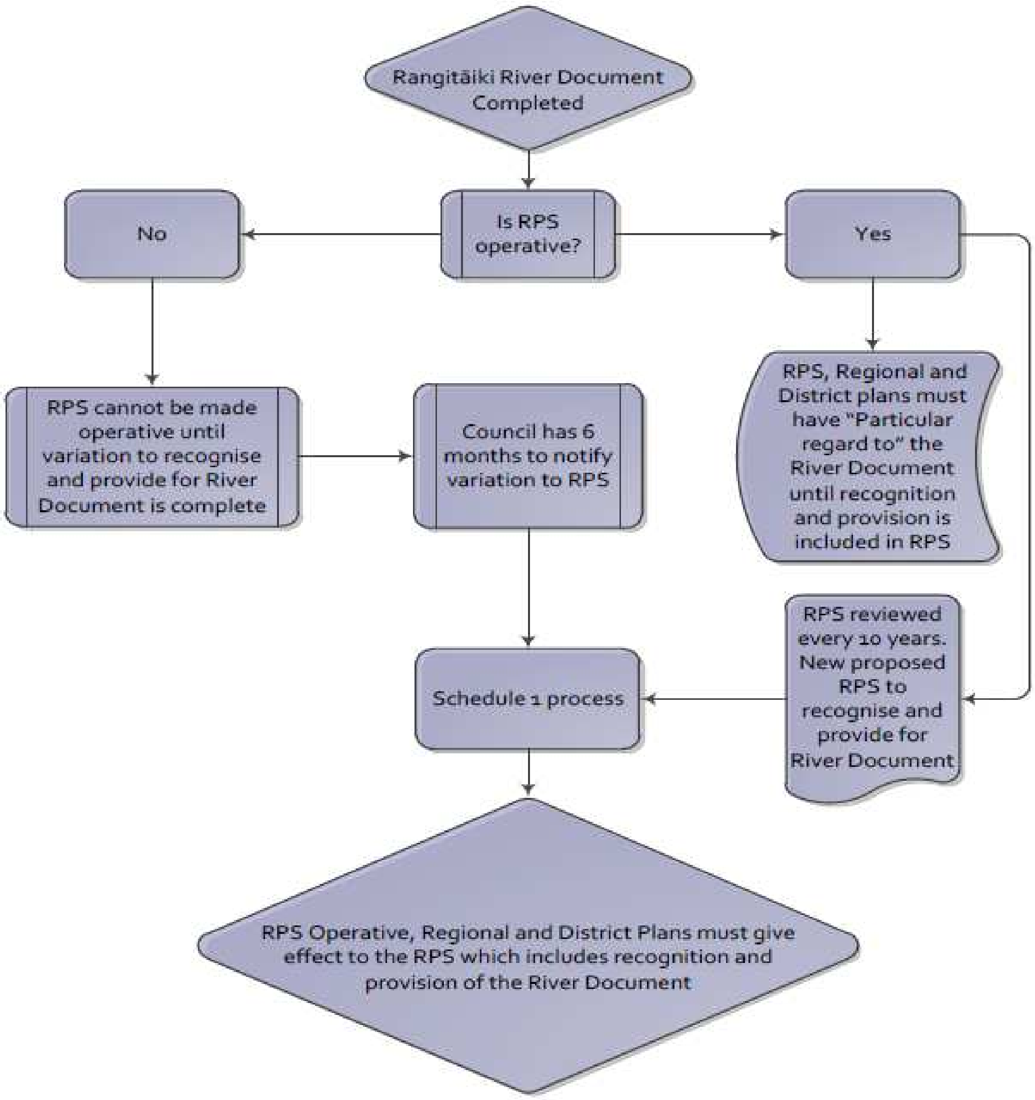


Figure 1 Rangitāiki River Document Recognition Process for RPS

Membership[1]

- One member appointed by Te Rūnanga o Ngāti Whare;
- One member appointed by Te Rūnanga o Ngāti Manawa;
- One member appointed by Ngāti Tūwharetoa (Bay of Plenty) Settlement Trust;
- One member appointed by Te Rūnanga o Ngāti Awa;
- One member appointed by Ngāti Hineuru;
- One member appointed by Tūhoe Te Uru Taumatua;
- One member appointed by the Whakatāne District Council;
- One member appointed by the Taupō District Council;
- Four members appointed by the Bay of Plenty Regional Council.

Note:

Despite the composition of the Forum, this is a joint committee of the Bay of Plenty Regional Council and the Whakatāne District Council.

[1] *Consequential amendment adopted Council Meeting 17/08/17*

Quorum

In accordance with Rangitāiki River Forum standing orders 2.3.3 and 2.3.4, the quorum for a meeting of the Forum is six members, comprising of:

- Three members appointed by the iwi appointers; and
- Three members appointed by the local authority appointers; and
- Must include a member appointed by Ngāti Whare and a member appointed by Ngāti Manawa.

Term of Committee

This Forum is a permanent committee under the Ngāti Manawa Claims Settlement Act 2012 and the Ngāti Whare Claims Settlement Act 2012 and therefore will not disbanded at the end of a triennium.

The establishment of the Forum is also supported by the Ngāti Whare
Deed of Settlement – Clauses 5.49 (October 2009) and the Ngāti Manawa
Deed of Settlement – Clause 5.40 (October 2009).

Ngāti Whare Deed of Settlement

5.49 The Crown and Te Rūnanga o Ngāti Whare acknowledge and agree that:

5.49.1 the parties are yet to finalise discussions in relation to a framework for the effective participation of Ngāti Whare in the management of the Rangitāiki River;

*5.49.2 following the signing of this Deed the parties will continue to discuss a framework that provides for the effective participation of Ngāti Whare in the management of the Rangitāiki River ("**Rangitāiki River management framework**"), with the objective of improving the health and wellbeing and sustainable use of the river;*

5.49.3 the discussions in relation to the Rangitāiki River management framework will:

a. be undertaken in good faith, honour and integrity and will reflect the wider commitments set out in the Deed of Settlement;

b. be undertaken in accordance with an agreed programme for further engagement and completed by the date of the introduction of the Settlement Legislation;

c. where appropriate, reflect a catchment wide and integrated approach to management of the Rangitāiki River and its resources;

d. reflect the need to recognise and provide for the interests of other iwi, local authorities, and other entities with interests or statutory roles in relation to the Rangitāiki River;

e. develop a programme for engagement with other iwi, local authorities, and other entities with interests or statutory roles in relation to the Rangitāiki River; and

f. allow for the Rangitāiki River management framework to be incorporated in the Settlement Legislation as necessary either at the time of introduction to Parliament or by way of a Supplementary Order Paper.

5.49.4 the discussions will be based on:

a. Ngāti Whare's principles, to be agreed with the Crown, regarding the Rangitāiki River;

b. as appropriate, the principles of other iwi with interests in relation to the Rangitāiki River as agreed with the Crown;

c. the need to protect the integrity of existing statutory frameworks; and

d. the need to ensure consistency and fairness between settlements.

5.40 The Crown and Ngāti Manawa acknowledge and agree that:

5.40.1 the parties are yet to finalise the redress for the effective participation of Ngāti Manawa in the management of the Rangitāiki River;

5.40.2 following the signing of this deed the parties will continue to discuss a framework that provides for the effective participation of Ngāti Manawa in the management of the Rangitāiki River (the "Rangitāiki River management framework"), with the objective of improving the health and best use of the river;

5.40.3 the discussions will be based on:

a. Ngāti Manawa's principles regarding the Rangitāiki River as set out in clause 5.41;

b. the need to protect the integrity of existing statutory frameworks; and

c. the need to ensure consistency and fairness between settlements;

5.40.4 the discussions will:

a. be undertaken in good faith, honour and integrity and will reflect the commitments set out in the deed of settlement;

b. be undertaken in accordance with an agreed programme for further engagement and completed by the date of the introduction of the settlement legislation;

c. reflect the need to recognise and provide for the interests of other iwi, local authorities, and other entities with interests or statutory roles in relation to the Rangitāiki River;

d. develop a programme for engagement with other iwi, local authorities, and other entities with interests or statutory roles in relation to the Rangitāiki River; and

e. allow for the Rangitāiki River management framework to be incorporated in the settlement legislation as necessary either at the time of introduction to Parliament or by way of a Supplementary Order Paper.

Specific Responsibilities and Delegations

To avoid doubt, the Forum, except as identified in the functions above, has the discretion to determine in any particular circumstance:

- Whether to exercise any function identified.
- To what extent any function identified is exercised.

Provision for other groups to join the Forum

Other iwi and local authorities through consensus of the Forum, may join the Forum.

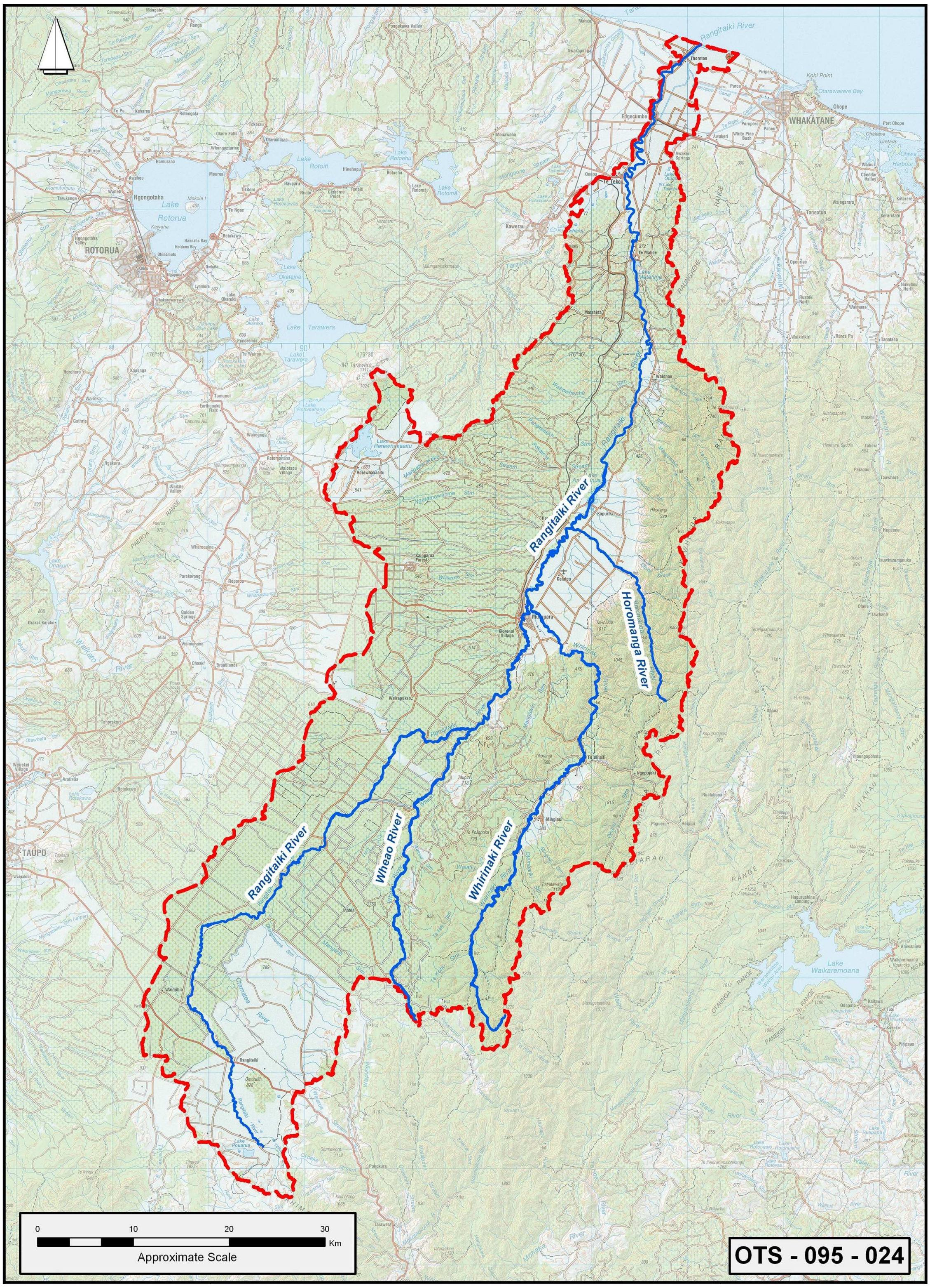


Figure 2 Map of the Rangitāiki River Catchment

Public Forum

1. A period of up to 15 minutes may be set aside near the beginning of the meeting to enable members of the public to make statements about any matter on the agenda of that meeting which is open to the public, but excluding any matter on which comment could prejudice any specified statutory process the council is required to follow.

2. The time allowed for each speaker will normally be up to 5 minutes but will be up to the discretion of the chair. A maximum of 3 public participants will be allowed per meeting.

3. No statements by public participants to the Council shall be allowed unless a written, electronic or oral application has been received by the Chief Executive (Governance Team) by 12.00 noon of the working day prior to the meeting and the Chair's approval has subsequently been obtained. The application shall include the following:

   - name of participant;
   - organisation represented (if any);
   - meeting at which they wish to participate; and matter on the agenda to be addressed.

4. Members of the meeting may put questions to any public participants, relevant to the matter being raised through the chair. Any questions must be asked and answered within the time period given to a public participant. The chair shall determine the number of questions.

Membership

Chairperson:	M Vercoe (Te Rūnanga o Ngāti Manawa)
Deputy Chairperson:	E Rewi (Te Rūnanga o Ngāti Whare)
Appointees:	**Bay of Plenty Regional Council** Crs W Clark, T Marr, K Winters, D Love, M McDonald (Alternate) **Ngāti Hineuru** I Kahukiwa Smith, J Wall (Alternate) **Ngāti Tuwharetoa (BOP) Settlement Trust** Reverend G Te Rire, E August (Alternate) **Taupo District Council** Crs T Kingi, R Harvey (Alternate) **Te Rūnanga o Ngāti Awa** M Araroa, T O'Brien (Alternate) **Te Rūnanga Ngāti Whare** W Rangiwai (Alternate) **Tūhoe Te Uru Taumatua** N Rangiaho **Whakatāne District Council** Cr G Johnston, Mayor A Bonne (Alternate)
Committee Advisor:	S Kameta

Recommendations in reports are not to be construed as policy until adopted.

Agenda

1 Opening Karakia

2 Apologies

3 Public Forum

4 Acceptance of Late Items

5 General Business

6 Confidential Business to be transferred into open

7 Declarations of Conflicts of Interests

8 Previous Minutes

9 Reports

10 Public Excluded Section — 279

Resolution to exclude the public

THAT the public be excluded from the following parts of the proceedings of this meeting.

The general subject of each matter to be considered while the public is excluded, the reason for passing this resolution in relation to each matter, and the specific grounds under section 48(1) of the Local Government Official Information and Meetings Act 1987 for the passing of this resolution are as follows:

General Subject of Matter to be Considered	Reason for passing this resolution in relation to this matter	Grounds under Section 48(1) LGOIMA 1987 for passing this resolution
10.1 Public Excluded Rangitāiki River Forum minutes - 16 March 2018	To maintain legal professional privilege	Disclosing the information may constitute contempt of Court.

11 Confidential business to be transferred into the open

12 Readmit the public

13 Consideration of General Business

14 Closing Karakia

Previous Minutes

Minutes of the Rangitāiki River Forum Meeting held at Waiohau Marae, 2495 Galatea Road, Waiohau on Friday, 16 March 2018 commencing at 10.45 a.m.

Present:

Chairman: M Vercoe (Te Rūnanga o Ngāti Manawa)

Deputy Chairman: E Rewi (Te Rūnanga o Ngāti Whare)

Appointees: Councillors: D Love, K Winters, W Clark (Bay of Plenty Regional Council), Rev G Te Rire (Ngāti Tuwharetoa (BOP) Settlement Trust), N Rangiaho (Tūhoe), M Araroa (Te Rūnanga o Ngāti Awa), Councillor G Johnston (Whakatāne District Council), I Kahukiwa Smith (Hineuru), Councillor T Kingi (Taupō District Council), Alternates: W Rangiwai (Te Rūnanga o Ngāti Whare), T O'Brien (Te Rūnanga o Ngāti Awa)

In Attendance: Bay of Plenty Regional Council: S Stokes (Eastern Catchments Manager), K O'Brien (Strategic Engagement Manager), H Simpson (Senior Advisor Treaty), S Omundsen (General Manager Catchment Management), I Morton (Strategy & Science Manager), N Green (Senior Planner Water Policy), N Willems (Team Leader Eastern & Rangitāiki Catchments), P Chapman (Project Manager), M Lee (Planner Water Policy), M Kapa (Land Management Officer), S Kameta (Committee Advisor); C Bluett (Te Rūnanga o Ngāti Awa), A Riwaka (Te Ohu Kaimoana), R Piddington, C Fern (Trustpower), Cr A Silcock, S McGhie, N Woodley (Whakatāne District Council); S Keane; D Kohai (Ngāti Patuheuheu), N Kohai (Ngāti Haka), J Tupe (Ngāti Koro, Patuheuheu, Ngāti Haka), R Tupe, C Savage (Ngāti Haka Patuheuheu), T Akuhata (Ngāti Rongo/Ngāti Haka), M Te Pou (Te Whare Kura Māori-a-rohe o Waiohau), T Tupe (Waiohau)

Apologies: Councillor R Harvey (Alternate, Taupo District Council), E August (Alternate, Ngāti Tuwharetoa (BOP) Settlement Trust), Councillor T Marr (Bay of Plenty Regional Council), Councillor M McDonald (Alternate, Bay of Plenty Regional Council)

1 Pōwhiri/Welcome

A pōwhiri took place at 9.30 am prior to commencement of the meeting at 10:45 am.

2 Karakia

Kaumātua Te Taahe Akuhata opened the meeting with a karakia.

3 Verbal Update from Ngāti Haka/Patuheuheu Hapū

A mihi was given by Mr Matutaera Te Pou pertaining to how the meeting would be conducted on tikanga and kawa of Patuheuheu and Ngāti Haka within Tama-ki-Hikurangi. Mr Te Pou expressed his political views, which were acknowledged and gave a report on the education of their tamariki and the importance of their waterways in relation to the whenua and people.

School Principal Mr Te Taahae Akuhata reflected on community past practices and knowledge as a platform to resurrect both old and new knowledge with the assistance of new technology, learning together as a community.

Reverend Te Rire responded with a mihi that acknowledged Mr Te Pou and Mr Akuhata's korero.

4 Apologies

Resolved

That the Rangitāiki River Forum:

1 Accepts the apologies from Councillor Rosie Harvey, Elaine August, Councillor Matemoana McDonald and Councillor Tiipene Marr tendered at the meeting.

Te Rire/Johnston
CARRIED

5 Declaration of Conflicts of Interest

No conflicts of interest were declared.

6 Previous Minutes

6.1 Rangitāiki River Forum Minutes - 10 November 2017

Corrections

A member noted that some discussion points were omitted from the minutes and requested that they be included, with the following amendments to be made:

1. Minute Item 7: Rangitāiki River Scheme Review (agenda page 21) – amend third paragraph to read: "<u>Sir Michael responded to questions. Comment was raised that direct engagement with Ngāti Awa was needed when the Regional Council proposed to undertake consent activities that were the subject of the Review findings, that the consents would be referred to the respective Iwi affected by the proposed consent activities and that a report on such activities would go to the Forum. Sir Michael advised </u>that consultation with respective Iwi post-review was outside the bounds of the Review Panel's responsibilities and would be a matter for the Regional Council to consider<u>. In regard to river ramping</u>, while this was not within the scope of the Review, the report had noted that ramping may have had a role in undermining bank stability and that reference had been made to a study currently underway on ramping."

2. Minute Item 8.2: Matahina HEPS: Certified Fish Passage Options Report (agenda page 22-23):

   a) Replace second sentence in fourth paragraph with: "Consideration was sought that fish passage design be undertaken in close cooperation with river Iwi, who relied on the expert advice of Mr Bill Kerrison. Concern was also raised that succession planning and the improved infrastructure design to support the current trap and transfer method had been slow to come and that it remained dangerous to use by an elder person."

   b) Amend second sentence in fifth paragraph to read: "In response to questions raised, Mr Piddington advised that Trustpower was committed to consulting with and considering feedback from Iwi in relation to fish passage design, that they were currently discussing succession plans with Mr Kerrison and that in comparison to alternative methods, the current trap and transfer method provided the benefit of transferring elvers further upstream past Aniwhenua Dam."

Resolved

That the Rangitāiki River Forum:

1 Confirms the Rangitāiki River Forum minutes of 10 November 2017, as a true and correct record, with the foregoing corrections.

Clark/Love
CARRIED

7 Reports

7.1 Consultation on the proposed Long Term Plan 2018-2028

Refer PowerPoint Presentation Objective ID zA209701.

General Manager Catchment Management Sarah Omundsen informed of Regional Council's Long Term Plan 2018-2028 (LTP) that was out for consultation and submissions. Ms Omundsen advised of LTP budget spends over the next 10 years, the continuation of projects of interest within the catchment, apportioning of rates funding and key consultation topics that Council was seeking feedback on.

The following matters were clarified in response to questions:

1. Regarding opportunities and matters worthwhile submitting on, Council was looking for submissions on all parts of the LTP. Submissions lodged a few days past the closing date for submissions would be considered;

2. In regard to Civil Defence Emergency Management (CDEM), Council was awaiting a report on the National CDEM review and recognised that CDEM needed to be strengthened;

3. The Regional Council was progressing its way through recommendations from the Rangitāiki Independent Review, with budget captured within the LTP. An update on implementation and progress would be reported to the Forum. It was noted that the Forum wished to be proactive and provide feedback on how implementation progressed. The need to keep local communities updated on progress was also noted.

4. Waiohau School Principal Te Taahae Akuhata expanded on some of the projects that local students were engaged with and advised he would like to engage with the Regional Council regarding access to resources and funding to support some of their school projects.

   Ms Omundsen advised that while not highlighted in the LTP Consultation Document, community aspirations were supported in the LTP, with Environmental Enhancement Funding of $500K available, which local catchment managers could further assist with enquiries.

5. Flood Recovery Project Manager Paula Chapman advised work was occurring on flood recovery work across the region, including the Edgecumbe flood recovery work. She advised 20 sites within the Rangitāiki Catchment had significant damage, which Council was working with various agencies to support associated recovery projects. Comment was raised regarding flood damaged farmland, which staff undertook to follow-up. It was noted that investigation into river ramping was pending and would be addressed by the Cardno report.

Resolved

That the Rangitāiki River Forum:

1 Receives the report, Consultation on the proposed Long Term Plan 2018-2028.

Winters/Love
CARRIED

7.2 Update on the 2017/2018 Annual Work Plan for Rangitāiki Catchment Programme

Eastern Catchments Manager Simon Stokes provided an update on progress and key highlights for the first six months of the 2017/2018 Annual Work Plan for the Rangitāiki Catchment Programme, with the following matters noted:

1. Progress on the community plan for Aniwaniwa had been delayed due to post-flood recovery work and other issues that had arisen, with completion anticipated by end of June 2018.

2. The Whakatāne District Recovery Project was still underway and being led by Whakatane District Council. Some flood affected residents were still out of their homes with 65% returned. Key goals for the project were getting people back home, continuation of Navigator support and Rivers & Drainage recovery as a major piece of work.

3. While flood recovery works could be impacted by a current lack of availability of contractors, a good project management structure was in place to prioritise work.

Clarification was provided in response to questions:

4. Support for new community initiatives could be explored by contacting Mr Stokes, Land Management Team Leader Nancy Willems or Land Management Officer Mieke Kapa.

5. Grant funding for the Rangitāiki Wetland Restoration Project totalled $1.5M over five years with 50 percent shared by the Ministry for the Environment and the

Bay of Plenty Regional Council. Members were advised all but one landowner had given their support for the project, with Southern Generation awaiting progress and completion of the Lake Aniwaniwa community plan.

Flood Recovery Project Manager Paula Chapman confirmed that the Reids Canal Floodway Project was about to go through a resource consent variation process. Further details were not available for the meeting, but would be reported to the Forum at a future date.

6. Concern was raised with gravel and weed issues at Lake Aniwaniwa. Mr Stokes advised a further meeting at the marae would be arranged for the Waiohau community on various matters including work activities, consultation timeframes and next steps.

Resolved

That the Rangitāiki River Forum:

1 Receives the report, Update on the 2017/2018 Annual Work Plan for Rangitāiki Catchment Programme.

Araroa/Rangiaho
CARRIED

7.3 Rangitāiki River catchment - Operations and General Update

Team Leader Eastern & Rangitāiki Catchments Nancy Willems highlighted key points from the report regarding operational activity and general matters occurring within the Rangitāiki River catchment.

7.3.1 Te Hekenga Nui o Te Tuna Plan

In relation to the Te Hekenga Nui o Te Tuna Plan, Ms Willems introduced Ngāti Awa Customary Fisheries Authority (NACFA) Representative Charlie Bluett who advised meetings had been held with Iwi Forum members, Te Ohu Kaimoana and quota management holders regarding Iwi and hapū concerns about the decline of long fin tuna populations and customary catches. Mr Bluett noted at a recent meeting with Iwi that NACFA had offered their services to contribute towards the issues raised. He advised that discussions had found the biggest impact was not only with commercial takes, but included barriers to migratory pathways, habitat and pollution.

Mr Bluett introduced Te Ohu Kaimoana (TOK) representative Mr Alan Riwaka who informed:

- Discussions with Iwi and hapū had provided the commercial industry with greater awareness and appreciation of the impacts, with positive discussions raised on the aspirations of Iwi and the fishing industry and similar issues occurring elsewhere.

- Quota management area (QMA) data on total allowable catch was less than 20% of the catchment (< 5 tonnes) however, noted that more discussion on this was needed.

- Duplication of work was occurring regarding the issues of commercial fishing, migration pathways, habitat and pollution.

- Respective agencies, Iwi and hapū supported putting forward a proposal to the Forum to combine and integrate resources into the work of the Te Hekenga Nui o Te Tuna Plan, noting involvement from NACFA, TOK and Te Wai Māori.

Mr Riwaka acknowledged Bill Kerrison's mahi along with Mr Bluett's and others at the table.

In response to questions, the following advice was provided:

1. Regarding the whereabouts of tuna, migratory paths in and out to sea were noted as being equally important with both needing to be addressed;

2. The Te Hekenga Nui o Te Tuna Steering Group would work with Mr Bluett and others on the Forum's behalf and report back to the Forum.

3. Mr Bluett and Mr Riwaka supported involving the Ministry for Primary Industries, as a statutory responsibility to Iwi and the Forum; and it was noted that Te Ara Whānui o Rangitāiki objectives had been well received by NACFA and TOK.

4. In regard to the impacts of climbing spindleberry, alligator weed and privet on the tuna lifecycle, river habitat and ecology, Ms Willems advised the extent of spindleberry was unconfirmed and would be monitored. Alligator weed died off in winter and renewed in spring, was a significant issue and rated high as a pest plant, with annual surveys conducted at existing and new sites.

7.3.2 **Trustpower's Fish Passage Options and Implementation Recommendations**

Forum members discussed the recommendations outlined in Trustpower's Fish Passage Options Implementation Table (refer Report Appendix 2) with clarification provided as follows:

1. In regard to Recommendation 4 – using commercial tuna from another catchment as an alternative source for spillway trials was proposed. It was explained that the permit process would require approval from Iwi. If the trials did not work, other options would be investigated.

2. A query was raised on the need for spillway trials to occur at Aniwhenua Dam. It was noted that while Aniwhenua Dam was also a significant barrier for downstream tuna migration, Southern Generation was not obligated to provide for tuna passage until renewal of their resource consent.

Forum members provided the following feedback:

3. Regarding Recommendation 4 - Comment was raised that it would be inappropriate to use tuna from another Iwi's catchment, regardless of being commercially sourced. Iwi members advised they required further time to discuss with their kaumātua and Iwi, the subject of sacrificing their own tuna for spillway trials.

4. Forum members delegated to Te Hekenga Nui o Te Tuna Steering Group members to progress Recommendations 3, 4 and 6 and to report back to the Forum.

5. In regard to Recommendation 11 – Members requested Trustpower provide further information on the special permit application process.

Resolved

That the Rangitāiki River Forum:

1 Receives the report, Rangitāiki River catchment - Operations and General Update.

2 In regard to Recommendation 3 contained in Appendix 2: Trustpower – Fish Passage Options Implementation Table:

a. Delegates to the Te Hekenga Nui o Te Tuna Steering Group to support Trustpower with progressing discussions with Bill Kerrison on succession planning.

Araroa/Love
CARRIED

3 In regard to Recommendations 4 and 6 contained in Appendix 2: Trustpower – Fish Passage Options Implementation Table:

a. Requests Te Hekenga Nui o Te Tuna Steering Group to report back to the Rangitāiki River Forum.

4 In regard to Recommendations 11 contained in Appendix 2: Trustpower – Fish Passage Options Implementation Table:

a. Requests Trustpower to provide the Rangitāiki River Forum with further information regarding Trustpower Limited's (TPL) application for Special Permit to undertake live tuna trials.

Love/Rangiaho
CARRIED

Adjournment

The meeting adjourned at 1.25pm and reconvened at 1:57pm.

Order of Business

With the leave of the Forum, the Chair advised that Public Excluded Agenda Item 11.1 would be received next on the agenda.

7.4 Public Excluded Section

Resolved

Resolution to exclude the public

THAT the public be excluded from the following parts of the proceedings of this meeting.

The general subject of each matter to be considered while the public is excluded, the reason for passing this resolution in relation to each matter, and the specific grounds under section 48(1) of the Local Government Official Information and Meetings Act 1987 for the passing of this resolution are as follows:

General Subject of Matter to be Considered	Reason for passing this resolution in relation to this matter	Grounds under Section 48(1) LGOIMA 1987 for passing this resolution
Proposed Change 3 Appeal: Joinder of Rangitāiki River Forum	To maintain legal professional privilege	Disclosing the information may constitute contempt of Court

Araroa/Johnston
CARRIED

7.5 Freshwater Futures Programme Update

Refer PowerPoint Presentation Objective ID A2828282.

Strategy & Science Manager Ian Morton and Senior Planner Nicola Green summarised matters from the report regarding regional and national activities focused on implementing the National Policy Statement for Freshwater Management (NPS-FM).

Discussion and advice was provided on the following matters:

- A member queried how Council intended to incorporate cultural aspects into NPS-FM monitoring. Staff advised that surface water catchment modelling was science-based only and that cultural monitoring was a matter for tangata whenua and that staff would seek their advice and involvement in the future. The recently approved Mātauranga Māori Framework – He Korowai Mātauranga would provide guidance for staff.

- It was noted that *'He Korowai Mātauranga*' was an internal resource to assist Council staff with their work, with further edits required to it. Additionally, development of an implementation plan was needed and anticipated to be completed later in the year, at which time an update could be provided to the Forum.

- Ngāti Whare had engaged with Landcare Research who had developed a sustainable Matauranga Māori model to research and monitor the state of the Whirinaki Forest, which may provide practical examples to assist with '*He Korowai Mātauranga'* implementation work, which staff acknowledged for follow-up.

- Regarding surface water quantity and allocation, a modelling tool to indicate fish habitat protection levels called EFSAP, was being developed. It was confirmed that water consents were included in surface water modelling and could be demonstrated at a future time. Groundwater modelling was well underway for the lower Rangitāiki catchment, with mass modelling being initiated.

- Regarding national matters:

    - The Minister for the Environment had requested feedback from the Land & Water Forum (LAWF) to report by May 2018 on water degradation and what could be achieved by 2020.

    - A lot of work was occurring to link national Climate Change and Freshwater outcomes, with Regional Councils feeding into discussions on practical changes that could be made;

    - Draft regional swimmability targets required by the NPS-FM were due to be released at the end of March 2018. The national target required 80% of lakes and rivers to be swimmable by 2030 and 90% swimmable by 2040. Bay of Plenty region's current classification was sitting high at 94.5% for rivers and 85% for lakes. It was noted that action plans were in place for lakes requiring improvement. Staff had recommended maintaining good management practices, while continuing discussions with local communities to look at community targeted standards.

- Havelock North inquiry had led to councils in the Bay of Plenty taking a cohesive joint risk assessment approach for municipal and groundwater bore supplies. In regard to private drinking water supplies, the Ministry of Health would be looking to educate communities of contamination risks, as it would be up to individuals to ensure against those risks.

Resolved

That the Rangitāiki River Forum:

1 Receives the report, Freshwater Futures Programme Update.

Love/Kingi
CARRIED

7.6 Appeals to Proposed Change 3 (Rangitāiki River) to the Bay of Plenty Regional Policy Statement

The report informed the Forum of two appeals lodged with the Environment Court on Proposed Change 3 (Rangitāiki River) to the Bay of Plenty Regional Policy Statement. The report was taken as read and accepted with no further discussion raised.

Resolved

That the Rangitāiki River Forum:

1 Receives the report, Appeals to Proposed Change 3 (Rangitāiki River) to the Bay of Plenty Regional Policy Statement.

Rangiaho/Kingi
CARRIED

Councillors Kevin Winters, David Love and Bill Clark ABSTAINED and requested that this be recorded.

7.7 Deferral of Item: Te Ara Whānui o Rangitāiki Implementation Workshop Summary

Due to timing, the Chair sought deferral of the item until the next Forum meeting, which members agreed.

The Chair noted the need for the Forum to review its Terms of Reference and to consider how to capture and include the views and input from new members.

Resolved

That the Rangitāiki River Forum:

1 Defers consideration of the report, Te Ara Whānui o Rangitāiki Implementation Workshop Summary to the next meeting of the Forum.

Vercoe/Winters
CARRIED

8 Closing Karakia

The meeting closed with a karakia provided by Kaumātua Mr Cleve Savage.

The meeting closed at 3:02 pm.

Reports

Report To: Rangitāiki River Forum

Meeting Date: 08 June 2018

Report From: Yvonne Tatton, Manager, Governance

Forum Membership Appointment

Executive Summary

This report is to inform the Forum of a new membership appointment onto the Forum.

Recommendations

That the Rangitaiki River Forum:

1 **Receives the report, Forum Membership Appointment;**

2 **Confirms the appointment of Janice Wall onto the Rangitāiki River Forum as the alternate member for Hineuru, replacing David Jones.**

1 Purpose

This report is to advise the Forum that Hineuru has appointed Janice Wall as their alternate member on the Forum, replacing David Jones.

Janice will be in attendance at the Forum Meeting on Friday 8 June.

2 Council's Accountability Framework

Current Budget Implications

The cost of members' attendance at meetings lie where they fall, with the exception that meeting attendance costs for Iwi appointed members are met by the Bay of Plenty Regional Council and are covered within Council's existing Governance budget.

Future Budget Implications

Future meeting attendance costs are provided for within the Governance budget with no future implications.

Shari Kameta
Committee Advisor

for Manager, Governance

31 May 2018

Receives Only – No Decisions

Report To: Rangitāiki River Forum

Meeting Date: 08 June 2018

Report From: Namouta Poutasi, Water Policy Manager

An Update on Plan Change 12 - Progress in the Rangitāiki Water Management Area

Executive Summary

The purpose of Plan Change 12 is to implement the *National Policy Statement for Freshwater Management* in both the Rangitāiki and the Kaituna-Pongakawa-Waitahanui Water Management Areas. A large body of work is supporting Plan Change 12 which is still in development. The particular focus for June to September this year are to:

- Involve iwi and hapū to ensure tangata whenua values and interests are identified and reflected
- Use catchment model forecasts and science-based information to support freshwater limit setting discussions.

The results will provide guidance in building solutions for managing water quality and water takes.

Recommendations

That the Rangitāiki River Forum under its delegated authority:

1 Receives the report, *'An Update on Plan Change 12 - Progress in the Rangitāiki Water Management Area'*.

1 Purpose

This report builds on previous updates to the forum with progress towards the development of the *Rangitāiki and Kaituna-Pongakawa-Waitahanui Water Management Area* plan change to the Bay of Plenty Regional Natural Resources Plan (Plan Change 12). The focus of this report is to bring the forum up to date with progress of the plan change 12 project and to share technical information that has been previously mentioned is in development.

2 Background

Since 2016, the Freshwater Futures team (the team) has been working with iwi and community groups towards improved management of freshwater in rivers, lakes, wetlands, springs and streams. The work is intended to support setting measurable freshwater objectives and limits (on water take and discharges in particular) which are required under the National Policy Statement for Freshwater Management (NPS-FM).

The NPS-FM requires detailed planning and execution of tasks, particularly in identifying and recognising community and iwi values and interests prior to drafting the policies and rules. Those detailed planning tasks can be summarised as Figure 1.

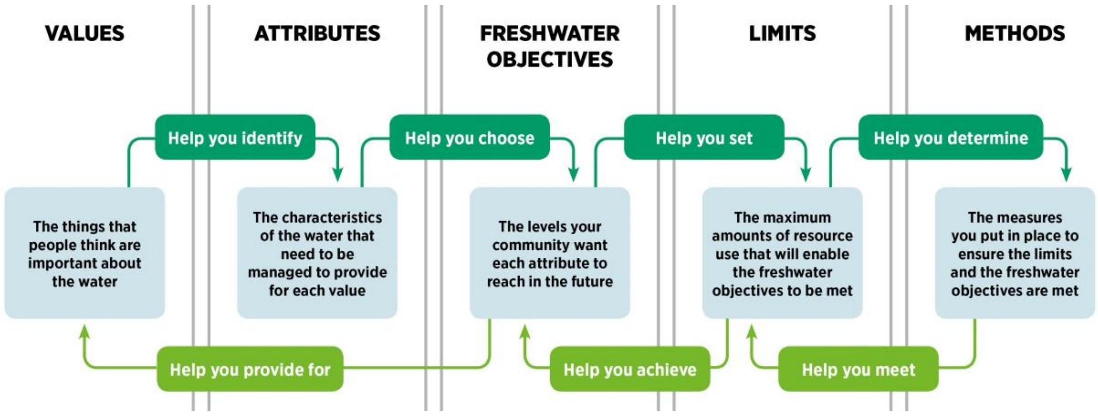


Figure 1: National Objectives Framework process set down in the National Policy Statement for Freshwater Management 2014 (amended 2017).

To achieve this, Council needs to engage with community and tangata whenua in order to understand and identify their values and interests in freshwater. This will also enhance Council's understanding of the fresh water interactions in the region. To date, community and iwi engagement has enhanced the understanding of the value people place on the rivers, lakes, streams, springs and wetlands, and the range of views held by different sectors of the community.

2.1 Plan Change 12 development phases

The project is now entering a *'problem solving'* phase, as shown in Table 1.

Period	**2015 – 2017** **Awareness raising/ discovery**		**2017 – 2018** **Problem solving**		**Late 2018 – 2019** **Solution building**	
Phase	**Phase 1** Data gathering, awareness raising, forming community groups	**Phase 2** Discussions with community groups, draft Freshwater Management Units, baseline science	**Phase 3** (we are here) Using model project nutrient movement, causes confirmed, ***exploring solutions***	**Phase 4** Solutions short-listed, consulting, detailed analysis, ***plan drafting, solution building***	**Phase 5** ***Draft plan*** and analysis released for all stakeholders' consideration.	**Phase 6** Proposed for formal submissions (*Schedule 1 process*)
Policy/ Rule content	**Pre-draft**		(we are here)		**Draft**	**Proposed**

2

Engaging iwi and tangata whenua	Hui-a-iwi tuatahi – *Freshwater values*	Hui-a-iwi tuarua - Freshwater current states Hui-a-iwi tuatoru – Tangata whenua interests Rūnanga CEO advice/discussion	Confirm water bodies and location special to tangata whenua. Estimated implications on freshwater	(*Seeking guidance*)	Consult on the written draft (*seeking advice*)	Proposal opens for written submissions, hearing and deliberation.

Table 1 – Plan Change 12 development phases.

3 Outcome alignment to Te Ara Whānui o Rangitāiki

Plan Change 12 will partially address the objectives and actions in Te Ara Whānui o Rangitāiki which are:

- Water quality is restored in the Rangitāiki catchment (Objective 3)
- Prosperity in the Rangitāiki catchment is enabled within the sustainable limits of the rivers and receiving environment (Objective 4)
- Work with rural industries, iwi, landowners, the community, and other willing stakeholders in the Rangitāiki catchment to articulate their aspirations for prosperity and values for freshwater through the Freshwater National Policy Statement framework (Action 4.1)
- Identify, forecast, and assess emerging pressures on the resources in the Rangitāiki catchment and likely opportunities and targets for restoring water quality (Action 3.3)
- Develop sustainable environmental flow and Rangitāiki Catchment load limits (e.g. nutrients, sediments, and bacteria) through the Freshwater National Policy Statement framework, including establishing:
    - The current state and anticipated future state
    - Freshwater objectives
    - Limits for meeting freshwater objectives (Action 3.1).

Appendix 1 demonstrates the alignment between objectives in the Te Ara Whānui o Rangitāiki and the working draft narrative (and measureable) Plan Change 12 freshwater objectives.

4 Updates Current Activities

4.1 Involving iwi and hapū in freshwater management

The team is continuing to engage with iwi and hapū in the Rangitāiki Catchment to share knowledge (science, modelling, learnings so far), and to gain a better understanding of iwi freshwater values and interests. Iwi freshwater values and interests are important for setting freshwater limits and need to be well documented.

Over the next three months, the team will engage to:

- Learn more about fresh water bodies (and/or parts of) that are important to hau kāinga - their location, and the activities that strengthen their association with them eg, mahinga kai, swimming, rituals

- Understand how changes in water quality and level/flow affect tangata whenua values/interests.
- Share our current understanding.
- Confirm other groups we should be contacting.

In preparation, we have:

- Collated, mapped and reviewed a number of Cultural Impact Assessments (CIAs) lodged with Toi Moana; to further inform Council's understanding of tangata whenua values and associations with waterways
- Reviewed iwi and hapū management plans
- Reviewed recent submissions into council processes to gather current information on iwi and hapū concerns
- Worked hard to prepare a robust catchment model to help make best use of water science.

Following this values gathering phase (i.e. towards the end of this year) we plan to consult wider (i.e. hui-iwi, public open-days, make use of media) and seek feedback on possible solutions to identified problems. Proposed solutions will be informed by and reflective of tangata whenua values and interests.

4.2 Update on Rangitāiki Freshwater Futures Community Group progress

The last Rangitāiki Freshwater Futures Community Group (the Group) workshop was held on 3 April 2018. The information shared with the Group is accessible online (Google search *"Rangitaiki Community Group Workshop"*), and attached to this report as:

- *Appendix 3* Briefing Notes Workshop 7: Mitigation Bundles and Information on Surface and Groundwater Quantity
- *Appendix 4* Fact sheet – Setting Environmental Flows in Water Management Areas
- *Appendix 5* Fact sheet – Introduction to Groundwater Environmental Level Setting in Rangitāiki Catchment.

The workshop records/notes are also included as Appendix 6.

The Rangitāiki Freshwater Futures Community Group has stated that their preliminary preferred state for in-river values include ecological health, significant indigenous species, mahinga kai, fishing, and contact recreation. The working draft narratives for measurable freshwater objectives are prepared based on these and are included as Appendix 1.

4.3 Update on Current Science Understanding and Freshwater Modelling

State and trends of the Rangitāiki River and lakes

The key freshwater quality and quantity issues are summarised in Appendix 7 and are largely consistent with information the forum has previously seen. Rising nitrogen trends may need to be addressed to avoid further nutrient enrichment in the hydro-electricity generation dam lakes – though our understanding of these hydroelectric lake systems is incomplete. Below the hydro dams, and as previously noted, water quality does not appear to be significantly impacting ecosystems.

Freshwater estimating or forecasting models

We are using a number of models to help improve our understanding of the Rangitāiki catchment. They include:

- SOURCE (Source Surface Water Catchment).
  This relies on numerous sub-catchment calculations to estimate surface and groundwater runoff, nutrient transport, fertiliser application rates and so on. It gives estimates of Nitrogen, Phosphorus, *E.Coli* and sediment in surface-water, and traces them back to their source. SOURCE can assess the effect of different mitigation options and will be used to build confidence around proposed water management recommendations.
- EFSAP (Environmental Flows Strategic Allocation Platform).
  This is a water planning and management tool. More information about EFSAP is in the Appendix 4 factsheet. Based on Council's past work, we expect EFSAP to confirm that:
  i) The smaller streams and slower flowing systems are most sensitive and may need different abstraction limits than large streams. EFSAP will help identify these water bodies and set bounds on acceptable take.
  ii) It may be ecologically preferable to allow takes from larger streams and main river branches instead of small streams/tributaries.
  iii) Tuna is not a good indicator species for minimum water flow, because they are tolerant to a wide range of flows compared to other species.
- Mass Balance water estimates (GNS Science) and MODFLOW groundwater model. These models help estimate groundwater levels. See Appendix 5 for a comprehensive discussion about the Rangitāiki situation.

SOURCE

Surface water catchment models have been developed for the Rangitāiki catchment.

To recap, SOURCE will estimate the sources and loads of Nitrogen, Phosphorous, *E.Coli* and sediment, as well as the concentrations under different scenarios. Scenarios we will test in SOURCE include:

- Current land and water use
- Reference state (natural vegetation and no water use)
- Future development
- Exploratory mitigation scenarios (see Figure 2).

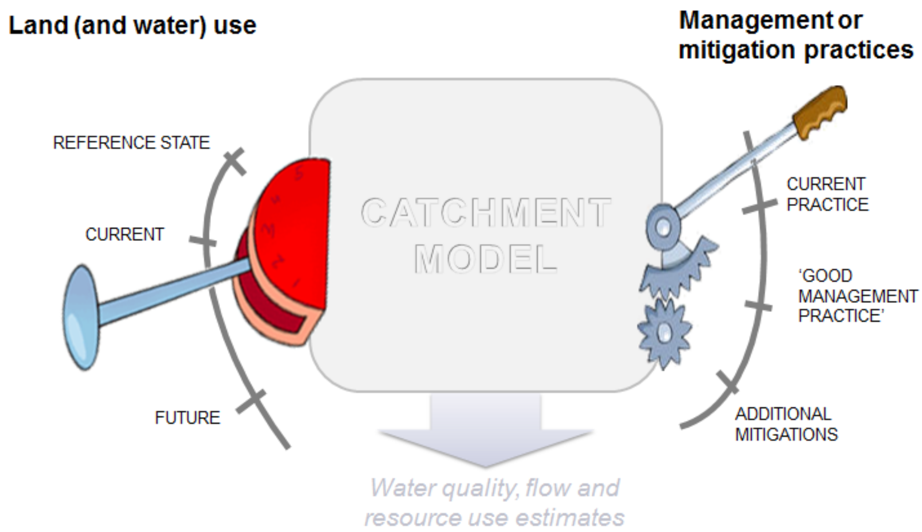


Figure 2: Land and water use scenarios and management scenarios that will be developed and modelled in order to estimate contaminant sources and outcomes for water quality and flows

It should be noted that mitigation scenarios have been prepared with advice from PerrinAg Consultants and Landcare Research, with feedback from Freshwater Future Community Groups and industry organisations. See Appendix 3 for the comprehensive reports and documentation on that discussion.

What we are beginning to see

At the last forum meeting (March 2018) the team presented progress on:

- key contaminants (nitrogen, phosphorous, *E. Coli* and sediment)
- the approach to setting environmental flows
- developing mitigation scenarios including good management practice.

Broadly, and consistent with material the forum has previously seen, initial results suggest:

- In the Rangitāiki, like many other areas, water quality in the lower reaches is more impacted than the upper reaches. i.e. water quality starts of very high, then progressively worsens.
- Most of the Rangitāiki catchment is in the "A" band for national ecological and swimmability measures. By that measure, relative to many other areas in New Zealand, the Rangitāiki catchment has good water quality.
- The lower reaches of the Rangitāiki River are still "swimmable" and are in the "B" banded for *E. coli*.
- Relative to the other Water Management Area (ie, Kaituna-Pongakawa-Waitahanui), a large portion of nutrients in the Rangitāiki River appears to be derived from natural sources (we are currently checking this).

Groundwater

Rangitāiki groundwater is discussed in Appendix 5 '*Introduction to Groundwater Environmental Level Setting in Rangitāiki Catchment*'.

Our understanding of groundwater is evolving but for the Rangitāiki remains incomplete. Based on our limited understanding we will need to be cautious if revisiting the conservative Plan Change 9 groundwater limits. Further detail can be provided at the meeting.

Information coming up

Over the next two months, the team is expecting to receive further water quantity and quality modelling results and a “coastal receiving environment” report which explores the limits needed to achieve agreed estuary outcomes for the Maketū and Little Waihī estuaries.

5 Next steps

Further iwi and hapū engagement is getting underway. When science information, modelling projections and iwi and hapū values are confirmed, the next step will be to seek comments on management options, and more widely discuss how Plan Change 12 may begin to take shape. We intend to keep the forum abreast of this work.

6 Māori Implications

Iwi and hapū recognise the importance of fresh water in supporting a healthy ecosystem, which includes human health, and have a reciprocal obligation as Kaitiaki to protect freshwater quality. In setting the freshwater objectives and limits in the Rangitāiki, Kaituna and Pongakawa and Waitahanui, it is recognised that iwi and hapū have a kinship relationship with fresh water through shared whakapapa.

Addressing tangata whenua values and interests across freshwater well-being, and including iwi and hapū in the overall management of fresh water, are key to giving effect to the Treaty of Waitangi.

James Low
Water Policy Team Leader

Nicki Green
Senior Planner (Water Policy)

Michelle Lee
Planner (Water Policy)

for Water Policy Manager

31 May 2018

APPENDIX 1

Draft narrative measurable objective for in-river values close alignment with Te Ara Whanui o Rangitaiki objectives

Appendix

Draft measurable freshwater objectives for in river values: Te Ara Whānui o Rangitāiki, Regional Policy Statement proposed Change 3: Rangitāiki, and Rangitāiki Freshwater Futures Community Group narrative objectives for in-river values, showing close alignment

In-river values	**Te Ara Whānui o Rangitāiki Pathways of the Rangitāiki –** River Document	**Proposed RPS Change 3**	**Working draft narrative objectives for in-river values *prepared by* Rangitāiki Freshwater Futures Community Group.** *Note: Final wording of any narrative objectives to be included in Plan Change 12 will be developed by Council in full consideration of RMA requirements.*		
			Lower	**Mid-Upper**	**Urewera/Whirinaki**
Ecosystem Health Indigenous species – particularly Tuna Mahinga kai	Tuna within the Rangitāiki catchment are protected, through measures including enhancement and restoration of their habitat and migration paths (O1) The habitats that support indigenous species and links between ecosystems within the Rangitāiki catchment are created, protected, and enhanced (O2)	The habitat and migration paths of tuna are restored and enhanced in the Rangitāiki River catchment (O32, subject to appeal) The habitats that support indigenous species and linkages between ecosystems within the Rangitāiki River catchment are created, enhanced where degraded, and protected where significant (O33) … sustains customary food sources	Water quality and quantity provides for: • ecosystem health for significant indigenous species; and • mahinga kai and species that are important for fishing which are safe to eat[2].		
Wetlands and their functions			Wetlands will be restored and enhanced to improve their intrinsic value and functions		
Drinking water supply		… provides for safe drinking water sources, where the water is used for that purpose (Policy RR 3B – subject to appeal)			
Contact recreation, particularly swimming		… safe for contact recreation (Policy RR 3B)	Water quality, quantity and levels will be suitable for swimming.	Water quality will be improved to be suitable for swimming[3].	Water quality *continues* to be suitable for swimming.
Water quality (generally)	Water quality is restored in the Rangitāiki catchment (O3)	Water quality in the Rangitāiki River catchment is maintained and improved where degraded (O34)	Current water quality is maintained *or* improved in every surface waterway.		
Mauri Natural form and character Amenity	Naturalness of the river and the landscape of the Rangitāiki catchment is respected (O7)	The qualities and characteristics of areas and features that contribute to the amenity values and quality of the Rangitāiki River catchment environment are maintained and enhanced where degraded (O38)	The enhancement of the form, natural character and mauri of rivers and streams will be a priority.	The improvement of the form, natural character and amenity value, and mauri of rivers and streams will be a priority.	The maintenance of the form, character and mauri of rivers and streams will be a priority.
Wai tapu Sites of cultural significance		… suitable for cultural ceremonies(Policy RR 3B)	Water quality and quantity will provide for wai tapu, sites of cultural significance and customary activities.		
Access / Tauranga Waka	Access to the Rangitāiki and its tributaries is maintained and enhanced (O8)	Access to the Rangitāiki River and its tributaries is maintained and enhanced (O39)	Water quality and quantity will provide for safe passage and accessibility for water craft/waka		

[2] Plan change 12 project will set water quality objectives for safe collection. Ensuring mahinga kai is safe to eat requires application of Food Safety Standards that are not within Council's functions.

[3] Monitoring at two sites in this FMU show water quality is currently safe for swimming.

APPENDIX 2

Engagement approach (phase 3) with Iwi and Hapu

Appendix

Engagement approach (*Phase 3*)

How we work together

The Freshwater Futures programme aims to deliver maintaining or improving quality and quantity of the region's fresh water. The Rangitāiki River Forum plays a key role in the NPS-FM process.

Figure 1 shows the proposed engagement approach. It shows Community Groups and tangata whenua provide their views, ideas and feedback on certain topics, which are then reported to the Forums (Co-Governance) and the Council. Council receives advice from the Forum and regional advisory groups, and then makes decisions to inform the changes to the Regional Natural Resources Plan.

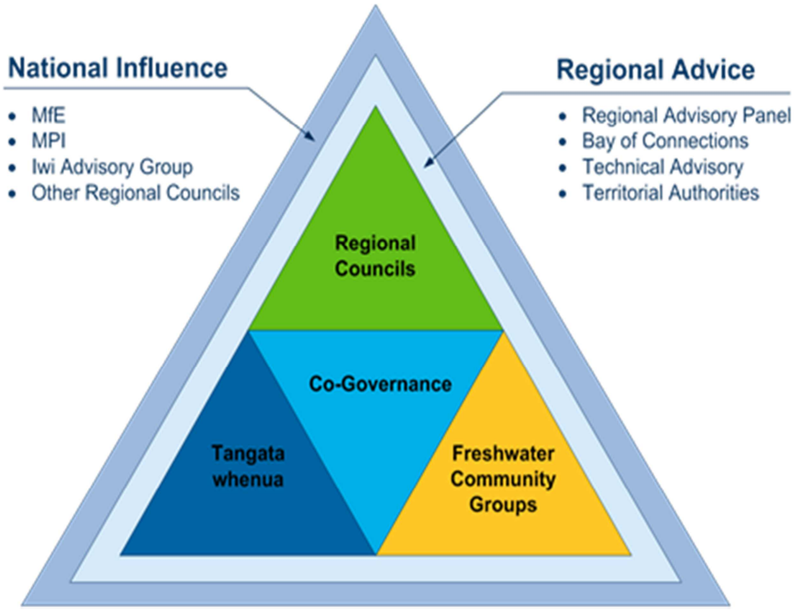


Figure 1 – Freshwater Future programme engagement approach.

Note that Plan Change 12 is still currently in the pre-draft stage. The inputs from tangata whenua and the Community Groups will shape the policy/rule content.

Who do we target in Rangitāiki

Many[1] iwi and hapū *rohe* or *areas of interest* overlap within and beyond the Rangitāiki catchment. These iwi include: Ngāti Whare, Ngāti Manawa, Ngāi Tūhoe, Ngāti Awa, Ngāti Tūwharetoa BOP, Ngāti Hineuru, Ngāti Tūwharetoa, Ngāti Rangitihi, Ngāti Mākino, Raukawa, Ngāti Tahu - Ngāti Whaoa, and Tūhourangi. There are also a large number of Māori Land Trusts and Maori organisations in these areas.

[1] According to the map records that are currently available, 21 iwi have interests in parts of Rangitāiki and Kaituna-Pongakawa-Waitahanui WMAs and 98 associated hapū.

The group the team to engagement first are:

- Iwi authorities – in their own right and to seek direction in relation to key hapū and land trusts
- Organisations who have expressed tangata whenua interests and/or concerns in recent submissions on Council plans.

Engagement methods

Engagement will acknowledge previous conversations on freshwater values and concerns raised in the past, and seek confirmation and (or additions) to that information.

Various engagement options are available. For the nature of the content, it could be considered most effective to have small focused group discussion. The current options include (but not limited to):

- Kanohi-ki-te-kanohi, kōrero and draw on a map
- Use on-line interactive maps, people can enter information in their own time/place
- Correspondence via post/email the collated material
- Use Skype, FaceTime, phone to discuss with our policy team members
- Workshop or a drop-in session to discuss and work through the content.

Timing

This engagement phase is approximately last for three months before leading into the next solution building phase. Wider consultation is envisaged for the upcoming summer when the draft solutions had been developed and ready to be shared for wider feedback.

The team also seek guidance on how tangata whenua would like to be involved in the next solution-building phase (phase 4).

The wider engagement

The team will also seeking comments from other groups over the next three months. The focus will be on testing ideas and understanding the potential implications of various policy directions.

APPENDIX 3

Rangitaiki Freshwater Community Group Workshop 7 papers

Rangitāiki Freshwater Futures Community Group Workshop Agenda

Tuesday 3 April 2018

Co-Chairs:	**Larry Wetting / Alamoti Te Pou**
Members:	**Alan Law, Atamira Nuku, Beverly Hughes, Bill Kerrison, Councillor Bill Clark, Cathy Brown, Christina Bunny, Colin Maunder, Craig Rowe, Daryl Christie, Earl Rewi, Gareth Boyt, George Johnston, James Doherty, John Gibson, Kerry Snowdon, Kirsty Joynt, Linda Conning, Mark Ross, Matt Gow, Matt Osborne, Ngapera Rangiaho, Nick Doney, Nicholas Woodley, Robert Pouwhare, Steve Brightwell, Tom Lynch, Wetini Paul**
BOPRC Staff:	**Simon Stokes (Relationship Manager), James Dare (Science), Santiago Bermeo (Water Policy), Kerry Gosling (Facilitator), Stephanie MacDonald (Support Facilitator), Nicki Green (Water Policy), Andrew Millar (Water Policy)**
Administrator:	**Michelle Lee (Water Policy)**
Apologies:	
Venue:	**Galatea Hall**
Time:	**9.00am – 2.30pm**

8.30am	**Join us for a cup of tea catch up**
9.00am	**Welcome** **Purpose** **National and regional updates**
10.00am	**Morning Tea** **Mitigation bundles and costings** BOPRC has engaged Perrin Ag Consultants & Landcare Research to give us some advice on mitigation practices to be considered within our catchment model, building on previous feedback from the community group. Perrin Ag & Landcare will also be estimating the cost of implementing these mitigation practices. During this workshop we will be considering Perrin Ag & Landcare's recommended mitigation bundles and baseline profit estimates, against which costs will be estimated later on. A background report and workshop paper will be sent out separately, ahead of the workshop.

12.30pm	**Lunch**
1.00pm	**Plan Change 9 – Rangitāiki matters**

The purpose is to outline/clarify some issues and range of submitter points that were heard at the recent Plan Change 9: Water Quantity hearing and which are particularly relevant in the Upper Rangitāiki catchment – in particular, how unauthorised dairy shed wash down is to be managed. This issue cannot be resolved by the community group, but sound understanding is important as the group moves towards considering minimum flows and allocation limits. Presentation and handouts will be provided on the day. No briefing note.

Introduction to Environmental Flow Setting for rivers

In this session we will introduce key terms and concepts for minimum flow and allocation setting, and introduce the EFSAP tool and how it will be used. The purpose is to prepare the group for considering options for flow and allocation limits at the next meeting. Presentation and handouts will be provided on the day. No briefing note.

Introduction to groundwater environmental level setting

The purpose is to discuss options for setting groundwater quantity limits in the Rangitāiki Water Management area. The groundwater modelling work to inform setting groundwater quantity limits has commenced. However, the initial results will not be available until December 2018. More robust results with a greater level of confidence will not be available until sometime after that. Options and implications for setting limits prior to the completion of the groundwater modelling work will be discussed and preferred approach identified.

Next Steps

2.30pm	**Close**

WORKSHOP PAPER

To: **Rangitāiki Freshwater Futures Community Group**

From: Santiago Bermeo
Senior Planner (Water Policy)

Date: 27 March 2018

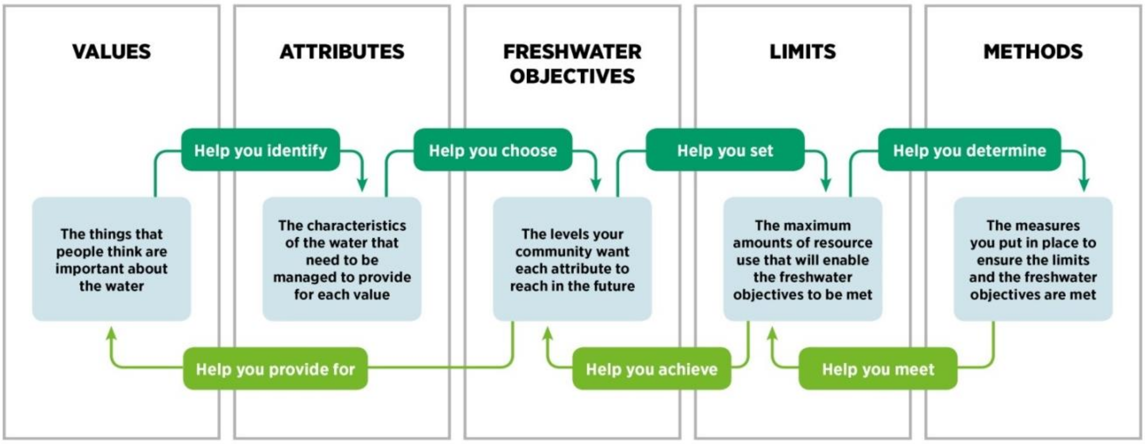
Subject: **Mitigation bundles and baseline profit estimations**

1 Purpose

The purpose of this paper is to introduce new material we will consider during Workshop 7 in relation to mitigation bundles and baseline profit estimations. It also summarises previous discussions and activities we have completed in earlier workshops in relation to this topic.

2 Mitigation practices are a method to achieve freshwater quality objectives

Mitigation practices are, in this case, farming and growing practices aimed at reducing contaminant loss from agricultural land use. Mitigation practices are some of the methods that would give effect to limits and freshwater objectives, as illustrated in the diagram below. Mitigation practices will be grouped into bundles, based on cost/ease of adoption and effectiveness. The impact of these mitigation bundles on contaminant loss and water quality outcomes will be tested through the bio-physical catchment model.



At this stage we are only exploring what mitigation practices would allow us to meet desired water quality objectives; these are not concrete options yet. Likewise, at this point we are not too worried about how these bundles of practices could eventually be implemented.[1]

[1] Eventually, it could be through regulation (e.g. Regional Plan provisions, consent conditions), industry self-regulation (e.g. supply agreements) or incentives. It may also be possible that some practices could be adopted in some parts of the catchment, or for some land uses, and not others.

Following this exploratory stage, we will revisit desired water quality objectives and the methods required to achieve them, in a solution-building stage.

3 What we have done previously

During Workshop 5 we carried out a brief brainstorming session of all methods that could reduce contaminant loss. During Workshop 6 we started narrowing down the longlist of methods identified and classifying them into “Good Management Practices” (i.e. standard expected practice from environmentally responsible water and land users) and additional mitigations (i.e. practices that go beyond standard expected practice). Because not all community group members had an opportunity to consider the full longlist of practices during Workshop 6, we also carried out an online survey at the end of 2017 to get additional feedback. Some useful feedback was gathered and we thank the members that responded. Please find attached as Appendix 1 a summary of responses to the online survey.

4 Advice on mitigation bundles, baseline profits and cost estimation

We have engaged Perrin Ag Consultants and Landcare Research to give us some advice on the make-up of mitigation bundles. Perrin Ag Consultants and Landcare Research will also be estimating the cost of implementing these bundles (in terms of reduction in farm/orchard profit).

We expect that once we have results from the bio-physical catchment model (in terms of water quality outcomes under different scenarios) and outputs from the Perrin Ag/Landcare Research mitigation economic analysis, the community group would be in a good position to revisit desired water quality outcomes and methods to achieve them, reflecting on the freshwater values identified earlier in the process.

Attached as Appendices 2 and 3 are reports from Perrin Ag/Landcare Research on suggested mitigation bundles and baseline farm/orchard profit estimations, against which mitigation costs will be estimated. The full reports are provided for members that would like to dive into the detail but the key sections to consider are Tables 2 to 4 (pp. 18 – 20 in Appendix 2) and the estimated baseline profit figures in Appendix 3.

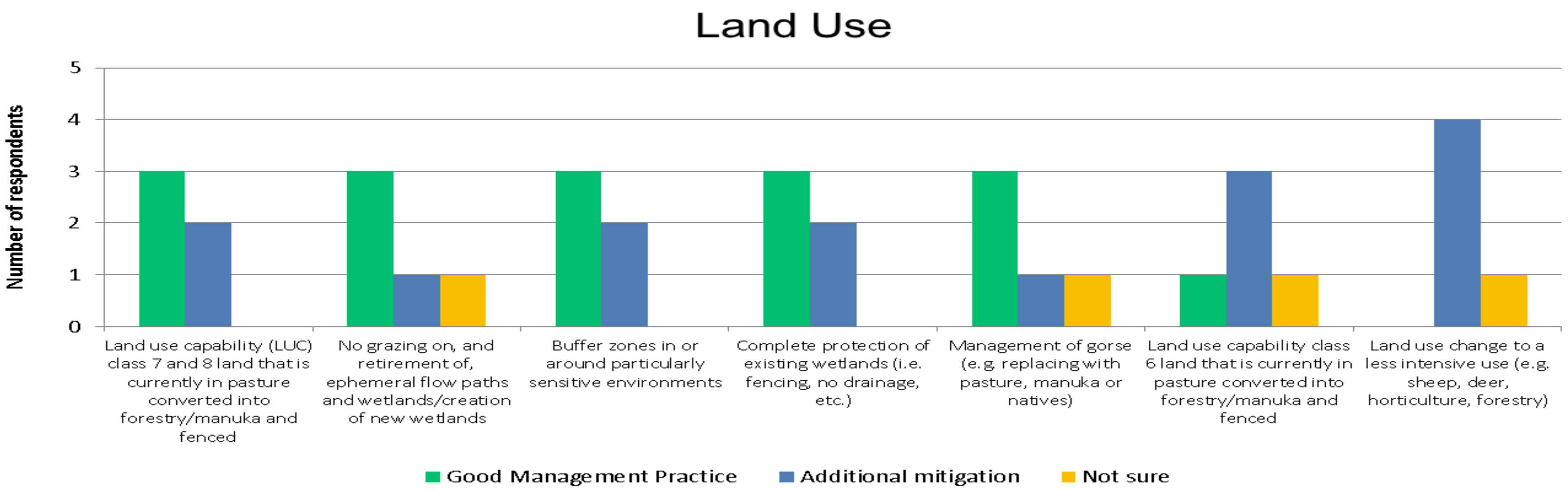
5 Feedback we would like from you

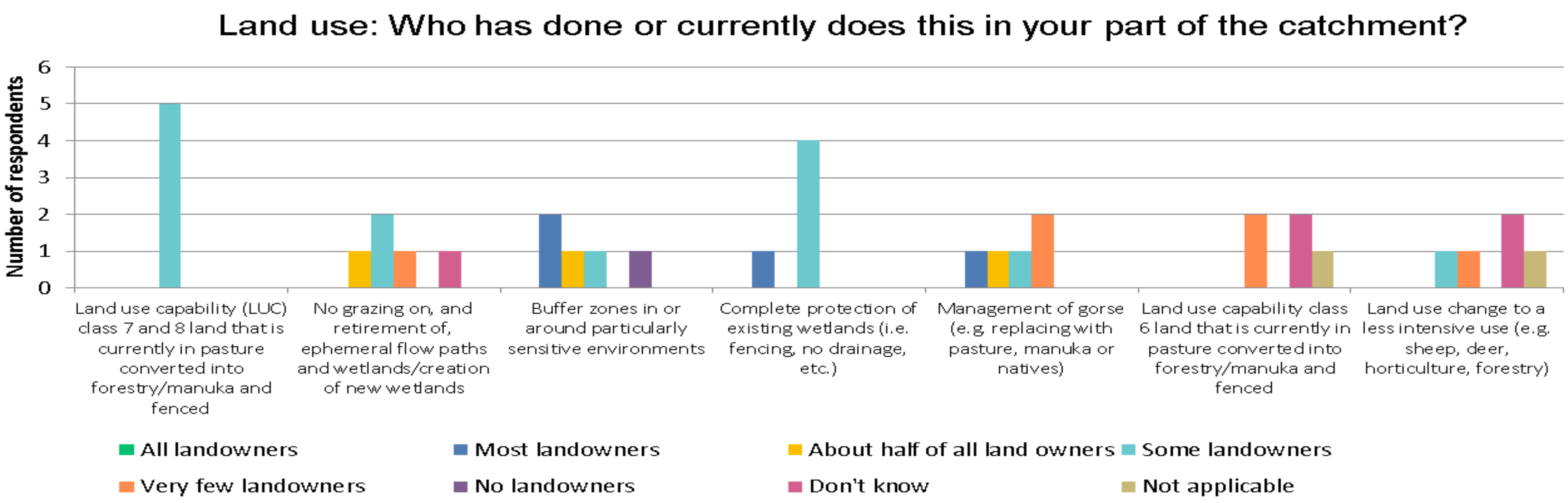
Feedback that we would like from you during Workshop 7 includes:

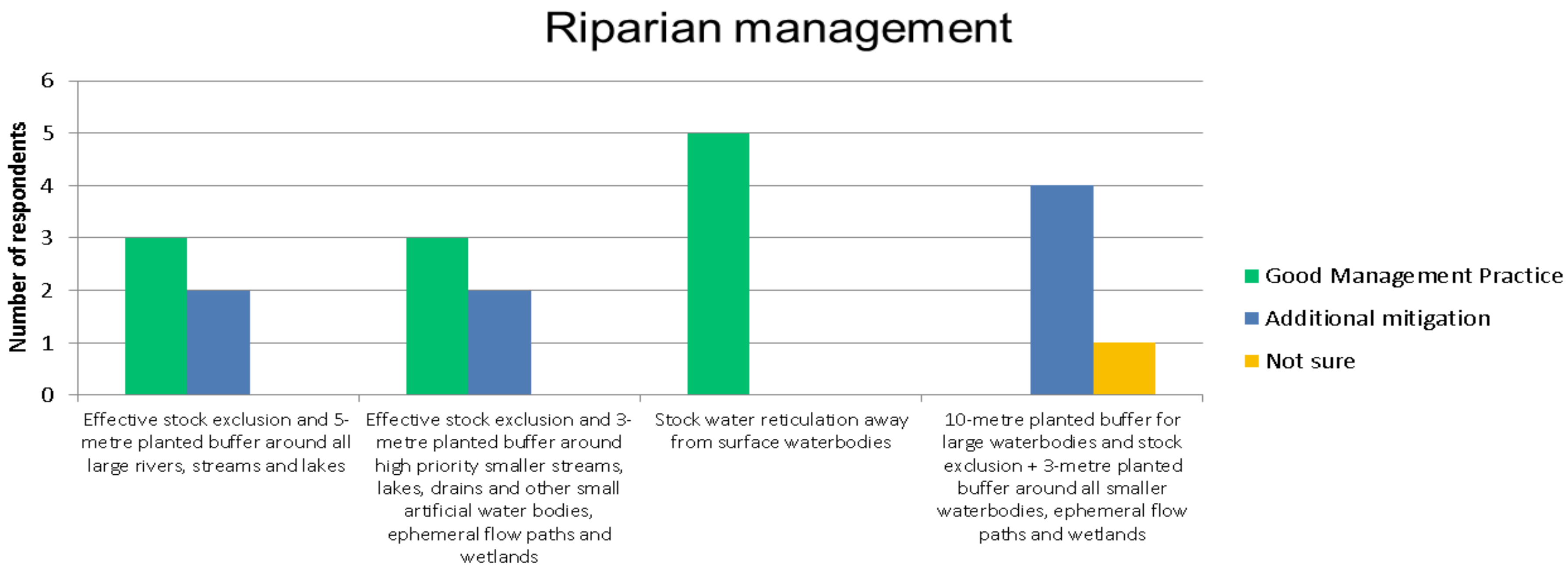
- Do the proposed mitigation bundles seem OK to you?
- Are the proposed increases in riparian fencing/buffering/planting practices reasonable and realistic?
- Is there anything from the original longlist that is no longer included that you think should still be included?
- Anything included in the bundles that you think should not be?
- Would you make any changes to the bundle make up?
- What are the current levels of implementation of all these practices?
- Are the baseline profit estimates within the ballpark of what you expected?

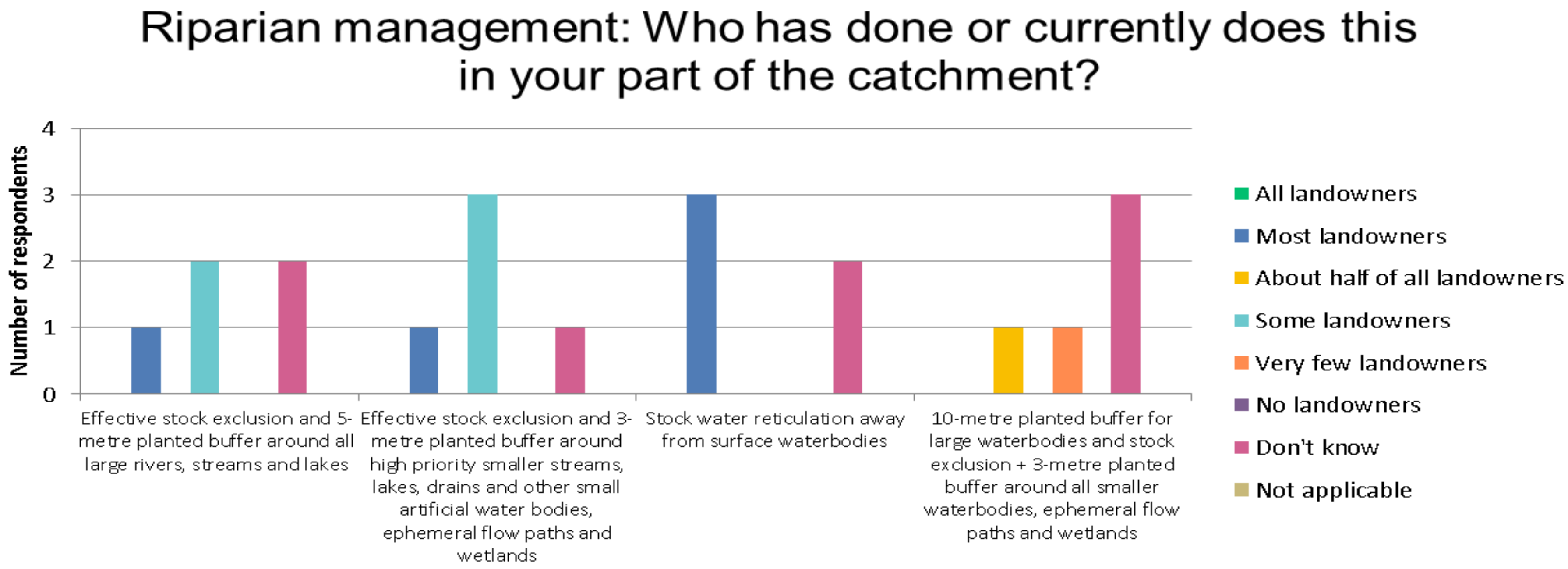
Appendix 1 – Summary of results from community group survey on methods to achieve water quality objectives

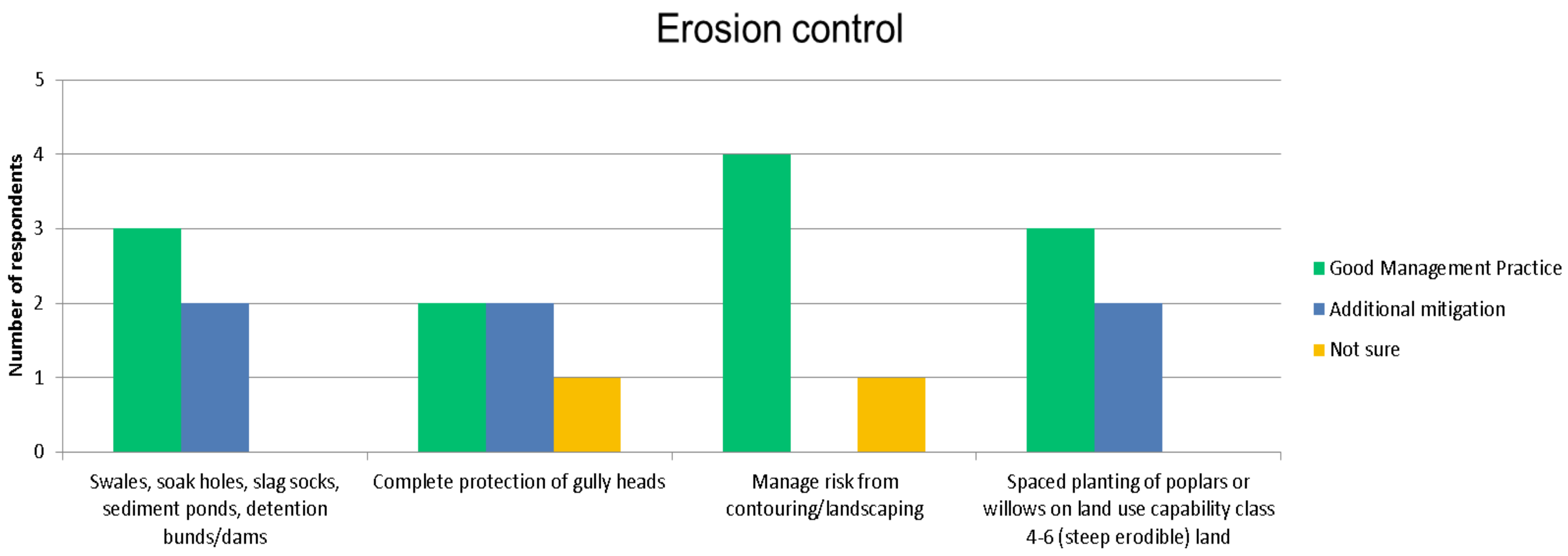
Total responses: 11 (5 from Lower Rangitāiki, 6 from Mid-Upper Rangitāiki)

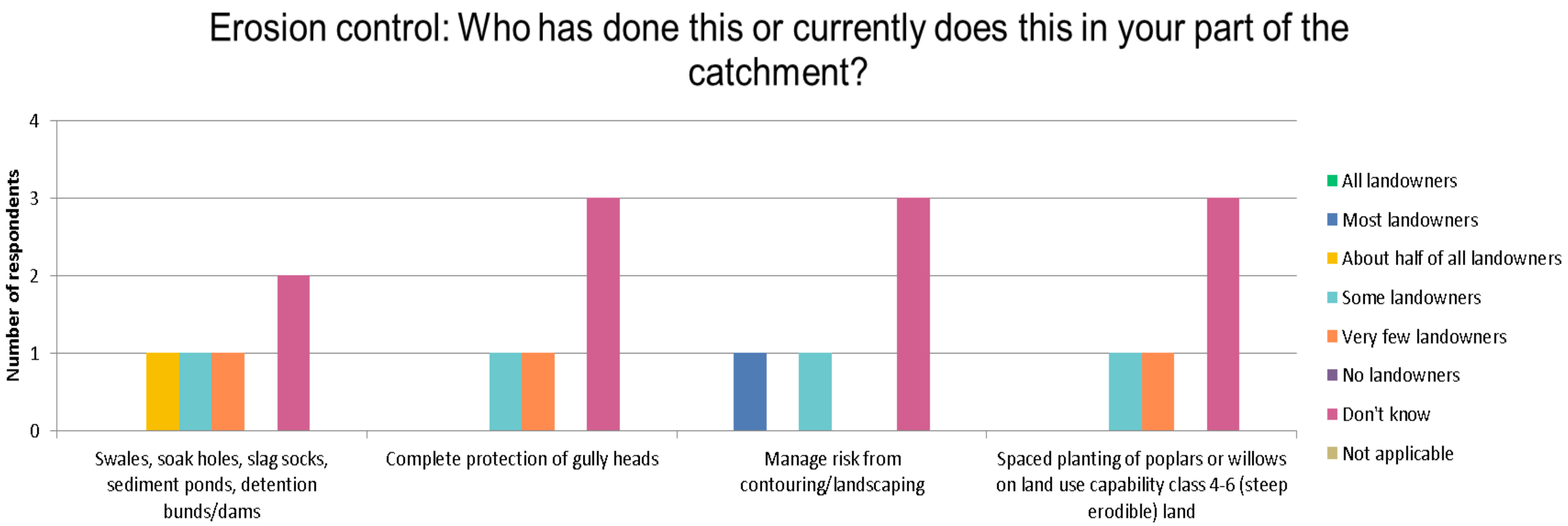


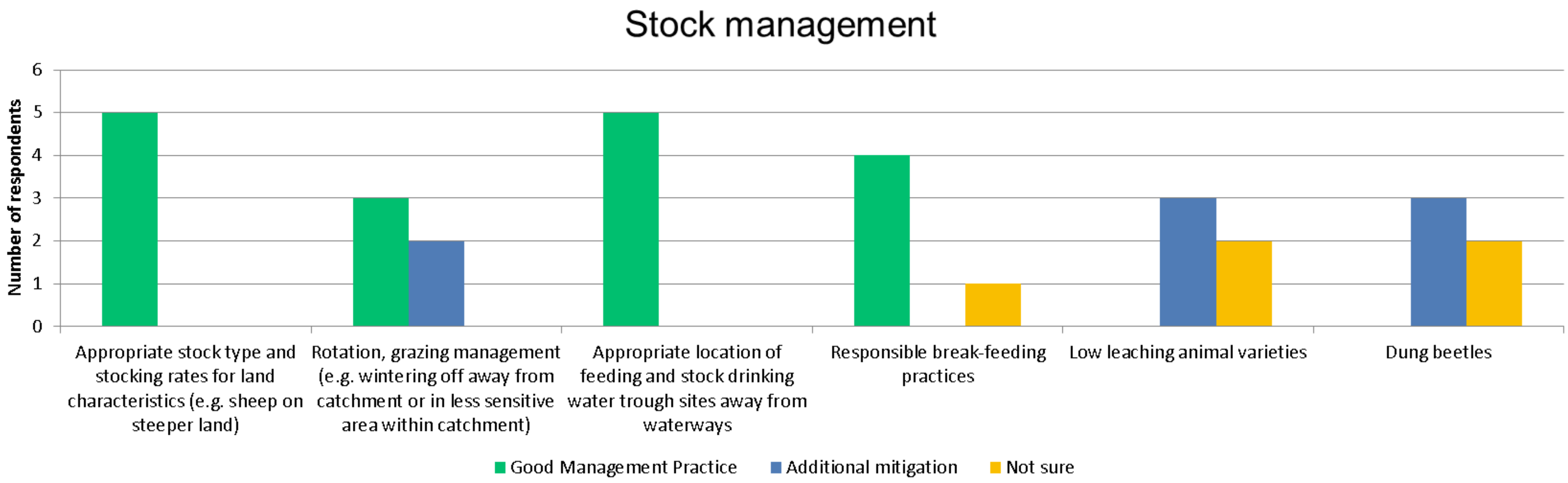


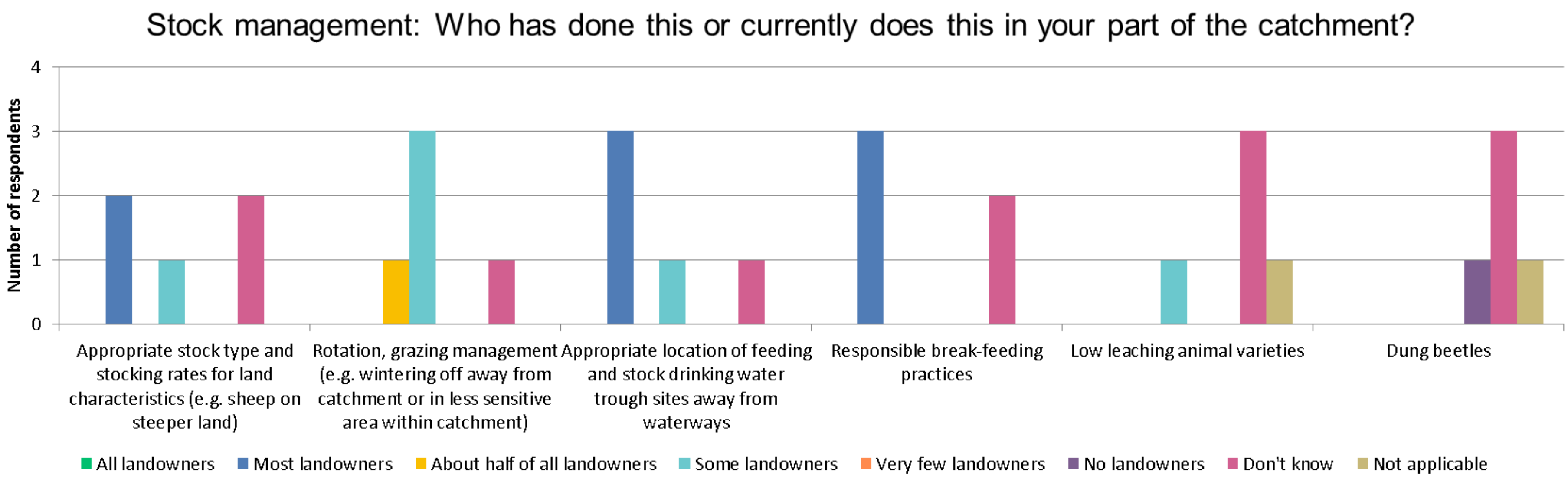

Riparian management
Number of respondents
0
1
2
3
4
5
6
Effective stock exclusion and 5-metre planted buffer around all large rivers, streams and lakes
Effective stock exclusion and 3-metre planted buffer around high priority smaller streams, lakes, drains and other small artificial water bodies, ephemeral flow paths and wetlands
Stock water reticulation away from surface waterbodies
10-metre planted buffer for large waterbodies and stock exclusion + 3-metre planted buffer around all smaller waterbodies, ephemeral flow paths and wetlands
Good Management Practice
Additional mitigation
Not sure

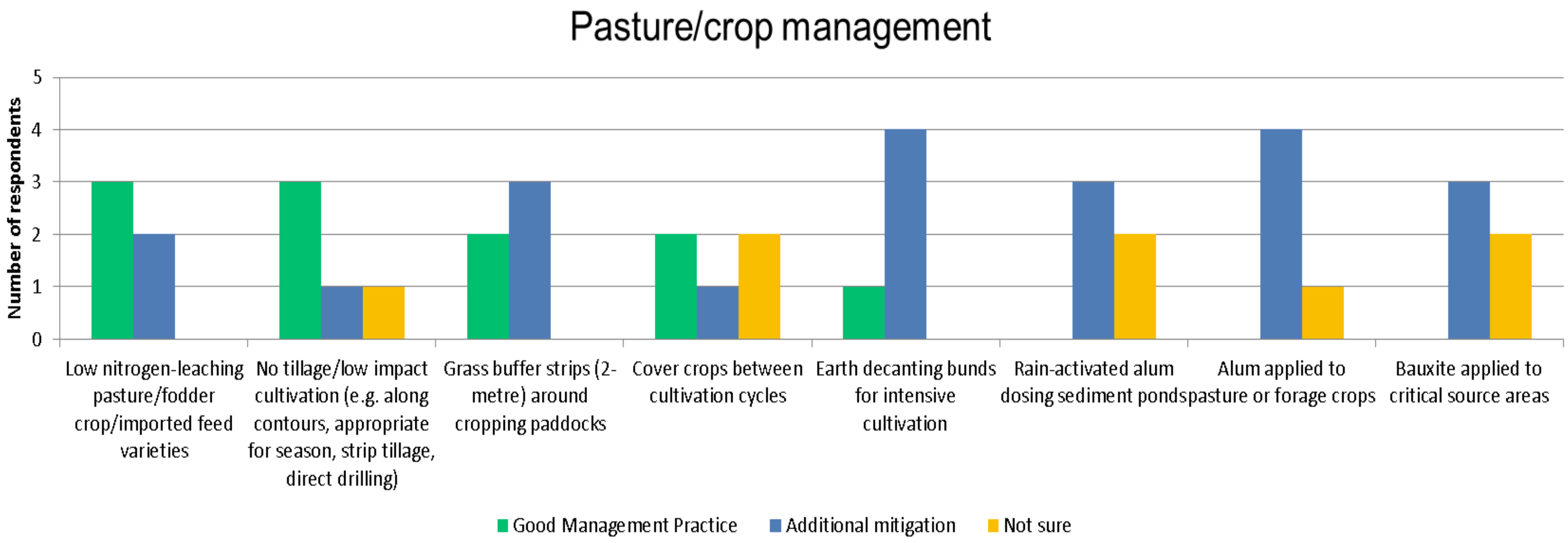

Riparian management: Who has done or currently does this in your part of the catchment?
Number of respondents
0
1
2
3
4
Effective stock exclusion and 5-metre planted buffer around all large rivers, streams and lakes
Effective stock exclusion and 3-metre planted buffer around high priority smaller streams, lakes, drains and other small artificial water bodies, ephemeral flow paths and wetlands
Stock water reticulation away from surface waterbodies
10-metre planted buffer for large waterbodies and stock exclusion + 3-metre planted buffer around all smaller waterbodies, ephemeral flow paths and wetlands
All landowners
Most landowners
About half of all landowners
Some landowners
Very few landowners
No landowners
Don't know
Not applicable

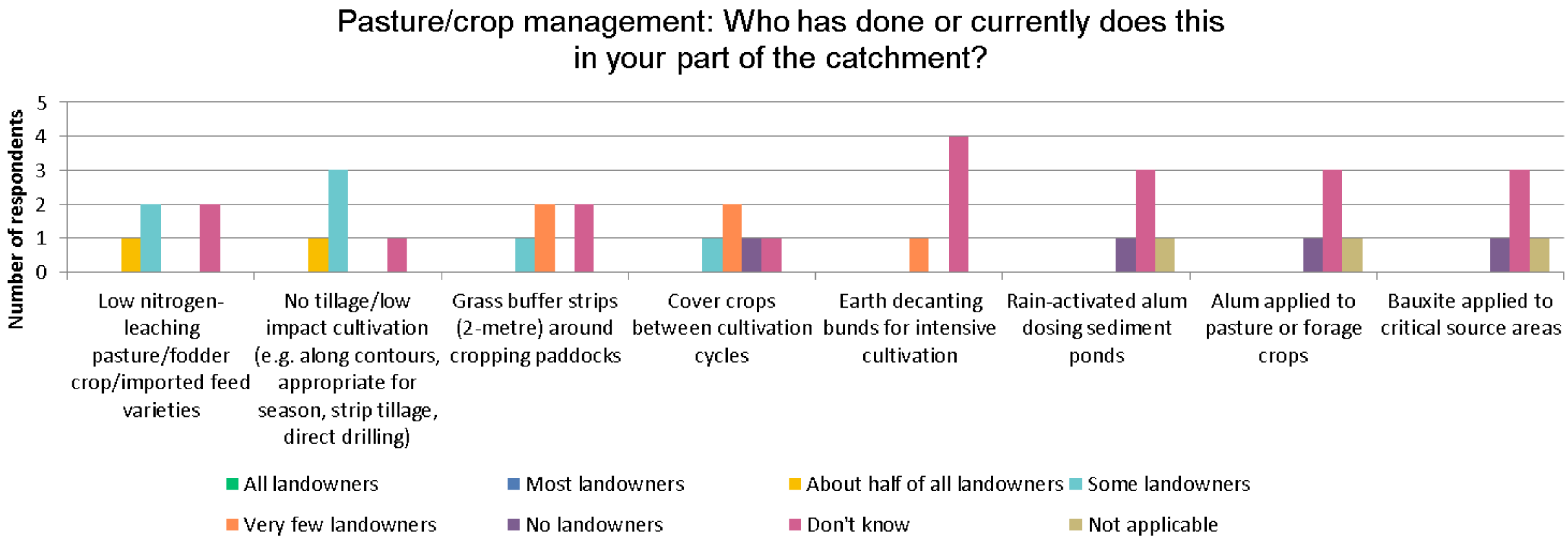

Erosion control
Number of respondents
5
4
3
2
1
0
Swales, soak holes, slag socks, sediment ponds, detention bunds/dams
Complete protection of gully heads
Manage risk from contouring/landscaping
Spaced planting of poplars or willows on land use capability class 4-6 (steep erodible) land
Good Management Practice
Additional mitigation
Not sure


Erosion control: Who has done this or currently does this in your part of the catchment?
Number of respondents
4
3
2
1
0
Swales, soak holes, slag socks, sediment ponds, detention bunds/dams
Complete protection of gully heads
Manage risk from contouring/landscaping
Spaced planting of poplars or willows on land use capability class 4-6 (steep erodible) land
All landowners
Most landowners
About half of all landowners
Some landowners
Very few landowners
No landowners
Don't know
Not applicable


Stock management
Number of respondents
6
5
4
3
2
1
0
Appropriate stock type and stocking rates for land characteristics (e.g. sheep on steeper land)
Rotation, grazing management (e.g. wintering off away from catchment or in less sensitive area within catchment)
Appropriate location of feeding and stock drinking water trough sites away from waterways
Responsible break-feeding practices
Low leaching animal varieties
Dung beetles
Good Management Practice
Additional mitigation
Not sure


Stock management: Who has done this or currently does this in your part of the catchment?
Number of respondents
4
3
2
1
0
Appropriate stock type and stocking rates for land characteristics (e.g. sheep on steeper land)
Rotation, grazing management (e.g. wintering off away from catchment or in less sensitive area within catchment)
Appropriate location of feeding and stock drinking water trough sites away from waterways
Responsible break-feeding practices
Low leaching animal varieties
Dung beetles
All landowners
Most landowners
About half of all landowners
Some landowners
Very few landowners
No landowners
Don't know
Not applicable


Pasture/crop management
Number of respondents
0
1
2
3
4
5
Low nitrogen-leaching pasture/fodder crop/imported feed varieties
No tillage/low impact cultivation (e.g. along contours, appropriate for season, strip tillage, direct drilling)
Grass buffer strips (2-metre) around cropping paddocks
Cover crops between cultivation cycles
Earth decanting bunds for intensive cultivation
Rain-activated alum dosing sediment ponds
Alum applied to pasture or forage crops
Bauxite applied to critical source areas
Good Management Practice
Additional mitigation
Not sure


Pasture/crop management: Who has done or currently does this in your part of the catchment?
Number of respondents
0
1
2
3
4
5
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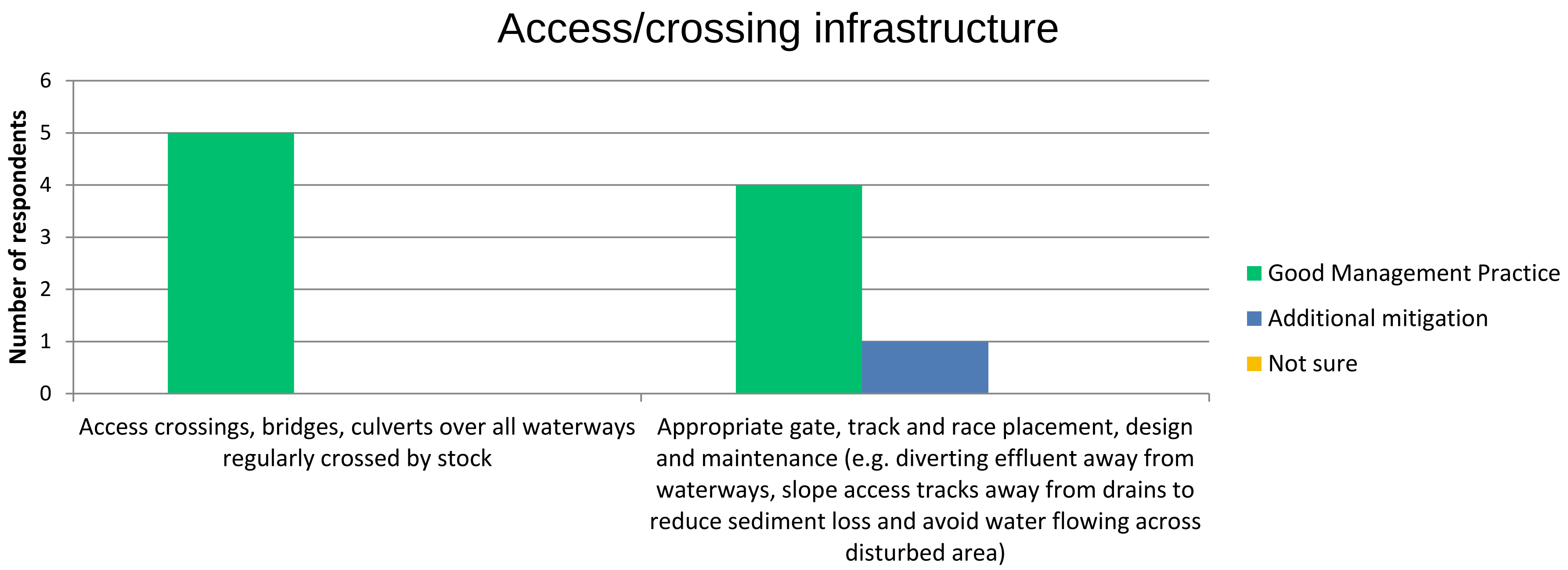
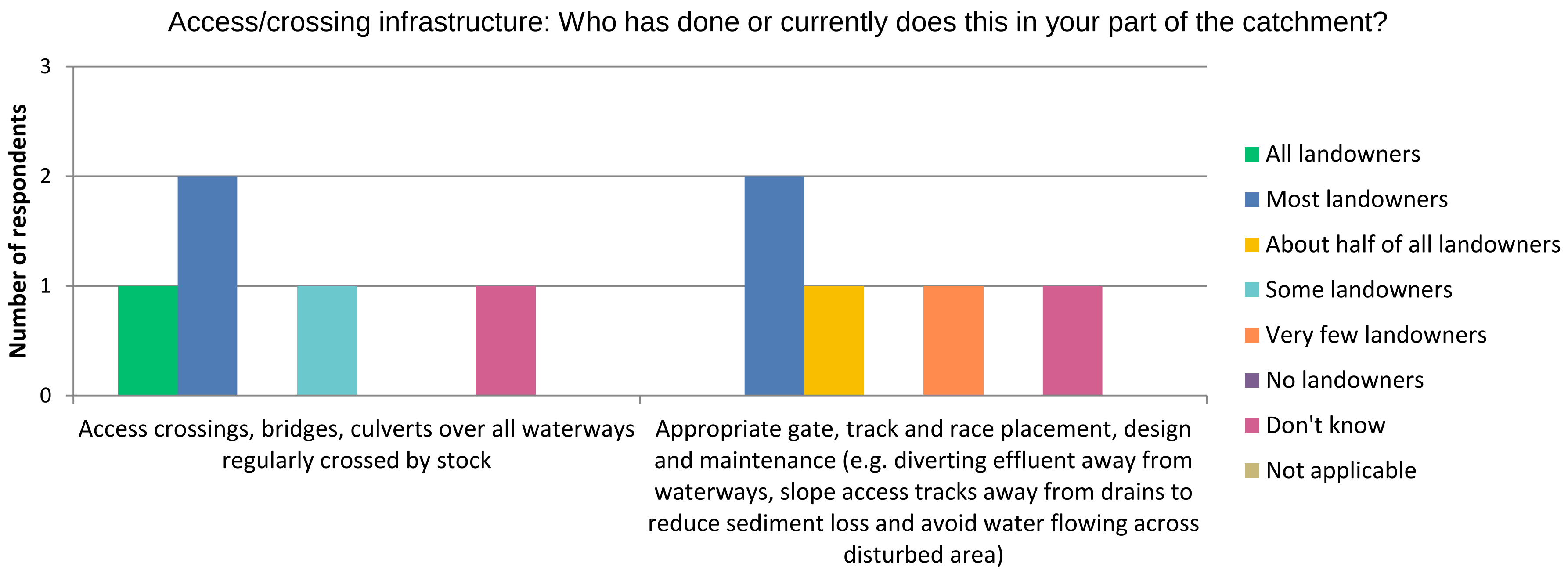
No tillage/low impact cultivation (e.g. along contours, appropriate for season, strip tillage, direct drilling)
Grass buffer strips (2-metre) around cropping paddocks
Cover crops between cultivation cycles
Earth decanting bunds for intensive cultivation
Rain-activated alum dosing sediment ponds
Alum applied to pasture or forage crops
Bauxite applied to critical source areas
All landowners
Most landowners
About half of all landowners
Some landowners
Very few landowners
No landowners
Don't know
Not applicable



Access/crossing infrastructure
Number of respondents
6
5
4
3
2
1
0
Good Management Practice
Additional mitigation
Not sure
Access crossings, bridges, culverts over all waterways regularly crossed by stock
Appropriate gate, track and race placement, design and maintenance (e.g. diverting effluent away from waterways, slope access tracks away from drains to reduce sediment loss and avoid water flowing across disturbed area)



Access/crossing infrastructure: Who has done or currently does this in your part of the catchment?
Number of respondents
3
2
1
0
All landowners
Most landowners
About half of all landowners
Some landowners
Very few landowners
No landowners
Don't know
Not applicable
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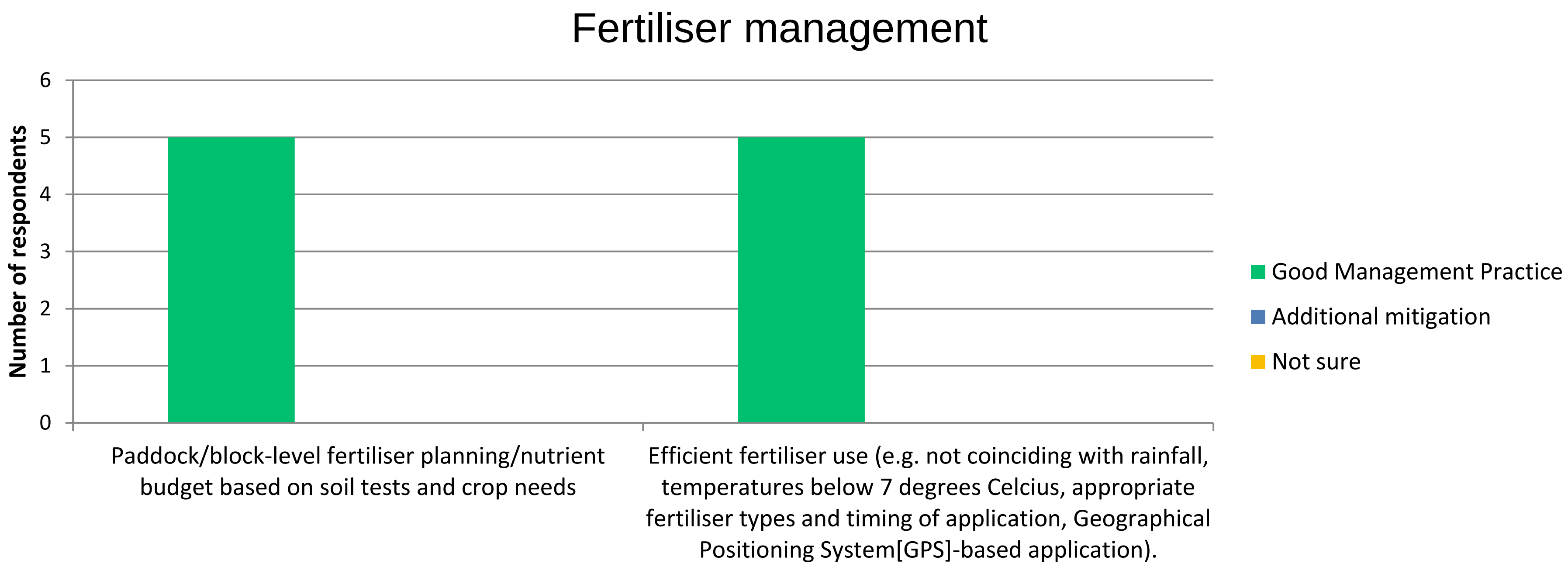
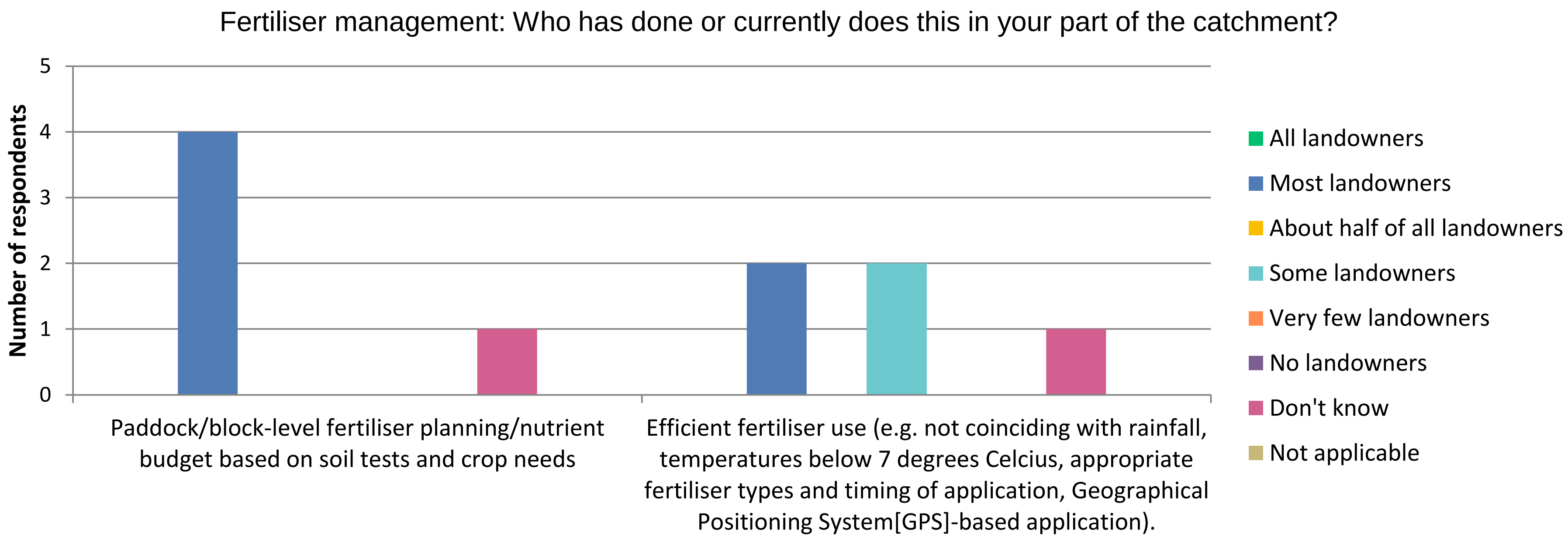
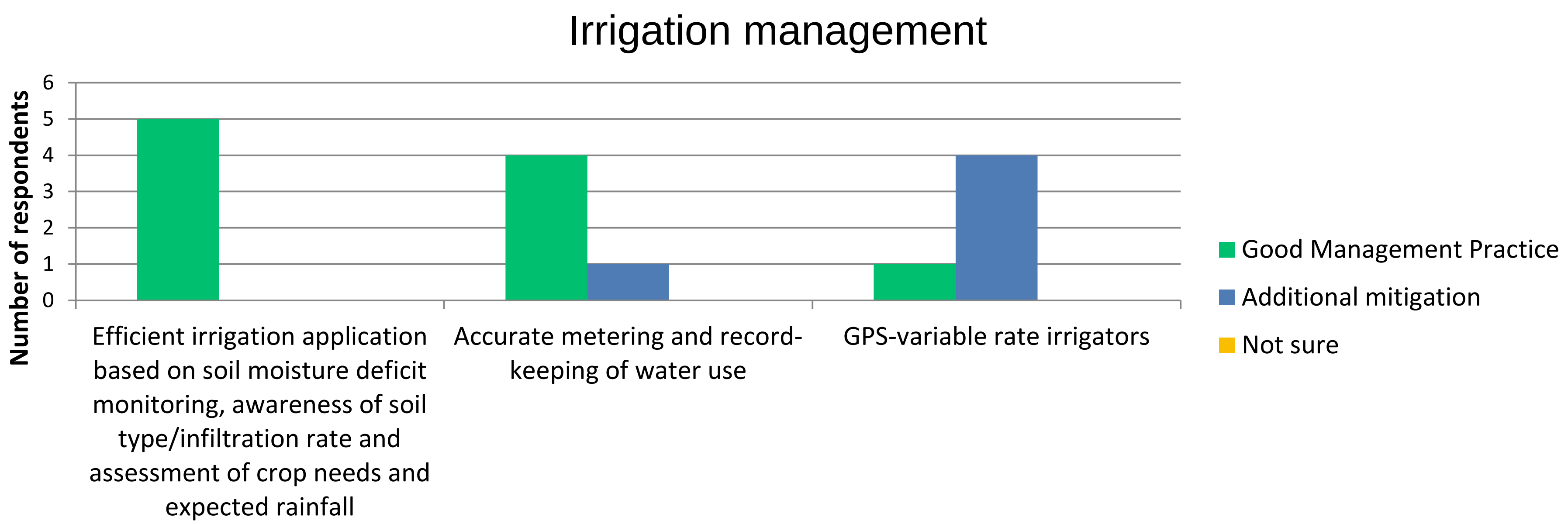
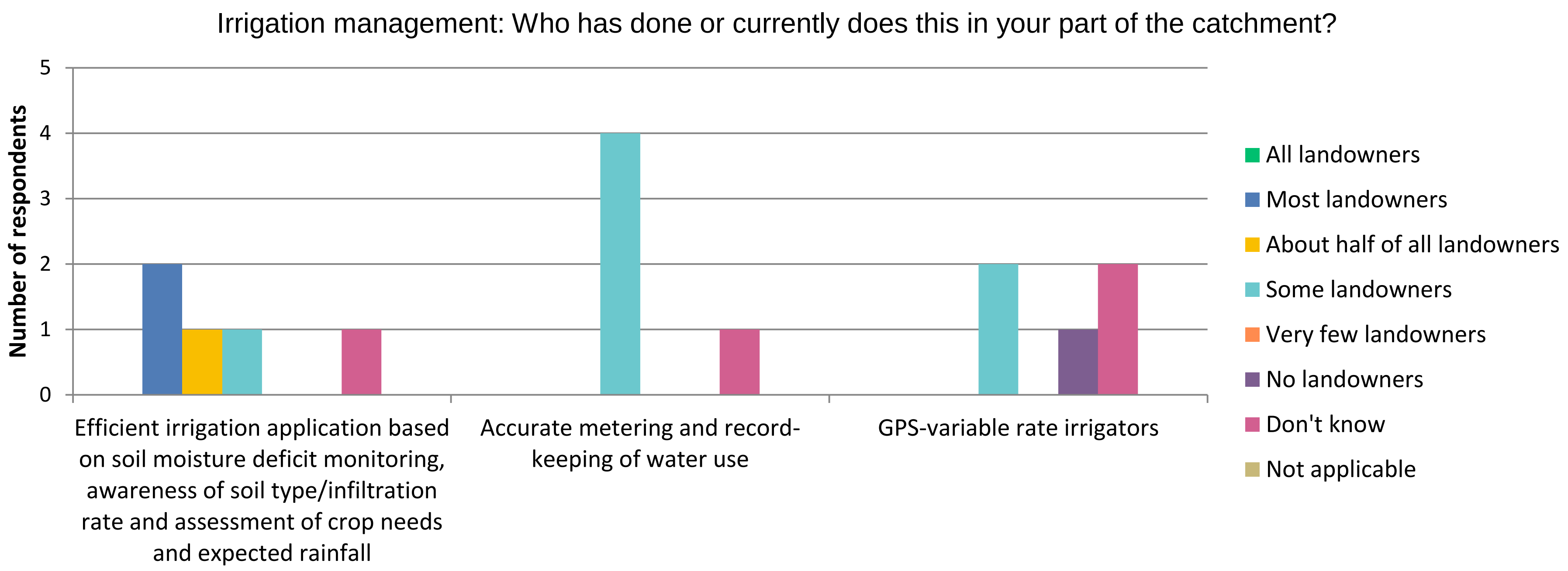
Appropriate gate, track and race placement, design and maintenance (e.g. diverting effluent away from waterways, slope access tracks away from drains to reduce sediment loss and avoid water flowing across disturbed area)


Fertiliser management
Number of respondents
0
1
2
3
4
5
6
Paddock/block-level fertiliser planning/nutrient budget based on soil tests and crop needs
Efficient fertiliser use (e.g. not coinciding with rainfall, temperatures below 7 degrees Celcius, appropriate fertiliser types and timing of application, Geographical Positioning System[GPS]-based application).
Good Management Practice
Additional mitigation
Not sure


Fertiliser management: Who has done or currently does this in your part of the catchment?
Number of respondents
0
1
2
3
4
5
Paddock/block-level fertiliser planning/nutrient budget based on soil tests and crop needs
Efficient fertiliser use (e.g. not coinciding with rainfall, temperatures below 7 degrees Celcius, appropriate fertiliser types and timing of application, Geographical Positioning System[GPS]-based application).
All landowners
Most landowners
About half of all landowners
Some landowners
Very few landowners
No landowners
Don't know
Not applicable


Irrigation management
Number of respondents
6
5
4
3
2
1
0
Efficient irrigation application based on soil moisture deficit monitoring, awareness of soil type/infiltration rate and assessment of crop needs and expected rainfall
Accurate metering and record-keeping of water use
GPS-variable rate irrigators
Good Management Practice
Additional mitigation
Not sure


Irrigation management: Who has done or currently does this in your part of the catchment?
Number of respondents
5
4
3
2
1
0
Efficient irrigation application based on soil moisture deficit monitoring, awareness of soil type/infiltration rate and assessment of crop needs and expected rainfall
Accurate metering and record-keeping of water use
GPS-variable rate irrigators
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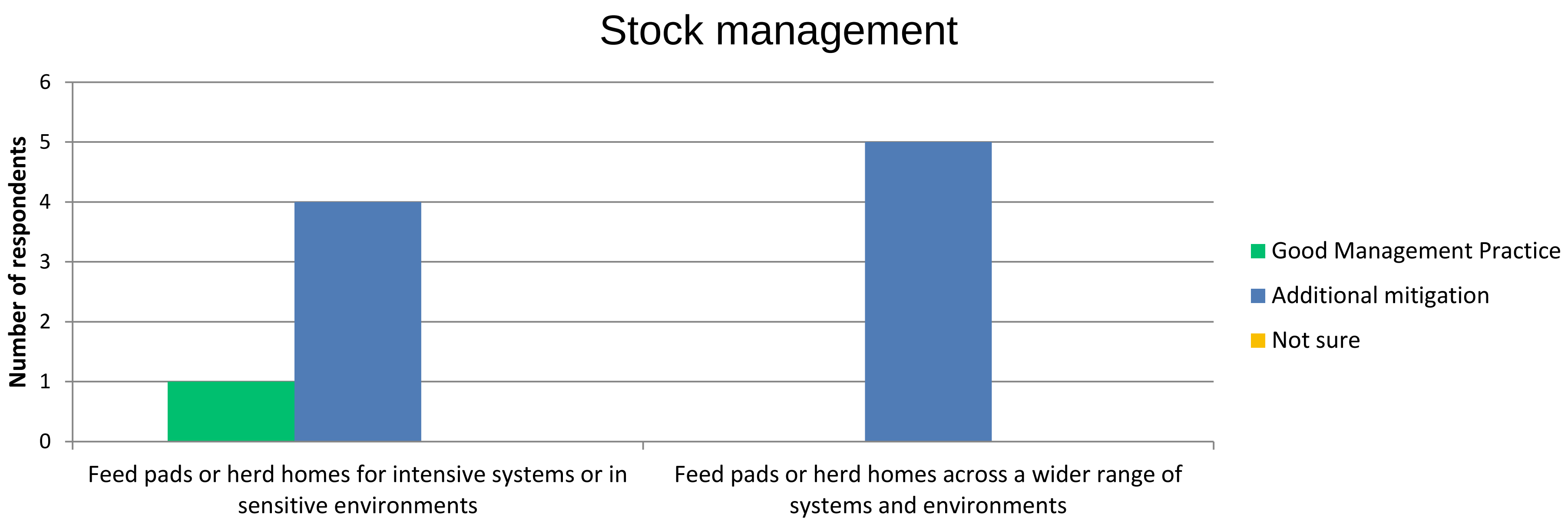
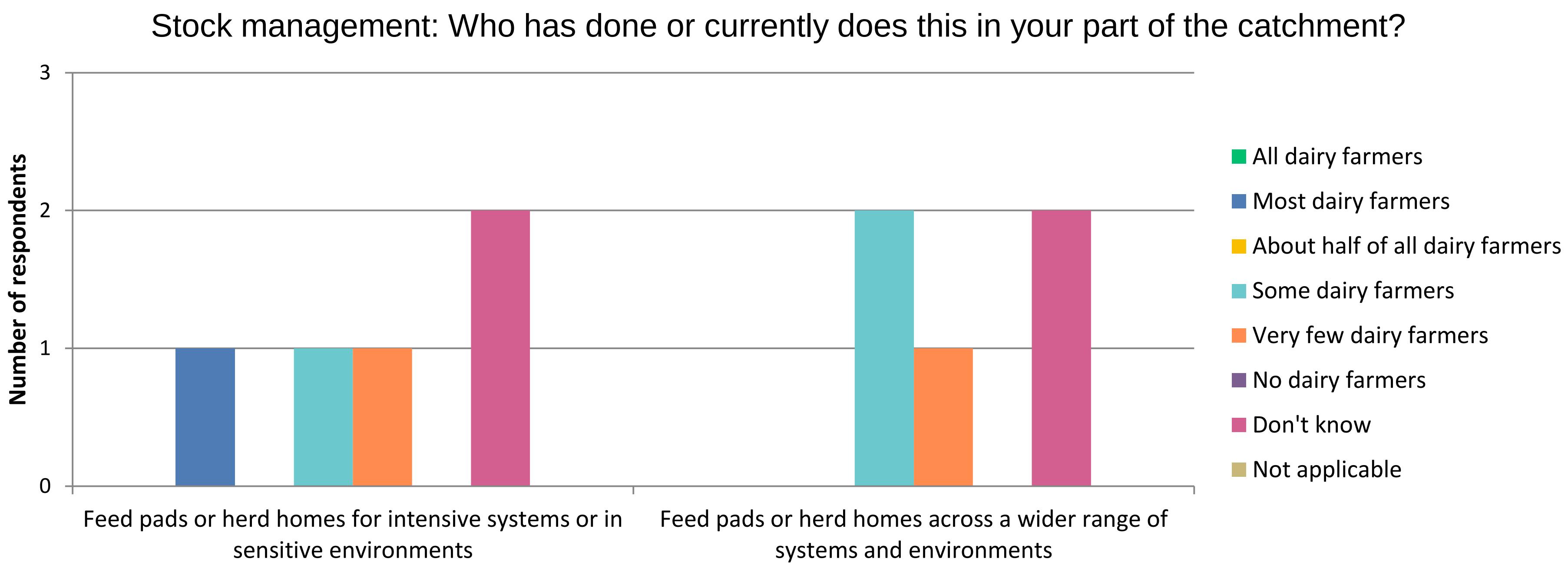
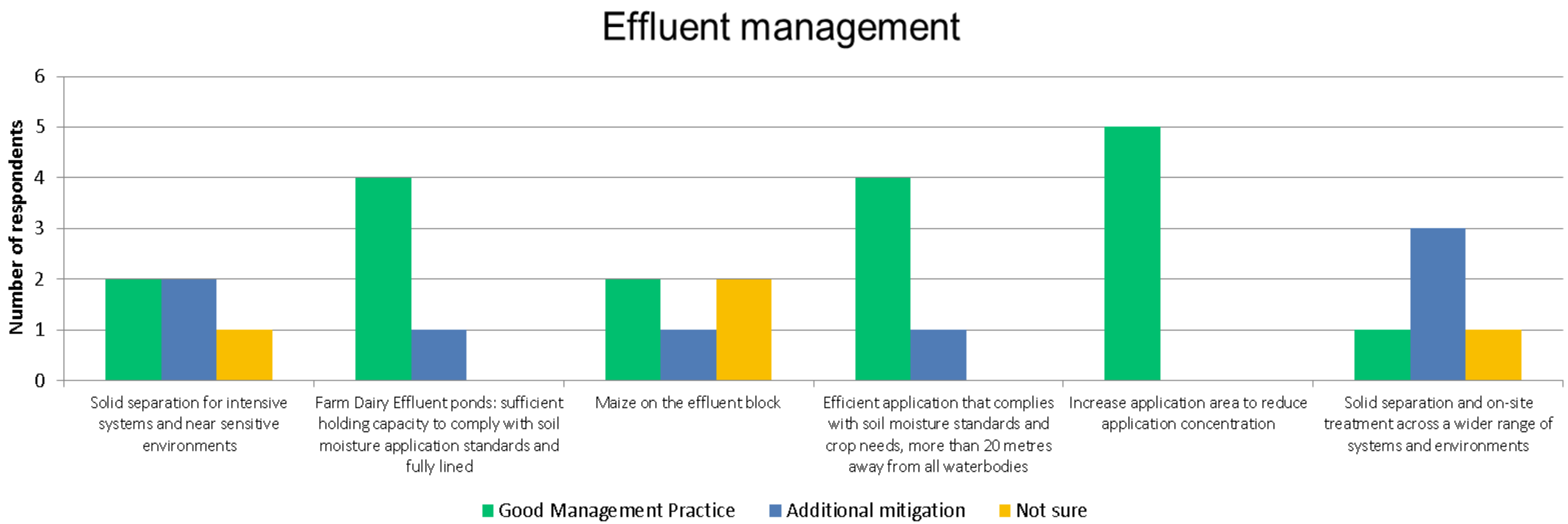
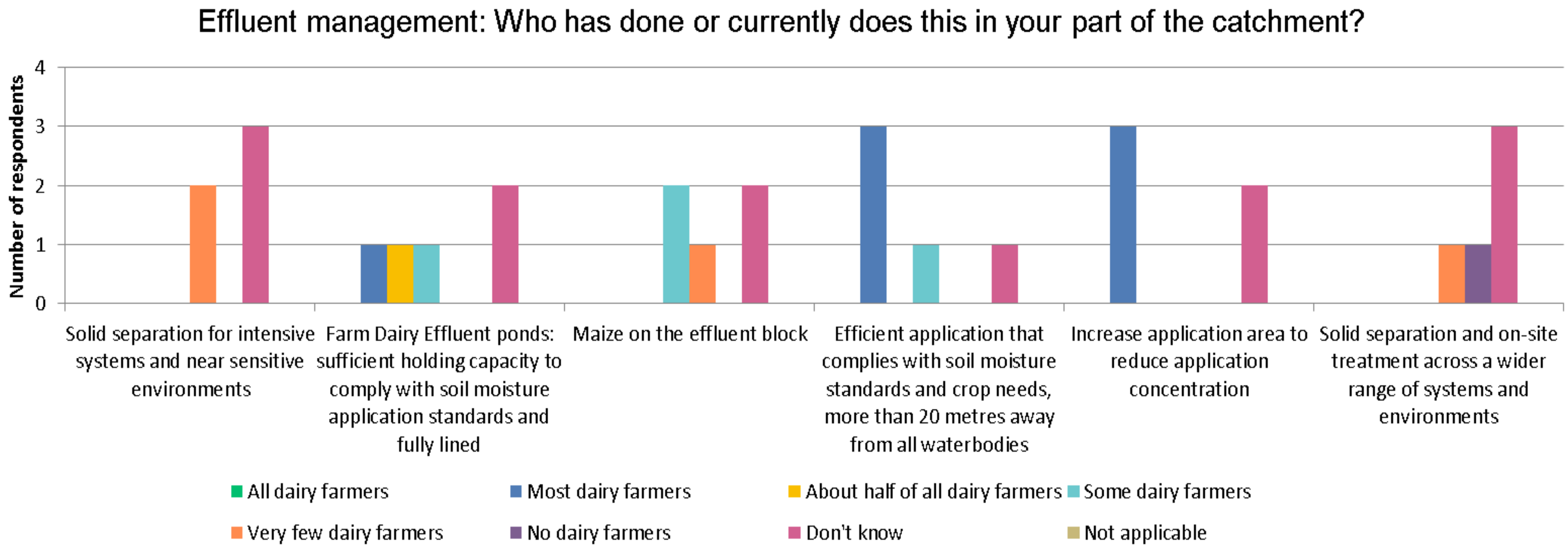
About half of all landowners
Some landowners
Very few landowners
No landowners
Don't know
Not applicable


Stock management
Number of respondents
6
5
4
3
2
1
0
Good Management Practice
Additional mitigation
Not sure
Feed pads or herd homes for intensive systems or in sensitive environments
Feed pads or herd homes across a wider range of systems and environments


Stock management: Who has done or currently does this in your part of the catchment?
Number of respondents
3
2
1
0
All dairy farmers
Most dairy farmers
About half of all dairy farmers
Some dairy farmers
Very few dairy farmers
No dairy farmers
Don't know
Not applicable
Feed pads or herd homes for intensive systems or in sensitive environments
Feed pads or herd homes across a wider range of systems and environments


Effluent management
Number of respondents
0
1
2
3
4
5
6
Solid separation for intensive systems and near sensitive environments
Farm Dairy Effluent ponds: sufficient holding capacity to comply with soil moisture application standards and fully lined
Maize on the effluent block
Efficient application that complies with soil moisture standards and crop needs, more than 20 metres away from all waterbodies
Increase application area to reduce application concentration
Solid separation and on-site treatment across a wider range of systems and environments
Good Management Practice
Additional mitigation
Not sure


Effluent management: Who has done or currently does this in your part of the catchment?
Number of respondents
0
1
2
3
4
Solid separation for intensive systems and near sensitive environments
Farm Dairy Effluent ponds: sufficient holding capacity to comply with soil moisture application standards and fully lined
Maize on the effluent block
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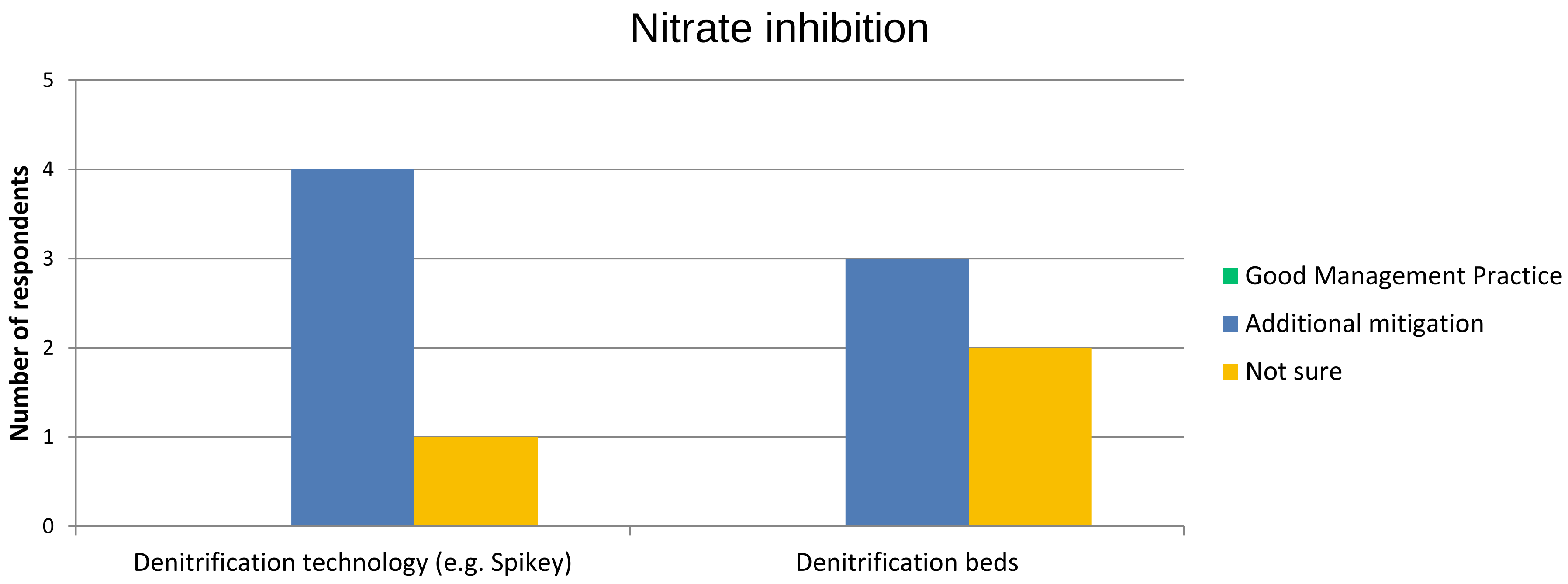
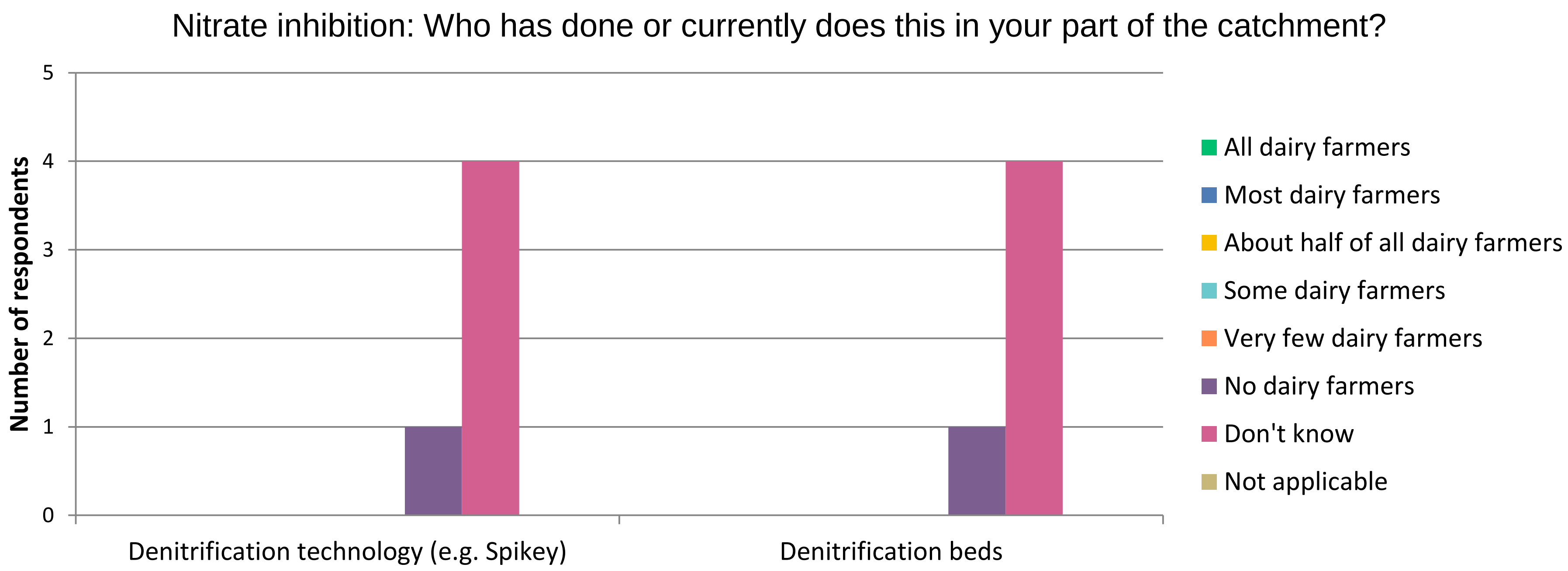
Solid separation and on-site treatment across a wider range of systems and environments
All dairy farmers
Most dairy farmers
About half of all dairy farmers
Some dairy farmers
Very few dairy farmers
No dairy farmers
Don't know
Not applicable


Nitrate inhibition
Number of respondents
5
4
3
2
1
0
Denitrification technology (e.g. Spikey)
Denitrification beds
Good Management Practice
Additional mitigation
Not sure


Nitrate inhibition: Who has done or currently does this in your part of the catchment?
Number of respondents
5
4
3
2
1
0
Denitrification technology (e.g. Spikey)
Denitrification beds
All dairy farmers
Most dairy farmers
About half of all dairy farmers
Some dairy farmers
Very few dairy farmers
No dairy farmers
Don't know
Not applicable

Section	Respondent comments
Land use	▪ Not sure what ephemeral flow paths are ***BOPRC comment: ephemeral flow paths are temporarily flowing streams (e.g. after heavy rainfall).***
Riparian management	▪ Buffer widths mentioned are minimalist - not sufficient. Dairy farms seem to fence right on the edge of the bank which doesn't allow for stream stabilisation. Stock exclusion and buffer is definitely good practice but planting is possibly additional mitigation ▪ Most water bodies have stock exclusion, but not necessarily a 3 metre buffer planted yet.
Stock management	▪ I know very little about farm practices, in particular current practice. ▪ Need discussion of effluent irrigation to land v pond treatment ▪ wintering off only moves the problem to another catchment
Pasture/crop management	▪ Cover crops not always possible due to the winter conditions in this catchment
Irrigation management	▪ Note absentee landowners, particularly on kiwifruit blocks, irrigate regardless of rainfall. ▪ GPS- variable rate instigators would mean one would have to remove more trees in a catchment where trees have enhanced the climate.
Stock management	▪ Need to balance these practices with other considerations e.g. climate change and energy efficiency, animal welfare and rural amenity issues
Effluent management	▪ Separating solids is a no-brainer - the amount of water needed to dilute/move solids is massive.
Nitrate inhibition	▪ Science is still out on this
Forestry	▪ NES-PF provides adequate practise to manage impacts ▪ In the lower Rangitāiki there are giant kokopu in the Omataroa forest and spring-fed streams below the Manawahe hills. Don't know yet if NPS-PF will sufficiently protect these... Don't know yet ▪ I am sure that this has impacted on the state of the Whirinaki River and the build up of the river. There are implications for the flood management also.
Hydro-electricity	Review peak flows/ramping rate frequency/in-out flow conditions and flushing rates: ▪ Should be a component of the overall work ▪ Ramping is possibly the biggest contributor to bank erosion/sedimentation ▪ Needed Any other methods or comments: ▪ Review amount of water allocated. Aniwhenua needs some creative thinking about the impacts it is having
Storm water	Water sensitive urban design (e.g. swales, wetlands, rain gardens): ▪ Should be good practise ▪ These should be standard practice for all new developments. ▪ recycle/ water collected for use Road and track maintenance: ▪ Need a guide - such as NES-PF ▪ Farmers should use retention ponds/elephant holes, similar to forestry

Section	Respondent comments
	Standards and limits for storm water discharges: ▪ Need standards that are attainable and measurable ▪ Yes Land use restrictions (e.g. percentage of impervious site coverage): ▪ Use natural capital ▪ Yes Any others?: ▪ Green rooves substantially reduce run-off ▪ an increase in urbanisation leads to an increase in storm water
Wastewater	Treatment plant upgrades to relevant standard for load reduction: ▪ Yes x 2 ▪ Needed Standard for on-site effluent treatment: ▪ Yes ▪ Yes but depends on density Peak flow management at wastewater treatment plants: ▪ Yes Standards and limits for wastewater discharges: ▪ Yes ▪ needed
Restrictions	Nutrient Discharge Allowance allocation (property, sub-catchment or nutrient user group level): ▪ urban sewerage needs to be applied to land ▪ yes ▪ Based on natural capital ▪ Yes where nutrient levels are too high ▪ Possible Fertiliser use restrictions: ▪ Not as a general rule. Dairy farmers already have their N leaching figures so those leaching too much can be targeted ▪ good farm practice i.e. nitrogen app rate ▪ Based on natural capital ▪ As above ▪ , more so better use of fertiliser Restriction on winter grazing on certain soil classes: ▪ not needed ▪ Yes x 2 ▪ Where this is necessary ▪ this one has to be looked at across all of NZ to understand the impacts Stock type and stocking rate restrictions ▪ not needed ▪ Yes x 2

Section	Respondent comments
	▪ Based on natural capital ▪ this catchment already has lower stocking rates due to the soil type Land use restrictions in or around particularly sensitive environments: ▪ okay as long as balanced between protecting environment & viability of land use ▪ Yes x 2 ▪ Based on natural capital ▪ this is possible Transferable land development rights [A type of economic instrument where the development of land or certain land uses are limited, yet landowners can transfer the limited rights to develop land (or undertake land use changes) amongst themselves]: ▪ sounds dangerous as the value could become so inflated that only large corporates can afford them ▪ not sure ▪ Based on natural capital, NOT grandfathered ▪ Depends on context if it will achieve the overall outcome ▪ this does protect the whole of the catchment but unsure of the long term effects
Other methods	Stabilise susceptible streambanks: ▪ Yes x 2 ▪ Should be undertaken ▪ There is a trade-off with natural character and habitat for wildlife. Better to fence off wider buffer, plant and allow natural vegetation. Mechanical removal of sediment: ▪ yes ▪ An option as required ▪ Extensive and creates further sedimentation. Maybe necessary in extreme cases but don't see any current need. Pumped drains/flood pumping stations quality requirements: ▪ yes ▪ Oxygen levels important for aquatic life Re-diversion, changing drainage network: ▪ yes if it helps ▪ Possible but I do not know much on this ▪ not sure - maybe helpful for flood mitigation Lake remediation: alum dosing, weed harvesting, aeration, floating wetlands: ▪ management tools ▪ An option if required - short term ▪ Seem to be useful Dilution: Maintain greater water volumes/flows: ▪ yes ▪ Don't like this approach - reduce the source of pollution or treat before discharge/irrigate to land Any other engineering or remediation methods? ▪ In the Rangitāiki the answer is prevention in most cases, rather than engineering solutions which have side effects.

Appendix 2

Recommended mitigation bundles for cost analysis of mitigation of sediment and other freshwater contaminants in the Rangitāiki and Kaituna-Pongakawa-Waitahanui Water Management Areas

Prepared for the Bay of Plenty Regional Council

Final draft report, forming partial delivery for Milestone 1A

Version 1.2

26 March 2018

Perrin Ag Consultants Ltd and Landcare Research

Contents

1 Executive summary

A list of 42 agricultural land use management and land use change mitigations were evaluated for their effectiveness and cost to the farm or orchard system in order to develop mitigation bundles for use in evaluating the cost of improving water quality in the Kaituna-Pongakawa-Waitahanui and Rangitāiki water management areas.

Similar to Vibart et al. (2015) and Daigneault and Elliot (2017), a cumulative three-layer framework, was developed to bundle the mitigations. However, in this case, bundles were primarily determined based on cost at the farm gate, filtered for effectiveness at reducing contaminant losses. These mitigation strategy bundles, designed to be applied cumulatively to farm and orchard systems, are:

(i) M1: low barrier to adoption; primarily defined by being of low cost (equivalent to less than 10% of EBIT[1]) with at least a low effectiveness;

(ii) M2: moderate barrier to adoption; primarily defined by direct costs and/or lowered revenue equivalent to more than 10% but less than 25% of EBIT and at least medium effectiveness for the targeted contaminant;

(iii) M3: high barrier to adoption, primarily defined by significant reductions in pre-mitigation profitability (>25% EBIT) and high effectiveness at contaminant reduction;

Total land use change mitigations were considered a separate bundle (M4) and excluded from consideration.

These bundles were then further considered for applicability on each of the five major land use categories used in the APSIM model, which will be the basis for the economic analysis to be completed in April and May 2018.

Testing both the definitions of the bundles and farmer/grower familiarity with the individual mitigations themselves at the planned community group and industry meetings will be critically important.

[1] Earnings (or profit) before interest and tax

2 Overview

In this report, we aim to provide guidance on the suggested bundling of different practices to reduce sediment and other freshwater contaminants from rural land use in the Bay of Plenty Region. Such bundling needs to be structured around both the cost to growers from implementation and the effectiveness of the mitigation(s) in reducing contaminant load.

Studies looking at the effectiveness and cost of both individual and suites/bundles of on-farm and on-orchard mitigations to improve water quality have been regularly undertaken in the last decade. These have tended to look at the four primary contaminants to water – nitrogen (N), phosphorus (P), sediment and bacteria such as *Escherichia coli (E. coli).* As a result, there is reasonable understanding amongst the scientific and farming community about the relative costs and benefits of various systems and land use changes with regard to mitigating contaminants to water from agricultural land use.

Previous publications that summarise mitigation options for farmers include Low et al (2017), McDowell et al (2013), McKergow et al (2007), Ritchie (2008), Waikato Regional Council (2013) and Wilcock et al (2008). A bundled approach to considering mitigations has previously been considered in New Zealand, including by Vibart et al (2015), Daigneault & Elliot (2017) and Monaghan et al (2016). However, research to increase understanding around the applicability of and expected effect from the adoption of individual and bundled practice change within individual regions, freshwater management areas and sub-catchments is ongoing.

Accordingly, in this report we have attempted assess the costs of sediment and other freshwater contaminants' reduction from implementing different mitigations, with a long list of suggested practices used by the BOPRC in canvassing community groups in the targeted Water Management Areas as the starting point.

To make such assessment, we have completed a high-level review of the current literature related to on farm land use management practices and supplementary (technological) mitigation options, as well as our own experiences in evaluating cost to farmers and growers from implementing practice change, which has often involved analysis using Farmax and OVERSEER software.

We note that the literature reviewed is not consistent in its estimates or reporting of "cost" to farmers/grower in terms. "Cost" has previously been defined as everything from a relative cost assessment, gross (absolute) cost, cost as a percentage reduction in profit through to a cost per unit of contaminant reduced. With the emphasis in this piece of work being on the cost to farmers and growers, expressing the cost of a mitigation as the equivalent percentage reduction in annual operating profit (defined here as earnings before interest and tax) is probably of most help.

Based on the expected cost of mitigation options identified in the review, the potential mitigations will be structured into suggested low, medium and high cost mitigation bundles for subsequent modelling. Using a framework proposed by Macdonald (2018) (see Section 4 below), proposed mitigations will also be cross-referenced against effectiveness. This will ensure that potentially high cost mitigations with low effectiveness at reducing contaminant load will not be recommended.

2.1 Description of contaminants and key pathways to water

2.1.1 Sediment loss

Sedimentation happens in wetlands, lakes, slow-flowing parts of rivers and estuaries, when the sediment load received from the freshwater catchment exceeds their capacity to flush out the sediment. Sediment loads can be caused by mass movement, gully, sheet and rill, streambank and human induced ground erosions. Sedimentation might increase when there is land without (native and exotic) forestry[2] on steep slopes, land with heavily grazed vegetation, soils with poor infiltration and saturated soils. The sedimentation damages fish population, degrades benthic habitat, and smothers river beds.

2.1.2 Nitrogen loss

Nitrogen typically enters waterways as nitrate (NO_3-) through drainage, with such losses variable throughout the season based on rainfall, underlying pasture growth and soil moisture conditions. OVERSEER modelling can account for some of these drivers of loss rates. While direct losses are possible through fertiliser or effluent application [via overland flow], the uneven redistribution of N via the livestock urine patch is the primary driver of N loss in pastoral systems. Mineralisation of soil organic matter from cultivation or the excessive applications of nitrogen (to ensure N is non-limiting to a developing plant) are more typical drivers of loss in arable and horticultural systems.

Most mitigation practices in relation to reducing N loss to water focus on improving the N conversion efficiency of the agricultural system.

2.1.3 Phosphorus loss

While OVERSEER modelling can estimate average P losses from farming activity, the reality is that such losses are neither uniform across the relevant parts of the property, either spatially or temporally. It is recognized that 80% of all P losses from a pastoral farming operation come from 20% of the property (Gburek & Sharpley, 1988), particularly those areas where transport mechanisms (i.e. water flows) and contaminant sources , such as stock camping areas, water trough surrounds, coincide. These have been defined by McDowell & Srinivasan (2009) as critical source areas (CSAs).

While it is impossible to eliminate the creation of these CSAs within a farming or horticultural environment, strategies to slow the movement of storm water through ephemeral channels (to facilitate sediment deposition) or break the connectivity between ephemerals and these risk areas tend to dominate P loss mitigation.

2.1.4 Bacterial contamination

E. coli is used as an indicator of freshwater bacterial contamination from animal faeces and is one of the attributes of the “Human Health” water quality value. The higher *E. coli* indicate an increasing risk of infection in humans who use fresh water for primary and secondary recreation activities. *E. coli* enters streams through a direct deposition of faecal matter of livestock, discharges of dairy effluent into streams, overland flow from excess irrigation water and drainage. The main source of such freshwater contamination is ultimately grazing livestock.

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[2] Including after forestry harvest

3 Assessment of mitigations

Descriptions of sediment and freshwater contaminant reduction and costs of mitigation options are given in Table 1 overleaf based on a review of published research. More detailed description of each mitigation option is given in Appendix 1.

In considering the mitigations in Table 1 below, it is important to recognise that the evaluations of effectiveness ("expected reduction [in losses] from baseline") have been developed from a mixture of empirical research and modelled analysis. The reality is that the impact in real situations could be highly variable depending on individual situations. As such, the information presented should be considered useful for the purposes of relative assessment, rather than absolute accuracy.

Table 1: Summary of water contaminant mitigation practices to be considered in the Kaituna-Pongakawa-Waitahanui and Rangitāiki Water Management Areas

? = Uncertain

*Will include the annual opportunity cost of capital associated with capital investment

** Can include the annual depreciation cost of capital investment

Aspect	**Mitigations**	**Expected reduction from baseline**				**Cost (% reduction in EBIT)* level**	Initial capital	Operating (recurring) costs**	**Additional details**	**References**
		N leaching	P loss	Sediment	*E. Coli*					
Land use	Land use capability (LUC) class 6, 7 and 8 land that is currently in pasture converted into forestry/mānuka and fenced	4%	15%	80%	?	Medium (steep land) to High (easy contoured land)	$1,000-$2,000/ha	0	Opportunity cost is 100% of profits from the area occupied by trees, but generates income from trees over time.	Daigneault et al (2017); Doole (2015)
	Creation of new wetlands (assumes 1% of farm area)	40%	70%	80%	Up to 50%	High	$8,940/ha of wetland, including planting and fencing	$300/ wetland	One wetland can cover 400 ha of area	Daigneault and Samarasinghe (2015); Doole (2015); Low et al (2013)
	Management of gorse (e.g. replacing with pasture, mānuka or natives)	80%[1], 50%[2]	?	?	?	Medium	$1,000-$2,000/ha	0	Opportunity cost is 100% of profits from the area occupied by trees, but generates income from trees over time.	Magesen & Wang (2008)
	[Complete] Land use change to a less intensive use (e.g. sheep, deer, horticulture, forestry)	50%[3], 80%[4]	?	?	?	High		$140-$1,000/kg per N loss reduction	The cost levels occur depending on former and current land use practice. Excludes loss of capital value	Perrin Ag (2012)

[1] Area converting to trees

[2] Area converting to dry stock

[3] When converting from dairy to dry stock

[4] When converting from pasture to trees

Aspect	Mitigations	Expected reduction from baseline				Cost (% reduction in EBIT)* level	Initial capital	Operating (recurring) costs**	Additional details	References
		N leaching	P loss	Sediment	*E. Coli*					
Riparian management	Effective stock exclusion and planted buffer around water bodies	15% [1]; 5% [2]	10%[1] 5%[2]	40%	25-35%	Medium to high	$255/ha	0	A minimum of $255/ha, subject to the opportunity cost of buffer, its width and range of waterbodies are excluded.	Doole (2015); Keenan (2013); Monaghan and Quinn (2010)
	Stock water reticulation away from surface waterbodies	15% [1]; 5% [2]	10%[1] 5%[2]	40%	25-35%	Medium	$142-$601/ha	$3.13-$12.56/ha	Results in good medium-term payback, but some benefit may be extracted through higher carrying capacity, which may increase N losses	Doole (2015); Journeaux and Van Reenen (2017)
Erosion control	Swales, soak holes, slag socks, sediment ponds,	0	0-20% from swales	Swales: 40%; Sediment ponds: 50%	0	Medium to high	$255-$1,300/ha	0	Swales cost $255/ha; sediment ponds cost $750-1,300/ha,	Keenan (2013)
	Detainment bunds	0	Variable	Variable	?	Medium	$300-$500/ha of catchment	Elimination of P fertiliser from ponding areas	Detention bunds appear to be effective at catching particulate P in overland flow, but what this actually equates to on a farm or catchment scale is not fully understood. Not modelled in OVERSEER.	Clarke et al. (2013), Paterson (n.d.)
	Complete protection of gully heads	None	None	70-90%	0	High	$1,000-1,650/ha	0	Considering protection using afforestation	Daigneault et al (2017)
	Manage risk from contouring/ landscaping	?	?	40%	0	Low	0	$82/ha cropped	Implemented on cropped area	Keenan (2013)
	Spaced planting of poplars or willows on land use capability class 4-6 (steep erodible) land	None	20%	70%	0	Low to Medium		$34/ha	Costs are annualized	Daigneault and Elliot (2017)

[1] for dairy
[2] for dry stock

Aspect	Mitigations	Expected reduction from baseline				Cost (% reduction in EBIT)* level	Initial capital	Operating (recurring) costs**	Additional details	References
		N leaching	P loss	Sediment	*E. Coli*					
Access/crossing infrastructure	Access crossings, bridges, culverts over all waterways regularly crossed by stock	?	95%	99%	?	High	?	?	Can be a significant cost depending on the size of the catchment the waterway drains.	Low et al. (2017)
	Appropriate gate, track and race placement, design and maintenance (e.g. diverting effluent away from waterways, slope access tracks away from drains to reduce sediment loss and avoid water flowing across disturbed area)	?	?	?	?	Low to medium	?	?	Maintaining water tables and laneway camber is cheap to achieve, but shifting gateways out of flow paths can be costly if an existing race network also needs to be altered. At a whole farm level, contaminant reduction can be significant (up to 80% if all managed effectively)	McDowell & Srinivasan, 2009
Stock management	Appropriate stock type and stocking rates for land characteristics (e.g. sheep on steeper land)	21%	2%	None	?	Low to Medium	35% reduction in profits per hectare in comparison to baseline practice	None	Reductions in stocking rate of lamb finishing farms with some beef finishing	Doole (2015)
	Change in sheep to cattle ratio by increasing sheep ratio	19%	4%	None	?	Low	91% increase in profits per hectare in comparison to baseline practice		Includes hill-country beef farm with no sheep. Mitigation practice is introduction of sheep. Impact on profitability does depend on market.	Doole (2015)

Aspect	Mitigations	Expected reduction from baseline				Cost (% reduction in EBIT)* level	Initial capital	Operating (recurring) costs**	Additional details	References
		N leaching	P loss	Sediment	*E. Coli*					
Stock management	Rotation, grazing management (e.g. wintering off away from catchment or in less sensitive area within catchment)	36% for dairy; 16% for S+B	30% for dairy; 20% for S+B	40% for dairy; 10% for S+B	10% for dairy; 10% for S+B	Low	None	$2-$30/head/week, depending on stock class and species	Can be costly, but a regular component of many dairy farm systems due to high rate of return. However, applicability as a mitigation moving forward ?	McDowell et al (2005); McDowell and Houlbrooke (2009)
	Appropriate location of feeding and stock drinking water through sites away from waterways	None	Variable	Variable	Variable	Medium	Variable		Extent of contaminant reduction depends on the extent of hydraulic connectivity from these CSAs	
	Responsible break-feeding practices	None	Up to 80%	Up to 80%	?	Low	None	2.5% reduction in crop areas	Should be no significant cost associated with this change in management approach.	Orchison et al (2013)
	Low leaching animal varieties	9%	None	None	None	Medium	Variable	Variable		Perrin Ag (2013)
	Dung beetles	?	?	?	?	Medium	$7,000 per farm for colony establishment.		Insufficient field data in NZ to warrant serious consideration	
	Barns for intensive systems or in sensitive environments	15%- - 17%	15%	None	10%	High	$1,000-$2000/cow	$171/ha	Less than half case study farms in Journeaux & Newman generated a return that exceeded their cost of capital. Utilising a barn to reduce N losses is unlikely to be profitable	Greenhalgh (2009); McDowell (2014); Perrin Ag (2013); Journeaux & Newman (2015); Daigneault et al. (2017)

Aspect	Mitigations	Expected reduction from baseline				Cost (% reduction in EBIT)* level	Initial capital	Operating (recurring) costs**	Additional details	References
		N leaching	P loss	Sediment	*E. Coli*					
Fertiliser management	Paddock/block-level fertiliser planning/nutrient budget based on soil tests and crop needs	10%	10%	None	None	Low		$500 per year	Gains likely to be in association with other practices highlighted by appropriate nutrient budgeting	
	Maintaining optimal soil phosphate levels	None	18%	None	None	Low		Potentially as high as $200/ha/year savings while mining excessive soil P levels	Extend of gain will depend on level of above optimal soil enrichment	Perrin Ag (2017c)
	Use of low solubility P fertiliser	None	6%	None	None	Low		None	The value of P in RPR tends to be lower than in superphosphate, but sulphur will generally also need to be added as well. The availability of the P from RPR will be limited initially, so best used in conjunction with mining of soil Olsen P levels	
	Efficient fertiliser use (e.g. not coinciding with rainfall, temperatures below 7 degrees Celsius, appropriate fertiliser types and timing of application, GPS-based application).	3%	?	None	None	Low			Costs based on fertiliser application level	Perrin Ag (2017a)
	Reducing fertiliser N use	15%-33%	None	None	None	Medium	May result in reduction in stock numbers if being used to support capital livestock	Net benefit-$350/year/kg N loss reduction	The extent of any profitability change tends to relate to the cost of any feed purchased in to replace the N boosted pasture or the amount of production forgone by the loss of the feed.	AgFirst (2009), Perrin Ag (2012)
	Use of plant growth regulators (Gibberellic acid)	4-29%	?	None	None	Low		$36/ha	Application level is 20 g/ha	Ghani et al. (2014), Bryant et al. (2016)

Aspect	Mitigations	Expected reduction from baseline				Cost (% reduction in EBIT)* level	Initial capital	Operating (recurring) costs**	Additional details	References
		N leaching	P loss	Sediment	*E. Coli*					
Feed and crop management	Low nitrogen-leaching pasture/fodder crop/imported feed varieties	33%	6% increase	None	None	Low		$87-$391/ha reduction in profits depending on reduction of maize	Represents hill-country bee-breeding farm without sheep and the use of maize-silage crop for dairy support	Doole (2015
	No tillage/low impact cultivation (e.g. along contours, appropriate for season, strip tillage, direct drilling)	10%	50%	25%	None	Low		$171/ha	Expected reduction of 10% in EBIT from arable cropping	Daigneault and Elliot (2017)
	Grass buffer strips (2-metre) around cropping paddocks	10-20%	15-30%	65%	80-95%	Low		$175/ha to be mitigated	Price is dependent on area, buffer width and vegetation used	Barber (2014); Low et al (2017); Wilcock et al, (2009)
	Cover crops between cultivation cycles	70-80% if planted in March; 25% if planted in June	None	None	None	Low		$80/ha for cropped area		Low et al (2017)
	Earth decanting bunds for intensive cultivation	None	None	87.5%	None	Low		$130/ha	Recommended capacity is 0.5% (50m/ha) for catchments less than 5ha, and 1% (100m/ha for catchments over 5ha	Barber (2014), Low et al (2013), Doole (2015)
	Alum applied to pasture or forage crops	None	30% at grazed croplands; 5-30% at pasture	None	None	High		On grazed land $160-$260/kg of P conserved; On grazed cropland $150-$500/kg of P conserved		McDowell (2010)
	Bauxite applied to critical source areas									

Aspect	Mitigations	Expected reduction from baseline				Cost (% reduction in EBIT)* level	Initial capital	Operating (recurring) costs**	Additional details	References
		N leaching	P loss	Sediment	*E. Coli*					
Effluent management	Solid separation					Medium to high				
	Closed loop effluent recycling	?	?	?	?	Medium	$397,000 (based on stated payback of 7.5 years and a suggested $53,000 annual gap between annual costs of pond system versus the FORSI system)	$18,000 per annum	Still require solids separation (via a screen) and disposal of solids to land. No trial work available, but concept has long term potential for farms constrained by soil moisture levels for land-based liquid effluent disposal	Forsi systems
	Farm Dairy Effluent ponds: sufficient holding capacity to comply with soil moisture application standards and fully lined	?, but as much as 5%	10-30%	0	?	Medium	$30,000-$100,000 depending on size of farm	$30/kg of P conserved	High capital cost	McDowell (2010), Low et al. (2017)
	Maize on the effluent block	Variable	None	None	None	Low		$140/ha benefit assuming half of N fertiliser could come from effluent	Should allow a reduction in base N fertiliser requirements	FAR 2008, Johnstone et al 2010).
	Efficient application that complies with soil moisture standards and crop needs, more than 20 metres away from all waterbodies	Variable	Varia ble	0	Varia ble	Low to medium			$500 for basic soil moisture probe, but on high risk soils more investment may be required	
	Increase application area to reduce application concentration	Variable	Varia ble	0	Varia ble	Medium to high			Depends on spatial layout of the farm and existing effluent areas	

Aspect	Mitigations	Expected reduction from baseline				Cost (% reduction in EBIT)* level	Initial capital	Operating (recurring) costs**	Additional details	References
		N leaching	P loss	Sediment	*E. Coli*					
Irrigation	Efficient irrigation application based on soil moisture deficit monitoring, awareness of soil type/infiltration rate and assessment of crop needs and expected rainfall	10%	None	None	None	Low		$58/ha of annualized costs		McDowell et al (2013), Strong (2001)
Denitrification	Use of nitrification inhibitors	10%	None			Medium			Products currently banned for use in NZ	Di & Cameron (2007)
	Denitrification technology (i.e. Spikey)	10%	None	None	None	Medium	Investment in equipment	Potentially increased pasture production could offset increased costs, but limited field trials	Moderate capital investment, returns potentially good, but inadequate field trials	Bates & Bishop (2016)
	Denitrification beds	25%	None	None	None	High		$137/ha of annualised cost	High capital cost plus. Loss of some fertiliser value from dairy effluent	Schipper et al (2010); McDowell (2013)

4 Proposed mitigation bundles

In contrast to Vibart et al. (2015) and Monaghan et al. (2016), in this study the mitigation practices that are summarised in Table 1 have been bundled based on their cost level (expressed as a reduction in pre-mitigation farm profit as measured by EBIT), but first having been filtered based on their effectiveness as proposed by Macdonald (2018). This framework is presented in ***Figure 1*** below.

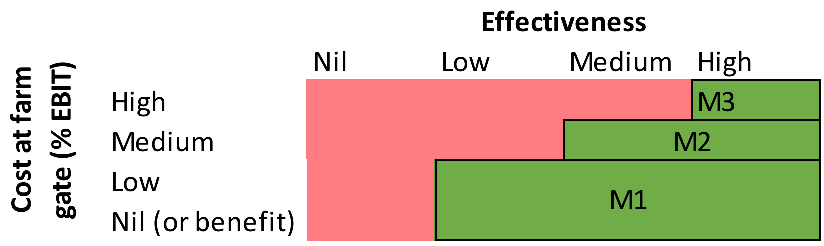

Figure 1: Bundling framework as suggested by Macdonald (2018)

For clarification, the "cost" of mitigation should include the opportunity cost of any capital employed and the loss of value (depreciation) over time, even though the former isn't captured in EBIT. These total mitigations are simply being considered in relation to amount of pre-tax profit that might be consumed as a result of its implementation.

The bundles are therefore broadly defined as:

(i) M1: low barrier to adoption; primarily defined by being of low cost (equivalent to less than 10% of EBIT) with a minimum least low effectiveness;

(ii) M2: moderate barrier to adoption; primarily defined by direct costs and/or lowered revenue equivalent to more than 10% but less than 25% of EBIT and at least medium effectiveness for the targeted contaminant;

(iii) M3: high barrier to adoption, primarily defined by significant reductions in pre-mitigation profitability (>25% EBIT) and high effectiveness at contaminant reduction;

The mitigation bundles are designed to be applied cumulatively to farm and orchard systems i.e. M2 mitigations are applied only after applicable M1 mitigations have been implemented on farm.

This framework potentially includes two additional bundles, which have not been listed in the following tables:

(i) M0: existing mitigation management practice already assumed to be largely in place within farm systems (such as stock exclusion of dairy cattle from some waterways) with essentially no cost to adoption.

(ii) M4: total land use changes

Based on the above, the proposed mitigation bundles M1 to M3 for this analysis are presented in Table **2** through to Table **4** overleaf.

Table 2: Summary of the proposed M1 mitigation bundles to be considered (as applicable) in the Kaituna-Pongakawa-Waitahanui and Rangitāiki Water Management Areas

Mitigation bundle	Land use type				
	Dairy pastoral	Non-dairy pastoral	Arable	Horticulture	Forestry
M1	▪ Full stock exclusion from all large waterbodies, all wetlands and 3m planted buffer[1] ▪ Relocation of troughs and placement of feeding equipment ▪ Adoption of low N leaching forages ▪ Reduced tillage practices ▪ Laneway run-off diversion ▪ Efficient fertiliser use: o Maintain optimal Olsen P o Improved nutrient budgeting o Use of plant growth regulators [to replace N] ▪ Efficient irrigation practices (soil moisture monitoring) ▪ Grow maize on effluent blocks ▪ Timing of effluent application in line with soil moisture levels (assumes sufficient storage)	▪ Full stock exclusion from all large waterbodies, all wetlands and 3m planted buffer ▪ Targeted space plating of poles ▪ Stock class management within landscape ▪ Relocation of troughs ▪ Adoption of low N leaching forages ▪ Some no tillage practices ▪ Maintain optimal Olsen P ▪ Efficient fertiliser use ▪ Appropriate gate, track and race placement, design	▪ Grass or planted buffer strips ▪ Complete protection of existing wetlands ▪ Cover crops between cultivation cycles ▪ Manage risk from contouring ▪ Reduced tillage practices ▪ Maintain optimal Olsen P ▪ Efficient fertiliser use	▪ Complete protection of existing wetlands ▪ Laneway run-off diversion ▪ Maintain optimal Olsen P ▪ Efficient fertiliser use ▪ Efficient irrigation practices (soil moisture monitoring)	▪ Management of gorse ▪ Laneway run-off diversion ▪ Complete protection of existing wetlands

[1] As noted above, it is assume some stock exclusion is already in place under current practice (M0).

Table 3: Summary of the proposed M2 mitigation bundles to be considered in the Kaituna-Pongakawa-Waitahanui and Rangitāiki Water Management Areas

Mitigation bundle	Land use type				
	Dairy pastoral	Non-dairy pastoral	Arable	Horticulture	Forestry
M2	▪ Full stock exclusion from medium size waterbodies and 3m planted buffer ▪ Detention bunds ▪ Complete protection of gully heads ▪ Reductions in seasonal stocking rate ▪ Controlled grazing with stand-off pads ▪ Reducing fertiliser N use ▪ Lined effluent storage ▪ Increase effluent application area	▪ Full stock exclusion from medium size waterbodies and 3m planted buffer ▪ Convert LUC class 6-8 pasture land into forestry/mānuka and fenced ▪ Management of gorse ▪ Stock reticulation away from surface waterbodies ▪ Detention bunds ▪ Complete protection of gully heads ▪ Whole paddock space planting of poles ▪ Reductions in seasonal stocking rate ▪ Changing stock ratios to reflect lower N leaching potential	▪ Swales ▪ Complete protection of gully heads ▪ Reducing fertiliser N use ▪ Strip tillage		

Table 4: Summary of the proposed M3 mitigation bundles to be considered in the Kaituna-Pongakawa-Waitahanui and Rangitāiki Water Management Areas

Mitigation bundle	Land use type				
	Dairy pastoral	Non-dairy pastoral	Arable	Horticulture	Forestry
M3	▪ Stock excluded from, and planted buffers adjacent to, a wider range of waterways (e.g. ephemeral, seeps, small streams) ▪ Nil/restricted grazing (with barns) ▪ Partial afforestation of easier contoured land ▪ Creation of new wetlands ▪ Reducing stocking rates ▪ Alum applied to pasture ▪ Denitrification beds ▪ Adoption of new irrigation infrastructure	▪ Buffer around excluded water ways (7m) OR ▪ Stock excluded from, and planted buffers adjacent to, a wider range of waterways (e.g. ephemeral, seeps, small streams). ▪ Creation of new wetlands ▪ Alum applied to pasture ▪ Reducing stocking rates	▪ Creation of new wetlands ▪ Sediment traps		▪ Creation of new wetlands

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6 Appendix 1

6.1 Land use

6.1.1 Land use capability (LUC) class 6, 7 and 8 land that is currently in pasture converted into forestry/mānuka and fenced

In areas where potential pasture production is low (<4t DM/ha), conversion from pastoral farming to forestry is likely to have minimal impact on farm profitability when considered on the basis of long term pricing for timber and animal products. Costs are mainly related to tree plantation establishment and harvesting, and opportunity cost of alternative land use. For instance, Perrin Ag (2013) found that when afforestation of steep hill country was modelled on case study farms in the Upper Waikato, there was limited (if any) reduction of long term enterprise operating profit. However, the precise forestry regime, harvest requirements and location relative to ports and/or mills can have significant impacts on forest profitability. We note also that the recent National Environmental Standards for Plantation Forestry place limits on the afforestation of land deemed to be of very high erosion susceptibility.

The economics of plantation mānuka for honey production are questionable given current establishment costs, yields and price and the suitability of targeted lands for the cost-effective harvest of the biomass needed for oil extraction is likely to be low.

6.1.2 Wetland and ephemeral flow path management and protection

Stock exclusion from wetlands is recognised as having positive impacts on downstream water quality. A study of a Waikato hill country seepage wetland by Hughes et al (2013) found that cattle actually spent little time grazing in the shallow wetland and the direct effects of their grazing were minor, fluxes of cattle derived pollutants and damage to wetland margins and vegetation were detected. However, deeper wetlands tend to be avoided by livestock and don't spend sufficient time in them to have a notable effect on contaminant load or sediment disturbance.

On balance, given the loss of productivity from excluding livestock from wetlands is likely to be low and the concern about the long-term effect on water quality from stock access and exclusion is a sensible practice and likely to be achievable with limited cost.

The actual development of new artificial wetlands can be extremely expensive and as a result are often better considered at a whole-of-catchment scale. The review by Low et al (2013) suggested the cost could be between $550 and $7,500/ha, depending on the extent of nutrient and sediment capture desired and the nature of the existing flow in planned wetland area. In contrast, the study by Daigneault and Samarasinghe (2015) estimated that each new wetland can cost $100,000 that covers 400 ha of area. The capacity of new wetlands to take up nutrient losses from the receiving catchment is significant, although this can take a number of years to do so and such features will eventually reach equilibrium. Also, there are high positive impacts of wetlands in reducing *E. coli* (50%) and sediment losses (80%) (Low et al., 2013; Daigneault and Samarasinghe, 2015).

6.1.3 Management of gorse (e.g. replacing with pasture, mānuka or natives)

From a fundamental point of view, the eradication of gorse and conversion to alternative ground covers is likely to result in a reduction in N loss to water. Magesan & Wang (2008) calculated nitrogen losses to water from mature gorse stands in the Rotorua catchment at 36kg N/ha and 40kg N/ha, which would be equivalent to losses from either intensive dairy support activity or extensive dairy farm systems in the same area. However, there is insufficient information in the literature on the effect of gorse on P losses, sediment and *E. coli*.

6.1.4 Land use change to a less intensive use (e.g. sheep, deer, horticulture, forestry)

Land use change to less intensive activities can substantially change the nutrient leaching, erosion and *E. coli levels*. However, currently, such practice tends to have limited appeal for land owners. This is typically a result of the following factors:

- Cost of transition can be high i.e. cost of orchard development ($220,000/ha for kiwifruit pergolas and shelter), deer fencing (>$20/m) and handling facilities;
- Barriers to entry to the supply chain of lower intensity alternatives with profitable returns i.e. licences for crop varietals (G3 kiwifruit licence), supplier shares (i.e. Dairy Goat Co-op milk supply rights), limited markets for supply (sheep milk);
- Likely loss of capital value with "permanent" land use change including potentially low salvage value of prior investment (i.e. dairy land being planted in radiata pine);
- Perceived or real loss of profitability and annual cash flow, particularly where existing businesses are moderately or highly geared (pasture land converting to forestry);
- Inadequate land owner knowledge of the alternative land uses;
- Personal preference.

6.2 Riparian management

6.2.1 Effective stock exclusion and planted buffers around drains, rivers, streams and lakes

Effective stock exclusion and riparian fencing with planted buffer includes vegetation around rivers, streams and lakes. A summary of the existing literature by Doole (2015) suggests that the width of the buffer does have an impact on the extent of N loss reduction, but whether this is due to a greater interception area or a reduction in pastoral area (with a commensurate reduction in stocking rate) is unclear.

Such a mitigation option focuses on preventing livestock from direct deposition of manure into these waters or direct stream bank erosion using the planted buffer. This management option will have a substantial reduction in sedimentation and *E. coli*, while to a lesser extent in reduction of N leaching and P losses. There is a concern that nutrient cycling within the riparian areas can act as an indirect source of N and P loss if planted vegetation is not regularly cut and removed (Collier et al, 2013). According to Doole (2015), use of 5-metre pastoral buffer strip can reduce actual N leaching of about 15% and 5% for dairy and dry stock farms respectively, assuming livestock had access to water ways previously.

For P loss reduction the levels are even more modest than for N leaching mitigation, and is about 10% and 5% for dairy and dry stock farms (Doole, 2015). In addition, based on estimates of Keenan (2013), Daigneault et al. (2017a) showed that it is possible to reduce 40% of sediment with grass buffer strips. The type of vegetation within the buffer is unimportant as long as there is no bare ground. The cost of establishing riparian vegetation strip is around $255/ha for horticulture (Keenan, 2013), but this will vary depending on the choice of any planted vegetation.

To date, most of the regulation and voluntary practice change around riparian management has been centred on high order (i.e. large) water bodies and lowland drains. However, McDowell et al (2017) found that 77% of national contaminant load was coming from lower-order (i.e. smaller) streams that are not currently required to be fenced. With P being the primary nutrient entering water ways from overland flow and direct [stock] deposition, the fencing of low-order streams in areas of high P load may be extremely effective in reducing pollution.

As regards to the relative cost and challenge to adoption, Vibart et al (2015) considered excluding dairy cattle from waterways to fall into an M1 bundle, sheep & beef cattle into M2 and utilising a buffer strip (7m) within M3.

6.2.2 Stock water reticulation away from surface waterbodies

The replacement of natural water sources with reticulated supply for livestock has the potential to improve the profitability of the pastoral operations where it is implemented, although the installation of reticulated supply is likely to require additional co-investment. Journeaux & van Reenan (2017) found in a study of 11 farmers that stock water reticulation can result in the significant internal rate of return of 53% on average. Such mitigation option can reduce *E. coli* and sediment by about 30% and 40% respectively, and with contribution on N leaching and P loss of about 10% depending on livestock type. However, stocking rate tended to increase with the introduction of reticulated stock water in the case study farms, which may in practice, lead to limited (if any) reductions of N loss to water.

6.3 Erosion control

6.3.1 Swales, soak holes, slag socks, sediment ponds, detention bunds/dams

Sedimentation (or erosion) can be controlled using swales, soak holes, slag socks, sediment ponds, detention bunds/dams. Swales are broad grass strips (like riparian grass buffer strips) used to treat sedimentation. Such practice can reduce sedimentation by 40%, in contrast to the baseline land use practice such as horticulture and pasture grazing, but is highly slope dependent. The cost of such practice is about $255/ha (Keenan, 2013).

A constructed soak hole can act as a sediment trap, where sediment is collected and left to discharge to a controlled outlet or soak into the ground.

Slag socks are installed sock technologies/materials that intercept and address sedimentation of clay particles. Sediment retention ponds are constructed ponds to trap sediment at bottom of sub-catchment to tackle surface erosion and are suitable for all farm land use types. The sediment ponds can reduce erosion by 50% in comparison to farming practices, and cost of such mitigation option ranges between $750 and $1300/ha of catchment (Keenan, 2013). Detention bunds/dams or debris dams are effective in trapping erosion and associated P from water leaving pastoral farmland during rainfall and runoff events, and their effectiveness depends on influent load in the ephemeral stream. Detainment bunds temporarily pond ephemeral water (via controlled outflow) behind an earth bund (about 1.5 m high) for settling sediment and associated nutrients to onto the pasture and become part of the soil matrix (Clarke et al., 2013). Clarke et al. (2013) observed the largest retention of sediment and P was 2.7 t and 6.8 kg of P respectively in just one ponding event, but what this equated to on a whole far, scale wasn't apparent. Average P retention in the Hauraki Stream catchment is 0.2 kg of P per ponding event that could save $28,000 for lake restoration costs over 20 years (Clarke et al., 2013).

6.3.2 Complete protection of gully heads

Once gullies have begun to form they must be treated as soon as possible to reduce negative consequences. To control gullies, building detention dams or bunds and revegetation such as afforestation and space-planting should be undertaken. Afforestation plantations can reduce erosion by 90% from the baseline if trees are not harvested (reduce erosion by 80% if trees are harvested) and can cost farmers $1000/ha (Daigneault et al, 2017). Space planting assumes that areas are planted and all tree plantations are maintained. Such land use practice can reduce sedimentation by 70% and costs $1650/ha (Daigneault et al, 2017). Typically dams are used in combination with tree plantations to control the runoff into gullies to trap sediment within gully systems.

6.3.3 Manage risk from contouring/landscaping

Tillage practices and cultivation on slope ridges can increase erosion. Contour strip cropping can be used and includes strip of pasture or small grain alternation with a strip of row crops. Ridges in contour strip cropping reduce the possibility of erosion. Contour strip cropping can reduce soil erosion by as much as 50% as comparing to farming up and down hills (USDA, 2013).

Cover crops are cultivated often solely to manage erosion. Planting cover crops can lead to the seasonal reduction in surface erosion in contour farming by planting legumes, cereal rye, clover and other crops in horticultural farms. According to Keenan (2013), erosion reduction effectiveness of cover crops is 40% from baseline erosion, which can cost $82/ha in an arable situation.

6.3.4 Spaced planting of poplars or willows on land use capability class 4-6 (steep erodible) land

While the space-planting poles on erosion prone hill country has long been accepted as an effective means of reducing erosion (Hicks 1995), the economic imperative for it is not great. Analysis by Parminter et al (2001) concluded that the productivity gain from soil retention was typically less than the suppression effect from shading on pasture dry matter production and that only on highly erodible soils and where farmers were happy with low returns on the investment from planting was the cost-benefit positive for the landowner. This analysis excluded the potential public good benefit from reducing soil erosion.

6.4 Stock management

6.4.1 Appropriate stock type and stocking rates for land characteristics (e.g. sheep on steeper land)

Treading damage to soils from livestock is recognised to have the potential to increase both the risk of surface run-off and the loss of sediment, phosphorus and nitrogen in any run-off. This risk is heightened in periods of high soil moisture, which in New Zealand typically coincides with the winter period. Nguyen et al (1998) concluded that intensive winter grazing on hill country pasture is potentially a major source of contaminant runoff to receiving waters. This is more likely to occur with [older] cattle than with sheep, but the lower pasture covers potentially achievable under sheep grazing regimes (albeit not desirable from an animal performance perspective) can expose soil to greater erosion risk. Limiting/excluding cattle older than 18 months from steeper hill slopes during winter is a recommended practice.

The risk of soil erosion from deer pacing fence lines on fragile soils can be significant but can be successfully managed by a combination of sensible fencing solutions (including remedial options for existing farms) and stock management practices (New Zealand Deer Farmers' Association 2012). However, the introduction/expansion of deer onto properties with more fragile soils (i.e. pumice) does need to be considered carefully.

The impact of stocking rate and stock type on N loss to water is reasonably well understood, with the urine patch the primary driver of N loss to water in pastoral grazing systems. As a result of urinary dynamics cattle will have a higher N loss signature than deer or sheep, and female stock a greater N loss signature than males. All things being equal, higher stocking rates will generate higher N loss to water as a result of higher quantities of N cycling through the farm system and more N therefore subject to the inefficient return via the urine patch. According to Doole (2015) appropriate stock type and stocking rates have lower P loss (2%) than N leaching (21%) reduction, and can lead to profit reduction of 35% per hectare in comparison to the baseline practice. Temporal dynamics are increasingly recognised as being important, with late summer/autumn urine patches to pasture potentially having more impact that those deposited in the late winter, even with higher underlying soil drainage.

6.4.2 Rotation, grazing management (e.g. wintering off away from catchment or in less sensitive area within catchment)

The grazing of stock off-farm as a management practice has typically been limited to dairy farm operations, where either:

(i) a reduction in dry period feed demand is a cost-effective solution to shift feed into the early spring period to support the higher feed demands associated with lactation; or
(ii) the removal of replacement heifer feed demand allows an increase in the stocking rate of cows in-milk, with an increase in the marginal return per kg DM consumed.

The improvement in system N conversion efficiency from both strategies, as well as the reduction in urinary N deposition at a period of high drainage and low pasture growth from these management practices has also typically resulted in a reduction in direct farm N losses to water. In addition, there is high conversion efficiency for P loss, *E. coli* contaminant and erosion reduction, depending on livestock type, from rotation and grazing management. For instance, implementation of such mitigation options at dairy farm can reduce 30%, 40% and 10% of P loss, sediment and *E. coli* with a $9-$30/head/week (McDowell et al., 2005; McDowell and Houlbrooke, 2009).

However, the “exporting” of N and P loss, *E. coli* and sediment from one catchment to another as a mitigation strategy is potentially only a short-term solution, as the importance of water quality in receiving water bodies across New Zealand is of increasing importance.

6.4.3 Appropriate location of feeding and stock drinking water trough sites away from waterways

The importance of reducing the hydraulic connectivity of critical source areas from flow paths and waterways has been highlighted by McDowell & Srinivasan (2009). However, to reduce the cost of installation the location of stock facilities (primarily troughs) have often been placed adjacent to stock access ways, which can commonly be in flow paths. The cost of mitigation will depend on the distance required for relocation and whether the reticulation system has sufficient pressure to deliver water to the new location.

6.4.4 Responsible break-feeding practices

Research conducted by Orchiston et al (2013) demonstrated that break feeding [winter] forage crops with a view to managing overland flow dynamics within the crop paddock (cows entering at top end of the paddock, strip grazed moving in a downhill direction, protection of critical source areas from grazing, back-fencing every 4-5 days) resulted in a considerable reduction in the yields of sediment and nutrients carried in the flow. The cost of achieving such reductions was assessed as low (including a loss of 2.5% of potential crop yield through loss of area cropped).

6.4.5 Low leaching animal varieties

The relative profitability of the sheep, cattle and deer enterprises has a significant impact on the likely profitability of using livestock system change to reduce nutrient losses. While increasing the sheep/deer to cattle ratio tends to lower nitrogen losses, depending on their positions within their respective commodity cycles, implementing such a change might not lead to an increase in profitability if the lamb price is low in comparison to the beef price. Changes in livestock policies, particularly where breeding stock is involved, often have significant lag periods before increases in profitability are achieved and are not easily reversed once implemented. Altering specie ratios may also present challenges for the management of pasture quality and parasite burden.

6.4.6 Dung beetles

Initial NZ research (Forgie et al 2014) is suggestive that dung beetle activity in New Zealand pastures will result in reduced surface run-off, which is in line with the limited global research in this area (Brown et al 2010, Doube 2008). However, the impact of such reduction in surface run-off would have on suspended solids, bacterial load and/or nutrient loss has not been quantified.

6.4.7 Stand-off pads or barns in dairy farm systems

Feed pads have limited impact on reducing contaminant loads to water given:

(i) the short period of time they tend to be in use; and
(ii) that the benefits from potential improvement in feed utilisation is typically captured by increased milk production, not reduced feed use, so the quantum of nutrients cycling through the farm system increases.

The use of stand-off pads in conjunction with duration-controlled[3] grazing throughout the season has, based on empirical trial work, the potential to significantly reduce the loss of N in drainage to water (in the order of 30%-40%). P loss reduction is lower than N leaching and is close to 15% reduction, while *E. coli* mitigation is about 10% lower than the current/baseline dairy farm practice (McDowell, 2014; Perrin Ag, 2013; Journeaux and Newman, 2015; Daigneault et al. 2017). However, this may come at the cost of lowered pasture production due to the changes in both the timing and form of the application of nutrients from animal excreta to the pasture (Christensen et al 2011).

Journeaux & Newman (2015) concluded, based on an analysis of 14 case study dairy farms that, in general, "inclusion of a barn without intensification of the farming system will result in a reduction in nitrogen losses, but at a (potentially significant) cost… [and] that intensifying the farm system to make the barn profitable often results in a rapid erosion of the environmental benefits". A 2013 analysis of a dairy support operation in the Taupo-Ohakuri catchment, part of the Upper Waikato Drystock Nutrient Study (Perrin Ag 2013), assessed that installing a wintering facility resulted in a reduction in EBIT of ($113)/ha (23%) for a 17% reduction in N loss. At the same time, in average terms the annual operating costs are about $171/ha (Greenhalgh, 2009; Daigneault et al. 2017). A significant increase in the rate charged for contract winter grazing was required to offset the loss in profitability.

[3] Where cows graze for only 4 hours each morning and evening to consume their desired daily pasture intake and are then removed from the pasture for rumination. This differs from restricted grazing, where cows are totally withheld from the pasture during a given period (say autumn & winter) and pasture is harvested and fed to the cows on a pad or barn facility.

Capital costs to farmers will tend to be less for stand-off pads than that for barns, but the costs can vary widely and can be between $1,000 and 2,000 (Greenhalgh, 2009; Daigneault et al. 2017).

6.5 Pasture/crop management

6.5.1 Low nitrogen-leaching pasture/fodder crop/imported feed varieties

There are a number of alternative forage species that early research indicates have the potential to lower farm N loss to water, albeit such impacts are not well captured in OVERSEER.

Lucci et al (2015) found evidence that suggested chicory planted after a winter brassica crop recovered greater amounts of winter deposited N than a conventional ryegrass white clover sward, but this is yet to be captured in OVERSEER. Analysis by Perrin Ag (2017) indicted replacing summer brassica crops with chicory had a positive impact on farm profit, but the impact on N loss reduction as expressed in OVERSEER was limited to differences in cultivation, not crop variety.

Modelling by Khaembah et al (2014) suggested that diverse pasture mixes (containing at least 50% of alternative species such as plantain and chicory) could result in reductions in urinary N concentration and hence N leaching), but the economic impact was not determined. Subsequently, Edwards et al (2015) observed a 20% reduction in cow urinary N concentration for cows grazing a diverse pasture sward compared to those on conventional ryegrass/white clover. In similar research, Box et al (2016) found cows grazing a monoculture of plantain had reductions in urinary N of up to 56% from that of cows grazing conventional pasture. Again, insufficient data exists to include such impacts within the OVERSEER model, but the impact on productivity through the introduction of high herb content swards is unlikely to be significant, particularly if winter active varieties are selected. Doole (2015) found that substitute of maize-silage crop with low nitrogen imported feed can reduce N leaching 33% than the current feed given to livestock. However, such imported feed increased P loss by 6% and resulted in profit reduction of $87 and $391/ha depending on reduction of maize.

The Forages for Reduced Nitrogen Leaching (FRNL) project (Dairy NZ 2017) has found that leaching from a urine patch was 25-35% lower under Italian ryegrass based pastures than under other types of pastures due to cool-season N uptake of Italian ryegrass.

6.5.2 No tillage/low impact cultivation (e.g. along contours, appropriate for season, strip tillage, direct drilling)

It is generally accepted that the establishment of crops or forages using conventional “full” cultivation methods result in greater rates of mineralisation of N in soil organic matter than no-till alternatives. However, the impact that this has on actual N loss on soil drainage can be variable. Carran (1990) found that a similar amount of nitrate was present in the sub-soil in mid-winter after establishment of spring sown wheat crops out of established pasture irrespective of tillage method. However, research to date in the FRNL project found that compared with conventional tillage, direct drilling autumn-sown forage crops reduced the compaction that results from winter grazing, leading to as much as a 20% improvement in the yield of a subsequent cereal [catch] crop, which in turn increases N uptake from the soil. According to Daigneault and Elliot (2017), eliminating crop disturbance from tilling can also reduce P loss and sediment along with N leaching but reduce EBIT of arable crops by 10%.

In practice, there is little difference in the cost of establishment of crops using no-till techniques, with greater weed and pest control often required. However, irrespective of the impact on freshwater and water contaminants reduction, direct drilling or strip tillage will lower the risk of run-off and soil loss and represent a useful practice change on farm.

6.5.3 Winter forage crop management

Lucci et al (2013) assessed that the major risk of N losses associated with winter forage crops was associated with the risk of redistribution of N in the crop via the urine returned to the soil via grazing animals. Their research on crop establishment on pumice soils demonstrated no loss of yields associated with direct drilling compared with conventional cultivation (which would typically be expected to lead to greater mineralisation) and the potential for forage brassicas to remove high levels of mineral N from the soil during growth. Their research also suggested that total DM yields did not increase with fertiliser N applications in excess of 200kg N/ha.

Research by Carlson et al (2013) also indicated the N losses from grazed winter forage brassicas might be reduced through later season (i.e. late July), rather than earlier season grazing (June), further complemented by ensuring the subsequent crop had the potential to uptake significant amounts of mineral N still in the soil.

6.5.4 Grass buffer strips (2-metre) around cropping paddocks

The appropriateness of grass buffer strips of this width is essentially limited in application where there is little risk of surface run-off and they are essentially in place to deliver livestock exclusion from flow paths or stream channels (McKergow et al, 2007). In a cropping context, such width strips are best used for the exclusion of stock from critical source areas whilst grazing forage crops (see Responsible break-feeding practices above). Grassed swales used for controlling overland flow through ephemeral flow paths amongst arable cropping activity should ideally be 3m wide (Barber 2014). Grass buffer strips are particularly effective in reducing sediment loss and *E. coli* (Wilcock et al., 2009; Barber 2014; Low et al., 2017).

6.5.5 Cover crops between cultivation cycles

Cover crops are usually grown to be ploughed into the soil, but not harvested or grazed, in order to improve soil quality. Cover crops stabilise soil, accumulate nutrients left from previous land uses, improve drainage and soil structure, and can fix nitrogen (for some cover crops). Such cropping practices are suitable for all farm land use practices (Low et al, 2017). The N leaching reduction from cover ranges depending on crop and season, and can be about 70-80% reduction from the baseline for cover crop sown in March, and about 25% reduction for cover crop sown in June. The cost of cover crop cultivation is approximately $80/ha, depending on cover crop. However, this land use has some limitations as it might lead to substantial reduction in N leaching for some crops, e.g. barely, while have meagre effect on the whole farm outcomes (Low et al, 2017).

6.5.6 Earth decanting bunds for intensive cultivation

An earth decanting bund for intensive cultivation is a temporary berm of compacted soil to create a damming area where ponding can occur (Low et al., 2017). Earth decanting is established along the flat contours at the bottom of paddocks. The paddock can hold the runoff to drop out the sediment by moving the headland further up the paddock (Low et al., 2017). According to Doole (2015) the efficacy in sediment reduction of earth decanting bunds in the Lower Waikato region is 87.5% and its cost is $130/ha.

6.5.7 Rain-activated alum dosing sediment ponds

TBC

6.5.8 Alum applied to pasture or forage crops

Another option to mitigate P loss is to decrease the source by adding P-sorbing agents such as aluminium sulphate (alum). In cases when alum can bind to the soil before being washed off, it can be effective to decrease P loss. Application of alum to grazed cropland can reduce P loss by 30%, compared to untreated land use and can cost between $160 and $260/kg of P conserved (McDowell, 2010). Alum use on pasture can be effective to reduce P loss by 5 to 30% than under the baseline land use practices, and costs range from $150 to $500 /kg of P conserved (McDowell, 2010). The cost-effectiveness will be influenced by the availability of a ready source of cheap materials. Alum for P loss reduction might be obtained as a by-product from the fertiliser industries.

6.5.9 Bauxite applied to critical source areas

TBC

6.6 Access/crossing infrastructure

6.6.1 Access crossings, bridges, culverts over all waterways regularly crossed by stock

Surface runoff from farming is a great source of P, sediment load and *E. coli* loss to waterways is considered even to have higher pollution than runoff from pasture (Low et al., 2017). Management requires good track design, bunding of culverts and bridges. Implementation of such mitigation options can help to decrease total P loss in runoff by 95% and suspend sediment by 99% (Low et al., 2017).

6.6.2 Appropriate gate, track and race placement, design and maintenance (e.g. diverting effluent away from waterways, slope access tracks away from drains to reduce sediment loss and avoid water flowing across disturbed area)

This essentially comprises the management of critical source areas (with hydraulic connectivity) discussed by McDowell & Srinivasan in 2009.

6.7 Fertiliser management

6.7.1 Paddock/block-level fertiliser planning/nutrient budget based on soil tests and crop needs

The value of whole farm paddock soil testing is questionable. Withnall (2015) suggests that dairy farms utilising this technique are reducing the range in soil fertility status over their farm (i.e. applying less nutrients to areas of high fertility and more nutrients to areas of low fertility), potentially implying that the incidence of [P] fertility above optimal levels is lowered. However, Edmeades (2011) notes the inherent variability in the soil test results for typically tested nutrients and fertility measures, highlighting the reality that a soil Olsen P measure of 20ppm and 30ppm could both be 25ppm. He suggests that taking soil tests (20 cores from a transect) from blocks of similar soil group, slope, land use, and past management history still represents the best process and cost-efficient method for identifying soil nutrient status.

6.7.2 Maintaining optimal soil phosphate levels

Lowering soil Olsen P status provides one of the most powerful mitigations as regards reducing P loss that is quantifiable in OVERSEER. For example, Morton and Roberts (1999) state that near maximum pasture production is achieved at soil Olsen P levels of 38 on pumice soils. However, on rolling contour, soil Olsen P levels of this nature massively increase the risk and extent of P loss. Given both the typical utilization of pasture grazed in situ on dry stock properties and the economic returns from dry stock farming activities, it is questionable as to whether there is an economic return from maintaining soil P reserves at these levels.

Econometric analysis presented by Edmeades in 2008 indicated that the economically optimal soil Olsen P level at a superphosphate price of $400/t can vary between 10 and 24 depending on the level of underlying farm profitability (as expressed in terms of gross margin).

6.7.3 Efficient fertiliser use (e.g. not coinciding with rainfall, temperatures below 7 degrees Celsius, appropriate fertiliser types and timing of application, Geographical Positioning System[GPS]-based application).

Analysis of Grafton et al (2011, 2013) infers that at an application rate of 100kg/ha of urea (46%), lowering the coefficient of variance (CV) of spread from 40% to 20% improves the observed DM response rate in pasture from N fertiliser from 10:1 to 11.2:1. This relationship was the basis for the assumption that N fertiliser application can be reduced to 89.2% of pre-precision technology levels without reducing DM production, cow intakes and milk production. Analysis by Perrin Ag (2017b) indicated that for farms of a suitable scale, use of precision fertiliser spreading technology was likely to increase profitability while reducing N losses.

Grafton et al also comment that reduction in CV of spread for superphosphate would reduce risk of accidental discharge into sensitive (i.e. riparian, drainage) areas etc. However, this is not able to be modelled in OVERSEER, nor is there sufficient research to establish whether phosphate fertiliser applications could be reduced as a result of this technology without compromising existing soil P reserves (as measured by Olsen P).

However, adoption of what is generally considered best practice in relation to the application of fertiliser would be expected to reduce the risk of direct nutrient loss to water. Such practices would include applications being undertaken in accordance with the Spreadmark Code of Practice, P fertiliser not be applied if the three-day weather forecast indicates there is likely to be heavy rainfall, avoiding P applications to ephemeral flow paths and during the months of May through August and considering withholding P fertiliser from all significant stock camping areas. Such practices are already encouraged in the guidance documents for the preparation of nutrient management plans required by farmers in the Rotorua Catchment under BOPRC Plan Change 10 and the Farm Environment Plans under the WRC Plan Change 1

6.7.4 Reducing N fertiliser use

The use of nitrogenous fertiliser, even when applied in line with best management practices has a contributory impact on increasing nitrogen losses from the farm system. This occurs through both increasing the quantity of N cycling through the farm system and typically allowing higher stock intensities to be farmed, normally through the higher risk winter leaching period. The elimination of N in dairy systems might be managed through the importing of additional feed or the use of gibberellin (see 6.7.5 below). However, in dry stock systems where the returns per kg DM eaten are typically lower than the cost per kg DM of imported feed, it is typically more profitable to lower feed demand (i.e. reduce stock numbers) than increase feed supply (i.e. purchase more feed).

Analysis in the Upper Waikato Drystock Nutrient Study (Perrin Ag, 2013) found that the cessation of fertiliser nitrogen usage, typically accompanied by a reduction in stocking rate, generally led to a reduction in system N losses with no reduction in EBIT. This was typically due to the marginal cost of the N fertiliser exceeding the return from the feed reduced.

6.7.5 Use of plant growth regulators (Gibberellic acid)

Gibberellic acid (GA_3) is a plant hormone that when applied to grasses and cereals typically results in the elongation of leaf, sheath and stem (a dry matter response), providing the plant has already experienced sufficient vernalisation (chilling) (Bryant 2014). GA is a growth promoter and won't work in the total absence of plant available N in the soil.

Ghani et al (2014) found that the %N in herbage of pastures treated with GA were significantly lower than those untreated which would reduce urinary-N excretion under grazing. Subsequent modelling suggested whole farm annual N losses could be reduced by 4-29%, although some of these reductions would be associated with the replacement of N fertiliser applications with GA (i.e. same DM production for less N applied). Bryant et al 2016 also concluded that using GA to increase DM yield with reduced herbage protein concentration may have reduced environmental impact through reducing N intake of livestock.

Unpublished PhD research from Woods (2017) indicated that in a lysimeter trial the application of GA had no direct impact on reducing N leaching [through promoting plant uptake of urinary N that would have otherwise leached] which suggests that any whole system N loss reduction from the use of GA is associated with the substitution of N fertiliser and an improvement in whole system N use efficiency. However, Bates & Bishop (2016) propose that this lack of N loss reduction was due to the GA being applied to pasture of insufficient mass to promote a response or that conditions were too cold to get any growth at all (Bates et al 2017).

In conjunction with the urease inhibitor NPBT, GA and (if required) and dissolved organic carbon (marketed as ORUN®) is being promoted as a means to increase the lateral movement of urine patches (the NBPT) and then utilise the N in the urine patch before it leaves the root zone (via the GA), with Bates & Bishop (2016) suggesting targeted application to the actual urine patch is the preferred method.

6.8 Irrigation management

6.8.1 Efficient irrigation application based on soil moisture deficit monitoring, awareness of soil type/infiltration rate and assessment of crop needs and expected rainfall

Metering irrigation water can help to adjust the irrigation application levels and avoid overuse of irrigation water that can increase the leaching of nutrients and bacterial contaminants. Also, technology can help to avoid poor timing of required irrigation for crops and thus improve crop growth.

6.9 Effluent management

6.9.1 Solid separation

Separation of the solid fraction from effluent is a mechanism to lower application depths for the liquid fraction of farm dairy effluent , in conjunction with conventional irrigation, and where effluent volumes are likely to be significant (such as from housing, pads) or contain greater volumes of coarse, fibrous material.

Separation of solids may also allow more targeted application of the nutrient in dairy effluent, as total %N is highly associated with the dry matter fraction of dairy effluent (Longhurst et al 2017).

The ability to lower the application rate will be beneficial on higher risk soils [that can't sustain higher application rates in achieving appropriate depths] or where targeted application of the nutrients in solids (such as in cropping programmes) may be more manageable than significant land based slurry application.

6.9.2 Farm Dairy Effluent ponds: sufficient holding capacity to comply with soil moisture application standards and fully lined

If farms have insufficient effluent storage they will be forced to irrigate when soils are actively draining, creating direct losses of nutrients and *E. coli*. While most regional authorities require that effluent is not applied in such conditions, the reality is that many farmers with permitted or consented effluent management facilities are unable to operate with full compliance all of the time.

It is also noted that Houlbrooke et al 2014 identified the losses from old two-pond systems that discharge to water as the single largest effluent risk to surface waters, which reinforces the move to eliminate these systems by regional authorities, where they still exist.

6.9.3 Maize on the effluent block

The main water quality benefit from growing maize for silage on pastoral areas receiving dairy effluent is a reduction in the quantity of fertiliser nutrient required to be applied in the first and potentially second year's crops, which reduces the risk of direct losses to water and lowers the introduction of mobile nutrients into the farm system. There is an expected improvement in farm profitability from doing so as well (FAR 2008, Johnstone et al 2010).

6.9.4 Efficient effluent application that complies with soil moisture standards and crop needs, more than 20 metres away from all waterbodies

The depth of applied effluent (measured in mm) should always be less than the soil moisture deficit at the time of application. If effluent irrigation occurs on soils that are too wet, then run off to surface water bodies or drainage below the root zone will occur, with valuable nutrients and also bacteria being lost from the farm and contaminating the environment (Dairy NZ 2014).

Deferred irrigation and low application irrigation systems (e.g. irrigation sprinklers) are effective options to reduce contamination related with land uses. The nutrient losses resulting from a single poorly managed irrigation event is estimated in the order of 12 kg N/ha and 2 kg P/ha, approximately one third of the average total whole farm N losses and three times the annual average pastoral P loss (McDowell, 2010). The potential to decrease nutrient losses with better irrigation techniques is great. Such irrigation techniques can be established based on the agro-ecological conditions such as soil types and climate as well irrigation requirement of crops. Deferred irrigation and low application irrigation systems are not only environmentally beneficial, but also can be cost effective.

6.9.5 Increase application area to reduce application concentration

Using N from the fertiliser effluent system to replace N fertiliser is a good mechanism for improving N conversion efficiency on a farm, which will typically result in lower N losses to water. Roach et al (2001) found that nitrate leaching increases significantly when pond FDE is applied at rates above 200 kg N/ha/year and that lowering the application rate to target 100kg FDE N/ha/year (increasing the application area) would deliver maintenance potassium requirements at the same time. The cost-benefit of this will depend on the fertiliser benefit of the additional K and the cost of expansion.

6.10 Nitrate inhibition

6.10.1 Denitrification technology (e.g. Spikey)

The use of dicyandiamide (DCD) as a means to limit N losses from grazed winter forage crops was successfully demonstrated by Shepherd et al (2012), but due to the presence of DCD found in milk products in 2013, this product is not currently available for use in NZ farming systems. When its use (as described by Shepherd et al) was previously modelled by Perrin Ag (2013) for the Waikato Regional Council, it did introduce a cost to the farm system that wasn't able to be recouped through productivity gains.

However, the "Spikey" technology developed by Pastoral Robotics Ltd (Bates & Bishop 2016), with the ability to detect individual urine patches and then apply an alternative treatment to prevent the rapid conversion of urea to nitrate (see 6.7.5 above) may be as equally effective as blanket DCD application, were it still a viable tool.

6.10.2 Denitrification beds

Denitrification beds have application when dealing with point source discharge, like effluent from a farm dairy parlour or a tile drain. Essentially lined containers filled with organic carbon (typically wood chip or coarse sawdust), the wood chips act as an energy source for denitrifying bacteria that convert NO_3^- to N gases. While initial trial work in NZ found a denitrification bed removed the entire N load from dairy effluent (Cameron et al 2010), the applicability of this technology on farm at this juncture is uncertain, given the economic value to the farm system of recycling the N fraction of FDE as a fertiliser and the need to still dispose [to land] of the treated FDE, which will still be high in other nutrients, such as K and P.

Appendix 3

Baseline land use models for cost analysis of mitigation of sediment and other freshwater contaminants in the Rangitāiki and Kaituna-Pongakawa-Waitahanui Water Management Areas

Prepared for the Bay of Plenty Regional Council

Initial draft report, forming partial delivery for Milestones 2A & 2B

Version 1.1

26 March 2018

Perrin Ag Consultants Ltd and Landcare Research

1 Dairy farms

Five dairy farm systems were modelled. The chosen farm variants and their suggested primary parameters were primarily informed by the work of Green et al (2017), which had utilised input from BOPRC Land Management personnel, community groups and DairyNZ staff.

The farms were all modelled as long term feasible models in Farmax Dairy Pro software, utilising base pasture production curves (derived from cage cuts) that were subsequently adjusted to better reflect observed regional parameters. Stocking rates were based on regional dairy statistics, again slightly modified based on input from local industry experts. Operating profit (earnings before interest and tax) utilised a $6.00/kg MS milk price, with operating expenses (including an arms' length adjustment for [unpaid] wages of management) based on the latest published DairyBase Economic Survey data for the Bay of Plenty region. All grazing was assumed to be sourced externally, with all young stock assumed grazed off the farm area from weaning until returning as in-calf heifers. Effluent areas were assumed at 4ha per 100 cows, with maintenance fertiliser and nitrogen expenditure was based on modelled requirements. The key parameters of the five farm systems are each described briefly below and then summarised in **Table *1***. The baseline economic output for the dairy farm systems is presented in Appendix 1. All analysis currently excludes the impact of Fonterra supplier shares.

1.1 Lower Kaituna-Pongakawa-Waitahanui dairy (System 3)

This model is designed to be representative of the higher stocked dairy farms on the coastal flats of the Kaituna-Pongakawa-Waitahanui (KPW) Water Management Area. Largely comprising of gley soils with open drain systems, this 122ha farm calves down 390 cows (3.2 cows/ha), peak milking 374 cows (3.1 cows/ha) and producing 1,054kg MS/ha. No silage is made on farm and 50% of the milking herd are grazed off for six weeks. Palm kernel expeller is fed to cows in early and late lactation. Annual N fertiliser usage averages 173kg N/ha. A stand-off area was assumed to be used during the winter and early spring to protect soil from pugging. Operating profit is calculated at $1,946/ha.

1.2 Mid Kaituna-Pongakawa-Waitahanui dairy (System 3)

Representative of the farms on higher ground but less than 100m above sea level, the Mid KPW dairy model comprises 122ha of pumice soil, calving down 304 cows to peak milk 290. Milk production is 837kg MS/ha, but all cows are wintered on. With improved drainage, 3ha of maize silage is grown on-farm to help extend lactation in autumn. Palm kernel is fed to cows in both shoulders of the season and 19.2ha of grass silage is cut in late December and subsequently fed to dry cows over winter. N fertiliser use applied to pasture averages 131kg N/ha/year. Operating profit is calculated at $1,381/ha.

1.3 Upper KPW dairy (System 3)

The 122ha Upper KPW model is similar to the mid KPW model, but the farm system reflects lower pasture growth potential, both from increased altitude but also steeper contour. A summer chicory crop is utilised to buffer poorer summer growth rates and lower pasture quality and palm kernel expeller is used to feed milkers in the shoulders of the season. Lower winter pasture growth rates are buffered with 50% of dry cows grazed off for six weeks. N fertiliser use averages 123kg N/ha/year. Milk production is 805kg MS/ha. Operating profit is calculated at $1,092/ha.

1.4 Rangitāiki unirrigated dairy (System 2)

The 117ha Rangitaiki dairy model is designed to be representative of the non-irrigated dairy farms in the lower Rangitaiki plains. High pasture growth potential results in average production of 1,035kg MS/ha from 330 cows calved down. Only minimal maize silage imported into the farm system in autumn to extend lactation and all cows are wintered on. N fertiliser use is 120kg N/ha, with surplus pasture harvested in February that is subsequently fed to dry cows over winter. Operating profit is calculated at $2,561/ha.

1.5 Rangitāiki irrigated dairy (System 2)

Modelled off a partially (50%) irrigated (K line) dairy farm in the Galatea valley, this 117ha farm system produces 1,072kg MS/ha from 315 cows to calve down. The low winter growth rates require 25% of the herd to be grazed off over winter and calving date is assumed to be later than the other farm models. A summer chicory (6ha) and maize crops (4.8ha) are grown on the un-irrigated portion of the farm each year, with the maize fed to milkers both in the autumn and again in the spring. PKE is used to supplement milkers in early lactation and silage harvested off the irrigated portion of the farm fed to dry cows over autumn and winter. A total of 132kg N/ha is applied to pasture. Operating profit is calculated at $2,301/ha.

Table 1: Base parameters for the five dairy farm systems modelled

Model name	Lower KPW	Mid KPW	Upper KPW	Rangitaiki	Rangitaiki irrigated
System	3	3	3	2	2
Effective area (ha)	122	122	122	117	117
No. cows (to calve)	390	304	304	330	315
Cows peak milked	374	290	290	316	301
Stocking rate (SR; cows ha^{-1})	3.1	2.4	2.4	2.7	2.6
Comparative stocking rate	85	84.1	87.4	82.6	84.3
Pasture yield (t DM ha^{-1})	14.2	11.3	10.4	15.6	13.9
Pasture consumed (t DM ha^{-1})	11.9	9	8.5	12.1	10.4
Imported feed/total feed (%)	16%	13%	14%	3%	3%
Annual milk solids production (kg)	129,572	102,122	98,234	121,102	126,215
MS (kg cow^{-1})	346	352	339	383	419
MS (kg ha^{-1})	1062	837	805	1035	1079
MS (as a % of liveweight; LW)	83.6	84.9	80.2	91.7	98.6
Feed conversion efficiency (kg DM eaten kg MS $produced^{-1}$)	13	12.8	13.1	12.3	11.1
Financial indicators					
Operating profit ($ ha^{-1})	1,946	1,381	1,092	2,561	2,301
Area receiving effluent (% total)	13%	10%	10%	11%	11%
Area irrigated (% total)	-	-	-	-	50%
Fertiliser inputs applied to pasture					
N (kg ha^{-1})	173	131	90	90	90
P (kg ha^{-1})	45	37	35	50	53
Soil Olsen P (mg L^{-1})					

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2 Sheep & beef farms

Three sheep & beef farms were modelled in Farmax Pro, two for the KPW FMU and a single model for the Rangitaiki catchment. As noted in Green et al (2017), sheep & beef farming in the Rangitaiki catchment is dominated by Landcorp's Rangitaiki Station. While it is important to recognise this farm system is unlikely to be representative of the smaller family operations that still occur in the catchment, it is difficult to ignore the specifics of this farm system given the scale of this operation. The partial integration of this property's deer operation with its cattle operation makes the specific modelling of this system to align with the parameters of the APSIM model impossible. As a result a representative Rangitaiki farm system with a low sheep:cattle ratio has been modelled to complement the exclusive Rangitaiki deer system (see below). While only a single KPW S+B model, comprising dairy support, had been proposed, a second farm system model was subsequently developed, comprising a breeding ewe flock and breeding cows, in addition to dairy heifer grazing.

The size of the modelled farms were informed by the annual Beef + Lamb New Zealand Economic Service Sheep & Beef Farm Survey, with general parameters for the Class 3, 4 and 5 survey farms providing base physical and economic parameters for the Rangitaiki S+B (Class 3), KPW S+B and Rangitaiki D (Class 4) and KPW DS (Class 5) models respectively. Maintenance fertiliser and nitrogen expenditure was based on modelled requirements

Operating profit was defined as earnings before interest and tax and included an adjustment for the market value of all labour (paid and unpaid) in the farm system, based off the FTE parameters in the survey. Income was assessed using base schedule relationships in Farmax Pro, with the sheep schedule set at $5.50 (per kg carcass weight), prime bull $5.50, prime steer $5.55 and venison at $7.50. Wool was set at a base price of $3.40/kg greasy and velvet at $100/kg. Grazing rates per head per week were set at $6.50 for calves, $9.00 for yearlings and $25 for cows.

2.1 KPW dairy support

This 234ha property has an average slope of 12.6 degrees, comprising 22ha of flats, 155ha of rolling land, 52ha of easy country and 5ha of steep land. It's assumed this farm operation grazes 445 dairy heifer replacements from 4 months of age through to 21 months of age and winters 334 cows on pasture and silage for 8 weeks. N use is limited to 30kg N/ha to 120ha in the autumn to build up covers ahead of the grazing dairy cows arriving in late May. Operating profit was estimated at $421/ha.

2.2 KPW S+B

This variant on the KPW dairy support model is a 324ha farm, with a similar area of flats, but a greater proportion of steeper land (16.4 degrees). The farm runs a flock of 1,250 MA ewes and 540 ewe hogget replacements. Lambing at 128%, all non-replacement lambs are finished before the start of winter at an average carcass weight of 17.5kg. The cattle policy comprises 50 Hereford x Friesian breeding cows, mated to a terminal sire and with all progeny sold store at weaning. Replacement in-calf cows are bought in the autumn. In addition to the breeding cows, 300 dairy heifer replacements are contract grazed from 4 months of age to 21 months of age. N fertiliser is applied at 30kg N/ha to the 94a of flats and rolling country in the autumn. Operating profit was estimated at $71/ha.

2.3 Rangitāiki Sheep + Beef

The Rangitaiki sheep & beef model is a 584ha farm system, with a low (36%) sheep component and a diverse cattle policy, with an Angus breeding cow herd (all progeny finished), additional yearling steers purchased and finished, a bull beef operation and a dairy heifer grazing operation. The breeding ewe flock lambs at 130%, with all non-replacement lambs finished to a carcass weight of 17.2kg by May each year. Approximately half the bulls are slaughtered before their second winter, with the balance sold before spring. Steers are killed at an average carcass weight of 320kg and heifers killed at 255kg carcass weight. Winter crops (4% of the farm area) are sown each year and 84ha of surplus pasture is harvested in early summer for winter feed. Over 80% of the farm receives an N application of 30kg N/ha; 40% in the spring and 60% in the autumn. Operating profit was estimated at $177/ha.

3 Deer farm

3.1 Rangitāiki Deer

The modelled deer farm is a breeding-finishing system modelled off that of Rangitaiki Station. At an assumed size of 324ha, the farm system winters 874 Ma and R2 hinds, fawning at 90% and 75% respectively. All non-replacement progeny are finished before their second winter, with the stags and hinds finished to 55kg and 51kg carcass weight respectively. As with the Rangitaiki sheep & beef model, 4% of the farm area is sown into winter crop and the 50% of the farm area gets an application of N fertiliser in the spring, with the other 50% receiving an autumn application. Surplus pasture (40ha) is conserved for use in the winter. Operating profit was estimated at $57/ha.

4 Arable farm

4.1 KPW Arable

A single variant arable model was developed, based around a 40ha maize silage production system (yielding 22t DM/ha), with the maize followed by an annual ryegrass crop that is able to support 300 dairy cows for eight weeks and then used to produce 300 wrapped bales of silage before being re-sown into maize again. Operating profit was estimated at $3,500/ha.

Table 2: Base parameters for the five dry stock and arable farm systems modelled

Model	KPW DS	KPW S+B	Rangitaiki S+B	Rangitaiki D	KPW A
Effective area (ha)	234	324	584	324	40
Stocking rate (RSU ha^{-1})	12.8	12.9	10.7	9.4	6.7
Pasture yield (t DM ha^{-1})	9.4	8.8	7.69	7.7	9
Pasture consumed (t DM ha^{-1})	7.05	7.12	5.87	5.15	3.7
Number of livestock carried through winter (1 July)					
Breeding ewes	-	1,250	1,454	-	-
Total sheep	-	1,826	1,786	-	-
Breeding cows	-	50	67	-	-
Dairy heifers	445	300	276	-	-
Dairy cows	334			-	300
Total cattle	779	352	693		-
Hinds	-	-	-	874	-
Total deer	-	-	-	1,681	-
Animal production					
Meat (kg net carcass weight ha^{-1})	336	239	233	124	86
Wool and velvet (kg net wool /velvet ha^{-1})	-	38	22	0	-
Total (kg net product ha^{-1})	336	277	255	124	86
Feed conversion efficiency (kg DM eaten kg product^{-1})	21	26	23	41	43
Animal reproduction					
Ewe efficiency index (%)	-	55%	54.4%	-	-
Cow efficiency index (%)	-	39.5%	39%	-	-
Hind efficiency index (%)	-	-	-	41%	-
Financial indicators					
Operating profit ($ ha^{-1})	421	71	177	57	3,545
Fertiliser inputs applied to pasture					
N (kg ha^{-1})	15	9	27	32	
P (kg ha^{-1})	22	22	18	16	12
Soil Olsen P (mg L^{-1})					

5 Forestry

Two forestry models were considered – one a radiata plantation model and the other a mānuka plantation established for honey production.

5.1 Pinus radiata

TBC

5.2 Mānuka

TBC

6 Kiwifruit

TBC

Appendix 1: Summary of model development

Landuse	APSIM	Refinements from Green et al.	Revised Perrin suggestions	Final models	Model name
Dairy	Dairy	Lower KPW (flat) dairy	Lower KPW (flat) dairy	Lower KPW (flat) dairy	Lower KPW
		Mid-Upper KPW (hill) dairy	Mid-Upper KPW (hill) dairy	Mid KPW	Mid KPW
				Upper KPW	Upper KPW
	High intensity dairy	Rangitaiki (flat) dairy	Rangitaiki (flat) dairy	Rangitaiki (flat) dairy	Rangitaiki
			Rangitaiki (flat) irrigated dairy	Rangitaiki (flat) irrigated dairy	Rangitaiki irrigated
Sheep & Beef	Sheep & Beef	Sheep & Beef	Rangitaiki extensive breeding/finishing sheep cattle operation;	Rangitaiki extensive breeding/finishing sheep cattle operation;	Rangitaiki S+B
				Mid-Upper KPW sheep & beef	KPW S+B
			Mid-Upper KPW dairy support	Mid-Upper KPW dairy support	KPW DS
Kiwifruit	Kiwifruit	Green	Green	Green	Kiwi green
		Gold	Gold	Gold	Kiwi gold
		Organic	Organic	Organic	Kiwi organic
Deer	Deer	Deer - venison operation	Rangitaiki breeding/finishing vension operation	Rangitaiki breeding/finishing vension operation	Rangitaiki D
Arable	Maize	Maize silage	Lower KPW maize silage and dairy support (winter cows)	Lower KPW maize silage and dairy support (winter cows)	KPW A
Vegetables	Vegetables	Te Teko vegetable rotation	Lower Rangitaiki vegetable rotation		
Forestry	Forestry	Radiata pine	Radiata pine	Radiata pine	Radiata pine
				Mānuka	Mānuka
Numbe of models	*7*	*10*	*12*	*15*	*15*

Appendix 2: Baseline dairy farm model profitability estimates

	Lower KPW	Mid KPW	Upper KPW	Rangitaiki	Rangitaiki irrigated
	($)	($)	($)	($)	($)
Income					
Milk sales	777,411	612,730	589,289	726,611	757,404
Net Livestock Sales	44,346	33,178	33,724	34,647	34,250
Contract Grazing	-	-	-	-	-
Change in Livestock Value	-	-	-	-	-
Total Revenue	821,757	645,908	623,013	761,258	791,654
Expenses					
Labour costs	136,884	106,140	106,140	115,656	110,166
Stock expenses					
Animal Health	33,461	26,048	25,941	28,148	27,051
Breeding	10,628	8,241	8,241	8,980	8,553
Farm Dairy	6,009	4,783	4,530	5,300	4,894
Electricity	16,082	12,470	12,470	13,588	12,943
Feed expenses					
Pasture Conserved	-	6,720	-	7,840	10,468
Feed Crop	-	8,400	11,250	-	16,860
Bought Feed	51,223	44,173	29,728	16,320	4,358
Calf Feed	2,335	1,829	1,817	1,877	1,871
Grazing	95,355	47,966	79,123	49,238	61,652
Other Farm Working					
Fertiliser (Excl. N)	36,356	29,524	27,328	36,621	37,557
Nitrogen	32,034	24,343	22,891	21,341	23,539
Irrigation	1,098	1,098	1,098	1,053	43,875
Regrassing	7,200	1,800	5,400	7,200	2,220
Weed & Pest Control	5,002	5,002	5,002	4,797	4,797
Vehicle Expenses	13,176	13,176	13,176	12,636	12,636
Fuel	8,418	8,418	8,418	8,073	8,073
R&M Land/Buildings	32,086	32,086	32,086	30,771	30,771
Freight & Cartage	8,228	6,380	6,380	6,952	6,622
Overheads					
Administration Expenses	18,300	18,300	18,300	17,550	17,550
Insurance	8,540	8,540	8,540	8,190	8,190
ACC Levies	4,514	4,514	4,514	4,329	4,329
Rates	18,178	18,178	18,178	17,433	17,433
Total Farm Working Expenses	545,107	438,129	450,551	423,893	476,408
Depreciation	39,284	39,284	39,284	37,674	45,981
Total Farm Expenses	584,391	477,413	489,835	461,567	522,389
Earnings before interest and tax	237,366	168,495	133,178	299,691	269,265
per ha	1,946	1,381	1,092	2,561	2,301

Appendix 3: Baseline dry stock and arable farm model profitability estimates

Land use	Sheep & beef			Deer	Arable
Model	KPW DS	KPW S+B	Rangitaiki S+B	Rangitaiki D	KPW A
	($)	($)	($)	($)	($)
Income					
Sheep					
Sales - Purchases	-	94,132	128,547	-	-
Wool	-	43,983	44,499	-	-
	-	138,115	173,047	-	-
Beef					
Sales - Purchases	-	20,626	225,046	-	-
Contract Grazing	339,661	150,908	162,422	-	48,000
Deer					
Sales - Purchases	-	-	-	274,002	-
Velvet	-	-	-	6,764	-
Crop & feed sales	-	-	-	-	278,500
Total Revenue	339,661	447,764	733,561	280,766	326,500
Expenses					
Labour (at arms length)	78,960	67,626	74,269	67,301	13,500
Stock					
Animal Health	-	11,009	11,263	8,568	-
Shearing	-	18,878	20,706	-	-
Velveting	-	-	-	1,043	-
Feed/Crop/Grazing					
Conservation	30,460	7,684	29,460	14,000	11,100
Forage Crops	-	-	-	-	144,000
Regrassing	-	-	14,400	7,800	-
Other Farm Working					
Fertiliser (Excl. N 8	24,570	35,640	47,865	23,328	2,040
Nitrogen	5,472	4,284	22,348	14,791	-
Lime	2,160	2,991	5,390	2,991	369
Weed & Pest Cont	4,898	6,781	12,223	6,781	837
Vehicle Expenses	7,200	9,969	17,970	9,969	1,231
Fuel	5,644	7,815	14,086	7,815	965
Repairs & Mainter	29,809	41,674	61,984	30,229	2,677
Freight & Cartage	7,497	10,481	15,590	7,603	673
Electricity	3,869	5,408	8,044	3,923	347
Standing Charges					
Administration Ex	9,112	12,617	22,741	12,617	1,558
Insurance	4,666	6,461	11,645	6,461	798
ACC Levies	2,015	2,809	5,051	2,798	344
Rates	11,115	15,390	27,740	15,390	1,900
Total Farm Working Expense	227,447	267,517	422,775	243,408	182,339
Depreciation	13,712	18,986	34,222	18,986	2,344
Total Farm Expenses	241,159	286,503	456,997	262,394	184,683
Earnings before interest and	98,502	161,261	276,564	18,372	141,817
per ha	421	71	177	57	3,545

APPENDIX 4

Water Management Environmental Flow Setting Information Sheet March 2018

Setting Environmental Flows in Water Management Areas

This information pack has been prepared for engagement with iwi, hapū, community groups, stakeholders and general public when working towards setting environmental flows in Water Management Areas. It provides a brief introduction to:

1. Natural river flows and their influence on in-river values;
2. Effects of take, use, damming and diversion activities on natural river flow regimes, and particularly why low flow management is important (p.4);
3. How we can estimate effects of changes in low flow on in-river values using habitat protection levels for indicator species (p.5);
4. How we will determine minimum flows and allocation limits, using EFSAP modelling to help us (i.e., the Environmental Flow Strategic Assessment Platform model) (p.10);
5. How EFSAP works and how it can support discussions and decision making (p.10).

1. What is river flow and why is it important?

River flow is the volume of water that moves past a point in a given time, usually measured in cubic metres per second (m^3/s). The size and variability of flow within a river influences in-stream and out-of-stream values such as: ecosystem health and habitat for key species, mahinga kai, river aesthetics, water quality, recreational opportunities, and the amount of water available to take and use.

Changes to flow, and in particular minimum flow size and duration, influences the diversity and abundance of fish and invertebrate species, as flow sensitive species can find themselves with less available habitat to live in and species that are better adapted become more dominant. The Department of Conservation report entitled ‘Conservation Status of New Zealand Freshwater Fish, 2013’ states that 74% of New Zealand’s resident native fish taxa are considered to be ‘Threatened’ or ‘At Risk’[1]. Poorly managed water allocation is thought to be a significant contributor[2], emphasising the importance of considering their flow needs when setting minimum flows and allocation limits. The following table explains how different parts of a flow regime influence specific in-stream values. Figure 1 depicts this flow profile in a time series. Figure 2 is a flow duration curve, which plots the amount of time that a river is at a particular flow level.

Key point to remember:

- At low flows, aquatic ecosystems can be under stress and key species are most likely to have constrained habitat and/or competition for space.

[1] Goodman, J.M.; Dunn, N.R.; Ravenscroft, P.J.; Allibone, R.M.; Boubee, J.A.T.; David, B.O.; Griffiths, M.; Ling, N.; Hitchmough, R.A.; Rolfe, J.R. 2014: New Zealand Threat Classification Series 7. Department of Conservation, Wellington. 12 p.

[2] http://www.doc.govt.nz/documents/about-doc/concessions-and-permits/conservation-revealed/nz-native-freshwater-fish-lowres.pdf

Table 1. Key aspects of natural river flow regimes and how they influence in-stream values.

Aspect of flow regime	Influence on in-stream values
Large floods e.g., a flood we might expect only once a year or less often	• Influence overall form of channel • Maintain the channel • Affects the nature of the river corridor - floodplain surface, vegetation cover, and the need for river control measures (e.g., planting, groynes, stop banks) • Substantially disturb and disrupt ecosystems • Spring floods may be needed to open river mouths and enable migratory fish to travel in and upstream from the sea
Smaller floods and freshes e.g., happen a few times per year and remain contained within the channel)	• Mobilise sediment in some parts of the river bed • Remove periphyton and other aquatic vegetation • Assist juvenile salmonids and larvae of migratory native fish to get to the sea • Flush and refresh the river – remove silt and algal coatings, and inhibit vegetation from colonising on exposed gravel beds in the river • Also disturb and disrupt parts of the ecosystem • Timing between freshes is important as different species take different lengths of time to recover (e.g., MCI within weeks vs. trout may take years)
Flow recession that is, when the river is declining after a flood or fresh	• Can provide enhanced kayaking/white water rafting opportunities • May restrict angling
Low flows	• Greatest competition for water "space" - Wetted Useable Area is lowest • Aquatic ecosystem stress likely to be at its highest (other than catastrophic stress of high flood)[3] • Low disturbance - high biological productivity permits recolonization by MCI and fish after flood • Re-establishment of aquatic vegetation • Good native fish and bottom dwelling invertebrates may occur in small streams at low flow, but higher flows are required for juvenile salmonids, and adult trout need even more.
Flow variability the pattern of highs and lows during the year, including the magnitude of change and the duration/frequency	• Key element of natural character of a river • Seasonal variation may have important biological functions • Long periods of low flow (4-6 weeks) can start to affect native fish and periphyton growth

[3] Although in some cases this is not the biggest driver of reduction in fish species, e.g., commercial harvest may be more so.

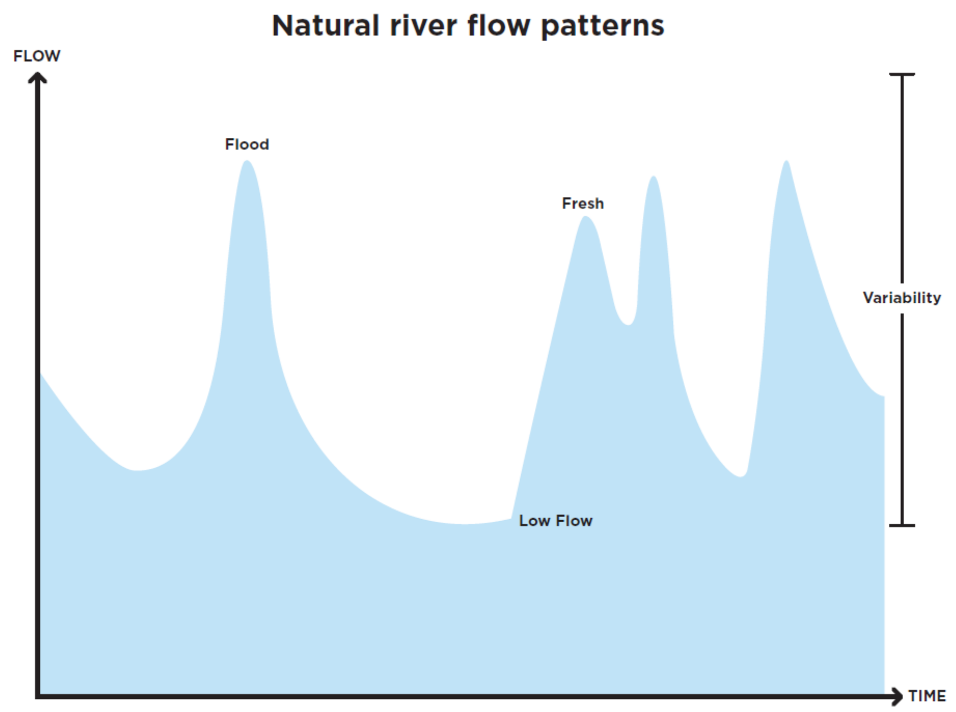


Figure 1. Key aspects of a natural river flow regimes.

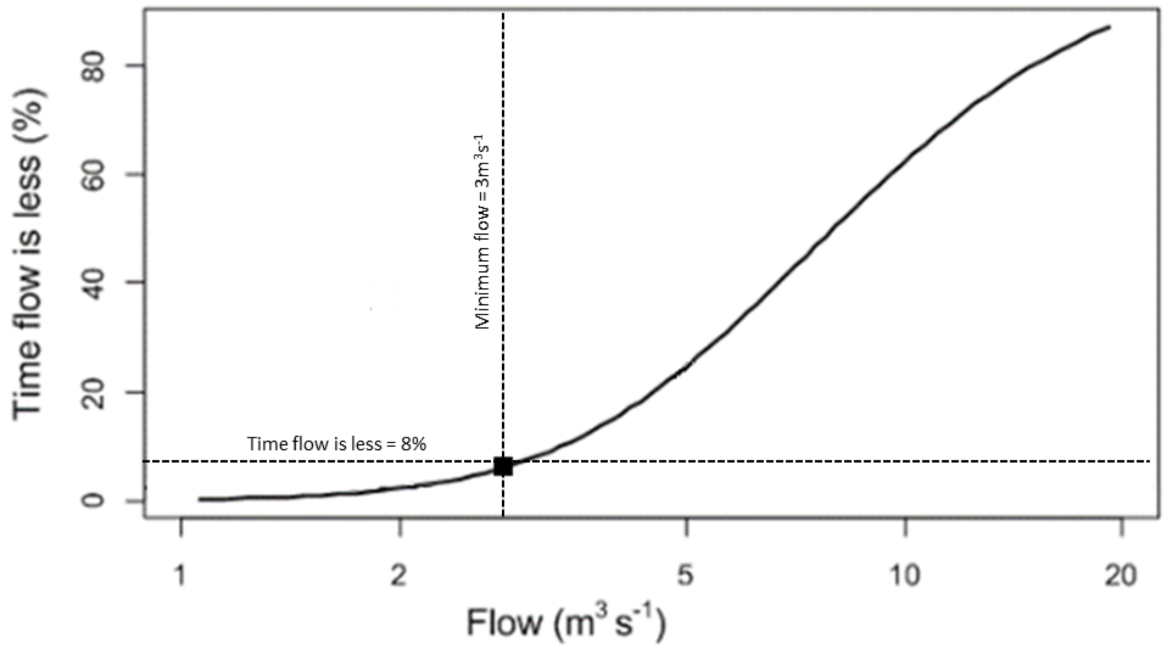


Figure 2. Flow duration curve show the percentage of time that the river is at or below certain flows

2. Effects of activities on natural river flow regimes

Generally:

- damming is the only activity that affects channel forming floods.
- large scale diversion can increase the duration and decrease the magnitude of low flows significantly, and can also reduce the frequency of freshes.
- water take/abstraction (individually or cumulatively) reduces flows significantly during periods of low flow, and can extend periods of low flow, but usually has little effect on frequency of floods or freshes.
- in-river values of small rivers are more susceptible to adverse effects of taking water than large rivers.

The main ways Council can manage effects of water take/abstraction (individually or cumulatively) are to:

- set minimum flows in a regional plan and restrict/stop abstraction when river is below this flow. Restrictions can also begin as the river flow falls close to minimum flow.
- set a total allocation limit in a regional plan and allow no more than that to be taken, or require more detailed assessments of effects if more water is sought.
- require resource consents for most damming and diversion activities, and larger takes of water, to ensure appropriate conditions can be set to provide for minimum flow, seasonal variation, flushing and channel forming flows.

Key point to remember:

- Council *must* set minimum flows and total allocation limits to manage the effects of many water takes on in-river values.
- The region-wide interim allocation limit for rivers 10% of Q5 and the minimum flow is 90% of Q5, unless the existing allocation is already more than this. **Q5** is the 7 day mean annual low flow that has a 20% chance of occurring in any year.
- New minimum flow and allocation limits will be set within each Water Management Area, involving the community, iwi and hapū.

3. How can we measure effects of altered low flows on in-river values?

As a good start, we can estimate effects of altered low flows on key indicator fish species and this can indicate effects on ecosystem health, other significant species, mahinga kai and fishing. Effects on other values, like recreation, and sites of cultural significance will need other assessments.

Weighted Usable Area (WUA) and Mean Annual 7 day Low Flow (MALF) are important surrogate measures for space and food for fish species in rivers. It is assumed that WUA at MALF is the natural limiting flow in rivers. Scientists have developed WUA curves for several indigenous fish species as well as trout and salmon. The shape of these curves differs between species, reflecting different flow preferences as shown in Figure 3.

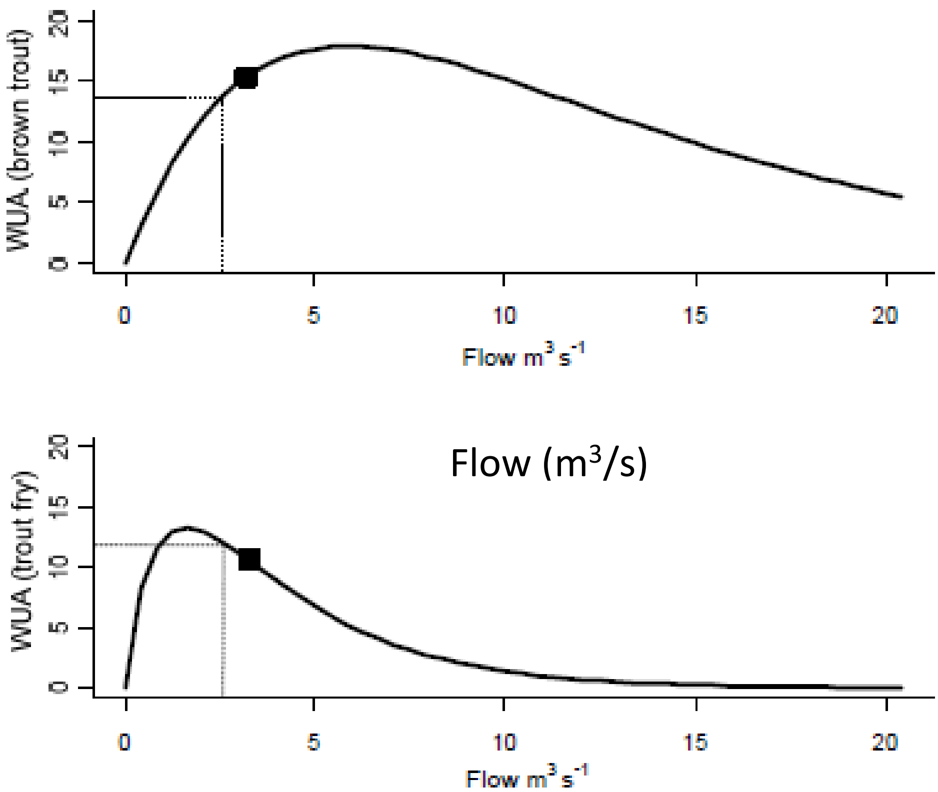


Figure 3: Examples of Weighted Useable Area curves for two fish species, demonstrating that fish have different optimal and sub-optimal flow preferences

The key fish species present in each Water Management Area (WMA) have been identified, and the most flow hungry species can be used as indicator species. When minimum flows provide sufficient habitat protection for indicator species, other species are also protected.

Indicator species selected for Kaituna-Pongakawa-Waitahanui WMA are rainbow trout, longfin eels, and koaro. While trout are not native species, they are one of the most flow hungry, and providing flow for these is likely to provide for all others, but will mean less water would be available for use.

Indicator species selected for Rangitāiki WMA are longfin eels, shortfin eels, redfin bully

We will explore how natural flows in large and small rivers in each WMA provide for habitat protection and what might happen to this **habitat protection level** if we apply different minimum flow and allocation limits.

What habitat protection level is good enough?

Scientists have recommended general habitat protection levels that will ensure detrimental effects are unlikely. These are conservative, because a change in available habitat will only result in a population change if all available habitat is in use. This is often not the case because other factors have reduced the population (e.g., fishing, obstacles to fish passage, high temperatures, habitat loss, or poor water quality).

If we apply lower protection levels (in order to make more water available for use), we will need to look in more detail at the implications for each species. In some cases, a species can live in a wide variety of flow conditions, e.g., adult eels, whereas other species are more sensitive to flow conditions, e.g., trout. Habitat protection levels should not be reduced for species on DoC threat status of 'declined' or 'at risk'.

Table 2: Recommended habitat protection levels, being the % of habitat that would exist at MALF. Species in red rows have a Department of Conservation threat status of declining or at risk.

Target Species	Protection level (% of habitat at MALF)
Shortjaw Kokopu	100
Giant Kokopu	100
Other Kokopu	95
Dwarf galaxias	95
Koaro (adult)	90
Inanga	90
Trout angling	95
Trout spawning/rearing	90
Bullies, excl. bluegill	90
Smelt	80
Eels juvenile	80
Eels adult	75
Torrentfish	60
Bluegill bullies	60

4. What are minimum flows and allocation limits

The **minimum flow** is the flow at which most water takes (and some diversions) will be required to stop. Some critical takes may be restricted but not stopped. If minimum flow provides for optimal habitat (usually the same or more than annual natural MALF) then extending duration of minimum flow will have less effects whereas, if minimum flow provides less than optimal habitat then the effects of extended duration may be higher.

Management flow is the minimum flow plus the allocation limit. If everyone took their full allocation of water at once, the remaining flow in the river would reach minimum flow. For this reason, management flow is the river flow level where we should consider starting to restrict water takes in order to avoid breaching minimum flows.

Reliability is measure of the percentage of time a water user can expect to take their full water allocation without being subject to water take restrictions and/or be required to stop taking water.

The total **allocation limit** is the most water that can be taken (when the river is above minimum flow) and ensures sufficient flow variability is maintained (e.g., maintain freshes, and low flow is not too long).

Harvesting allocation is a potential additional total water allocation that would only be available for harvest when river flow is above a specified high flow. This is a less reliable water supply.

Figures 4 and 5 illustrate these concepts.

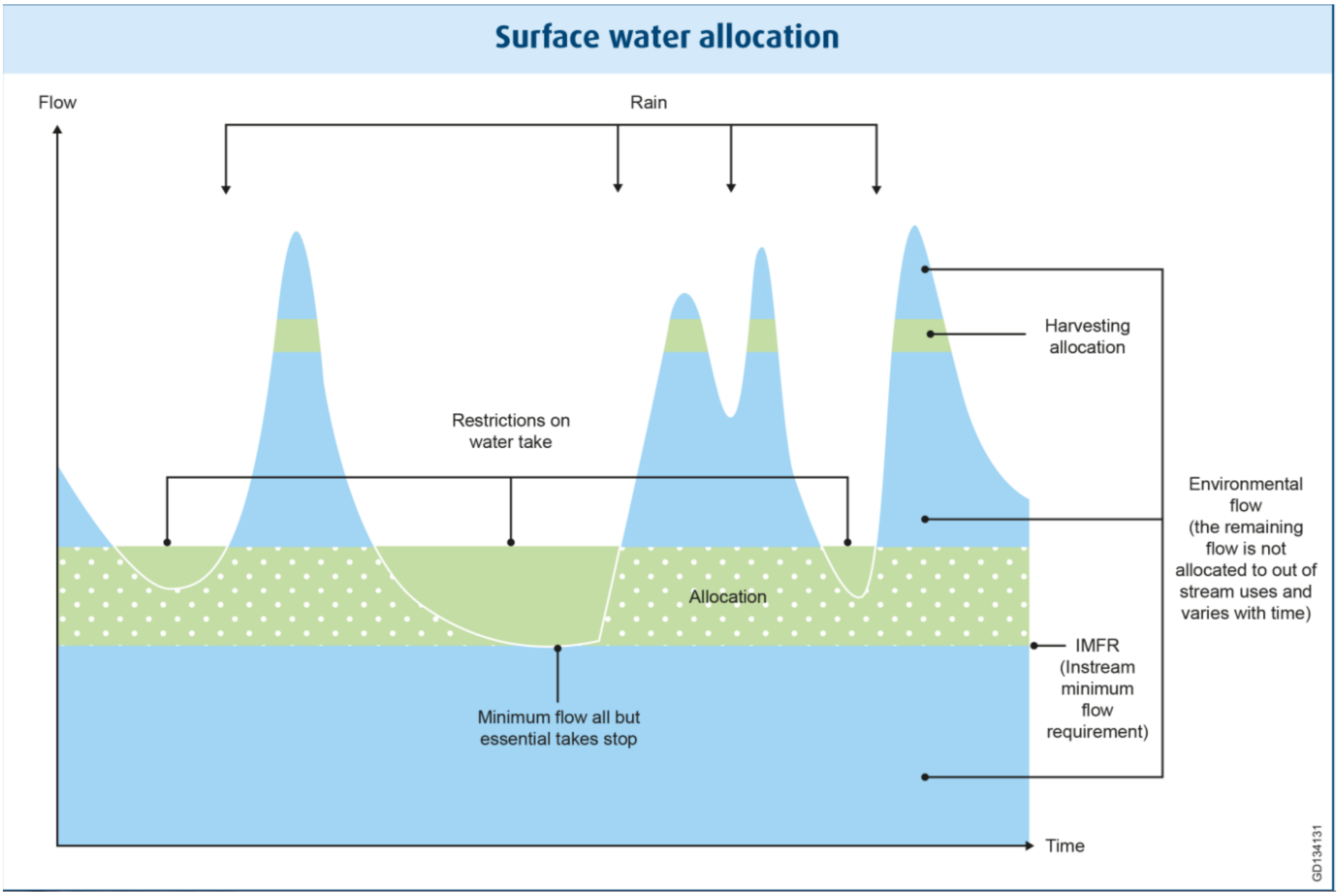


Figure 4: Surface water allocation diagram illustrating how minim flows and allocation limits relate to in-river flows

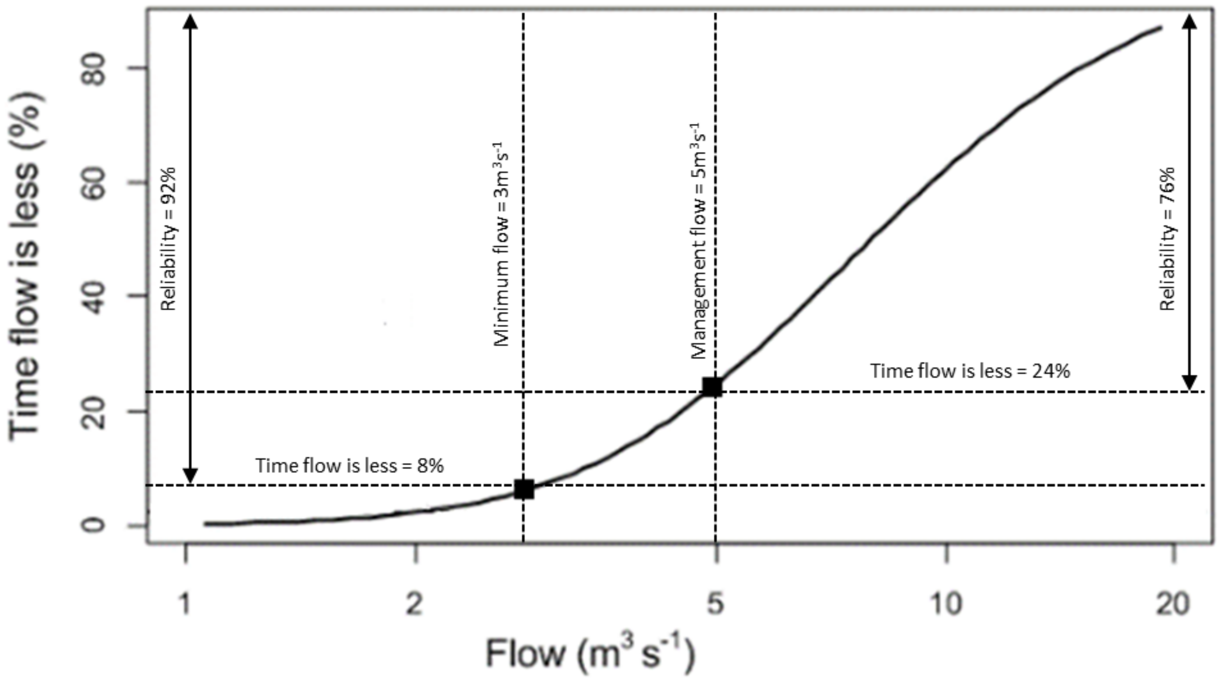
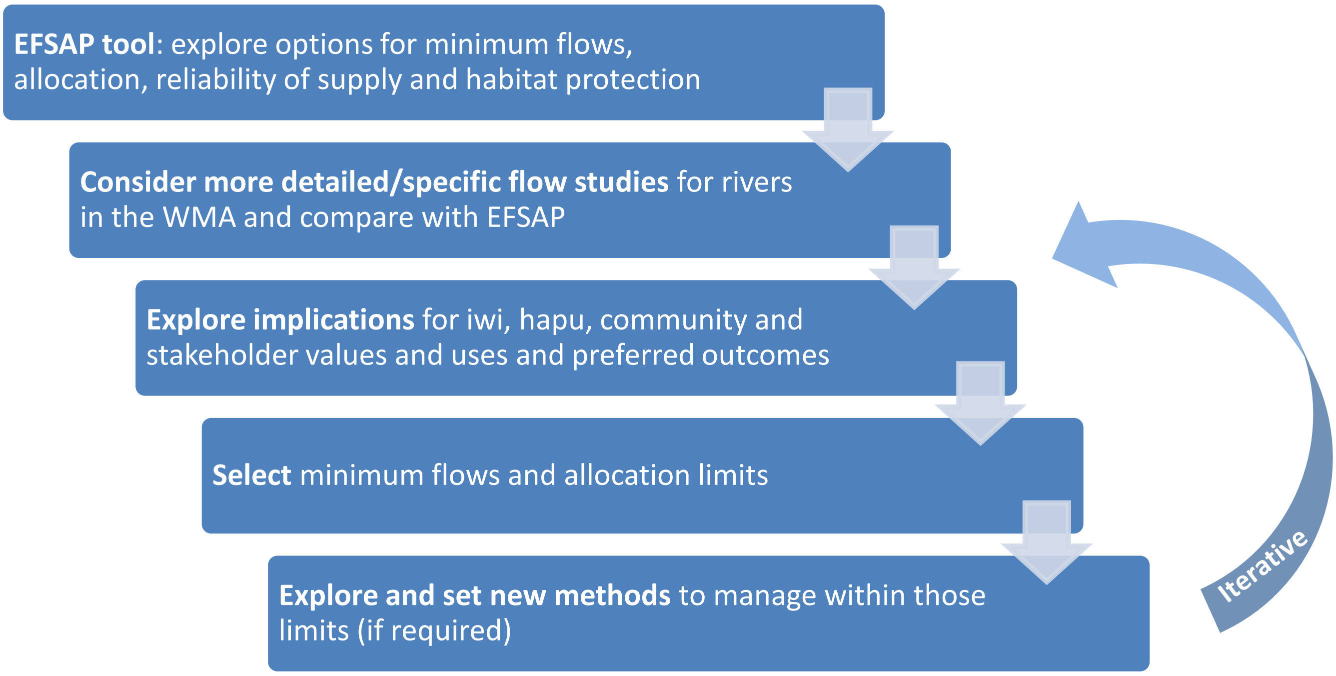


Figure 5: Flow duration curve demonstrating the relationship between minimum flow, management flow and reliability

5. How minimum flows and allocation will be identified in WMAs



- The EFSAP model results will be used to inform the discussion around setting water quantity limits, not to set limits directly.
- Existing information (e.g. detailed flow studies, including those for resource consent applications) will provide more resolution and may also provide information about flows needed for values other than fish (e.g., cultural and recreation values)
- There will be opportunities for the community to have their say through the community engagement process.
- If the new allocation limits are not currently met (i.e., the water is over-allocated) we will need to identify how we will "claw back" on water use to achieve them.
- Flow limits will be set by BoPRC councillor's after all previous steps have been satisfied and adopted in to a proposed regional plan change. This will be subject to public submissions, hearings and appeals.

6. What is EFSAP and how does it work?

The EFSAP model simulates the consequences of different flow management decisions for fish habitat, and the supply of water for out-of-stream purposes. This tool helps people to understand how different water allocation and reliability might affect fish habitat and also how habitat protection might affect water available for use.

EFSAP incorporates three other types of model:

1. The **River Environment Classification (REC)** is a spatial model which comprises a digital representation of the entire New Zealand river network. Within the Bay of Plenty Region there are 28,384 segments with an average length of 704m. Each segment contains information such as: catchment area, stream order, as well as climatic, topographical, geological, and land cover characteristics of the upstream catchment. EFSAP uses the REC model as a spatial framework with which to operate.

2. **TopNet** is a calibrated hydrological model developed by NIWA scientists that provides flow duration curves, mean flow, and MALF for each segment of the REC.

3. **Habitat flow models** link predicted flow to habitat availability for every reach in the REC framework. These are specific to species and, in some cases, life stage.

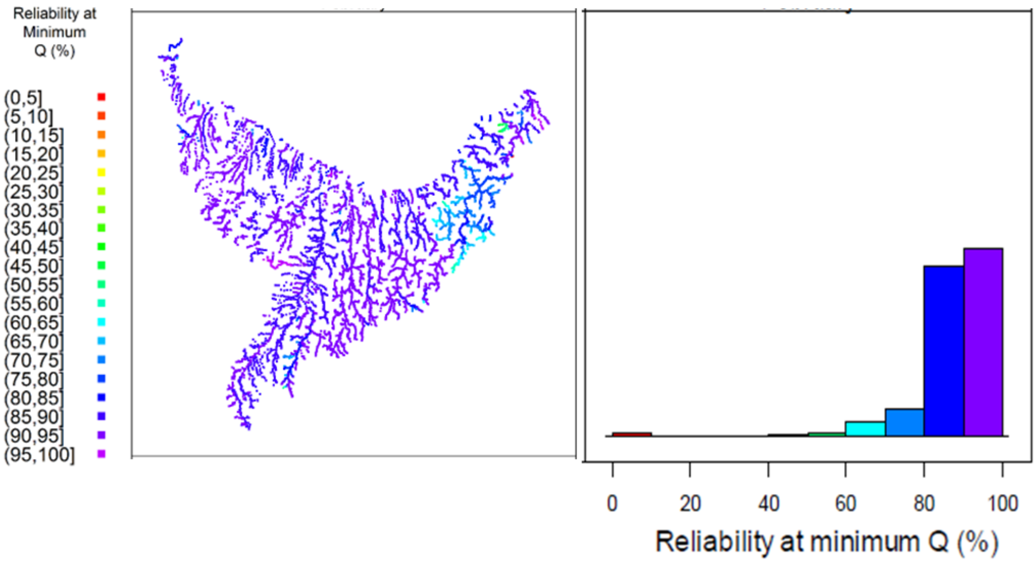
EFSAP is based on the analysis and simulation of four key variables:

- Flow changes relative to total allocation (ΔQ)
- Minimum flow (Qmin)
- Reliability of supply (R)
- Habitat change (ΔH)

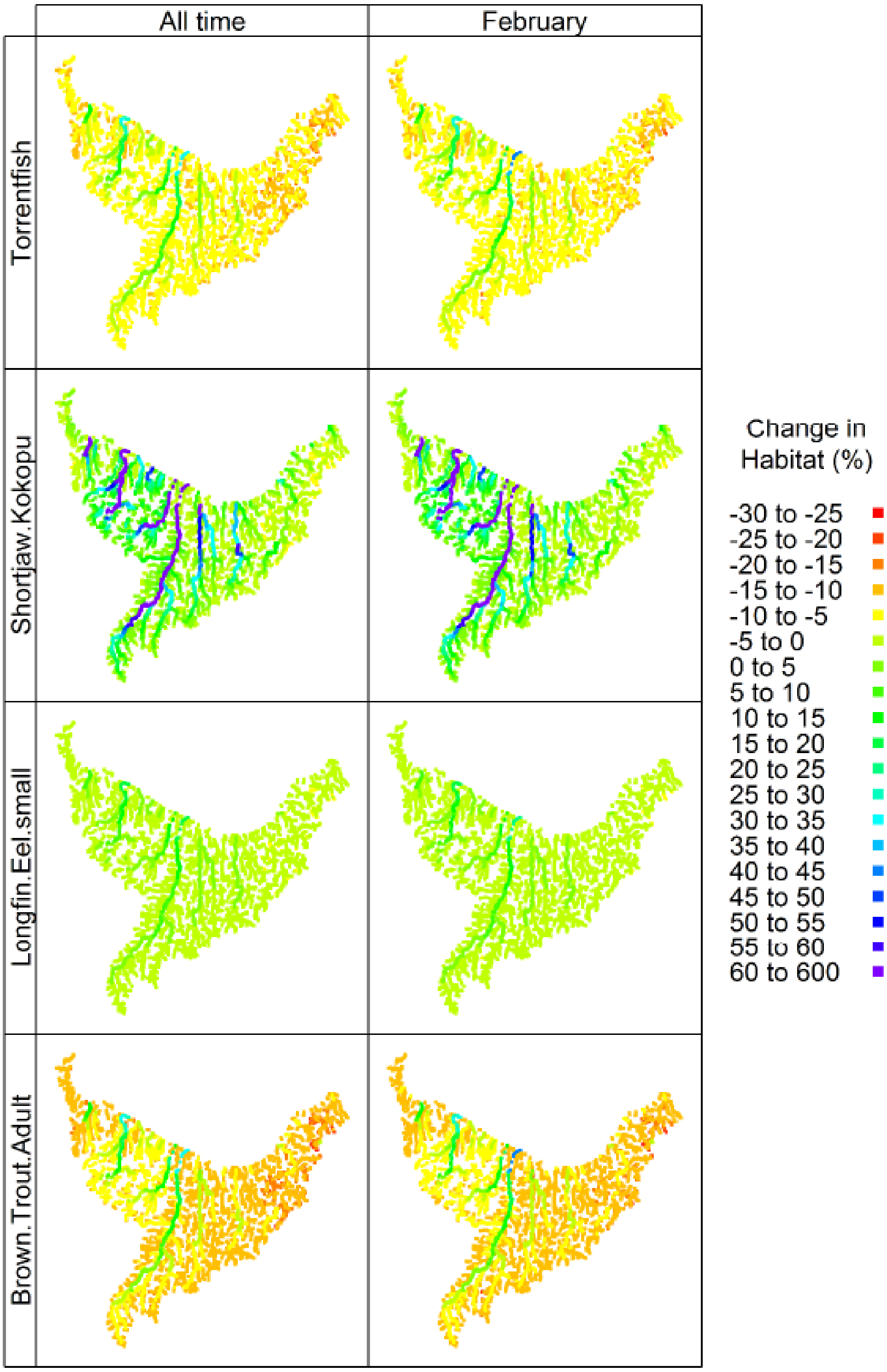
Simulations can be carried out using any two of these variables to specify the other two at all locations on the river network. For example, Qmin and ΔQ could be input to determine R and ΔH for any reach in the modelled network. Simulations can be run where calculations for each reach are independent of each other (i.e. upstream allocation has no effect on downstream results), or cumulative (i.e. where upstream allocation affects the amount of water downstream of the reach).

Outputs

Reliability Plots – Show where, and how many streams are likely to encounter reliability problems.



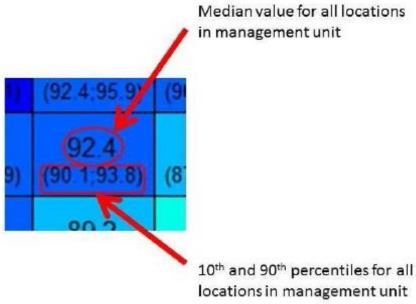
Species Specific Habitat Plots – Provide information about the extent of habitat change for a management scenario.

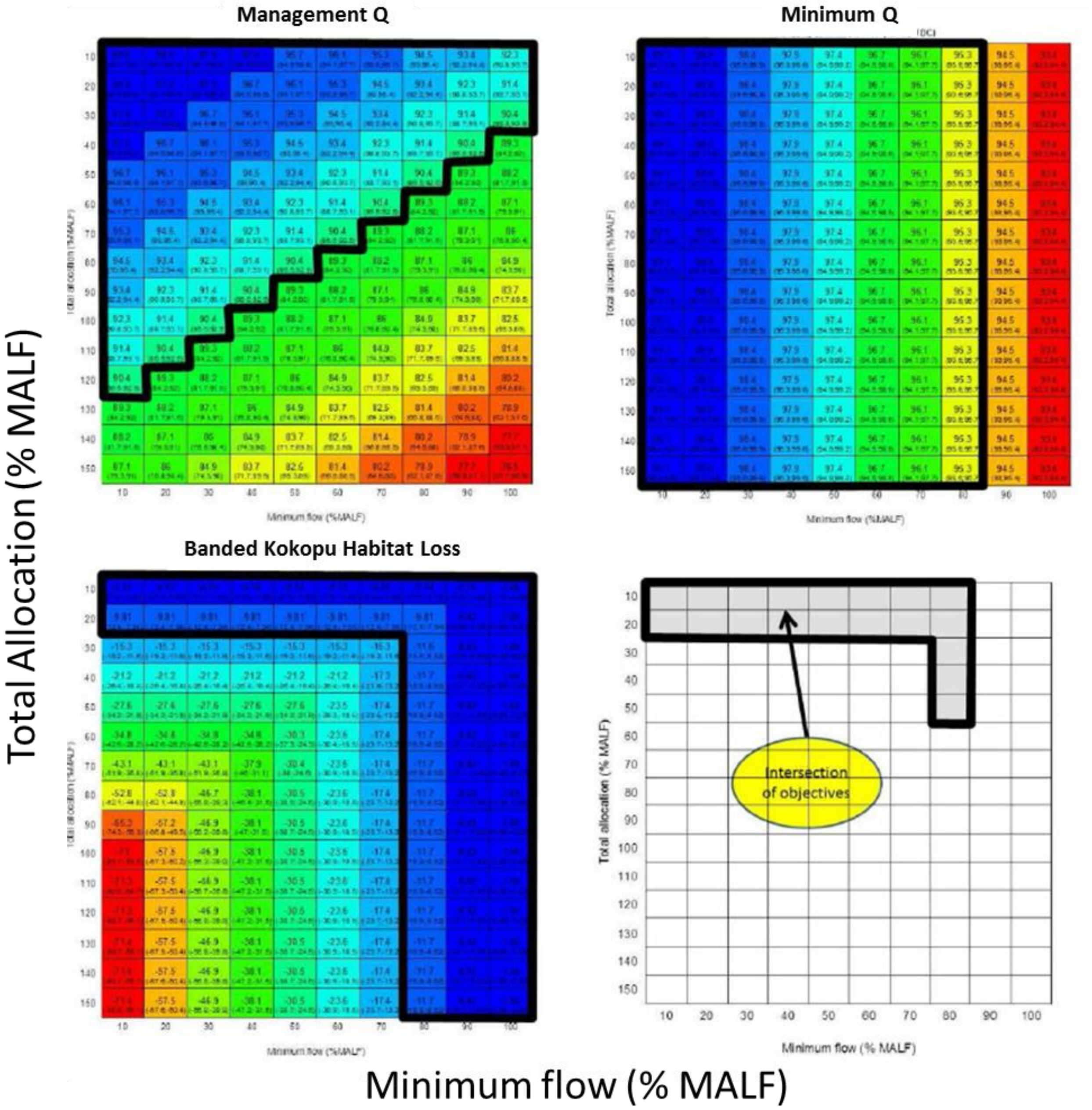

All time
February
Torrentfish
Shortjaw.Kokopu
Longfin.Eel.small
Brown.Trout.Adult
Change in Habitat (%)
-30 to -25
-25 to -20
-20 to -15
-15 to -10
-10 to -5
-5 to 0
0 to 5
5 to 10
10 to 15
15 to 20
20 to 25
25 to 30
30 to 35
35 to 40
40 to 45
45 to 50
50 to 55
55 to 60
60 to 600

Decision Space Diagrams – Can be used to determine which combination of limits satisfies a set of defined objectives. For example, if we set the arbitrary objectives of:

- median reliability at management flow ≥90%;
- median reliability at minimum flow of ≥95%;
- median loss of Banded Kokopu habitat ≤15%.

We could set Qmin and management flow according to the lower right pane.





How do we intend to use EFSAP?

Table 3: Inputs to the EFSAP model

	Range	Reason
Area	WMA specific	Environmental flows are being established within each WMA consecutively over time.
Stream classes	Small and large streams (≥ $10m^3/s$) in Volcanic Steep, Volcanic Gentle and Non-volcanic rivers	Biophysical classes recommended by Snelder et al (2016)[4] as reliability and habitat protection respond distinctly differently to allocation and minimum flow ranges.
Species	WMA specific	We decided to model the most common and "flow hungry" species within each WMA. This was decided upon by calculating the percentage of occurrence within each WMA (according to the NZFFDB) combined with probability of occurrence from FENZ predictive models, and applying a flow preference score based on work by Ian Jowett (2012)[5].
Stream Order	≥3	First and second order streams are omitted because many of these are unlikely to have flow for much of the year, and they are generally found in steep country where abstraction is unlikely to occur.
Habitat protection levels	100% down to 50%	Jowett (2012) suggested protection levels for a range of different species. While these ideally represent starting objectives for maintaining specified levels of ecosystem health, it would be useful for the EFSAP analyses to include decision diagrams showing what happens across a range of habitat protection levels (down to 50%). However, for species with DOC threat status, it is suggested that we use only the suggested protection levels is recommended by Jowett.
Reliability	100% down to 50%	EFSAP models are to be run with a reliability range between 50-100%. Then, if necessary in areas under abstraction pressure, communities could consider benefits of setting a "low reliability" allocation if other objectives were not met.
Minimum flow	100% MALF down to 50% MALF	This range provides simulation results for scenarios that are environmentally conservative as well as more resource-use enabling.
Allocation limits	10% MALF up to 80% MALF	
Timeframes	February (all years) and Annual	EFSAP analyses are to be run firstly using the February flow duration curves (FDCs), as this is when abstraction is usually highest, and flows usually the lowest. In this way, any models will be developed for times when maximum pressure is potentially being placed in the streams. The analyses will also be run for full year data.

[4] Snelder, T., Fraser, C., and Suren, A. (2016). Defining a biophysical framework for freshwater management units for the Bay of Plenty Region. Prepared by Land Water People for Bay of Plenty Regional Council. February 2016.
[5] Jowett, I. (2012). *Methods for setting ecological flow requirements in the Bay of Plenty Regional Water and Land Plan* (Rep. No. IJ1202).

APPENDIX 5

Rangitaiki Groundwater Limits Information Sheet 2018-03-28

Introduction to Groundwater Environmental Level Setting

1.0 Introduction

As part of work towards a Rangitāiki Water Management Area (WMA) plan change process for water quality and quantity, we will consider whether we can set more specific groundwater allocation limits for hydrogeological units underlying Rangitāiki WMA than the current region-wide allocation threshold (in Proposed Plan Change 9).

While Council has commissioned detailed groundwater modelling, the results will not be available for some time. In the mean-time, the technical information available is the same as used for setting conservative region-wide interim groundwater allocation limits. Amendment to these interim limits would largely be dependent on willingness to accept some increase in the risk of effects on groundwater levels and stream flows in return for some additional water availability / less over-allocation. There is also a risk that when future information is available from detailed models, the allocation limit will have to be amended up or down again. The allocation zones may also change to better reflect hydrological units.

This paper introduces groundwater concepts and information (sections 2-5), then presents two options for community group feedback/advice (sections 6-7). Community group advice will assist Council to decide whether to progress consideration of Rangitāiki specific groundwater allocation limits at this stage or not.

2.0 Groundwater models now and in the future

The technical groundwater quantity information Council currently relies on for the Rangitāiki Water Management Area (WMA) is based on a **simple water balance model**. The simple water balance model is based on limited information and has greater uncertainty associated with it compared to more complex groundwater models that require more information.

A 'steady state' (magnitude and direction of flow is constant with time) MODFLOW groundwater model is being developed for Rangitaiki to help inform setting more robust groundwater quantity limits and results are expected in December 2018. A 'transient' MODFLOW groundwater model (magnitude and direction of the flow changes with time) will then be developed. The transient model will provide a greater level of confidence than the steady state model. However, development of the transient model is dependent on the collection of seasonal groundwater level changes over a number of years and results will not be available for several years.

Options for setting groundwater limits based on the simple water balance model before either the steady state, or transient groundwater model results are completed, are discussed here.[1] Alternatively limits could be set based on the initial steady state MODFLOW groundwater model. This is likely to be more feasible in the Mid –Upper Rangitāiki than in the Lower Rangitāiki. This is because doing so in the Lower Rangitaiki will have implications on other adjacent WMA's that are not currently part of the community engagement process.

[1] Note: Any assessment of setting groundwater limits is based on effects on the groundwater and surface water bodies as a whole. Sufficient water may be available for allocation within groundwater limits to grant a consent. However, this does not necessarily mean there will not be any local effects on other water users or connected surface water bodies and these will continue to be assessed on a case by case (individual consent) basis.

3.0 Aquifer and Stream Types

There are generally two kinds of aquifers (or more accurately, two ends in the spectrum of types of aquifers): confined and unconfined as shown in Figure 1 below.

Unconfined aquifers are those into which water seeps from the ground surface directly above the aquifer. In an unconfined aquifer the water is not under pressure. A bore penetrating an unconfined aquifer will have a water level in it at the same level as the water table.

Confined aquifers are those in which an impermeable dirt/rock “capping” layer exists that prevents water from seeping into the aquifer from the ground surface located directly above. Water seeps into the aquifer from some distance away. In a confined aquifer the water is under pressure. A bore penetrating a confined aquifer will have a water level above the top of the aquifer.

Unconfined aquifers can interact with surface water bodies. **Gaining streams** are streams that receive water from these groundwater systems. **Losing streams** are streams that lose water to the groundwater system. Different parts of the same stream can be gaining and losing in different locations. The same part of a stream may be gaining or losing at different times. Streams may change between gaining and losing depending on the relative water levels between the stream and the groundwater system. Taking groundwater reduces the water level/pressure in the aquifer and may intercept groundwater discharging to a stream as baseflow, reducing the amount of water discharging to the stream, or even drawing water from the stream. The greater the amount of water taken from the ground, the greater the potential is for effects on baseflow to streams.

Figure 1 Groundwater movement in an aquifer (confined and unconfined parts of the aquifer are in blue)

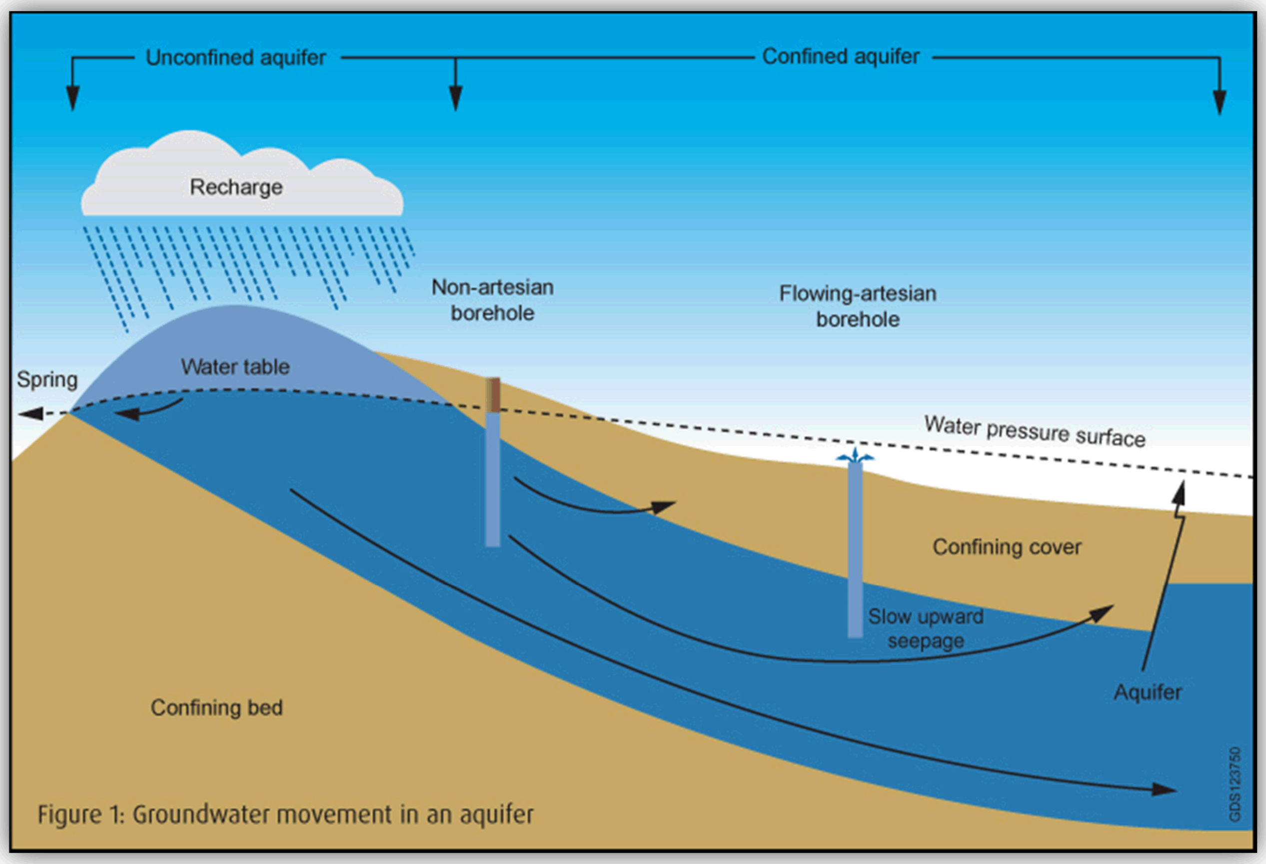


Figure 1: Groundwater movement in an aquifer

4.0 Geology and Allocation Zones

The Rangitāiki WMA is geologically complex. The Mid-Upper Rangitāiki groundwater area has the same boundary as the surface water catchment boundary above the Matahina Dam. The aquifers in the Rangitāiki Plains area extend across a number of different surface water catchments including: the Tawawera River catchment, part of the Rangent and part of the Whakatāne River catchment. The MODFLOW groundwater model being developed includes the aquifers across the wider Rangitāiki Plains.

4.1 Mid-Upper Rangitāiki

The simplified surface geology and structure of the Mid-Upper Rangitāiki area is presented in Appendix 1. The area has greywacke basement in the Ikawhenua Ranges to the west. These rocks are separated by north-south trending faults from volcanic deposits to the east. The volcanic rocks to the east are predominantly ignimbrites (Whakamaru Group, Matahina Formation and Kāingaroa Formation) and more recent localised pumice deposits (Okataina volcanics and Taupō Group). There are Tauranga Group sediments on top within the Galatea, Waiohau and Minginui basins located along the north-south trending faults. The greywacke rocks are generally not productive aquifers, except where they are highly fractured. The ignimbrites, Tauranga Group and pumice are productive aquifers. The aquifers that groundwater is taken from are generally assumed to be unconfined.

Council's current simple water balance model establishes groundwater allocation zones for the purpose of managing groundwater allocation and use. These zones are based on surface water catchment boundaries and the simplified hydrogeological units. Some of the zones actually contain different hydrogeological units at greater depth that may not be unconfined. The groundwater allocation zones for the Mid-Upper Rangitāiki area are presented in Appendix 2.

4.2 Rangitāiki Plains

The simplified structure and geology of the Rangitāiki Plains is presented in Appendix 3. The greywacke basement in the area has been subjected to on-going block faulting that has formed the Whakatane Graben. The graben is a basin like structure created by the block faulting. There are a number of major faults in the area. The Edgecumbe Fault has caused the major displacement of up to 2.3km vertically. The eight major geological units overlying the greywacke basement are:

- Q1 non-marine: recent terrestrial sediments (various)
- Q1 marine: recent marine sediments (pumiceous sand)
- Q2-Q4 non-marine: older terrestrial sediments (gravel)
- Q5 marine: Marine sands
- Q6-Q8 non-marine: older gravels
- Volcanics undifferentiated: Various volcanic material (in the south)
- Matahina Ignimbrite
- Greywacke basement (oldest)

The Matahina Ignimbrite is a productive aquifer. It becomes increasingly confined by the overlying Tauranga Group material toward the coast.

Groundwater allocation zones were established for the purpose of managing groundwater allocation and use based on surface water catchment boundaries and the groundwater flow direction. The groundwater allocation zones are not separate aquifers or aquifer boundaries. They are simply management areas. Within these zones below the ground surface there are a series of different geological layers that form different aquifers. Groundwater can move between groundwater allocation zones. The groundwater allocation zones for the wider Rangitāiki Plains and area within the Lower Rangitāiki WMA are presented in Appendix 4. The MODFLOW groundwater model will better represent hydrogeological units.

5.0 Water Balance

Simple water balance calculations were undertaken to estimate the amount of groundwater recharge in each of the zones. Groundwater recharge is the portion of the rainfall that infiltrates into the ground to replenish the aquifer. The calculations were generally based on rainfall minus actual evapotranspiration.[2]

A groundwater balance in each allocation zone was then determined by calculating groundwater recharge minus groundwater outflow to surface water i.e. 'baseflow' The aim was to maintain groundwater levels to preserve stream base flow. Surface water baseflow estimates were based on stream flow information.

In summary, the simple calculations for each groundwater allocation zone were:

Rainfall – evapotranspiration = groundwater recharge

Groundwater recharge – baseflow = groundwater balance.

6.0 Alternative Options for Groundwater Allocation Limits

The interim allocation limits in the Region-wide Proposed Plan Change 9 (PPC9) are based on 35% of the groundwater balance calculated in each allocation zone.

Two options are considered for setting Rangitāiki specific groundwater limits before the MODFLOW model results are available.

Option 1 is to stick with the PPC9 limits based on 35% of the calculated groundwater balance. Option 2 is to set limits based on a greater percentage of the calculated groundwater balance. 50% of groundwater balance was selected. Potentially this could range from 35% up to 100% depending on the level of risk of alteration in groundwater levels and surface water flow that is accepted.

The following risk guidance for water balance models has been broadly estimated by scientists:[3]

- Low (up to 10% of **recharge**)
- Medium (11% to 25% of **recharge**)
- High (over 25% of **recharge**)

Groundwater allocation limits for the two options were expressed in terms of % of groundwater **recharge** within each groundwater allocation zones in order to compare them with the guidance provided above. Results are presented in Table 1 below.

A comparison of consented allocation to limits based on the two options is presented in Appendix 5.

[2] The approach used to estimate the amount of groundwater recharge in the Mid-Upper Rangitāiki was slightly different. It also included surface water run-off inflows and outflows. Quick flow was not included in the Rangitāiki Plains because good estimates of surface water inflows and outflows were not available at points into and from the Rangitāiki Plains.

[3] The level of risk will be different for other models that are expected to have greater levels of confidence. The proposed National Environmental Standard on Ecological Flows and Water Levels, Discussion Document, suggested 15% and 35% of recharge depending on the type of aquifer. This was rhod used to calculate recharge.

Table 1 Allocation limit options as % of groundwater recharge

Groundwater Management Zone		**Option 1 – PPC9 (35% of groundwater balance) % of recharge**	**Option 2 – alternative (50% of groundwater balance) % of recharge**
Mid-upper Rangitaiki	Headwaters	12.0	17.2
	Kaingaroa South	12.3	17.5
	Galatea Plain	12.3	17.5
	Minginui	12.3	17.5
	Kaingaroa North	12.3	17.5
	Pokairoa	12.3	17.5
	Waiohau Basin	12.3	17.5
	Matahina	10.1	14.4
	Ikawhenua	12.3	17.5
Lower Rangitāiki	Edgecumbe Catchwater	14.3	20.5
	Mangamamako	0	0
	Ngakauroa Stream	29.8	42.6
	Nursery Drain	5.4	7.6
	Rangitaiki Dunes	0	0
	Reids Central Canal	30.8	44.0
	Waikowhewhe	0	0

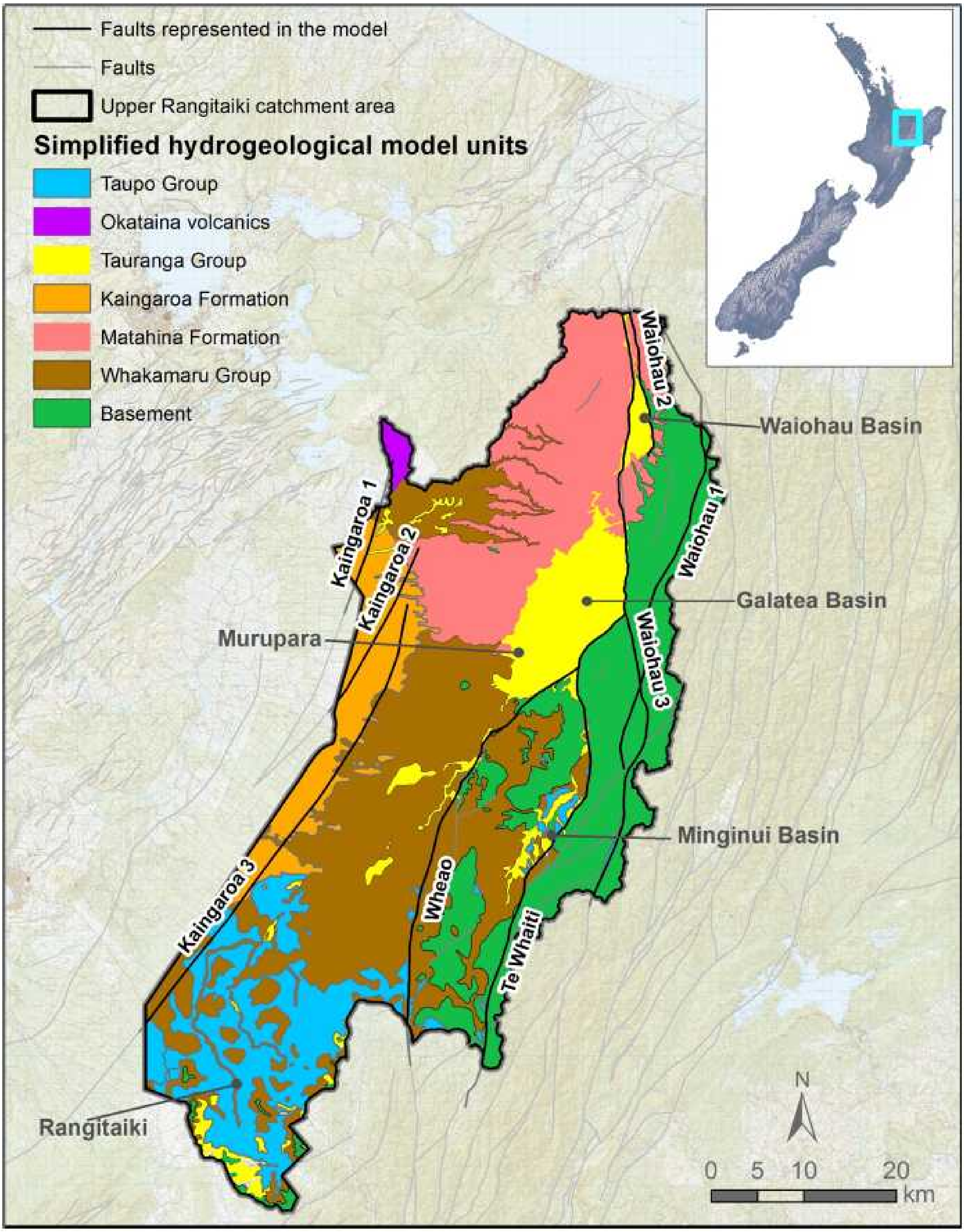
7.0 Options Assessment

Advantages and disadvantages of the two option considered are summarised in Table 2 below.

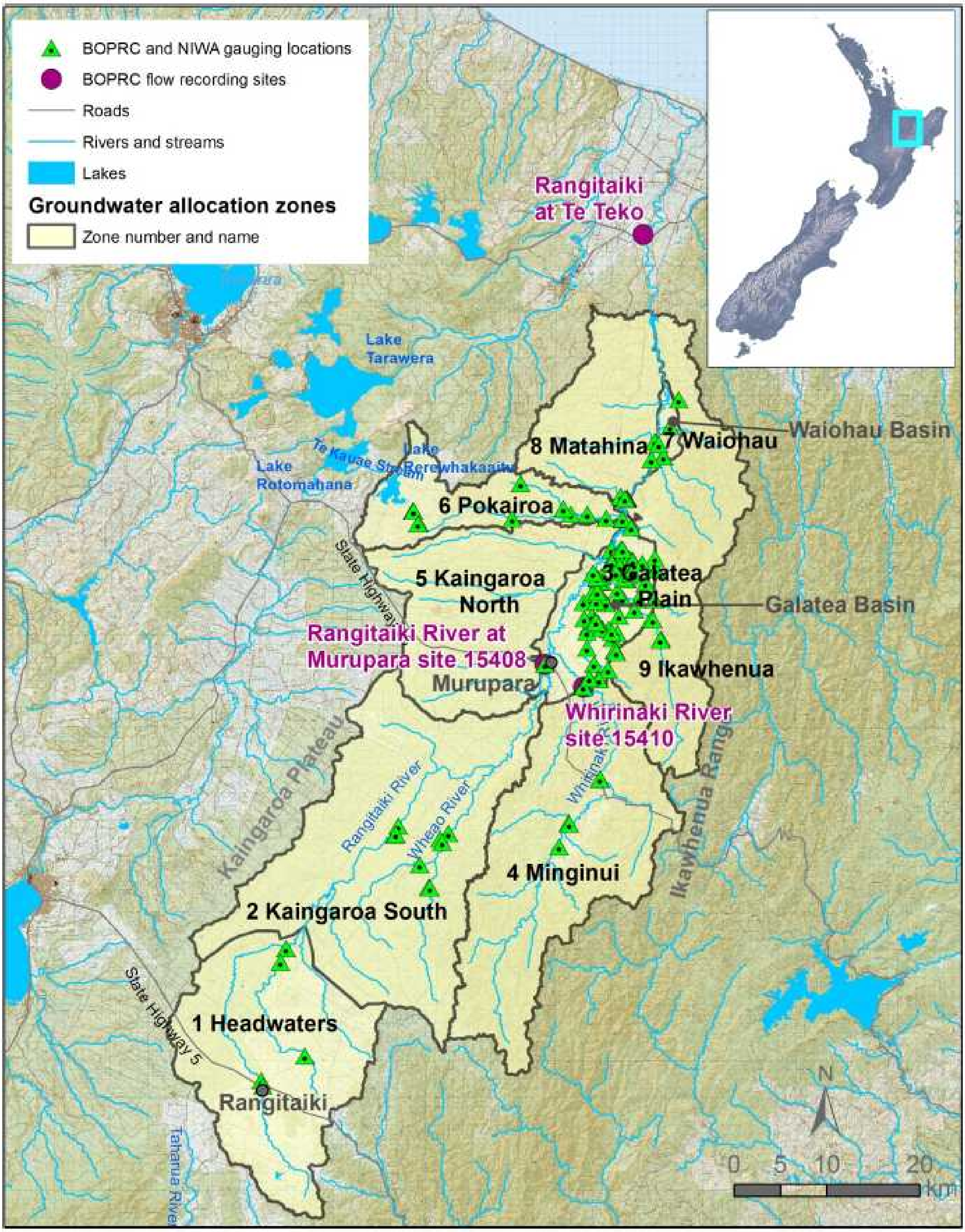
Table 2 Assessment of options

Option	PPC9	Alternative
Advantages	• Low risk for Upper Rangitaiki • Low/medium risk for Rangitaiki Plains • Maintains status quo • Accommodates existing authorised takes except in 4 Rangitaiki Plains zones • Minimises allocation clawback potential in the future if MODFLOW modelling shows a need for more restrictive limits • No further change process required until more reliable/detailed modelling is available to defend it.	• Accommodates existing takes except in 4 Rangitaiki Plains zones • In some zones more water would be available; or the degree of over allocation would be reduced.
Disadvantages	• Does not accommodate existing authorised takes in 4 Rangitaiki Plains zones • Greater development constraint.	• Medium risk Upper Rangitaiki • Medium/high risk Rangitaiki Plains • Increase allocation clawback potential in the future if MODFLOW modelling shows a need for more restrictive limits • Relies on current simple water balance model and management zones.

Appendix 1


Faults represented in the model
Faults
Upper Rangitaiki catchment area
Simplified hydrogeological model units
Taupo Group
Okataina volcanics
Tauranga Group
Kaingaroa Formation
Matahina Formation
Whakamaru Group
Basement
Waiohau 2
Waiohau Basin
Kaingaroa 1
Kaingaroa 2
Waiohau 1
Galatea Basin
Murupara
Waiohau 3
Minginui Basin
Kaingaroa 3
Wheao
Te Whaiti
Rangitaiki
N
0 5 10 20
km

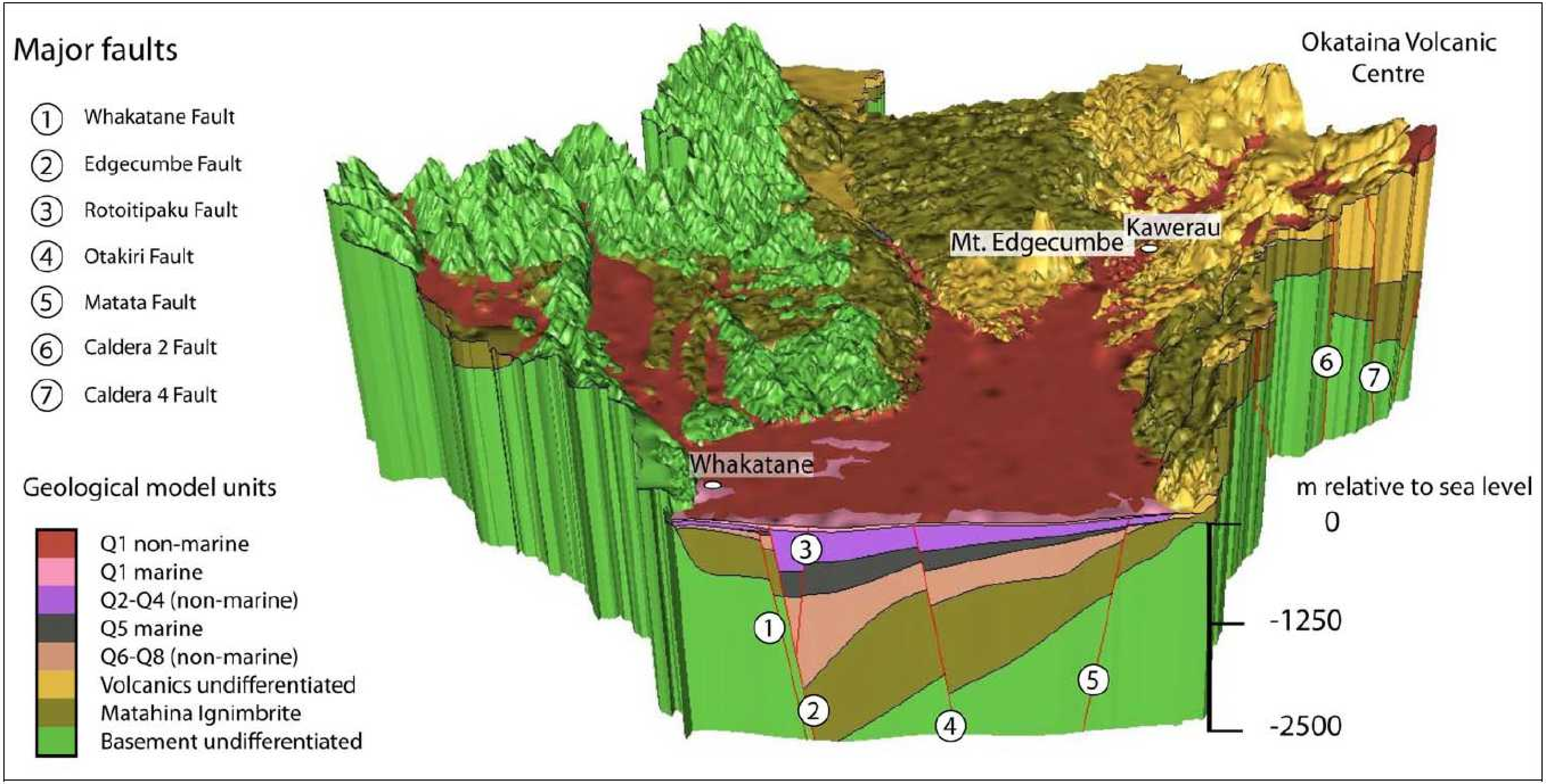
Appendix 2



BOPRC and NIWA gauging locations
BOPRC flow recording sites
Roads
Rivers and streams
Lakes
Groundwater allocation zones
Zone number and name
Rangitaiki at Te Teko
Lake Tarawera
Lake Rotomahana
Te Kauae Stream
Lake Rerewhakaaitu
8 Matahina
7 Waiohau
Waiohau Basin
6 Pokairoa
5 Kaingaroa North
3 Galatea Plain
Galatea Basin
Rangitaiki River at Murupara site 15408
Murupara
9 Ikawhenua
Whirinaki River site 15410
State Highway
Kaingaroa Plateau
Rangitaiki River
Wheao River
Whirinaki
4 Minginui
Ikawhenua Range
2 Kaingaroa South
1 Headwaters
State Highway 5
Rangitaiki
Taharua River
N
0 5 10 20 km

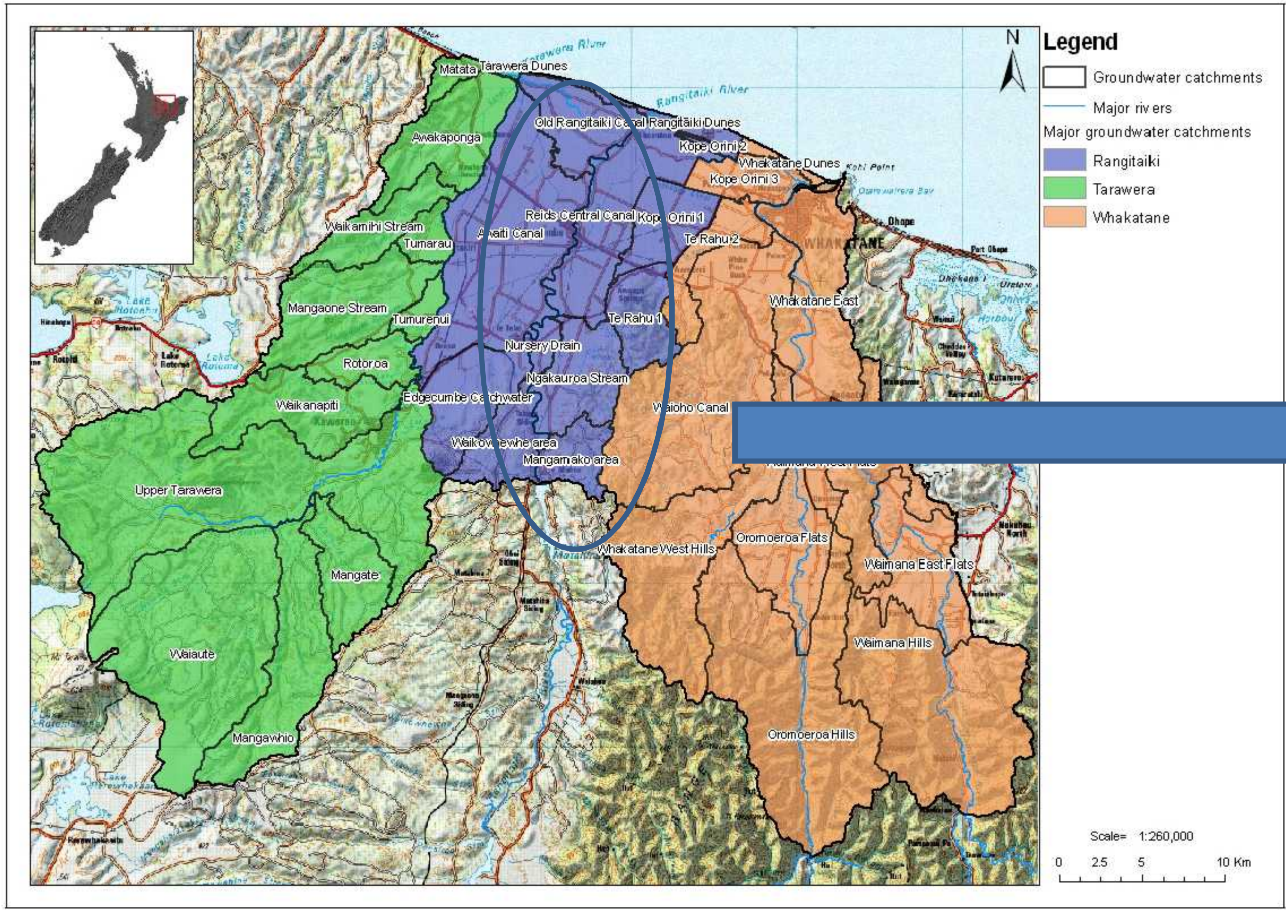
Appendix 3

Three dimensional model of the Rangitāiki Plains geological units and faults

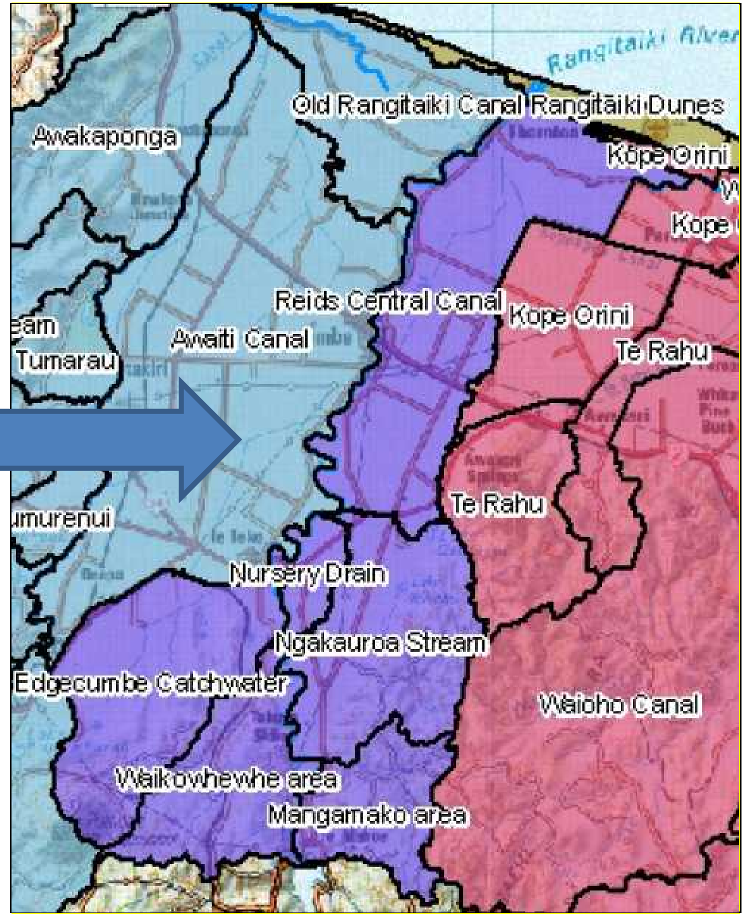


Appendix 4

Groundwater allocation zones for the wider Rangitāiki Plains



Groundwater allocation zones within the Lower Rangitaiki WMA (shown in purple)



Appendix 5

Comparison of consented allocation to limits based on the two options

Groundwater Management Zone		Consented Allocation[4] m³/year	Option 1 – PPC9 (35% of groundwater balance) m³/year	Option 2 – alternative (50% of groundwater balance) m³/year
Mid-upper Rangitaiki	Headwaters	1460	35,320,320	50,457,600
	Kaingaroa South	0	44,426,340	63,466,200
	Galatea Plain	4,720,890[5]	8,498,952	12,141,360
	Minginui	80,520	45,198,972	64,569,960
	Kaingaroa North	0	27,042,120	38,631,600
	Pokairoa	698,130	15,066,324	21,523,320
	Waiohau Basin	0	1,545,264	2,207,520
	Matahina	0	16,556,400	23,652,000
	Ikawhenua	0	22,792,644	32,560,920
Lower Rangitāiki	Edgecumbe Catchwater	719,021	3,355,430	4,793,472
	Mangamamako	3,402,734	0	0
	Ngakauroa Stream	4,487,573	4,845,506	6,922,152
	Nursery Drain	741,096	143,489	204,984
	Rangitaiki Dunes	113,530	0	0
	Reids Central Canal	785,246	5,750,590	8,215,128
	Waikowhewhe	1,535,803	0	0

[4] Based on the Bay of Plenty Regional Council report, Assessment of water availability and estimates of current allocation levels October 2016, for the Lower Rangitaiki and the method used in the report to calculate allocation in the Mid-Upper Rangitaiki
[5] Includes recently expired consent for 118,730m³/year

APPENDIX 6

Notes from Rangitaiki Freshwater Community Group Workshop 7 on 3 April 2018

Rangitāiki Freshwater Futures Community Group Workshop 7 Notes: Update, mitigation bundles and water quantity

Galatea Hall, 50A Mangamate Road, Galatea

Tuesday 3 April 2018 commencing at 9.08am

Members present: Larry Wetting (Chair), Alamoti Te Pou (Deputy Chair), Alan Law, Atamira Nuku, Bill Clark, Bill Kerrison, Cathy Brown, Christina Bunny, James Doherty, John Gibson, Kerry Snowden, Kirsty Joynt, Linda Conning, Mark Ross (partial), Matt Gow, Ngapera Rangiaho, Nicholas Woodley, Tom Lynch

Apologies: Beverley Hughes, Colin Maunder, Craig Rowe, Daryl Christie, Earl Rewi, Matt Osborne, Nick Doney, Steve Brightwell, Wetini Paul

Other absent members: Gareth Boyt, George Johnston, Robert Pouwhare

BOPRC Staff present: Simon Stokes (Relationship Manager), Kerry Gosling (Facilitator), Stephanie Macdonald (Facilitator), Nicki Green (Senior Planner – Water Policy), Santiago Bermeo (Senior Planner – Water Policy), James Dare (Environmental Scientist), Andrew Millar (Senior Planner – Water Policy), Michelle Lee (Planner – Water Policy, scribe).

External presenter: Lee Matheson (Perring Ag Consultants)

Related documents circulated prior to or at the meeting:

- Workshop briefing paper – Mitigation bundles and baseline profit estimations.
- Introductory information: Setting environmental flows in Water Management Areas.

1 Welcome /Updates/Focus of the day

Simon Stokes welcomed everyone to the meeting. James Doherty opened the workshop with a karakia. Facilitators introduced Nicholas Woodley from the Whakatāne District Council.

1.1 Agenda, purpose and updates

Nicki explained the work programme and current progress. Kerry introduced the purpose of the workshop, and the agenda for today.

- National, regional and Plan Change 12 updates
- Mitigation bundles and costings
- Rangitāiki groundwater quantity
- Surface water quantity
- Plan Change 9 update – dairy wash-down takes: issues in upper Rangitāiki
- Next steps.

Key presentation slides are available online.

Confirmed the purpose of the group (as outlined in slides). The Council is also engaging with iwi and hapū on this work in parallel. Staff are responsible for presenting the agreed and different views gathered to Councillors who are the decision makers.

2 National and Regional update

Council is keeping a watching brief on possible water management changes brought in by the new Government. The Minister for the Environment signalled in his speech to the Resource Management Law Association the Government may introduce changes to policy and regulation relating to freshwater management. It is possible there will be a new sediment attribute in the NPSFM. Halting the decline in water quality is a priority for the new Government. How this will be done has yet to be determined.

Nicki explained the "draft regional 'swimmability' targets". The modelling undertaken by the Ministry for the Environment is showing the region is meeting the national target already. But there is an expectation further improvements will be made in the region to help contribute to meeting the national target. These regional targets do not replace or override the work we are doing in this WMA to set objectives and limits for swimmability/primary contact recreation.

Regional updates included: Te Maru O Kaituna - river document, RPS Change 3 (Rangitāiki River) and Plan Change 9 (Water Quantity).

Question / comments:

What is the nature of the appeals on the Regional Policy Statement Change 3 (Rangitāiki River)? A: Two appeals have been lodged. Details are publically available on this webpage: https://www.boprc.govt.nz/change3.

What is the status of the Rangitāiki River in terms of Swimmability? A: The Government's national modelling is high level and does not include all tributaries. Modelling results showed the water quality in the Rangitāiki River is suitable for swimming (see LAWA or Council websites for results). Not all swimming spots were modelled nationally for swimming water quality targets.

Are swimming sites off the main river stem, like Whirinaki being considered? A: The Government's modelling probably does not include the Whirinaki. The Council's water quality modelling for the whole catchment is currently progressing. It includes *E.coli* contamination.

3 Project update

Nicki explained where we are in the process and gave a quick reminder of what had been presented in previous workshops. This included water quality modelling. The results of the modelling work are expected to be available in May/June.

The key part of this workshop is considering mitigation options.

4 Mitigation bundles and costings

Santiago Bermeo advised this work is related to the river quality modelling work. Good management practice and mitigation option material was drawn from the Group's previous input during workshops 5 and 6. Furthermore, an online survey (to the Freshwater Futures community group members only) was conducted after that workshop. While some useful feedback came through, the response rate was low.

Work was commissioned from PerrinAg and Landcare Research on mitigation bundles, costs and effectiveness. The mitigation measures are grouped into four bundles: Current, M1, M2 and M3 (the terminology has changed from 'good management practice' and 'additional mitigations'). These bundles will be factored into the modelling work. The feedback also suggested a list of potential land use restrictions and measures to further management point source discharges. Those are not included in the mitigation bundles and will be considered later.

The mitigation bundle recommendations are based primarily on a literature review and the consultant's experience of farming systems in the catchment. Staff will also discuss these recommendations with the dairy, kiwifruit, sheep & beef and forestry industries.

This work is exploratory at this stage. No mitigation measures or management options have been finalised yet.

Modelling will never be 100% correct, we are trying to represent reality the best we can and look at relative changes. The proposed mitigation practice bundles are based on expected effectiveness and cost, but this will be tested through the upcoming analysis.

Mitigation bundle costs will generally be expressed in terms of operating profit (Earnings before Interest and Tax (EBIT)), not net profit. This is because we are mainly interested in the impact of mitigation practices across similar farming systems, regardless of capital structure or individual financial circumstances [e.g. whether they own their farm/orchard freehold or not]. EBIT allows us to compare the relative difference in cost between options, regardless of different capital structure or individual financial circumstances.

Question / comments:

Are the mitigation options specific to the Rangitāiki? A: Not at this point. The draft mitigation bundles are the same for Rangitāiki and Kaituna catchments. They may need to be separated into the separate catchments later on if that was deemed to be necessary.

Has the work been peer reviewed? A: Not yet, other than internally within BOPRC, Perrin Ag and Landcare Research.

People currently undertake different mitigation options to various degrees. How is current management practice determined? A: The modelling is based on average practices for each farming/growing system. Current management practice is based on information from the prior workshops, the results from the survey and the consultant's knowledge of the catchment. Upcoming discussions with industry bodies will also help to better define current practice.

Is economic/price volatility considered? A: Yes, some sensitivity analysis on changes to output prices, input costs will be undertaken.

We have areas of significant land use change. Land use is changing from dairying to forestry as compliance costs are becoming too expensive. Is land use change being considered? A: We are looking at land use change. However, it is not part of the work on mitigation bundle options but rather development scenarios, discussed previously with the community group. Land use change will have a significant effected on water quality.

Have you considered the productivity of low class land? A: Yes, some of the mitigation practices include retirement of marginal low class land, which would generally be less productive.

Would the subsidised costs be accounted for? A: The costs considered here are the 'absolute' cost excluding subsidies, but we can discount subsidies later on.

Are environmental costs included? A: At present we are just looking at farm costs.

Is the value of the land included in the cost of each mitigation option? No, although changes in profitability may affect land value. [It is very tricky to predict the impact of environmental regulation on land values, see for example: https://www.agfirst.co.nz/project/effect-environmental-constraints-land-prices/]

The use of EBIT (Earnings Before Interest & Taxes) was questioned. A: See the full report and the notes above about the use of EBIT.

4.1 Activity - Mitigation bundles and costings

Staff asked for members in their sector group to provide focused feedback on the mitigation bundles. Mitigations are targeted at reducing nitrogen, phosphorous, sediment and *E.coli.*

Groups were provided with the mitigation bundle worksheet, for members to consider mitigation bundles. The key questions were:

1. **Are the mitigations in the right bundles? Why / why not?**
2. **Are there any sector appropriate mitigations missing that should be added?**
3. **Are any of the listed mitigations out of the question?**

The facilitators also asked the group to select the top three mitigation options for each bundle.

Clarification about what we call small, medium and large streams. Not formally defined but for the purposes of today, generally*:*

- The Dairy Accord applies to a stream that is deeper than 30cm (about reaching below the knee) and wider than 1m. The Dairy Accord required these streams to be fenced-off. So consider anything less than this to be a small stream.
- If the land has been drained and the drain was not a natural stream, it is not classified as a "stream".
- If a natural stream has been straightened, it is still classified as a stream.
- "Streams" in this exercise only refers to permanent streams, not ephemeral/intermittent streams.
- Large rivers might be considered as those with average flow greater than $10m^3/s$, e.g. the main stem of Kaituna.

The output of this activity by areas is summarised in Appendix One of this workshop note.

Question / comments:

It is challenging for members to assess whether a certain practice is currently common across the industry in the catchment or not. Fonterra is taking action against the odd few farmers that don't comply with the Dairy Accord. Letters have been sent to farmers that don't comply. Their milk will not be collected unless they comply.

Farmers only use fertiliser when it is necessary, because fertiliser use is expensive. It's up to farmers to decide on the application, rather than just rely on the advisors who are selling the fertilisers. There can be differences in opinion on how much fertiliser use is necessary.

Widening planted buffer zone around drains makes it more difficult to clean drains out.

Members suggested:

- Removing the word "planted" in dairy pasture bundles one and two: there was a discussion about using the word planted, or vegetated, or managed buffers and concerns with whether pest plants like blackberries would be considered to be "planted". "Vegetated and managed" was agreed.
- Changing the word "infrastructure" to "technology" in dairy pasture mitigation bundle three.
- There was a discussion about the difference between permanent changes in stocking rates in M3 (i.e. to reduce intensity) and temporary or seasonal reductions in M2 (to reduce discharge during riskier periods).

Members also discussed the following options/considerations:

- Cut and carry zone. Lee noted this is only a mitigation if the fodder is carried out of the catchment.
- Milking once-a-day. Lee noted it is nitrogen importation that makes the difference, not the frequency of milking.

- Managing bringing in stock feed, which is related to grass growth.
- Fit for purpose riparian margins – steep areas may need a wider buffer zone. Mitigation riparian plants and safe rongoa use. Using indigenous plants for improving water quality was discussed. Some plants are used as rongoa. What effects could contaminants have on native plants? Using Mahoe instead of willow to stabilise river banks could be considered.

5 Baseline financial modelling

Lee presented and explained the baseline financial modelling for various farming systems.

6 Update Region-wide Water Quantity Plan Change (PC9) – addressing dairy wash-down take: issues in upper Rangitāiki

A resource consent is required to take and use water unless it is provided for under the Resource Management Act 1991 (RMA), or there is a rule in a regional plan that allows for water to be taken as a permitted activity. If water requirements for dairy farm wash-down and cooling water exceed the volume allowed to be taken as a permitted activity a resource consent is required. There are dairy farms in the upper Rangitāiki (and across the region) that now require a resource consent for wash-down and cooling as use is greater than the permitted activity threshold (under the operative regional plan). A rule in PC9 makes such consent applications a controlled activity for a period of 12 months.
A range of submissions in support and against were received. Hearings have been held and the hearings panel will issue their recommended decisions in June.

To find out more information about the Region-wide Water Quantity Plan Change (PC9), including the fact sheet and the progress, visit the webpage https://www.boprc.govt.nz/waterquantity.

Question / comments:
Is council recommending that water meters be required to determine the efficient use of water? Is a water meter required for dairy farm wash-down and cooling water? Water can be taken for stock drinking under the RMA without a resource consent. Under PC 9 all resource consents to take water require a water meter. Information for metering requirements for water used on a dairy farm will be provided.

7 Surface water flow

To prepare members for the next workshop, James Dare, introduced the Environmental Flows Strategic Allocation Platform tool (EFSAP) for setting surface water quantity limits. At this stage, no feedback is sought.

- EFSAP will be used to help set environmental flows for fish habitat needs.
- Flow is important for stream ecology, as well as from cultural, fishery and recreation perspective.
- Maintaining flow variability in streams is important.
- Defining the minimum flow requirements and the reliability of supply will help support decisions on setting surface water quantity limits.
- Appropriate surface water quantity limits provide for flow variability in the stream.
- Further work with iwi and hapū to set flows and levels for cultural values is required.

Questions and comments:
When the river morphology changes, how would it be reflected in the flow? A: While the total quantum of water volume does not change, the change in water levels may have impact on freshwater values, like swimming.

Does Council's model take account for the flow and levels suitable for kids swimming and diving off the bridge in Te Teko? EFSAP does not address recreational water level needs. Further work is required to address these needs.

Has there been any general change of flows in the Rangitāiki in the last thirty years? A: The "flow duration curve" changes depend on local factors like rainfall, terrain, soil and the condition of the site.

What percentage of water use is surface water compared to groundwater? In the Rangitāiki 87% of the water taken is from surface water and 13% is from the groundwater.

Would Trustpower's water use be limited to the new minimum flow? A: No, the resource consent sets the agreed conditions and restrictions including minimum flows, based on more detailed research.

The fact sheet 'Setting Environmental Flows in Water Management Areas' was distributed to members, (available online).

8 Rangitāiki groundwater

Andrew explained the background and options for setting groundwater limits in the Rangitāiki Water Management Area. Simple groundwater balance assessments have been developed based on the current information. Interim groundwater allocation limits based on the simple water balance assessments were established in the Region-wide water Quantity Plan Change 9. More complex groundwater models with greater levels of confidence are being developed. However, they will not be complete in time to use in the Rangitāiki Water Management Area plan change process. We are seeking community group views on setting different locally specific groundwater allocation limits based on allocating a greater proportion of the simple water balance, before the complex groundwater model is complete. This would make more water available for allocation. However, it would increase the risk of adverse environmental effects on the groundwater resource, surface water bodies connected to it; and those who take from those surface water bodies. Those groundwater management areas that are currently over-allocated would remain over-allocated. The alternative would be delaying setting new locally specific groundwater quantity limits until further monitoring data is collected and the complex groundwater model is completed.

Questions and comments:
What changes have been observed in groundwater recharge with recent high rainfall events? A: Information will be provided on groundwater levels.

Is there sufficient information to process the Murupara water bottling take consent and are consent applications peer reviewed? A: An application to take groundwater for bottling in Murupara has not been lodged yet. Consent applicants are required to do an assessment of the environmental effects (AEE) of their proposal. The AEE must reflect the nature and scale of the proposed activity. The council reviews the AEE as part of making a decision on an application. The council can use consultants to assess the AEE. There is no requirement for a separate peer review in addition to the council's assessment.

Is water storage in the upper Rangitāiki a practical alternative supply option to groundwater? Trustpower's resource consent allows it to take up to 160m^3/second above the Matahina dam. The flow in the Rangitāiki only exceeds that volume during flood events for very short periods of time (days) – approx. 1.5-2% of the time. There are lots of challenges with harvesting high flows. We will explore options if we need to.

The fact sheet 'Introduction to Groundwater Environmental Level Setting' was distributed to members, (available online).

The group was not comfortable to form a view and needed time to read and think about the notes circulated.

9 What's next / Next Step

BOPRC staff will circulate revised mitigation bundles, following discussions with industry groups, and taking on board community group feedback.

Workshop 8: May/June 18:

- mitigation costs
- draft objectives
- modelling results - baseline and development
- flow setting results

The Group noted:

- Whakatāne District Council is consulting on the long Term Plan.

A member suggested using a "Facebook Group" to provide a safe zone for members to ask each other questions. If it is something the Group wants to do, council can help with setting it up.

10 Noted actions

1. Council to set up closed Facebook page for discussions.
2. Staff to contact forestry sector regarding forestry mitigation measures.
3. Revised mitigation bundles are to be circulated to group members before commencing modelling work.
4. The metering thresholds proposed by the *Region-wide Water Quantity Plan Change 9* are to be circulated. See these hyperlinks to flowcharts related to metering requirements for irrigation system and dairy farm[1].
5. Provide voice-overs for the presentation on Environmental Flow and Groundwater level setting through the group portal online.
6. Provide information on the groundwater levels / recharge rate with high rainfall events.

   Recharge rates increase with higher rainfall. There is not a linear relationship between changes in rainfall and recharge rates. An increase in rainfall does not result in the same percent increase in groundwater recharge. Monitoring bores in the Rangitāiki area show that groundwater level change from summer to winter. These changes are in response to recharge from rainfall and groundwater abstraction. A monitoring bore in the Mid-Upper Rangitāiki tapping the unconfined ignimbrite aquifer shows groundwater levels in the last two years recovered to approximately 5.0 metres higher than in the previous year, when records began. A monitoring bore in the Lower Rangitāiki tapping the sand/ignimbrite/gravel aquifer shows groundwater levels in the last 5 years recovered to the same level. However, that level is approximately 0.5 to 2.0 metres lower than in the preceding 22 years, when records began. Groundwater is managed on the basis of average annual recharge, rather than recharge in a particular year.
7. Provide a brief update on tuna habitat protection project in the Rangitāiki catchment.
8. Provide information (if any) on likely impacts of contaminants on river/stream buffer native plants[2].

[1] The links to the metering requirement flowchart factsheets are: https://www.boprc.govt.nz/media/570960/20161018-plan-change-9-do-i-need-a-meter-or-resource-consent-for-dairy-farming.pdf and https://www.boprc.govt.nz/media/570959/20161101-do-i-need-a-meter-or-resource-consent-for-my-irrigation-system.pdf

11 Feedback to Councillors

Members provided the following feedback to Council decision-makers.

- The cost of improved water management should be equitable between rural and urban communities.
- Fish habitat is declining and getting worse – this is a big issue for some/many members and there is concern about whether the management options make a difference.
- A “business as usual” option will not be good enough. Group members are looking for change.

Workshop ended at 2:55 pm with a karakia.

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[2] Most common water pollutant (bacteria, nutrients and sediments) considered here do not cause harm in using native plant rongoa. The plants will be safe for human consumption after washing them with clean water or cooking.
Human safety could be of a concern when consuming roadside plants, plants of geothermal areas and areas that keeping /treating industrial run-off (eg. treated timber), where the plants may contain a build-up of harmful chemicals and heavy metals.

Appendix One – Workshop activity feedback on Mitigation Bundle Options

These tables reflect community group feedback. Further amendments may be made by Council after discussions with industry organisations.

Dairy pasture sector (Discussed draft to be consulted with industry)

M0- Current Practice	M1 Mitigation One (less impact and lower cost)	M2- Mitigation Two	M3- Mitigation Three (Greatest impact and greatest cost)	Outliners
One wire fence alongside stream Paddock rotation plus break feeding Effluent use of N application	**Effluent fertiliser use, it GPS** **Timing of effluent application** **Full stock exclusion… (large)** • Audit required • Vegetation Effluent irrigation Grow maize on effluent blocks Laneway run-off div. Relocation of Troughs Suggest 'all' waterways Any work on cut & carry zones? Adoption of low N leaching forages Reduced tillage practices	**Increase effluent application area** **Rotation in seasonal stocking rate** **Full stock exclusion from medium waterbodies** reduce fertiliser N use controlled grazing with stand-off pads Complete protection of gully heads Detention bunds Lined effluent storage	**Stock excluded from wider range of waterways** **Adoption of new irrigation (and effluent) technology (include infrastructure)** **Creation of new wetlands** Denitrification beds Reducing stocking rates, increase efficiency, eg seasonal reduction grass growth matched with stocking Partial afforestation of easier contoured land Nil/restricted grazing with barns Alum applied to pasture	Once-a-day or twice-a-day milking Protection of indigenous plants. Principle Be aware of planting for erosion purpose

Note: These notes from 3 April 2018 workshop are provided without prejudice. As part of the process, the content records key discussions points, which do not form the group's recommendation to Council, except where it is explicitly stated so.

	Seasonal stocking rate reduction	Cut & Carry Zone **'Managed' instead of 'planted' buffer**	Should distance fit contour and soil type?	

Non-dairy pasture sector

M0- Current Practice (most properties already doing this mitigation)	**M1 Mitigation One** (less impact and lower cost)	**M2- Mitigation Two**	**M3- Mitigation Three (Greatest impact and greatest cost)**	**Outliners**
	Full stock exclude all water body plus 3m 'managed' buffer **Efficient fertiliser use** **Adoption of low N leaching forages** **Stock class management within landscape** • Dairy cows shipped out for winter • Contour dependent Appropriate gate track & race placement (contour dependent) Some not tillage practices Maintain optimal Olsen P Targeted space planting of poles Relocation of troughs	**Full stock exclusion (mdm streams) plus 3m buffer** **Stock reticulation away from surface waterbodies** **Reduction in seasonal stocking rate** Convert LUC 6 – 8 pasture to forest /mānuka Detention bunds Complete protection of gully heads Whole paddock space planting of poles Management of gorse Changing stock ratios to reflect N leaching potential	**Stock excluded from and 'managed' buffer… wide range…** **Creation of new wetlands** **Reducing stocking rates** Alum applied to pasture Buffer around excluded water (7m) or… Difficult	Managed gra grass length

Due to time constraints in the workshop, the feedback on sectors (including horticulture, forestry and arable) was collected separately.

Note: These notes from 3 April 2018 workshop are provided without prejudice. As part of the process, the content records key discussions points, which do not form the group's recommendation to Council, except where it is explicitly stated so.

APPENDIX 7

Key freshwater management issues in Rangitaiki Water Management Areas

Appendix

Key freshwater management issues in Rangitāiki Water Management Areas

In Rangitāiki, rising nitrogen trends will need to be halted and possibly reduced in order to address nutrient enrichment.

1. Nitrogen is increasing in the upper Rangitāiki catchment[2]. Potential land use change and intensification pose a significant risk that nitrogen levels will continue to increase, affecting ecological health, amenity and recreation values.
2. 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.
3. 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].
4. 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.
5. Monitoring results available for some recreation sites show E. coli concentrations do not meet the minimum acceptable state for swimming (full immersion) stated in the operative NPS-FM. Some popular swimming spots are not monitored[4].
6. 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.
7. Sediment monitoring data is limited. The majority of this sediment load is likely to be generated in high rainfall events for which there is currently limited data available.
8. The Macro-invertebrate Community Index (MCI) values are lowest in streams/rivers draining pasture. MCI is relatively stable in Rangitāiki catchment.
9. Lower Rangitāiki River and surrounding lowlands have been heavily modified to enable farming and flood management, as well as flow regime changes by HEP dam operations, and this has had significant effects on water quality, ecosystem health and habitat.

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[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)

10. 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[5].

[5] 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)

Receives Only – No Decisions

Report To: Rangitāiki River Forum

Meeting Date: 08 June 2018

Report From: Simon Stokes, Eastern Catchments Manager

Te Hekenga Nui o Te Tuna

Executive Summary

This report provides an update of the status of Te Hekenga Nui o Te Tuna, and activities within the catchment that fall under this.

The Rangitāiki River Forum requested the steering group progress a number of recommendations from Trustpower's implementation recommendations table provided at the last meeting and a response is provided to each of those. The spillway trial is resolved for now, with a firm decision from iwi that it is not acceptable. Trustpower is already involved in Te Hekenga Nui o Te Tuna and the wider grouping of the Tuna Forum provides another avenue for their ongoing involvement in discussions.

A new project plan is provided which provides a more holistic approach to the enhancement of tuna within the catchment, and an integrated structure to move the kaupapa of Te Hekengā Nui o Te Tuna forward with wider involvement. The Steering Group is supportive of the proposal to integrate the new project plan and the existing action plan as one and move forward with implementation, provided the proposed structure and plan is endorsed by the Rangitāiki River Forum.

Recommendations

That the Rangitāiki River Forum under its delegated authority:

1 **Receives the report, Te Hekenga Nui o Te Tuna;**

2 **Endorses the proposed structure integrating the Tuna Forum, and the existing Te Hekenga Nui o Te Tuna Steering Group;**

3 **Endorses the new project plan for implementation;**

4 **Notes a need for written confirmation from the Forum and/or the Forum iwi partners with regard to not supporting the spillway trials at Matahina.**

1 Purpose and content of report

The purpose of this report is to update the Forum on work relating to tuna in the catchment and provides:

- Feedback from attendees of the Fish Passage Guidelines workshop;
- follow-up information as requested at the last meeting, with regard to Trustpower's options implementation table appended to the previous general update report;
- the status of actions underway within the original (2016) action plan for tuna;
- the establishment and development of a new group, the Tuna Forum;
- discuss and request endorsement of a proposed structure integrating the Tuna Forum and Te Hekenga Nui o Te Tuna, reporting to the Rangitāiki River Forum;
- request endorsement of a new project plan around a wider approach to enhancing tuna in the catchment.

This report still refers to the Action numbering for the 2016 Te Hekenga Nui o Te Tuna action plan in reporting progress against actions underway. Transition into the new project plan will be discussed and future reporting, if that plan is endorsed by the Rangitāiki River Forum, will refer to those Objectives and Actions instead. The project plan is discussed in Section 7 and included as Appendix 2.

2 New Zealand Fish Passage Guidelines

The New Zealand Fish Passage Guidelines set out recommended practice for the design of instream infrastructure to provide for fish passage. They have been developed by NIWA and the Department of Conservation in partnership with the New Zealand Fish Passage Advisory Group, to improve understanding and promote better management of fish passage requirements in New Zealand.

The Guidelines were launched in Wellington in April and representatives from the Te Hekenga Nui o te Tuna, the Tuna Forum and the Rangitāiki River Forum were funded by council and Trustpower to attend the launch workshop.

The Fish Passage Guidelines will be looked to for remediation options when we start working our way through smaller structures in the catchment that we know are barriers to fish passage, as well as providing much needed guidance when new structures are being placed.

Attendees will provide a debrief to the Forum on what they learnt.

3 North Island Tuna Fisheries Review

This process was delayed beyond the original time-frames. Fisheries New Zealand (formerly MPI) now expect to be consulting publicly in mid-June, with submissions open for approximately 4 weeks. The Tuna Forum will work with the Steering Group to develop a submission.

4 Update – Trustpower implementation table from previous meeting.

At the March Rangitāiki River Forum meeting, the Te Hekenga Nui o Te Tuna Steering Group was tasked with progressing recommendations 3, 4 and 6 from the Fish Passage Options implementation recommendations provided at that meeting, and provide clarification around the special permit requirements from item 11. An update for each is provided.

4.1 Recommendation 3: Succession planning

This has not been progressed by the steering group. The issue of successional planning for Kokopu Trust was raised by Trustpower, and briefly discussed at the Tuna Forum meeting on 15th May.

It was noted that trap and transfer is seasonal, and finding a replacement with the level of knowledge, passion and reliability will be challenging. Ngati Manawa expressed interest in being involved in successional planning discussions. Any changes in who does the trap and transfer programme will require the involvement of the Kokopu Trust.

The reason Trustpower has raised successional and contingency planning is to ensure fish passage continues to be provided at Matahina HEPS, and compliance with their resource consents. The Kokopu Trust holds the only special permit from MPI to trap and transfer native fish at Matahina HEPS. If the Kokopu Trust is unable to trap and transfer native fish at Matahina HEPS, Trustpower will be in breach of their consent requirements. Trustpower proposes to hold their own special permit to trap and transfer fish in the event the Kokopu Trust is unable to do.

Trustpower has applied to MPI for special permit to trap and transfer native fish, as detailed in their approved Fish Passage Options report. This will require support from iwi for the permit application.

Members of the Tuna Forum expressed interest in the special permit being registered to an Iwi organisation, rather than Trustpower. Trustpower is open to this possibility, and interested to discuss the matter further. Trustpower's key concern is being able to continue to provide for fish passage at the dam and demonstrate compliance with their resource consents to Bay of Plenty Regional Council and Ministry of Primary Industries.

The discussion around permits also applies to Recommendation 11.

4.2 Recommendation 4 – Spillway trial

Members of the Tuna Steering Group have discussed (within their iwi) and decided that the live eel trial and the use of emergency spillway to provide downstream fish passage is unacceptable.

Trustpower acknowledge this decision and will postpone the live eel trial at this point. This means there is no longer a need for a special permit application to bring tuna from the Waikato.

Trustpower has made it known to the Tuna Forum that the option to use the spillway to provide downstream fish passage, without undertaking the live eel trial is still being considered.

4.2.1 Regulatory compliance response:

In September 2017, the Bay of Plenty Regional Council certified Trustpower Limited's (TPL) Fish Passage Options Report. The report was required to be produced through various conditions of consent 65750. One of the specific recommendations of the certified report was that a downstream spillway trial be carried out by TPL. The trial was to involve temporarily ceasing generation, combined with using the spillway as a bypass to allow for an alternative downstream migration pathway for adult eels.

Given that the proposal has not been supported by iwi, TPL are now unwilling to carry out the trial. Not only is support from the forum required in order for TPL to obtain the required permits from MPI, neither TPL nor BOPRC are willing to proceed with the trial without the support of the River Forum partners.

It is important that the Rangitāiki River Forum, and/or the iwi partners, provide written confirmation of this decision to BOPRC because it means that TPL are unable to meet the recommendation of the certified report.

A letter from the Bay of Plenty Regional Council will need be sent to TPL advising them that not undertaking the trial will not be deemed to be a breach of their consent requirements. They will still have to meet the other requirements and recommendations from the report.

4.3 Recommendation 6 – Use trap and transfer to support educational initiatives

This would be part of a wider communications and engagement strategy. This work stream has yet to be actioned through the previous and the new Te Hekenga project plan. This does not preclude the option of taking up or pursuing options outside of that, should there be interest and availability.

4.4 Recommendation 11 – Special Permit application for live tuna trials

See recommendation 4. There is no longer a request to support a special permit application to take eels from Waikato and undertake the live tuna trial at Matahina.

Trustpower still request Iwi support for their trap and transfer special permit.

The special permit is required as a contingency plan should Bill be unable to operate for any reason, with a clear statement above that there is no intent to replace Bill/Kokopu Trust at this point in time. This would provide security for Trustpower and their ability to meet their consent requirements.

4.5 Other recommendations and updates

Recommendations 5 and 8: Trustpower are actively engaged in Action A. There is regular dialogue with BoPRC and Te Hekenga Nui o Te Tuna work. Trustpower attended the 15 May Tuna Forum meeting, and took several members from the Tuna Steering Group on a tour of the scheme the following day. Trustpower has also sent members to a conference in Wellington for the launch of the National Fish Passage Guidelines workshop.

Recommendation 7: There has been some dialogue between Trustpower and Southern Generation around coordination of their fish passage activities. SG already contributes financially to the upstream trap and transfer in recognition that it mitigates for both the dams, so a first step towards better collaboration has been taken.

Recommendations 6 and 9: Trustpower have offered to take RRF and/or Te Hekenga Nui o Te Tuna/Tuna Forum members on a tour of their operation. A group was taken onto the lake after the last Tuna Forum meeting. They have also discussed to quite a level of detail into the Action A report (fish passage at the dams) as to the considerations for different options for structures to achieve passage at the dams. This was a valuable exercise and gave the project group a higher degree of insight into the problem and implications. This information has been built into the Action A report.

5 Southern Generation/Nova

With regard to the use of spillways for downstream migration, when directly queried by Southern Generation (SG) about the Aniwhenua scheme, the decision (for Matahina) was not considered by iwi representatives at that project group meeting to apply to the potential use of the Aniwhenua spillway for downstream migration. RRF have queried whether spillway trials were needed at Aniwhenua. SG indicated that they consider the spillway an option, although a trial was not discussed. The barrage is 10 m high, so there is potential.

SG continue to work on trap and transfer for downstream migration, and are also actively involved in the discussions around long term options for up and downstream passage for tuna.

6 Te Hekenga Nui o Te Tuna 2016

6.1.1 **Current actions – status update**

The status of actions is summarised in the table below, with further detail following.

Action	Description	Status
A1	Literature review focussing on tuna passage upstream and downstream past the two hydro dams	Complete
A2	Interviews and round table discussions with identified experts	Complete – part of A1
B1	Literature review/information gathering – tuna fisheries management, legislation, Māori fisheries management tools	Underway
B2	Interviews and/or surveys – mātauranga Māori	Not started
F	Community awareness and engagement strategy	Not started

The project time-frames will need to be reviewed again in light of the new project plan, if this is endorsed.

Action A: The report is now a final draft (Appendix 1) and the Te Hekenga Nui o Te Tuna Steering Group is seeking endorsement from the Rangitāiki River Forum to finalise the document and use it to move on to the next stage, if no further adjustments are requested. Both the Hydroelectric power companies (HEPs) – Trustpower and Southern Generation – have reviewed the report and content has been included to identify options considered possible and therefore worth further investigation. The implications of some of these options are also provided.

Southern Generation were able to identify some options that appeared feasible for their smaller barrage at Lake Aniwaniwa, and have continued work on trap and transfer of downstream migratory tuna.

We consider this report to now be completed, and covering both action A1 and A2.

Action B1: The Tuna Forum has included several objectives and actions in the new project plan which effectively cover the workstream around fisheries and fishery management. The Rangitāiki River Forum has already engaged with MPI around the fisheries review, and Te Ohu Kaimoana would work with the Steering Group on developing a submission to that review should further opportunity arise.

The intent is for the Tuna Forum to start work on a harvest strategy for the catchment, moving into the new project plan.

Action B2: Mātauranga Māori is an underpinning concept in implementing several objectives and actions of the new project plan. This allows the project to understand the health of tuna by applying the empirical, and complimentary, approaches of mātauranga Maori and western science for a holistic understanding of the wellbeing of tuna. This includes sharing of knowledge between Māori (local, traditional, historic) and western science, developing indicators for the health of tuna populations, and enabling opportunities for hands on involvement and participation of activities within the catchment to re-connect the community with their river and the tuna within. The use of mātauranga Māori to inform the project enhances both the scientific and relationship/community outcomes sought in the project.

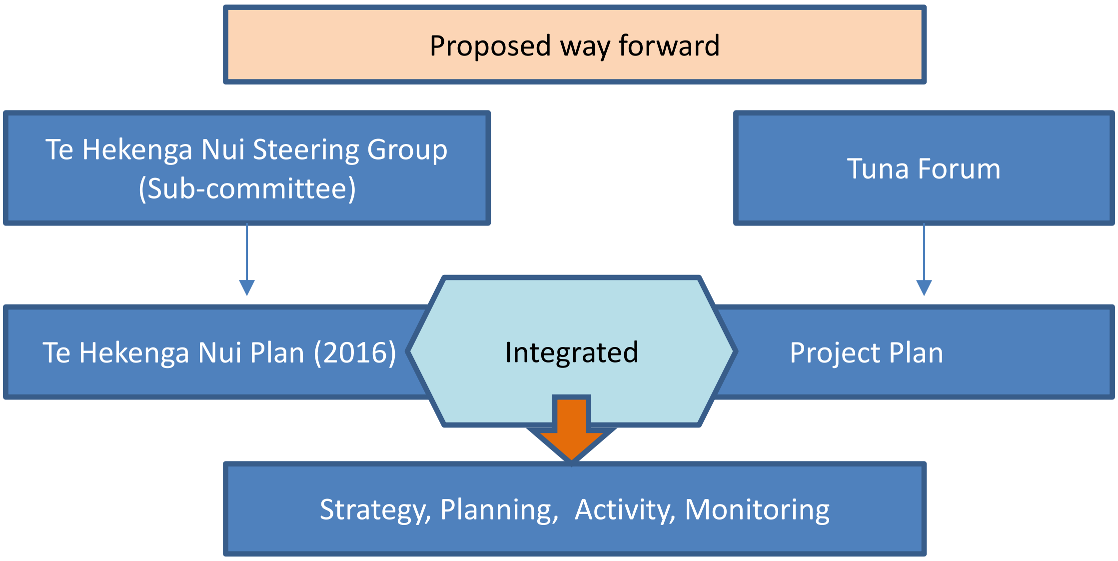
7 The Tuna Forum

The Tuna Forum is the name proposed for a wider group representing iwi, commercial fishers and support organisations coming together to work within a broader project plan. The purpose of the group is to contribute to the vision for tuna within the Rangitāiki Catchment that is set out in Te Ara Whānui O Rangitāiki.

7.1 Proposed structure

Currently we have the Te Hekenga Nui o Te Tuna Steering Group, consisting of RRF representatives, plus BOPRC operating in support of the work. The proposal is to integrate the current Tuna Forum grouping, which includes representation from a wide range of stakeholders like the HEPs, the Iwi Collective Partnership, MPI and Te Ohu Kaimoana, and commercial fishers, and a new project plan, with the current Te Hekenga Nui o Te Tuna Steering Group and the original 2016 Action Plan.

Iwi recognise the need for all stakeholders to collaborate and work together for common goals – the restoration of the long finned tuna in our waterways. This proposal serves to enable and facilitate the achievement of goals set down in Te Ara Whānui as well as those articulated by the Tuna Forum in their Project Plan. The intention is to integrate our approach so that effort and resources are used responsibly and goals are achieved.



The title Te Hekenga Nui o Te Tuna remains as an overarching name that refers to the kaupapa, rather than to a specific document, so that the new project plan is developed and the work continues under the Te Hekenga Nui o Te Tuna umbrella. The membership of the Tuna Forum may change, expand and contract depending on the projects underway at the time. Projects may have a project group associated if considered useful, and these would be established at the beginning of that piece. Project groups report back to the Tuna Forum and the Steering Group.

The Steering Group enlarges to incorporate the Tuna Forum Chair and Te Ohu Kaimoana. The group retains oversight over Te Hekenga Nui o Te Tuna as a whole, and are responsible for reporting up to the RRF and making recommendations as appropriate. The Steering Group will also be responsible for taking up requests from RRF and feeding back on those. The Steering Group needs to stay small so as not to become unwieldy.

7.2 The new project plan

The new project plan replaces the original Action Plan, covering the actions and issues from the original, but enlarging the scope of Te Hekenga Nui o Te Tuna to a wider range and more complete picture of issues affecting tuna in the Rangitāiki Catchment, and is included as Appendix 2. The plan is structured around the key problems for tuna in the Rangitāiki Catchment:

- Sustainability and fishing,
- Fish passage,
- Water quality,
- Habitat degradation,
- Coordinated management.

The Action Plan consists of five goals, with Objectives and Actions under each aiming to fulfil that goal. This is not exhaustive, and it is likely that further actions will be needed as project work may raise other items or concerns for follow-up, and planning for some objectives and actions will become more detailed than documented here.

We believe that this action plan does provide a more comprehensive picture of the issues for tuna in the catchment, and does not lose the content of the 2016 Action Plan. Those Actions are still contained in the new project plan and those underway continue to be progressed.

8 Māori Implications

There are positive effects for Māori in supporting this kaupapa. Several Rangitāiki iwi are represented within the steering group and the project group. The project has been endorsed by the Rangitāiki River Forum, which exists to support iwi legislation with the crown. This project has been developed to directly address the aspirations and objectives of Māori from Te Ara Whānui o Rangitāiki – Pathways of the Rangitāiki.

Nancy Willems
Team Leader, Eastern & Rangitaiki Catchments

for Eastern Catchments Manager

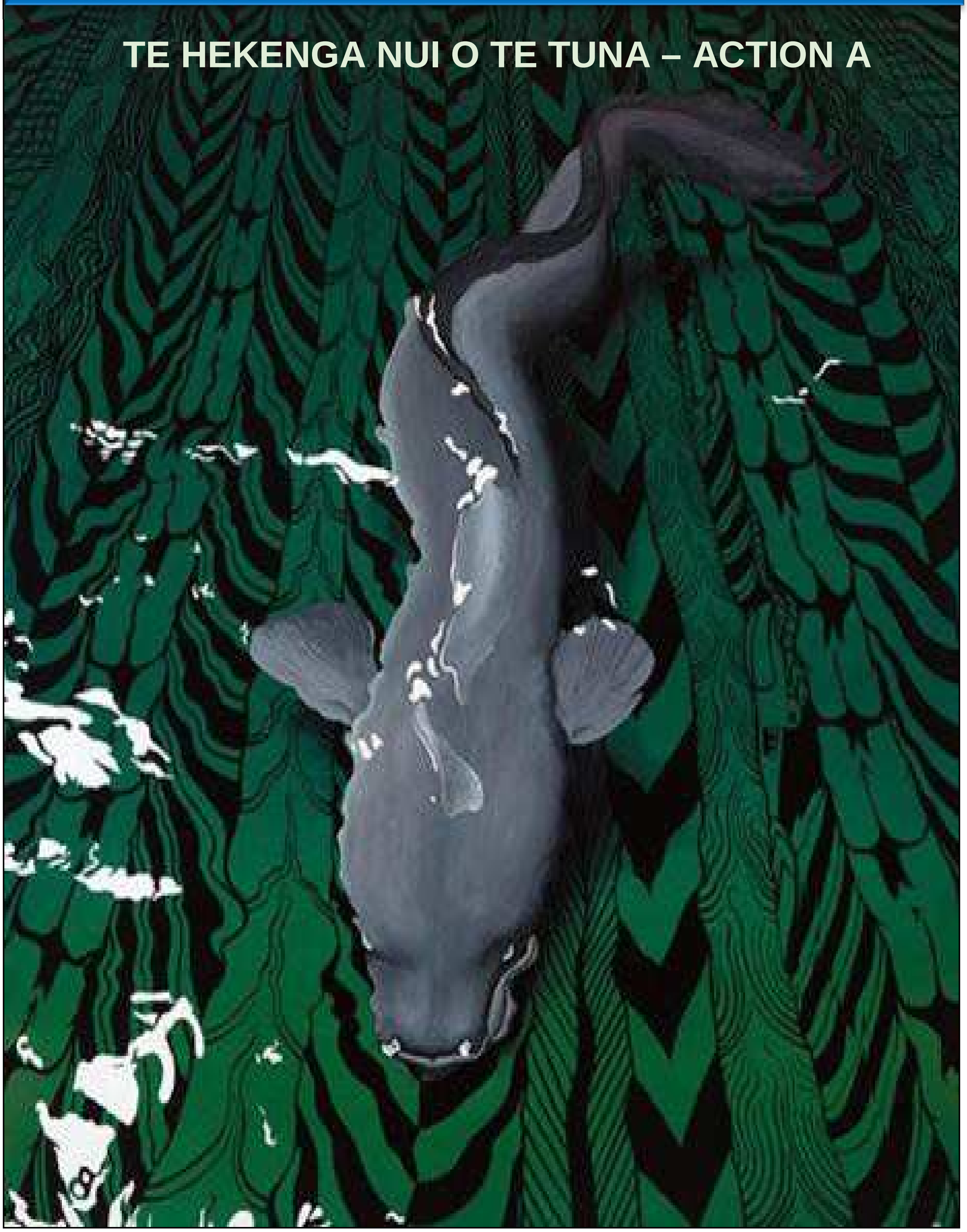
31 May 2018

APPENDIX 1

Literature review Tuna Passage Options Rangitaiki - Action A May 2018 - final draft

LITERATURE REVIEW:
TUNA PASSAGE OPTIONS FOR MATAHINA AND ANIWHENUA HYDRO DAMS RANGITĀIKI RIVER CATCHMENT

TE HEKENGA NUI O TE TUNA – ACTION A



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LITERATURE REVIEW:

TUNA PASSAGE OPTIONS FOR MATAHINA AND ANIWHENUA HYDRO DAMS - RANGITĀIKI RIVER CATCHMENT

TE HEKENGA NUI O TE TUNA - ACTION A1.

Prepared for the Rangitāiki River Forum, May 2018.

Authors

Dr Kura Paul-Burke, MUSA – Marine & Environmental Services

Nancy Willems – Bay of Plenty Regional Council

Te Hekenga Nui o Te Tuna Steering Group

Ngāti Whare	- Daryl Christie (2016)
	- Earl Rewi (2018)
Ngāti Manawa	- Dr Byron Rangiwai (2016)
	- Atamira Nuku (2018)
Ngāti Awa	- Tuwhakairiora O'Brien-
Ngāti Tūwharetoa (BOP)	- Rev. Graeme Te Rire
Ngai Tuhoe	- Ngapera Rangiaho
Trustpower	- Christopher Fern, Ryan Piddington
NOVA	- Craig Rowe
Southern Generation	- Peter Mulvihill

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Simon Stokes	- Manager Eastern Catchments
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Sandy Hohepa	- Māori Policy Officer

Report Reference

Paul-Burke, K. (2017). Literature Review: Tuna fish passage. Te Hekenga Nui o Te Tuna - Action A. Report prepared for the Rangitāiki River Forum, April 2017. Bay of Plenty Regional Council.

Cover Page Image by Elliot Mason, 2012.

Executive Summary

The purpose of this literature review is to provide information on examples of fish passage methods at large structures. It is intended that the information identified in the literature review will assist decision-makers in the protection and enhancement of tuna populations in the Rangitāiki catchment.

These methods could be used to establish passage for tuna to enable their migration up and downstream of Matahina and Aniwhenua dams in the Rangitāiki River catchment.

In the Rangitāiki River, the main stem is clear for fish to migrate until they reach Matahina HEPS. . While we know that other structures, like culverts with drop-offs, flood control pumps and weirs, will also affect their ability to migrate more widely into the tributaries and sub-catchments, this report is specifically about tuna moving over the two hydro dams – Matahina and Aniwhenua – in the Rangitāiki Catchment.

Fish passage concerns elsewhere in the catchment can sometimes be technically less challenging and could be assessed under the New Zealand Fish Passage Guidelines. This issue will require further investigation to quantify its extent within the catchment.

The aim is for tuna to be able to move up and down the catchment to complete their life cycle, provided a feasible manner to achieve this can be identified and implemented. The aspirational goal for iwi is for this to be made possible without the need to handle the tuna. Enabling other species to migrate up and down the catchment is also desirable and their needs are considered alongside tuna as the key target.

Past reports have provided an overview of studies on different aspects of adult tuna migration (Kearney et al, 2013; Mitchell, 1996), recruitment of elver (Martin et al, 2009; Jellyman & Hardy, 2011; Kearney & Kerrison, 2013) and potential downstream eel passage options (Watene & Boubeè, 2005; Goldsmith, Ludgate, Ryder, 2009; Boubeè & Jellyman, 2009) in the Rangitāiki catchment..

This report contains, in Part 1, a review of upstream passage solutions which includes various technical; fish ladders, vertical slot fish passage and barrier removal which allow volitional passage[1] of selected target species. Part 1, further provides a review of non-volitional approaches including fish lifts and manual trap and transfer operations (Armstrong, 2010; Noonan et al, 2012; Linnanasaari & Curry, 2015).

In Part 2, a review of downstream passage identifies three main options: 1) spillway passage; 2) turbine passage; and 3) fish bypass structures (including various collection facilities of downstream migrating fish for transportation), (Larrinier, 2001; Larrinier & Marnulla, 2004; Brown et al, 2007; Foust et al, 2011).

The science of fish passage and fish passage options has a long history of application. However, guarantees for success in either up- or downstream passage for eel populations remains uncertain. Effectiveness depends on a number of design, biological and environmental factors which are specific to each structure. It should be noted that a fish passage system or structure that is designed to allow fish to pass upstream may not allow for passage downstream,. and structures do not guarantee effective fish passage and migration. However, not including any fish passage or trap and transfer ensures that affected species cannot migrate at all (Waldman, 2013).

Ensuring passage over the dams also does not account for other factors that may affect their ability to thrive within the catchment. Wider habitat concerns are outside the scope of this literature review.

[1] Meaning fish passage made continuously available without trap and transfer. Fish use it when they are behaviourally and physiologically ready.

Contents

Introduction

One of the well-established effects of hydropower generation is the building of dams that create impediment for tuna movements and migrations[2]. In the Rangitāiki River, the main stem is clear for fish to migrate until they reach Matahina HEPS. . While we know that other structures, like culverts with drop-offs, flood control pumps and weirs, will also affect their ability to migrate more widely into the tributaries and sub-catchments, this report is specifically about tuna moving over the two hydro dams – Matahina and Aniwhenua – in the Rangitāiki Catchment.

Fish passage concerns elsewhere in the catchment can sometimes be technically less challenging and could be assessed under the New Zealand Fish Passage Guidelines. This issue will require further investigation to quantify its extent within the catchment.

Tuna are catadromous, and so make two migrations in their lifetime: one as juveniles travelling from spawning grounds in the sea, to freshwater and riparian habitat, and the other as reproductively mature adults migrating downstream from inland waterways to their spawning grounds at sea[3].

For eels to thrive, it is important to provide safe, swift passage for juveniles travelling upstream and adults migrating downstream. There are many types of passage infrastructure in use at and around dams, depending on factors such as a dam's age, size, location and purpose[4]. However, the most common types of fish passage options are added many years after a dam is built[5].

The aim of a tuna fish pass is to provide conditions to allow elvers to ascend up and over a dam, which is otherwise impassable either at all times or under some conditions, or where ascent is otherwise difficult to the extent that recruitment upstream is sub-optimal[6].

Successful or functional fish passage requires three conditions to be met[7]:

1) Passage must be safe – minimal stress, injury and mortality

2 Linnansaari & Curry, 2015
3 Jellyman & Hardy, 2001
4 Jellyman & Hardy, 2001
5 Larinier, 2001; Noonan, Grant, Jackson, 2012
6 Solomon & Beach, 2004
7 Brownell, Haro, McDermott, Blott, Rohde, 2012

2) Passage must be effective – a large proportion (>90%) of fish must be passed[8]

3) Passage must occur with minimal delay – fish must be able to reach their destination within the necessary ecological and physiological window of time.

The following table identifies relevant issues for fish passes:

Table 1. Relevant Issues for developing fish passes (adapted from Solomon & Beach, 2004).

1	Eels must be able to locate the appropriate starting point for ascent e.g. the lower entrance of the pass. This may be achieved by constructing the entrance where the fish will naturally congregate, or by providing some attracting mechanism.
2	Eels must be able to enter the facility without undue[9] effort and without causing undue stress.
3	Eels must be able to reach the top (head) of the dam without expending undue effort. In practice this is often achieved by restricting the volume and velocity of flow within the pass, provision of resting areas for climbing eels, and providing a substrate which slows and disorganises the flow of water. Having a suitable substrate allows the tuna to be able to ascend the dam by crawling as much as swimming. This approach exploits the natural behaviour of the eel in seeking edge-effects and shallow water in its migrations, as well as its natural climbing behaviour.
4	The fish leaving the pass should be able to continue upstream migration.
5	The fish pass should work under all conditions of head and tail water levels which prevail during the period when fish are migrating at the site, or perhaps more realistically, for those that prevail for most of this time. Some flow must be maintained at all times – a dry fish pass will not work.
6	The fish should be protected from excessive predation at all points of the facility including at the entrance, exit and within the pass.
7	Facilities for monitoring the effectiveness of the pass should be incorporated into the design.
8	Limited funding and other constraints may require that provision of facilities is prioritised, and that designs are cost-effective.
9	Vandalism, theft or harvesting of eels may be a problem at almost any site. Robust construction and locked covers may help, but a determined vandal may see such features as a challenge. Another approach is to site facilities where the general public do not have access.

[8] Baras, 2001
[9] Undue = excessive. In this context interpreted as so much effort as to significantly stress the animal and/or lead them to exhaustion and/or unable to complete the climb.

These factors may not all be achievable under all circumstances. Attracting tuna to the safe downstream passage and away from the turbines, or to an up-stream passage option, is not straightforward, and managing predation on open ramp type passes, and where fish accumulate at an outfall can also be challenging. It is also important to note that a passage that provides for tuna may not provide for other species. A pass that provides for all species would be the ideal. This would require a pass that caters to the poorest climbers, and the current priority is for tuna to be provided for at a minimum. The ability to retrofit a fish passage to the existing dam structures will also be a key consideration, and some fish pass options may not meet this requirement.

Hydroelectric Power Schemes

Hydroelectric power is generated by the force of falling water. The water is held behind a dam, forming an artificial lake, or reservoir. The force of the water being released from the reservoir through the dam spins the blades of a giant turbine. The turbine is connected to the generator that makes electricity as it spins. After passing through the turbine, the water flows back into the river on the other side of the dam. The higher the dam the greater the fall of water which results in more power that is generated[10].

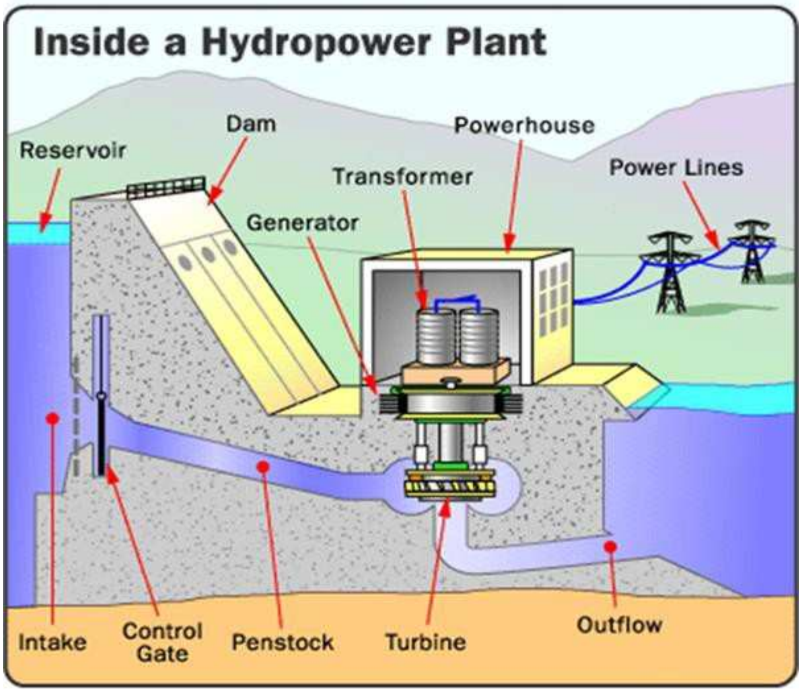

Figure 1. Image of a hydropower plant (HowStuffWorks, 2001).

[10] TVA, 2013

Hydroelectric power schemes or dams provide electricity, flood control, recreation and transportation as well as water for domestic and agricultural use. However, dams also change the ways rivers function, and may interfere with the life cycles of migrating species. They are barriers to juvenile eels migrating upstream, and an obstacle as adult eels return downstream to the ocean to spawn[11].

Matahina Hydroelectric Power Scheme

Matahina Hydroelectric Power Scheme was commissioned in 1967 and is located on the Rangitaiki River in the central North Island. Matahina is an 86 metre high earth dam and is the largest of this type in the North Island. The earth dam is built on 24 metre deep foundations, 365 metres wide at its base, and 396 metres long. Matahina has 3.8 million cubic metres (3.8 billion litres) of water behind the dam which drives two 50,000 hp turbines that drive two 40 MegaWatt (MW) generators to produce an average annual generation output of 290 GigaWatt (GWH)[12].

Aniwhenua Hydroelectric Power Scheme

The Aniwhenua dam is located on the Rangitāiki River and was commissioned in 1980. The Scheme incorporates a 2.2 long headrace canal, which flows to the head pond through two 3.4m diameter steel penstocks, at a rate of 75 cubic metres per second, to the powerhouse 35 metres below. The flow drives two 12.4 MW generators and produces an average 127 GWH per annum[13] before being discharged back to the river just below the Aniwhenua Falls[14]. The dam is built in an area of ignimbrite rock and air fall volcanic ashes. Equipment includes radial and flap type flood gates, wheeled penstock intake closure gates and twin vertical shaft Francis turbines[15].

[11] Kwok, 2009
[12] LMK Consulting Limited, 2014; ElectroNet Services, Ltd, 2013
[13] Pioneer Generation, 2016
[14] ElectroNet Services Ltd, 2013
[15] LMK Consulting Limited, 2014

PART 1: Upstream Passage Structures

1. Introduction

The first written reports of fishways date back to 17th century France, where bundles of branches were used to create steps in steep channels, allowing fish to bypass obstructions. Today, most fishways follow a similar basic concept, allowing fish to pass around the barrier by swimming through a series of gaps or slots that control the velocity or speed of water[16].

Volitional[17] fish passage refers to structures where fish enter and navigate upstream without assistance, i.e., the fish willingly swim through the structures. The general idea is to divide the total vertical head or height of the obstruction into a series of smaller vertical increments that are made passable for the eel by slowing the water velocity using a series of baffles, weirs or other physical structures[18].

Engineered fish ladders are historically the most common strategy for upstream passage at small to medium structures.[19].

Tuna are incapable of jumping (upstream), therefore vertical barriers of more than approximately 50% of their body-length represent a barrier to upstream migration[20]. As well as large scale dams, this can also apply to culverts, small scale weirs, fords and culvert aprons with drop-offs. Their swimming abilities are limited but they are adept at exploiting boundary layers and crawling over rough substrates[21].

The need to provide upstream passage facilities for ensuring the long term sustainability of migratory freshwater fish populations is now well recognised[22]. However, the choice of passage installed, depends upon the characteristics of the barrier, such as the head height, available space, surrounding environment and economic resources.

The following section briefly describes some options available to facilitate upstream passage of migrating elvers that are being used in New Zealand and internationally.

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[16] Ministry of Primary Industries, NSW, n.d.
[17] Meaning fish passage made continuously available without trap and transfer. Fish use it when they are behaviourally and physiologically ready.
18 Linnansarri & Curry, 2015
[19] Katopodis & Williams, 2012
[20] Knights & White, 1998
[21] Baker, 2016
[22] Williams & Boubee, 2009

The practicalities and achievability of retrospectively fitting structures to either the Aniwhenua or Matahina dam structures is not considered in depth and would be the subject of further investigation into the feasibility of the options described.

1.1 Substrate Ramp Passes or Fish Ladders

Introduction

Fish ladders or ramps are the most common type of fish pass at low head hydroelectric facilities in New Zealand, and are often referred to as elver ladders[23]. Fish ladders work by providing a sloping waterway (in a channel or pipe) for fish to go up, with an appropriate substrate or base that creates roughness, slows the flow and provides areas where fish can move upstream either by swimming or climbing[24]. At sites where glass eels are present, an additional or alternative climbing substrate is advised, such as gravel or bristle mats. Larger sized eels require more coarse climbing substrates.

Baffle ladders, ramps or fishways offer the shortest upstream route around vertical barriers and are generally installed on or at relatively steep slopes[25]. They are fitted with specific shaped deflectors (baffles) which help to reduce the flow of water allowing fish to swim or climb up and over the barrier[26]. These type of fishways do not generally have resting areas, although pools can be included to provide a resting area or to further reduce the velocity of flow[27].

Baffle fishways are best suited for species with relatively good swimming capabilities (i.e., fast swimmers with endurance). The most common baffles are the Denil and the Alaskan Steep pass. The Denil fish pass places baffles on the floor and/or walls of a rectangular flume with a relatively steep slope (10 to 25 percent), in order to reduce the mean velocities of the flow. The baffles, of varying shapes and size are extremely efficient in slowing the flow of water[28].

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23 Williams & Boubee, 2009
24 Solomon & Beach, 2004
25 Larinier, 2002
26 Armstrong et al, 2010
27 Linnansari & Curry, 2015
28 Larrinier, 2002

The Alaska Steep pass is a prefabricated, modular style, Denil fish pass originally developed for use in remote areas. This fish pass has a more complex configuration than the original Denil model. The baffles are hydraulically more effective which means that steeper 25-35 percent slopes can be used[29].

Figure 2.: (A) Floor baffles fish pass, River Thames, UK. (B) Denil and Alaska steep pass fishways. (C) Juvenile eels climbing pvc pipes, John Day Dam (NOAA, 2016). (D) Bristle mat substrate and baffle fish pass at Chadbury Pass, River Avon, UK (Solomon & Beach, 2004). (E) Fish ladder at Cathaleen's Falls Dam, Ireland.(F) Fish ladder at Reservoir Creek, Christchurch, New Zealand (Meji, 2016).

[29] Mallen-Cooper, 2007

Discussion

At the John Day Dam (47 metres height) in Virginia, USA, the installation of a fish ladder included sloping ramps with peg board pvc pipes and a slow trickle of water allowing juveniles to rest around pipe pegs[30]. Catch barrels were positioned near the top of the dam, from which the eels were manually released. Since the installation of the fish ladder over 2 million eels have migrated upstream into historic habitat[31].

In Ireland, at Cathaleen's Dam (27 metres) on the River Erne, two elver ramp passes were installed in the 1960's. A third pass was added in 1994. The ramps are 70cm width, approximately 1.5 metres in length. Clumps of heather were laid over the substrate to prevent predation. The system is considered to work well, with an annual total of 647 to 1536 kg of elvers recorded between 1996 and 2001. At the height of the run an excess of 100kg per day of passing elvers has been recorded. Bristle mats were installed on the substrate to assist climbing elvers[32]. According to the Atlantic States Marine Fisheries Commission (2010), eel passage climbing ramps are the preferred design for migrating American eel.

Advantages

Fish ladders and ramps offer the shortest upstream route around vertical barriers and can be installed in relatively steep slopes. They are well understood and proven to be effective in many, but not all, situations. Baffled ramps offer a cost-effective solution for re-establishing fish communities upstream of low dams or obstacles . The addition of pipes, gravel or bristle mats as substrate, assists climbing eels.

Disadvantages

Baffle fishways have a traditional reduced use in high dams, as there are no resting pools within the fishways and eels must make the climb in one attempt. Both baffle types (Denil & Alaskan Steep-pass) can become clogged with debris and have limited tolerance for forebay and tailrace water level fluctuations . They are not especially suitable for poor swimmers or small fish because of the relatively high water velocities. Open ramp type fish passes leave fish vulnerable to predation, and without shading, elevated water temperatures can become a problem.

[30] NOAA, 2016
[31] Linnansari & Curry, 2015
[32] Solomon & Beach, 2004

Feasibility for Rangitaiki Catchment

Matahina

Strengths	• Technically feasible and an engineered solution could be designed • Current intake into trapping station could be used • No manual intervention required
Weaknesses	• Not a good option for poor climbers • Predation along, and at trap outlet into Lake Matahina • Angle of ramp/pass needs to be low enough (<5^{o}) to provide best opportunity to native fish. Might result in a large structure. Example: • at 5% slope, 60m (typical head to tail water variation) = 60/0.05 = 1200m • at 3% slope = 2000m long. • Will be a challenge to get an engineered solution over/under Galatea Road without having a drop in angle • Maintenance, and or removal of debris from the structure
Considerations	• Design needs to ensure cool water is supplied for temp control • Gravel removal from Rangitaiki River to remove back eddy • Further design into providing upstream inlet at both river banks • Design consideration for operating range for Lake Matahina • Manual samples to determine % shortfin and longfin elvers moving upstream
Capital cost	$$-$$$
Operational Cost	$/year
Practical?	Unknown – requires further investigation to confirm.

Aniwhenua

A Denil style pass at Monowai (barrage 5-6 m) appears to be working at that site and has potential to be applied at Aniwhenua. The Monowai pass includes screens to protect fish from predation and a constant supply of water is provided to the pass.This is one option that Southern Generation considers worth further investigation for up-stream passage for elvers.

1.2 Vertical-Slot Fish Passage

Introduction

A vertical-slot fish passage is similar to a pool-and-weir system, except that each dam has a narrow slot in it near the channel wall. This allows fish to swim upstream without leaping over an obstacle.

Vertical-slot fish passages also tend to handle reasonably well the seasonal fluctuation in water levels on each side of the barrier. Recent studies suggest that navigation locks have a potential to be operated as vertical slot fishways to provide increased access for a range of biota, including poor swimmers[33]. This is unlikely to be a practicable option for large barriers like Matahina because the angle requirements for fish to be able to swim against the current would make the pass too long.

Figure 3. Image (L) of Vertical slot fish pass at Mauzac dam on the Dordogne River in France and (R) at Iffrezheim Dam on the Rhine, Germany (Larinier, 2002).

[33] Silva, Lowry, Macaya-Solis, Byatt, & Lucas, 2017

Discussion

Manipulation of the dimensioning and hydraulic characteristics particularly in terms of energy dissipation can modify the performance of these passes[34]. Modifying the length to width ratios of vertical slot passes and introducing energy dissipating devices near the slots helps improve energy dissipation and reduce re-circulation eddies, both of which tend to limit the use of passes by small fish.

On the Murray River, Australia, several vertical slot passes have been constructed at 3 – 5% slopes that pass small fish, but at 5% slopes are not effective for fish <100mm, which excludes several species that do not grow that big. Recently trials have been conducted to increase the range and size of species using such passes by increasing bed and wall roughness, introducing middle sills that partially block the vertical slot, and reducing head drops at the entrance (Mallen-Cooper, Zampatti, Stuart & Baumgartner, 2008).

The wall roughness consisted of a secondary wall at a twenty degree angle to the side-wall, consisting an array of 30cm perforated pipes set at a forty five degree angle in a frame. The reduced turbulence resulting from these measures permitted much smaller fish down to 25mm to pass, and increased passage rates by up to four times with wall roughness and six to thirteen times for middle sills. However, the method was selective with some species still not able to pass[35].

Elvers tend to climb wetted margins or make use of the boundary layer and interstices in the substrate to progress up-stream, and may not be able to successfully climb this type of pass unless design measures are in place to cater specifically for them[36].

Advantages

Capable of accommodating large changes in upstream water level provided that the downstream level varies in a similar manner. Provides a large range of water depth within the slot at which fish may choose to pass from one pool to another. Can cope with large bed load. Suitable for a wide range of fish species and fish sizes, especially with full depth notch(es) and bed roughening material utilised to create lower velocity

[34] Tarrade, Texier, David, Larinier, 2008
[35] Armstrong et al, 2010
[36] Boubee *et al*, 1999

boundary and refuge areas. With bed roughening may also pass some invertebrates.

Disadvantages

The overall slope of this type of pass is generally low at 5-12.5% thus costs are generally high. Can be prone to debris blockage. Elvers may not be able to climb it without suitable margins and/or resting areas and/or substrates or other facilities specifically designed for them.

Feasibility for Rangitaiki Catchment

Matahina

Strengths	• Could possibly be used for up and downstream migration • No manual intervention required
Weaknesses	• Challenging to get the transition from the lake working for downstream passage due to lake level variation • Not a good option for poor climbers • Angle of ramp/pass needs to be low enough (<5^{o}) to provide best opportunity to native fish. Might result in a large structure. Example: • at 5% slope, 60m (typical head to tail water variation) = 60/0.05 = 1200m • at 3% slope = 2000m long. • Will be a challenge to get an engineered solution over/under Galatea Road without having a drop in angle
Considerations	• Design needs to ensure cool water is supplied for temp control • Gravel removal from Rangitaiki River to remove back eddy • Further design into providing upstream inlet at both river banks • Manual samples to determine % shortfin and longfin elvers moving upstream
Capital cost	$$$$$
Operational Cost	$/year
Practical?	No, due to the length of the fish pass it would make it cost prohibitive

Aniwhenua

This is a potentially feasible option for Aniwhenua and worth further investigation.

1.3 Trap and Transfer

Introduction

Trapping and transferring elvers and eels that arrive at a structure provides for fish passage. This option provides flexibility in where fish are released upstream of the structure and may preclude the need for passage facilities at other obstructions upstream. It may allow optimal dispersion to be achieved, and avoids heavy predation which can occur where predators learn that the exit from a pass may be a productive feeding ground[37].

Trap and transfer operations at hydro-dams are sometimes included as resource consent conditions for the dams.

Discussion

The Kokopu Trust has undertaken manual transfer of elvers and native fish from below Matahina Dam throughout the upper catchment, including Lake Aniwhenua, began in 1993[38]. This trapping program continues.

The program is very successful with approximately 614,500 elvers (136,000 longfin elvers and 478,500 shortfin elvers) trapped and transferred in 1997/98[39].

At Matahina Dam an upstream trap is located on the right bank of the tailrace near the outlet of the transformer cooling water outfall. A review of elver transfer records calculated an average of 1,144,000 elvers per year have been transferred for the last 10 years (since 1997/98)[40]. The majority of the catch is transferred to Lake Aniwhenua and the upper Rangitāiki River, with the remainder transferred to Lake Matahina[41].

At Wairere Falls Power Station, King Country Energy also maintains a ramp and trapping system in each of their two tailraces. There is also a trap and transfer system at Patea Dam in Taranaki which is owned and operated by Trustpower. This system is operated during key upstream migration periods, and begin in 2003/2004.

[37] Solomon & Beach, 2004
[38] Boubee, Lee, Dean, Kusabs, 1997
[39] Goldsmith, Ludgate, Ryger, 2009
[40] Smith et al, 2007
[41] Martin, Boubee, Bowman & Griffin, 2005

Figure 4: Fish trap and access at Matahina HEPs.

Figure 5: Fish trap access and tramp at Patea HEPS.

Advantages

Manual trap-and-transfer programmes have been shown to provide upstream fish passage for a range of native fish and elvers.. A trap-and-transfer programme ensures tuna are able to reach the upper catchment[42]. Trap and transfer allows for the scientific assessment of the numbers and species of fish, including eels, and also allows for the release of elvers into strategic locations up-stream of the dams. It allows for the dispersal of multiple species, regardless of swimming ability. MPI use this data for their recruitment modelling assessesesment. Without trap and transfer numbers MPI would not know recruitment of eels into New Zealand.

Predation can be reduced by covering the trap.

Disadvantages

There is significant discomfort from iwi with regard to the need for manual handling of eels in both directions.

From a biological perspective, predation at gathering points will still be an issue, although predation at the trap structure can be reduced by covering the trap. It may also be facilitating the establishment or increasing numbers of native species in the upper catchments that might not otherwise normally be found there, or only in low numbers. Short finned eel are appearing widely into the mid-upper catchment, possibly outside their natural distribution. This could be considered a disadvantage in terms of altering the natural distribution of different species.

Up-stream migration for a cohort is prevented altogether if personnel are not available to make the manual transfer.

[42] Jellyman & Hardy, 2011

Feasibility for Rangitaiki Catchment

<u>Matahina</u>

Strengths	• Shown to be a successful method of providing upstream fish passage to all native fish species • Species composition, weight, and quantity can be easily recorded, and assessed against other trapping programs throughout NZ • Native fish can be transferred above Aniwhenua HEPS • Predation is low
Weaknesses	• Manual intervention • Contractor required to operate the trapping station • TPL required to release fish into areas where they wouldn't normally occur • Trapping station is located in an area which can be sporadically flooded • Health and Safety
Considerations	• Requires a knowledgeable contractor with approval from Iwi and Hapū to release fish into their rohe • Ministry of Primary permit required
Capital cost	$ - $$
Operational Cost	NA
Practical?	Yes

<u>Aniwhenua</u>

This is a feasible option, and currently the scheme cost shares with Trustpower for up-stream trap and transfer.

1.4 Fish lifts and locks

Introduction

A fish lift consists of a large holding chamber located at the downstream level of the dam. It is linked to an upstream chamber at the forebay level by a sloping or vertical shaft. Automated control gates are fitted at the extremities of the upstream and downstream chambers[43].

The operation principle of the fish lock is to attract fish into the downstream holding pool, which is closed and filled along with the sloping shaft. Fish exit the upstream chamber through the opened gate. A downstream flow is established within the shaft through a bypass located in the downstream chamber to encourage fish to leave the lock, or are tipped or drained into the head pond. A fish lift is well suited to tall or high head barriers and dams[44].

Fish locks operate in a similar manner as a navigational lock. The fish swim into the lock chamber when the lower gate is open. Periodically the lower gate closes and the chamber is filled with water to bring its level up to that of the head-pond. An upper gate is then opened[45]. Both lifts and locks involve a considerable level of engineering but they are well suited to very high head situations where a conventional pass may be impractical[46]. There are four operational stages[47]:

- **An attraction stage** in which the upper and lower gates are open and water flows through the lock structure to attract fish into a holding chamber. The conditions for fish attraction are those that are used for pool passes.

- **A filling stage** in which the fish entrance gate is closed and the incoming water, either directly from the headwater gate or indirectly into the lower part of the chamber via a valve, causes the water level within the lock to raise and

[43] Solomon & Beach, 2004
[44] Travade et al, 2002
[45] Armstrong, Aprahamian, Fewings, Gough, Reader, Varallo, 2010
[46] Solomon & Beach, 2004
[47] Adapted from Armstrong et al, 2012

equilibrate with the upstream level. Fish are required to rise up through the body of the lock chamber in this stage.

- **A fish exit stage** during which the lower gate is partially opened and the upper water inlet gate is manipulated to provide an attractive flow of water to entice fish to leave the lock. The fish then have the opportunity to leave the lock chamber and enter the upstream water body.

- **An emptying stage** during which the upstream gate is raised above the upstream forebay water level, allowing the lock to empty slowly; or fish may be 'emptied' into the head pond; or, fish may be removed by an operator.

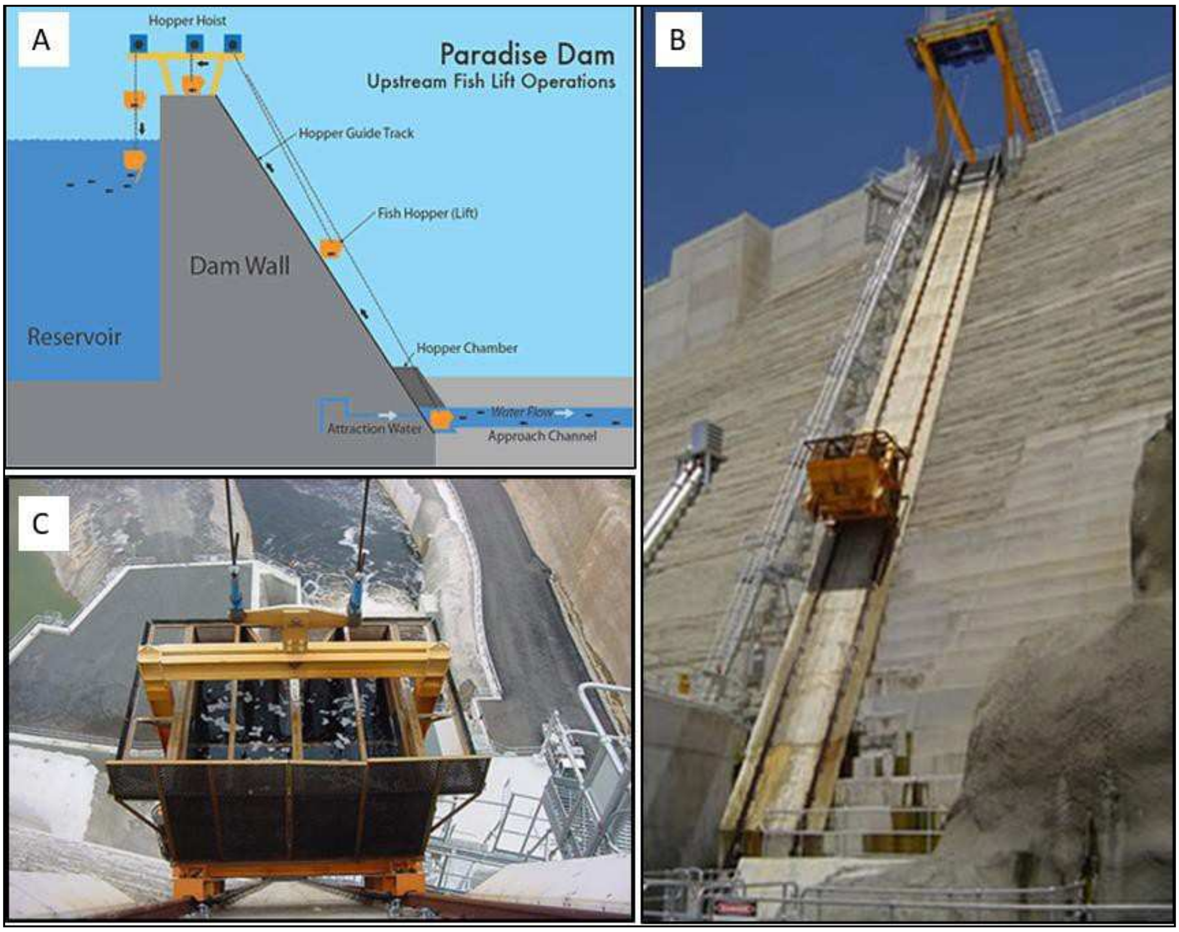

Figure 6. Fish lift at Paradise Dam in Biggenden, Queensland Australia (McNaught, n.d.). This example was specifically designed for lungfish and was not successful with only three fish recorded.

Discussion

In New Zealand a fish lift has been part of the elver transfer operation at Karāpiro Dam (52 metres height) since 1995 and most of the elvers obtained at this site are collected by this system. However this is supplemented by manual trap and transfer operations, and the lift does fail periodically[48].

Upstream migrating eels climb into a holding trap, which is floating and allows for changes in the tailrace water level to be accommodated. The eels are held in a holding tank prior to being release in the upper catchment by operators[49].

In Queensland, Australia an upstream fish lift was installed on at Paradise Dam (37.1 metres height) on the Burnett River[50]. The fish lift consists of a 7,500-litre caged container known as the hopper that sits at the downstream base of the dam wall. When operating, water is passed through the hopper to attract into it. The hopper is lifted over the dam wall to release any fish that have entered the hopper into the reservoir. The hopper is then returned to the base of the dam and the cycle is repeated[51].

In the River Arguenon (Britanny, France). The Ville Hatte Dam (14 metres height) eel lift has a plug in the base of the hopper which is held closed by a spring-loaded plunger. When the trap is hauled to the crest of the dam by an electrically operated winch, a lever mechanism opens the plug and releases the eels into the reservoir. The fish lift usually completes one complete cycle per day.

Advantages

Overall, fish lifts offer a partial solution to fish passage issues related to high head dams, where conventional pool passes are not feasible. Most Borland lifts have been installed in dams of 6m to 18m in height, although some examples are on dams of up to 42m high[52] or as little as 4-5m high[53]. Fish lifts assist the passage of most fish

[48] https://www.eelenhancement.co.nz/single-post/2017/05/31/Karapiro-Elver-Transfer-Summary-20162017 - downloaded 15 December 2017.
[49] Boubee & Jellyman, 2009
[50] Humpheries & Walker, 2013
[51] Humpheries & Walker, 2013
[52] Armstrong et al,
[53] Travade et al,1992

species including those with weak swimming abilities[54].

Disadvantages

Fish lifts are expensive and require considerable engineering expertise. Other disadvantages include; poor attraction of fish into the lift structures, sensitivity to head water level variation, difficulty of establishing optimum operating protocols, high maintenance and the discontinuous nature of operating. Numerous locks have proved to be either not very efficient, or totally inefficient[55].

Feasibility for Rangitaiki Catchment

Matahina

Strengths	• An engineered solution could designed • Ability to sample migrating fish • Ability for a wide range of climbing fish species to be moved upstream
Weaknesses	• Technically very challenging to design, with numerous hydraulic or mechanical parts - high maintenance • Unsure how to move fish over Galatea Road. Might require manual intervention or civil works to the road and/or dam • Challenging to get the transition from the lake working for downstream passage due to lake level variation
Considerations	• Design needs to ensure cool water is supplied for temp control • Further design into providing upstream inlet at both river banks
Capital cost	$$$$$
Operational Cost	$$/year
Practical?	Unsure

Aniwhenua

This would be excess to requirements for the barrage at Lake Aniwaniwa.

54 Linnansarri & Curry, 2015
55 Larinier & Marmulla, 2004

1.5 Removal of the Barrier Introduction

Dam removal is the process of demolishing a dam, leaving a river to flow freely. It is undertaken for a variety of reasons that include environmental rehabilitation, structural weakness, maintenance expense and dam failure. This is not an option for the Matahina or Aniwhenua dams, but could be considered for other obsolete structures elsewhere in the catchment.

Discussion

In USA, 900 dams were removed between 1990 and 2015. In the Chesapeake Bay area the removal of dams was facilitated to ensure the safe passage of migrating American eel between freshwater Virginia Rivers, the Chesapeake Bay and the Atlantic Ocean[56].

Figure 7. Gilnes Canyon dam removal on the Elwha River in Washington State. (National Park Service, n.d.).

[56] Chesapeake Bay Program, 2014

PART 2: Downstream Passage

Introduction

The fundamental requirements for downstream passage facilities are quite different to those for upstream migration. Unfortunately, large uncertainty still exists in arranging functional downstream fish passage systems in New Zealand.[57].

The main challenge is to prevent or discourage migrating tuna from entering HEPS intakes.. When downstream migrant tuna are confronted with a dam, they spend time searching along the headrace, presumably for an unobstructed pathway downstream[58]. Tuna that are unable to find a pathway have been shown to return upstream, often to the exact location where they were residing previously.

Migrants can impinge or get stuck against the screens or enter station intakes, and are often killed during passage through the turbines[59 60]. Recent evidence suggests that downstream migrant tuna will readily use alternate lower-mortality passage locations, if these are available to them[61].

Downstream eel passage technologies are much less advanced than those for upstream passage and are the areas most in need of research[62]. This is partly due to the development of effective tools for downstream migration, which is much more difficult and complex than upstream passage[63].

Four options are identified for downstream passage: 1) spillway passage; 2) turbine passage; 3) fish bypass structures (including various collection facilities of downstream migrating fish for transportation); 4) manual trap and transfer of eels downstream.

The following section briefly describes some of the options available to facilitate downstream passage for migrating eels, noting that these do not include detailed assessments of the technical feasibility of establishing any of these options at either

[57] Armstrong, Aprahamian, Fewings, Gowing, Reader, Varallo, 2010
[58] Brown, Boubee, Haro, 2007
[59] Te Kūwaha, 2007
[60] Brown et al, 2007
[61] Brown et al, 2007
[62] Armstrong et al, 2010; Linnansarri & Curry, 2015; Noonan et al, 2012
[63] Larinier & Mamulla, 2004

Matahina or Aniwhenua dam.

2.1 Spillway

Introduction

A spillway is a structure used to provide the controlled release of water flows from a dam into a downstream area, typically the riverbed of the dammed river. Spillways ensure that the water does not overflow and damage or destroy the dam[64]. The spillway channel (similar to a very large slide) is the vehicle with transports the water to the river below. In order for a spillway to allow for downstream eel passage, the water level in the dam must be at or above the spillway level during the key migration season[65].

Figure 8. Spillway at Matahina Dam to the right of the image (Paul-Burke, 2016).

[64] New Hampshire Department of Environmental Services, 2011
[65] Baker, 2016

Discussion

In New Zealand a trial to gauge the effectiveness of spillway gate opening to provide downstream eel passage was undertaken at the Patea Dam[66] (82 metres) by Boubeè et al (2002)[67]. In the trial one of the two bottom opening spillway gates was opened by 150mm. The spillway gate opening event occurred on three consecutive nights between 7.30pm and 11pm (April, 2000) following heavy rainfall upstream. A net was set 1km downstream of the spillway.

The power turbines were operating for some of the time that the net was set. A total of 119 eels were caught in the net, with 5% identified as exhibiting external signs of damage (bruising, skin abrasion, cuts)[68].

According to Ryder Consulting (2009) a trial was undertaken at Matahina Dam on 24 June 2009 identifying the co-ordination of spillway gate opening with up- and downstream eel migration as a means to providing eels with the opportunity to bypass the power turbine intake and pass via the spillway to the lower Rangitaiki River and downstream to the sea[69]. Gate opening heights of 120mm, 200mm, and 350mm were used for water releases down the Matahina Dam spillway. It was found that an opening height of 120mm was considered the minimum height necessary to allow model eels to pass under the spillway gate without damage, however further investigation is required[70].

Further observations at Wairere Falls Power Station in New Zealand indicated that a significant number of eels pass over the weir when it overtopped during periods of high flows. Once over the dam, migrant eels continue to swim downstream quickly, but if the flow is interrupted, they will stop and wait for the next high flow event, and become prone to capture by fishers[71].

From these observations it appears that either partially opening spillways or allowing weirs to be overtopped for at least two hours at night during migration peaks may allow a significant number of migrant eels to pass safely over the dam.

Advantages

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66 Watene & Boubee, 2005
67 Boubee, Chisnall, Watene, Williams, Roper, Haro, 2002
68 Boubee et al, 2002
69 Ryder Consulting, 2009
70 Ryder Consulting, 2009
71 Stevenson & Boubee, 2009

Spillways are already present at most dam sites. Power turbines are able to continue operation during spillway use by eels in some cases. At Matahina it is possible to temporarily shut off generation to allow eel migration, however there are implications[72] (see disadvantages). There is an ability to control gate opening heights and gauge the effects on physiology of tuna and the surrounding environments and environmental factors. Research indicates that partially opening spillways for at least two hours at night during migration peaks may allow a significant number of eels to pass safely over the dam[73].

Disadvantages

International studies indicate that damage to fish and therefore survival rates is related to the way that energy is dissipated in the spillway[74]. Various sources of mortality have been identified including abrasion against spillway surfaces, turbulence in the stilling basin at the base of the dam, sudden variations in velocity and pressure as the fish hit the water, and physical shock or damage from collisions with baffles[75].

At Matahina, shutting off generation is a financial cost in terms of lost power generation.

[72] Goldsmith and Ryder, 2017
[73] NIWA, n.d
[74] Larinier and Travade, 2002
[75] Larinier and Travade, 2002

Feasibility for Rangitaiki Catchment

Matahina

Strengths	• Spill gates operational, and requires no construction works • Migration triggers are generally well understood, and able to develop an operational procedure to ensure best opportunity to downstream migration • Shown to be effective at Patea HEPS
Weaknesses	• Live eel trial required to demonstrate that eels can safely pass downstream • Stakeholders have concerns for the wellbeing of tuna passing underneath gates • In some instances it will require TPL staff or contractor to visually inspect headpond to initiate spilling
Considerations	• Spill gate operational procedure to be developed • Collaboration with Aniwhenua operators when they are trapping tuna to ensure spill gates are operating
Capital cost	$
Operational Cost	$$/year
Practical?	Yes

Aniwhenua

The barrage at the Aniwhenua HEPS is 10 m and the use of the spillway is an option for further investigation for downstream migration.

2.2 Turbines

Introduction

Fish passing downstream through water turbines may be injured or killed. The extent of the injury can depend upon the type of turbine installed, the speed of the turbine rotation, the species and physical shape of the fish..

Discussion

Large, elongate fish such as adult eels are particularly vulnerable to damage as they pass through turbines. For adult eels, typical mortality values are between 15 and 30% for large low-head Kaplan turbines but can be 50 to 100% in the smaller turbines used in most small-scale hydropower developments.

A review of the problem in New Zealand concluded that the survival of large migrant eels (>800 mm) through turbines was likely to be nil[76]. Therefore, turbine designs that allow passage of eels with a low to nil rate of injury have been investigated. The ability to retro-fit such turbines to an existing power station is unknown, but considered to be unlikely as a technically viable option.

Small diameter, fast rotating, turbines are reported to cause the most damage to downstream migrating fish

Kaplan and Francis turbines

Kaplan turbines have a propeller type design with a variable pitch blade that allows the turbines to be operated across a range of flows[77]. Francis turbines typically have more blades and are common at high head dams[78]. The mortality rate of fish passing through Kaplan and Francis turbines can dramatically vary between sites and applications and is largely dependent on the turbine, operation, head height of dam, and the size of the fish passing through the turbines[79].

[76] Mitchell & Boubee, 1992
[77] Trumbo, Ahmann, Renholds, Brown, Colotelo, Deng, 2014
[78] Larinier, 2000
[79] Larinier & Travade, 2002

However, mortality rates for Kaplan turbines typically range from 5-20%, while mortality rates for Frances turbines range from 5 to >90%[80]. According to Lannasaari & Curry (2015) Francis turbines with their additional blades and smaller diameters increase the probability of blade strike during turbine passage particularly for larger fish.

Fish Friendly Turbine Designs

Environmentally enhanced turbines have emerged as an alternative to conventional Kaplan and Francis turbine designs[81]. The designs increase fish survival while maintaining power generating efficiency.

Two fish friendly turbine designs that minimise injury and mortality of fish while maintaining power production[82]. are the MGR and the Alden turbine. The MGR has been installed and tested at a full scale in the Columbia River system[83]. A similar full scale trial has yet to be completed using the Alden turbine[84], and it's not clear if these will protect tuna or are only suitable for salmonids (eg; trout).

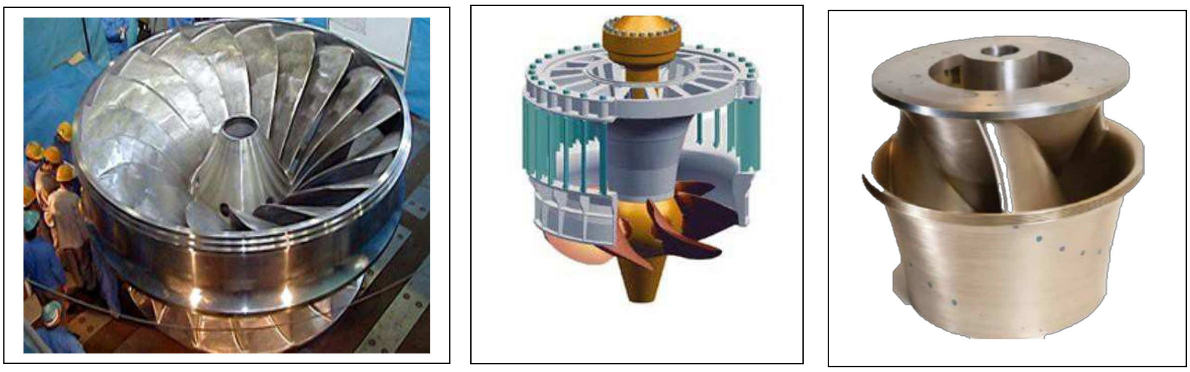

***Figure 9**.* Images of (L) Francis, (C) Kaplan – minimum gap runner, and (R) Alden Turbine

Minimum Gap Runner (MGR)

The MGR turbine was developed by modifying a conventional Kaplan turbine to minimize the gaps between the adjustable runner blades and hub, the blade tips and

[80] Larinier, 2000; Larinier & Travade, 2002
[81] Linnansarri & Curry, 2015
[82] Odeh, 1999
[83] Čada & Rhinehart, 2000
[84] Linnansaari & Curry, 2015

the discharge ring at all blade positions[85.] These modifications were intended to minimize the areas where fish injury and mortality. The changes were also expected to improve the operating efficiency of the turbine in terms of power generation[86]. The MGR design implemented at the Bonneville dam in Oregon, USA showed a decreased 1.5% injury rate compared to a 2.5% injury rate at an adjacent Kaplan turbine[87].

Alden fish friendly turbine design

Alden Research Laboratory incorporated an integrated design called Alden turbine that had no gaps between the runner blades (which are attached to a rotating shroud).

The design eliminated the low pressure vortices that occur near the blade tips and eradicated any chance of fish being caught between blades and the turbine walls.

In order to reduce the chance of blade strikes, the design uses only three blades which are much longer than conventional blade with nearly 180 degrees wrap. The 3:1 scale model of the turbine on live fish tests found that American eels had a 100% survival rate[88]. However, further testing is required.

Advantages

Fish friendly turbines provide an alternative for new dams.

Disadvantages

For most existing stations the costs and logistics towards implementation would be significant; the only practical means of reducing the extent of injury and mortality is to discourage fish from entering the turbines.

Feasibility for Rangitaiki Catchment

This is not considered feasible for the HEPS in the Rangitaiki Catchment.

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[85] Čada & Rhinehart, 2000
[86] Odeh, 1999
[87] Robb, 2011
[88] Robb, 2011

2.3 Fish Bypass Structures

Introduction

Structures that direct fish away from potential hazards such as turbines and towards safe, bypass routes are known as bypass facilities. A multitude of bypass designs exist and all consist of two major components: 1) a design or system that directs or funnels downstream migrating fishes towards a safe passage route; and 2) a bypass facility that allows fishes to safely migrate through the dam works and into the tailrace[89].

Effective (functional) bypass routes must be designed and situated such that fish are funneled, directed, or enticed towards and into the bypass facility. This requires a sound understanding of the biology of the targeted fish species i.e., downstream migration patterns and swimming position in the water column (e.g., swims on the surface vs bottom)[90]. Physical barriers such as screens prevent fish from passing through turbines. Sufficient screen area must be provided to create low flow velocities to avoid fish becoming trapped against the screens, and deterrent or bypass structures need to consider operational and safety requirements of a dam operation. Options are numerous and must be designed specifically at each dam to suit.

Discussion

In New Zealand, there is currently only one example of a successful downstream bypass option for migrating eels at high head dams[91]. Boubee and Williams (2006) have shown that migrant eels found and used two 100 mm diameter surface bypass holes drilled side by side in the dam wall, approximately 0.6m below the water surface at Wairere Falls Power Station (19.6 metres head), with 544 and 744 eels recorded using the bypass in 2002 and 2003 respectively. Two further 150 mm entrances have been subsequently added and monitoring undertaken in 2008 indicated that 1,044 migrant eels used the bypasses that year (Baker, 2016).

In Northeast England, the effectiveness of a Larinier super active baffle fishway at a low-head barrier on the River Derwent was tested. This found that high turbulence

[89] Linnansaari & Curry, 2015
[90] Solomon & Beach, 2004
[91] Baker, 2016

and/or the physical characteristics of baffles may inhibit lamprey use of the pass.

In the migration season for 2014-15 studded modular plastic tiles were added adjacent to the fishway wall. Results showed that 85.8% of the 197 tagged lamprey entered the fishway, of which 42.6% entered the tile entrance. Reduced local flow velocity in combination with increased availability of resting habitat within the tiles may have facilitated increased passage[92].

Bypass alternatives, such as the installation of small bypass pipes, have proven to be effective (Boubée and Williams 2006) but only when it is the only option of bypassing an impoundment. In addition to bypass alternatives, altered operations conditions at hydro projects during peak passage events may be necessary to attract eels to non-turbine passage routes. Alternative operations may include temporary shutdown coinciding with the operation of a bypass system or inadvertent spill where spill bays exist or tapered operations that would attract eels to location of an alternate passage route such as a bypass system.

Decreased searching behaviour will also decrease the overall transit time of eels moving through each impoundment and will likely decrease the stress and increase the rate of survival during downstream passage. Without alternative, non-turbine passage routes, with the increasing number of hydro dams being contemplated and excessive fishing pressure affecting eel populations in non-impounded waterways it is likely that the number of large adult eels that successfully migrate out to sea to spawn will continue to decline[93].

[92] Tummers, Silva, O'Briend, Jang, Lucas, 2016
[93] Brown et al, 2007

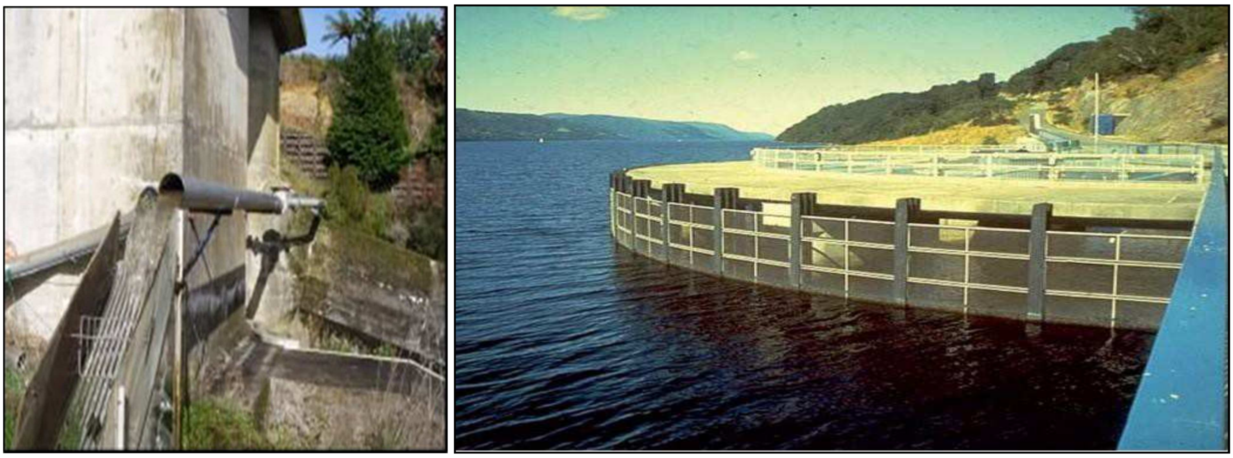

Figure 10. Images of (L) bypass at Wairere Falls Power Station, New Zealand (Boubee, n.d.) and (R) fine mesh screen at a hydroelectric power plant intake on the Loch Ness in Scotland (Travade, 2010).

Feasibility for Rangitaiki Catchment

Matahina

Strengths	• No manual intervention required (could be designed to allow it though) • System could be designed to provide up and downstream passage • TPL has experience with designing, implementing and operating a successful bypass at Patea HEPs
Weaknesses	• Deciding on where the most effective location is for bypass intake might require technical studies • Might require a large flow to attract migrating eels - waste water depending on design. Challenges to attract eels into the system
Considerations	• Bypass structure could include something through the station, an artificial watercourse around the station etc • Operation of Matahina might need to alter to ensure eels are attracted to the bypass intake structure • Debris management
Capital cost	$$$$$$
Operational Cost	$$/year
Practical?	Unsure

Aniwhenua

A vertical slot or similar type of pass could service downstream migration at the Aniwhenua barrage, however managing the flow required to attract migrating eels to the pass (rather than the canal or other intakes) could be challenging. The spillway option would negate the need for this.

2.4 Downstream Manual Trap and Transfer Introduction

There are a number of known environmental triggers known to influence the downstream migration of eels. These are increases in water level and flow associated with rainfall, and lunar periodicity, with maximum activity just before the last quarter[94] (Todd 1981), and water temperature. However, rainfall and flow have been shown to be the best predictors of eel migrations (Boubée et al. 2001). Therefore, a downstream trap and transfer programme will be most effective when targeting nights associated with increased rainfall.

Discussion

In Europe and New Zealand, trap and transfer programmes for downstream migrant eels have been initiated as mitigation measures at hydroelectric facilities. In New Zealand, downstream migration of mature eels in the Rangitāiki River is limited by the presence of the Aniwhenua Barrage and Matahina Dam[95]. Mtichell (1996) reported an attempt to net migrating eels at the Aniwhenua Barrage so as to manually transfer them downstream of the Matahina Dam. The timing of the downstream migration was difficult to predict in advance, however adult eels have been successfully captured and transferred. An investigation into the key environmental variables that regulated downstream migration was initiated by Boubee, Mitchell, and Chisnall (2001).

In a report by Boubèe et al (2001) migration occurred over a few nights in autumn, beginning when temperatures began to decline and ending when temperatures dropped below 11º C. It was found that sixty percent of migrant eels arrived at Aniwhenua when rainfall exceeded a cumulative total of 40mm over three days. According to Goldsmith et al (2009) the Kokopu Trust currently operates a trap and transfer program for adult migrant eels at the Aniwhenua Barrage and Matahina Dam on behalf of Trustpower[96].

At the Manapōuri Power Scheme fyke nets (15x 1-m diameter with 20+ m leaders) are deployed within Lake Manapōuri during the downstream eel migration season and

[94] Todd, 1981
[95] Goldsmith, Ludgate, Ryder, 2009
[96] Goldsmith, Ludgate, Ryder, 2009

migrants are transferred to downstream areas[97].

In 2010 – 2011 over 3,900 migrants (mostly females) have been transferred below the dams. Since 2001, a trap and transfer operation for downstream migrant eels has also been operating in the upper Waitaki catchment[98].

A series of reports by Kearney et al (2013) on the distribution and recruitment of elvers into the Rangitāiki catchment highlighted the difficulties of undertaking a rigorous trap and transfer programme in Lakes Matahina and Aniwhenua due to difficulties with working under adverse climatic conditions often encountered during times of rainfall. Downstream tuna migration occurs mainly during these times.

According to Kearney, Kerrison & Kayes (2013) the long-term efficacy of a trap and transfer programme should be viewed as an interim measure until a proper intake deterrent measure is identified. This supports the long term aim of iwi in removing any human handling of migrating eels into the upper catchment, although currently remains the one known safe passage for down-stream migrating eels in the absence of any other options.

Advantages

Manual trap and transfer ensures the safe passage of adult eels over the dam. As for elver transfers it can move fish past both dams and allows record keeping of numbers transferred and other metrics to improve knowledge of tuna health and migration habits.

Disadvantages

Labour intensive and reliant on human effort[99], however the increase in awareness and learnings gained from hands on involvement could be beneficial. For this approach to be cost-effective predicting the migration runs across the season is fundamental[100].

[97] Boubee, Jellyman, Sinclair, 2008
[98] Robb, 2011
[99] Boubee & Jellyman, 2009
[100] Baker, 2016

Feasibility for Rangitaiki Catchment

Matahina

Strengths	• Allows for eels throughout the catchment to be moved downstream of both HEPs • Species composition, weight, and quantity can be easily recorded, and assessed against other trapping programs throughout NZ • Nationally accepted, and tested method of providing downstream fish passage
Weaknesses	• Manual intervention required • Dependent on Kokopu Charitable Trust • Forestry debris can limit areas where trapping can occur • Health and safety (cannot not be undertaken near to station intakes)
Considerations	• Ministry of Primary Industry permit • Contractors to seek the approval of Iwi and Hapū to set nets within their rohe • Cultural considerations when moving eels downstream from within the catchment
Capital cost	$
Operational Cost	$/year
Practical?	yes

Aniwhenua

Options are being investigate for Aniwhenua HEPS, including coordination/collaboration/costshare with Trustpower.

PART 3: Closing Comment

The science of fish passage and fish passage options has a long history of applications. However, guarantees for success in either up- or downstream passage for eel populations remains uncertain. Large uncertainty is associated in arranging functional fish passage for migrating eel species. Recommendations justifying any particular fishway type cannot be made without applying careful site-specific considerations. This report does not analyse potential options for effectiveness. This has been done to some extent by other experts against consent requirements for the operation of the Matahina Dam, and there is significant uncertainty as to the suitability of any of these options for Matahina or Aniwhenua. This will be worked through in the next stage of the overall Te Hekenga Nui o Te Tuna Action Plan.

Effectiveness depends on the fish species' swimming or climbing ability, and how the tuna moves up and downstream. A fish passage that is designed to allow fish to pass upstream may not allow passage downstream, for instance. Fish passages do not always work. However, not including any fish passage at all ensures that affected species cannot migrate. (Waldman, 2013)

According to Larinier (2002):

> "*Except for the solution of removing the obstruction, there is no 'miracle' fish passage facility which is more effective than all the others: experience shows that numerous pool fish passes, Denil fishways, fish lifts and natural bypass channels have proved to be equally effective – or ineffective*[101]*".*

[101] Larinier, 2002

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This report summarises the findings of a two year study on variation of glass eel supply to Barnegat Bay (New Jersey, USA) to dams at three sites. It was found that passive passage of glass eels over dams can be accomplished by providing consistent, relatively low flow from above a dam over a substrate and through a pipe pass. At one of the three sites it was found that two large holes in the base of the cement at the dam face created two eddies below the dam which created a potentially confusing back-current for eels. Glass eels are positively rheotactic, therefore want to swim against the current heading upstream as opposed to with a current. No eels were recorded at the dam face of the site with the two eddies.

Armstrong, G., Aprahamian, M., Fewings, G., Gough, P., Reader, N., & Varallo, P. (2010).
***Environmental agency fish pass manual*. Environmental Agency. Bristol.**

This report provides comprehensive information on fish pass types, selection, construction, technical and non-technical solutions for a number of fish species including Eels.

Atlantic States Marine Fisheries Commission. (2010). *Upstream fish passage technologies for managed species.* Fish Passage Working Group – Eels. September, 2010. ASMFC.

The report summarises a variety of fish passage designs for migrating eels. *Pool-and-weir* design identified that eels of all sizes will use this style of fishway to a certain degree. The key may be low water velocities, small drops per weir, and 'leaky' weir boards that allow small eels to wiggle through gaps to pass from pool to pool. ***Vertical slot*** design found that eels of all sizes have been documented using large vertical slot fishways. Passage of eels may be enhanced when the lower portion of the slot is blocked with sill blocks that have gaps around them, allowing small eels to avoid the high velocity flows of the slot. If a vertical slot fishway is planned as the main avenue for upstream migration of eel, some special design feature such as submerged orifices through the weirs, stuffed with porous climbing substrate, may increase the effectiveness of this design.

Eel pass – Climbing ramps this is the preferred design for passing American eel. At sites where glass eels are present, an additional or alternative climbing substrate is advised. Larger eels require more coarse climbing substrates. The key to success is selecting an appropriate location for the entrance where eels can find it. ***Removal*.** The report identified that if the species of eel migrated above the site prior to the construction of the dam, it is likely that it will go above the site after the dam is removed. Therefore, this is the most effective of all fish passage technologies.

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This paper reviews aspects of the downstream migration of eels and other diadromous species in the United States and New Zealand. The paper focuses primarily on how passage problems have been implemented, and performance of structures in operational protocols in both countries.

Boubee, J., Jellyman, D., Sinclair, C. (2008). Eel protection measures within the Manapouri hydro-electric power scheme, South Island, New Zealand. *Hydrobiologia* (2008) 609: 71-82.

This report summarises mitigation measures that have been implemented at the Manapouri Power Scheme (South Island, New Zealand). The measures include the release of compensation flows, the reconstruction of a fish pass and a catch and transfer programme for upstream migrating juveniles and adult down migrants (silver eels). It was found that eels are most active when lake levels were rising and searching behaviour was exhibited, especially near the natural lake outlet. It was also found that eels appeared reluctant to travel to the opposite side of the lake where the hydropower station is located. Information is assisting the development of more effective methods for capturing eels in the lake for downstream transfer.

Boubée, J.A., Mitchell, C.P., Chisnall, B.L., West, D.W., Bowman, E.J. and Haro, A. 2001. Factors regulating the downstream migration of mature eels (Anguilla spp.) at Aniwhenua Dam, Bay of Plenty, New Zealand. New Zealand Journal of Marine and Freshwater Research, 35: 121-134.

The report provides information on an investigation into the key environmental variables that regulated downstream migration. It was found that migration occurred over a few nights in autumn, beginning when temperatures began to decline depending temperatures dropped below 11º C. Sixty percent of migrant eels arrived at Aniwhenua when rainfall exceeded a cumulative total of 40mm over three days.

Brown, L., Boubee, J., Haro, A. (2007). *Behaviour and fate of downstream migrating eels at hydroelectric power station intakes.* 6th International Symposium on Ecohydraulics, Christchurch.

This report provides results of 3D tracking movement of eels as they approached, encountered and passed downstream of the Arapuni (Karapiro Reservoir) hydropower station. The study assessed pre-passage behaviour of longfin and shortfin eels. Pre-passage behaviour investigated time, duration, and number (i.e. one or more multiple passage attempts) of tagged eel detection. It was found that eels will search for non-turbine alternative passage locations. Recommendations from the study included the installation of small bypass pipes; altered operations conditions during peak passage events, to attract eels to non-turbine passage routes.

Čada, G. & Rinehart, B. (2000). Hydropower R&D: Recent advances in turbine passage technology. Prepared for the U.S. Department of Energy. Idaho Operations. DOE/ID-10753.

The report described R&D activities across the U.S. related to survival of fish entrained in hydroelectric turbines. As part of the Columbia River Fish Mitigation Program, studies were conducted that focused on juvenile fish passage through turbines, developed biologically based turbine design criteria, and evaluated prototype advanced turbines that are designed to improve survival of juvenile salmon and steelhead.

Chesapeake Bay Program. (2014). ***Fish passage and dam removal.*** **Report to restore the Chesapeake Bay fish passage projects on many tributaries. Virginia, USA.**

The report provides an overview of the removal of dams in the Chesapeake Bay watershed area to facilitate the safe passage of migrating American eel between freshwater Virginia rivers, the brackish Chesapeake Bay and the Atlantic ocean. In 2014, the Harvell Dam on the Appomattox river was removed. The Monumental Mills dam on the Hazel River was removed in 2004-2005. Removal opened up 71 miles of spawning habitat on the mainstem Rappahannock river and 35 miles on the Rapidan River.

Foust, J., Coulson, S., Hecker, G., Allen, G., Perkins, N. (2011). ***Alden Fish-Friendly Turbine: Final Considerations for Development and Application.*** **Presented at the American Fisheries Society 141st Annual Meeting "New Frontiers in Fisheries Management and Ecology: Leading the Way in a Changing World". 7 September 2011, Washington State Convention Center, Seattle.**

This report provides an overview of the Alden turbine design. The Alden turbine is designed for smaller, radial flow applications to provide safe migrating fish during power production. The Alden turbine features a runner geometry that incorporates only three blades with thick entrance edge profiles to reduce fish strike probability and resulting mortality rates. Technical comparisons focusing on sizing, performance and fish survivability relative to conventional turbine types including Francis, Kaplan and Voith Hydro’s minimum gap (MGR) Kaplan.

Gätke, P., Baran, E., Fontes, H., Makrakis, S., Makrakis, M., Räsänen, T., Samadee, S. (2013). ***Fish passage opportunities for the Lower Seasan 2 dam in Cambodia: Lessons from South America*****. Mekong Challenge Program for Water & Food Project 3. ICEM – International Centre for Environmental Management, Hanoi Vietnam.**

This report identifies fish passage success factors for migrating fish (eels). Success of fish passage closely linked to water velocity, depth and low turbulence. Report discusses year round discharge pass system and behaviour and swimming capabilities of target species should be considered a priority.

Greif, R., Steimle, K., Brown, R. & Gessler, D. (2013). Cost-effective passage design for high-head hydro facilities. ***Hydroworld Review*****.**

This report investigates the provision of safe downstream fish passage over high-head dams.

The decompression raceway models were tested as an innovative approach that is more cost-effective than traditional downstream passage at high-head dams. Pressure tests demonstrated minimal potential for injury (no injuries for 142 fish tested). Results verified the expected hydraulic performance of the decompression raceways, and the computed velocities demonstrated a uniform deceleration with no flow separation and minimal potential for impingement of fish against screens.

Goldsmith, R., Ludgate, B., Ryder, G. (2009). Matahina hydroelectric power scheme: Aquatic ecology assessment. Report prepared for HOBEC on behalf of Trustpower Limited. Dunedin, New Zealand: Ryder Consulting.

The report provides a comprehensive overview of manual transfer of eels from the Matahina Dam to upper catchment, including Lake Aniwhenua which began in 1993. The report identified in 1991 a gravel-lined fish elver pass was also constructed to assist elver movement upstream[103] but is no longer in use.

However, the manual trap and transfer program has continued. In 1996 NIWA managed an elver capture and transfer program on behalf of ECNZ and EnvBOP[104]. The program was very successful with approximately 614,500 elvers (136,000 longfin elvers and 478,500 shortfin elvers) trapped and transferred in 1997/98[105]. The program is currently operated by the Kokopu Trust on behalf of TPL.

A review of elver transfer records calculated an average of 1,144,000 elvers per year have been transferred for the last 10 years (since 1997/98)[106]. The majority of the catch is transferred to Lake Aniwhenua and the upper Rangitāiki River, with the remainder transferred to Lake Matahina[107]. The report identifies downstream migration of mature eels in the Rangitaiki River is limited by the presence of the Aniwhenua Barrage and Matahina Dam[108].

James, A. & Joy. M. (2008). ***A preliminary assessment of potential barriers to fish migration in the Manawatu river catchment, North Island, New Zealand.*** **Report prepared for Horizons Regional Council, June 2008. Foundation of Research, Science & Technology. Envirolink Contract RefL 437-HZLC45.**

This report assessed ninety-one in-stream structures in the Manawatu River catchment for their potential to impede that passage of native fish species. Only of few structures had existing fish passes of which none were functional. The report identifies that in-stream structures are legally required to provide for fish passage or have written dispensation. Recommendations asserted that Horizons Energy must continue to ensure the designers and installer of new in-stream structures are aware of their legal obligations regarding fish passage.

Kearney, M., Kerrison, B., Kayes, P. (2013). ***Defining the migration of adult eels within the Rangitaiki River.*** **Report for Te Rūnanga o Ngāti Awa. Whakatāne, New Zealand.**

This report provides an evaluation of the temporal and biological characteristics for adult eel migrants within the Rangitāiki catchment. The report highlights the difficulties encountered when attempting to undertake a catch and transfer programme for migrant eels, including restricted access and unsafe working environments. It was found that migratory seasons were characterised by extreme weather patterns and flooding episodes between March and June, limiting the ability to capture migrant eels. Significant amount of logs and debris were flushed downstream from Lake Aniwhenua eventually ending in Lake Matahina creating navigational hazards and restricting the capacity to launch and use boats. At Lake Aniwhenua a profusion of duckweed made it difficult to sight eels and it became impossible to net eels due to the surface weed.

Kearney, M., Kerrison, B., Kayes, P. (2013). ***Distribution and abundance of shortfin Anguilla australis and longfin A. dieffenbachia eel in the Whakatāne region.*** **Report for Te Rūnanga o Ngāti Awa. Whakatāne, New Zealand.**

The report provides an evaluation of the distribution and abundance of freshwater eel in five different eel fisheries with the Whakatāne region. The eel fisheries included section of the Rangitāiki, Tarawera and Whakātane River catchments, of which the Aniwhenua and Matahina hydro lakes were included. It was found that the size and conditions of eels differed between locations. The condition of longfin eels from Lake Aniwhenua were poorer than those sampled from Lake Matahina, the Rangitāiki River and the Tarawera River. Likely due to food availability. The heaviest longfin was found in Lake Matahina. The greatest number of shortfin eels were sampled from the lower reaches of the Rangitāiki River.

Kearney, M., Kerrison, B., Kayes, P. (2013b). ***Recruitment of elver into the Rangitāiki catchment 2010-2013.*** **Report for Te Rūnanga o Ngāti Awa. Whakatāne, New Zealand.**

This report discussed the findings of a manual trap and transfer operations at the Matahina Dam in New Zealand. The report includes data from 2010/11, 2011/12 and 2012/13 elver migration seasons. It was found that shortfin elvers dominated the catch. This was thought to be due to larger longfin elvers congregating at the bottom of the holding tank, while smaller shortfin elvers swimming towards the top. A study of elver schooling behaviour within holding tanks was recommended. The report found that elver migration may begin when the average daily water temperatures were about 16 - 18ºC. It was also found that at the end of the season average daily temperatures were remaining between 17 - 18ºC when catches ceased. From 2010 – 2013 an estimated 80% of elvers were transferred into or upstream of Lake Aniwhenua, with the remaining 20% released into Lake Matahina.

Kerrison, B. & Kearney, M. (n.d.). Comments on the Matahina upstream and downstream fish passage protocols. Written Statement of Evidence to the Bay of Plenty Regional Council for Resource Consent Conditions for the on-going operation and maintenance of the Matahina Hydro-electric Power Scheme.

This paper provides critical feedback to proposed resource consent conditions for downstream passes for eels at the Matahina Dam complex. The paper provides support to a pilot survey investigating the feasibility of utilising spill gate escapement for adult migrant eels; and factors that trigger downstream migration. The paper identifies that there is no post survival (days, weeks, months) rates for eels that have passed down spill gates. The paper strongly opposed any spillway escapement of migrant eels, until supporting evidence is provided, trialled at the Matahina Dam. The paper provides diagrammatic representation for a downstream passage initiative, similar to an upstream fish lift.

Larrinier, M. (2001). ***Environmental issues, dams and fish migration.*** **Institut de Mecanique des Fluides. Toulouse, France.**

This report identifies critical factors to assist successful upstream passage of migrating fish and eels in France. The report summarises technical considerations regarding different types of fish passes throughout the world.

Lafaille, P., Acou, A., Guillouet., J., Legault, A. (2005). Temporal changes in European eel, Anguilla anguilla stocks in a small catchment after installation of fish passes. Fisheries Management and Ecology, Wiley-Blackwell, 2005. 12: 123-129.

This report investigates changes in abundance of European eel in the River Fremue, France over an 8 year period. Natural connectivity of the river was disturbed by three high dams that inhibited eel upstream migration and reduced recruitment by elvers and yellow eels. After eel passes were installed, fish became more abundant upstream. No decline in eel numbers and biomass were found. It was concluded that eel passes are important to conserve and/or to recover eel stocks.

Legault, A. (1994). Preliminary study of the fluvial recruitment of eels. Management of Aquatic Ecosystems. Number 335, 1994: 33-41.

This report discusses the results of a study of upstream migration of eels in the River Arguenon (Brittany, France). The dam of Ville Hatte constitutes an impassable obstacle at 10 km from the sea. It controls a 383 km^2 catchment area and is equipped with a ladder that was used to trap eels during a 7 months survey, between March 24 and October 25, 1992.

During the study, over 166 kg of eels were caught. The individual weight of caught eels ranged between 0.3 and 350 g, but most of them weighed less than 1 g. Thus, over 215,000 fishes got over the dam using the ladder. The eel ladder is the only way to pass over the dam. Therefore, the assessment of the captures permits to calculate the recruitment rate of the whole catchment, 561 eels per km^2 in 1992. A yearly evaluation of this rate could be used for a long term study of the population dynamics in eels at the scale of the whole catchment.

Linnansarri, T. & Curry, R. A. (2015). ***Fish passage in large rivers: A literature review.*** **Mactaquac Aquatic Ecosystem Study. Report Series 2015-016. Canadian Rivers Institute, University of Brunswick V + 55 p.**

This report summarises upstream and downstream fish passage solutions. The report identifies that upstream passage solutions include various technical (baffle and pool-and-weir fish ladders); nature-like fishways which allow for volitional passage; and non-volitional approaches – fish lift and fish locks which are a default choice in large, high-headed dams. Effective downstream passage requires full development of all 3 identified passes – spillway passage; turbine passage; and fish bypass structures. The report found that the most efficient fish passage either up- or downstream will require trade-offs between power generation and the success of passage. This is due to the fact that attraction of fish must be induced by provision of flow.

LMK Consulting Ltd. (2014). Report on hydroelectric dams in New Zealand and fish passage. Report prepared for Wai Maori Trustee Limited. October 2014.

This report summarises information on hydroelectric power schemes throughout New Zealand. The report identified the name, location and name of consent holder for the relevant dam; when the resource consent is up for renewal and conditions (if any) of consent as they relate to fish passage. The hydroelectric dams and schemes covered in the report are by region.

Mallen-Cooper, M. (2007). Optimising denil fishways for passage of small and large fishes. *Fisheries Management and Ecology.* February 2007.

This report discusses an experimental fishway that was trialled at three different slopes (8.3%, 14.3% and 20%) to examine the potential of the single-plane Denil fishway for passage of small- and large-bodied native fishes in Australia. The results dispel the notion that Denil fishways are poor for small fishes. Manipulating the design parameters of slope, length, width and possible depth-over-breadth ration enables Denil fishways to pass a wide size range of fish.

Martin, M., Stevenson, C., Boubee, J., Bowman, E. (2009). *Recruitment of freshwater elvers, 1995-2009.* New Zealand Fisheries Assessment Report 2009/58 November 2009.

The report summarises the recruitment of elvers trapping and transfer operations at 11 sites around New Zealand. About 98% of the total shortfin catch was captured at North Island sites, and 94% were captured at Karapiro and Matahina dams. No significant longfin recruitment trend recorded. However, shortfin elver catches from Karapiro and Matahina indicate that since 1995-1996 recruitment has been increasing.

Mitchell, C. P. (1996). *Trapping the adult eel migration at Aniwhenua Power Station.* Science for Conservation: 37. Department of Conservation, Wellington, New Zealand.

This report identifies methods employed to trap and transfer migrating eels without harm using nets at Aniwhenua Dam, New Zealand. It was found that when rainfall is exceeds a cumulative total for 5 days of 40mm in the Ruatahuna area from February until April, there will probably be an eel migration. Eels should be transported to Matahina for release when it is dark. The study found difficulty in predicting which specific nights the eels were going to migrate. The net used in the trial was only 50 metres long, which was too small to fully cover the canal resulting in eels dying on the screens despite the trapping trial being in place. It was also found that the trapping of migrant eels was not an Ika Whenua tradition.

Mitchell, C. P. & Boubee, J. A. T. (1989). *Investigations into fish pass design stage 1.* New Zealand Freshwater Fisheries Miscellaneous Report No. 50. Ministry of Agriculture and Fisheries. Rotorua, New Zealand.

This report summaries a study which sought to establish feasibility of fish passes for short and long finned eels. The report identifies information gaps in downstream and upstream migration fish passes including; swimming and climbing behaviour and passage through turbines.

Noonan, J., Grant, J., Jackson, C. (2012). *A quantitative assessment of fish passage efficiency*. Fish and Fisheries, 2012. Wylie Online Library.

The report provides a quantitative evaluation of overall success rates of restoring fish passage across 61 dams across Canada, between 1960 and 2011. The report found that while Denil or baffles fishways were generally the most economical option, they also provided the lowest mean passage efficiency with approximately 16% successful survival rate. The more expensive pool and natural fishways were the most effective.

The report found that water velocity through the fishway was positively correlated with upstream passage efficiency, however too few data were available for a more robust analysis. It was also found that a longer fishway would increase the energy expenditure of the migrating fish, and thus decrease passage efficiency. Energy expenditure may be more related to fishway steepness than length, and fishway length and slope were negatively correlated. The poor success of Denil fishways may be related to the shortness and steepness the structures.

Robb, D. (2011). Hydropower's fish-friendly turbines. *Renewable Energy Focus* 12(2): 16-17.

This report summarises field tested designs aimed to reduce stresses that migrating fish experience when they go through a turbine. The MGR design implemented at the Bonneville dam in Oregon, USA showed a decreased 1.5% injury rate compared to a 2.5% injury rate at an adjacent Kaplan turbine. Alden Research Laboratory incorporated an integrated design called Alden turbine that had no gaps between the runner blades (which are attached to a rotating shroud). The design eliminated the low pressure vortices that occur near the blade tips and eradicated any chance of fish being caught between blades and the turbine walls.In order to reduce the chance of blade strikes, the design uses only three blades which are much longer than conventional blade with nearly 180 degrees wrap. The 3:1 scale model of the turbine on live fish tests found that American eels had a 100% survival rate. However, further testing is required.

Ryder Consulting. (2009). Downstream eel passage trial: Matahina hydroelectric power scheme. Report prepared for TrustPower Limited, July 2009.

The report identifies an alternative to manual trap and transfer operation and identifies the co-ordination of spillway gate opening with up- and downstream eel migration as a means to providing eels with the opportunity to bypass the power turbine intake and pass via the spillway to the lower Rangitaiki River and downstream to sea. Information on the success of the Patea Dam in Taranaki, NZ by are discussed with potential application to the Matahina Dam. The report provides an overview of the methods employed in a spillway trial at Matahina Dam on 24 June 2009.The report discussed the testing of shock and injury to model eels with sensors implanted in to the 'belly' of the eels. Results found that model eels travelling down the Matahina Dam spillway should not experience significant injury, however eels travelling down the spillway from Gate 3 were sometimes pushed against the spillway, which could cause abrasion damage. Gate opening heights of 120mm, 200m, and 350mm were used for water releases down the Matahina Dam spillway. It was found that an opening height of 120mm was considered the minimum height necessary to allow eels to pass under the spillway gate without damage, however further investigation is required. It was found that eels travelled down the spillway approximately twice as fast as when the spillway gate opening was increased from 120 to 350 mm (an increase of approximately 3 to 6 seconds travel time).

Stevenson, C. & Baker, C. (2009). *Fish passage in the Auckland region – a synthesis of current research.* Prepared for Auckland Regional Council. Environmental Research. Niwa Project ARC08227. Hamilton, New Zealand.

The report provides guidance for the construction and retrofitting of in-stream structures to allow the upstream passage of fish. Four passage options are provided for culverts. For non-culverts, only general principles are described.

Tummers, J., Winter, E., Silva, S., O'Brien, P., Jang, M., Lucas, M. (2016). Evaluating the effectiveness of a Larinier super active baffle fish pass for European river lamprey *Lampetra fluviatilis* before and after modification with wall-mounted studded tiles. *Ecological Engineering.* 91 (2016) 183-194.

This report tested the effectiveness of a Larinier super active baffle (SAB) fishway at a low-head barrier on the River Derwent, Northeast England. It was found that high turbulence and/or the physical characteristics of baffles may inhibit lamprey ascent of the pass. In migration season 2014-15 studded modular plastic tiles were added adjacent to the fishway wall. It was found that 85.8% of the 197 tagged lamprey entered the fishway, of which 42.6% entered the tile entrance. Reduced local flow velocity in combination with increased availability of resting habitat within the tiles may have facilitated increased passage.

Waldman, J. (2013). Block migration: Fish ladders on U.S. dams are not effective. *Yale Environment 360. April 2013.*

This report identifies the long-term results of fish passages on large, heavily dammed rivers. The results found that the overall record of fish passage is mixed. Fish ladders often work well but are in constant need of fine-tuning. The report offers no solutions to the improve fish passage including fish ladders.

Watene, E., & Boubee, J. (2005). Selective opening of hydroelectric dam spillway gates for downstream migrant eels in New Zealand. *Fisheries Management and Ecology* 12(1): 69-75. January 2005.

This report discusses the selective opening of the Patea hydroelectric dam spillway gates to potentially provide safe downstream passage for sexually mature (silver) eels in New Zealand. During autumn 2000, one of the spillway gates at the 82-m high Patea Dam was opened for the 2.5 h and a large fyke net set across the river about 1.5 km below the dam. Fifty one live endemic longfin eels, 60 live shortfin eels, and eight dead shortfin eels were captured. All but three of the eels caught were downstream migrants, and aside from the dead eel, only a small portion (5%) had external signs of injury. It was likely that the majority of the eels captured passed over the spillway, but some may have originated from the section of river between the dam and the net or gone through the turbines.

To further test the ability of eels to survive passage over the spillway, three controlled spills were made in autumn 2001 and 102 eels released immediately upstream of the partially opened spillway gates. A net stretched across the base of the concrete spillway was used to recover the eels. Most of the eels recovered from the spillway had low levels of injury. However, during the third controlled spill, 10 wild migrant eels were also caught with none showing any external signs of injury. This indicated that the damage noted on the recovered eels were the result of handling rather than passage over the spillway. It was concluded that selective opening of hydroelectric dam spillway gates can provide safe downstream passage for migrant eels.

Young, R., Smart, G. & Harding, J. (2004). Impacts of hydro-dams, irrigation schemes and river control works. Freshwaters of New Zealand. Chapter 37: 37.1-37.15.

This book chapter discusses fish passes for up- and downstream migration of native fish species including eels. The chapter identifies the eel pass at Patea Dam, the vertical slot fish pass at Mararoa Weir, Manapouri Control structure as some of the few that have been relatively successful in assisting eel passage up- and downstream. The chapter further discusses issues in rivers with multiple dams including Rangitāiki River.

APPENDIX 2

Tuna Project Plan (Draft) - May 2018

INTRODUCTION

This action plan has been developed by Te Hekenga Nui o te Tuna Steering Group (Steering Group), in its capacity as a formal sub- committee of the Rangitāiki River Forum. The purpose of the Steering Group is to develop and implement an action plan, and strategies, that contribute to the vision that is set out in the Rangitāiki River Forum's vision document, Te Ara Whānui o Rangitāiki:

> *"Tuna within the Rangitāiki Catchment are protected, through measures including the enhancement and restoration of their habitat and migration paths…so the tuna (eels) are fat and plentiful in the Rangitāiki River waterways."*

The name of this programme, Te Hekenga Nui o te Tuna, recognises the mighty migration effort and significant obstacles tuna must overcome in order to fulfil their biological lifecycle in the Rangitāiki catchment. Although "heke" refers to the downstream migration, the title is an overarching name that is about the kaupapa, rather than a specific document. The mahi is about tuna in general, movement in both directions, covering a wide range of issues that can affect tuna and actions that aim to remedy those issues.

This plan replaces the action plan developed in 2016.

BACKGROUND

Statutory Body

The Rangitāiki River Forum is a statutory body established under the Ngāti Whare Claims Settlement Act 2012, and Ngāti Manawa Claims Settlement Act 2012. The purpose of the Rangitāiki River Forum is the protection and enhancement of the environmental, cultural, and spiritual health and wellbeing of the Rangitāiki River and its resources for the benefit of present and future generations[1].

The Rangitāiki River Forum is a joint committee of the Bay of Plenty Regional Council and the

[1] Refer to the Forum's Terms of Reference for details.

Whakatane District Council within the meaning of clause 30(1)(b) of Schedule 7 of the Local Government Act 2002. The Rangitāiki River Forum is a permanent committee and will not be disbanded at the end of a triennium.

The members of the Rangitāiki River Forum comprise representatives from Ngāti Whare, Ngāti Manawa, Ngāti Awa and Ngāti Tuwharetoa ki BOP, and councilors from the Bay of Plenty Regional Council (BOPRC) and Whakatāne District Council (WDC).

The Settlement Legislation requires that all persons exercising functions and powers under the Resource Management Act 1991, that affect the Rangitāiki River, must have particular regard to the habitat of longfin (*Anguilla dieffenbachii*) and shortfin tuna (*Anguilla australis*) in the Rangitāiki River.[2] The Rangitāiki River catchment includes the Whirinaki River, Wheao River, Horomanga River.

A Fisheries protocol has also been agreed by the Crown and Iwi and requires the Minister and Chief Executive of the Ministry for Primary Industries to provide Iwi with ongoing input and participation in fisheries management processes that affect fish stocks in the Rangitāiki catchment. The protocol acknowledges the special relationship Iwi have with all species of fish, aquatic life, and seaweed found within Rangitāiki River catchment, and iwi interest in the sustainable utilization of these resources.

Support for the Plan

This plan is supported by various groups including Ngati Whare, Ngati Manawa, Tuhoe, Ngatiawa, Tuwharetoa, the Iwi Collective Partnership, Mai I nga Kuri a Wharei ki Tihirau Fishery Forum, Eel Enhancement Company, Te Ohu Kaimoana, Te Wai Maori, Bay of Plenty Regional Council, and Whakatane District Council.

[2] Section 125 of Ngāti Manawa Claims Settlement Act 2012 and Section 129 of Ngāti Whare Claims Settlement Act 2012

THE PROBLEMS

Te Hekenga Nui o te Tuna is informed by discussions between Iwi and Industry during the last two years. These discussions have highlighted problems within the Rangitāiki River catchment and the tuna fishery. The Industry has committed to working with Iwi to deal with various issues that are of common concern.

The main issues highlighted relate to sustainability, fishing extractions, fish passage, river and ground pollution, habitat degradation, and a lack of management communications and alignment across and within sectors and communities.

Sustainability and commercial fishing

Sustainability and kaitiakitanga is at the forefront of the Steering Group's thinking. There have been concerns about sustainability since at least 2007. At this time commercial catches were cut in half as part of the strategy to rebuild the tuna fishery, particularly longfin. Questions have also been raised about the status of tuna populations in 2018. There is a view that the fishery may still be in trouble to the extent that it was in 2007. Some suggest the longfin tuna are at risk of becoming extinct.

Commercial fishing has been identified by commentators as responsible for the decline in the tuna fishery in the Rangitāiki River, especially for longfin stocks. The only catch data available for the Rangitāiki River catchment at present is the commercial catch data. There is no information available for customary and recreational catches, as well as information for other sources of fishing mortality. There is also no information to inform the setting of a catch limit, and/or other management measures.

Fish Passage

Blocked fish passage for tuna and other fresh water fish is of considerable concern to the Steering Group and the Forum. Dams are a limiting factor in the survival of tuna populations as they impede and block fish passage up and down the river. It's unlikely that very many elvers, if any, are able to climb the Matahina dam. Small structures such as culverts can and do inhibit tuna and other freshwater fish passage, particularly in moving out of the main stem into the tributaries. Today, the existence of tuna above the Matahina dam relies upon the trap and transfer program that has been in place for many years. There would otherwise not be a tuna fishery today above the Matahina dam.

Habitat Degradation

Habitat degradation in the Rangitāiki River catchment has been going on for a long time. The first major change came in the early 1900s when the lower catchment lands were drained to support farming. The river in many places has been realigned to mitigate flooding risks. The strategy has worked but it has come at the expense of losing in stream tuna habitat. The tuna fishery will not grow unless there is adequate habitat for them to shelter and live.

Water quality

Pollution is an increasing problem as agriculture and horticulture becomes more intensified and nutrient inputs increase. These activities can increase the nitrate levels in rivers and tributaries, while erosion and sediment run-off from a range of land uses reduces water clarity and adds fine sediments to rivers and streams, which affects in-stream habitat. Long fin tuna prefer a stony cobble bottom, and fine sediments reduce this habitat type as well as affecting invertebrate food sources. Other pollution sources are derived from industrial and housing areas.

Coordinated Management

There is no coordinated management relating to the Rangitāiki River and environs, and its fishing resources. Nor is there any sharing of information that could assist decision makers achieve better results from the decisions and investments they make. The broadening of the Te Hekenga Nui o Te Tuna steering group aims to improve connections and coordination in terms of sharing information and decision-making processes.

SCOPE OF THE ACTION PLAN

There are 5 goals in this action plan:

1. Develop and begin implementation of a tuna harvest strategy for the catchment.
2. Develop a strategy and implementation plan to address fish passage issues in the Rangitāiki River catchment – this includes passage at dams, smaller structures (eg; culverts and fords), and flood pumps.
3. Develop and implement a strategy to address tuna habitat issues in the Rangitāiki River.
4. Develop and begin to implement a strategy to address water quality issues.
5. Develop a communications, education and engagement program relating tuna and the work to be undertaken.

Each of the goals is considered a workstream in the overall project, and each objective contributes to the achievement of the goal.

Goal 1: Develop and implement a tuna harvest strategy for the Rangitāiki River catchment

The purpose of this strategy is to manage commercial and non-commercial tuna fishers by managing extractions within the Rangitāiki River catchment. The intention is to manage effort and maintain catches within a catch limit for the Rangitāiki River catchment. There are 8 objectives for this goal.

Objective 1: Develop a submission on the review of the tuna fishery in QMA21. The aim is to ensure management decisions are consistent with the Steering Group's goals and objectives.

Action 1: Te Ohu Kaimoana will work with the Steering Group to develop a submission on any review of the QMA 21 tuna fisheries.

Objective 2: Agree and implement a catch limit and other management measures to help manage customary, recreational and commercial catch, based on existing available information.

Action 1: Review MPI catch data and develop an estimate of commercial data.

Action 2: Facilitate discussions with Steering Group representatives to yield an estimate for customary needs and current catches.

Action 3: Establish a recreational catch allowance based on 20% of the customary catch.

Action 4: Set other fishing related mortalities at a number based upon best available information.

Action 5: Investigate and develop other management measures such as gear requirements to apply within the catchment.

Objective 3: Identify areas of the river where extractions may need to be actively managed or constrained, and how. The intention is for iwi and industry to agree measures within these areas.

Action 1: Identify the legislative tools available to manage spatial areas under the Resource Management Act, Fisheries Act, and Conservation Act, and National Parks Act.

Action 2: Identify non-legislative tools that may be available or able to be developed to manage spatial areas and fishing activities.

Action 3: Identify areas of the river that will be spatially managed.

Action 4: Agree how the areas will be managed and implement measures.

Objective 4: Develop a framework and methodology for surveying of tuna stocks in the Rangitāiki River catchment in order to establish appropriate stock rebuild targets for shortfin and longfin stocks, and report progress against targets.

Action 1: Facilitate a meeting with relevant MPI science experts and managers to develop options for surveying/measuring tuna stocks within the catchment.

The Steering Group will work with MPI to develop options for setting rebuild targets (eg; data, methodology, working within legislative processes and statutory agreements).

Action 2: Identify/develop stock health indicators to measure performance of sustainability strategies within the catchment, including methodology and data collected. This may include cultural health indicators as well as science based population data and methods, and will include parameters to be reported, reporting frequency and audiences.

The aim is to ensure surveys are affordable, fit for purpose, and can be used for monitoring and management of the tuna fishery, and that information is shared appropriately.

Action 3: Establish and agree realistic stock rebuild targets.

Action 4: Report back on stock health indicators for tuna, using methodology and data developed in Actions 2 and 3.

Objective 5: Put in place a customary harvest reporting system for customary fishers to use for management purposes. The information will remain the property of the iwi.

Action 1: Provide iwi and kaitiaki with access to Ika Net or other devices.

Action 2: Train kaitiaki to use Ika Net or other devices.

Objective 6: Develop a process to enable iwi/hapu representatives to feed into the development and operation of an industry annual harvest strategy.

Action 1: The Steering Group will work with industry to develop a strategy that enables iwi and hapu representatives to input to the industry annual harvest strategy.

Objective 7: Develop a communications strategy between iwi and industry regarding fishing activities in the Rangitāiki River catchment.

Action 1: Facilitate discussions between iwi, industry, and BOP Regional Council, to agree a communications strategy

Goal 2: Address fish passage issues in the Rangitāiki River catchment

The intention is to achieve successful upstream and downstream tuna migrations. Dams and power stations, smaller structures like culverts and fords, and pumping schemes all present barriers to tuna.

Objective 1: Full participation of power companies and other relevant groups in the development of a strategy to mitigate fish passage barriers in the Rangitaiki Catchment.

Action 1: Identify relevant groups and contacts to include.

Action 2: Work with power companies to build on mitigation measures that are currently in place at power stations on the Rangitaiki River, including improving on measures currently in use.

Action 3: Work with other groups (eg; BOPRC Rivers and Drainage section; Whakatane District Council Roading section; private landowners) to identify and mitigate fish passage issues in areas of relevance to them.

This action would include mapping barriers and working together around scheduling and funding works to re-establish fish passage – See objective 2.4 and actions below.

Action 4: Develop working relationships with national and international experts on fish passage, freshwater ecology and fish behavior, that can add value to the work being undertaken.

Objective 2: Compile information on what is known about local, national and international dams and power stations regarding tuna passage and mortality.

Action 1: Identify information sources relating to elvers and adult fish within the Rangitāiki River catchment.

Action 2: Identify what mitigation measures are in place at each hydroelectric power station on the Rangitāiki River, and how successful they are.

Action 3: Develop an estimate of the level of tuna mortality due to dams and power generation on the Rangitāiki River.

Action 4: Identify mitigation measures that are being used globally to address fish passage issues and assess their appropriateness for the Rangitaiki River power schemes.

Action 5: Investigate technology options that may help to manipulate the behavior of tuna to steer them away from turbine water intakes and/or into potential fish passage structures.

Action 6: Work with power companies to identify preferred fish passage options (upstream and downstream) to move to the next step of feasibility and technical design.

Action 7: Develop a staged approach to implement the installation of the preferred fish passage options for the power schemes.

Objective 3: Determine the extent of the problem of tuna being killed in flood pumps and drain clearance operations undertaken by council and land owners, and work together to develop and implement mitigations as appropriate.

Action 1: Identify the location and specifications of flood pumps within the Rangitāiki River catchment, with a view to identifying the potential for retro-fitting or otherwise allowing safe passage for eels.

Action 2: Identify BOP Regional Council drain clearance programs within the Rangitāiki River catchment.

Action 3: Estimate the level of tuna mortality from flood pumps and drain clearance programs. This may include monitoring and investigation work.

Objective 4: Identify and address fish passage issues at smaller structures in the Rangitāiki catchment so that tuna can move unimpeded into the tributaries.

Action 1: Survey and inventory fish passage issues at smaller structures in the catchment, using existing information and data collection tools to begin with.

Action 2: Implement mitigation measures for smaller structures in the catchment progressively, using national and local guidelines and recommendations, working with the appropriate administering body or landowner.

Goal 3: Address tuna habitat issues associated with the Rangitāiki River catchment

The goal is to protect and enhance tuna habitat, to grow and sustain larger populations of tuna in the Rangitāiki River catchment.

Objective 1: Gather information as to habitat availability for tuna in the Rangitāiki River catchment.

Action 1: Survey and inventory the river in terms of the availability or otherwise of tuna habitats within the Rangitāiki River and tributaries.

This action would map the characteristics of the river from bottom to top with specific regard to whether or not it appears to provide habitat or tuna, based on expert advice.

Action 2: Determine the extent of siltation and gravel buildup within the catchment, and their impact on tuna populations.

Action 3: Investigate problems associated with silt and gravel buildup in the Rangitāiki catchment which is impacting the tuna fishery and potential management options to reduce sedimentation and gravel build-up.

Objective 2: Identify the legislative tools that govern the protection of tuna habitat, and the tools that are available to iwi to manage habitat through the Resource Management Act and Fisheries Act. What are the opportunities for iwi to decide RMA outcomes relating to habitat? Make recommendations on actions to be taken.

Action 1: Compile a table that identifies the various management tools under both sets of legislation, and develop recommendations for implementation.

Objective 3: Undertake a literature search for strategies used to protect and enhance habitats for tuna and freshwater fisheries stocks more generally. The search should include artificial means of creating high density tuna housing.

Objective 4: Investigate the requirements for farming tuna in enclosed or controlled environments and assess the potential to develop this within the Rangitaiki Catchment.

Action 1: Undertake a literature search around existing knowledge for farming tuna, levels of success, limiting factors, current state of research.

Objective 6: Prioritise the protection of existing ecosystems and significant sites.

Action 1: Identify ecosystems and significant sites, and their protection status.

Action 2: Identify high priority sites and their management needs.

Action 3: Identify actual and potential options to implement management

Goal 4: Address water quality issues in the Rangitāiki River catchment

The aim is to develop a strategy to prevent and/or reduce pollutants entering the Rangitāiki River catchment.

Objective 1: Identify pollution sources from, or into, the Rangitāiki catchment and potential mitigation and management options.

Objective 2: Consider the impacts of water ramping by power companies on water quality and tuna. Develop measures to mitigate these adverse impacts.

Goal 5: Develop and implement a strategy to increase awareness and engagement of the community with regard to the protection and enhancement of tuna and tuna habitat.

Objective 1: Develop and implement a community awareness and engagement strategy.

Action 1: Engage a suitably qualified person to develop the strategy and implementation plan. This person would work with the Steering Group and iwi, and also identify connections and synergy with communication and engagement needs for interlinked work programmes such as Rangitaiki River Forum, Rangitaiki Wetland Restoration project (Freshwater Improvement Fund).

Action 2: Encourage schools and community groups to support restoration of tuna habitat and wetlands., and support implementation

Action 3: Identify areas (from Objective 6) that could be restored by schools and/or other community groups and provide support.

Action 4: Implementation of the plan.

Objective 2: Improve the knowledge base for decision making with regard to tuna, habitats, fishing, migration.

Action 1: Identify national and international experts (from Goal 2, Objective 1) who can improve the knowledge base of the tuna steering group and other interested and affected stakeholders and invite them to the catchment to do so.

Action 2: Identify and/or develop opportunities for hands on involvement and participation in activities within the catchment relating to tuna, to re-connect the community with their river and the tuna within.

PRESENTATION - Fish Passage guidelines presentation

Receives Only – No Decisions

Report To: Rangitāiki River Forum

Meeting Date: 08 June 2018

Report From: Chris Ingle, General Manager, Integrated Catchments

Rangitaiki River Scheme Update

Executive Summary

The major rivers and drainage schemes of the Bay of Plenty suffered severe riverbank damage as a result of ex-tropical cyclone Debbie and Cyclone Cook in April 2017.

The implications of those events have had significant impacts for the community living alongside and within the Rangitaiki Catchment.

The Rangitaiki River Scheme Review resulted in 29 recommendations and the Council is involved in a number of work streams that respond to that report and last year's flooding events. The work includes:

- The Flood Recovery Repair project which comprises the repair of 520 damaged sites on our rivers and waterways across the region with a repair estimate in excess of $45m including the College Road stopbank realignment
- Evacuation planning for Edgecumbe
- Lake Matahina and Lake Aniwaniwa management during an event
- Improving the Rangitāiki catchment's river and rainfall monitoring network
- Rangitāiki Floodway design and construction
- Region-wide long term flood risk management

The Forum has an inherent interest in the ongoing progress of these work streams.

Recommendations

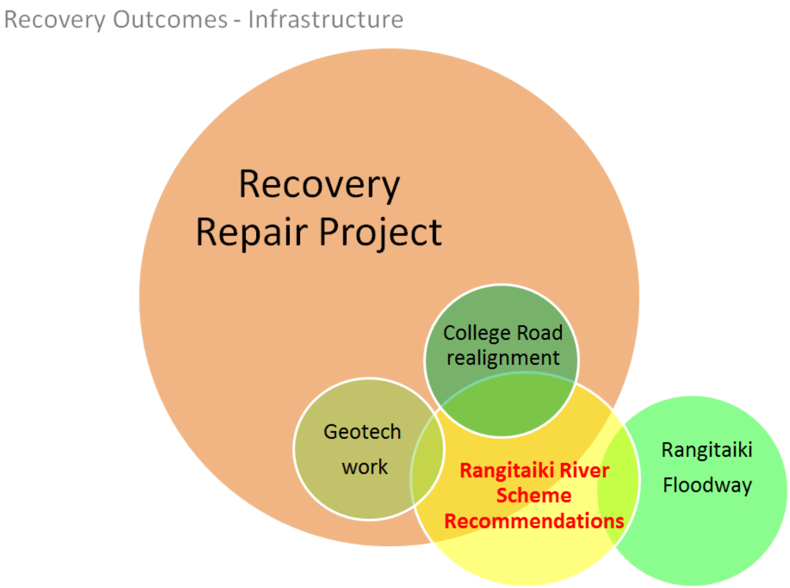
That the Rangitāiki River Forum under its delegated authority:

1 Receives the report, Rangitaiki River Scheme Update.

1 Background

This report provides an update of the significant Rivers and Drainage/Engineering projects and work streams underway in the Rangitāiki River Scheme. Much of the work has originated due to the Flood events of April 2017 or has been accelerated as a result of those events.

The projects are linked as follows;



2 Flood Repair Project

The major rivers and drainage schemes of the Bay of Plenty suffered severe riverbank damage as a result of ex-tropical cyclone Debbie and Cyclone Cook in April 2017. The Flood Recovery Repair project involves the repair of 520 damaged sites on our rivers and waterways across the region with a repair estimate in excess of $45m. Over half of the work is associated with the Rangitāiki-Tarawera Rivers Scheme ($28m) which includes the College Road stopbank realignment.

2.1 Project Delivery

The Flood Recovery Project is progressing well. Systems and resources have been implemented to support the project and physical works are underway on high priority sites across the Region; to date work on 98 sites has been completed with 19 of those in the Rangitāiki-Tarawera Rivers Scheme. The entire project is planned for completion by 30 June 2021. All damaged sites have been prioritised with reference to risk to the community and community assets, the consequence of further damage and the practicability of completing the work. Work at present is concentrating on those sites with a high or very high priority. Remaining sites will continue to be monitored and regularly reassessed as to priority.

The work programme is highly dependent on access to resources, materials and contractors. Access to suitably graded rock within an acceptable distance to site is essential for much of the work being undertaken at present. While this has been sustained by procuring rock material from Manawahe for the Tarawera and some Rangitaiki works, it has been hindered by the interruption of supply from the Blue Rock Quarry (Whakatane) and Matahina Quarry.

The work is procured using Councils Panel Contract of suppliers for Rivers and Drainage works. These are preapproved contractors who have the systems, resources experience and track record to complete the individual works that make up the project. The availability of panel approved contractors is a key element. There is an abundance of construction works underway and planned in the BOP at present and contractors are fully employed not only with BOPRC works but other key projects of our Local Authorities, NZTA and various private companies. Contractors are actively recruiting (staff, skilled machine operators, drivers, equipment and subcontractors) from outside the area to meet local demand.

Works will comply with existing resource consents, polices and bylaws for Rivers and Drainage activities. Significant works like the College Road stopbank realignment require separate consent, such as land use and subdivision.

2.2 Geotechnical Work

The flood event highlighted a number of assets and sites that need to be investigated to ensure they are providing the level of protection required. This work includes investigation into the strength and stability of various concrete flood walls across council's river schemes along with an assessment of several seepage sites.

Four concrete floodwalls on the Rangitāiki have undergone geotechnical investigation. Analysis of these results is underway. Investigations into floodwalls on the other schemes are scheduled for 2018/2019 (Whakatane) and 2019/2020 (Waioeka/Otara).

The investigative work being carried out now will likely lead to physical works over the first three years of the Long Term Plan (LTP) 2018-2028.

2.3 Communication and Engagement

Communications and engaging with individuals and groups with an interest in the repair work has been a priority. While the community focus for recovery from the April event is quite rightly associated with the Edgecumbe community, the riverbank damage across the region has had a much wider impact.

- The project team are reporting regularly to the River Scheme Advisory Groups. These meetings are scheduled at 6 monthly intervals. Updates are also provided through reporting to this Forum.
- The project continues to input into the regular District Recovery Newsletters "Kia Manawanui" along with the intermittent rural support newsletter
- A number of opportunities have been taken to discuss the project with key stakeholders and interested groups such as Federated Farmers, Rural Support Trust, MPI, Fonterra, Local Authorities, Ngati Awa, Ngai Tūhoe, various property owners (Trusts) and individual hapu
- Individual letters have been sent to property owners of adjacent land to identified damaged assets/sites to inform them about the project and when works are likely to occur in their locations
- The project has been promoted through various media opportunities (local paper, Farmers Weekly publication, local radio station)
- The project has been discussed at a number of LTP consultation events that have been held across the region
- The development of a comprehensive communications plan is underway to support the project.

2.4 Repair Project Recoveries

2.4.1 MCDEM – Response Costs

Ministry of Civil Defence and Emergency Management (MCDEM) have accepted a first claim made up primarily of response costs to 30 June 2017. Eligible costs and the applicable threshold are defined in the guide to the National Civil Defence and Emergency Management Plan 2015. Council's threshold is approximately $1,039,000. Eligible costs include care for directly affected people, taking necessary precautions or preventative actions to reduce the immediate danger to human life, and taking the necessary precautions or actions to reduce the potential consequences of any emergency. Local authority overhead costs, staff costs, and emergency operations centre costs are not eligible.

2.4.2 MCDEM – Infrastructure Costs

Essential infrastructure recovery repair may be claimed as an eligible response cost. The guide specifically notes repair or recovery of river management systems is included and costs are reimbursed at a defined percentage of the repair cost ('like to like' asset). This opportunity is only relevant where an existing essential asset has been damaged.

2.4.3 Special Policy Central Government

The National Civil Defence and Emergency Management Plan 2015 provides for special policy financial support for local authority programmes of work that as part of the recovery process, decrease the likelihood of the recurrence of an emergency in the future. Special policies require the specific approval of cabinet. In our situation the quantum of rivers and drainage recovery work associated with betterment (new assets, or increased level of service or capacity) is significant (approximately $28m of the estimated programme cost across the region). The Chief Executive has signalled Councils intention to promote a special policy application through MCDEM. It is noted that Council sought and received some Special Policy support for reinstatement costs as a result of flooding events in 2004.

2.4.4 Insurance – Infrastructure Costs, Business Interruption and Material Damage

Council's infrastructure assets and increased cost of working are partly insured for loss caused by a natural catastrophe event including flood. The councils insured infrastructure assets are insured by asset group for each scheme. Staff are working with the allocated loss adjustor on completed jobs and sites in progress. This opportunity is only relevant where an existing essential asset has been damaged.

3 Rangitāiki River Scheme Review Recommendations - Update

The Rangitāiki River Scheme Review ('the Review') was received by Council and released to the public in October 2017. It contains a number of recommended actions, which are relevant across both short term and long term horizons, and cover various Council activities.

An internal working group was established in November 2017 to coordinate Councils response to the recommendations. Its purpose is to:

1. Ensure that all work needed, is covered in response to the Review;
2. Enable linkages between work streams to be capitalised upon;
3. Ensure a collective picture of the response;
4. Enable clear communication with governors, partners and stakeholders on overall response progress;
5. Consideration of both a short term and long term view;
6. Ensure strategic alignment and impacts on wider work are understood.

The internal working group is ensuring that links are made between implementing the Review recommendations and other work in the catchment.

3.1 Implementation Progress

Work that Council is undertaking to deliver on the Review recommendations is by way of a series of 'workstreams' that cut across and combine recommendations. A number of these actions were underway prior to the Review.

3.1.1 Implications for Māori

Eastern Bay of Plenty Iwi have a strong interest in the Review recommendations and the long term management of the river. There is alignment between the desire for 'naturalness of the river', in the Te Ara Whanui O Rangitaiki, and the 'making room for rivers' concept in the Review.

Sir Michael Cullen verbally presented his report to the Rangitāiki River Forum on 10 November 2017. A verbal update was provided to the Forum on Council progress on implementing the Review recommendations on 16 March 2018.

Engagement with Ngāti Awa and Ngāti Tuwharetoa on the review recommendations and proposed changes to the Rangitāiki Floodway has begun and is ongoing.

3.1.2 Evacuation Planning

The Review recommended that evacuation plans are developed for Edgecumbe with Regional Council, Civil Defence, and Whakatāne District Council working together. It also recommended the consideration of variable river level thresholds and the state of scheme upgrades, be part of this planning.

Council have been working with Whakatāne District Council and Civil Defence agencies to respond to the recommendations and further strengthen evacuation planning. Progress includes:

- Flood Evacuation Protocols for Edgecumbe - complete
- Evacuation Plan for Edgecumbe – currently in draft form, the Whakatāne District Council will share this with the community in early June before being finalised.
- Edgecumbe Community Response Plan - to be developed once the Evacuation Plan is finalised.

3.1.3 Lake Management

The Review recommended Council work with Trustpower to review the Lake Matahina Flood Management Plan and agree protocols around forecasts and timing for safely lowering the lake level prior to and during an event. Also included in the recommendations for the Flood Management Plan was the development of templates for communication during a flood event. The Review also recommended that Council work with Pioneer Energy around the potential use of Lake Aniwaniwa to mitigate flood flows and that consideration be given to the outcomes of the Cardno report into the effect of ramping of river levels.

Progress in recent months includes:

- Communication protocols and templates have been reviewed, strengthened and agreed as recommended. This action is now complete.
- Staff from both organisations are now working on the detail of protocols to safely and feasibly lower the lake earlier in an event. This includes the timing and the steps to lower the lake; giving consideration to factors such as forecasts, river flows, dam releases, and dam safety.
- Working with Pioneer Energy is second priority behind Trustpower due to the lower potential flood attenuation in Lake Aniwaniwa. This potential attenuation is being modelled and quantified this financial year.
- The Rangitaiki Stopbank Erosion (Cardno) report has been delayed and is now due in July 2018.

3.1.4 Monitoring Network

The Review recommended a assessment of the Rangitāiki catchment river and rain monitoring network and in particular that consideration be given to spatial coverage and redundancy. It also recommended that the flood hydrology of the Rangitāiki River is updated to include the April 2017 event. Finally, river level staff gauges were recommended to be placed beside critical structures such as floodwalls, to assist with public record.

Regional Council have been reviewing the monitoring network in the catchment to ensure there is increased spatial coverage and redundancy, and making LTP provision for this activity:

- Three new monitoring sites have been identified and the first of these, a new rainfall site, has been installed in the Whirinaki at Te Whaiti. A river level monitoring site will accompany this.

- The remaining two new monitoring sites are scheduled to be installed in conjunction with soil lysimeters and will provide a dual purpose
- The flood hydrology of the river has been updated post event and is being externally reviewed
- Staff gauges are programmed to be installed on the river schemes, including one at Edgecumbe.

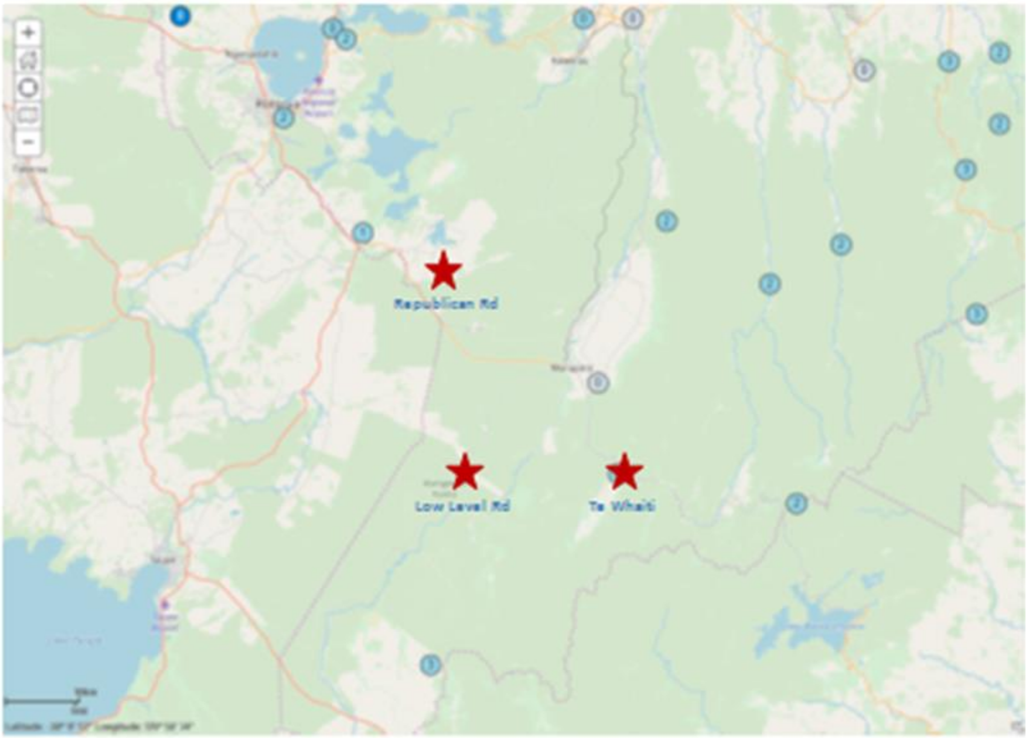


Fig 1: Proposed sites (red stars). Circles are existing sites within the rainfall network.

3.1.5 **College Road and Catchment Stopbanks**

The Review made a number of technical recommendations around the College Road floodwall replacement and on future flood defence designs. It also recommended reviewing downstream floodwall conditions and the use of impermeable barriers which is included as geotechnical work (section 2.2 of this update).

The College Road stopbank reconstruction project is well underway with the relocation of services and work on the construction of the stopbank foundations. The design includes the Review recommendations. Council has engaged with a community technical advisory group on this work and the design has been reviewed by the Review panel geotechnical expert.

3.1.6 **Rangitāiki Floodway Infrastructure - Upgrades**

The Review recommendations endorsed the planned upgrades for the Rangitāiki Floodway infrastructure. This included recommendations on the design and timely implementation of preferred options. The upgrades to the Rangitāiki Floodway are part of medium-term solutions, to managing flood risk in the catchment. It also recommended that long-term solutions are progressed in the catchment taking account of climate change and wider ecological and cultural values.

- Future options for the upgrade of the infrastructure have been modelled. These include a lower fixed crest spillway and ponding areas, in line with the Review recommendations
- Engagement is currently underway on these options with potentially affected landowners and community groups
- A recommendation to Council on the preferred options will be made in the 2018/19 financial year, after the completion of the community engagement. This will enable works in the 2019/2020 financial year.

3.1.7 **Long Term Flood Risk Management**

The Review recommended Council give high priority to developing and implementing long term flood risk management solutions in the Rangitāiki that take into account climate change and the making room for rivers concept. It also recommended Council ensure that there is comprehensive region-wide coverage and application of the hazard management framework.

Across the region Council has two mechanisms for flood risk management: the River Scheme Sustainability Project, which covers the four river scheme catchments and the Regional Flood Risk Project, which covers the remaining 48 catchments.

- Work in the Rangitāiki is a part of the River Scheme Sustainability Project. While upgrades to the Rangitāiki Floodway are part of medium-term solutions, longer term solutions are also currently being assessed. These options will take into account climate change and the “making room for rivers” concept. A draft report is due in September 2018.

- The Regional Flood Risk Management Project involves Council working together with Tauranga City Council, Western Bay of Plenty District Council and Whakatāne District Council on four pilot studies to develop a Regional Flood Risk Framework. The outcomes of this work would then be applied over the 48 non-scheme catchments across the region and would prioritise the mitigation effort in these catchments based on risk. This work will take further precedence in the 2018/2019 financial year, when more resource becomes available.

3.1.8 **Communications and Engagement**

The Review recommended that Council engage with the community when considering future options for the Rangitāiki Floodway and ensure full notification of any consent applications. The Review also found that parts of the community did not understand the flood risk that they live with and that future engagement needs to include raising awareness of the (residual) risk of living on a flood plain. Improved communication and engagement is an opportunity to build community understanding of the flood risk that exists in the catchment, even allowing for flood defences.

Progress includes:

- Engagement is underway on the Rangitāiki Floodway future options and has included one-on-one sessions with potentially affected landowners and a community information day. This work is ongoing.
- Additional communications resource has been engaged to assist with current and future Rivers and Drainage work streams including major projects and the Review recommendations implementation

4 Summary

The major rivers and drainage schemes of the Bay of Plenty suffered severe riverbank damage as a result of ex-tropical cyclone Debbie and Cyclone Cook in April 2017.

The implications of those events have had significant impacts for the community living alongside and within the Rangitaiki Catchment. Council is involved in a number of work streams that respond to the Rangitaiki River Scheme Review and the effects of the April 2017 flood event.

This work will be of ongoing interest and input from the Rangitāiki River Forum and staff will be reporting regularly to the forum on work progress.

Mark Townsend
Engineering Manager

for General Manager, Integrated Catchments

31 May 2018

Receives Only – No Decisions

Report To: Rangitāiki River Forum

Meeting Date: 08 June 2018

Report From: Simon Stokes, Eastern Catchments Manager

Rangitaiki River catchment - Operations and General Update

Executive Summary

This report provides an update on general matters and operations occurring within the Rangitāiki River Catchment to the work of the Forum.

The following matters are covered:

- Biodiversity and riparian management;
- Biosecurity;
- Updates from Kotahitanga;
- Rangitāiki Wetland Restoration project
- Update on Whakatane District Recovery Programme
- Kaitiakitanga and strategy mapping project.

Recommendations

That the Rangitāiki River Forum under its delegated authority:

1 Receives the report, Rangitāiki River catchment - Operations and General Update;

1 Update on general activity

The following information provides an update on general activity and operations occurring within the Rangitāiki River Catchment of interest to the work of the Forum.

1.1 Biodiversity and riparian management

Programmed works have completed 20 km of fencing to secure waterways and wetlands in the catchment, with a few more kilometres still to be finished for the year. At this time the focus is on wrapping up activities and administrative requirements for the end of the year. Most programmes will complete their activities for the year.

Lochinver have finished their one year programme of works and are interested in another year of work in the coming year. This would include fencing wetlands and waterways, poplar plantings (erosion control).

Tauhara North have completed all their waterway fencing requirements for their industry requirements and the works programme.

Wai o Te Hau are having a community planting day around Te Puna o Keira in June, and also planting the margins of Te Manukapiko before year end.

1.2 Central Plateau meeting

A meeting was organised in the upper catchment to update the central plateau landowners on matters of interest or that may affect them. Topics covered included an update on Proposed Plan Changes 9, and 12; biosecurity issues for that area (rooks, *Pinus contorta*, *Mycoplasma bovis*); and the importance of and threats to frost flats on the central plateau. Sixteen people attended, representing the range of properties: the larger sheep and beef properties, dairy farms, and multiple owned Māori land blocks, as well as Ngāti Hineuru, with positive feedback received.

1.3 Rangitāiki Wetlands Restoration Project (Freshwater Improvement Fund)

The request for proposals (RFP) process for the role of Project Manager and Operations Implementation has been completed. This became lengthy in terms of time-frames but we're confident that we have a good outcome.

There were 14 responses to the RFP (this is a lot!), and the panel shortlisted three respondents from the list. The panel included expertise in wetlands and wetland restoration, project management and iwi perspective to cover the different aspects of the requirements for the project. The decision was discussed with the business owners for the project, which includes representatives from the Rangitāiki River Forum.

Our preferred respondents are Place Group. They bring strong project management, experience with wetland restoration projects in the context of co-governance in the Waikato, and experience in building strong relationships with iwi within those projects, and experience working a MfE funded project.

Wildland Consultants have been doing site evaluations to build restoration plans for the sites, and have visited all of the sites on the ground. Drafting of restoration plans is underway and drafts are due in early July for discussion with landowners.

1.4 Biosecurity

1.4.1 Alligator weed

Surveillance was completed over the summer and no further infestations from the December monitoring were found, so the known extent of alligator weed is unchanged. It is possible that more infestations will be found summer 18/19 as fragments become established and become more easily detected.

1.4.2 Regional Pest Management Plan – outcome of long term plan deliberations

Submissions have closed on the Discussion Document for the Long Term Plan, which included setting the budget for the Biosecurity Activity, which enables delivery of the Regional Pest Management Plan (RPMP). This document presented three options for resourcing for RPMP implementation, one status quo and two options for increased resourcing.

Of the 238 submissions received on our consultation document, 137 provided direct feedback on the options for Biosecurity funding. Of those providing feedback on the options, the majority – 64 submissions – supported Council's preferred Option 2, to increase resourcing by $500,000 per annum to allow programmes with a positive cost-benefit to proceed. There was also strong support from 56 submissions for Option 3 which proposes to significantly increase funding of Biosecurity by $1 million per annum. The remaining 17 submissions supported Option 1 – to maintain Biosecurity funding at current levels.

In summary, nearly 88% of submitters who provided feedback on the LTP Biosecurity options believed an increase in resourcing for Biosecurity is necessary to address our current pest challenges.

For the Rangitāiki Catchment, maintaining status quo would not address serious concerns from submitters around wallabies and alligator weed, two species of significant concern. Increased resources under option 2 would allow for more funding to contain pests like wallabies, alligator weed and wilding conifers, all relevant to this catchment. A third option was also presented that would allow for resourcing to these kinds of species, as well as funding work into well-established pests like woolly nightshade, however there was less support for this alternative.

The recommendation from council's Biosecurity report to Council follows, noting key items of relevance to the Rangitāiki Catchment include aquatic weeds, alligator weed, wallabies, climbing spindleberry, old man's beard and wilding conifers:

> "We recommend adopting Option 2 (increased funding of $500,000 compared to 2017/18 Annual Plan) in year two of the LTP with further increases over year two and three ($250,000 additional in each of the two years). Funding would then be maintained over years 4 – 10 at $1 million over 2017/18 Annual Plan.
>
> This recommendation is in response to the strong support through submissions for increased funding for biosecurity and the need to provide more support for catfish. This approach would also spread the increase in rates associated with increasing biosecurity work and allow time for our contractors to 'scale-up' so they can deliver improved programmes.
>
> As additional funding for catfish was not considered when the proposed LTP budget was developed, we recommend Council does not pursue managing gorse in the Rotorua catchment through the RPMP at this stage. This approach would free up funding to increase catfish management by $100,000. Submitters were silent on the need for Biosecurity Act rules to manage gorse in the Rotorua catchment.
>
> This approach would allow funding to:
>
> - Investigate wash-down and cleaning facilities at high risk boat ramps;
> - Assist with the pathway management of aquatic weeds, catfish and other potential pests;
> - Provide additional support for other high profile programmes such as; wallabies, alligator weed, old man's beard, and climbing spindle berry;
> - Support the national wilding conifer programme once it expands into the Bay of Plenty;

- Provide increasing support for community initiated projects managing woolly nightshade and wild ginger; and
- Carry out targeted surveillance, management and compliance of woolly nightshade and wild ginger."

The recommendations were accepted by Councillors. The new RPMP will be drafted in line with this, with an aim to have a proposed RPMP in place before the end of September. This will then be open for submissions, followed by hearings and finalising the document into the new calendar year. The goal is to have a new operative RPMP in place by the start of the 2018/2019 financial year.

1.4.3 **Mycoplasma bovis**

Ministry for Primary Industries (MPI) provided an update to the regional BioManagers group in Wellington on 18th May on the status of this disease. Nationally 37 farms have confirmed infections, and 75 have restricted place notices[1]. Tracing of animal movements has identified 1700 more farms for further investigation. As at 17 May there have been no infections found in the Bay of Plenty, however there are infected farms on the North Island.

There is work underway for reducing the potential spread of this disease by establishing national hygiene protocols. The Regional Council is aware, as we have several functions that involve council staff potentially moving from one property to another. We are working to minimise this risk with cleaning and decontamination protocols, and minimising potential exposure by avoiding high risk areas, as directed nationally, although vehicles are considered low risk. Infection is spread animal to animal, and via bodily fluids. It does not infect humans. You can find more information via the MPI website (https://www.mpi.govt.nz/protection-and-response/responding/alerts/mycoplasma-bovis/ .

1.5 Relevant updates from Kotahitanga

1.5.1 **Marae Wastewater Discharges**

Under the current On-site Effluent Treatment Regional Plan, any discharge from an on-site effluent treatment system (e.g. a septic tank of aerated wastewater treatment system) that is more than 2m3/day requires consent. All Marae need consent as the discharge will be more than this limit, particularly during large events. Some Marae already have resource consents for their systems (initial estimate is 49 Marae). Marae that are connected to reticulated sewerage systems do not need resource consent.

Marae often play an important role within a community. They can also be used at times of civil emergency and so their on-site effluent treatments systems need to be robust and be able to operate effectively even under high load conditions. Consents assess the capacity of the on-site effluent treatment system, and ensure the system is managed to protect the environment and human health. Marae consents can include requirements to bring in Porta-Loos during large events to avoid overloading the system.

Bay of Plenty Regional Council has progressed initial desk-top work to gather information on Marae on-site effluent treatment systems across the region. This

[1] This means that animals or anything that may be contaminated cannot be moved from, or brought onto that place to or from another place without authorisation (due to the risk of contamination and/or spread of disease or pest).

included collecting information on location, current consent, connection to reticulated sewerage, contact details, and soil type at the site. Phase 2 of this work will use existing information to engage with individual Marae to assess the actual risk. However, Phase 2 is subject to funding and resourcing which has not been confirmed at this stage. A key issue is the potential costs of consents and upgrading of OSET systems where necessary. Funding options for these matters is expected to be explored as part of the project. Marae that are connected to reticulated sewerage schemes, or already have resource consent would not be affected by Phase 2.

1.5.2 **He Korowai Mātauranga (The Mātauranga Māori Framework)**

He Korowai Mātauranga will be used as an internal staff resource to enhance staff awareness on the value of mātauranga Māori (Māori knowledge). It will also assist Council to meet its legislative responsibilities.

The implementation Plan Te Whakatinana Matauranga is in the first phase of planning and it is envisaged that this will be completed at the end of May 2018, the next step will be the implementation of the document within the Regional Council.

2 Rangitāiki Catchment Programme Annual Work Plan dashboard report

The Forum will now receive a Rangitāiki Catchment Programme annual work plan dashboard report which provides a quick and focused summary on key projects occurring in the catchment work programme. The dashboard includes Whakatāne District Council and Taupō District Council and will be used by the three councils with regards to their internal programme reporting. The March-April dashboard is attached in Appendix 1. It is intended to provide a dashboard to the Forum at each hui. It doesn't replace the annual comprehensive reporting to the Forum on planned work and results.

The dashboard provides a quick reference snapshot against the pieces of work in terms of scope, schedule and budget, with some snippets of information against progress, updates and upcoming activities.

You will note that currently we have a green status for the overall programme which means that we are on track with implementation. The amber status highlights that there are some key projects behind schedule. At this stage of the financial year, it would be fair to suggest that some projects will end the year behind schedule. Explanations are provided in the dashboard.

3 Whakatāne District Recovery programme update

The post cyclone recovery programme being led by the Whakatāne District Council is ongoing. The following information is a brief summary of the current programme status. Some recent highlights:

- 218 families from moderately affected (yellow) houses have had repairs completed and are able to move back home – we now have 71% returned home

- Navigators continue to make contact with flood affected families to provide support. The main issues are health & wellbeing. Additional building advisory support is available to those families who are undertaking or managing their own home rebuilds.

- The residential advisory service (RAS) has scheduled a final visit for Mid May 2018 but will continue to provide support if any further requests are received.

- Major media coverage occurred which marked the 1 year anniversary since the flooding event occurred. (TV, Newspaper, Social media, etc). A Community event was also held on Saturday 7th April 2018 in Edgecumbe to mark the 1 year anniversary. The event was called "Kotahitanga" which highlighted that there can be unity in adversity. The event was well supported by the Community.

- Many components are now signalled as “Business As Usual” for associated Agencies which means that work is committed to and ongoing, it’s not in a recovery phase.
- The recovery team has completed a significant document titled Whakatāne District Recovery Debrief – April 2017. This document contains a debrief and insight of the recovery programme and processes with guidelines and toolkits such as templates, for use locally and across NZ communities. The document has been very well received by CDEM and was on display at the recent emergency management conference in Wellington. A copy can be obtained from Whakatane district council – contact Julian Rewiti.

  Ongoing Recovery activities are:

- Monitoring of Returned Home status
- Navigator support for the community
- BOPRC stopbank and rebuild (road and land)
- BOPC flood repairs project well underway with significant progress in the Rangitāiki river catchment
- Whakatāne District Council road repairs ongoing – focus has been on Galatea road washout near Te Mahoe
- Community updates – recently rural BBQ’s were held to keep the rural communities up to date – in Waimana, Tāneatua, Galatea, Edgecumbe and Te Puke.

See Appendix 2 for more in depth details in the recent sitrep report.

4 RPS Proposed Plan Change 3

An Environment Court facilitated mediation occurred on 23 February 2018. Parties are awaiting a second mediation date to be scheduled by the Court.

5 Kaitiakitanga and strategy mapping project

A project has been initiated to map the objectives and actions of Forum members own strategy and annual plan documents, with the objectives and actions within Te Ara Whanui o Rangitāiki – Pathways of the Rangitāiki. There is also a specific focus on the Kaitiakitanga objective to understand what is already occurring to deliver these actions or what gaps still exist. This objective was identified in 2014 as a key area of focus that will help the implementation of Te Ara Whanui o Rangitāiki – Pathways of the Rangitāiki.

The resulting mapping will provide a matrix of understanding for members as well as the Forum, to ascertain what is already happening with regards to supporting the purpose of the Forum and to identify where gaps still exist.

Mrs Huia Nuku-Tohiariki from Murupara has been contracted to complete the project by the end of July 2018. Mrs Nuku-Tohiariki will engage with etahi o ngā kaitakawaenga mo ia iwi roopu: Ngāti Manawa, Ngāti Whare, Ngāti Awa, Te Kōpere o te iwi o Hineuru, Ngāti Tūwharetoa ki Kawerau; Tūhoe- Te Uru Taumatua, Bay of Plenty Regional Regional Council, Whakatāne District Council, and Taupō District Council.

6 Māori implications

The report provides information relating to actions that support the delivery of Te Ara Whānui o Rangitāiki – Pathways of the Rangitāiki, which supports positive implications for Māori in the long term. Te Ara Whānui o Rangitāiki is required by legislation and takes into consideration all planning documents of importance to Māori.

Nancy Willems
Team Leader, Eastern & Rangitaiki Catchments

for Eastern Catchments Manager

31 May 2018

APPENDIX 1

Rangitaiki Catchment Annual Work Programme - March-April Dashboard

Rangitāiki River Forum Dashboard March-April 2018

Programme Manager	Simon Stokes	As of Forum meeting	Jun-18	Green
Project Sponsor	Chris Ingle	Previous RAG status	Jan-Feb 2018	Green

Category	Previous RAG Status	RAG Status Current	Comment on any RAG where status is not Green.
Overall	Please select	Green	
Schedule	Please select	Amber	Schedule slippage has occurred within a number of projects
Scope	Please select	Green	
Resources	Please select	Green	
Budget	Please select	Green	

No.	Annual Work Plan Projects 2016/17	Scope	Budget	Schedule
	SHARED	**Scope**	**Budget**	**Schedule**
1	Te Hekenga A Nui O Te Tuna (Tuna Plan)	Green	Amber	Amber
	BAY OF PLENTY REGIONAL COUNCIL	**Scope**	**Budget**	**Schedule**
1	Eastern/Rangitaiki Catchments Land Management - Freshwater Improvement Fund - Rangitāiki Wetland Restoration Project	Green	Green	Amber
2	Freshwater Futures - Plan Change 12	Green	Green	Amber
3	Māori Policy - Matauranga Maori framework	Green	Green	Amber
4	Maritime - Cameras installed at Rangitāiki River mouth	Green	Green	Amber
5	Regulatory Compliance	Green	Green	Green
6	Rivers & Drainage - Rangitāiki Drainage Scheme culvert renewals	Amber	Amber	Amber
7	Rivers & Drainage - Flood Recovery	Green	Green	Green
8	Rivers & Drainage - College Road, Stopbank realignment	Green	Green	Amber
9	Rivers & Drainage - Rangitāiki Floodway (Stage 4)	Amber	Green	Amber
10	Rivers & Drainage - Rangitāiki Floodway (Stage 5)	Green	Amber	Amber
11	Science - Rangitāiki Water Management Area - Current State and Gap Analysis	Green	Green	Amber
12	Biosecurity	Green	Green	Green
13	Consents	Green	Green	Green
	WHAKATANE DISTRICT COUNCIL	**Scope**	**Budget**	**Schedule**
1	Whakatāne District Recovery Plan – Rangitaiki.	Green	Green	Green
2	Lake Aniwaniwa	Green	Green	Green
3	Edgecumbe Township	Green	Green	Green
4	Thornton Domain	Green	Green	Green
5	Integrated Waste Water Scheme	Green	Amber	Green
	TAUPO DISTRICT COUNCIL	**Scope**	**Budget**	**Schedule**
1	District Plan Review	Green	Green	Green
2	TD2050 Refresh	Green	Green	Amber

Programme ~~Progress~~ Highlights

- Eastern/Rangitaiki Land Management - Te Hekenga Nui o Te Tuna: completion of final report for Action A, the aim is to present this to the Rangitāiki River Forum at the June 8 Hui.
- Eastern/Rangitaiki Land Management - Rangitāiki Wetland Restoration Project: signing of the Deed is completed.
- Māori Policy - The Mataraunga Māori Framework - He Korowai Matauranga was approved by Komiti Māori on 27 February 2018.
- Rivers and Drainage/Engineering - Rangitāiki Floodway (Stage 5): work deferred until 2018/2019, public consultation is underway for consent variation.
- Science - Groundwater flow model for the Tarawera-Rangitāiki-Whakatāne: due for completion date of June 2018 has now been delayed due to the expansion of the area modeled to include the upper Rangitāiki, minor impact on budget.
- Taupō District Council - TD2050 refresh draft: out for consultation date has changed from late 2017 to August 2018.
- Whakatāne District Council - Whakatāne District Recovery Plan (Rangitāiki): Recovery is still underway and in accordance with the latest programme.
- Biosecurity - Wallaby update: Surveillance cameras placed west of Galatea Road bridge recorded no wallabies. Planning underway for small scale 1080 operation at Nursery Road in Matahina Forest.

Programme Updates

- Eastern/Rangitaiki Land Management - Rangitāiki Wetland Restoration Project: complete contract negotiations process and handover to the appointed Project Managers; this will also include working closely with them in project planning processes to ensure all needs are met.
- Eastern/Rangitaiki Land Management - Te Hekenga Nui O Te Tuna: The wider tuna group (likely to be the Tuna Forum) includes wider stakeholders and the aim is for the new structure to be endorsed and supported by the Rangitāiki River Forum. A new project plan is being worked to address the wider issues for tuna .
- Freshwater Futures - A Freshwater Futures Community Group workshop for Rangitaiki (and Kaituna/Pongakawa) was held in early April. This Workshop focused on discussing/ exploring alternative futures (limit setting) including changes in land-use practice; outcomes from modelling; economic implications of various future options etc.
- Maritime - Cameras at the Rangitāiki River Mouth: Contractor is very busy and will reschedule when possible.
- Regulatory Compliance - 19 consent related site visits were undertaken in the Rangitāiki catchment during 1 March to 30 April 2018; of those, 15 sites visited were rated Complying, 3 were reated Low-risk non-compliance and 1 site was given a rating of Moderate non-compliance.
- Maori Policy - Matauranga Māori Framework - The implementation Plan Te Whakatinana Matauranga is in the first pahse of planning and it is envisaged that this will be completed at the end of May 2018, the next step will be the implementation of the document within the Regional Council.
- Rivers & Drainage - Flood Recovery - 223 sites needing repairs (within the Rangitāiki-Tarawera Rivers Scheme and Rangitāiki Drainage Scheme), 44 completed and a further 9 in progress. Matahina Quarry rock supply is currently unavailable and staff are working with the owner and operator to find a solution; focusing on works not requiring rock in the interim.
- Rivers & Drainage - College Road, Stopbank realignment - work commenced on 19 March, expected completion in August 2018. Last reporting period flagged a projected overspend for the building demolition/removal; Council has now approved additional budget.
- Science - Current State and Gap Analysis - ongoing NERM monitoring as planned, other work occuring includes - survey of Lake Matahina, salt wedge (inanga spawning site) surveys of the lower Rangitāiki River have been completed; report on lowland drain water quality and ecology (Alastair Suren) is complete, currently out for comment with Rivers & Drainage and Policy teams before publishing.
- Biosecurity - Alligator weed survey and control of Rangitāiki River for 17/18 was completed in April (3 surveys). New EPA permission in place for applying aquatic herbicides to water. No new Alligator Weed terrestrial sites found in 17/18.
- Consents - Creswell application update - hearing was held in Whakatāne during the first week in May 2018, final recommendations from staff were to grant the regional consents but to decline the district consents. The applicant is to provide further information in their right of reply which is expected by 18 May. The panel will consider whether they have sufficient information to make a decision in order to close the hearing, if that occurs then a decision will be made within 15 working days.
- Whakatane District Council - Business case has been sent to Central Government and BOPRC for consideration in terms of funding ($30-$40m) to integrate wastwater schemes for Matata, Edgecumbe and Whakatāne, with the possible inclusion of Tāneatua. Progress with the project is dependent on external funding. A meeting of key Ministers is being arranged to discuss the business case.

Programme upcoming Activities

- Eastern Land Management - Lake Aniwaniwa Management Plan - draft version will be sent out to the stakeholders for final comments, due for completion by the end of the 17/18 financial year
- Freshwater futures - RDD workshop on PC12 planned for 17 May 2018, the agenda will cover PC12 modelling outputs - eSource, EFSAP, MODFLOW; planning for wider enagement; region wide plan change options and feedback from Community Groups.
- Environmental Enhancement Fund - $80,000 is still available for any community groups within the Rangitāiki Catchment wishing to apply, the fund remains open all year.
- Science - installation of 2 lysimeter (rainfall recharge) sites in the upper Rangitāiki catchment (Republican Road Rerewhakaaitu and Goudes Road); this will improve our estimates of ground water availability.

Bay of Plenty REGIONAL COUNCIL

District Council

GREAT LAKE TAUPŌ
Taupō District Council

APPENDIX 2

Whakatane District Recovery Programme Status Report April 2018

STATUS REPORT

Whakatāne District RECOVERY PROJECT Kia manawanui

WHAKATĀNE District Council Kia Whakatāne au i ahau

√	Achieved
☺	On track
😐	Progressing
☹	Not on track
✋	Handover to BAU

Approved by Recovery Manager Barbara Dempsey
As at : 11th April 2018

Reconnect our Community (Tūhononga)

COMMUNITY

Highlights for the month

• 218 families from moderately affected (yellow) houses have had repairs completed and are able to move back home.
• Navigators continue to make contact with flood affected families to provide support. The main issues are health & wellbeing. Additional building advisory support is available to those families who are undertaking or managing their own home rebuilds.
•The residental advisory service (RAS) have scheduled a final visit for Mid May 2018 but will continue to provide support if any further requests are received.
•Major media coverage occurred which marked the 1 year anniversary since the flooding event occurred. (TV, Newspaper, Social media, etc)
•A Community event was also held on Saturday 7th April 2018 to mark the 1 year anniversary. The event was called "Kotahitanga" which highlighted that there can be unity in adversity. The event was well supported by the Community.

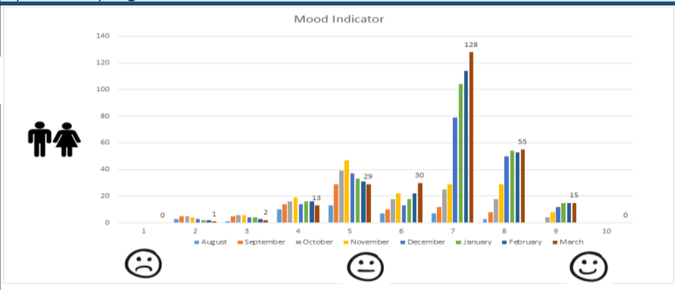
Emerging Issues/Risks	Action	Person to action
The target was "90% of affected families/whanau are back in their homes by Christmas 2017". The current return is 71% and remains steadily increasing. The limitations and rebuild timeframes have been influenced by: weather, insurer and owner agreement timelines, technical repair issues for some land and houses, home owners after cash settlements then arranging own works, actual practical rebuild timeframes, some home owners including additions or extensions to their rebuild, and trades works peaks.	*The actual returned home status and drivers for rebuild schedules are key monitoring requirements.This ongoing understanding allows existing and new strategies to be implemented such as: building advisory service for home owners undertaking or arranging own works, navigator support for at risk families, and simple touch base with people to check progress and offer any support.*	*WRO*

Project Status

Welfare and Wellbeing

Miletsones planned for this period	Timeframe	Status
Community Hubs established in Edgecumbe, Kawerau, Murupara and Whakatāne.	May/June	√
Psycho-social recovery plan is developed, agreed and implemented.	June 2017 & ongoing	√
Research, development and successful implementation of a 'fit for purpose' navigator service.	June 2017 & ongoing	√
Community partners made up of local authorities, iwi and central government agencies convene and collaborate on joined up wrap around service delivery for the wellbeing of affected residents.	July 2017 & ongoing	√
Services to the community are developed which outlines a range of reactive and proactive strategies.	June 2017 & ongoing	☺

Update on progress

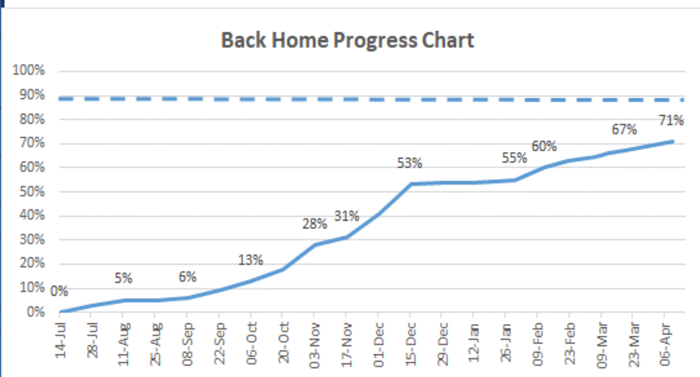


Community

Milestones planned for this period	Timeframe	Status
Perception survey on safety returns back to pre-flood levels within 2 years.	2019	✋
Property values readjust within 3 years.	2020	✋
List of communication groups & clubs opening and closing demonstrate continuity.	August 2017	√
A calendar of monthly events and community development activities has been planned out to reach a wide range of the community, including school holiday care programme.	June 2017	√
Community expo's and open days will be held to provide timely information to affected residents on a range of topics (e.g. insurance, health, Liveable Homes Project, Worksafe)	May 2017 June 2017 September 2017	√
Community group develops Community Plan with WDC support.	Commence September 2017	√
A community engagement plan is developed and implemented.	June 2017	√
An iwi engagement plan is finalised and implemented.	July 2017	√
Community acknowledge or commemorate event in a way that the community deems appropriate. (Event held on 7th April 2018)	Feb 2018	√
Ongoing use of the community leaders group.	Ongoing	√
Volunteer coordinator is in place; process to connect work with volunteers is developed and the donation of appropriate materials is sought.	July 2017 Ongoing	√

Home by Christmas

Milestones planned for this period	Timeframe	Status
Process developed to monitor the repair progress.	June 2017	√
"Welcome home" packs developed.	June 2017	√
At least 90% of affected families/whanau available are back in their homes by Christmas 2017 (refer comments in issue/risk section)	90% by Christmas 2017 (actual 71% at 13th April 2018)	☹
Process agreed for managing donated goods.	June 2017	√



Restoring the Natural & Rural Environment (Whakahou)

NATURAL AND RURAL

Highlights for the month

- *College Road Stopbank Realignment: The land clearance has been completed and major works underway.*

Project Status

Primary Sector Support			Environmental Effects		
Milestones planned for this period	Timeframe	Status	Milestones planned for this period	Timeframe	Status
Recovery Action Plan developed for rural sector.	September 2017	☹	Respond to complaints within 3 working days.	Ongoing	√
Clean up of rural properties complete.	December 2017	✋	All complaints investigated.	Ongoing	√
A range of reactive and proactive strategies to engage affected rural individuals and families and build strong support networks are provided, including: Good yarn workshops, Local BBQs, Dairy NZ discussion groups, Rugby bus trip, Field days and Ladies morning teas.	Ongoing	√	Compliance monitoring occurs as set out in schedule 1A and 2A of the BOPRC Resource Management Act and Building Act Charges Policy.	Ongoing (determined by consent)	√
Workshops for affected farmers delivered (topics: farm management, animal health, soils, agronomy, wellness etc.).	Ongoing	√	Stakeholder perception survey demonstrates greater than 75% satisfactory involvement in environmental issues. (referred to BOPRC for consideration as BAU)	November 2017	✋
No flood related cases are outstanding.	Ongoing	✋	Clear messaging is delivered to the rural	May 2017	√
Positive Regional Economic Quarterly Reports. (Part of BAU for EBoP CoC monitoring)	December 2017	✋	All amenity areas are open and accessible.	June 2017	√
Outreach to affected rural properties is no longer flood related.	2019	√	Site assessments for impact on biodiversity are completed.	October 2017	✋
Land use management advice provided to landowners.	October 2018	✋	If required, recommendations for remediation are received.	December 2017	✋
MPI funding round is successfully taken up by affected rural properties.	September 2017	√	Biosecurity plans, if appropriate.	December 2017	✋
			Erosion assessment of pre and post river banks.	August 2017	√
			Urgent erosion sites are repaired.	August 2017	✋
			Damaged sites are repaired.	2020	✋

Repairing our homes and restoring our communities (Waihanga)

BUILT

Highlights for the month

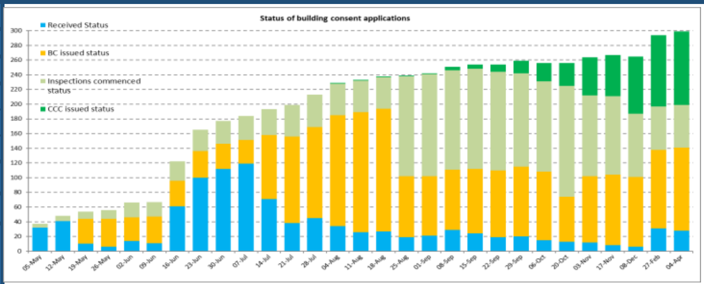
Progress has been steady for those "returned home". 71% was reached during the 1st week of April 2018.

Project Status

Housing

Milestones planned for this period	Timeframe	Status
Chemical contamination testing of silt.	June 2017	√
Clean-up of silt complete (sections).	end July 2017	√
Clean up of silt complete (under housing).	August 2017	√
Asbestos removed safely from all affected properties.	June - July 2017	√
Education and training sessions provided.	June - July 2017	√
Portacabins sited on private properties.	July 2017	√
Portacabins available in Whakatāne Holiday Park.	July 2017	√
Other temporary housing options are investigated.	August 2017	√
Liveable Homes Project complete by November 2017.	November 2017 (actual Jan 2018)	√
People back in homes – 90% by Christmas. (refer comments in issues/risk at beginning of report) Repairs however are continuing to progress.	90% by Christmas 2017 (actual 71% at 13 April 2018)	😐
Insulation component of Liveable Homes Project complete.	October 2017	√
Insulation for non-Liveable Homes Project homes is complete. (Now part of EBET BAU).	90% by December 2017	✋
Investigate demand for future residential land in Edgecumbe. (Now part of WDC BAU)	September 2017	✋

Update on progress



Building assessment summary	Red (severe damage)	Yellow (moderate damage)	White (light / no damage)
Edgecumbe urban	15	253	221
Plains incl. Poroporo	0	41	9
Tāneatua / Rūātoki	0	11	2

Reasons for significant variances from plan

The target of "People back in homes – 90% by Christmas" is not achieved. However, the current return is 71% and remains steadily increasing. The limitations and rebuild timeframes have been influenced by: weather, insurer and owner agreement timelines, technical repair issues for some land and houses, home owners after cash settlements then arranging own works, actual practical rebuild timeframes, some home owners including additions or extensions to their rebuild, and trades works peaks. The target however provides a strong focus for Recovery programmes and strategies and remains a key monitoring requirement.

Infrastructure

Milestones planned for this period	Timeframe	Status
THREE WATERS		
Three waters infrastructure is fully functioning (BAU).	May 2017	√
All temporary infrastructure removed.	December 2017	√
Investigate future protection of Edgecumbe and Tāneatua wastewater ponds in the LTP. (Now BAU as part of Integrated Wastewater Project investigation)	June 2018	✋
Repair of community facilities are complete.	May 2017	√
RIVER CONTROL MEASURES		
Independent review of the stop bank breach is complete.	End July 2017	√
Geotechnical investigations.	July 2017	√
Site clearance works.	Completed end of Feb 2018	√
Reinstatement commences.	October 2017 (commenced March 2018)	√
Planning consents.	November 2017	√
Long term future of severely affected area through community plan. (Now part of BAU and Coordinator established)	March 2018	✋
Stopbank Works on College Road, Edgecumbe are completed.	June 2018	☺
Stopbank repairs complete.	End March 2018	😐
College road renewed.	June 2018	☺

Milestones planned for this period	Timeframe	Status
ROADING		
All roads are open (temporary solutions).	August 2017	√
Horomanga Bridge (temporary bridge installed).	20 July 2017	√
Horomanga Bridge (permanent repair).	design commencing, construction to start approx. Oct 2018	✋
Kopuriki Road reopened.	Mid May 2017	√
Te Whāiti Road reopened.	7 July 2017	√
Te Whāiti Road – less complex damaged sites repaired.	End August 2017 - (construction underway - completion end of Feb 2018)	✋
Te Whāiti Road – complex sites requiring investigation & design complete. - (13 complex sites under preconstruction)	May 2018 - (construction commencing Oct/Nov 2018)	✋
Galatea Road – Te Mahoe underslip – opened to single lane access.	End April 2017	√
Galatea Road – Te Mahoe underslip – 2 lanes reinstated. - tenders closed -	November 2017 - construction to commence Mar 2018	✋
Pekatahi Bridge reopened.	16 June 2017	√
SH2 (Waimana Gorge) reopened.	23 June 2017	√
AMENITY AND COMMUNITY VISION		
Community group develops Community Plan with WRO support.	September 2017	√
Works complete to re-establish amenity in Edgecumbe and other areas. (Future initiatives Plan and BAU)	Commence September 2017	✋

ECONOMY

Highlights for the month

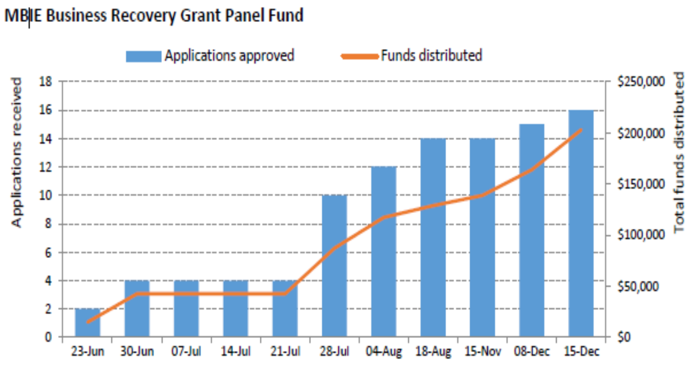
A MBIE funded evaluation of the 'Whakatāne Business Support Grant Programme' has been contracted via the Recovery Team to Sapere Research Group. The aim of the evaluation is to assess the effectiveness of the programme's outcomes to gauge how much of a difference the programme made to flood-affected businesses and their ability to recover. A research team is conducting a series of interviews with businesses and others involved in distributing the fund during the beginning of March 2018. MBIE's final report will be completed and provided to MBIE by the end of April

Project Status

Business Continuity

Milestones planned for this period	Timeframe	Status
Business needs assessment carried out.	July 2017	√
Outreach to affected businesses by phone and visits.	July 2017	√
Fact sheets and web page for business recovery.	July 2017	√
Business networking and training held to support and assist affected businesses.	July 2017 (ongoing)	√
Monitor any business closures.	May 2017	√
Seminars and workshops to provide information and advice. (Final workshop completed - Icehouse Business Training completed 9 April 2018)	July 2017 (onwards)	√
MBIE funding round is successfully taken up by affected businesses – Terms of Reference.	September 2017	√
Networking and supporting events are planned and held on fortnightly basis. (BAU as required)	May 2017 (ongoing)	✋
"Buy Local" campaign plan.	July 2017	√
Recovery newsletter on Edgecumbe open for business.	July 2017	√
Advertising implemented (e.g. radio, newspaper, other). Began mid Dec, completed end of March 2018	July 2017	√
Free wifi in Edgecumbe investigated and installed if possible.	August 2017	√
Scoping report on economic opportunities developed.	October 2017	✋

Update on progress



	New Applications reviewed	Applications approved	Applications Withdrawn	Applications Declined	Applications that did not supply info	Dollar value of applications approved	Potential Applications in the pipeline
Latest panel: 15 December	0	1	0	0	0	$ 38,851.55	0
In total	25	16	2	5	2	$ 202,919.05	0

Receives Only – No Decisions

BAY OF PLENTY REGIONAL COUNCIL TOI MOANA

Report To: Rangitāiki River Forum

Meeting Date: 08 June 2018

Report From: Simon Stokes, Eastern Catchments Manager

Te Ara Whanui o Rangitāiki Implementation Workshop Summary

Executive Summary

The purpose of this report is to summarise the workshop results and provide next steps from the hui held on November 10, 2017, at Te Rūnanga o Ngati Manawa, Murupara.

Rangitāiki River Forum members provided feedback to a range of questions over three workshop sessions. For the first time since the approval of Te Ara Whānui o Rangitāiki – Pathways of the Rangitāiki, in 2014, we now have a comprehensive view of our individual and collective activity in achieving the objectives. We now also have a picture of what success could look like, what the indicators could be of that success, and of the opportunities in front of us. We also have a picture of the barriers to action.

The Forum needs to decide on next steps.

Recommendations

That the Rangitāiki River Forum under its delegated authority:

1 Receives the report, Te Ara Whanui o Rangitāiki Implementation Workshop Summary;

1 Background

The workshop was held at the request of the Chair and Deputy Chair to provide understanding of our individual and collective activity in achieving the objectives of Te Ara Whanui o Rangitāiki.

What we wanted to achieve at this workshop was;

1. Clearly understand what we are doing to achieve objectives.
2. Developed indicators of success – what does that look like.
3. What the opportunities and barriers currently are to delivering on objectives and actions.

4. Clearer understanding of the growing gaps and intentions of members.
5. Information that supports members understanding of the alignment of their own strategy's and Te Ara Whanui o Rangitāiki – Pathways to the Rangitāiki aligns.

The workshop feedback has been collated and is in a supporting document.

2 Rangitāiki River Forum purpose and function

The Rangitāiki River Forums purpose and function were highlighted during the workshop to remind Forum members of their focus. They are repeated in this report as they have been used in an assessment of the feedback.

Rangitāiki River Forum Purpose (from current Terms of Reference)

- Is the protection and enhancement of the environmental, cultural, and spiritual health and wellbeing of the Rangitāiki River and its resources for the benefit of present and future generations, as set out in Ngāti Manawa Claims Settlement Act 2012 and the Ngāti Whare Claims Settlement Act 2012.

Rangitāiki River Forum Functions (from current Terms of Reference)

The principle function of the Forum is to achieve its purpose. Other functions of the Forum are to:

- Prepare and approve the Rangitāiki River Document for eventual recognition by the Regional Policy Statement, Regional Plans and District Plans.
- Promote the integrated and coordinated management of the Rangitāiki River
- Engage with, and provide advice to:
  - Local Authorities on statutory and non-statutory processes that affect the Rangitāiki River, including under the Resource Management Act 1991.
  - Crown agencies that exercise functions in relation to the Rangitāiki River.
- Monitor the extent to which the purpose of the Rangitāiki River Forum is being achieved including the implementation and effectiveness of the Rangitāiki River Document.
- Gather information, disseminate information and hold meetings
- Take any other action that is related to achieving the purpose of the Forum.

3 Workshop summary

The following is a summary assessment of the workshop sessions in relation to what we wanted to achieve at our workshop.

3.1 Clearly understand what we are doing to achieve objectives

This is the first time since 2014 we have a picture of what all Forum members are doing. A range of involvement by Forum members is occurring across the eight objectives in the current year. Some are observing and some are heavily involved. Objective 8 relating to access to the Rangitāiki River and its tributaries has the least activity in progress, in essence due to the priority focus on other objectives while Objective 1 in relation to tuna is very active. However the picture of what we are doing collectively next year is less defined and would get less clear if we looked out five years. Some objectives and their actions are understood by Forum members so that what they are doing supports achieving the objective. But it could also be said that the measure of success or clarity of achievement for each objective and its actions is not clear for us all. This could make it difficult for Forum members to truly engage with understanding to garner support from within their organisation.

In summary there is a lot of positive momentum and action. To enable that further, a clearly defined coordinated approach for the Forum giving clarity of each other's work is required. That approach needs to be supported by an understanding of when an action is achieved and how is that indicated. This will help each Forum member with their own business progression, interwoven with Rangitāiki catchment business and help to communicate what the Forum is doing to the catchment and wider community.

How does the Forum want to address this?

3.2 Developed indicators of success – what does that look like

"More kids bombing off bridges" sums up this session's feedback.

The overriding message about what success looks like and what indicators could be used all related to people. Forum members provided extensive responses to what success looks like and indicators to support that success against each Objective. In summary, two key themes emerged, centred on the river;

- success will be shown by the health of the river and its inhabitants and;
- the engagement and enjoyment of people with the river.

The indicators were again centred around both themes e.g. more kids bombing, more tuna habitat, celebration of knowledge and practice, and more people use and visit the river. There was also an element of emotion in the words used by workshop attendees, which could be summed up as being about respect and responsibility.

There is now information that can be used to work out what success looks like and what can be indicators at a level which can be developed against each Objective and their actions. With reflection on the first question (3.1) and the missing elements there, we now have a starting place to support that mahi to come. A refreshed understanding of this aspect will not detract from the vision and goals in Te Ara Whanui o Rangitāiki.

3.3 What the opportunities and barriers currently are to delivering on objectives and actions

The feedback highlighted more opportunities than barriers which is a good result. Interestingly the two key themes of opportunity were about education (for all on the many aspects of the Rangitāiki river catchment) and for more communication and relationship building. Essentially everyone highlighted the need to keep building that bond between each other. These two themes are the probable answers to the feedback on barriers. The barriers could all be seen as responses to a still maturing clarity of understanding and opportunity, particularly between iwi and councils and crown. This is also supported by insufficient direction about what success looks like in achieving the objectives and their actions. One way to reduce the barriers is to educate and communicate through growing relationships.

How does the Forum want to use this information in developing a way forward?

3.4 Clearer understanding of the growing gaps and intentions of members

The ability of the workshop feedback to help answer this question is not as clearly defined as for the other questions. Having said this, the results of the other questions do highlight some understanding of the gap between members of the business of the Forum. An example of a current gap is that not all Forum members have been involved since the beginning in 2012. This means that Te Ara Whanui o Rangitāiki may not have as much clarity for new members, nor have they developed a relationship with the document's kaupapa as they were not participants. As would be expected this does not allow for as cohesive and as clear a collective intention of the Forum and its business. We have new members to join later this year or next year – Tūwharetoa ki Taupō and so it is a good time to review how we induct and integrate new members.

In summary there will always be gaps and differences of intentions of Forum members, this is healthy. But if everyone is focused and understands their role in achieving the Forum purpose and its functions, then those gaps and intentions should become minimal.

How does the Forum wish to address this risk or other associated risks?

3.5 Information that supports members understanding of the alignment of their own strategy's and Te Ara Whanui o Rangitāiki – Pathways to the Rangitāiki.

Essentially the workshop achieved this in drawing out of the Forum members what they are doing as per question 1. This information can be used to assess alignment of their role in Forum business versus their own strategic aspirations. This is work that needs to be completed by Forum members independently or can be supported by other Forum members or Bay of Plenty Regional Council staff involved in Te Ara Whanui o Rangitāiki.

The ability to do this in the future will be determined by how the Forum approaches moving forward in a more coordinated way, as per earlier comments in this report.

4 Next steps

The workshop has achieved what it set out to do. It has highlighted the commitment and participation of Forum members in implementing Te Ara Whanui o Rangitāiki – Pathways of the Rangitāiki. It has also highlighted the future. But it has also highlighted the need to progress more clearly how we are doing, what we are doing and when it is successful and achieved.

Previously the Forum has received reports about 'Implementing Te Ara ō Rangitāiki – Pathways of the Rangitāiki' and 'Catchment programme updates'. These reports endeavoured to provide guidance and an overview on implementation of the actions. However these reports aren't a collective priority for action nor do they truly elaborate any strategic intent of the Forum.

The Forum is also now clearly referenced in the Rangitāiki River Scheme Review (the Cullen Report), which is a major focus for the catchment. But is it clear yet what the Forum's role will be in this process and how does that interweave back into the Forum's business and fit into its strategic intent?

The Forum has committed in 2018 to review its Terms of Reference. Reviewing the Terms of Reference thoroughly will only be possible if the Forum has addressed some of the workshop feedback.

In conclusion, the workshop feedback has highlighted that there is still further work to be completed to allow the Forum to be clear and focused collectively on achieving its purpose. This will need to align with the objectives, policies and methods of Proposed Change 3. The following suggested next steps provide an uncomplicated approach.

4.1 Suggested next steps:

- Define a coordinated approach - hold te ohu (workshop) with all Forum members (or relevant personnel) in 2018 to set a clear strategic five/ten year pathway (plan) based on Te Ara Whanui o Rangitāiki. The timing of te ohu may depend on the progress of Proposed Change 3.
- In the te ohu agree on what success looks like and what indicators to use. This will help evolve new opportunities as put forward.
- Commit to finding a suitable coordinated approach to implementing action and reporting back to the Forum where roles and responsibilities are clear.
- Gain commitment from each of the Forum members to secure support from their organisations to fully participate in the te ohu.
- Complete a review of the Terms of Reference once a ten year pathway has been endorsed.
- Ensure education and communication is delivered

5 Implications for Māori

The implications for Māori with this kaupapa are that all councils have responsibilities to Māori under the Local Government Act and Resource Management Act. In providing this report and committing to next steps options we are aiming to meet those responsibilities. The implications are that Māori will be heavily involved and there will be positive effects for all tangata whenua in the Rangitāiki River catchment. Our catchment iwi are involved in the decision making with regards as to how we move forward on the kaupapa of this report. In doing so relevant iwi planning documents, Treaty settlement legislation or any other document expressing matters of importance to Māori are taken in account.

Simon Stokes
Eastern Catchments Manager

29 May 2018

SUPPORTING DOCUMENT - Rangitaiki River Forum Workshop Results - November 10 2017