Policy and Planning Committee

Tuesday 17 July 2018
10.30am
Taranaki Regional Council, Stratford

Agenda for the meeting of the Policy and Planning Committee to be held in the Taranaki Regional Council chambers, 47 Cloten Road, Stratford, on Tuesday 17 July 2018 commencing at 10.30am.

Members	Councillor M P Joyce	
	Councillor B K Raine	
	Councillor C S Williamson	
	Councillor D L Lean	(ex officio)
Representative Members	Mr J Hooker	(Iwi Representative)
	Mr P Muir	(Taranaki Federated Farmers)
	Councillor P Nixon	(South Taranaki District Council)
	Mr M Ritai	(Iwi Representative)
Apologies	Councillor C L Littlewood*	
	Councillor D H McIntyre	
	Councillor D N MacLeod	
	Councillor N W Walker	
	Ms E Bailey*	(Iwi Representative)
	Councillor G Boyde	(Stratford District Council)
	Councillor R Jordan	(New Plymouth District Council)

* may attend the meeting via *Zoom* audio/visual

Notification of Late Items

Election of Chairperson Due to the absence of the Policy and Planning Committee Chairperson and Deputy Chairperson, the Committee is required to elect a Member (who is present) to act as Chairperson for the meeting (*Taranaki Regional Council Model Standing Orders 13.2*)

Agenda Memorandum

Date 17 July 2018

Memorandum to
Chairperson and Members
Policy and Planning Committee

Subject: Confirmation of Minutes – 5 June 2018

Approved by: A D McLay, Director-Resource Management

B G Chamberlain, Chief Executive

Document: 2085858

Resolve

That the Policy and Planning Committee of the Taranaki Regional Council:

1. takes as read and confirms the minutes of the Policy and Planning Committee meeting of the Taranaki Regional Council held in the Taranaki Regional Council chambers, 47 Cloten Road, Stratford, on Tuesday 5 June 2018 at 10.30am
2. notes the recommendations therein were adopted by the Taranaki Regional Council on 26 June 2018.

Matters arising

Appendices

Document #2064643 – Minutes Policy and Planning Committee

Minutes of the Policy and Planning Committee Meeting of the Taranaki Regional Council, held in the Taranaki Regional Council Chambers, 47 Cloten Road, Stratford, on Tuesday 5 June 2018 at 10.30am.

Members	Councillors	N W Walker	(Committee Chairperson)
		M P Joyce	
		D H McIntyre	
		B K Raine	
		C S Williamson	
		D L Lean	(ex officio)
		D N MacLeod	(ex officio)
Representative Members	Ms	E Bailey	(Iwi Representative)
	Councillor	G Boyde	(Stratford District Council)
	Mr	J Hooker	(Iwi Representative)
	Councillor	R Jordan	(New Plymouth District Council)
	Mr	P Muir	(Taranaki Federated Farmers)
	Councillor	P Nixon	(South Taranaki District Council)
	Mr	M Ritai	(Iwi Representative)
Attending	Messrs	B G Chamberlain	(Chief Executive)
		A D McLay	(Director-Resource Management)
		G K Bedford	(Director-Environment Quality)
		G C Severinsen	(Policy and Strategy Manager)
		C L Spurdle	(Planning Manager)
		P Ledingham	(Communications Officer)
		R Ritchie	(Communications Manager)
		S Tamarapa	(Iwi Communications Officer)
	Mrs	K van Gameren	(Committee Administrator)
	Mrs	F Mulligan	(Iwi Representative)
	Mr	K Holswich	(Iwi Representative)
	Mr	H Eriwata	(Iwi Representative)
	Mr	B Jansma	(Environmental Scientist)
	Ms	G Marcroft	(Policy Analyst)
	Mr	R Phipps	(Science Manager)
	Mrs	V MacKay	(Science Manager)
	Mr	C L McLellan	(Consents Manager)
	Mr	J Clough	(Wrightson Consulting)

Apologies The apology from Councillor C L Littlewood was received and sustained.

Notification of Late Items There were no late items of business.

1. Confirmation of Minutes – 24 April 2018

Resolved

THAT the Policy and Planning Committee of the Taranaki Regional Council

1. takes as read and confirms the minutes and confidential minutes of the Policy and Planning Committee meeting of the Taranaki Regional Council held in the Taranaki Regional Council chambers, 47 Cloten Road, Stratford, on Tuesday 24 April 2018 at 10.35am
2. notes that the recommendations therein were adopted by the Taranaki Regional Council on 15 May 2018.

MacLeod/Hooker

Matters Arising

The impacts of recent extreme rainfall in the Gisborne region and the discharge of forestry slash to rivers was raised and a discussion held over the likelihood of this being an issue for Taranaki and how this could be managed under the NES – Production Forestry. Concerns had been previously expressed by Cr Boyde about similar incidents in Stratford District.

2. Update on submissions to the Proposed Coastal Plan for Taranaki

2.1 Mr C L Spurdle, Planning Manager, spoke to the memorandum updating the Committee on the submissions received to the Proposed Coastal Plan for Taranaki and the process from here.

2.2 The Committee noted and discussed the number of Hearing Commissioners that the Council has who are accredited under the *Making Good Decisions Programme* (currently three). As Members retire or no longer keep their accredited status current, the Council may wish to consider sending other Members through the programme to plan for the future and/or appoint external commissioners with the required skills.

Recommended

That the Taranaki Regional Council:

1. receives the memorandum on the *Update on submissions to the Proposed Coastal Plan for Taranaki*
2. notes and endorses the Council's submission on the *Proposed Coastal Plan for Taranaki*
3. notes 61 submissions have been received on the *Proposed Coastal Plan for Taranaki*
4. notes that officers have commenced the analysis and summary of submissions.

Williamson/Raine

3. *Our Land 2018*: National environment report from ministry for the Environment/Stats NZ

3.1 Mr A D McLay, Director-Resource Management, spoke to the memorandum presenting to the Committee the main findings and observations from the report *Our Land 2018: Data to 2017* recently released by the Ministry for the Environment and Stats NZ.

Recommended

That the Taranaki Regional Council:

1. receives the memorandum *Our Land 2018: National environment report from the Ministry for the Environment/Stats NZ*
2. notes the release by the Ministry for the Environment/Stats NZ of the report referenced in the memorandum.

Williamson/Muir

4. New Zealand Fish Passage Guidelines

4.1 Mr G K Bedford, Director-Environmental Quality, spoke to the memorandum introducing the *New Zealand Fish Passage Guidelines* prepared by the National Institute of Water and Atmospheric Research (NIWA) and the Department of Conservation (DOC) in partnership with the New Zealand Fish Passage Advisory Group and to recommend the Guidelines be taken into account by the Council when promoting fish passage in Taranaki.

4.2 Mr B Jansma, Environmental Scientist, provided a presentation *Barriers to Fish Passage* to the Committee in support of the item to provide a local context on fish passge work undertaken in the region.

Recommended

That the Taranaki Regional Council:

1. receives the memorandum *New Zealand Fish Passage Guidelines*
2. notes that the guidelines will provide a useful tool for this Council in further promoting good fish passage management in Taranaki.

Joyce/Raine

5. Deep South National Science Challenge: Climate Adaptation Ambassadors' Workshop

5.1 The memorandum introducing a research project being undertaken as part of the Deep South National Science Challenge to steer research on climate change adaptation through to policy and action via a network of climate adaptation ambassadors was received and discussed.

Recommended

That the Taranaki Regional Council:

1. receives the memorandum *Deep South National Science Challenge: Climate Adaptation Ambassadors' Workshop*
2. notes that the workshop was the first of several to be held during 2018 which will lead to a second phase of research in 2019
3. notes that Mr Gray Severinsen, Manager Policy and Strategy, has been appointed the Council's contact point on climate change issues.

Williamson/Boyde

6. Second quarterly monitoring report on urban development indicators for New Plymouth District

6.1 Mr C L Spurdle, Planning Manager, spoke to the memorandum introducing the second *Quarterly Monitoring Report on Urban Development Indicators for the New Plymouth Distr*ict that gives effect to one of the required elements of *the National Policy Statement on Urban Development Capacity*.

Recommended

That the Taranaki Regional Council:

1. receives the memorandum *Second quarterly monitoring report on urban development indicators for New Plymouth district*
2. notes that the Quarterly Monitoring Report has been prepared by the New Plymouth District Council and gives effect to district and regional council requirements under the NPS-UDC
3. notes that both councils have written to the Minister for the Environment to request an extension of the timeframe for completion of the Future Development Strategy.

Jordan/Lean

7. Water Quantity Accounting System for Taranaki

7.1 The memorandum introducing the Council's water quantity accounting system, as required for resource management and the National Policy Statement for Freshwater Management, was received and discussed.

7.2 Mr R Phipps, Science Manager, provided a presentation *Water Quantity Accounting System for Taranaki* to the Committee in support of the item.

Recommended

That the Taranaki Regional Council:

1. receives the memorandum *Water Quantity Accounting System for Taranaki*

2. notes the Council has meet the water quantity requirements of the National Policy Statement for Freshwater Management
3. notes that the accounting system will be part of a broader discussion on water allocation policy that will involve workshops with water stakeholders, including water users, iwi, and Fish and Game Council to further discuss water allocation in the region.

Raine/Williamson

Closing Karakia Mr M Ritai (Iwi Representative) gave the closing Karakia to the Policy and Planning Committee and Karakia for kai (lunch).

There being no further business, the Committee Chairperson Councillor N W Walker, declared the open meeting of the Policy and Planning Committee meeting closed at 12.00pm.

Confirmed

Chairperson _____

N W Walker

Date **17 July 2018**

Agenda Memorandum

Date 17 July 2018

Memorandum to
Chairperson and Members
Policy and Planning Committee

Subject: Proposed Coastal Plan for Taranaki: Summary of decisions requested

Approved by: A D McLay, Director – Resource Management

B G Chamberlain, Chief Executive

Document: 2060960

Purpose

The purpose of this memorandum is to present Members with the summary of decisions sought for the *Proposed Coastal Plan for Taranaki* (Proposed Plan) and to outline the process from here.

A copy of the document *Proposed Coastal Plan for Taranaki - Summary of Decisions Requested* and public notice for further submissions is appended to this item for Members' information. Full copies of the submissions are also available on the Councils' website: www.trc.govt.nz/coastal-plan-review-2.

Executive summary

- Pursuant to the *Resource Management Act 1991* (RMA) the Taranaki Regional Council (the Council) has commenced the formal review process involving the release of the Proposed Plan.
- The Proposed Plan was the culmination of a comprehensive pre-plan notification engagement process, involving early engagement, consultation on position papers and technical reports and the earlier release of a Draft Plan.
- The Proposed Plan was publicly notified for submissions on 24 February 2018. The deadline for submissions was 27 April 2018 and 61 submissions were received.
- Officers have undertaken an analysis of the 61 submissions and prepared the attached Summary of Decisions Requested Report. Pursuant to Clause 7 of the First Schedule of the RMA, the Council must publicly notify that it has prepared a summary of decisions requested in response to the public submissions on the Proposed Plan.
- The full submissions are available to view on the Council's website and hard copies are also available from the Council premises.
- Pursuant to Clause 8 of the First Schedule of the RMA, the Council will also invite further submissions in support or opposition to the submissions made on the Proposed Plan. Further submissions can be made by any person if they represent a relevant aspect

of the public interest; or if they have an interest in the Proposed Plan greater than the interest that the general public has.

- The deadline for further submissions would be 4 August 2018. After further submissions have been received, officers will begin pre-hearing discussions and consultations with the aim of working through the issues raised with the submitters prior to the formal hearing of submissions on the Proposed Plan.

Recommendations

That the Taranaki Regional Council:

1. receives the memorandum on the summary of submissions to the *Proposed Coastal Plan for Taranaki;*
2. notes that 61 submissions have been received on the Proposed Plan;
3. agrees that the *Proposed Coastal Plan for Taranaki - Summary of Decisions Requested* document be publicly notified;
4. agrees that the Council invite further submissions in support or opposition to submissions made on the Proposed Plan.

Background

Pursuant to the *Resource Management Act 1991* (RMA) the Taranaki Regional Council (the Council) is responsible for promoting the sustainable management of the coastal marine area (CMA) of the Taranaki region and is required to prepare a Coastal Plan. The CMA refers to the 'wet bit' of the coast. Its landward boundary is the mean high water mark and it extends seaward to 12 nautical miles (22 km). Beyond this is the Exclusive Economic Zone, which is managed by the Environmental Protection Authority (EPA), based in Wellington.

Taranaki's 'rule book' governing the coastal marine area is under review. The current Coastal Plan was prepared and made operative on 1 October 1997. The Plan was the first prepared under the RMA.

As Members are aware, the Council has commenced the formal review process involving the release of a *Proposed Coastal Plan for Taranaki* (the Proposed Plan) and the receipt of public submissions. The Proposed Plan, was publicly notified on 24 February 2018, with the deadline for submission being the 27th of April.

The Proposed Plan was the culmination of a comprehensive pre-plan notification engagement process, involving early engagement, consultation on position papers and technical reports and the release of a Draft Plan. Early engagement with stakeholders has generally paid dividends for this Council in reducing the time and cost of the formal plan process under the RMA and further developing relationships with stakeholders. The pre-plan consultation resulted in many changes to the proposed plan, including those made as a result of iwi consultation.

The Proposed Plan was also forwarded to a wide range of key stakeholders and other interested parties, including those who had previously commented on the Draft Plan, tangata whenua, district councils, major consent holders, oil and gas sector groups, Department of Conservation, other government departments, and non-government organisations with an interest in coastal matters.

Submitters on the Proposed Plan

Through the public submission process, 61 initial submissions were received on the Proposed Plan. Table 1 below outlines the list of submissions received.

Table 1: List of submissions on the Proposed Plan

Submission Number	Submitter Name	Submission Number	Submitter Name
1.	Tom P Waite	32.	Port Taranaki Ltd
2.	Federated Farmers	33.	New Zealand Defence Force
3.	Roger Maxwell	34.	Fay Mulligan and Carol Koha
4.	Allen Pidwell	35.	Radio New Zealand Ltd
5.	Point Board Riders Inc	36.	Todd Energy
6.	Trans-Tasman Resources Ltd	37.	Petroleum Exploration and Production Association of NZ
7.	Waikato Regional Council	38.	Nigel Cliffe
8.	Silver Fern Farms Management Ltd	39.	Maniapoto Māori Trust Board
9.	Karen Pratt	40.	Te Rūnanga o Ngāti Mutunga
10.	South Taranaki Underwater Club	41.	Te Korowai o Ngāruahine Trust
11.	Bruce Boyd	42.	Ngati Hine Hapū of Te Atiawa
12.	Chorus New Zealand Ltd	43.	Royal Forest and Bird Protection Society
13.	Spark New Zealand Trading Ltd	44.	Nga Motu Marine Reserve Society Inc
14.	Vodafone New Zealand Ltd	45.	Powerco
15.	Surfbreak Protection Society	46.	Z Energy Ltd, BP Oil Ltd and Mobil Oil NZ Ltd
16.	Ministry for Primary Industries	47.	Fonterra
17.	David Pearce	48.	Taranaki District Health Board
18.	Surfing Taranaki	49.	Cam Twigley
19.	South Taranaki District Council	50.	Te Kāhui o Taranaki Trust
20.	Meridian Energy Ltd	51.	Taranaki Energy Watch Inc
21.	Climate Justice Taranaki Inc	52.	Emily Bailey
22.	Lyndon De Vantier	53.	Taranaki Regional Council
23.	New Plymouth District Council	54.	Maritime New Zealand
24.	Paora Aneti 17 & 18 Māori Reservation Trustees	55.	Kiwis Against Seabed Mining
25.	New Zealand Petroleum and Minerals	56.	Greenpeace
26.	Transpower NZ Ltd	57.	Heritage New Zealand
27.	Taranaki Chamber of Commerce	58.	Te Atiawa
28.	Grant Knuckey	59.	KiwiRail
29.	Department of Conservation	60.	Te Kaahui o Rauru
30.	First Gas Ltd	61.	Te Rūnanga o Ngāti Ruanui Trust
31.	Komene 13B Māori Reservation Trustees		

The summary on submissions

A report on the 61 submissions has been prepared entitled *Proposed Coastal Plan for Taranaki - Summary of Decisions Requested*. The summary identifies and summaries the issues raised in individual submissions and the decisions requested by submitters.

Many submissions indicate support for the overall content and management approach contained within the Proposed Plan with a number of submissions requesting that certain provisions be retained. However, there have also been many requests for change, some of which are to clarify the meaning of current provisions or to add further context and others which seek deletions from or additions to specific provisions of the Proposed Plan.

Many submitters have sought similar amendments and this is obvious with several common themes emerging, for example:

- integrated management;
- coastal management areas;
- use and development;
- regionally important infrastructure;
- tangata whenua principles;
- surf breaks;
- indigenous biodiversity; and
- rules – mixed views on the level of control considered appropriate.

Iwi have been involved in the process to this point through consultation and workshops. Some iwi also contributed directly to the Plan and provided sites of significance for inclusion in the Plan (important for consent notification process determinations). The Council received twelve submissions on the Proposed Coastal Plan from iwi and hapu members. The main issues/themes that have been identified from these submissions relate to recognition of tangata whenua principles, taonga values, identification and naming of surf breaks, rules relating to water discharge and petroleum activities, iwi involvement and notification and consultation of activities within the CMA. Officers will continue to work with iwi and hapu to address these issues within the pre-hearing consultation process and attempt to reduce the number of concerns that have been raised.

Further submissions and the process from here

The First Schedule of the RMA sets out a formal statutory process that the Council must follow for the review of the Coastal Plan.

Officers have undertaken an analysis of the 61 submissions and prepared the attached Summary of Decisions Requested Report. Pursuant to clauses 7 and 8 of the First Schedule of the RMA the Council is now required to:

- publicly notify the availability of a summary of all decisions requested by persons making submissions on the Proposed Plan; and
- request further submissions in support of or opposition to any submissions made.

Accordingly, officers have prepared the attached draft public notice of the availability of the summary of submissions and an invitation for the public to make further submissions in support or opposition of the original submissions is to be notified on 21 July 2018. The

Summary of Decisions Requested document, along with a copy of all the submissions received and a copy of the Public Notice, will be uploaded onto the Council's website. All submitters will be advised and also invited to make further submissions in support or opposition to the original submissions made.

Further submissions can be made by any person if they represent a relevant aspect of the public interest; or if they have an interest in the Proposed Plan greater than the interest that the general public has.

This further submission period closes on 4 August 2018.

Following receipt of further submissions, officers will commence pre-hearing discussions and consultation to potentially work through the issues raised. As part of this process:

- Council officers will prepare an Officers Report – this report will (in relation to each issue raised by submitters) contain officers' preliminary responses to and recommendations on how the Council might address each issue raised by the submissions;
- the Officers Report will be presented to a Policy and Planning Committee, with recommendations that the report be distributed to submitters as a basis for pre-hearing discussions with submitters; and
- pre-hearing meeting process to be undertaken to resolve or narrow down any issues raised by the submissions.

Following pre-hearing consultation and discussions, the 'Officer's report on decisions requested' (as amended by Officers following pre-hearing consultations) will be distributed to all submitters prior to the hearing of submissions. This allows all submitters to be informed of the further changes proposed as a result of the pre-hearing discussions, and to enable all submitters to consider these changes in light of their own submission and the need to attend the Taranaki Regional Council Hearing.

The Council will provide an opportunity for every person who makes a submission, and who request to be heard, to present their views in person to a Hearings Committee. A Hearings Committee will then consider all submissions and make recommendations on submissions to the full Council.

A Hearing Committee report will be considered by Council. This report will contain the deliberations and recommendations of the Hearing Committee on all submissions. The Council's decisions on the matters raised (in the submissions) will be publicly notified.

Any person who made a submission on the Proposed Plan may appeal Council's decisions to the Environment Court. Pending the outcome of any appeal received an amended version of the Coastal Plan for Taranaki, incorporating the agreed changes, will be adopted by the Council and made operative.

Decision-making considerations

Part 6 (Planning, decision-making, and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the Act.

Financial considerations—LTP/Annual Plan

This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Biosecurity Act 1993*.

Iwi considerations

This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Consultation with all iwi was undertaken on the Plan, as required by the RMA and as a matter of good practice, with valuable feedback received. Input at the Plan level is more strategic than at the consent level, because plans set the framework for consents.
Also refer to the above summary of submissions section for further information.

Legal considerations

This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Appendices

Document number 2069440: *Public notice for further submissions on the Proposed Coastal Plan*.

Appendices – one separate report

Document number 2016602: *Proposed Coastal Plan for Taranaki - Summary of Decisions Requested*.

Further submissions on the Proposed Coastal Plan for Taranaki

Pursuant to Clause 7 of the First Schedule of the Resource Management Act 1991, the Taranaki Regional Council gives notice that it has prepared a summary of decisions in response to the public submissions on the Proposed Coastal Plan for Taranaki.

The summary of decisions requested, public submissions, the Proposed Coastal Plan for Taranaki, and accompanying Section 32 Report are available at:

- The Taranaki Regional Council website at www.trc.govt.nz/regional-coastal-plan
- All public libraries in Taranaki
- As hard copies available during office hours from the Taranaki Regional Council premises at 47 Cloten Road, Stratford.

Pursuant to Clause 8 of the First Schedule of the Resource Management Act 1991 the Taranaki Regional Council now invites further submissions on the Proposed Coastal Plan for Taranaki. These can be made by any person if you represent a relevant aspect of the public interest; or if you have an interest in the Proposed Coastal Plan for Taranaki greater than the interest that the general public has.

Please note that a further submission may only express support or opposition for an existing matter raised. It must not raise any new points. In addition, the submitter must serve a copy of their submission on the person who made the submission to which the further submission relates. Further submissions can be made through:

- Completion of the online submission form at www.trc.govt.nz/
- Emailing Taranaki Regional Council at coastal@trc.govt.nz and including as the subject 'Further submission on the Proposed Coastal Plan for Taranaki'
- Posting your submission to Taranaki Regional Council, Private Bag 713, Stratford 4352 and including as the subject 'Further submission on the Proposed Coastal Plan for Taranaki'.

The closing date for further submissions is the 4th of August 2018.

For further information contact: Taranaki Regional Council, Private Bag 713, Stratford, phone 0800 736 222 or email coastal@trc.govt.nz.

Basil Chamberlain
Chief Executive, Taranaki Regional Council

Agenda Memorandum

Date 17 July 2018

Memorandum to
Chairperson and Members
Policy and Planning Committee

Subject: **Review of minimum flows and water allocation in Taranaki – consultant report**

Approved by: AD McLay, Director – Resource Management

BG Chamberlain, Chief Executive

Document: 2077525

Purpose

The purpose of this memorandum is to introduce the report produced by Dr Ian Jowett (Jowett Consulting), *Review of Minimum flows and water allocation in Taranaki*. The report has been prepared to support community discussion and consideration of minimum flow and allocation limits for Taranaki rivers within the regional *Freshwater and Land Management Plan*.

Staff will make a presentation to the Committee on the report.

Executive summary

The Taranaki Regional Council is currently undertaking a review of the current *Regional Freshwater Plan for Taranaki* (RFWP). A draft *Freshwater and Land Management Plan* (Draft Plan) has been developed and consulted on.

Stakeholder feedback was provided on numerous parts of the Draft Plan through the initial consultation process. This included specific feedback on the water allocation framework being proposed.

Submitters on the Draft Plan presented conflicting views. Some viewed the proposed limits as to restrictive and potentially constraining future use of water, while others saw them as to permissive and not affording sufficient levels of environmental protection. After receiving this and other feedback, the Council has decided more work and consultation is required regarding water allocation, amongst other things, before it publicly notifies a Freshwater and Land Management Plan under Resource Management Act 1991.

To assist in addressing water allocation issues raised by submitters, and provide a technical assessment to inform additional consultation related to water allocation policies and rules, the Council commissioned Dr Ian Jowett (Jowett Consulting Ltd.) to produce a technical report that investigated the following:

- The existing research on environmental flow requirements;

- The principles for setting minimum flow and allocation limits;
- Hydrological, water-quality and streambed invertebrate data relating to Taranaki rivers; and
- Recommendations or options for future environmental flow limits for Taranaki.

The report uses long-term monitoring data from nine Taranaki rivers to model the impacts of various combinations of minimum flow and allocation limits. The impacts are assessed both on the level of protection each combination of limits would offer for instream benthic invertebrates and fish populations, and the reliability of supply for water users under each scenario.

Arriving at minimum flows and allocation limits that provide a balance between protection levels and supply reliability is a major challenge of the plan review process. Increasing protection levels reduce the security of supply for water users and vice versa. Consequently, some form of trade-off will be required through the limit setting process.

The report does not recommend a specific combination of minimum flows and allocation limits for inclusion in the Draft Plan, but it does provide for comparisons between various possible combinations of limits to be made.

Officers propose to continue discussions with water users, iwi and other stakeholders potentially in individual workshop sessions and then to bring them together in a joint workshop or workshops. This is to attempt to resolve issues and finalise an approach that will not only be consistent with the *National Policy Statement for Freshwater Management* (NPS-FM) but will also be fit-for-purpose in the Taranaki context. Outcomes from that engagement will be included in the Council's proposed *Freshwater and Land Management Plan*.

A full copy of the report and a Factsheet that outlines the findings of the report and key policy considerations are appended to this item. The Factsheet will accompany the technical report when distributed to stakeholders and summarises key concepts and findings from the report.

Recommendations

That the Taranaki Regional Council:

1. receives the report *Review of minimum flows and water allocation in Taranaki*;
2. notes that the report will underpin technical discussions and the wider consultation of water allocation policy options to be incorporated in ta proposed *Freshwater and Land Management Plan;*
3. notes the Council intends to circulate the report and a factsheet and convene a series of workshops with key water stakeholders, including major water users, iwi, Department of Conservation and Fish and Game Council to further discuss and potentially resolve issues with water allocation policy in the region.

Background

The *National Policy Statement for Freshwater Management* (N PS-FM) requires all regional councils to set environmental flows that include an allocation limit and a minimum flow.

The relevant water quantity objectives and policies from the NPS-FM are as follows.

Objective B1
To safeguard the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems of fresh water, in sustainably managing the taking, using, damming, or diverting of fresh water.

Objective B2
To avoid any further over-allocation of fresh water and phase out existing over-allocation.

Objective B3
To improve and maximise the efficient allocation and efficient use of water.

Objective B5
To enable communities to provide for their economic well-being, including productive economic opportunities, in sustainably managing fresh water quantity, within limits.

Policy B1
By every regional council making or changing regional plans to the extent needed to ensure the plans establish freshwater objectives in accordance with Policies CA1-CA4 and set environmental flows and/or levels for all freshwater management units in its region (except ponds and naturally ephemeral water bodies) to give effect to the objectives in this national policy statement, having regard to at least the following:
a) the reasonably foreseeable impacts of climate change;
b) the connection between water bodies; and
c) the connections between freshwater bodies and coastal water.

Policy B2
By every regional council making or changing regional plans to the extent needed to provide for the efficient allocation of fresh water to activities, within the limits set to give effect to Policy B1.

Policy B3
By every regional council making or changing regional plans to the extent needed to ensure the plans state criteria by which applications for approval of transfers of water take permits are to be decided, including to improve and maximise the efficient allocation of water.

Policy B4
By every regional council identifying methods in regional plans to encourage the efficient use of water.

Policy B5
By every regional council ensuring that no decision will likely result in future over-allocation – including managing fresh water so that the aggregate of all amounts of fresh water in a freshwater management unit that are authorised to be taken, used, dammed or diverted does not over-allocate the water in the freshwater management unit.

Policy B6
By every regional council setting a defined timeframe and methods in regional plans by which over allocation must be phased out, including by reviewing water permits and consents to help ensure the total amount of water allocated in the freshwater management unit is reduced to the level set to give effect to Policy B1.

The current Regional Freshwater Plan sets minimum flows but does not set quantitative allocation volumes, but has qualitative standards that apply. Minimum flow limits in this plan require two-thirds (66%) of habitat to be retained at mean annual low flow (MALF). MALF is the lowest flow that could be naturally expected on a year-to-year basis. In real terms, this limit requires 66% of MALF to be retained as a minimum flow.

As part of an ongoing review of that plan, the Council developed policies and rules designed to give effect to the requirements of the NPS-FM in the Draft Plan, which was released for targeted public consultation in 2015. The Draft Plan sets objectives for setting minimum flows and allocation. The key objectives for water allocation are:

- appropriate use and development;
- ecosystem health and mauri;
- natural character; and
- biodiversity.

The new minimum flow limits proposed in the current Draft Plan were based on the Government's *Proposed National Environmental Standard for Ecological Flows* (2008), and range from 100% of MALF to 80% of MALF across freshwater management units. Minimum flow conditions on existing consents were to be retained. These limits represent an increase in minimum flow above current limits. Allocation limits proposed in the Draft Plan range from 10% of MALF to 30% of MALF, with additional allocation (up to 50% MALF) on large rivers. The Draft Plan also makes provision for harvesting of water at higher flows, where environmental impacts will be negligible.

Following feedback on that Draft Plan, the Council decided more work was needed before it publicly notifies the plan. This included commissioning Dr Ian Jowett (Jowett Consulting Ltd.) to produce a technical report that investigated the following:

- the existing research on environmental flow requirements;
- the principles for setting minimum flow and allocation limits;
- hydrological, water-quality and streambed invertebrate data relating to Taranaki rivers; and
- recommendations or options for future environmental flow limits for Taranaki.

Dr Jowett has significant New Zealand experience and previous experience working within the Taranaki region, which includes providing technical guidance to the Council when the current version of the RFWP was developed.

Discussion

Taranaki has 217 parent catchments, made up of more than 500 named rivers and streams. More than 300 rivers flow from the flanks of Mt Taranaki in a distinctive radial pattern across the ring plain. Typically, ring plain rivers are short, small and fast-flowing. Rainfall on the ring plain is high and generally plentiful.

By contrast, eastern hill country rivers display a branch-like pattern of drainage. The rivers of the hill country are generally longer than ring plain rivers and are contained by narrow valleys that carry relatively high sediment loads as a result of erosion. Rainfall on the hill country is generally plentiful but lower than the ring plain.

Only 46 (or 21%) of the 217 parent catchments currently have consents for the taking of water. Five Taranaki catchments – the Waiwhakaiho, Waitara, Tangahoe, Pātea and Waitōtara – account for 51% of all the consented water takes.

The Council is responsible for water resource management in their rivers. This involves balancing the two potentially conflicting objectives of safeguarding the ecology of the rivers while managing the efficient allocation and use of water.

The attached report prepared by Dr Jowett entitled *Review of Minimum flows and water allocation in Taranaki* uses data from nine monitoring sites in Taranaki. Each site has a minimum 10 years of hydrological and morphological data, to model the impacts of various combinations of minimum flow and allocation limits on both the levels of protection provided to instream species and the reliability of supply for water users.

The assessment of protection levels in the modelling is based on impacts expected on the benthic invertebrate and fish communities. This was probably the first New Zealand study to examine the combined ecological effects of minimum flows and allocation on these benthic communities.

Benthic invertebrates are used internationally, and in New Zealand, as a measure of ecosystem health. Benthic invertebrates are an important food source for native fish and trout. The macro-invertebrate community index (MCI) is commonly regarded as a measure of ecosystem health and has been identified as the one measure that was most closely related to Māori cultural values[1]. Maintaining a high MCI will also lead to high biodiversity and help meet MCI requirements of the NPS-FM. State of the Environment monitoring data for Taranaki shows widespread improvement in MCI values across the region over the last 20 years.

Native fish and trout can be affected by low flows through a reduction in the amount of suitable habitat if the flows are low for a sufficiently long period. At low flows, the amount of habitat suitable for fish with high flow requirements, such as torrentfish, kōaro and adult trout, declines linearly as flows reduce towards zero. To maintain populations of these fish species with high flow requirement, extended periods of low flows (> 30 day period) should be avoided. Because trout, kōaro and torrentfish have the highest flow requirements of any fish species, flows that maintain adequate habitat for them will be more than adequate for other fish species, such as tuna (eels) and inanga.

The impacts of revised combination of limits on water users is assessed in the report based on the number of days restrictions to takes would occur under various scenarios.

The modelling work presented in the report simulates the expected impacts across the sample of nine Taranaki rivers under various combinations of minimum flow and allocation limits. Minimum flows varying from 50% to 90% of the MALF were tested. A minimum of 66% of the MALF is the existing minimum flow requirement and 90% can be regarded as a level at which there would be no measurable effect. Allocations of 0 to 50% of the MALF were tested. Table 1 below shows a selected range of possible minimum flow and allocation options, based on average benthic and fish protection levels for Taranaki waterways. The options include protection levels achievable under the current RFWP (*status quo*), those proposed under the Draft Plan, and two alternatives.

[1] Tipa & Teirney 2003.

Table 1: Possible choices of minimum flows and allocation and the protection levels that they provide. Protection levels are percentages of benthic invertebrate production or fish habitat relative to invertebrate production and fish habitat at MALF

Description	Minimum flow as % MALF	Allocation volume as % MALF	Benthic invertebrate protection level	Fish habitat protection level	Days of partial restriction per year
Current Plan	66	33[2]	87	77	18
Draft Plan	90	30	93	86	42
Alternative 1	85	40	90	81	46
Alternative 2	80	30	91	83	30

The minimum flow and allocation has a relatively large effect on the number of days that there would be partial restrictions in a fully allocated catchment (see attached Factsheet), with the number of days of restriction more than doubling if a move from the current setting was made to that proposed in the Draft Plan, or Alternative 1 (Table 1). The comparative increases in protection level for the options are not as significant, with the potential reduction in benthic production ranging from 13% under the current plan to 7% under the Draft Plan. The potential effect on fish could be a reduction in numbers of 23% under the current plan, improving to a 14% reduction under the Draft Plan.

The actual effects on the benthic invertebrate community are likely to be less than indicated by the modelling carried out as the effects were calculated assuming that the maximum allowable allocation was abstracted all through the year. This would rarely be the case. Riparian management can also positively affect benthic invertebrates and fish communities by increasing shade to reduce water temperatures and creating cover and habitat diversity for fish. Riparian planting has been used to offset the effects of abstraction in many instances.

The report notes the Alternative Options 1 and 2 (Table 2) and the Draft Plan provisions provide a fish protection level of 80% and above on the basis that a 20% reduction in fish population is probably not detectable and that the reduction would only occur if the fish population were habitat limited. Similarly, a reduction of 10% in the state of the benthic invertebrate community is minor and probably not detectable. To put this in perspective, a fish protection level of 83% and a benthic protection level of 91% (Alternative 2) would reduce the number of large (> 40 cm) trout by approximately one fish per kilometre.

The key to setting minimum flows and allocations that meet community expectations for environmental objectives (i.e. the state of the benthic invertebrate community and fish populations) is to set appropriate protection levels and then to calculate the minimum flow and allocation that would achieve them. The setting of minimum flows and allocation limits is a process that involves the Council and community in order to achieve the best water management outcomes for the region taking into account environmental, cultural and economic considerations. Accordingly, stakeholder involvement is very important in determining the community's preferred option and a series of workshops is proposed to be held to discuss the methods and options provided in this report, particularly the levels of protection, minimum flows and allocation limits. The Council intends to use the report being presented to inform these community discussions from a technical and policy perspective.

The attached Factsheet has been prepared to summarise, for the layperson, key concepts and findings from the report, including policy considerations.

[2] Inferred allocation limit as no limits are specified in the existing plan

Officers propose to circulate the report and a factsheet and convene a series of workshops with key water stakeholders, including major water users, iwi, Department of Conservation and Fish and Game Council to further discuss options and potentially resolve issues with water allocation policy in the region

Decision-making considerations

Part 6 (Planning, decision-making and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the *Act*.

Financial considerations—LTP/Annual Plan

This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

As noted above iwi/hapu engagement will occur through workshops and consultation. The Council intends to further consult on the Draft Plan, including water allocation, Te Mana o te Wai (health and well-being of freshwater bodies) and Mātauranga Māori monitoring methods given these aspects of the NPS-FW are closely related.

It is intended to provide iwi with the opportunity to have a closed workshop session with Dr Jowett to share expertise as part of the process.

Legal considerations

This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Attachments

Jowett, I.G. (2018). Review of minimum flows and water allocation in Taranaki. Doc. 2074019.

Taranaki Regional Council water allocation Factsheet. Doc. 2071758.

Jowett Consulting Limited

Review of Minimum Flows and Water Allocation in Taranaki

Client Report: IJ1702

July 2018

Review of Minimum Flows and Water Allocation in Taranaki

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Prepared for

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Client Report: IJ1702

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Contents

Executive Summary

The National Policy Statement for Freshwater Management 2014 (NPSFM) statement requires regional councils to set environmental flows that include an allocation limit and a minimum flow.

The current Taranaki Regional Council Freshwater Plan (2001) sets minimum flows but does not set quantitative allocation volumes, although there are qualitative measures that have to be considered.

In preparing their Draft Freshwater and Land Management Plan (Draft Plan), the Taranaki Regional Council has considered NPSFM requirements and has undertaken targeted consultation. The Draft Plan sets minimum flows and allocation limits and for most catchments specifies minimum flows and allocation limits that are specified as defaults in the *Proposed NES for Ecological Flows*. It also establishes four freshwater management units (FMU). These are for outstanding water bodies, rivers draining from Mt Taranaki (ring plain), eastern hill country rivers, and coastal terrace streams.

Although there are few major catchments in the Taranaki region, there are more than 500 named rivers and streams, which on the volcanic ring plain are generally short, steep and fast flowing. Of the Taranaki rivers, about 17 have water level records with 10 or more years of record and only nine of these have detailed morphological measurements. Seven of these are in the ring plain and two in the eastern hill country. There are two streams in the coastal terrace FMU with water level records, but their length of flow record is too short to determine flow characteristics for the coastal FMU.. Flows in rivers classified as outstanding water bodies have a high level of protection and only allow minimal abstraction.

A common concern of submissions on the flows and allocation in the Draft Plan was how policies 7.7 (allocation) and 7.8 (minimum flow) worked together, both for environmental protection and their effect on reliability of supply.

This report addresses those concerns by discussing:

- the function of the Council in water resource management,
- research that has been carried out into effects of water abstraction and methods of assessing environmental flow requirements,
- principles involved in setting minimum flows and allocation,
- the technical basis for the minimum flows and allocation limits in the Draft Plan
- flow requirements in a sample of Taranaki rivers, and
- minimum flows and allocations[1] that would provide various levels of environmental protection.

The Taranaki Regional Council is responsible for water resource management in their rivers. This involves balancing the two conflicting objectives of safeguarding the ecology of the rivers while managing the efficient allocation and use of water.

The Draft Plan sets objectives for setting minimum flows and allocation. The key objectives are appropriate use and development, ecosystem health and mauri, natural character, and biodiversity.

Balancing water use with the environmental objectives raises the issue of what flow and/or stream characteristic would be used to determine an acceptable level of ecosystem health, mauri and

[1] in terms of percentage of the mean annual low flow

biodiversity. For the purpose of setting flows, ecosystem "health", mauri and biodiversity is indicated by the state of the benthic invertebrate community and fish population.

A basic concept of a minimum flow is that it should provide an acceptable level of protection for the stream. This is known as "standard setting".

Two standard setting methods for minimum flow tend to be used in New Zealand. These are a percentage of a flow statistic (historic flow method) and retaining a percentage of the habitat available at some index flow.

This report is probably the first New Zealand study to examine the combined ecological effects of minimum flow and allocation on ecosystem health, mauri[2] and biodiversity. Minimum flows and allocations are set to achieve target levels of protection for benthic invertebrate community and fish population (i.e., ecosystem health).

Over the last 20 years, New Zealand has been at the forefront of research into the effects of flow change on aquatic ecosystems and there is a considerable amount of information available on environmental flow requirements and the effects of flow changes.

Benthic invertebrates are used internationally and in New Zealand as a measure of ecosystem health. Benthic invertebrates are the food source for both native fish and trout. Trout abundance is directly related to invertebrate density and benthic invertebrates are most abundant in riffles, where native fish are also most abundant. The macro-invertebrate community index (MCI) is commonly regarded as a measure of ecosystem health and has been identified as the one measure that was most closely related to Maori cultural values[3]. Maintaining a high MCI will also lead to high biodiversity and help meet MCI requirements of the National Policy Statement for Freshwater Management (MfE 2015).

Two types of protection level are used in combination:

- to protect the state of the benthic invertebrate community, and
- to protect the fish community.

The overall effect of the minimum flow and allocation on the state of the benthic invertebrate community is assessed using the benthic production model. This model predicts an index of benthic invertebrate density for selected species with and without abstraction so that the minimum flow and allocation can be based on an appropriate level of retention. The protection level is the predicted benthic invertebrate density with abstractions as a percentage of the benthic invertebrate density with natural flows. The approach taken here is a risk based approach whereby the minimum flow and allocation should not cause unacceptable environmental degradation.

Native fish and trout can be affected by low flows through a reduction in the amount of suitable habitat if the flows are low for a sufficiently long period. At low flows, the amount of habitat suitable for fish with high flow requirements, such as torrentfish, koaro and adult trout, declines linearly as flows reduce towards zero, so that any reduction in long duration low flow has the potential to affect the fish population proportionally. To maintain populations of these fish species with high

[2] Taranaki iwi will be consulted with separately with regards to local meaning and application during stakeholder workshops.

[3] Tipa & Teirney 2003

flow requirement, low flows over a 30 day period (as indicated by the 30-day MALF[4]) should be maintained at an adequate level. Because trout, koaro and torrentfish have the highest flow requirements of any fish species, flows that maintain adequate habitat for them will be more than adequate for other fish species, such as eels and inanga. In some streams, there may be no fish access to the sea because of cliffs and waterfalls. If this were the case the fish protection level could be relaxed.

The key to setting minimum flows and allocations that meet community expectations for environmental objectives (i.e., the state of the benthic invertebrate community and fish populations) is to set appropriate protection levels and then to calculate the minimum flow and allocation that would achieve them. The setting of minimum flows and allocation limits is a process that involves the Regional Council and community in order to achieve the best water management outcomes for the region taking into account environmental, cultural and economic considerations.

Various combinations of minimum flow and allocation levels were applied to a representative sample of nine Taranaki rivers to determine the effect on ecosystem health, as measured by the two types of protection level. Minimum flows varying from 50% to 90% of the MALF were tested. A minimum of 66% of the MALF is the existing minimum flow requirement and 90% can be regarded as a level at which there would be no measurable effect. Allocations of 0 to 50% of the MALF were tested. Currently, there is no allocation limit, although 33% of MALF has been inferred by Council staff. The range of minimum flows and allocation limits presented in this report are broadly based on limits that have been used by regional councils and in the MfE (2008) discussion document.

The Draft Plan sets different minimum flow and allocation limits for flows less than and greater than 5 m^3/s based on recommendations in the *Proposed NES for Ecological Flows*. Of the nine Taranaki rivers modelled, seven had mean flows less than 5 m^3/s and two were slightly higher than 5 m^3/s. Two of the sample rivers were in the eastern hill country (FMU D) and the other seven were ring plain rivers (FMU B). The hydrology, water quality, and benthic invertebrate communities in both FMUs were similar except for slightly lower runoff and greater turbidity in the eastern hill rivers. Thus, there does not appear to be any ecological reason for setting different flows and allocations in these two areas.

Table 1 below shows minimum flow and allocation options based on average benthic and fish protection levels for Taranaki waterways. The options include protection levels achievable under the current Freshwater Plan (*status quo*), those proposed under the Draft Plan, and two alternatives. The alternative choices provide a fish protection level of 80% and above on the basis that a 20% reduction in fish population is probably not detectable and that the reduction would only occur if the fish population were habitat limited. Similarly, a reduction of 10% in the state of the benthic invertebrate community is small and probably not detectable. For example, a fish protection level of 83% and a benthic protection level of 91% would reduce the number of large (> 40 cm) trout from 7.4 per kilometre to 5.9 per kilometre.

Actual effects on the benthic invertebrate community are probably less than would be indicated by the protection levels because the effects were calculated assuming that the maximum allowable allocation was abstracted all through the year and this would rarely be the case.

[4] MALF is the average annual minimum flow calculated as a running mean over a period of days (e.g., 7 day or 30 days)

Table 1: Possible choices of minimum flows and allocation and the protection levels that they provide. Protection levels are percentages of benthic invertebrate production or fish habitat relative to invertebrate production and fish habitat at MALF

Description	Minimum flow as % MALF	Allocation volume as % MALF	Benthic invertebrate protection level	Fish habitat protection level	Days of partial restriction per year
Current Plan	66	33[5]	87	77	18
Draft Plan	90	30	93	86	42
Alternative 1	85	40	90	81	46
Alternative 2	80	30	91	83	30

The minimum flow and allocation has a relatively large effect on the number of days that there would be partial restrictions in a fully allocated catchment, with the number of days of restriction more than doubling in the Draft Plan and Alternative 1. The differences in protection level for the options look relatively small but the potential reduction in benthic production varies between 13% for the Current Plan and 7% for the Draft Plan. Similarly, the potential effect on torrentfish could be a reduction in numbers of 23% for the Current Plan to 14% for the Draft Plan. Trout numbers would also reduce by more than 20%.

There are 45 Taranaki rivers or catchments with consents to abstract water. In these, the total amount of water allocated in the consents is more than 30% of MALF in 36% of the rivers, more than 33% in 27% of rivers and more than 40% of MALF in 24% of rivers. The median amount of water allocated in the consents for Taranaki rivers or catchments is 19% of MALF.

The large abstractions were often from lakes or reservoirs, from streams where there is no access to the sea, or for public water supplies. Although allocation limits of 30-40% of MALF would mean that the limit would be exceeded in some rivers, this does not necessarily mean that there will be a discernible environment effect.

Riparian management can also affect benthic invertebrates and fish communities by increasing shade to reduce water temperatures and creating cover and habitat diversity for fish. Riparian planting has been used to offset the effects of abstraction.

In conclusion, the levels of protection proposed in the Draft Plan and other alternatives proposed in this report represent an increase level of protection from the *status quo* but conversely would represent increased restrictions on consented water users. Accordingly, stakeholder involvement is very important in determining the community's preferred option and a series of workshops will be held to discuss the methods and choices provided in this report, particularly the levels of protection, minimum flows and allocation limits. The Taranaki Regional Council intends to use this report to inform these community discussions from a technical perspective.

[5] Inferred allocation limit as no limits are specified in the existing plan

1 Introduction

Minimum flows in the current Taranaki Regional Council Freshwater Plan (2001) are based on a report by Jowett (1993) which suggested several methods by which minimum flows could be set. The Regional Council decided on a method where the minimum flow retained 66% of the habitat available for adult brown trout and food production available at mean annual low flow (MALF). No quantitative allocation volumes are established in the plan, although there are qualitative measures that have to be considered.

As part of the review of the Freshwater Plan, the Taranaki Regional Council (the Council) has prepared and undertaken targeted consultation on a draft Freshwater and Land Management Plan (Draft Plan) that takes into account the National Policy Statement for Freshwater Management 2014 (NPSFM). The policy in the statement requires regional councils to set environmental flows that include an allocation limit and a minimum flow.

The Draft Plan establishes four freshwater management units (Fig. 1) and sets minimum flows and allocation limits that take into account current water allocations and uses. Supplementary water takes of up to 10% of the flow are also allowed when the river flow is above the median flow. Supplementary takes are not considered further in this report because they are considered to have a minimal effect on river ecology.

Flows in rivers classified as outstanding water bodies (FMU A) are given a high level of protection in the Draft Plan and only allow minimal abstraction.

The Taranaki ring plain (FMU B), centred around Mount Taranaki, is the most populated part of the region and has fertile and free-draining volcanic soils that are well suited to pastoral farming. Dairying is the most common land use and is more intensive on the flatter lands of southern Taranaki. Two ring plain rivers (Hangatahua or Stony and Maketawa) are considered outstanding freshwater bodies and along with the Lake Rotokaire Scenic Reserve form FMU A.

The coastal terraces along the north and south Taranaki coast (FMU C) also have versatile and productive soils. However, the combination of light, sandy soils and strong winds in some localities (e.g. coastal sand country) make them susceptible to wind erosion if vegetation cover is lost.

The hill country, inland of the ring plain and coastal terraces, consists of older rock - siltstone, mudstone and sandstone, known locally as papa. This country is steep, and prone to soil erosion. A large part of the hill country is in public ownership and vegetated in indigenous forest. In other parts, the hill country supports both pastoral farming and commercial forestry.

Annual rainfall varies markedly throughout the region, ranging from less than 1,400 mm in coastal areas, to in excess of 8,000 mm at the summit of Mount Taranaki.

Taranaki has more than 500 named rivers and streams. Over 300 rivers and streams flow from the flanks of Mount Taranaki in a distinctive radial pattern across the ring plain. Typically ring plain rivers are short, small and fast-flowing.

By contrast, the eastern hill country (FMU D) displays a branch-like (dendritic) pattern of drainage. The rivers of the hill country are generally longer than ring plain rivers and are contained by narrow valleys that carry relatively high sediment loads as a result of hill country erosion.

The Waitara River is the largest river in the region a mean flow of 58 m^3/s at Bertrand Road. The Patea (mean flow 29 m^3/s at McColls Bridge) and Waiotara are two other rivers that could be considered large (mean flow > 10 m^3/s).

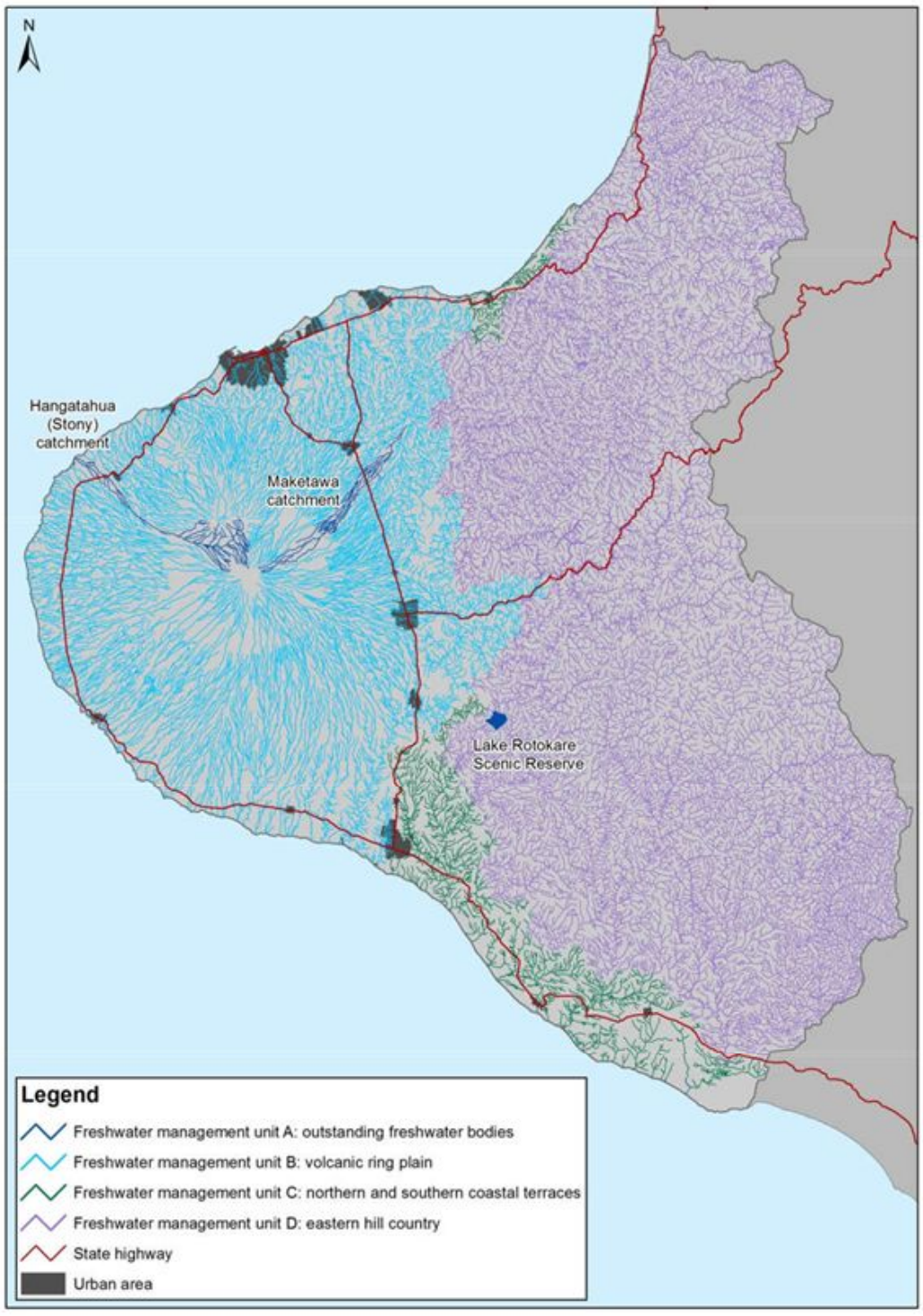


Figure 1: Proposed Freshwater Management Units for Taranaki

Of the Taranaki rivers, about 17 have water level records with 10 or more years of record and only nine of these have detailed morphological measurements. There are only two streams in the coastal terrace FMU with water level records. One, the Kaikura Stream, is in the southern coastal terrace and has been operating since 2014, and the other is in the northern coastal terrace and has been operating for 8 months. There is no morphological data for these streams and their records are not sufficiently long to determine flow characteristics of coastal terrace streams.

The flow regime of Taranaki rivers is dominated by frequent storms from the west and north and these usually affect ring plain, coastal and eastern hill country river. Consequently runoff from rivers exposed to the north-west is higher than those in the south and east although the general pattern of flows is similar. For example, the Waiwhakaiho River is a high runoff ring plain river draining the north-west of Mt Taranaki and the Kaupokonui is a ring plain stream draining the south of Mt Taranaki. The Mangaehu Stream is a tributary of the Patea River draining the eastern hill country river to the east of Mt Taranaki. 2013 was a relatively dry year and the pattern of flows is similar in all rivers (Fig. 2) although runoff (L/s/km^2) is higher and freshes more frequent in the Waiwhakaiho than in the other two rivers. The Pearson correlation between the eastern hill country river (Mangaehu) and southern ring plain river (Kaupokonui) is higher (0.74) than the correlation between the Mangaehu and Waiwhakaiho (0.54).

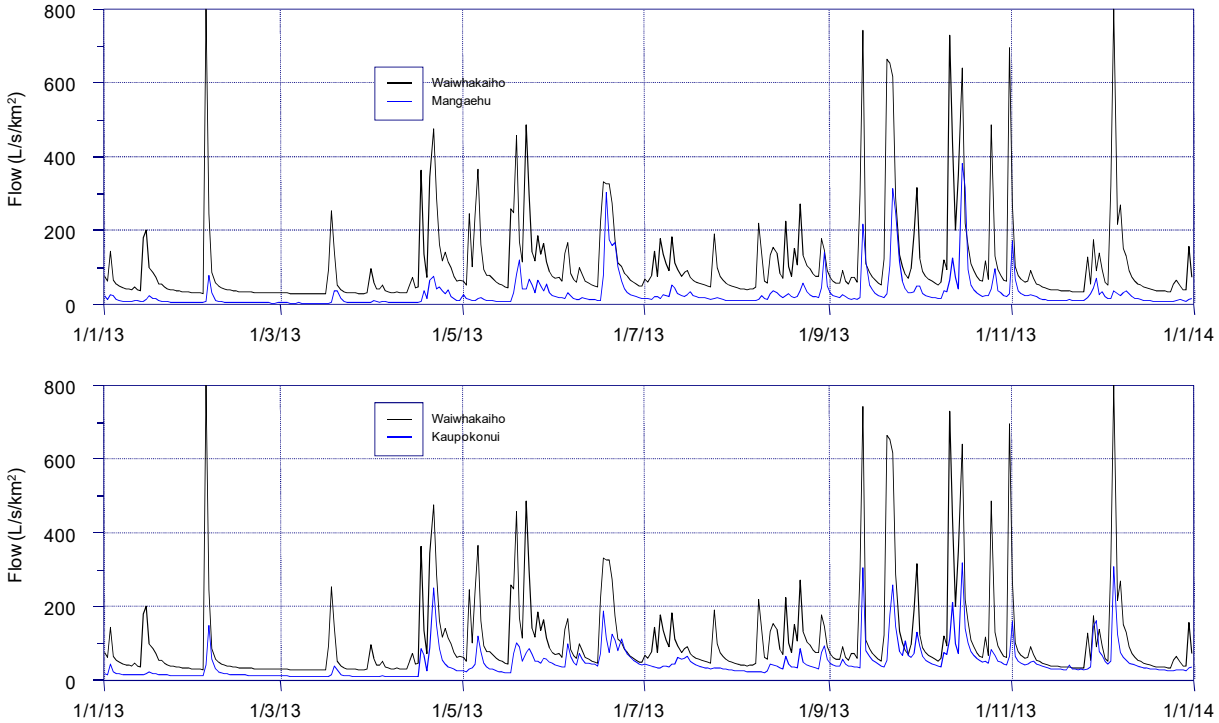


Figure 2: 2013 flows in the Waiwhakaiho River and Mangaehu Stream (above) and Waiwhakaiho and Kaupokonui rivers below.

For most catchments, the Draft Plan specifies minimum flows and allocation limits set as defaults in the Proposed NES for Ecological Flows (MfE 2008). However in some catchments with existing takes and high water use, the Draft Plan set limits reached through the prehearing process with stakeholders associated with resource consents. Almost all these cases have involved nationally or regionally significant water takes, such as urban supply or hydroelectricity generation.

Some submissions to the Draft Plan have questioned or requested more information on the methods used to determine the minimum flows and allocation limits.

In order to provide more information for submitters and to inform the plan and section 32 review this report describes the:

- function of the Council in water resource management,
- research that has been carried out into effects of water abstraction and methods of assessing environmental flow requirements,
- present method of minimum flow assessment and some principles involved in setting minimum flows and allocation,
- the technical basis for the minimum flows and allocation limits in the Draft Plan, and finally
- it examines flow requirements in a sample of Taranaki rivers and determines minimum flows and allocations that would provide various levels of environmental protection.

2 Planning framework

Amongst their many responsibilities, the Taranaki Regional Council is responsible for water resource management in their streams and rivers.

The Resource Management Act (RMA) and National Policy Statement for Freshwater Management (NPSFM) give some guidance with broad objectives to:

- safeguard the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems of fresh water, in sustainably managing the taking, using, damming, or diverting of fresh water, and
- improve and maximise the efficient allocation and efficient use of water.

The NPSFM (MfE 2017a) sets compulsory values of ecosystem health and human health for recreation. The attributes of ecosystem health given in the report are periphyton and water quality (nitrate, ammonia, dissolved oxygen and E. coli).

Flow related attributes receive little mention in the NPSFM although the macroinvertebrate index[6] (MCI) is included in monitoring. Regional council monitoring methods must include the MCI. Low scores or declining trends would indicate that ecosystem health is not being provided for. The report considered that it was not possible to define a nationally applicable attribute state for MCI because it varies significantly depending on local conditions (MfE 2017b). A similar comment could be made for fish and other aquatic biota that are likely to be affected by flow changes.

In practically all cases, abstraction of water from a river will have some detrimental effect on the aquatic ecosystem, although often the effect will be small and not measurable. The Council is required to find a balance between water use and environmental protection of the rivers and lakes. The "balance" is not determined by any cost-benefit study but rather by setting an appropriate level of environmental protection. Ideally, this level of protection is set by the Council in consultation with its stakeholders. In this process, the Council should not be an advocate for either water users or protection and as such is likely to be criticised by both sides of the debate.

[6] The MCI was originally developed by Dr John Stark when he was working with the TRC and there is much data available.

The Resource Management Act is "effects based" and resource consents are required to consider the effects of their activity. Similarly, Council decisions on minimum flows and allocation should consider actual and potential effects on the environment.

The minimum flows in the present Freshwater Plan were developed in 1993, and methods for assessing minimum flows and their associated standard of protection have developed since then. A series of reports have been produced beginning with the flow guidelines in 1998 (MfE 1998) and followed by a review of methods for setting minimum flows for the Southland Regional Council (Jowett & Hayes 2004), supporting technical reports for Horizon's One Plan (Hay & Hayes 2007) and the proposed National Environmental Standard (NES) for ecological flows (MfE 2008) and its associated technical report (BECA 2008).

Most of these reports discuss methods for determining the effects of minimum flows and only the proposed NES for ecological flows specifies actual minimum flows and allocation limits. One reason why technical reports do not specify actual minimum flows is that the selection of an appropriate minimum flow is a process that involves collaboration between the stakeholders which technical experts can assist by providing assessments of the effects of the various alternatives.

Minimum flows are set by rules rather than methods. The well-known Tennant or Montana method sets rules for various levels of protection, such as a minimum flow of 30% of the mean flow to provide near optimum conditions[7]. These rules were based on a method which determined that 30% of the mean flow provided water depths of more than 0.6 m and velocities of more than 0.6 m/s.

What is an environmental flow? In this report, an environmental flow is synonymous with the minimum flow. The minimum flow of a river is the flow at which most consent holders are required to cease abstraction. Naturally occurring low flows can be less than "the" minimum flow. The minimum flow is also used for the flow that is required to be discharged below a diversion - also called the residual flow. An ecological flow is a flow requirement for ecological purposes. An environmental flow regime is the flow regime that is required to maintain the stream environment (Biggs et al. 2008; Jowett & Biggs 2008). It would usually contain a minimum flow requirement as well as requirements that maintain a degree of flow variability including flushing (e.g. fine sediment and periphyton) and channel maintenance flows.

What is an allocation limit? The National Policy Statement for Freshwater Management 2014 requires regional councils to set environmental flows that include an allocation limit and a minimum flow. The reports mentioned above have focussed on minimum flow requirements with very little discussion of the effects of total allocation. The allocation in any consents is usually for the maximum take and the sum of maximum takes for all consents is the total allocation. In practice, most consent holders only abstract at a maximum rate for a short period of time. For example, irrigation takes only take water in the summer and only at peak rates when it is necessary. Actual takes are usually about 50% of the total allocation (MfE 2015). Total allocation, as specified in consents, is almost always higher than actual takes to allow for climatic and other forms of variation such as varying seasonal demands.

[7] Tennant's winter recommendation. In Montana winter is the season of low flows.

Supplementary allocation is the amount of water than can be taken when river flows are higher than normal[8] and are usually for purposes such as filling storage dams. Supplementary takes are considered to have a minimal effect on river ecology.

3 Methods for determining minimum flow and allocation

3.1 Review of Regional Council minimum flow methods

The first study of minimum flow requirements for the Taranaki region was carried out by Jowett (1993). He prepared a report for the Council outlining methods that could be used to determine minimum flows. Instream habitat surveys[9] were made of 11 rivers[10] which had a good degree of variation in size and gradient. Two methods were suggested both based on adult brown trout habitat at mean annual low flow (MALF) and food producing habitat. These habitat criteria were used because a nationwide study of brown trout abundance (Jowett 1992) had shown that these two factors were very important determinants of trout abundance and were the only factors that could be found that varied with flow. The 1992 study also identified benthic invertebrate density as the single most important factor related to brown trout abundance. At the time of the study habitat criteria were not available for native fish. Some options for determining the measures and levels of protection were presented in the report and the Council decided to use the habitat retention method which limited the amount of change caused by flow abstraction. For habitat retention, Jowett (1993) assumed a level of protection of one-third loss (i.e., retention of two-thirds) compared to MALF for food producing or brown trout habitat at naturally occurring low flows, but noted that there was no way of scientifically selecting a percentage loss of "natural" habitat which would be considered acceptable. The criteria applied to these Taranaki rivers were not solely for trout and the report noted that "consideration of food producing habitat is or should be common to all rivers, whether it is to maintain native fish, brown or rainbow trout or to maintain a "healthy" stream environment". The adult trout and food producing criteria specify that relatively deep and swift water is the most suitable habitat. When these criteria are applied to small streams and rivers the flow that retains two-thirds of the trout and food producing habitat available at MALF is essentially two-thirds of MALF.

Habitat suitability curves for native fish were developed subsequent to the 1993 study (Jowett & Richardson 1995; Jowett & Richardson 2008) and some Regional Councils began to use these as a means of determining minimum flows. The analyses for these methods are relatively complicated and often required field surveys. For example, the Bay of Plenty Regional Council, specified levels of protection based on the fish species present in the stream and required the minimum flow to retain the maximum level of protection (Wilding 1999). Jowett & Hayes (2004) suggested a similar method for the Southland Regional Council but based their levels of protection on categories based on instream values, essentially the "target" fish species and their perceived value. These methods can be based on either detailed instream habitat surveys (e.g., System for Environmental Flow Analysis, SEFA) and habitat suitability curves, quick surveys (WAIORA), or river information from a GIS type system (NIWA's River Environment Classification) and generalised habitat suitability curves.

[8] Usually median flow

[9] Instream habitat surveys are detailed measurements of water depths and velocities at closely spaced points across pools, runs, and riffles in a section of river. The surveys are calibrated so that they can be used to predict depths and velocities at other flows which in turn can be used to predict changes in habitat.

[10] Waiwhakaiho at SH3, Stony at Okato, Manganui at Tariki Road, Patea at Stratford, Kaupokonui at Skeet Road, Waingongoro at Eltham, Waiongana at SH 3A, Kapuni at SH 45, Mangoraka at Corbett Road, Kapoaiaia at Lighthouse, Tawhiti at Duffys Farm

A number of Regional Councils use minimum flows based on simple hydrological data such as the 5-year low flow or 90% of the 5-year low flow.

Biologically based rules-of-thumb, such as Tennant's method, do not appear to be used at present.

3.2 Research on the effects of water abstraction

Over the last 20 years, New Zealand has been at the forefront of research into the effects of flow change on aquatic ecosystems and there is a considerable amount of information available on environmental flow requirements and the effects of flow changes. The key milestones would be the first instream habitat survey of the Tekapo River in 1979 (Jowett 1982), the "100 rivers survey" (Biggs et al. 1990), development of habitat suitability curves (Hayes & Jowett 1994; Jowett & Richardson 2008), long term studies of fish populations in the Kakanui, Waipara and Rainy rivers (Hayes 1995; Jowett 1995; Jowett et al. 2005), case studies of the effects of flow change (Jowett & Biggs 2006), benthic production models (Hayes et al. 2014) and bioenergetic models (Hayes et al. 2016).

3.2.1 Relationship between flow and ecology

The flow regime has three components that control aquatic biota (fish, benthic invertebrates and periphyton) (Biggs et al. 2008; Jowett & Biggs 2008). The three components are:

1. the magnitude, duration and frequency of low flows,
2. the frequency and magnitude of floods and freshes, and
3. flows between the extremes, often represented by the median flow.

Although all three components have some effect on fish, invertebrates and periphyton, the degree to which component exerts the most control depends on the life cycle of the biota.

Low flows act as a "habitat bottleneck" for long-lived biota such as trout and native fish. This is because mortality occurs when flows are low and suitable fish habitat restricted, and the population can take several years to recover (Jowett et al. 2008). Flows need to be low for some time, probably 30 days or so, for significant mortality to occur (Jowett et al. 2005). The recovery of a population from a low flow event depends on the life cycle. For trout, the population recovers in 3 or so years if trout spawning is successful (Hayes 1995). For native fish, most species recover in a year. However, if low flows occur year after year then those flows will limit the populations, and in the case of native fish, supply of larvae to the seas around New Zealand would be reduced leading to a general decline in national populations. Hence the concept that the MALF, the low flow that occurs every second year or so, is a limiting hydrological parameter for fish populations (Jowett et al. 2008).

The frequency of floods and freshes is most important for periphyton because the velocities and the bedload movement that occurs during these events clean periphyton from the stones of the stream bed. Periphyton growth begins almost immediately after a flood with the growth rate depending on factors such as water temperature and nutrient levels (Jowett & Biggs 1997). The disturbance of the stream bed during floods also reduces benthic invertebrate densities, and their recovery is not as fast as that of periphyton. Trout can also be affected by large floods (Jowett & Richardson 1989), especially during incubation and emergence (Jowett 1995; Hayes 1995).

The flows between the extremes of low flows and flood flows influence the productivity of the stream for benthic invertebrates. As flows increase, benthic invertebrate populations increase with the improvement in habitat. The trout population will also be affected by the productivity of the stream, with the trout densities increasing as the invertebrate production increases (Jowett 1992).

Ideally, long-term solutions to river flow management need to take a holistic view of the river system, including geology, fluvial morphology, sediment transport, riparian conditions, biological habitat and interactions, and water quality, both in a temporal and spatial sense. In practice, only projects with a high degree of hydrologic alteration, such as major diversions and dams, require detailed consideration of all of these river processes.

Rivers can also be improved by means other than flow management. Riparian planting and improvements to water quality are examples of two ways in which the aquatic ecosystem can be improved as discussed more fully later.

3.2.2 Assessment of environmental flow requirements

The instream flow incremental methodology (IFIM; Bovee 1982) is an example of an interdisciplinary framework that can be used in a holistic way to determine an appropriate flow regime by considering the effects of flow changes on instream values, river morphology, physical habitat, water temperature, water quality, and sediment processes (Fig.3). Its use requires a high degree of knowledge about seasonal and life-stage requirements of species and inter-relationships of the various instream values or uses.

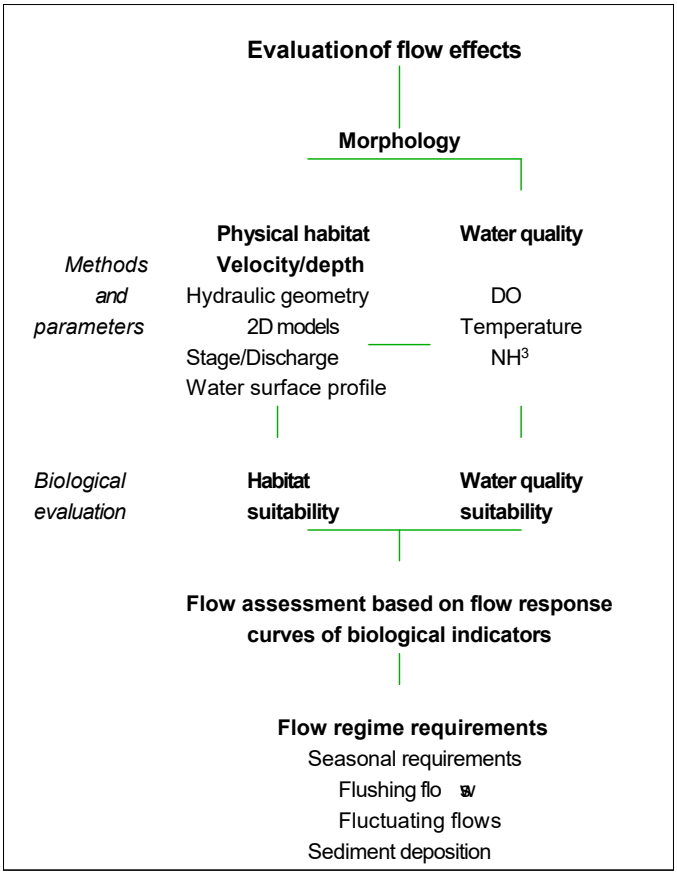


Figure 3: A framework for the consideration of flow requirements.

Other flow assessment frameworks are more closely aligned with the "natural flow paradigm", a concept that emphasises the need to partially or fully maintain or restore the range of natural intra- and interannual variation of hydrologic regimes in order to protect native biodiversity and the evolutionary potential of aquatic, riparian and wetland ecosystems (Poff et al. 1997). The range of

variability approach (RVA) and the associated indicators of hydrologic alteration (IHA) allow an appropriate range of variation, usually one standard deviation, in a set of 32 hydrologic parameters derived from the 'natural' flow record (Richter et al. 1997). The implicit assumption in this method is that the natural flow regime has intrinsic values or important ecological functions that will be maintained by retaining the key elements of the natural flow regime. Arthington et al. (1992) described a holistic method that considers not only the magnitude of low flows, but also the timing, duration and frequency of high flows. This concept was extended to the building block methodology (BBM), which "is essentially a prescriptive approach, designed to construct a flow regime for maintaining a river in a predetermined condition" (King et al. 2000). It is based on the concept that some flows within the complete hydrological regime are more important than others for the maintenance of the river ecosystem, and that these flows can be identified and described in terms of their magnitude, duration, timing, and frequency.

A holistic consideration of every aspect of flow and sediment regime, river and riparian morphology, and their associations with the life cycles of the aquatic biota requires a degree of knowledge about individual rivers that is rarely available. The aim of the minimum flow is to retain adequate water depths and velocities in the stream or river for the maintenance of the critical values. Most flow assessments and habitat suitability criteria consider physical habitat at a meso- to macro-habitat level rather than microhabitat. In this way, suitable average depths and velocities can be maintained in the main habitats, with a degree of habitat diversity that is generated by the morphology of the river, and is largely independent of flow. The geomorphological and flow-related ecological processes that are associated with low to median flows are generally taken into consideration in instream flow methods. However, fish passage or seasonal flow requirements may need to be investigated in situations where fish passage may be an issue or where the species has distinct seasonal habitat requirements. Consideration should also be given to downstream effects. The effect of an abstraction is usually greatest immediately below the abstraction site, but diminishes as the river flow is supplemented by contributions from tributaries and the proportional change in flow reduces.

Commonly used methods of setting minimum flows can be classified into two basic types; historic flow and hydraulic-habitat methods.

Historic flow methods are coarse and largely arbitrary. An ecological justification can be argued for the mean annual low flow (MALF) and retention of the natural flow regime, and the concept of a low flow habitat bottleneck for large brown trout has been partly justified by research (e.g., Jowett 1992), but setting flows at lower levels (e.g., the 5 year 7 day low flow — $Q_{7,5}$) is rather arbitrary.

Hydraulic-habitat methods have a direct link to habitat use by aquatic species. They predict how physical habitat (as defined by various habitat suitability models) varies with flow, and the shapes of these curves provide the information that is used to assess flow requirements. Habitat based methods allow more flexibility than historic flow methods, offering the possibility of allocating more flow to out-of-stream uses while still maintaining instream habitat at levels acceptable to other stakeholders (i.e., the method provides the necessary information for instream flow analysis and negotiation).

3.2.3 Instream habitat methods

The ecological goal of habitat methods is to provide or retain a suitable physical environment for aquatic organisms that live in the river. Habitat methods tailor the flow assessment to the resource needs and can potentially result in improved allocation of resources. The consequences of loss of

habitat are well known; the environmental bottom line is that if there is no suitable habitat for a species it will cease to exist. It is essential to consider all aspects such as food, shelter, and living space (Orth 1987; Jowett 1995) and appropriate habitat suitability curves are the key to the successful application of habitat based methods. The procedure for calculating habitat suitability and deriving the relationship between flow and habitat is described in Appendix I.

Habitat methods can also be used to determine flow regime requirements, in terms of both seasonal variation and flow fluctuations. Flow fluctuations are an important component of the habitat of most naturally flowing streams. Such fluctuations remove excess accumulations of silt and accumulated organic matter (e.g., from algal mats) and rejuvenate stream habitats. Extended periods without a flow disturbance in the Waipara River resulted in either an increase or no change in benthic invertebrate density with little change benthic community composition (Suren & Jowett 2006).

NIWA is developing a tool to use GIS type data (River Environmental Classification) to estimate morphological characteristics of streams and then to apply generalised models (Booker 2016).

Generalised curves are based on the analysis of flow-habitat relationships in a large number of New Zealand rivers. The flow-habitat relationships in this analysis are made dimensionless by plotting the average habitat index for each species against the flow per unit width of river (Lamouroux & Jowett 2005). Thus, if the variation of width with flow is known, it is possible to predict the generalised habitat-flow relationship. The application of generalised habitat models is simpler than instream habitat analysis and both rely on actual field measurements of stream morphology. The application of generalised curves is not advised for rivers with unusual morphology, such as braided and spring-fed (Jowett et al. 2008).

Instream habitat models can be incorporated into models of abundance, as described in Section 3.2.6, and these can give better estimates of the effects of flow on trout and benthic invertebrates than simple habitat models.

3.2.4 Instream habitat validation studies

Instream habitat analysis is widely used around the world (Tharme 1996) and the computer programme used for this analysis (SEFA and its predecessor RHYHABSIM) is used in many countries . The concept is simple. Water depths and velocities are predicted by a hydraulic model and the suitability of depths and velocities is assessed by comparing them with the depths and velocities that are used by the various fish species.

The strength of instream habitat analysis is that it is based on empirical data (rating curves derived from measurements of flow and water level) for the prediction of depths and velocities. Habitat suitability curves are (or should be) based on empirical measurements of density or presence absence of biota. An instream habitat analysis predicts the depth and velocity of each point in the river and evaluates its suitability. Hence, the combination of the hydraulic modelling and a habitat suitability curve should predict where biota are most likely to be found and the overall suitability of various flows for those biota. A simple test is to determine the suitability of various flows using instream habitat methods and then to observe whether those flows provide the conditions in which you are likely to find the biota. The flow in the Ohau River below Lake Ohau was set to provide good trout habitat and it is generally accepted that the flow does provide good habitat. Similarly flows in the Tekapo and Waiau rivers were set to provide good trout and food producing habitat and both maintain good invertebrate and trout populations despite the large reductions in flow.

The use of RHYHABSIM in New Zealand has been tested in a number of studies. Mosley & Jowett (1985) showed that the model was capable of predicting water depths and velocities in the Ashley River and Jowett & Duncan (2011) showed that the model could predict depths and velocities in the braided Hurunui River.

The brown trout regression model (Jowett 1992) uses trout and food producing habitat (as well as some other variables that do not vary with flow) to predict trout densities in NZ rivers. The model explained 87.7% of the variation in brown trout abundance at 59 sites in 57 different rivers around NZ. In those rivers there was a significant correlation between trout density and adult trout habitat (Jowett et al. 2008). In another test, the model predicted the distribution of brown trout in the Kakanui River (Jowett 1995). The regression model showed that both brown trout habitat and food producing habitat are required to predict trout abundance and that the flow requirements of food producing habitat are greater than those for adult trout habitat.

Jowett et al. (2008) showed that the ecological effects of flow regime changes in 6 rivers on trout, native fish or benthic invertebrates were consistent with instream habitat analyses. In the Waiau River an increase in flow increased trout numbers and that state of the fishery appears to be similar to that when the river flow was very much higher. In the Monowai River an increase in flow from 0.2 m^3/s to 6 m^3/s doubled invertebrate density and taxa richness. In the Moawhango River, an increase in residual flow from near zero to 0.6 m^3/s resulting in an invertebrate population similar to that above the flow modifications. When the 7 day annual minimum flow reduced from 66 to 20 L/s in the Onekaka River, there was a 61% reduction in koaro low flow habitat and a corresponding reduction of 80% in koaro numbers. Similarly, longfin eel numbers reduced by 52% compared to a 33% reduction in low flow habitat. Redfin bully numbers were low and variable and there was no obvious reduction in their numbers despite a 40% reduction in habitat.

The response of koaro to the flow change in the Onekaka River was similar to that observed for fast water species in the Waipara River (Jowett et al. 2005). In the Waipara River, torrentfish and bluegill bully numbers declined when flows were low for 30 days or more, but there was little effect on the numbers of Canterbury galaxias and upland bullies. The 3 year study of native fish in the Waipara River concluded that prolonged low flows reduced the abundance of fish species that prefer high water velocities, and favoured those that prefer low velocities. During periods of low flow, proportionally more fish were found in riffles than runs, implying that riffle habitat is important in the maintenance of fish stocks and biodiversity during periods of low flow. The key elements of the flow regime were the magnitude and duration of low flows, as well as the occurrence of spring floods that allowed recruitment of diadromous species[11] (Jowett et al. 2008).

3.2.5 Habitat observations

Suitable habitat is a necessary requirement for all aquatic species to live in rivers. Habitat requirements are usually relatively broad because narrow requirements would severely limit the establishment of an aquatic species. Habitat suitability is defined by observing the locations occupied by a species in a large number of streams and rivers. The definition can be based on meso-habitat types, such as pools, runs and riffles or on measures of physical habitat such as substrate type, depth and velocity. The description can also be widened to cover any attribute of a stream and river that contributes to the suitability for a particular species. The presence of cover elements for trout is one example.

[11] Species that migrate between the sea and freshwater as a necessary part of their life cycle

Benthic invertebrates and many species of native fish are most abundant in riffles (Pridmore and Roper 1985; Brown & Brussock 1991; Jowett & Richardson 1995). Jowett & Richardson (1993) showed that pools, runs and riffles could be classified by Froude number [12] and that the density of benthic invertebrate species was generally highest in depths and velocities classified as riffle habitat.

Habitat suitability is defined by the relative density of a species. The density is highest in the most suitable habitat, and the density is lowest or zero in the least suitable habitat.

For some species, it is easy to measure their density at a number of locations and to derive suitability criteria from that data. For other species, such as large trout, it is not practical to measure their density at a location. When living in a river, trout select specific locations for feeding, such as in runs or the heads of pools. Their habitat selections are determined by measuring the locations of a large number of trout. When these locations are and compared to the habitats that are present in the river, it is possible to calculate the density of trout in the various habitats and thus determine habitat suitability. Observations of brown trout behaviours while drift-diving Taranaki rivers (Teirney & Jowett 1990) did not indicate that they were behaving differently to brown trout in rivers used to define habitat suitability (Hayes & Jowett 1994).

Water velocity is probably the most important characteristic of a stream. Without it, the stream becomes a lake or pond. In small gravel bed rivers, an average velocity of at least 0.2-0.3 m/s tends to provide for most stream life. Velocities lower than this are unsuitable habitat for many fish species and stream insects, and allow deposition of sand and finer materials which is also unsuitable habitat. In large rivers, water depth of more than 0.4 m provides habitat for swimming species, but benthic fish are often found in shallower water.

The magnitude of the flow that provides good quality habitat will vary with the requirements of the species and with the morphology of the stream. Gradient is important because it determines stream energy. High energy streams contain a high proportion of riffle habitat and because of this they are more resilient to flow reduction than low gradient streams. The way in which depth and velocity change with flow tends to vary with the gradient. When flows reduce in a low gradient stream the reduction in water level is small compared to the reduction in velocity and velocities decrease faster than depths. In high gradient streams both water level and velocity tend to fall together so that the energy, as measured by the velocity to depth ratio or Froude number, tends to remain high.

The flow at which limiting conditions of depth and velocity occur varies with stream morphology. Generally, minimum flow increases with stream size simply because stream width increases with stream size. However, the relationship is not linear. In general, small streams require a higher proportion of the natural stream flow to maintain minimum habitat than do large rivers. This is because habitat modelling in small streams shows that a reduction in flow usually results in a similar reduction in habitat. However in large rivers, habitat modelling indicates that the reduction in habitat is often less than the reduction in flow. The boundary between small and large is probably in the order of 5-10 m^3/s, but this could vary depending on the species present in the river.

[12] Velocity divided by the square root of the product of depth and acceleration due to gravity

Brown trout

There are three sets of habitat suitability curves for adult brown trout based on data collected in New Zealand rivers. These were in Mataura[13], Travers[14], and Mohaka[15], in the Gowan River[16], and in the Clutha River[17] at the Lake Wanaka outlet .

The first study involved observing adult brown trout feeding locations in three rivers. This showed that the trout had selected similar locations in all three rivers (Hayes & Jowett 1994). Adult brown trout curves were derived from those data and showed an optimum velocity of 0.3-0.6 m/s.

Trout were surveyed in the Clutha River just below the Lake Wanaka outlet. A total of 51 adult brown trout were observed and the average depth and velocity of their locations were 3 m and 0.57 m/s, respectively. The habitat suitability curve derived from the Clutha data has an optimum velocity of 0.47-0.52 m/s (Jowett & Davey 2007, Jowett et al. 2008).

The Gowan River is a lake outlet with mostly boulder substrate, but is shallower than the Clutha River at the Lake Wanaka outlet. It has high water velocities and supports a very high trout numbers. It. Twenty-one adult brown trout were observed in the Gowan River in an average mean water column velocity of 0.69 m/s (range 0.25 m/s to 1.46 m/s). The average velocity at the fish location in the water column (velocity at the nose of the fish) was 0.34 m/s (range 0.06 m/s to 0.76 m/s) and the habitat suitability curve derived from these data has an optimum velocity of 0.6 m/s.

There is general agreement internationally on trout spawning requirements and in NZ brown trout spawning curves from Shirvell & Dungey (1983) are generally used.

Rainbow trout

There are three sets of suitability curves for rainbow adult trout based on observations in New Zealand rivers. These are based on measurements in the Tongariro, Clutha, and a set of Hawke Bay rivers.

The Tongariro data is based on trout angling locations identified by two experienced angling guides. These locations were surveyed and habitat suitability curves derived (Jowett et al. 1996).

A total of 104 large adult rainbow trout and about 80 medium rainbow trout were observed in the Clutha River at the Lake Wanaka outlet. The average depth and velocity of the location of the large trout were 2.95 m and 0.91 m/s, respectively. The habitat suitability curve derived from the Clutha data has an optimum velocity of 0.6 m/s. The velocities used in habitat analyses are the mean column velocities (velocity averaged over the full water depth) because this is the water velocity predicted by 1D and 2D hydraulic models. In the Clutha River, rainbow trout were found in mean water column velocities in excess of 1.2 m/s. However, the trout were actually near the bed of the river where the velocity would be less.

Habitat use by large and medium rainbow trout has also been surveyed in Hawke Bay rivers (88 trout in Ngaruroro and 114 in the Tutaekuri). The optimum depths and velocities for the(provisional)

[13] Southland
[14] Nelson Lakes National Park
[15] Drains Kaimanawa Forest park to Hawkes Bay
[16] Outlet from Lake Rotoaira, Nelson Lakes National Park
[17] Otago

suitability curves derived from these data have optimum depths and velocities of >0.53 m and 0.33 to 0.8 m/s, respectively (Hayes & Addley 2013).

Native fish

Native fish are generally found in relatively low velocities compared to benthic invertebrates and adult trout. In large rivers, most species live along the margins of runs and riffles where depths are less than 0.5 m. In smaller rivers, they will be found across the width of the river in runs and riffles. Habitat suitability dictates where they will be found. As the velocity in runs falls, the fish will tend to move into riffles where velocities are higher (Jowett et al. 2005). As the flow changes in a river, they can also move laterally into areas with more suitable velocity (Jowett & Richardson 1994).

Longfin eels have been described as ubiquitous (Jowett & Richardson 1995), and although they are diadromous, their climbing ability allows them to gain access to the headwaters of most New Zealand rivers, often beyond the reach of other diadromous species.

Shortjaw kokopu, koaro, redfin bully, and banded kokopu have good climbing ability and occur relatively frequently with one another. Small bush-covered streams are the preferred habitat of these four communities (McDowall 2000). Banded kokopu streams contain pool habitat whereas koaro are usually in cascade habitat.

Shortfin eel, inanga, and torrentfish are usually found at lower altitudes than the shortjaw kokopu, banded kokopu, and redfin bullies. Inanga in particular are found at very low altitudes. Inanga streams typically have low velocity water for feeding (Jowett 2002) and a relatively high percentage of pool habitat.

Shortfin eels are found in farmed catchments rather than native bush and are often associated with silty substrate. Torrentfish live in riffles in open riverbeds (McDowall 2000). Riffles are also the preferred habitat of bluegill bullies. The non-diadromous Crans bully occurs only in the North Island (McDowall 2000) and usually well inland. It is absent from the Bay of Plenty and East Cape.

Suitability curves

Fish densities were measured at 5,184 locations in 124 rivers along with measurements of depth, velocity and substrate at each sampling location to define native fish and juvenile brown trout habitat suitability curves (Jowett & Richardson 2008). The results of this large sampling effort were similar to the results of sampling fish in runs and riffles in 34 rivers (Jowett & Richardson 1995).

Habitat suitability curves are available for longfin and shortfin eels in two size categories, <300 mm and > 300 mm. These curves are based on data collected by electro-fishing during the day and show that small eels are usually found in shallow water and low to moderate velocities; larger eels are found in deeper water. During the day, large eels are usually in cover in the form of large instream debris or overhanging banks. Although the water velocity in cover locations is near zero, the velocity associated with large eels refers was measured where the eels were captured after they were drawn from cover by electro-fishing.

During the night, eels emerge from cover and forage for food. Jowett & Richardson (2008) compare day and night habitat use by eels in the Waipara River (Table 2) and these show that the larger eels forage in shallow water (c. 0.25 m) with moderate velocities (riffle habitat) and that small eels may move into water with slightly shallower water (c. 0.16 m) with lower velocities (0.18 m/s). This study also showed that other native fish species occupied shallower water and lower velocities during the

night than during the day (Jowett & Richardson 2008). The differences in day and night habitat for these species indicate that the flow requirements for day habitat would be greater than flow requirements for night habitat.

Table 2: Comparison of average day (394 sites) and night (612 sites) velocity and depth values for eels collected in the Waipara River, January and March 2005.

Species	Time	Velocity (m/s)	Depth (m)	N
Longfin eel	Day	0.25	0.41	14
	Night	0.15	0.25	76
Shortfin eel (<300 mm length)	Day	0.26	0.25	45
	Night	0.18	0.16	224
Shortfin eel (>300 mm length)	Day	0.17	0.60	69
	Night	0.33	0.22	223

Eel locations at night were also determining by spotlighting in the Waipara and Selwyn rivers. The average depth and velocity in which eels were found was 0.3 m and 0.33 m/s, respectively.

Benthic invertebrates and food production

Although many samples of benthic invertebrates have been collected in New Zealand rivers, few record the water depths and velocities in which the samples were collected and often sampling is standardised by sampling in consistent depths and velocities. The following studies have collected benthic invertebrate samples in a variety of depths, velocities and substrates.

Benthic invertebrates were surveyed in the Mohaka, Mangles, Waingawa and Clutha rivers (a total of 334 samples). Jowett et al. (1994) found that *Coloburiscus humeralis*, *Zelandoperla* spp., and *Aoteapsyche* spp. preferred coarse substrate and water velocities of more than 0.75 m/s. Invertebrate data suitable for the derivation of habitat suitability has also been collected in the Waitaki River (178 samples), Whanganui rivers (238 samples), Whatawhata streams (99 samples), Rainy River (393 samples), and Tongariro River (83 samples).

At present habitat suitability curves are available for the Mohaka, Mangles, Waingawa and Clutha rivers, for the Waitaki and for some species in the Rainy River. The Waitaki curves do not specify any depth suitability, although underwater observations in the river indicated that there might be some reduction in invertebrate density with depth.

Habitat suitability for benthic invertebrates appears to vary with river size (Jowett 2000) but Jowett (2003) was unable to find a consistent predictor of suitability in rivers of different sizes, although there appears to be a relationship with mean river velocity and depth (Fig. 4).

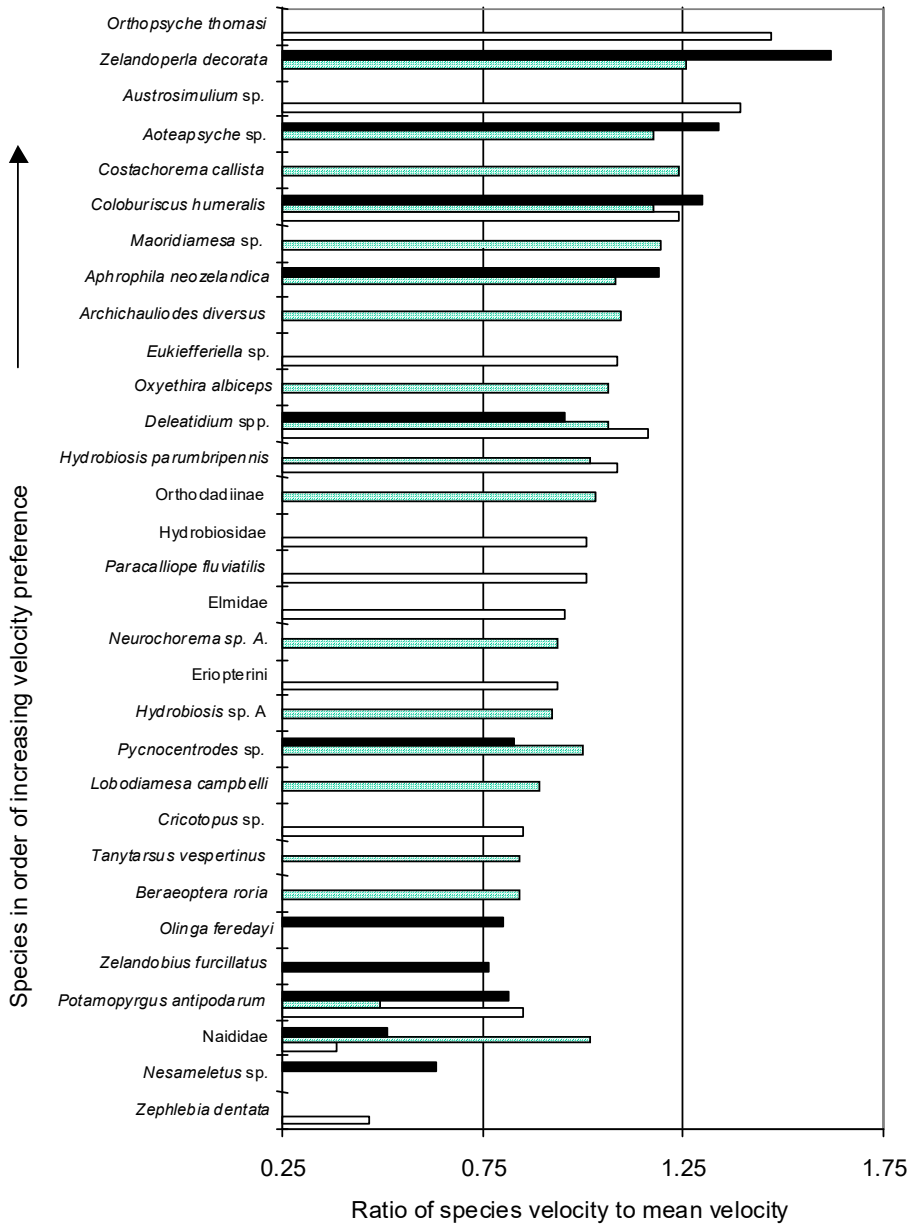


Figure 4: Relative velocity preferences of invertebrate species in small (<0.1 m^3/s) (no fill), moderate (1-10 m^3/s) (green hatched fill) and large (10-195 m^3/s) (solid black fill) rivers.

Summary of habitat suitability

Habitat use for trout, native fish, and benthic invertebrates appears to be associated with food availability and in the case of fish to be limited by swimming ability.

The velocities in which fish are found is related to swimming ability. Large bullies tend to be found in slightly faster and deeper water than small bullies. Large trout are found feeding in higher water velocities than small trout and even benthic invertebrate size tends to increase with water velocity (Jowett & Richardson 1990). Benthic invertebrates, particularly those with high MCI scores, are found in high water velocities and those velocities are higher than those in which most fish species are found. Only koaro are found in velocities approaching those of the high velocity invertebrates.

Brown trout densities have been found to be related to benthic invertebrate densities (Jowett 1992, Jowett et al. 1996) and many species of native fish live in riffles, where benthic invertebrates are abundant. Inanga feeding locations are in relatively low velocities, as dictated by their small size, but in areas where drifting food was concentrated (Jowett 2002).

Benthic invertebrates also tend to be abundant where their food sources are abundant. Jowett & Richardson (1990) found that the amount of periphyton was significantly related to *Deleatidium* abundance. Substrate with a slippery film of periphyton appeared to be the best habitat, clean substrate the worst, and substrate with a obvious layer of periphyton intermediate. The supply of plankton-derived food (seston) can result in an increase in the number of filter-feeders in a river downstream of a reservoir, as occurs in some natural lake outlets (Harding 1994).

Benthic invertebrates tend to be most abundant in average water depths, where there is coarse substrate and adequate light penetration or a food source, such as seston from a lake. Most benthic invertebrate species are not abundant in pools nor are they abundant in the stream margins where they can be exposed to the air by natural flow fluctuations (Jowett 2003). Pools have low velocities and contain little periphyton because the substrate is relatively fine and light penetration limited.

Trout can obviously live and feed in deep water, as they do in lakes. However in many rivers, the deep water is in pools where there are few drifting invertebrates available as food for the trout, so that trout tend to be found in runs or heads of pools below riffles. In the Clutha River, trout and their food source (filter-feeding invertebrates) were in water about 3 m deep.

3.2.6 Models of abundance

Brown trout abundance model

Using data collected for the "100 rivers survey", Jowett (1992) developed a model of the abundance of large brown trout in New Zealand rivers. Average habitat suitability (HSI) for trout habitat (space), and HSI for food production (food), plus seven other variables explained 87.7% of the variation in numbers of large brown trout in 59 New Zealand rivers. The model was:

Trout abundance per hectare = exp(1.095+3.2*trout HSI at low flow+0.132*%lake area-0.071*%sand+0.443*cover-26.7*sqrt(gradient)+3.7*food producing HSI-0.002*elevation-0.007*developed land)-1

The most important variables were HSI for trout habitat, HSI for food production, instream cover, and winter water temperature as an overriding factor. Other significant variables included percent sand substrate, % area of lakes in catchment, elevation, gradient, and percentage of the catchment developed for agriculture. Sand substrate is very poor food producing habitat and it is rare to observe brown trout in areas where the predominant substrate is sand; lake outlets are well known for their high trout stocks, probably because of the excellent food supply; the other factors also seem to be related to food production.

Perhaps the most interesting concept in the brown trout model is the flow at which the instream habitat variables (HSI) are calculated. In a natural river, flow and habitat vary with time. The quality of habitat was calculated at three flows; mean annual low flow, median flow, and mean flow. The quality of adult trout habitat at mean annual low flow was more closely related to trout numbers than the habitat available at the higher flows. This suggests that the quality of trout habitat at low flow is one of the limiting factors in the system – a kind of bottleneck. The quality of habitat for food production (benthic invertebrate habitat) at median flow was more closely related to trout numbers

than the amount at either low or mean flow. Thus, it appears that even if there is adequate habitat at low flows, a trout population is likely to be controlled by the food producing capacity of the river rather than the capacity during more extreme events. Ideally, the food producing capacity should be derived by integrating the amount of habitat over the full flow regime of the river. However this was not available at the time and habitat at median flow appeared to be a reasonable estimate.

Bioenergetics trout model

Hayes et al. (2016) bioenergetics model of trout abundance assumes that invertebrate drift will increase with flow and predicts that trout abundance will increase with flow until velocities exceed those in which trout can feed. The bioenergetics model is a sophisticated mechanistic model. It uses similar concepts to those embodied in Chapman's (1966) paper describing food and space as determinants of salmonid abundance and Jowett's (1992) study that found that trout abundance was related to both suitable habitat for adult trout and the amount of food available to them, either as benthic invertebrate biomass or as food producing habitat. Although drift is the most common source of food for trout, they can also feed by foraging for invertebrates on the river bed or aquatic plants.

Invertebrate drift derives from invertebrates that live on the bed of the stream and at normal flows the number of invertebrates drifting is relatively small compared to the number on the stream bed. The distances that invertebrates drift are also relatively small. Although drift derives from the benthos and many species have been reported to drift in a density dependent way, there is no general relationship between drift density and benthic invertebrate density (Brittain & Eckeland 1988; Shearer et al. 2003). It is generally accepted that invertebrate drift increases with water velocity during spates and that an increase in flow after a long period of stable flow will cause an increase in drift (Brittain & Eckeland 1988; Irvine 1985). Drift can also increase with an increase in turbidity or a reduction in flow. High levels of drift occur during floods because of substrate disturbance. Habitat analyses indicate that higher flows will usually increase benthic invertebrate density, so higher flows are likely to increase drift rates. Measurements in the Mohaka, Waingawa, Mangles, Clutha and Waitaki indicate that benthic invertebrate density begins to decline at locations in the river where the velocity exceeds about 0.8 m/s.

Benthic invertebrate production model

The benthic production model is a conceptual time series model of hydraulic conditions (velocity, shear stress, dimensionless shear stress, substrate stability, habitat suitability) and the influence of those parameters have on benthic abundance. The model predicts indices of abundance and habitat suitability. For each time step, hydraulic parameters are calculated at each measurement point of the river model and the abundance of benthic invertebrates at the measurement point is adjusted according to a set of biological processes. The processes that are considered are population growth through immigration/reproduction, population loss through emigration/mortality, and population movement within the reach as habitat suitability changes.

The benthic growth process comprises two mechanisms, colonisation through drift of invertebrates and growth through population increase (e.g., egg-laying by insects and physical growth of invertebrates).

The factor influencing growth is habitat suitability with abundance increasing logistically towards an asymptotic maximum determined by the suitability of the hydraulic conditions at the measurement point.

Population change is influenced by three factors. If the population is greater than can be supported by the habitat suitability then the population will decline through emigration. If the measurement point is exposed to the air then 100% mortality is assumed, and if the shear stress is sufficient to move the average substrate size, 100% mortality at the point is assumed. Seasonality can be accounted for by varying the growth rate sinusoidally through the year.

The input data are a flow series, a model of the river hydraulics and substrate and a habitat suitability curve. The input parameters are the summer growth rate per day (r default 0.025), the migration rate as a proportion of the summer growth rate (default 0.5), and the ratio of winter to summer growth rates. An initial abundance between 0 and 1 is also specified (default 0.4 of the asymptotic maximum).

Abundance appears to increase faster after substrate disturbance than would occur with recolonisation of an inundated or totally clean substrate. This has been described as resilience and may be because invertebrates can shelter within the substrate matrix. This is modelled by using a higher initial growth rate for recolonisation after disturbance than after inundation.

3.2.7 Water quality

High water temperatures are often associated with low flows. This is because the climatic conditions conducive to low flows are also likely to result in high water temperatures and not because low flows cause high water temperatures. Maximum water temperatures usually occur in summer when the weather is warm and dry and this usually coincides with periods of low flow.

The effect of flow on water temperature can be predicted by models that are based on well known principles of physics (e.g., Hockey et al. 1982; Theurer et al. 1984; Rutherford et al. 1997). The heating and cooling of river water results from solar radiation after allowing for shade, radiation from adjacent banks and vegetation according to air temperature, radiation from the water surface, evaporative cooling dependent on relative humidity and wind velocity, conduction to and from the stream bed depending on ground temperature and conduction to and from water surface depending on air temperature.

As a river flows downstream it is heated by solar radiation and cooled by evaporation[18] until it reaches an equilibrium where the daily heating equals the daily cooling. If the amount of shade changes, radiation reaching the rivers changes and the equilibrium temperature and water temperature will change. If the source of water is cold, such as from a spring in summer, water temperatures will gradually increase as the water flows downstream until equilibrium temperature is reached. If the flow and velocity of the water is reduced, the point at which equilibrium temperature is reached will move further upstream. However, equilibrium temperature is usually reached within a few kilometres in small streams (Rutherford et al. 2004) so that daily mean water temperatures are usually at equilibrium and changes in flow have little effect on the daily mean temperature.

The TRC has a riparian programme which will have a number of ecological benefits. Riparian vegetation and shade will:

- decrease water temperatures (Rutherford et al. 2004),
- improve the benthic invertebrate composition (Jowett et al. 2009),

[18] These are only the main heating and cooling mechanisms. Net heat flux is calculated as the sum of heat to or from long-wave atmospheric radiation, direct short-wave solar radiation, convection, conduction, evaporation, streamside vegetation (shading), streambed fluid friction, and the water's back radiation.

- increase instream habitat diversity (Jowett et al. 2009), and
- provide cover for some fish species (Jowett et al. 2009).

Monitoring of the riparian programme in the Kapoaiaia Stream (TRC 2017) has shown significant improvements in the macroinvertebrate communities and periphyton cover overall, as well as a significant decrease in temperature. Similarly, a NIWA study (Graham et al. 2018) of Taranaki ring plain rivers has shown that riparian planting improved macroinvertebrate indices at 59 monitoring sites and decreased *E. ecoli* concentrations at 11 monitoring sites.

The magnitude of the flow only has minimal effects on the daily mean water temperature. However, flow will influence the maximum and minimum temperatures over a 24 hour period, especially at low flows when the water is shallow. A reduction in flow will increase diurnal fluctuation because when the water is shallow it will heat faster during the day and cool faster during the night. The night cooling balances the day heating so that there is little change in daily mean water temperature. Usually, a flow reduction can increase maximum daily water temperatures by up to 1°C and the effect on daily mean water temperature is insignificant. In contrast, stream shading can alter temperatures by 2°C or so.

Dissolved oxygen concentration (DO) can be influenced by flow. Diurnal fluctuations in DO are affected by three fundamental processes: re-aeration, plant and bacterial respiration, and photosynthesis. Low concentrations of oxygen can occur in early morning if streams containing dense plants (aquatic macrophytes). These plants absorb oxygen during the night (respiration) and give off oxygen during the day (photosynthesis). Field measurement of diurnal oxygen fluctuations are used to obtain estimates of re-aeration rate and rates of photosynthetic production and respiration by plant and micro-organisms.

Flow influences this process by changing the re-aeration rate – the rate of oxygen exchange between the stream and atmosphere. Re-aeration increases as velocity and turbulence increases, but the formulation of this relationship will vary from stream to stream making the prediction of oxygen concentration uncertain at low flows. However, there are relatively few streams where the density of aquatic plants is sufficient to cause lethal DO during low flows.

3.2.8 Summary of research

The research carried out in New Zealand has long highlighted the importance of food availability to trout. Allen (1951) stressed the importance of food for the Horokiwi Stream trout population. Jowett (1992) found that the density of adult brown trout in 59 rivers was related to an index of food abundance and that there was a high correlation between trout abundance and benthic invertebrate biomass. Juvenile brown trout were also more abundant where benthic invertebrate density was high (Jowett et al. 1996). The three year study of trout in the Kakanui River by Jowett & Hayes (1994) concluded “food supply and suitable habitat for the production of trout food are aspects that should be considered when evaluating instream flow requirements”.

Hayes bioenergetics model (2016) shows similar results to the statistical model of Jowett (1992). Both models show that maximum trout numbers are likely to be supported by a flow which is higher than the flow that provides maximum adult trout habitat. Both models predict that a reduction in low flow will usually cause a decline in trout abundance.

In contrast, native fish do not seem to be so dependent on food availability. Jowett et al. (1996) found no correlation between native fish density and benthic invertebrate density. Graynoth (2007) found no evidence that low flows in the Waipara River were affecting the ability of native fish to

feed. However, most native fish do live in riffles where benthic invertebrate densities are highest so maintaining good riffle habitat will benefit both native fish and benthic invertebrates.

3.3 Principles for setting minimum flows and allocation

3.3.1 Minimum flow

The minimum flow is a protection mechanism to reduce the effect of abstractions on aquatic biota and other values, by setting a value below which abstractions cease or water restrictions are applied. In setting the minimum flow the concept is that it should provide an acceptable level of protection for the stream (Beecher 1990; Jowett 1997). Methods that set minimum flows are sometimes called "standard setting" (Annear et al. 2002).

As noted in Section 2, there are many reports that discuss methods for determining the effects of flow alteration but few describe how to progress from effects to minimum flow. The technical report (BECA 2008) associated with the proposed NES for ecological flows (MfE 2008) describes a hierarchy of methods. These range from simple hydrological rules of thumb to the application of bioenergetics models. Selection of a method depends on the complexity of the flow change (degree of hydrologic alteration) and the environmental values that are likely to be affected.

Methods that predict how stream characteristics change with flow are termed "incremental" (Annear et al. 2002). The incremental methods that have been used in New Zealand are:

1. Generalised habitat analysis (e.g., WAIORA), and
2. 1D or 2D instream habitat analysis.

These methods were discussed earlier and are discussed in more detail in Jowett et al. (2008) and Hay & Hayes (2007). In addition, there are models available that can evaluate the effect of flow changes on fish passage, water temperature, dissolved, oxygen, sediment transport, fish bioenergetics, periphyton accumulation, and benthic invertebrate production.

Two standard setting methods for minimum flow tend to be used in New Zealand. These are a percentage of a flow statistic (historic flow method) and methods that show how habitat changes incrementally with flow.

The easiest and probably most common method is to use a percentage of a flow statistic as the minimum flow. The 5-year low flow and 90% of the MALF are examples that have been used in New Zealand. The use of the MALF is preferable to the 5 year low flow because its computation is a simple arithmetic average of the annual minima and there is no need to fit a statistical distribution as required to estimate the 5 year low flow. A 7-day MALF is also better than a 1-day or instantaneous MALF because the 7-day moving mean smoothes any spikes or sudden fluctuations in recorded flow.

There are various ways of setting a minimum flow using incremental habitat methods, from maintaining a maximum amount of habitat, a percentage of habitat at low or median flow (habitat retention), or using a breakpoint (or "inflection point") on the habitat/flow relationship (Jowett 1997). While there is no percentage or absolute value associated with a breakpoint, it is a point of diminishing return, where proportionately more habitat is lost with decreasing the flow than is gained by increasing the flow.

The concept of a habitat retention method is that the minimum flow should retain a percentage of the suitable habitat available at the MALF for a target species. The level of habitat retention can be

varied according to the perceived value of the species, as has been done by the Bay of Plenty Regional Council and the Southland Regional Council.

There is often only one minimum flow monitoring site on a river, so that comparisons with nearby streams and rivers must be used to establish flow statistics for sites that do not have a flow monitoring site Natural flows will vary along the length of the river and the same or varying level of protection can be applied along the length of the river, so that the "minimum flow" would be the protection level applied to the estimated natural flow. This means that the "minimum flow" in the headwaters would be less than the minimum flow further downstream. Conversely, if the river were to lose water naturally then the "minimum flow" would be less than that upstream of the losses.

The use of a flow statistic to set a minimum flow is simple, although there can be disagreement about estimates of the flow statistic where there is no flow record. Flow statistics also change with time as more record is collected.

Estimates of flow statistics from ungauged catchments are usually made by comparison with a nearby gauged river or group of rivers draining from a similar source. The simplest way of transferring a flow or flow statistic from one catchment to an ungauged catchment or from a recorder site to another part of the catchment is to scale it by the respective catchment areas. Adjustment for different catchment rainfalls can also be applied to the catchment areas. If there are sufficient flow measurements at the ungauged site, a correlation with the gauged site can be established and this can be used to estimate flows and flow statistics.

Minimum flows based on the percentage of habitat at MALF require field measurements as well as an estimate of the flow statistic MALF. The use of habitat methods is not universally accepted despite the logic behind the method and the validation studies described earlier.

3.3.2 Protection levels

Setting appropriate levels of environmental protection is a world-wide challenge. For example, in Canada, they have a policy of no net habitat loss for salmon. In South-Western Florida the 15% habitat loss protection level used since 2002 was reviewed. They found that "*Numerous programs throughout the world provide instream flow protection, establish minimum flows or levels, or ensure water reservations…. In each case, a determination is made about the limits of permissible water abstraction. Many criteria are based on hydrologic standards, the protection of a single species, or management goal. … Because neither a commonly accepted protection level nor a common measure of protection exists, comparing standards between regulatory agencies remains a challenge.*" The same could be said about New Zealand. Documents like the RMA and NPSFM give general guidance with statements like "minimum acceptable state" and a "healthy ecosystem appropriate to the river type".

Water management plans rarely discuss the specific level of protection provided by their minimum flows.

Jowett & Hayes (2004) suggest that habitat retention levels should be set according to the perceived value of the fish species and management goals with the ultimate decision decided by consultation in the planning process. Although simple, a single level of protection for a region might not be the best way of managing water resources because not every river is the same. Site-specific studies might show that a higher or lower level of protection should be afforded to a river. The Bay of Plenty Regional Council and Southland Regional Council set protection levels in the water plans and the levels vary between 60% and 100% retention of the habitat available at MALF.

The balance between environmental protection and water use seems to vary between regions. Water short regions tend to value out of stream water use highly and other regions are more focussed on protecting the natural environment. Abstraction occurs in many New Zealand rivers and minimum flows have been applied to most abstractions. One would expect that we have gained some knowledge from this but there are very few documented cases of the effect of abstraction and the effectiveness of the minimum flow. This might suggest that the levels of protection are either appropriate or too conservative.

3.3.3 Allocation

The minimum flow is or should be the primary environmental protection mechanism because the detrimental effect of low flows on most aquatic organisms is shown in the research that has been carried out. A limit on total allocation can also act as a protection mechanism as well as a method of guaranteeing a certain reliability of supply to those granted consents for abstraction of water.

Total allocation affects the hydrology and ecology. The hydrological effects of increased allocation are:

- a reduction in mean and median flow,
- an increase in the duration of low flows and the amount of time at minimum flow, but
- no appreciable change in the magnitude and frequency of floods and freshes.

The main ecological effect of increased allocation is:

- a decrease in invertebrate production.

Total allocation and the minimum flow interact as protection mechanisms. If the total allocation is low, there is little point in setting a minimum flow. This was the case in the Motueka Conservation Order which allows 12% of the river flow to be abstracted without any minimum flow.

If total allocation is high then abstraction will reduce the river flow to the minimum each year, and the minimum flow becomes the 'new MALF' that limits fish populations. In such a case, the minimum flow would be set to provide an adequate level of protection with the expectation that flows are likely to reach the minimum flow each year.

The situation between these two extremes is when a moderate allocation results in the minimum flow being reached in some years but not in others. In this case the 'new MALF' is somewhere between the natural MALF and the minimum flow, and the difference between them can be regarded as the level of protection provided by the combination of the minimum flow and total allocation.

Little research has been carried out into methods for setting an allocation limit and in the past the limits have tended to be rather arbitrary and often set to provide reliability of supply to consent holders rather than for environmental purposes. For example, the Bay of Plenty Regional Council have allocated the flow difference between the minimum flow and the 5-year low flow so that consent holders would only have restrictions once every 5 years. Other councils have set a minimum flow at 95% of the 5 year low flow and allocated 5% of the 5 year low flow. Because the allocation with these methods is small, they are unlikely to have any environmental effect. The term "over allocation" simply means that more water has been allocated than the arbitrary limit. It does not mean that that over allocation will have a discernible environmental effect.

The interaction between the effects of allocation and minimum flows means that the level of protection for minimum flows should be related to the total allocation and the combined effect assessed. In theory, any combination is possible – from high allocation with a high minimum flow to low allocation with a low minimum flow.

4 Taranaki Regional Council Minimum Flow and Allocation

The minimum flow and allocation in the Council's Draft Plan is based on default recommendations in the proposed National Environmental Standard (NES) for ecological flows (MfE 2008).

The technical document supporting the NES (BECA 2008) does not discuss minimum flows, allocation or levels of protection. It sets out methods that could be used to help evaluate the physical and ecological effects of flow change. Many of the methods specified for high value steams with a high degree of hydrologic alteration are not necessary for typical water consents.

The discussion document (MfE 2008) specifies a default minimum flow and allocation based on stream size that would be used if no alternatives were specified by a Regional Council. The origin of these values is not specified in the report, but they were conservative values agreed to by a committee comprising representatives from Regional Councils, DOC, recreational canoeing, , Fish & Game, farming, irrigation, hydroelectric energy, Ngāi Tahu and the Ecologic Foundation. The minimum flow recommendation was conservatively based on the maximum levels of protection (90% of the habitat available at MALF) suggested by Jowett & Hayes (2004) and the principle that flow abstraction will have a relatively greater effect in small streams than in large rivers.

The MALF is the average annual minimum flow calculated as a running mean over a number of days. The following calculations are based on the 7 day MALF, except for the fish protection level which is based on a longer time period – the 30 day MALF.

A minimum of 90% of MALF was specified for rivers with a mean flow less than 5 m^3/s and a minimum of 80% of MALF for rivers larger than 5 m^3/s. The cut-off was based on mean flow rather than median or MALF because in ungauged rivers the mean can be estimated more easily and more accurately than the other hydrologic statistics.

The default minimum flows and allocations were intentionally conservative because they applied nationally to a wide range of rivers with different morphologies and flow regimes. The effect of abstraction varies with flow regime and morphology. The morphology of a river is determined by high flows which occur relatively infrequently, but biota are controlled by low flows which occur every year and for long periods. If the low flows are low compared to normal river flows, the depths and velocities and hence quality of the habitat are significantly lower than normal and any further reduction in flow will compound the detrimental effect. However, if the low flows are close to normal flow, there is relatively little reduction in depth and velocity and potentially less effect when flows are reduced. The relationship between low flows and normal flows is indicated by the ratio of MALF to median flow. In spring-fed, lake-fed and pumice streams, the ratio of MALF to median flow is high, in small east coast rivers the ratio is low and these rivers are most "at risk" from abstraction. In Taranaki, the rivers draining from the NW slopes of Mount Taranaki generally have relatively high ratios of MALF/median but most Taranaki rivers are in the normal range of 0.2-0.4 (Fig. 5).

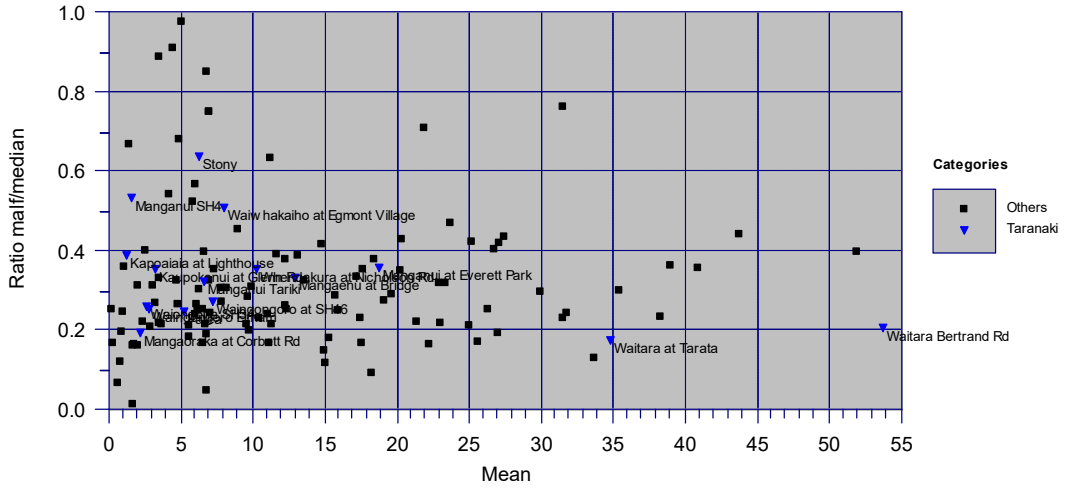
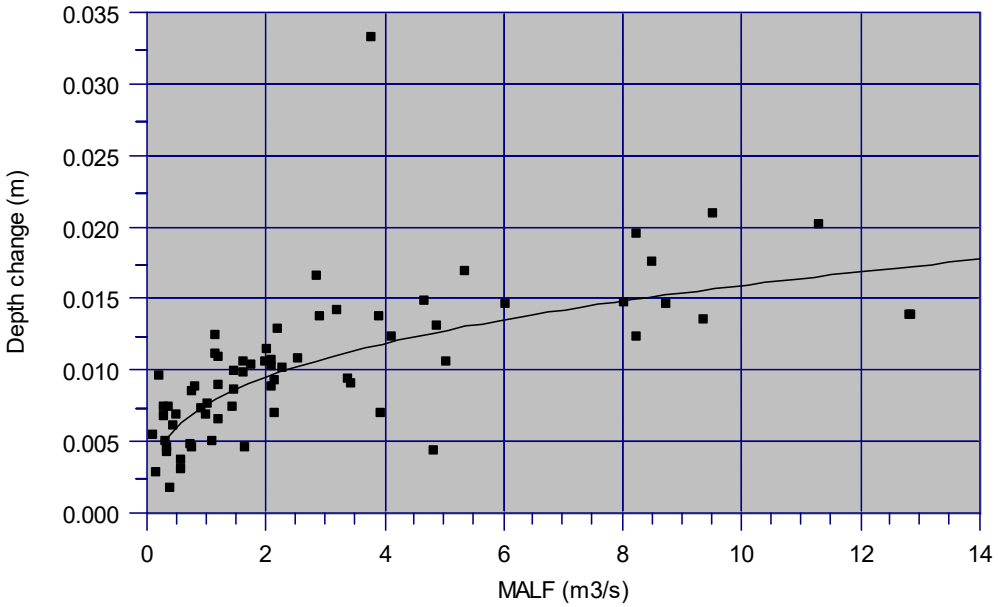


Figure 5: Relationship between mean flow and the ratio of MALF/median flow for Taranaki rivers and rivers elsewhere in New Zealand.

A 10% flow reduction below MALF would be barely detectable by flow gauging and would result in small changes in water depth and velocity. In 74 New Zealand rivers, the average reduction in depth for a 10% reduction below MALF was 10 mm (2.6% of the depth at MALF). For rivers with a mean flow less than 5 m^3/s, the median reduction in depth was 6 mm. The average reduction in velocity was 0.013 m/s (4.4% of the average velocity at MALF). The change in depth and velocity with flow varies with river size, with the amount of change increasing with river size (Fig. 6). This is the reason why the default minimum flow for rivers less than 5 m^3/s is greater than that for larger rivers.



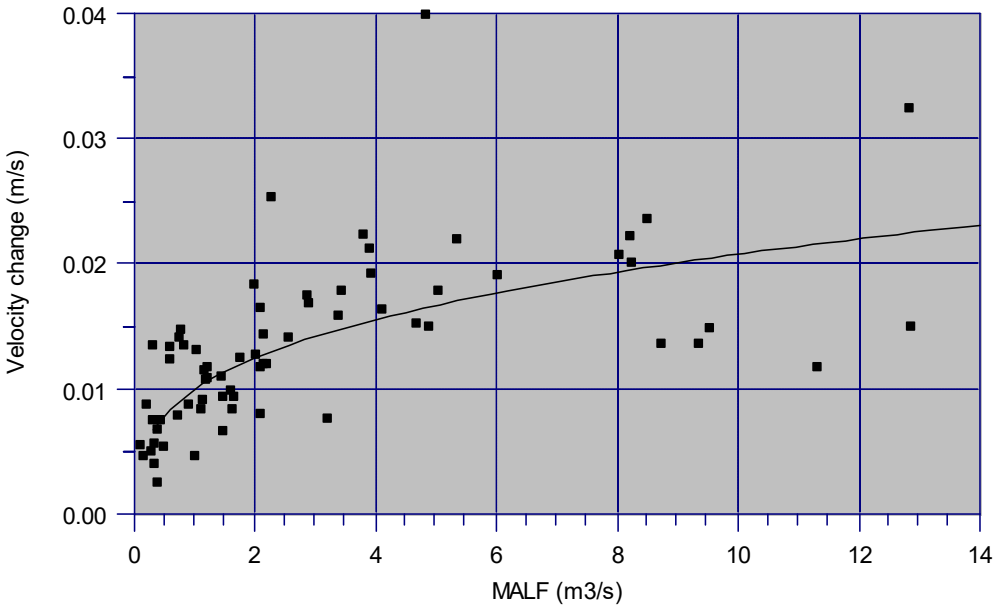


Figure 6: Relationship between change on average depth and velocity and mean annual low flow (MALF) when flow is reduced from MALF to 10% below MALF.

The default allocation specified in the discussion document (MfE 2008) is 30% of MALF for rivers with mean flows less than 5 m^3/s and 50% of MALF for larger rivers. These numbers were based on an analysis of the effects of allocation on periphyton accrual. The length of time since the last flood and fresh determines the amount of periphyton on the stream bed. Nutrient concentration and water temperature will affect the rate of accrual. The total allocation affects the length of time that the flow will be at minimum flow and hence the amount of periphyton that accrues. The length of time between naturally occurring flushing events (floods and freshes) depends on the climate. In the west, there are frequent heavy rainfalls but in the east there can be long periods between flushing events. Analysis of flow regimes in small east coast rivers indicated that 30% allocation would not increase the average time between flushing events sufficiently for nuisance levels of periphyton to accumulate. The effect of allocation on invertebrate production was not considered.

Of the 42 Taranaki rivers with consents to abstract water, allocation is less than 30% of MALF in 59% of rivers and less than 20% in 45% of the rivers. Of the remaining rivers, 20% have 30% to 50% of MALF allocated.

4.1 Flow Management objectives for TRC

The Draft Plan sets out its objectives. The most relevant to setting limits for minimum flows and allocation are:

3. Appropriate use and development

   Freshwater and soil resources in Taranaki are allocated and used efficiently and are available for sustainable use or development to support the social, economic and cultural well-being, and health and safety, of people and communities.

5. Ecosystem health and mauri of freshwater

The life-supporting capacity, mauri, ecosystem processes and indigenous species, including their associated ecosystems, of freshwater are safeguarded from the adverse effects of use and development including through achievement of the freshwater objectives identified in Schedule 2.

8. Freshwater quantity

   Freshwater quantity is maintained at sustainable levels through the management of efficient water allocation and efficiency of use.

9. Natural character

   Natural character of wetlands, lakes and rivers and their margins are protected from inappropriate use and development and the adverse effects of appropriate use and development.

10. Indigenous freshwater biodiversity

    Indigenous freshwater biodiversity is maintained and enhanced overall and areas of significant indigenous biodiversity are protected from the adverse effects of inappropriate use and development.

14. Use and enjoyment of freshwater bodies

    People's use and enjoyment of freshwater bodies, including amenity values, traditional practices is maintained and enhanced, and the health of people and communities as affected by secondary contact with freshwater is safeguarded, including through achievement of the freshwater objectives identified in Schedule 2.

Schedule 2 sets out the states for periphyton and water quality prescribed in the NPSFM. The Draft Plan does not specify a monitoring programme but they monitor benthic invertebrates routinely and are likely to include the 2017 NPSFM requirement for MCI monitoring.

Consideration of these objectives raises the issue of what flow and/or stream characteristic could be used to measure ecosystem health, mauri and biodiversity. One stream characteristic stands out as an indicator of ecosystem health - the state of the benthic invertebrate community. This can be represented by one index, either the MCI or benthic invertebrate density for taxa with high MCI scores.

Benthic invertebrates are used internationally and in New Zealand as a measure of ecosystem health. Benthic invertebrate abundance is related to trout abundance, benthic invertebrates are most abundant in riffles, where native fish are also most abundant, and MCI was identified as the one measure that was most closely related to Maori cultural values (Tipa & Teirney 2003). Benthic invertebrate life cycles are relatively short and for most species not all of their life is spent in water. As a result, their populations can recover from severe events such as floods and droughts.

The effect of the minimum flow and allocation on the flow regime and benthic productivity of a river, in terms of either MCI or total invertebrate density, can be assessed applying the benthic production model to flows over a number of years. This model will predict "production with and without abstraction" so that an appropriate minimum flow and allocation can be based on the loss of production and an appropriate level of protection.

The life cycle of fish is longer than that of benthic invertebrates and the density of trout and native fish, particularly those that are found in swift water, can be limited by low flows if they persist for long enough. The reduction in the 30-day MALF was used as a conservative indicator of the potential effect on fish species. It is conservative because if the density of fish is low, a reduction in habitat is likely to result in a redistribution of fish rather than a loss of fish. It is also conservative for other fish species whose habitat is not affected by flow reductions as much as that of species such as torrentfish and adult trout that prefer swift water.

Various combinations of minimum flow and allocation levels were applied to a representative sample of nine Taranaki rivers to determine the effect on ecosystem health, as measured by the two types of protection level. Minimum flows varying from 60% to 90% of the MALF were tested. A minimum of 60% of the MALF is slightly less than the current minimum flow requirement and 90% can be regarded as a level at which there would be no measurable effect. Allocations of 0 to 50% of the MALF were tested. Currently, there is no allocation limit.

The NPSFM requires regional councils and unitary authorities to establish freshwater accounting systems for both water quantity and quality. The approach taken here is the risk based approach (MfE 2015) whereby the minimum flow and allocation were decided on the basis that they would not cause unacceptable environmental degradation as determined by a method that considers the density of benthic invertebrates with high MCI values. The flow requirements of this criterion are high and will be higher than any habitat requirements for fish species.

4.2 Method of assessing the combined effect of minimum flow and allocation on benthic invertebrate abundance

4.2.1 Development of suitability curves for high MCI score invertebrates

Suitability curves were developed using data from the Rainy, Clutha, Mangles, Waingawa, Mohaka, Whatawhata, Whanganui, and Waitaki rivers. The 11 taxa used to calculate benthic invertebrate density were all relatively common with MCI scores (NIWA 2015) greater than 5 (Table 3). A total of 1431 samples collected in a range of water depths and velocities were available for analysis. Each river was analysed separately to account for differences in numbers between the rivers and an average curve derived (Fig. 7). A filter was applied so that depths greater than 1 m were excluded as few sites contained deep water samples. The curves show a linear decline in species number with depth, an increase in numbers with velocity up to about 0.9 m/s and a decline when velocities exceed 1.35 m/s. The best substrate was cobbles and boulders (categories 6 & 7), with silt (category 2) unsuitable. This suitability model indicates that high quality invertebrate habitat will be shallow water with high velocity and coarse substrate.

Table 3: Invertebrate species and MCI scores used to derive relationships between total number of species and depth, velocity and substrate.

	Species	MCI score
Mayfly	*Aoteapsyche*	8
	Nesameletus	8
	Coloburiscus	9
	Deleatidium	7
Stonefly	*Zelandobius*	7
	Zelandoperla	8
Beetle	Elmidae	6
Caddisfly	*Hydrobiosis*	8
	Olinga	9
	Pycnocentrodes	6
True flies	*Aphrophila*	9

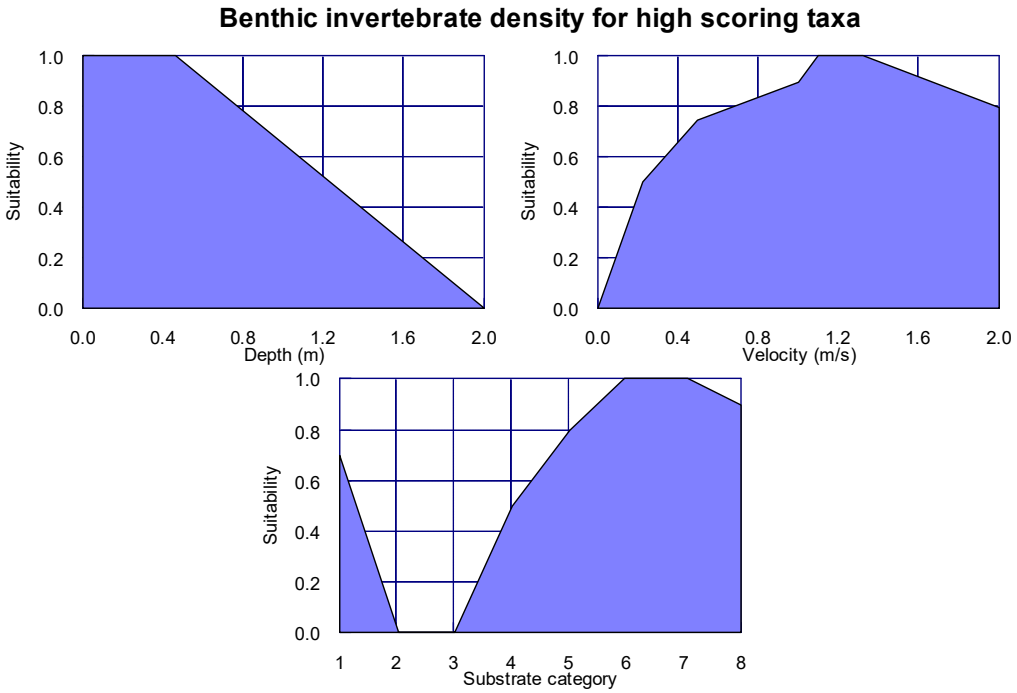


Figure 7: Habitat suitability criteria for density of high MCI score taxa.

4.2.2 Application of high MCI score curves to Taranaki rivers

The effect of flow abstraction with different minimum flows and allocations was evaluated in each of 9 Taranaki rivers. Instream habitat survey data were available for each river. The record of natural river flow was used to simulate the flows that would occur with full abstraction over range of minimum flows and allocations. Daily mean flow data for each river for the 11 year period 2006-2016 inclusive was used to calculate flows without any abstraction and flows with abstraction of up to 50% of MALF and minimum flows of between 50% of MALF and 100% of MALF. It was assumed

that whenever the natural flow exceeded the minimum flow as much water as possible was abstracted up to the maximum allocation.

The number of days per year at or below minimum flow was calculated for each combination of minimum flow and allocation as well as the number of days that takes might be restricted. The simulated flows are conservative because actual takes are usually about half of total allocation (MfE 2015). As explained in Section 2, total allocation is the sum of maximum rates, and in most cases maximum rates of take only occur when the demand, whether it is irrigation, town water supply or other form of take, requires it. Thus actual flows with abstraction are likely to be higher than the flows that have been simulated.

The natural river flows and the sets of simulated flows were used to calculate an index of benthic invertebrate density for high MCI score taxa for each day for the 11 year period 2006-2016. The average benthic density was calculated as the average over the 11 year period for each flow regime and contours plotted to show the effect of combined effect of minimum flow and allocation on potential benthic invertebrate density.

The level of protection afforded by each combination of minimum flow and allocation was expressed as a percentage of the average index of benthic invertebrate density for the natural flow regime. Opinions about an appropriate level of protection will differ, but assuming that some reduction in the numbers of high MCI score invertebrate species is acceptable, a retention level of 80-90% (10-20% reduction) is in accordance with the levels of protection in the proposed National Environmental Standard (NES) for ecological flows (MfE 2008).

5 Other matters to consider when setting environmental flow limits

5.1 Submissions

The Draft Plan received a number of submissions which dealt with the issue of minimum flows and allocation. These are shown in Appendix II.

A common concern was how policies 7.7 (allocation) and 7.8 (minimum flow) worked together, both for environmental protection and the effect on reliability of supply. These matters have been addressed in Section 4 of this report.

5.2 Flexibility

The dilemma faced by planners is that in setting minimum flows and allocation, they do not know what the future water uses will be and how often that water will be abstracted. For example, high abstraction throughout the year will reduce benthic production. High abstraction for a short period of time will have little if any effect on benthic production or fish. Thus, consents for emergency or short term (< week) abstraction above the allocation limit will have little effect.

Not all rivers are the same and river specific analyses may show that the effects of an alternative minimum flow and abstraction limit are within an acceptable level of protection. While a default minimum flow and allocation as in the Draft Plan is simple, there should be provision to allow other settings to be adopted after consideration of effects.

5.3 Group schemes

The possibility of forming group schemes should be considered on rivers where there are multiple users and the possibility of low reliability of supply. Group schemes have several advantages. They

provide for a more efficient allocation of resources. Basically, the scheme has an allocation, which is often less than the sum of the allocations required by the individuals. On any particular day, the available water is shared amongst the group by the group administrator. Group schemes are inherently fairer than the first in first served system and can reduce consenting costs when multiple consents are combined into one allocation. This will help meet Objective B3 of the NPSFM, which requires councils to improve and maximise the efficient allocation and use of water.

5.4 Exemptions to minimum flows

The Draft Plan allows for water to be taken when the river flow is below the minimum flow in special cases. Such a case might be for town water supplies, where public health concerns would warrant reducing the level of protection being applied to a river. Another case might be an emergency take for fire fighting which does not require a consent.

6 Taranaki Rivers

Hydrological, water quality and benthic invertebrate data were analysed to show a range of parameters for rivers in 2 of the 4 FMUs, ring plain rivers (FMU B) and eastern hill country (FMU C).

There were no streams or rivers with a sufficiently long flow records in coastal terrace streams (FMU D). In some cases, the flow regimes in these streams might be more like spring-fed streams because they may be fed from ground water.

Flows in the river classified as an outstanding water bodies (e.g., Stony River FMU A) have a high level of protection and only allow minimal abstraction, with the 7-d MALF as the minimum flow and a maximum allocation of 10% of MALF. The Stony River drains from Mt Taranaki and its flow regime would be similar to the Waiwhakaiho River.

The following analyses of hydrology, benthic invertebrates and water quality are intended to show general trends and values rather than a comprehensive analysis of all flow and water sampling sites in Taranaki.

6.1 Hydrology

Flow records were converted to daily mean values for the 11 year period 2006-2016 inclusive to give a consistent period of record for comparison. Flows in the Waitara River at Tarata and in the lower Manganui River are affected by the Motukawa hydroelectric scheme (average flow 3.3 m^3/s) and although there is record of the diversions there is too much missing data in the record to allow the flows for these two sites to be naturalised. The amount of runoff in the rivers varies according to the catchment's exposure and the average catchment elevation. Rivers exposed to the west tend to have high runoff whereas those exposed to the east have low runoff (Table 4). Because of this rivers draining the eastern hill country (FMU D) tend to have less runoff (Fig. 8).

Table 4: Hydrological characteristics of some Taranaki rivers in order of runoff volume.

River	Catchment area (km^2)	Annual runoff (m)	Mean flow(m^3/s)	Median flow (m^3/s)	MALF (7-day) (m^3/s)	FRE3[1]	FMU
Kapoaiaia at Lighthouse	18.6	1.83	1.08	0.69	0.25	14	B
Kaupokonui at Glenn Rd	59.6	1.67	3.16	2.06	0.73	10	B
Mangaehu at Bridge	421	0.91	12.18	6.68	1.98	12.5	D
Manganui at SH3	11.3	4.52	1.62	0.9	0.45	17.5	B
Mangaoraka at Corbett Rd	53.9	1.17	1.99	1.25	0.23	9.9	B
Patea at Skinner Road	81.0	1.92	4.93	3.14	0.75	11.7	B
Waingongoro at SH45	226	1.03	7.41	5.31	1.32	8.2	B
Waiongana at SH3	38.64	2.03	2.49	1.45	0.38	14.7	B
Waitara at Tarata*	704.3	1.36	30.29	14.36	-	-	D
Waiwhakaiho at Egmont Village	61.2	3.94	7.76	3.89	1.83	17.9	B
Whenuakura at Nicholson Rd	443.8	0.71	9.95	5.19	2.03	13.4	D

[1] Annual frequency of floods/freshes greater than 3 times the median
* 3.3 m^3/s from the Motukawa PS subtracted from recorded flow.

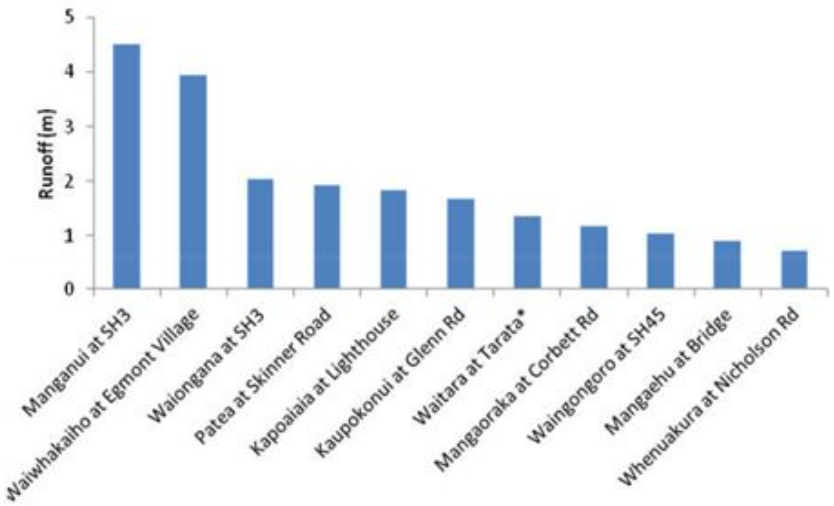


Figure 8: Annual runoff variation in nine Taranaki rivers.

6.2 Fish species

The New Zealand freshwater Fish database contains records of fish caught in New Zealand rivers. Rivers with access to the coast are dominated by diadromous fish species, which migrate from the sea as juveniles and spend their adult lives in freshwater. In general, a similar species assemblage is

found in each of the nine rivers with longfin and shortfin eels, brown trout, common bullies and inanga in most rivers. The species list is probably not comprehensive and additional sampling is likely to find that more native fish species are present than are listed in Table 5. For example, although torrentfish have not been reported in all rivers (Table 5, Fig. 9), they are likely to be present in all rivers with access to the sea. The Mangaehu Stream and upper Patea River sites are upstream of the Patea Dam and diadromous fish populations will be impacted. The Patea dam monitoring report (TRC 2018) shows that large numbers of elvers and good numbers of koaro and banded kokopu have been transferred upstream. Monitoring of the upstream fish populations has shown that longfin and shortfin eel populations had both increased in abundance, and had an improved size class distribution since the 2012 survey was completed. In addition, adult koaro were recorded in the upper Patea River, a species that had died out in the upper catchment prior to the change in transfer methodology. However, there was no improvement in the banded kokopu population.

Table 5: Number of occurrences of fish species in nine Taranaki rivers. The number refers to the number of records that report the occurrence of the species and reflects the sampling effort rather than the number of fish found. "YES" indicates that the TRC has recorded the species as present, although not yet recorded in the New Zealand Freshwater Fish Database.

Species	Kapoaiaia	Kaupokonui	Manganui	Mangaoraka	Tangahoe	Waingongoro	Waiongana	Waiwhakaiho	Whenuakura
Banded kokopu	1	1		5			7	3	
Bluegill bully								2	
Brown mudfish						22			
Brown trout	8	12	43	7		33	22	32	2
Common bully	1		10	3	2	8	4	14	2
Common smelt		1				3		1	2
Crans bully			60			6		1	1
Giant bully					1			1	
Giant kokopu	1				1	1			
Inanga	1	1	3	8	2	YES	9	7	2
Koaro		1					3	10	
Lamprey	YES	1			YES	1	1	2	
Longfin eel	11	18	74	14	1	28	50	74	4
Rainbow trout		YES				12			
Redfin bully	12	10	14	8	2	5	28	48	2
Shortfin eel	5	3	5	10	1	5	19	6	
Shortjaw kokopu	1	YES	3	3			5	1	1
Torrentfish		YES	10		2	4	3	11	1
Upland bully			4			7			1

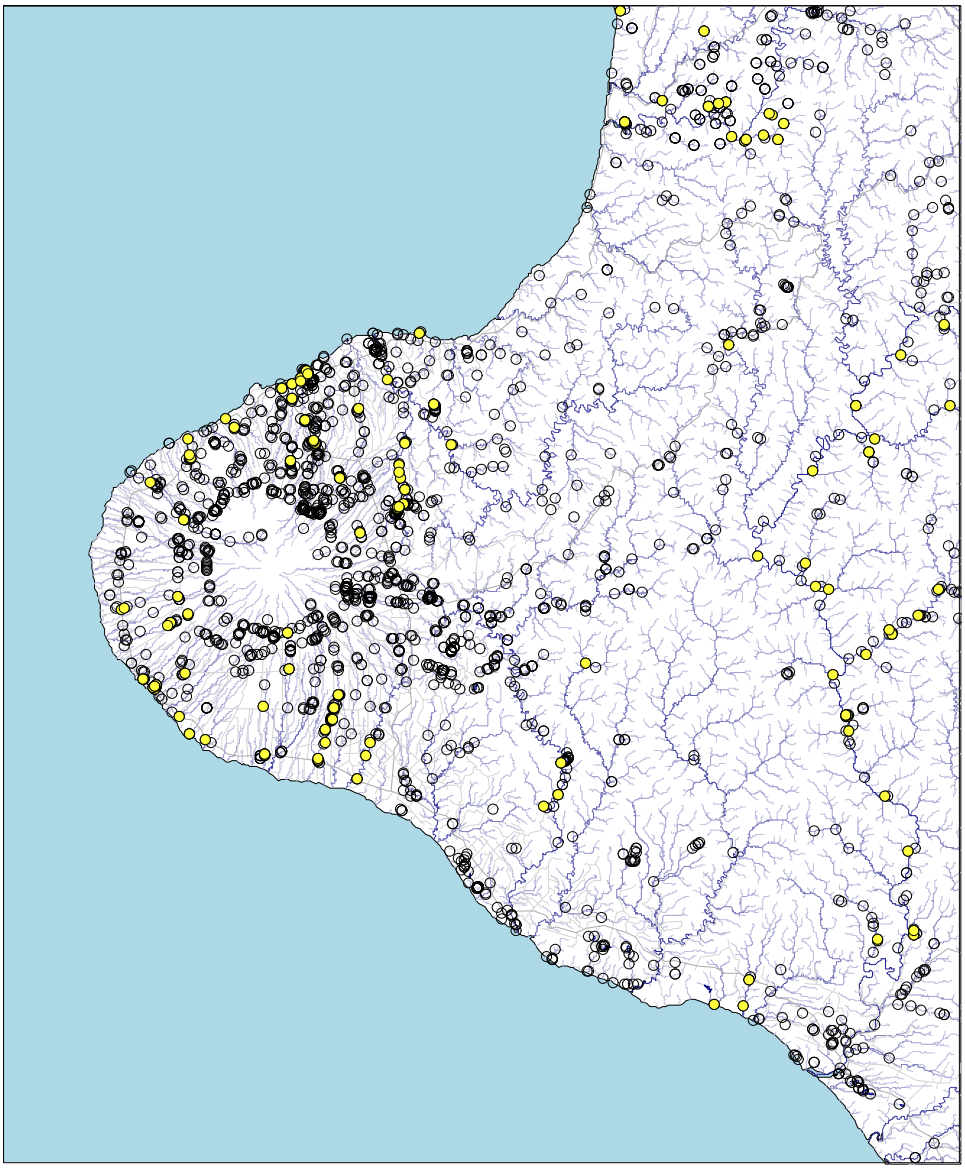


Figure 9: Torrentfish distribution in Taranaki rivers. Torrentfish locations shown as yellow circles, sampling sites as open circles.

6.3 Water Quality

Water quality has been regularly sampled at some sites and for some parameters since 1980 but there are relatively few samples collected from the Kapoaiaia and Tangahoe, so rankings for these sites cannot be considered definitive (Table 6). The four sites in FMU D were the most turbid (Fig. 10), as would be expected with sedimentary rock catchments. The only significant statistical difference in median water quality parameters between the 4 FMU D sites and the 6 FMU B sites was for turbidity (Kruskal-Wallis, *P*=0.01).

Table 6: Water quality measurements in ten Taranaki rivers. N = number of samples.

River	Conductivity @ 20'C (mS/m)		Dissolved reactive phosphorus (g/m^3)		Nitrite/nitrate nitrogen (g/m^3)		Ammoniacal nitrogen (g/m^3)		Turbidity (NTU)	
	N	Median	N	Median	N	Median	N	Median	N	Median
Kapoaiaia at Lighthouse	6	11.9	6	0.030	6	0.71	6	0.007	4	1.2
Kaupokonui at Glenn Rd	243	9.8	48	0.017	105	0.50	238	0.017	133	1.1
Mangaehu at bridge	269	9.9	279	0.006	252	0.10	274	0.012	147	4.3
Manganui at Bristol Rd bridge	277	10.0	2	0.006	2	0.30	1	0.016	158	0.8
Mangaoraka at Corbett Rd	277	14.5	266	0.009	241	0.86	267	0.021	150	2.1
Tangahoe below railbridge	3	23.2	1	0.026			1	0.037	2	6.3
Waingongoro at SH45	271	16.4	260	0.053	257	1.89	264	0.032	155	3.2
Waitara at Autawa Rd	27	8.8	27	0.007	26	0.16	27	0.018	26	19.0
Waiwhakaiho at Egmont Village	319	12.6	278	0.025	243	0.12	279	0.007	147	0.7
Whenuakura at Nicholson Rd	28	18.9	28	0.016	26	0.36	28	0.027	26	34.0

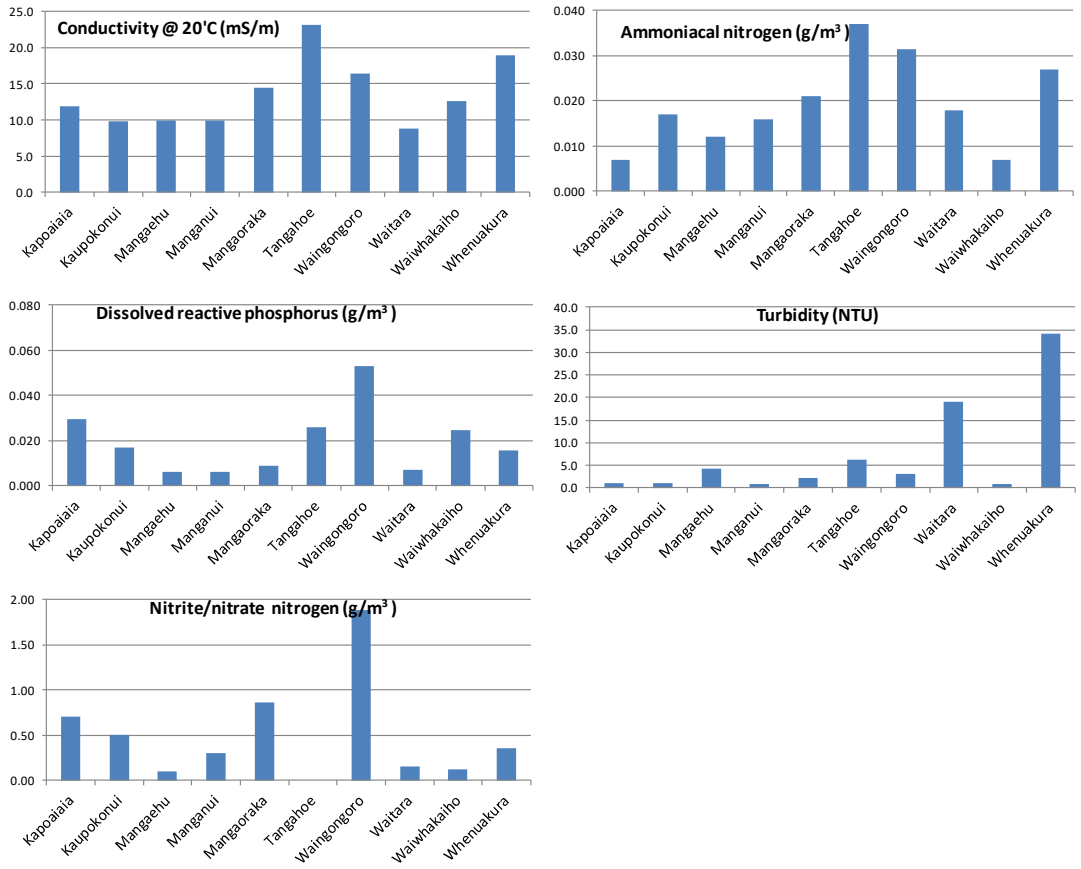


Figure 10: Water quality variations of median values in ten Taranaki rivers.

All available water quality were analysed and it is noted that the water quality has improved with time at some sites such as the site on the lower Waingongoro River (Fig. 11).

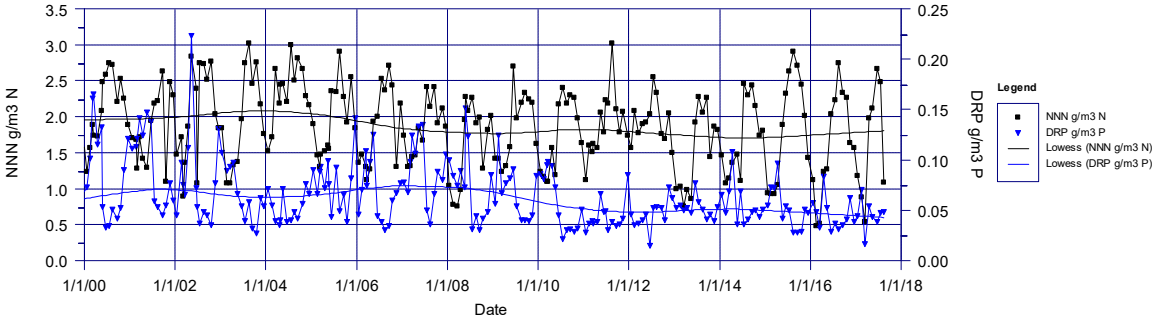


Figure 11: Waingongoro reduction in concentrations of dissolved reactive phosphorus and nitrite/nitrate nitrogen with time.

6.4 Benthic Invertebrates

Benthic invertebrate samples have been collected by kick sampling twice yearly since about 1996. There does not appear to be any clear pattern in the benthic invertebrate indices and there is not a lot of variation between the highest and lowest values. The proposed amendments to the National Policy Statement for Freshwater Management (2017b) suggest that an MCI of less than 80 would require the Council to investigate the reason for the low value and to take measures to increase it if caused by other than natural processes. There is relatively little variation in the two measures of stream "health" MCI and %EPT, the percent of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) in a sample (Table 7, Fig. 12). MCI values in ring plain rivers and their relationship with elevation and distance from source are discussed in detail in Stark & Fowles (2009).

Table 7: Measures of stream "health" MCI and %EPT (percent of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) in a sample) in ten Taranaki rivers. N = number of samples.

River	N	% EPT taxa		MCI (national)		MCI (Taranaki)	
		Median	Range	Median	Range	Median	Range
Kapoaiaia at lighthouse	36	32	11-47	89	75-103	86	75-101
Kaupokonui at Glen Rd	44	37.5	14-57	93	70-114	90	66-110
Mangaehu at Bridge	44	40	13-60	94	77-108	91	77-104
Manganui at Bristol Rd bridge (Waitara)	43	45	29-60	102	81-120	98	76-115
Mangaoraka at Corbett Rd	43	37	9-55	92	78-107	90	75-105
Tangahoe below railbridge	21	38	25-53	96	83-107	94	78-103
Waingongoro at SH45	45	38	15-56	97	75-111	94	73-106
Waitara at Autawa Rd	4	44.5	42-50	102	96-106	98	95-102
Waiwhakaiho at Egmont Village	43	53	32-65	117	87-134	110	87-125
Whenuakura at Nicholson Rd	4	31	28-34	93.5	86-98	86.5	81-94

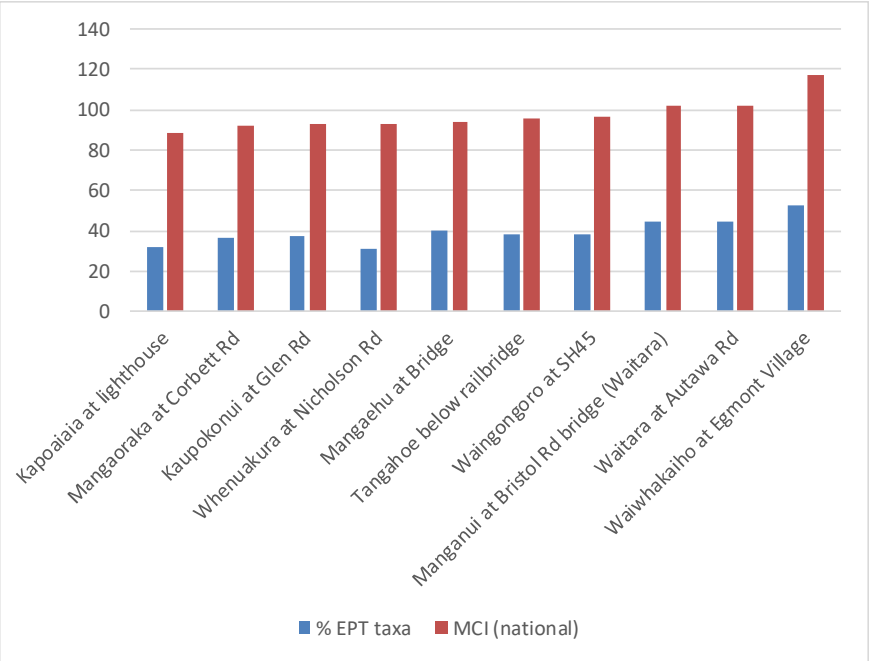


Figure 12: Variation of measures of stream "health (national MCI and %EPT) in ten Taranaki rivers.

7 Method for determining environmental flow requirements

7.1 Minimum flows and allocation to protect the state of the benthic invertebrate community

The combination of minimum flow and allocation affects the "health" of the river, as indicated by the average density of invertebrate taxa with high MCI scores.

Minimum flow and allocation affects the amount of time that the flow is at or below the minimum flow. This is sometimes called "flat-lining, but it is not detrimental unless the flow is "flat-lined" for more than about 30 days without an intervening fresh. This is unlikely in Taranaki rivers where there are frequent freshes (FRE3 >8 as shown in Table 4).

In order to abstract water without restriction, the river flow must be equal to or higher than the minimum flow plus the total allocation. The reliability of supply is the average number of days per year that the flow is less than the sum of the minimum flow and allocation. Total restrictions apply when the river is at or less than the minimum flow.

Nine rivers with mean flows (Table 8) varying from 1.08 m^3/s (Kapoaiaia Stream) to 7.76 m^3/s (Waiwhakaiho River) were analysed.

For each river, flows with the various combinations of minimum flow and allocation were simulated from instream survey data and natural river flows, assuming that all allocated water was abstracted whenever possible. This is conservative because it is unlikely that the maximum abstraction would occur all through the year, and in many cases abstraction is unlikely to reach the maximum allocated.

Instream habitat survey sites and long-term flow records were not necessarily collected at the same locations (Fig. 13). Factors used for estimating values for rivers without flow recorders at the instream habitat site are listed in Appendix II.

Table 8: Nine rivers with instream habitat survey data that were analysed to determine the effects of minimum flow and allocation on the index of benthic invertebrate density for high MCI scoring taxa and their estimated means and 7-day mean annual low flows (MALF).

River	Mean flow (m^3/s)	MALF (m^3/s)
Kapoaiaia Stream at lighthouse	1.08	0.25
Kaupokonui River at Skeet Road	1.58	0.375
Manganui River at Croyden Road	4.17	1.16
Mangaoraka River at Corbett Road	1.99	0.23
Patea River at Stratford	1.64	0.25
Tangahoe River below railbridge	4.33	0.972
Waingongoro River at Normanby	6.45	1.15
Waiongana Stream at SH 3A	2.49	0.38
Waiwhakaiho River at Egmont Village	7.76	1.83

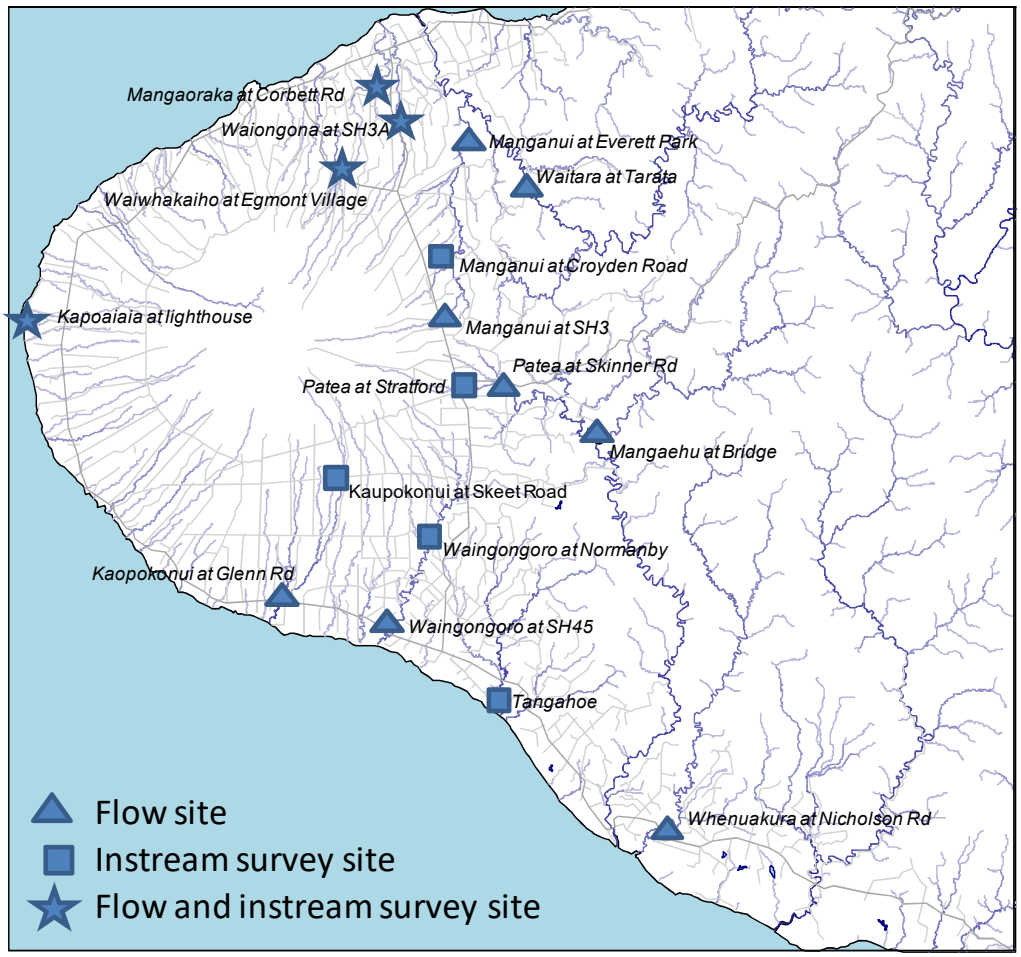


Figure 13: Location of flow monitoring sites and instream habitat surveys mentioned in text.

The benthic invertebrate protection level is the index of benthic invertebrate density for high MCI scoring taxa with full abstraction as a percentage of the index of benthic invertebrate density for high MCI scoring taxa without any abstraction calculated over 11 years. The number of days per year on which abstraction would be partially restricted and the number of days on which there would be total restriction of abstraction were also calculated over the 11 year period. The average index of benthic invertebrate density for high MCI species and the number of days per year that water restrictions would apply were averaged over the rivers.

The protection level for the benthic invertebrate community varied from 98% with a minimum flow of MALF and 10% abstraction to 77% for a minimum flow of 50% of MALF and 50% abstraction (Table 9, Fig. 14). There was relatively little variation between rivers as indicated by the standard deviations.

Results for each river are shown in Appendix II.

Table 9: Average benthic invertebrate protection levels (as % of benthic index at MALF) and standard deviations for minimum flows from MALF (100%) to 50% of MALF and allocations of 10-50% of MALF.

Allocation as % MALF	Minimum flow as % MALF					
	100	90	80	70	60	50
50	92.0 ± 4.0	89.3 ± 3.9	86.6 ± 4.4	83.4 ± 4.0	80.1 ± 4.6	76.8 ± 5.0
40	93.3 ± 3.2	91.0 ± 3.3	88.6 ± 3.9	85.8 ± 3.6	83.2 ± 4.1	81.1 ± 4.3
30	94.8 ± 2.5	92.8 ± 2.6	90.9 ± 3.2	88.6 ± 3.1	86.8 ± 3.3	85.4 ± 3.4
20	96.2 ± 2.0	94.6 ± 2.2	93.1 ± 2.1	91.7 ± 2.2	90.9 ± 2.4	90.4 ± 2.1
10	97.8 ± 1.4	96.9 ± 1.4	96.2 ± 1.4	95.5 ± 1.4	95.2 ± 1.3	95.0 ± 1.2

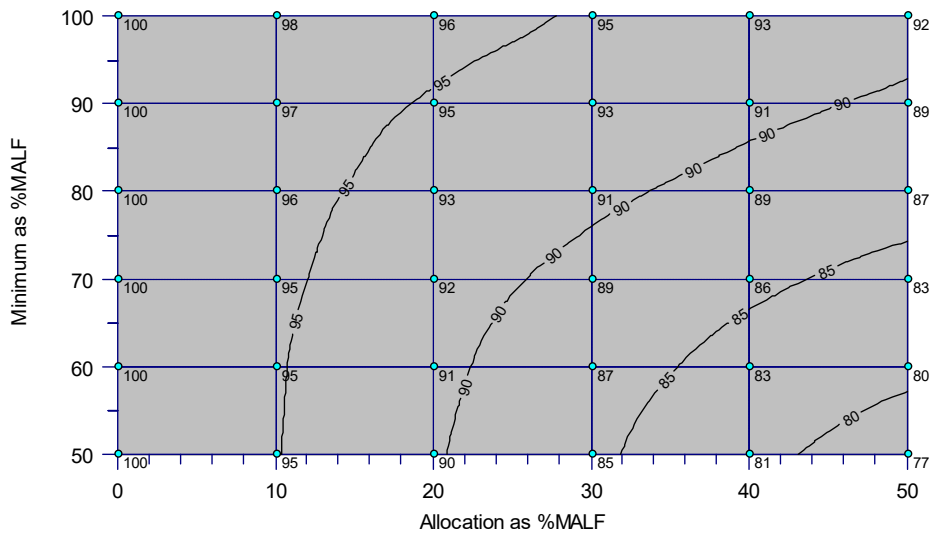


Figure 14: Contours of average percent retention in density of high MCI invertebrate species. Calculated values are shown at intersections of axes.

The number of days that no abstraction would be allowed varied with the minimum flow, from 18 days per year with a minimum of 100% of MALF to no days per year with a minimum flow of 50% of MALF (Table 10). Restrictions varied between rivers as indicated by the relatively high standard deviations (Table 10, Table 11). Rivers to the north and west of Mt Taranaki would provide a more

reliable water supply than those to the south and east. The number of days per year with partial restrictions increased with allocation from 0 to 18 for a minimum flow of 50% of MALF and from 18 to 64 for a minimum flow of 90% of MALF (Table 11, Fig. 15). Increasing allocation by 10% of MALF had a similar effect on partial restrictions as decreasing the minimum flow by 10% of MALF, so that a minimum of 90% of MALF and 30% of MALF allocation resulted in a similar number of restrictions as a minimum of 80% of MALF and an allocation of 40% of MALF.

Table 10: Average number of days per year with total abstraction restriction (i.e., natural flow at or below minimum flow) and standard deviations for minimum flows from MALF (100%) to 50% of MALF and allocations of 10-50% of MALF.

Minimum flow as %MALF	Days per year of full restriction ± std. dev.
100	18.01 ± 8.1
90	8.58 ± 5.8
80	2.97 ± 2.9
70	0.70 ±1.0
60	0.02 ± 0.04
50	0.00

Table 11: Average number of days per year with partial abstraction restriction (i.e., natural flow less than the minimum flow plus total abstraction) and standard deviations for minimum flows from MALF (100%) to 50% of MALF and allocations of 10-50% of MALF.

Allocation as % MALF	Minimum flow as % MALF					
	100	90	80	70	60	50
50	74 ± 19	64 ± 16	53 ± 13	42 ± 11	30 ± 9	18 ± 7
40	64 ± 16	53 ± 13	42 ± 11	30 ± 9	18 ± 7	9 ± 5
30	53 ± 13	42 ± 11	30 ± 9	18 ± 7	9 ± 5	3 ± 2
20	42 ± 11	30 ± 9	18 ± 7	9 ± 5	3 ± 2	1 ± 1
10	30 ± 9	18 ± 7	9 ± 5	3 ± 2	1 ± 1	0 ± 1

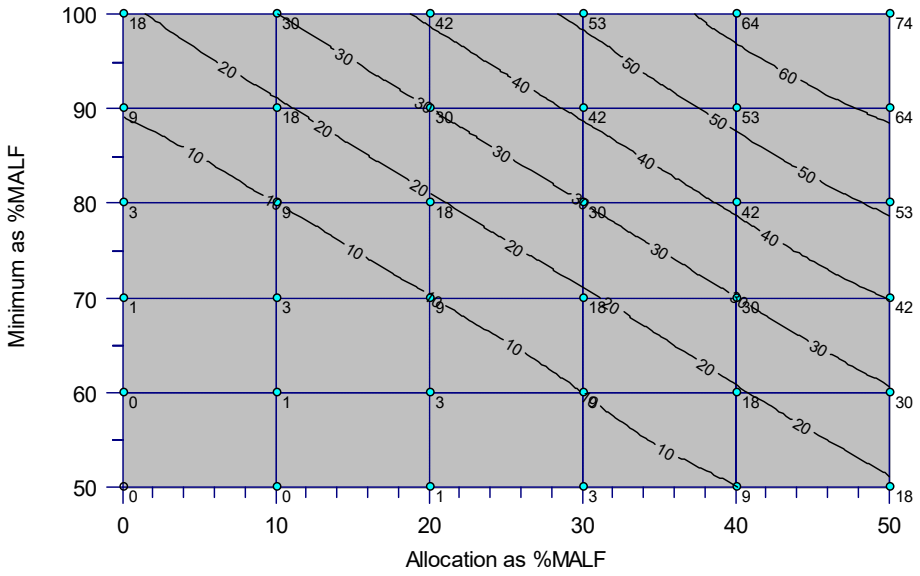


Figure 15: Contours of average number of days per year with partial abstraction restriction. Calculated values are shown at intersections of axes.

7.2 Habitat at 30-day low flow to protect the fish community

As described in Section 3.2, the minimum flow affects the amount of habitat available for aquatic species and at low flows the amount of habitat decreases as the flow decreases for most species. If the flow is at or less than the minimum flow for a sufficient length of time, native fish and trout populations can be affected.

Low flows act as a "habitat bottleneck" for long-lived biota such as trout and native fish. This is because mortality occurs when flows are low and suitable fish habitat restricted, and the population can take several years to recover (Jowett et al. 2008). Flows need to be low for some time, probably 30 days or so, for significant mortality to occur (Jowett et al. 2005). The recovery of a population from a low flow event depends on the life cycle. For trout, the population recovers in 3 or so years if trout spawning is successful (Hayes 1995). For native fish, most species recover in a year. However, if low flows occur year after year then those flows will limit the populations, and in the case of native fish, supply of larvae to the seas around New Zealand would be reduced leading to a general decline in national populations. Hence the concept that the natural MALF, the low flow that occurs every second year or so, is a limiting hydrological parameter for fish populations (Jowett et al. 2008).

The reduction in the amount of habitat at the 30-day MALF can be used as an index of the effect of minimum flows and allocation on fish. For fish species that prefer high velocities and/or deeper water, such as torrentfish and adult trout, there is an almost linear decline in available habitat as flows fall below MALF (Fig. 16). Other fish species, like redfin bullies do not experience such as sharp decline in habitat as flows reduce below MALF and are not affected by the flow reduction until flows are considerably less than MALF (Fig. 16). In assessing the potential effect of reduced flows on fish, the conservative assumption was made that fish habitat declined linearly below MALF, so that the potential effect is the % reduction in the 30-day MALF below the 30-day MALF with no abstraction.

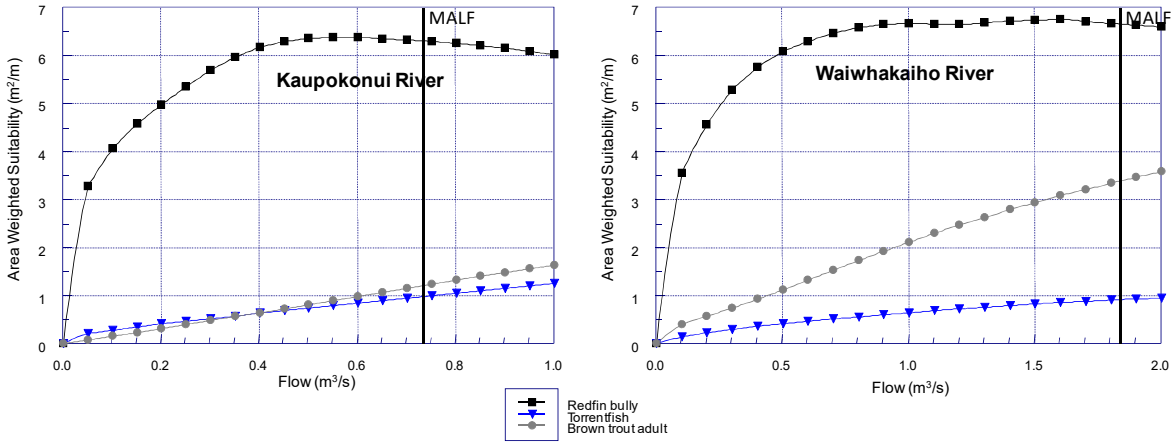


Figure 16: Examples of a linear decline in torrentfish and adult brown trout habitat below MALF compared to the change in redfin bully habitat.

As with the measure of stream "health", it is necessary to set a standard of protection for the reduction in 30-day MALF. With fish populations a change of 20% is likely to be undetectable given the natural variability of the population and annual recruitment from the sea for most native fish species.

Flows in each of the 9 rivers were modelled for various minimum flows and allocations and the 30-day MALF was calculated for each minimum flow and allocation scenario and the average calculated (Table 12, Fig. 17). There was relatively little variation between rivers, as shown by the standard deviations in Table 12.

Table 12: Average reduction in 30-day MALF ± standard deviation below natural 30-day MALF. Fish habitat protection levels are 100 minus the average reduction in 30-day MALF.

Allocation as % MALF	Minimum flow as % MALF					
	100	90	80	70	60	50
50	14.7 ± 2.1	18.7 ± 2.9	23.6 ± 3.5	28.8 ± 3.0	33.0 ± 2.9	36.2 ± 2.7
40	12.9 ± 1.9	16.6 ± 2.8	20.9 ± 3.4	25.2 ± 2.7	28.3 ± 2.3	30.2 ± 2.2
30	10.9 ± 1.7	13.9 ± 2.6	17.3 ± 3.0	20.5 ± 2.1	22.4 ± 1.7	23.3 ± 1.6
20	8.1 ± 1.5	10.3 ± 2.1	12.8 ± 1.7	14.5 ± 1.4	15.4 ± 1.1	15.7 ± 1.1
10	4.6 ± 0.9	5.7 ± 1.2	6.9 ± 0.8	7.6 ± 0.6	7.8 ± 0.6	7.9 ± 0.6

Contour plots of % reduction in MALF versus allocation and minimum flow are shown for each river in Appendix II.

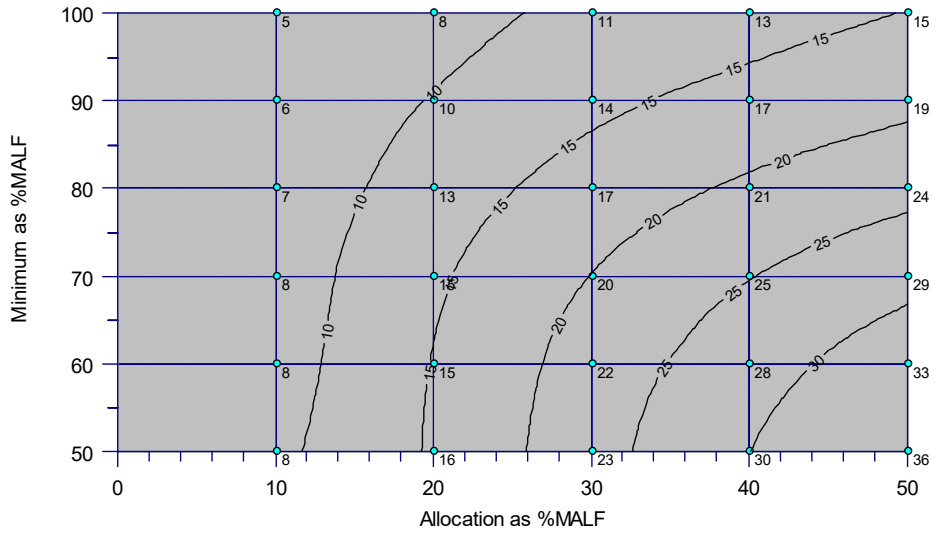


Figure 17: Contours showing the average reduction in 30-day MALF below natural 30-day MALF

8 Review of environmental flows in Draft Plan

The Council's Draft Plan specifies a minimum of 90% of MALF for rivers with a mean flow less than 5 m^3/s and a minimum flow of 80% of MALF for rivers larger than 5 m^3/s. The Draft Plan also specifies a maximum allocation of 30% of MALF for rivers with a mean flow less than 5 m^3/s and 50% of MALF for rivers larger than 5 m^3/s.

Only two of the nine rivers analysed had larger mean flows than 5 m^3/s. These were the Waiwhakaiho and Waingongoro. For the same minimum flows and allocations[19], there were no significant differences between the benthic invertebrate protection levels in these two rivers and the levels in the other 6 rivers (Kruskal-Wallis, $P > 0.55$).

Thus, there does not appear to be much difference between the flow requirements in rivers with flows greater than 5 m^3/s and those with flows less than 5 m^3/s. However, the two larger rivers had mean flows that were only slightly greater than 5 m^3/s and it is possible that a flow requirements in larger rivers (e.g., with mean flows greater than 10 m^3/s, such as the Waitara) might be differ from those analysed here. Specific studies would be needed to determine flow requirements in the lower Waitara River.

There is a high degree of correlation between the benthic invertebrate protection levels and the fish protection levels.

Benthic invertebrate protection level = 0.61x Fish protection level+40 $r^2 = 0.99$

The Draft Plan specifies a minimum of 90% of MALF and an allocation of 30%. This would give a benthic invertebrate protection level of 93% (Table 9) and a fish protection level of 86% (Table 12).

A minimum flow of 85% of MALF and a maximum allocation of 40% of MALF would give protection levels of 80% for fish populations and 90% stream "health" (Table 13). There would be up to 49 days

[19] as a % of their respective MALFs

per year with total abstraction restriction, but this would reduce significantly if actual allocation were 30% or less.

Table 13: Minimum flows, allocations and days of partial and total restriction for protection levels of 95% to 85%. Protection levels are percentages of benthic invertebrate production or fish habitat relative to benthic production and habitat at MALF

Benthic protection level	Fish habitat protection level	Minimum flow as % MALF	Allocation as % MALF	Days of partial restriction per year	Days of total restriction per year
95	90.2	50	10	0	0
		90	20	30	8.6
		100	30	53	18.0
90	82.0	55	20	2	0
		76	30	24	1.8
		86	40	48	5.8
85	73.8	50	30	3	0
		66	40	30	0.4
		74	50	47	1.7

The current minimum flow requirement of 66% of MALF[20] would give a fish habitat protection level of 77% and 87% benthic invertebrate protection at an inferred abstraction level of 33% of MALF. The number of days with partial and total restrictions would be 18 and 0 days, respectively.

9 Recommended environmental flow limits for Taranaki

9.1 Application of environmental flow limits in freshwater management units

The analyses of hydrology, fish communities, benthic invertebrate indices and water quality in the rivers of the B and D FMUs did not show any strong differences other than lower runoff and higher turbidity in the FMU D eastern hill country than in the ring plain rivers of FMU B. Thus with the data available, there does not appear to be any ecological reason for setting different flow limits in these two FMU zones. There is little data for the northern and southern coastal zones and if streams in these areas have good access to the sea, then there would be no ecological reason for different flow limits.

9.2 Protection levels

Two types of protection level can be applied. The first is to protect the state of the benthic invertebrate community and the second is to protect the fish community.

Benthic invertebrate density is related to trout abundance, benthic invertebrates are most abundant in riffles, where native fish are also most abundant, and MCI was identified as the one measure that was most closely related to Maori cultural values (Tipa & Teirney 2003).

[20] The existing minimum flow requirement where the minimum flow retains 66% of the habitat available for adult brown trout and food production available at mean annual low flow (MALF) is equivalent to 66% of MALF in small streams because the relationship between trout and food habitat and flow is linear at low flows.

The life cycle of fish is longer than that of benthic invertebrates and the density of trout and native fish, particularly those that are found in swift water, can be limited by low flows if they persist for long enough. The reduction in the 30-day MALF was used as a conservative indicator of the potential effect on fish species. It is conservative because if the density of fish is low, a reduction in habitat is likely to result in a redistribution of fish rather than a loss of fish. It is also conservative for other fish species whose habitat is not affected by flow reductions as much as that of torrentfish and adult trout.

The state of the benthic invertebrate community was represented by the average benthic invertebrate density[21] for taxa with high MCI scores. This average was calculated for the natural river flows over the full flow record (11 years) and for the river flows assuming that full abstraction was occurring according to the minimum flow and allocation. The protection level is the predicted benthic invertebrate density with abstractions as a percentage of the natural benthic invertebrate density.

The index of average benthic invertebrate density for high MCI scoring taxa will help meet MCI requirements of the National Policy Statement for Freshwater Management (MfE 2015). High MCI will also lead to high biodiversity.

The fish community protection level was that full application of the abstractions should not reduce the 30-day MALF by more than a percentage of the natural 30-day MALF. This is intended to protect the habitat and populations of trout and native fish species with high flow demands such as torrentfish. In some streams, there may be no fish access to the sea because of cliffs and waterfalls. If this were the case the fish protection level could be relaxed.

9.3 Minimum flow and allocation

The analyses carried out in Section 8 give a large number of choices for an appropriate minimum flow and allocation. Table 14 shows some of the possible choices. The alternative choices provide a fish protection level of 80% on the basis that the effects of a 20% reduction in the fish protection level is probably not detectable and that the reduction would only occur if the fish population were habitat limited. Similarly, a reduction of 10% in the state of the benthic invertebrate community is small and probably not detectable.

For example, the average number of large and medium-sized trout per kilometre of Taranaki rivers was about 19 per kilometre or 13 per hectare (Teirney & Jowett 1990). Alternative 2 in Table 14 would reduce trout protection level by 17% and benthic production by 9%. Applying the brown trout model (Jowett 1992) using average parameters for Taranaki rivers, this option would reduce trout numbers from 19 to about 15 per kilometre (from 13 to 10 per hectare), assuming that the trout density is controlled by habitat (fish protection level) and food (benthic protection level). The number of large trout (> 40 cm) would reduce from 7.4 per kilometre to 5.9 per kilometre. Alternative 1 would have a similar effect on trout. The current plan would reduce large plus medium trout numbers to about 13.6 per kilometre and the Draft Plan would reduce them to 15.8 per kilometre.

Actual effects on the benthic invertebrate community are probably less than would be indicated by the protection levels because the effects were calculated assuming that the maximum allowable allocation was abstracted all through the year and this would rarely be the case.

[21] The calculation gives an index of density

Table 14: Possible choices of minimum flows and allocation and the protection levels that they provide.

Description	Minimum flow as % MALF	Allocation volume as % MALF	Benthic invertebrate protection level	Fish protection level	Days of partial restriction
Current plan	66	33	87	77	18
Draft Plan	90	30	93	86	42
Alternative 1	85	40	90	81	46
Alternative 2	80	30	91	83	30

There are 45 Taranaki rivers or catchments with consents to abstract water. In these, the total amount of water allocated in the consents is more than 30% of MALF in 36% of the rivers, more than 33% in 27% of rivers and more than 40% of MALF in 24% of rivers. The median amount of water allocated in the consents for Taranaki rivers or catchments is 19% of MALF.

The large abstractions were often from lakes or reservoirs, from streams where there is no access to the sea, or for public water supplies.

Rather than setting a single allocation and minimum flow for all catchments, consideration could be given to:

- Setting the minimum flow according to the total catchment allocation, so that catchments with low demand could have a low minimum flow and high reliability of supply.
- Accepting reduced protection levels for abstractions where the consequences of a reduction in take might have serious effects on public health or the economy, as in Policy 2.3 of the Draft Plan. These could be listed in a schedule in the Plan.
- Varying protection levels according to the values listed in schedules of the Draft Plan.

There did not seem to be any reason to vary the limits with river size, but the mean flows in the rivers studied were all less than 10 m^3/s. It is possible that a lower minimum flow and higher allocation might apply to rivers with mean flows greater than 10 m^3/s.

9.4 Flat-lining

The length of time at or below the minimum flow is not sufficiently long to cause any problems with periphyton growth because of the frequent floods and freshes that occur in Taranaki rivers.

9.5 Reliability of supply

The environmental limits would cause problems in rivers where the full allocation is taken up. Restrictions on the amount of water taken would occur on up to 50 days per year on average and these would mainly be in the season of high demand for irrigation and water supply. An increase in the reliability of supply could be achieved by a reduction in total allocation or decrease in minimum flow. Such cases would need to be considered on a catchment by catchment basis considering the seasonal water needs, the effects of restrictions, and the possibility of group schemes (Section 5.3).

9.6 Flexibility

A regional minimum flow and allocation as proposed is simple but not all rivers are the same. For example, spring-fed streams and rivers larger than 10 m^3/s might merit special treatment in terms of environmental flow and there seems to be limited information on the coastal streams of FMU C.

It is impossible for a plan to foresee all possible future developments and some of these might be of high economic or social value, such as municipal takes and energy projects. The minimum flows and allocation limit in the plan should not prevent such future development and the consent process would allow appropriate limits to be adopted after consideration of instream values and effects of abstraction or diversion.

10 Stakeholders

The setting of minimum flows and allocation limits is a collaborative process that involves the Regional Council and community in order to achieve the best water management outcomes for the region. This report has been prepared to inform this process by advising on some principles of flow assessment, relevant scientific research and by carrying out analyses to determine the environmental effects of various combinations of minimum flow and allocation. It is probably the first study that has explicitly examined the environmental effects of minimum flow and allocation together.

The key to deciding appropriate levels of minimum flow and allocation is to decide on protection levels. The levels suggested in this report are broadly based on limits that are seen as acceptable by some other regional councils and in the MfE (2008) discussion document. However, invariably some stakeholders might want lower standards and others higher standards.

Stakeholder involvement is important and a series of workshops is recommended to be held to discuss the findings of this report, particularly the levels of protection and the suggested minimum flow and allocation for various types of take. The Taranaki Regional Council intends to use this report to inform these community discussions from a technical perspective.

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12 Appendix I – Instream Habitat Analysis

Modelling of instream habitat availability for selected species, over a range of flows, is a valuable tool when assessing potential effects of flow changes and making decisions about environmental flow requirements. This method is one of the most commonly used methods of assessing flow requirements (Tharme 2003). The background to methods used here is discussed in Jowett et al. (2008).

Habitat modelling entails measuring water depths and velocities, as well as substrate composition, across a number of stream cross-sections at a given flow (referred to as the survey flow). Points on the banks, above water level, along the cross-sections are also surveyed to allow model predictions to be made at flows higher than the survey flow. Calibration data for fitting rating curves are obtained from additional measurements of water level at each cross-section, relative to flow, on subsequent visits. The stage (water level) with no flow in the river (stage of zero flow) is also estimated at each cross-section to help fit rating curves. These data allow calibration of a hydraulic (instream habitat) model to predict how depths, velocities and the substrate types covered by the stream will vary with discharge in the surveyed reach.

12.1.1 Habitat mapping

The first step in the process is to carry out habitat mapping along the length of the reach between the dam and tailrace locations. The habitat types are assessed in the field after traversing the affected reach. The habitats would typically be classified as riffle, run, pool, and rapid. The length and location of each habitat type is recorded.

12.1.2 Cross-section selection

The number of cross-sections required depends on the morphological variability within the river, with homogenous stretches of river requiring fewer cross-sections than stretches that are highly varied morphologically. Studies have shown that relatively few cross-sections can reproduce the results from a survey in which a large number of cross-sections were sampled (see Jowett et al. 2008 for details).

The total number of cross-sections needed to generate a robust result should be proportional to the complexity of the habitat hydraulics, with 6 to 10 sampled for simple reaches and 18 to 20 for diverse reaches.

Each cross-section is given a percentage weighting based on the proportion of the habitat type in the reach that it represents. The underlying assumption is that the cross-sections measured provide a reasonable representation of the habitat throughout the reach. Reach results can be extended to longer sections of river, if the flows, river gradient and morphology do not change significantly.

12.1.3 Analysis

The procedure in an instream habitat analysis is to select appropriate habitat suitability curves or criteria (e.g., Fig. A1), and then to model the effects of a range of flows on the selected habitat variables in relation to these criteria. The habitat suitability index (HSI) at each point is calculated as a joint function of depth, velocity and substrate type using the method shown in Figure A1. Using the example in Figure A1, a given point in the river (representing an area of reasonably uniform depth and velocity) where the depth is 0.1 m, depth suitability is only 65% optimal, according to knowledge of the depth requirements of the fish. Similarly, the velocity recorded at the point is 0.25 m/s, which is optimal (suitability weighting of 1), and the substrate is fine gravel (sub-optimal, with a weighting of 0.4) and cobbles (optimal with a weighting of 1). Multiplying these weighting factors together

gives a joint habitat suitability weighting of 0.455 for that point in the river for the selected fish species. If the depth had been 0.2 m and there had been only cobbles, then that point in the river would have been optimal (i.e., 1 for depth × 1 for velocity × 1 for substrate = 1).

The point suitability values weighted by their respective areas are summed to give a measure of area weighted habitat suitability (AWS) for the given species at the given flow. This process is repeated for a series of flows with the depths, velocities, and habitat suitability being modelled for each flow.

Area weighted suitability plotted as a function of flow shows how habitat for a given species varies with flow (Fig. A2). These graphs are then used to assess the effect of different flows for target organisms. Flows can then be set so that they achieve a particular management goal.

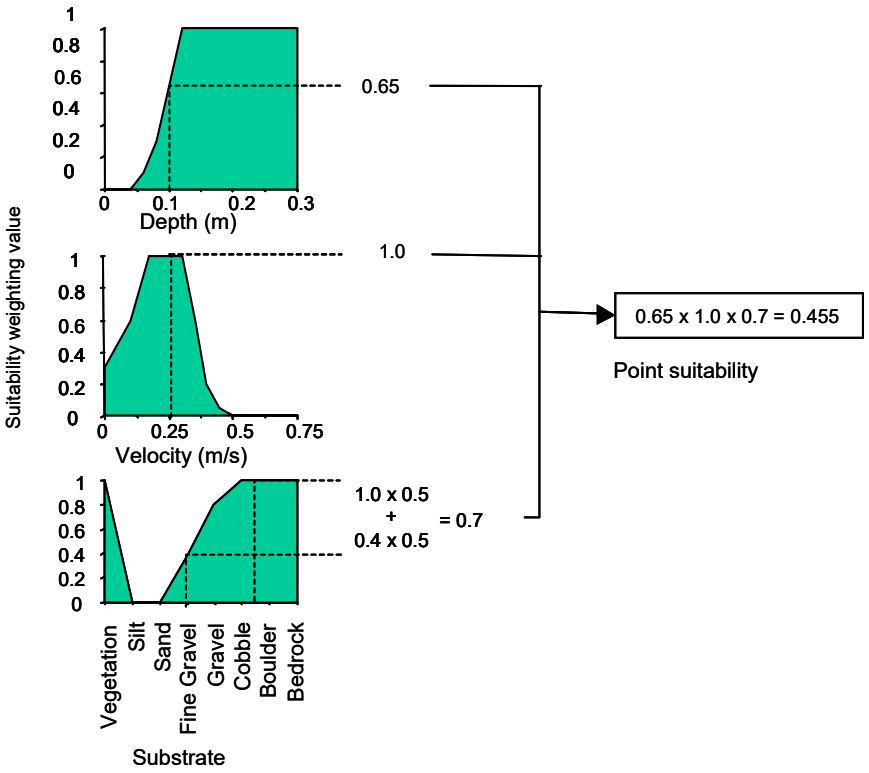

Figure A1: Calculation of habitat suitability for a fish species at a point with a depth of 0.1 m, velocity of 0.25 m/s, and substrate comprising 50% fine gravel and 50% cobble. The individual suitability weighting values for depth (0.65), velocity (1.0), and substrate (0.7) are multiplied together to give a combined point suitability of 0.455.

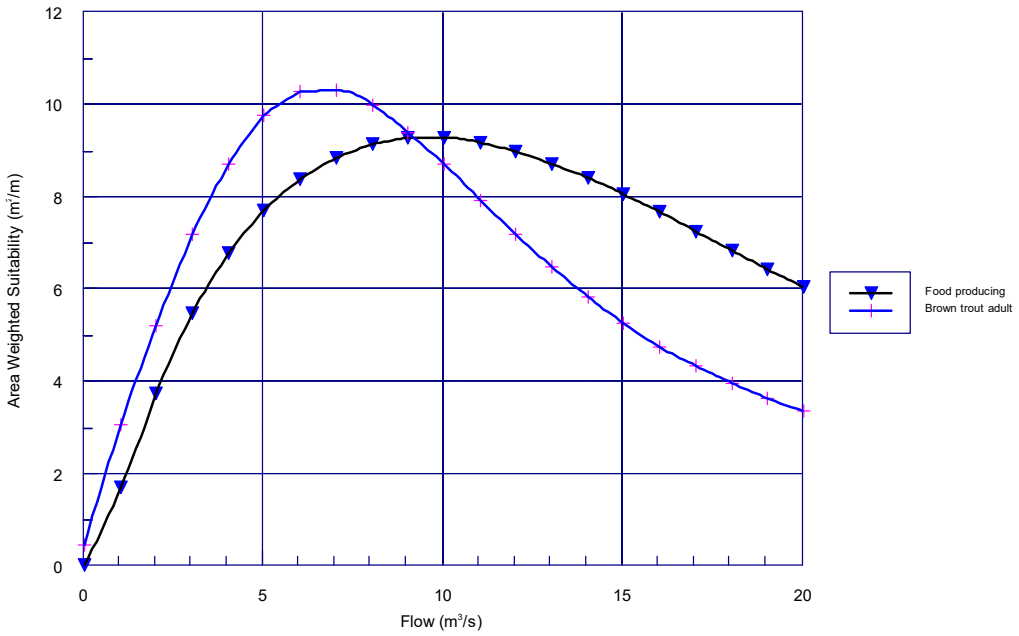

Figure A2: Example of graph showing how area weighted habitat suitability for adult brown trout and food production varies with flow.

13 Appendix I

5.2 Renewable Power Ltd

Policies 7.5 – 7.9	Opposed to the minimum flow requirements for rivers as it limits economic opportunity.

5.16 Contact Energy

	Supports in particular the introduction of minimum flows and river allocation limits
Minimum flows	Understands the reasons for needing to have minimum flows and river allocation limits. However, note concerns if water take is reduced too far, they may no longer be able to generate electricity as efficiently and cleanly as they can now, or at all.

5.24 DairyNZ

POL 7.5	Have serious concerns about the proposed blanket application of minimum flows, as it is not clear how this will impact on the reliability of supply for existing water users.
	Request defining allocable flows for water bodies must be set according to whichever is the greater of: - Existing consented and permitted water takes, or - A default method such as is currently proposed.
	Add a policy relating to review of consents for reasonable and efficient use if there is need for a minimum flow.
	Add an exception for dairy shed water takes and animal drinking water
Rule 46	As noted in relation to policies 7.5, 7.7 and 7.8, concerned about the imposition of minimum flows on existing consents, without a clear understanding of the impacts on security of supply for existing users. Suggest amending rule 46 to read: *'…(a) Actions to be taken when water bodies are at or below minimum flows…'*

5.27 Taranaki Fish and Game

Water takes	Suggest including provisions around ensuring that any takes are assessed against criteria which determines whether they are necessary, reasonable and efficient
	Suggest the renewal of existing consents should be required to meet plan requirements including ensuring that the take is first necessary and where it can show the take and use is necessary, the rate of take and volume taken should also have to be reasonable, given application of efficiency criteria
	Suggest existing takes should only be assessed as a controlled activity if they meet the conditions above and also meet the allocation and minimum flow limits and targets set in the Plan
	Suggest when existing takes fail to meet reasonable and efficient requirements, and/or fall outside of allocation limits and targets (core allocations and minimum flow) they should be assessed as discretionary activities
	Suggest where existing takes fall within over allocated catchments they will need to be clawed back over time
Allocation limits	Suggest that a new category be created within FMU B where water use is limited to no more than the existing level of use.
	Amend Policy 7.7 to clarify that MALF means the natural MALF unaffected by water takes and that as well as applying at the site of each take, the limits are also an overall catchment core allocation limit
	Suggest the inclusion of a new policy similar to that set out below. This should also apply to minimum flows: *The setting of limits for water quantity will be managed in a manner which:* ***(a)*** *Sustains the life supporting capacity of water bodies; and* ***(b)*** *Provides for the natural character of the waterbody which includes;* ***(i)*** *Natural elements, processes and patterns*

	(ii) *Biophysical, ecological, geological, geomorphological and morphological aspects; and* **(iii)** *The natural movement of water and sediment including hydrological and fluvial processes*
POL7.7	Amend to include a total water allocation limit for the Hangatahua (Stony) River of 30l/s
POL7.8	Suggest amending so that a minimum flow of MALF applies in FMUs A and B and in the small stream catchments (mean flow <5 cumecs) in FMU C

5.34 Department of Conservation

POL7.7	Would like to discuss the relationship between 7.7 and 7.8 to better understand how they work together.
	Seek clarification to understand whether Policy 7.7 is intended to apply per consented take, or cumulatively
	State that it is unclear how the provision for replacement of existing consents in Policy 7.5(b) will achieve the environmental outcomes sought by the policy.
POL7.8	Supports the minimum flow limits for FMUs A and B which are in line with the proposed NES
	Considers the minimum flow of MALF low for FMUs C and D. Refer to the proposed NES Suggest amending to: *(c) in Freshwater Management Units C and D is at or below:* *(i) ~~80%~~ 90% of the mean annual low flow for rivers with mean flows less than or equal to 5m³/s; or* *(ii) 80% of the mean annual low flow for rivers with mean flows greater than 5m~~3~~/s ~~in Freshwater Management Units C and D; and~~*
	State that allocation limits for FMUs C and D have been set based on river/stream size, so it seems appropriate to do the same for minimum flows
	Questions if TRC has considered minimum water levels for wetlands
	Supports provision (d) which provides for pest fish eradication

5.4 Nga Ruahine

POL 7.7	Suggests that MALF levels set at 50% seems high even for large rivers. Would like more information/clarification around this.
POL 7.8	Would like clarification around MALF (7.7 and 7.8). Believes these points are contradictory.

5.32 Methanex NZ Ltd

Reference in the Draft Plan	Comment/decision sought
POL7.7	Seeks clarification on how the proposed allocation limits will be set for a site, whereby water is sourced from across two freshwater management units, as is the case for the Waitara River. As allocation data is not currently available, uncertainty exists to whether the current allocation limits will remain or be amended through the plan process. States that the availability of the allocation information is critical to making an informed submission on the draft plan

5.38 Trustpower

POL7.4, 7.5, 7.6, 7.7, 7.8	Support this policy

14 Appendix II

14.1 Waiwhakaiho River

The instream habitat survey for this river is described in Jowett (1993).

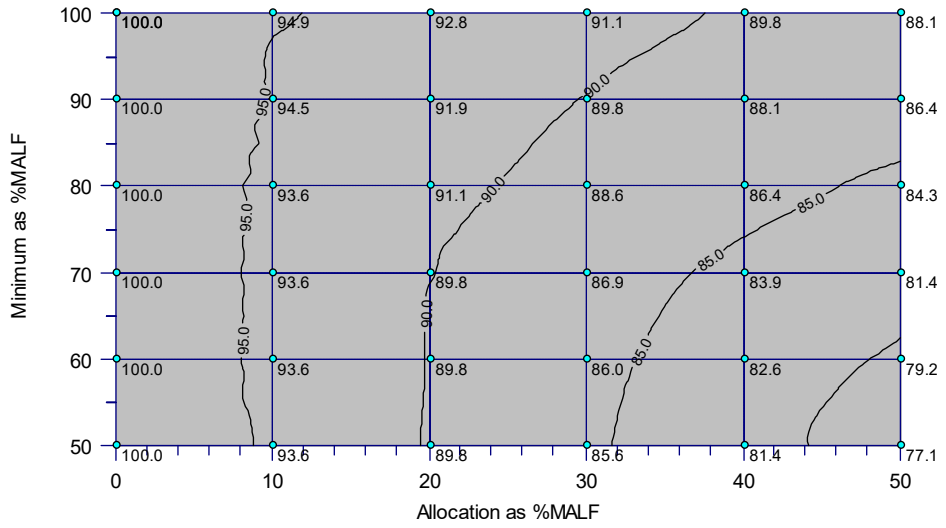

Figure A3: Contours of percent retention in density of high MCI invertebrate species for the Waiwhakaiho River. Calculated values are shown at intersections of axes.

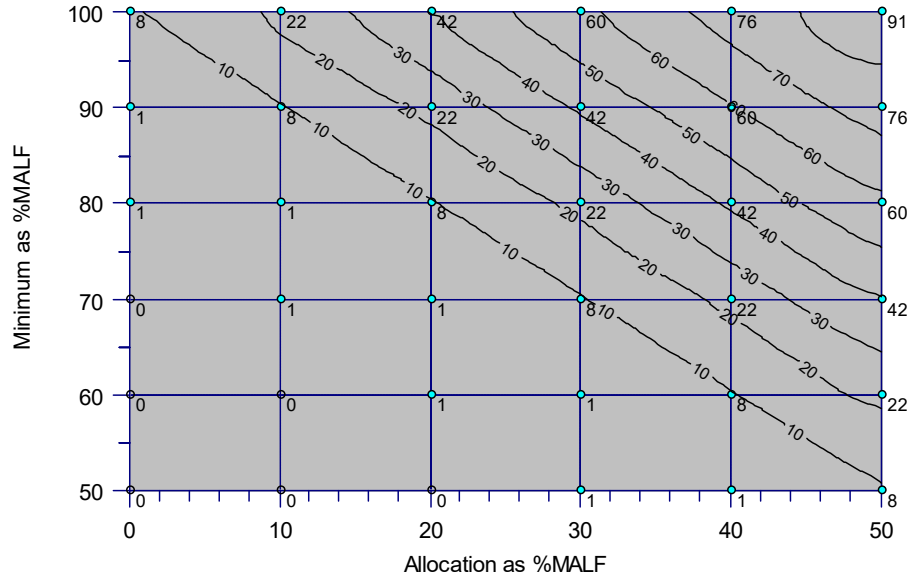

Figure A4: Contours of the average number of days per year of partial restrictions to abstraction from the Waiwhakaiho River. Calculated values are shown at intersections of axes.

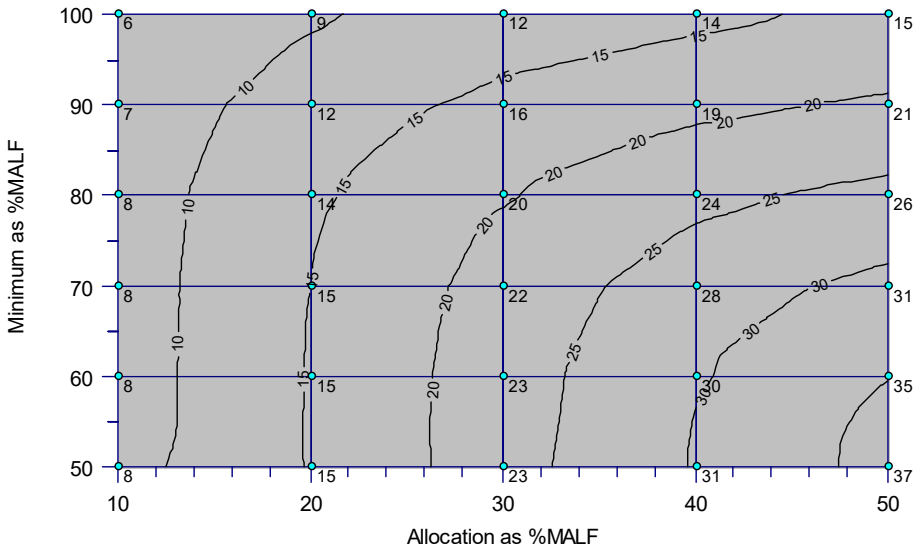

Figure A5: Contours of percent reduction in 30-day MALF from the Waiwhakaiho River. Calculated values are shown at intersections of axes.

14.2 Kaupokonui River

The instream habitat survey data for the Kaupokonui River were obtained at Skeet Road (Jowett 1993). The catchment area at Skeet Road is about half that of the flow recording site at Glenn Road, so Glen Road flows were divided by two before calculating indices of benthic invertebrate density for high MCI scoring taxa.

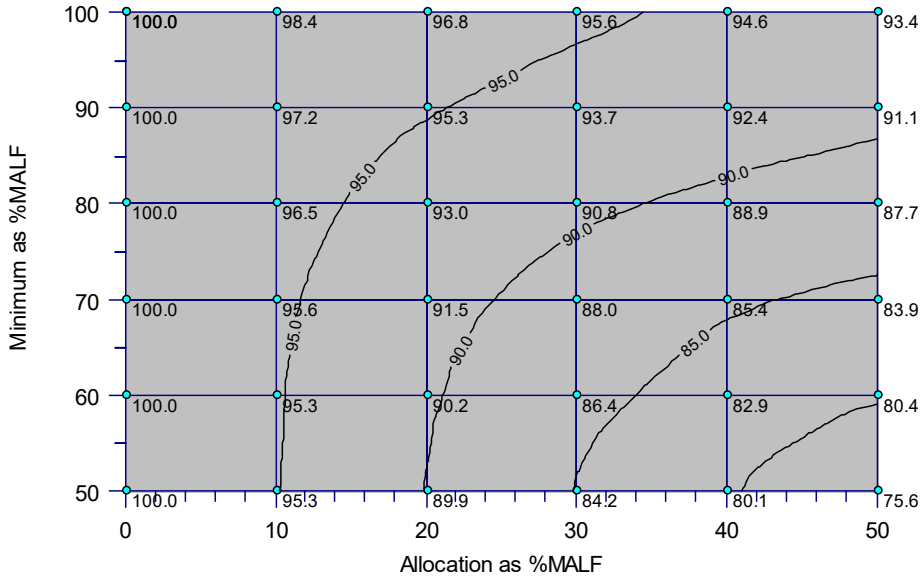

Figure A6: Contours of percent retention in density of high MCI invertebrate species for the Kaupokonui River. Calculated values are shown at intersections of axes.

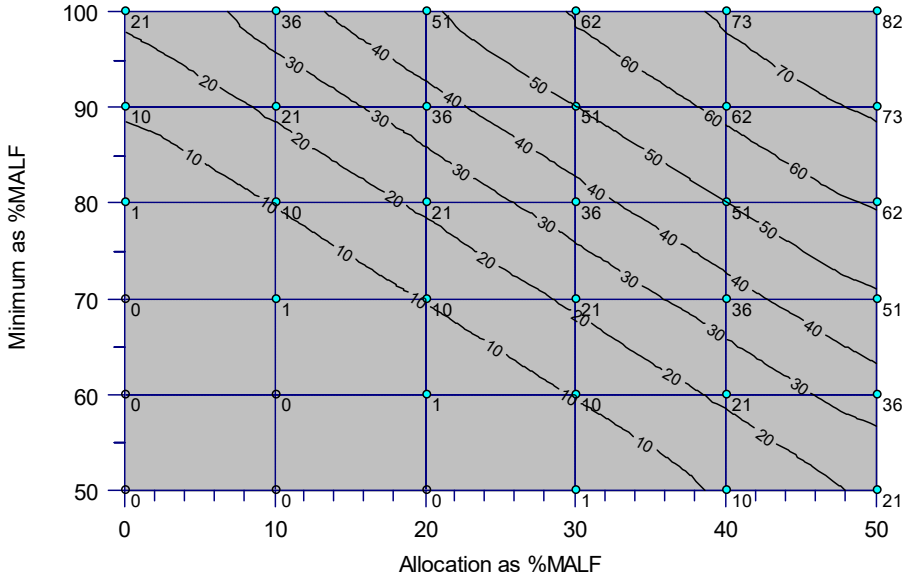

Figure A7: Contours of the average number of days per year of partial restrictions to abstraction from the Kaupokonui River. Calculated values are shown at intersections of axes.

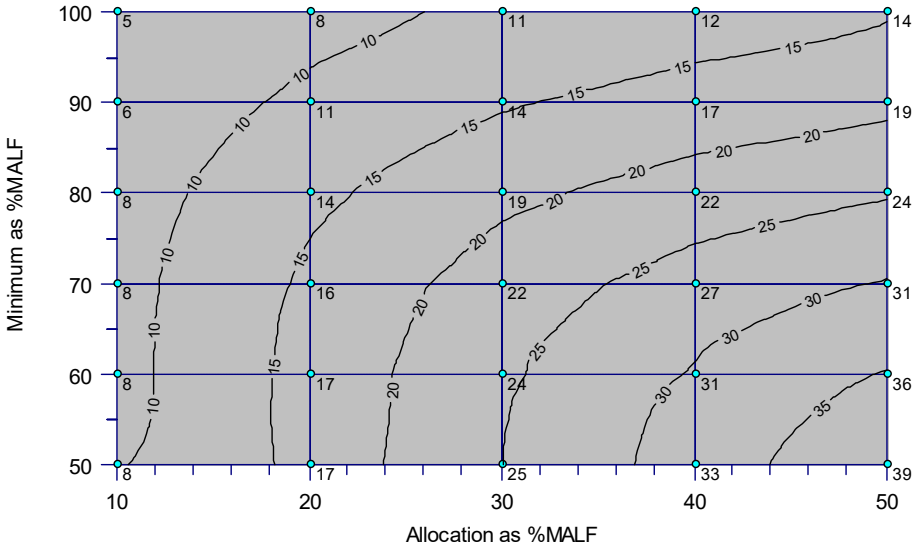

Figure A8: Contours of percent reduction in 30-day MALF from the Kaupokonui River. Calculated values are shown at intersections of axes.

14.3 Kapoaiaia Stream at lighthouse

The instream habitat survey for this Stream is described in Jowett (1993).

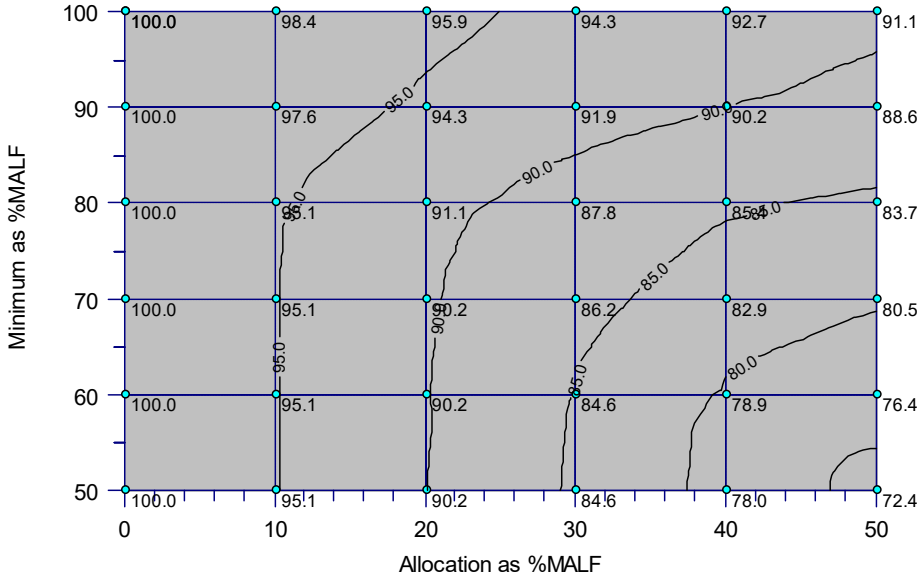

Figure A9: Contours of percent retention in density of high MCI invertebrate species for the Kapoaiaia Stream. Calculated values are shown at intersections of axes.

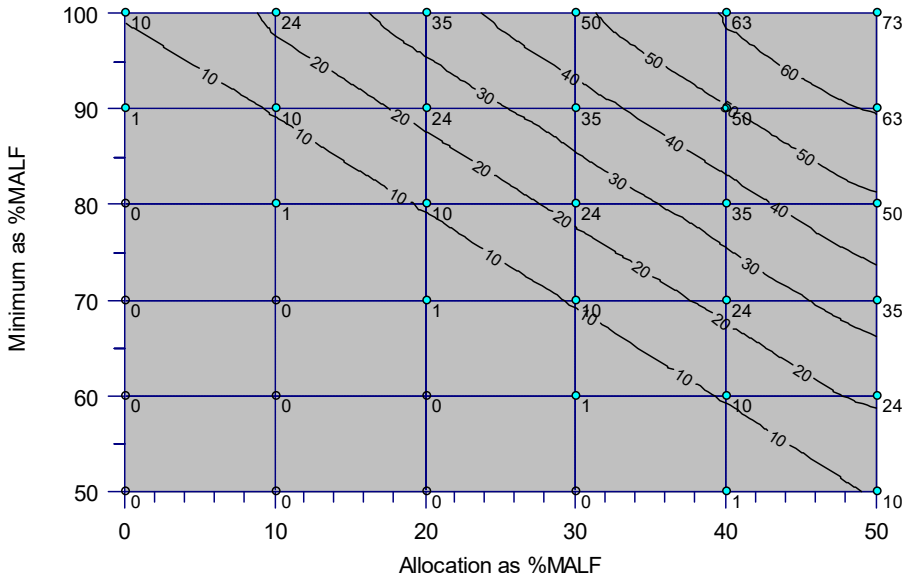

Figure A10: Contours of the average number of days per year of partial restrictions to abstraction from the Kapoaiaia Stream. Calculated values are shown at intersections of axes.

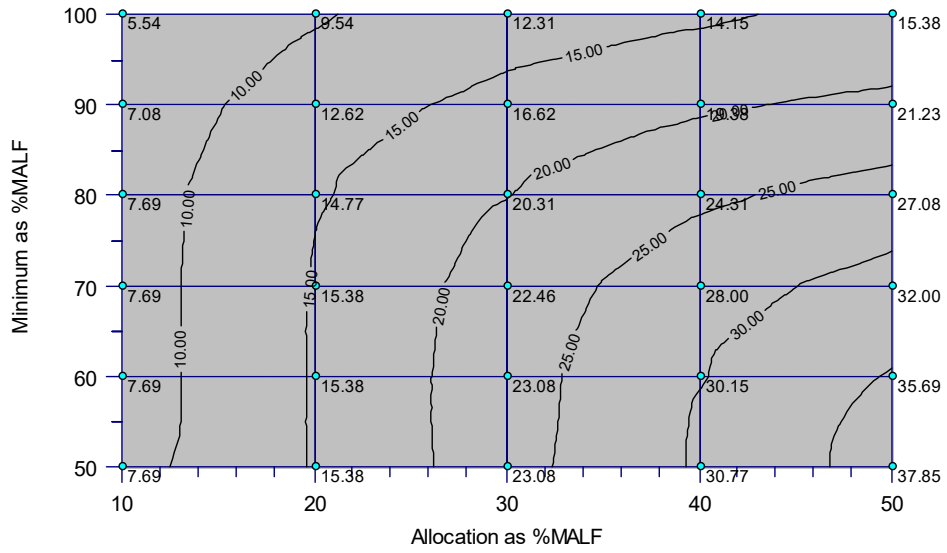

Figure A11: Contours of percent reduction in 30-day MALF from the Kapoaiaia Stream. Calculated values are shown at intersections of axes.

14.4 Patea River at Stratford

The instream habitat survey data for the Patea River were obtained at Stratford (Jowett 1993). The catchment area at Stratford is one third that of the flow recording site at Skinner Road, so Skinner Road flows were divided by one third before calculating indices of benthic invertebrate density for high MCI scoring taxa.

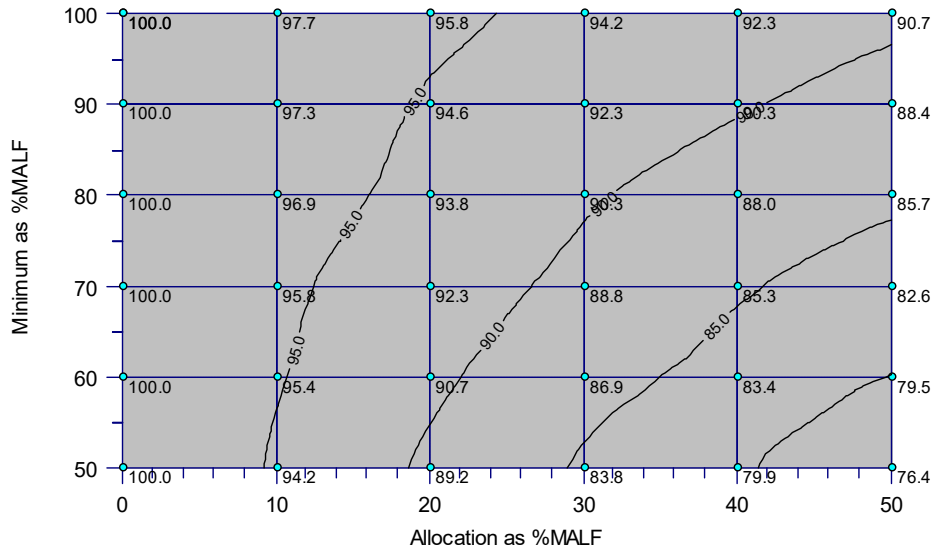

Figure A12: Contours of percent retention in density of high MCI invertebrate species for the Patea River. Calculated values are shown at intersections of axes.

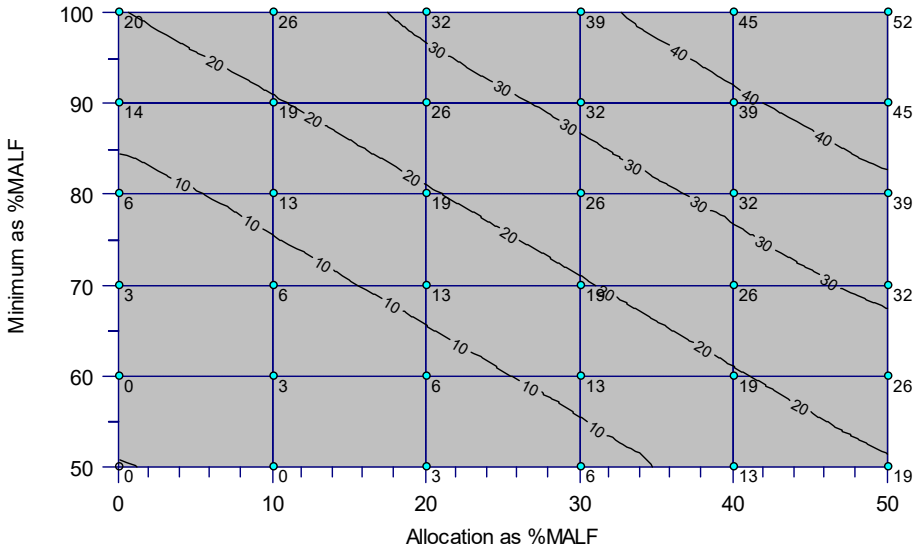

Figure A13: Contours of the average number of days per year of partial restrictions to abstraction from the Patea River. Calculated values are shown at intersections of axes.

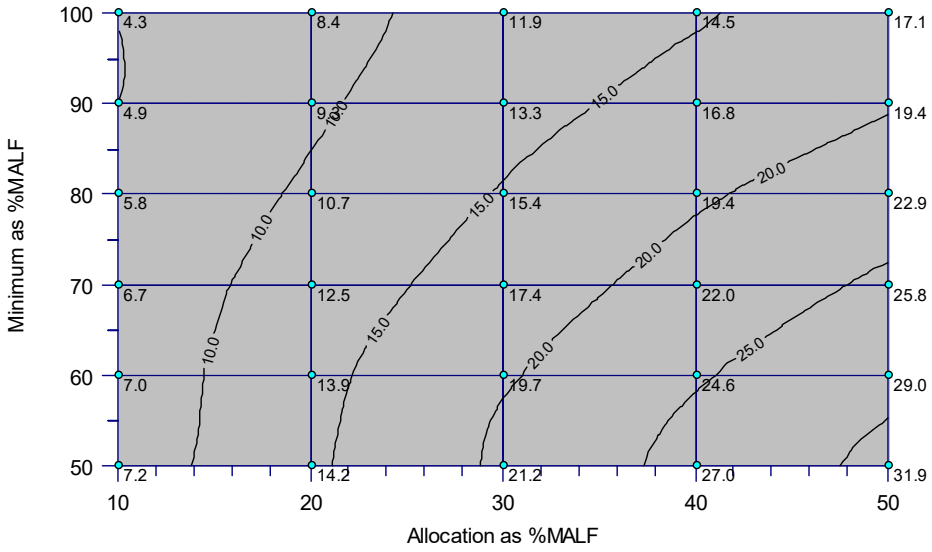

Figure A14: Contours of percent reduction in 30-day MALF from the Patea River. Calculated values are shown at intersections of axes.

14.5 Tangahoe River

There are no instream habitat survey data for the Whenuakura River so survey data from the Tangahoe River were used instead (Jowett 2014). The Tangahoe catchment is similar to that of the Whenuakura in that it drains the sedimentary eastern hill country. Both the flow recording site on the Whenuakura River and the Tangahoe instream survey data are near the coast. A short period of flow record for the Tangahoe River established that the Tangahoe River flow was 0.4337 times the

flow in the Whenuakura River. Whenuakura River flows were divided by 0.4337 before calculating indices of benthic invertebrate density for high MCI scoring taxa.

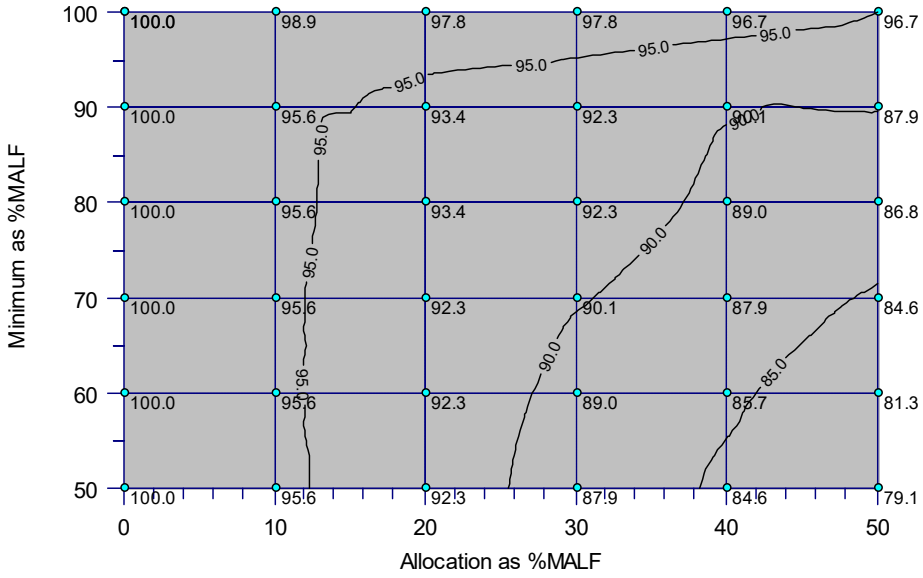

Figure A15: Contours of percent retention in density of high MCI invertebrate species for the Tangahoe River. Calculated values are shown at intersections of axes.

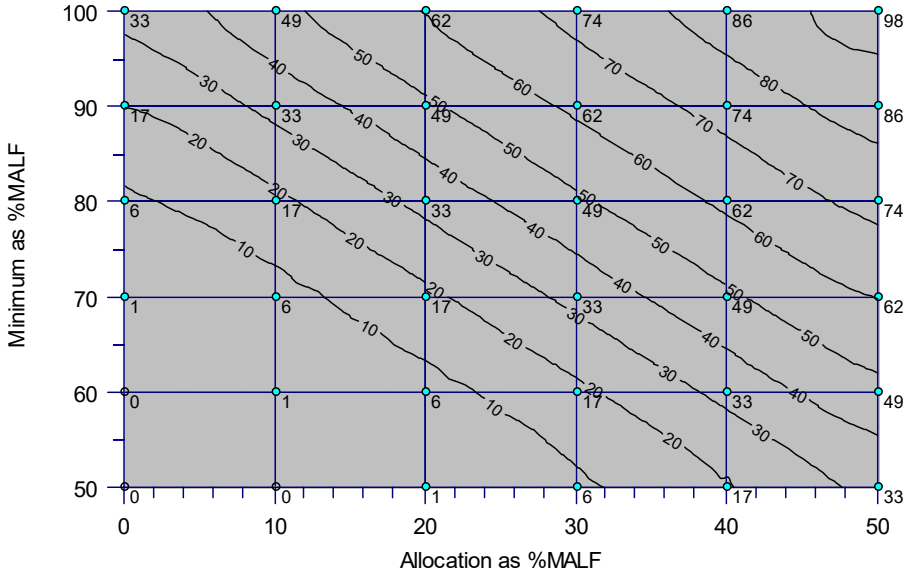

Figure A16: Contours of the average number of days per year of partial restrictions to abstraction from the Tangahoe River. Calculated values are shown at intersections of axes.

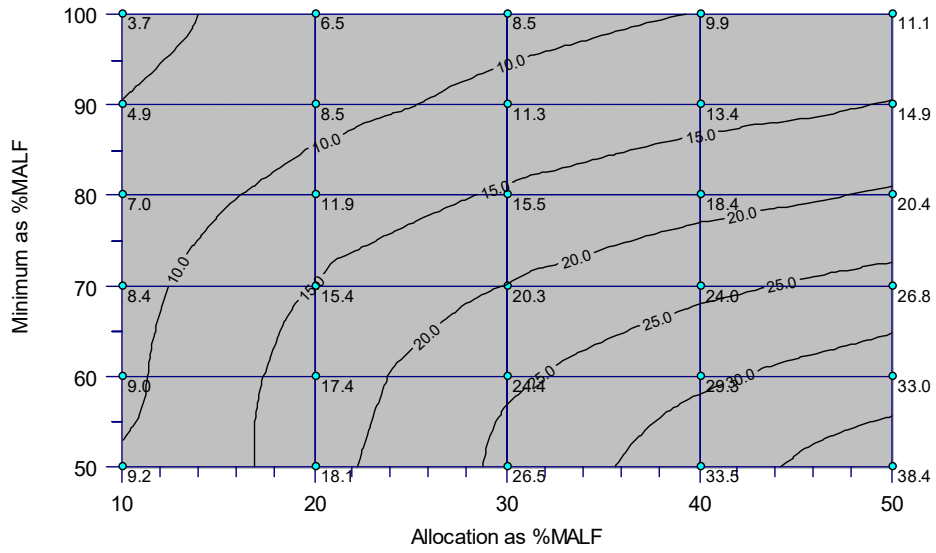

Figure A17: Contours of percent reduction in 30-day MALF from the Tangahoe River. Calculated values are shown at intersections of axes.

14.6 Mangaoraka River at Corbett Road

The instream habitat survey data for the Mangaoraka River is described in Jowett (1993).

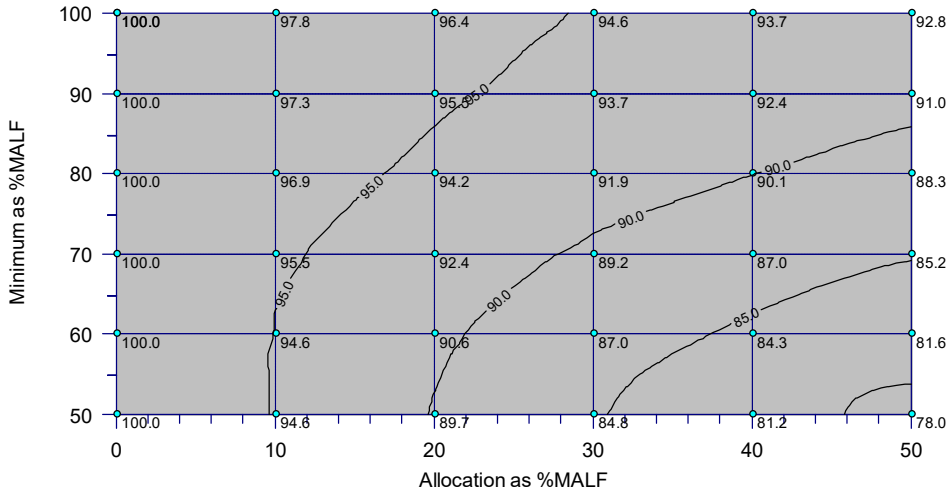

Figure A18: Contours of percent retention in density of high MCI invertebrate species for the Mangaoraka River. Calculated values are shown at intersections of axes.

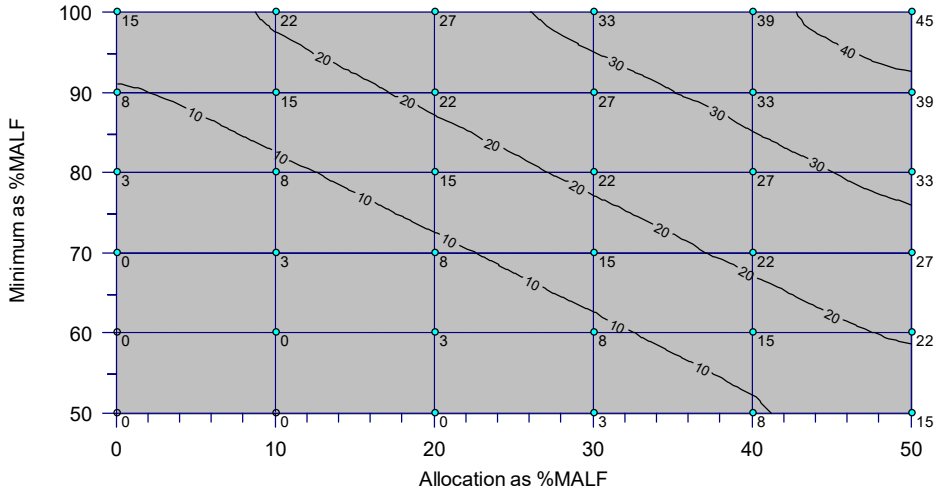

Figure A19: Contours of the average number of days per year of partial restrictions to abstraction from the Mangaoraka River. Calculated values are shown at intersections of axes.

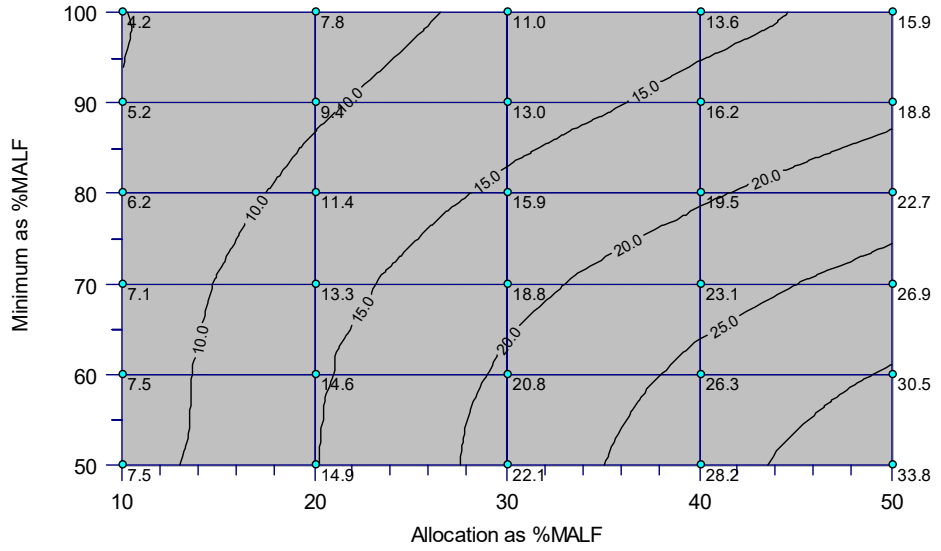

Figure A20: Contours of percent reduction in 30-day MALF from the Mangaoraka River. Calculated values are shown at intersections of axes.

14.7 Waingongoro River at Normanby

The instream habitat survey data for the Waingongoro River was carried out at the Normanby Loop and the flow data is from the SH45 site. SH45 flows were multiplied by 0.87 to give flows at the Normanby Loop.

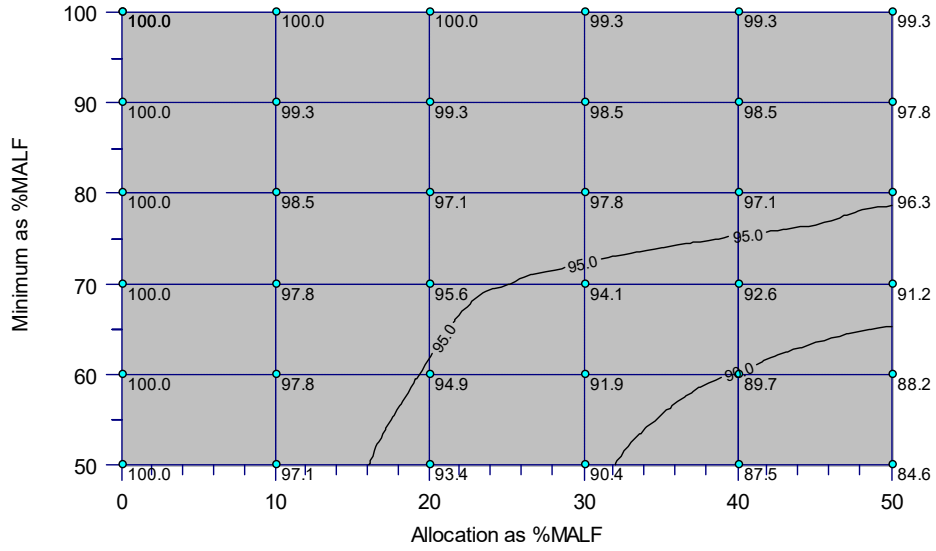

Figure A21: Contours of percent retention in density of high MCI invertebrate species for the Waingongoro River. Calculated values are shown at intersections of axes.

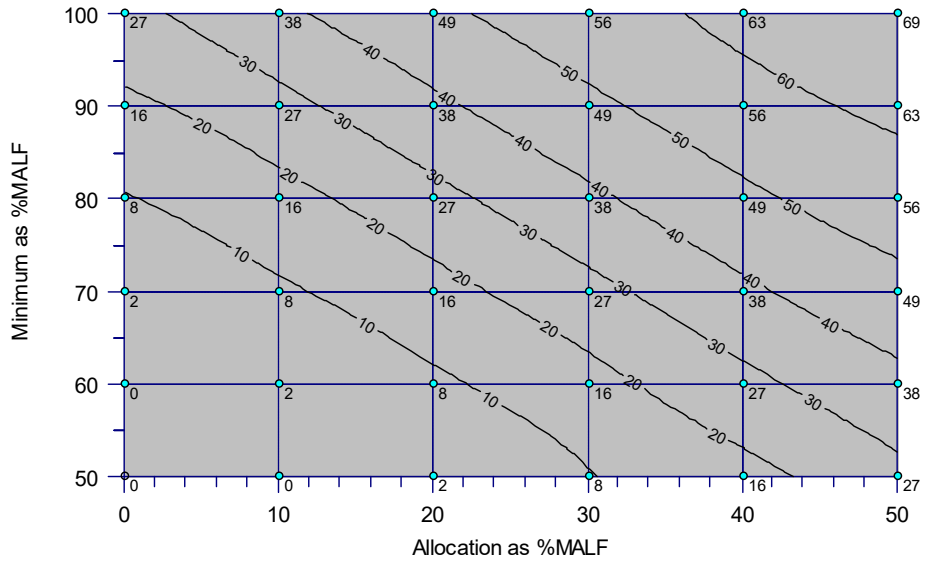

Figure A22: Contours of the average number of days per year of partial restrictions to abstraction from the Waingongoro River. Calculated values are shown at intersections of axes.

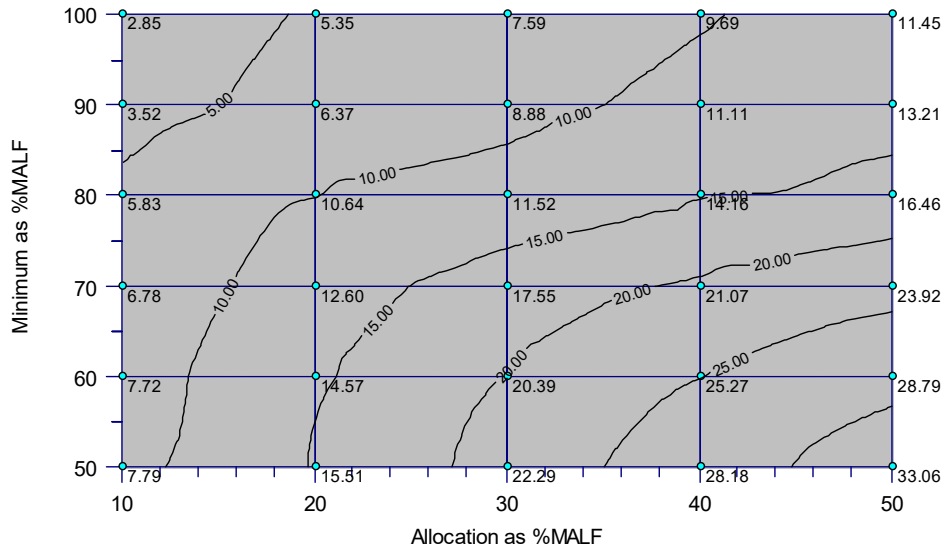

Figure A23: Contours of percent reduction in 30-day MALF from the Waingongoro River. Calculated values are shown at intersections of axes.

14.8 Manganui River at Croyden

The SH3 site on the Manganui River was used as the flow site for the instream habitat survey which was carried out at Croyden Road downstream of SH3. The MALF at SH3 is 0.45 m^3/s and the MALF at Croyden Road is 1.16 m^3/s, so flows at SH3 were multiplied by 2.58 before calculating indices of benthic invertebrate density for high MCI scoring taxa.

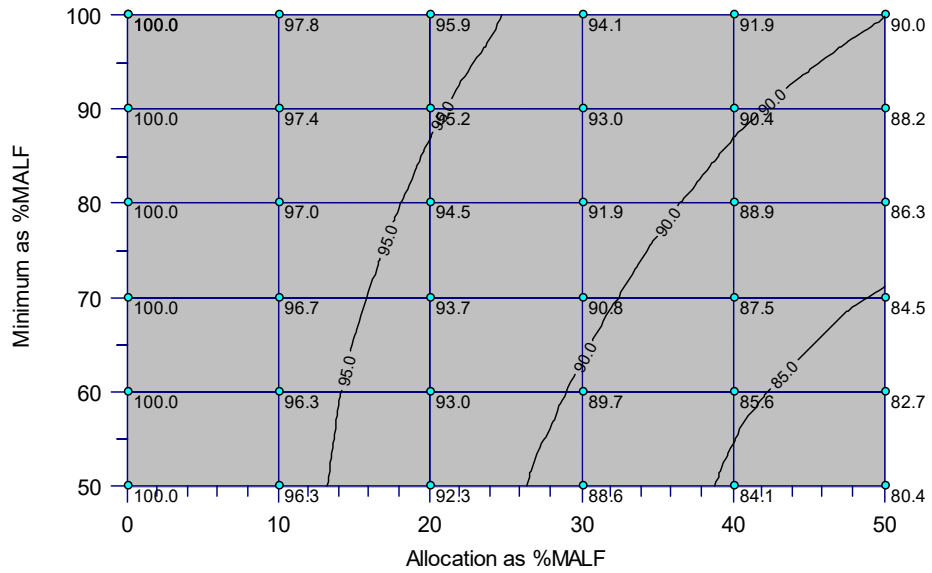

Figure A24: Contours of percent retention in density of high MCI invertebrate species for the Manganui River. Calculated values are shown at intersections of axes.

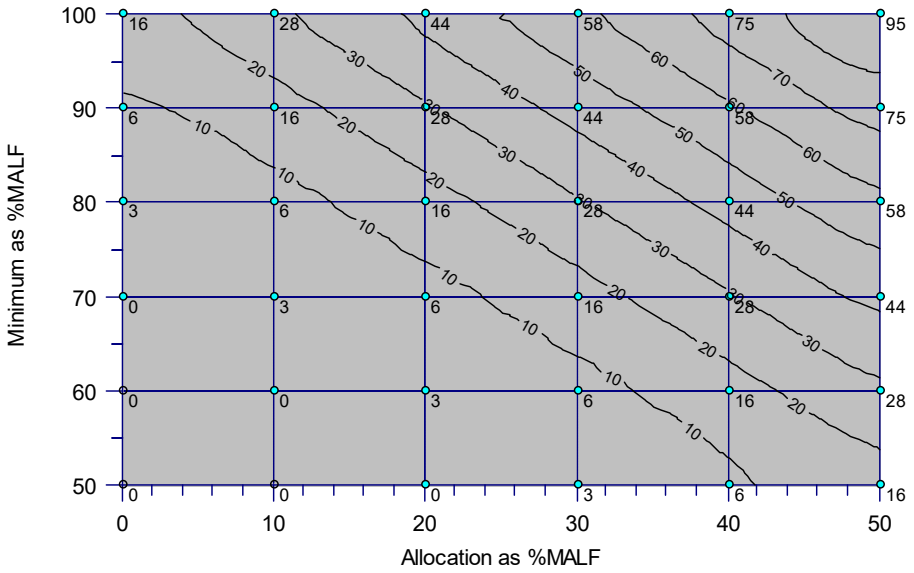

Figure A25: Contours of the average number of days per year of partial restrictions to abstraction from the Manganui River. Calculated values are shown at intersections of axes.

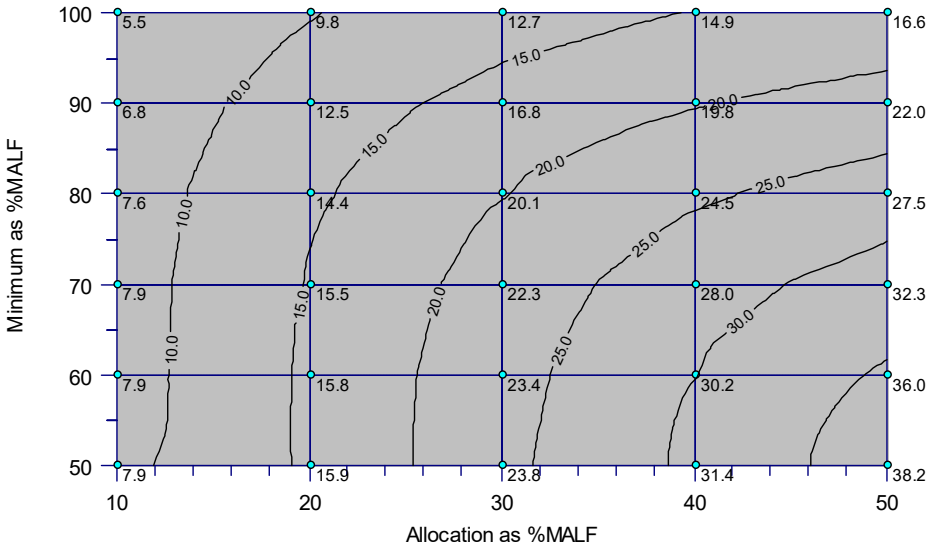

Figure A26: Contours of percent reduction in 30-day MALF from the Manganui River. Calculated values are shown at intersections of axes.

14.9 Waiongana Stream at SH3A

The instream habitat survey data for the Waiongana Stream is described in Jowett (1993).

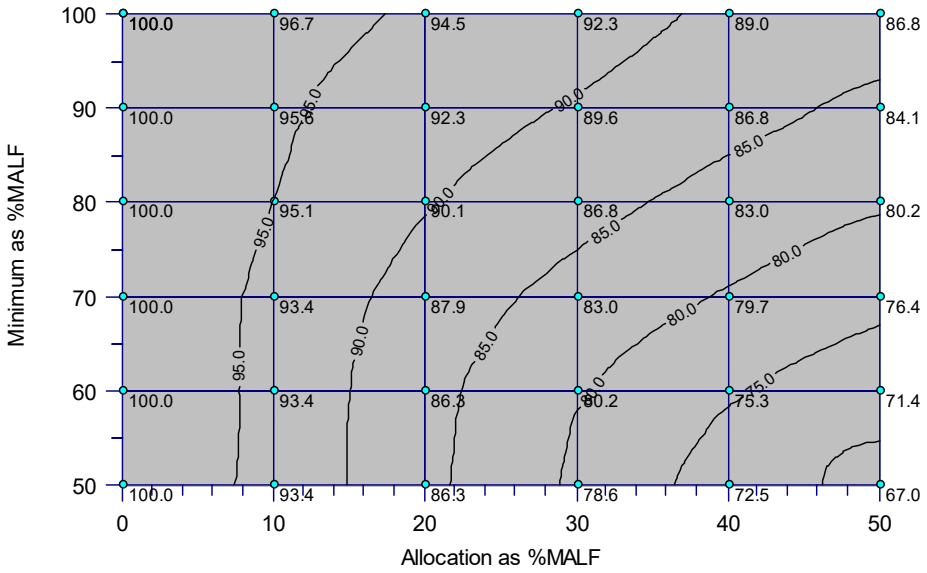

Figure A27: Contours of percent retention in density of high MCI invertebrate species for the Waiongana Stream. Calculated values are shown at intersections of axes.

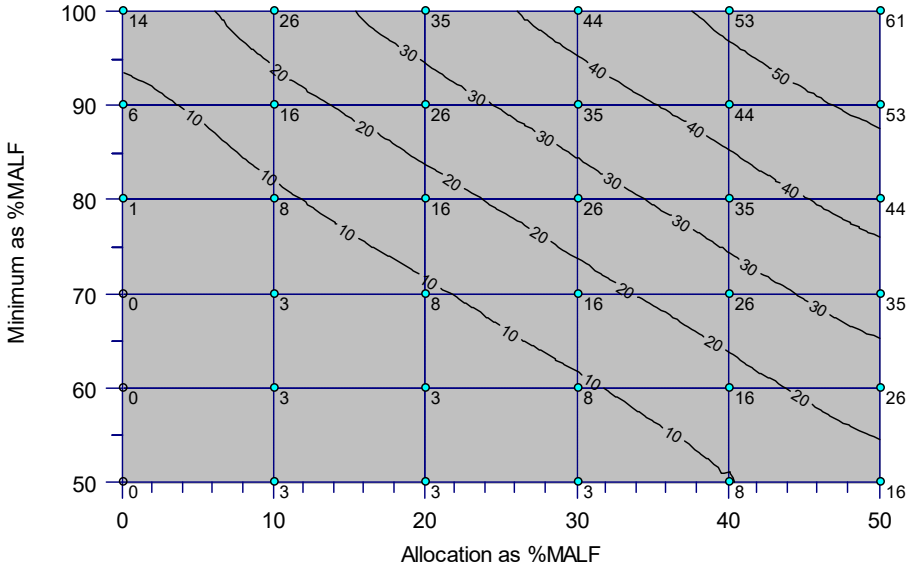

Figure A28: Contours of the average number of days per year of partial restrictions to abstraction from the Waiongana Stream. Calculated values are shown at intersections of axes.

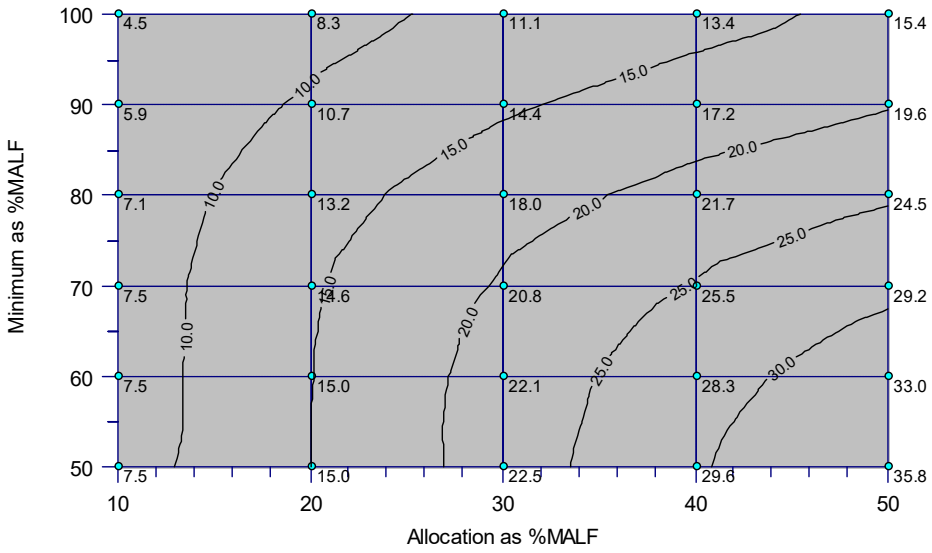

Figure A29: Contours of percent reduction in 30-day MALF from the Waiongana River. Calculated values are shown at intersections of axes.

Freshwater Review:

Review of minimum flows and water allocation in Taranaki

Taranaki gets a lot of rain and it's difficult to imagine the region ever running out of water. However, water allocation needs careful attention, particularly during drier periods and droughts. When water resources are stretched, enough water must remain in our rivers to ensure their ecological health and māuri (life force) are retained, but with enough water still available for appropriate use and development.

Working with people | caring for Taranaki

Taranaki Regional Council

Review of minimum flows and water allocation in Taranaki

The story so far

The Government has introduced new requirements around the management and allocation of freshwater. The *National Policy Statement for Freshwater Management 2014* (NPSFM) requires regional councils to set **environmental flows** that include an allocation limit and a minimum flow.

In Taranaki, the current Freshwater Plan (2001) sets minimum flows but does not set quantitative allocation volumes. As part of the review of that Plan, the Taranaki Regional Council (the Council) prepared and consulted on a Draft Plan that set revised minimum flows and new allocation limits. These were based on the Government's *Proposed National Environmental Standard for Ecological Flows* (2008).

Following feedback on that Draft Plan, the Council decided more work is needed before it publicly notifies a Proposed Freshwater Plan under the *Resource Management Act 1991*. This included commissioning Jowett Consulting Ltd to:

- Review research on environmental flow requirements.
- Review the principles for setting minimum flows and allocation.
- Examine hydrological, water-quality and streambed invertebrate data relating to Taranaki rivers.
- Offer recommendations or options for future environmental flow limits for Taranaki.

This factsheet presents a summary of the key findings from the consultant's report, 'Review of Minimum flows and water allocation in Taranaki'.


Jowett Consulting Limited

Review of Minimum Flows and Water Allocation in Taranaki

Key terms

- **'Environmental flows'** are a limit to ensure water takes do not cause unacceptable environmental degradation. Environmental flows must include a minimum flow and allocation.
- The **'minimum flow'** of a river is the flow at which most consent holders are required to cease abstraction (note naturally occurring low flows can be less than the minimum flow).
- **'Allocation'** is usually the maximum take. Maximum takes for all permitted and consented activities in the catchment make up the total allocation).

Water allocation in Taranaki

Taranaki has 217 parent catchments, made up of more than 500 named rivers and streams. More than 300 rivers flow from the flanks of Mt Taranaki in a distinctive radial pattern across the ring plain. Typically, ring plain rivers are short, small and fast-flowing.

By contrast, eastern hillcountry rivers display a branch-like pattern of drainage. The rivers of the hillcountry are generally longer than ring plain rivers and are contained by narrow valleys that carry relatively high sediment loads as a result of erosion.

Only 46 (or 21%) of the 217 parent catchments currently have consents for the taking of water. Five Taranaki catchments – the Waiwhakaiho, Waitara, Tangahoe, Patea and Waitotara – account for 51% of all the consented water takes.

Since 2008, demand for water from other, smaller streams has increased. Pasture irrigation has surpassed municipal water supply as the greatest use of the region's surface water resources. Other major users include the region's five hydroelectric power stations. Permitted takes (primarily for domestic and stock use) also make up a portion of Taranaki's water allocation.

A key question for all regions is how much water anyone can reasonably take from a river or stream before it begins to have an unacceptable impact on other uses and values associated with the waterbody.

Reduced water levels reduce the amount of habitat available for fish species and stream invertebrates, especially in shallow, wide streams. Species such as trout, eels and other native fish may be affected by higher water temperatures, lower dissolved oxygen levels, and reduced feeding opportunities.

Where in-stream flow habitats are altered significantly, this can, also affect the availability of mahinga kai (food) and affect recreational activities such as fishing and bathing.

Map of Taranaki rivers. Environmental flows must be set for freshwater management units and all waterbodies

Because of high rainfall, Taranaki's rivers and streams are regularly 'well-flushed' and can replenish and recover quickly. Water allocation decisions are largely based on a river's 'mean annual low flow', or MALF, which is the lowest flow that could be naturally expected on a year-to-year basis.

The MALF is the minimum needed to maintain a catchment's natural character and ecosystem health, while allowing a portion of the water to be taken for use and development.

Table 1: *Environmental flow scenarios for Taranaki waterways*

Options	Environmental flows		Protection levels		Days of partial water restrictions
	Minimum flow*	Allocation*	Benthic invertebrates	Fish	
Current Freshwater Plan	66%	40%	85%	74%	25
Draft Plan	90%	30%	93%	86%	42
Alternative 1	85%	40%	90%	81%	46
Alternative 2	80%	30%	91%	83%	30

* As percentage of MALF.

Determining levels of protection

When discussing what limits need to be set, the first thing to consider is the level of protection needed to sustain the health of rivers.

For the purpose of setting environmental flows and providing a measure for ecosystem health (which, in turn is a measure of māuri and biodiversity), the report *Review of Minimum flows and water allocation in Taranaki* examines options for setting minimum flows and allocations based on the protection of:

- Benthic (streambed) invertebrate communities.
- Fish populations that need high flows, such as trout and torrentfish.

The report is probably the first New Zealand study to examine the combined ecological effects of minimum flows and allocation on benthic invertebrates and fish populations.

Table 1 sets out four scenarios for protecting ecological health based on worst-case examples (low flow situations and assuming all takes are at maximum allocation). For benthic invertebrates, protection levels range from 85% to 93%, and for fish, 74% to 86%.

These alternative choices provide a fish protection level of above 80% on the basis that a 20% reduction in fish population is probably not detectable. The impact of any flow reduction also depends upon the fish species present and on the availability of suitable instream habitats necessary to support those species (e.g. loss of available riffle habitat for species preferring fast flowing water).

Options for determining environmental flows

The key to setting minimum flows and allocations is to determine appropriate protection levels and then to calculate the minimum flow and allocation that would achieve them.

The report *Review of Minimum flows and water allocation in Taranaki* examined various combinations of minimum flow and allocation levels to determine the effect on ecosystem health, as measured by the two types of protection level.

Table 1 shows minimum flow and allocation options relating to average benthic (streambed) and fish protection levels for Taranaki waterways.

The options include protection levels achievable under the current Freshwater Plan (status quo), those proposed under the Draft Plan, and two alternatives. Similarly, a reduction of 10% in the state of the benthic invertebrate community is also considered small and probably not detectable.

The actual effects of water takes on fish populations and the benthic invertebrate community are also probably a lot less than indicated by the protection levels because:

- They're calculated on the assumption that the maximum allowable allocation is abstracted all through the year, when this would be rarely the case.
- The effects are temporary. Rivers and streams will recover as flows increase. The report notes that flows need to be low for some time, probably 30 days or so, for significant fish mortality to occur.

Benthic (streambed) invertebrates are used internationally and in New Zealand as a measure of ecosystem health.

Of note, the report's analyses of hydrology, fish communities, benthic invertebrate indices and water quality in Taranaki rivers did not show any strong differences, other than lower runoff and higher turbidity in the eastern hillcountry compared to the ring plain rivers. So it concludes that there does not appear to be any ecological reason for setting different environmental flow limits across the region (or freshwater management units).

Reliability of supply

The levels of protection proposed in the report *Review of Minimum flows and water allocation in Taranaki* represent an increase level of protection from the status quo but conversely would represent increased restrictions on consented water users.

Depending on the community's preferred choice for protection levels set out in the report and adopted in a revised Freshwater Plan, there will inevitably be restrictions in the amount of water available for social and economic use and development.

An increase in the reliability of supply could be achieved by a reduction in total allocation or decrease in minimum flow. Conversely, the environmental limits would cause problems in rivers where the full allocation is taken up. In one scenario from Table 1, restrictions on the amount of water taken would occur on up to 46 days per year on average. These would mainly be in the late summer when demand for water is high.

Water use efficiency

Irrespective of what levels of protection are proposed, water must be used efficiently to avoid waste. Water metering of all water takes may therefore be necessary.

Flexibility – regional versus catchment limits

The report *Review of Minimum flows and water allocation in Taranaki* notes that proposed regional minimum flows and allocation limits are effectively default regional limits. However, not all rivers are the same.

The report highlights that it is impossible for a plan to foresee all possible future developments and some water takes might be of high economic or social value, such as municipal takes and hydroelectricity generation.

Any **'default'** regional environmental flow limits included in a revised Freshwater Plan should not prevent such future development, and the consent process should allow appropriate limits to be adopted after considering catchment-specific issues and the effects of abstraction or diversion.

The Freshwater Plan is being reviewed. Based on the outcomes of consultation on the Draft Freshwater Plan, this work, and the outcomes of the stakeholder workshops, a revised water allocation framework will be incorporated into a revised Freshwater Plan that will be publicly notified for public submissions.

The revised Plan will likely set out catchment-specific limits to allow existing takes to have priority over new applicants, and to allow their consents to be renewed without having to meet the proposed 'default' regional environmental flow limits if they continue to take at the same rate, have a proven need for the resource, and are using it efficiently.

During dry periods, restrictions on water takes are imposed when the MALF is reached. The MALF is also used to determine the maximum quantity of water able to be taken per day.

Providing catchment-specific limits recognises the existing policy framework, which supports and prioritises water use that deliver public benefits. And the reality is that large water uses, including community water supplies, industrial users and hydroelectric power schemes, require business certainty. It also recognises that these major water uses have previously been subject to resource consent processes, where allocation limits have been set at a catchment or sub-catchment level as a result of discussions with those responsible for native and trout fisheries.

However, new water takes will need to meet the new default limits unless exceptions apply. Exceptions will be confined to those water take activities that provide an added public good, such as community water supply and hydroelectricity generation. This also meets the requirements of national environmental statements and standards for urban development capacity, electricity transmission and renewable energy generation activities.

Can we provide for both environmental protection and for water takes that provide a public good?

Yes, but any water take applying to take an allocable volume above a 'default' limit would be required to provide evidence and satisfy Council that an alternative catchment-specific limit is appropriate.

The scenarios discussed in the report *Review of Minimum flows and water allocation in Taranaki* are based on Taranaki-wide water allocation information. Within a catchment, some of the report's underpinning assumptions on minimum flows or allocation volumes in the 'default' limits may not apply. The Council believes that for community uses, such as community water supply and hydroelectricity generation and other regionally important infrastructure, it should be possible to set a catchment-specific limit through the consenting process.

This would not amount to an exemption from the required protection level for water bodies. Rather, it would offer the ability to look at additional information that might produce a different number from the default but still provide the same level of protection.

Alternative water sources

Where there are restrictions on surface water availability, another option may be to store water for future use. Pasture irrigation and municipal water supplies can involve the use of dams – but large dam sites are not available on the ring plain. In some cases, groundwater may also be an alternative source of water. But this may not yield enough water, and may have quality issues arising from natural hydrological conditions.

Table 2: *Fully allocated* catchment for Taranaki waterways based upon 30% and 40% allocation scenarios.*

Allocation scenarios**		Purpose of takes
30% of the MALF	40% of the MALF	
Kapuni	Kapuni	Community water supply
Kaupokonui	Kaupokonui	Industrial
Mangaroa	Mangaroa	Irrigation
Oeo	***	Irrigation
Patea (above Mangaheu confluence)	Patea (above Mangaheu confluence)	Hydroelectricity, community water supply, mixed uses
Tangahoe	Tangahoe	Industrial
Waiaua 2	Waiaua 2	Hydroelectricity
Waihi 5	Waihi 5	Irrigation
Waikaikai	Waikaikai	Irrigation
Waingongoro	Waingongoro	Community water supply
Waiokura	***	Irrigation
Waiongana	***	Industrial
Waipapa 3	Waipapa 3	Recreation
Wairoa	Wairoa	Irrigation
Waiweranui	Waiweranui	Irrigation
Waiwhakaiho	Waiwhakaiho	Hydroelectricity, community water supply, mixed uses
Werekino	Werekino	Irrigation

* Refers to catchments where total allocation might exceed a default regional limit.

** Excludes small water takes that are not run of the river.

*** Water available for use.

The Plan going forward

We need to hear your views as a stakeholder so we can determine the community's preferred option. We're running a series of workshops to discuss the methods and choices outlined in this report, particularly the levels of protection, minimum flows and allocation limits.

The workshops are also an opportunity to discuss other related issues including, for iwi authorities, Te Mana o te Wai, the incorporation and integration of Māori principles in freshwater management, and the development of Mātauranga Māori monitoring methods.

The findings of this report and the workshop will feed into changes to the Freshwater Plan to incorporate environmental flow limits and an allocation framework. The aim is to ensure Taranaki continues to meet the social and economic needs of its people and communities while, at all times, ensuring water is available to allow the ecological functioning of our waterways and protecting associated values.

Inevitably, some trade-offs will occur. The key is to strike an appropriate balance for the region.

Questions

1. Who or what should have water-use priority in Taranaki?
2. What protection levels do you consider appropriate for ecological health and māuri (streambed invertebrates)?
3. What protection levels do you consider appropriate for fish?
4. How reliable should the water supply be for each category of user?
5. What requirements should the Council impose on consented activities to address and encourage water use efficiency?
6. Should the Council encourage water harvesting (storing water for future use)? If so, how could the Council do this?
7. Should the Council adopt new technologies for managing water allocation? Remote sensing and real-time monitoring data are possibilities – are there others?

Go to www.trc.govt.nz/draft-plan to find the report *Review of Minimum flows and water allocation in Taranaki*.

#2071758

Agenda Memorandum

Date 17 July 2018

Memorandum to
Chairperson and Members
Policy & Planning Committee

Subject: **Regional freshwater ecological quality: 2016-2017 results from state of the environment monitoring**

Approved by: G K Bedford, Director – Environment Quality

BG Chamberlain, Chief Executive

Document: 2065330

Purpose

The purpose of this memorandum is to present an update to the Committee on the latest annual results of the Council's state of the environment monitoring programme for fresh water ecological health (macroinvertebrate monitoring).

A full report is available upon request, *Freshwater Macroinvertebrate Fauna Biological Monitoring Programme Annual State of the Environment Monitoring Report 2016-2017,* providing the details of the monitoring of the Council's SEM macroinvertebrate monitoring sites in the 2016-2017 year, and including analysis of trends in this data since 1995 and over the last ten years. This memorandum summarises the report's data and findings, and includes the Executive Summary and the Recommendations from the report as an appendix.

A presentation on the report will be made at the meeting.

Executive summary

The Council's '*Regional Freshwater Plan for Taranaki'* (October 2001) states as two of its objectives for the region, 'to maintain and enhance the quality of the surface water resources of Taranaki by avoiding, remedying or mitigating the adverse effects of contaminants discharged to land and water from point-sources.... and diffuse sources' (Objectives 6.2.1 and 6.3.1). In doing so, the Council and community seek to provide for the values associated with surface water, and to ensure the maintenance of aquatic ecosystems (Environmental Results Anticipated ER1).

In order to ascertain the successful adoption and application or otherwise of the Council's policies and methods of implementation, the Council conducts 'state of the environment' (SEM) monitoring to obtain up to date robust information for parameters that characterise the region's environment and resources. The results and findings of the SEM programme for the region's freshwater systems can be interrogated to determine trends and changes in trends in the quality of the region's freshwater resources, alongside the information on the current 'state' of the region's in-stream ecological health parameters that SEM generates.

With SEM established in 1995, the database is extensive enough to allow regular robust statistical trend analysis, conducted according to recognised and nationally adopted methodologies, to inform such reviews. The trend analyses cover both trends during the entire record, and trends in the most recent ten-year period.

The latest results describing the state of and trends in the state of the macroinvertebrate communities of the region's waterways are presented herein for the information of the Council.

In 2015-2016, two new sites were added to the 57 sites already in the programme, in order to ensure good coverage of stream health within the Council's proposed Freshwater Management Units (as required by the Government's National Policy Statement on Freshwater Management). Also for the first time, trend analysis was undertaken based on the latest ten year period, in addition to analysis for the full 21 year record to that date. Using the data record from a shorter, more recent period sacrifices some certainty in the output results for the sake of identifying current rather than long-term trends.

The results for the 2016-2017 year and cumulative record continue to be overall as encouraging as in similar reports in the last few years and even more encouraging than those from earlier periods, with positive trends that had become markedly better with each year that passes continuing to be maintained in the 2016-2017 year.

In terms of Macroinvertebrate Community Index (MCI), the specific measure of the health of in-stream ecological communities, the study shows that in 2016-2017, spring survey MCI scores were generally typical (9% of samples had significantly higher and 3% significantly lower than long-term median scores); while in summer 12% had significantly higher scores but only 2% significantly lower. The seasonal difference between surveys was minimal- the mean spring MCI score was 2 units higher than in summer, while the median spring score was 1 unit lower than in summer.

Six sites scored their highest MCI values ever during the 2016-2017 monitoring period, while one site produced a new minimum score.

Trends across the full record: The updated trend analysis shows that at 49 of the 57 sites for which trends can be determined (86%), MCI scores give indications of improving. This is the highest number sites showing an indication of ecological improvement of any degree found to date. The percentage of sites showing indications of improving is being maintained at that of last year. Surprisingly and pleasingly, the relative number of sites showing improvement continues to be maintained at the high levels found in recent years, rather than begin to decrease as might generally be expected once rates of improvement begin to flatten out.

Changes in the indicative and in the statistically significant trends are summarised below.

Progressive changes in significant and highly significant trends in MCI scores (57 sites)

Year	Number of sites with +ve, very sig trend (p<0.01, FDR)	Number of sites with +ve, sig trend (p<0.05 but not highly sig)	**Total number of sites with positive trends of any significance**	Number of sites with negative trend of any significance	Sites with positive	Sites with negative
1995-2017	23	7	**30**	1	49	8
1995-2016	16	14	**30**	1	46	7

1995-2015	22	7	**29**	0	44	8
1995-2014	21	9	**30**	0	44	8
1995-2013	21	5	**26**	0	44	8
1995-2012	15	10	**25**	1	42	10
1995-2011	9	14	**23**	0	40	12
1995-2010	7	11	**18**	0	40	12
1995-2009	7	9	**16**	0	38	14
1995-2008	5	8	**13**	0	38	13

That is, the proportion of sites in the region showing indications of an improvement of any extent continues to exceed the proportion of sites showing declines, in a continually ncreasing ratio (the ratio is now at 6.1:1, up from 2.9:1 in 2008).

Applying a more rigorous statistical evaluation to the long-term trend data, there are 30 sites in one of the two categories showing strongly or very strongly significant improving trends. This continues the pattern that was evident in the previous three years, that the region continues to maintain the highest number of sites showing statistically significant ecological improvement ever recorded. There are more than double the number of sites showing strong or very strong improvement as there were less than 10 years ago. While in the previous year there had been a reduction in the number of sites where the statistical test of certainty (confidence) around the positive trend is strongest, in the year under review this reverted to the high numbers in this category found in earlier years.

In terms of the sites showing the most improvement in their ecological condition over the 22 years of monitoring, they are:

- the upper and mid reaches of the Kaupokonui Stream
- the upper and mid Kapoaiaia Stream
- mid Kurapete Stream
- the lower Mangati Stream, and
- lower Punehu Stream

Trends across the last ten years: As noted above, analysis of the trends at each site over the last ten years has also been undertaken. As a general rule, using a smaller record means a loss of confidence in detecting trends, and also means that natural variability at each site makes it harder to detect trends. Notwithstanding these caveats, the analysis shows that statistically significant improvements over the last ten years are found at 7 sites, almost all being mid or lower catchment sites.

State of ecological health: In terms of the question 'what is the state of the ecological health of our streams?', predictive scores have been developed for ring plain sites that are based on equivalent sites within a national dataset (River Environment Classification, or REC), and alternatively on its distance below the National Park boundary. The predictive modelling indicates for each site what the MCI 'should' be, if the site were as good as could be reasonably achieved. A summary for all results for the 2016-2017 year is provided below, by percentage allocation into 'significantly lower', 'no significant difference', or 'significantly higher' scores than expected.

Season	Spring 2016			Summer 2017		
Actual vs Prediction	> 10 units lower	± 10 units	> 10 units higher	> 10 units lower	± 10 units	> 10 units higher
REC Distance	28 0	63 78	9 22	24 3	68 81	8 15

In general, the majority of sites were not significantly different to their predictive scores. In terms of predicted scores based on distance modelling, MCI scores were more likely to be significantly higher than lower. The higher than expected scores were probably due to sites having improved since the distance predictive equations were created using data from 1981-2006. In terms of comparable MCI values nationwide, some sites in Taranaki in the mid and lower reaches of catchments were below typical scores.

In summary, the findings of the macroinvertebrate monitoring programme demonstrate that the Council and regional community are meeting the Long Term Plan (LTP) target, to maintain and enhance water quality in the region, even more robustly as each year goes by. The greatest proportion of the improving sites are located in mid to lower/mid-catchment reaches; significant improvement at the lowest sites is now evident, indicating that habitat improvement is occurring and drivers of cumulative adverse effects are being reduced throughout each catchment.

The cause of the positive trends is multi-faceted and complex. The maturing and extension of the riparian programme with planting and stock exclusion, continuing reductions in the number and improvements in the quality of discharges into waterways, and compliance regimes will all be playing a role. With the continuation of these programmes, further consequential gains in water quality and in in-stream ecological health across the region and in particular extending into the lowest reaches of the region's streams and rivers should occur.

The report makes recommendations to continue the freshwater macroinvertebrate ('MCI') component of the SEM programme in a similar format and to update the trend analysis reports following analysis at the end of the 2017-2018 year.

The National Policy Statement for Freshwater (2014) includes national objectives and policies that the Council must give effect to over time. As amended in 2017, this policy framework explicitly includes a requirement to monitor macroinvertebrate communities as the prime metric for ecosystem health, so the Council's long term regional freshwater ecosystem quality monitoring continues to provide key foundational data for setting appropriate limits and methods of implementation, and for assessment purposes. This programme also delivers on the expectations of iwi around monitoring stream health and giving effect to Council policies to maintain and enhance water quality, as expressed during the recent Long Term Plan submission process.

The value of this monitoring and analytical work lies in the advantage of up-to-date feedback to the Council and regional community on the consequences of land use and water quality management initiatives adopted in the region.

Recommendations

That the Taranaki Regional Council:

1. receives this memorandum noting the preparation of a report into the state of and trends in regional in-stream macroinvertebrate community health data for Taranaki, for 2016-2017 and over the period 1995-2017;
2. notes the findings of the SEM programme; and
3. adopts the specific recommendations therein.

Introduction

This Committee has been regularly informed of the findings that emerge from the Council's various freshwater 'state of the environment' monitoring programmes. These programmes are important as indicators of the effectiveness of the Council's and community's interventions and resource management initiatives addressing freshwater quality and in-stream health in the region. Members will be aware that there is a high level of interest nationally in the state and management of the country's fresh water resources.

The *Regional Fresh Water Plan for Taranaki* contains objectives to manage the state of the region's surface freshwater. Objective 6.2.1 requires the Council and region 'to maintain and enhance the quality of the surface water resources of Taranaki by avoiding, remedying or mitigating the adverse effects of contaminants discharged to land and water from point sources', while Objective 6.3.1 is an equivalent objective for diffuse sources of contaminants. In Section 10.3 of the Plan, the Council commits to continued monitoring, research and investigations related to fresh water quality, to provide information on the state of freshwater in the region and the effectiveness of the Plan.

The Council's 2012-2022 LTP has, under the 'Levels of service' specified for resource management, a commitment to the '*protection of the life-supporting capacity of water, in-stream uses and values*'. The measure for this activity is: '*Macroinvertebrate Community Index (MCI) values (a measure of freshwater community richness and composition) at 50 regionally representative sites*.' The target throughout the duration of the LTP is that '*the proportion of sites showing a trend (whether significant or indicative) of improvements in MCI against a base year of 1995 to exceed the proportion showing decline over the same period*.'

Staff have, and have been trained in, the software and methodology used at national reporting level by NIWA for trend analysis of data related to freshwater systems, to ensure that data and analysis provided to the Council and the public of Taranaki is robust, defensible, and consistent with analyses delivered at a national level. In this way timely and reliable feedback on the quality and health of the region's streams and the effectiveness of water quality management in the region can be generated and utilised.

Discussion

One of the Council's 'State of the Environment' monitoring programmes measures the abundance and composition of macroinvertebrate communities on streambeds, as an indicator of stream ecological health. The Council has delivered this programme for 22 years to date, i.e. since 1995. Staff have now reported the data for the 2016-2017 year, including an

analysis of trends in stream ecological health for Taranaki both over the period 1995-2017 (the entire record) and over the last ten years.

The Executive Summary for the report is attached. In particular it notes that 59 sites were surveyed, from 26 rivers and streams, and it explains the representative significance of each site. Each site and water course is chosen with regard to location, representativeness, regional variability in river environment, position within a catchment, and surrounding land use, and with regard to evaluating the effects of riparian management.

MCI values were typical in the spring and slightly above typical in the summer surveys in 2016-2017. Spatially, MCI scores were lower at sites located lower in catchments (as is usual- the consequence of more open and exposed stream beds, lower flows, higher temperatures, sedimentation on stream beds, and cumulatively higher levels of some contaminants, resulting in a shift in the proportion of more sensitive taxa). In summer, MCI scores tended to be higher than typical in upper catchments and lower than typical at sites in lower reaches.

Six of the 59 sites recorded new maximum MCI values in one or other of the two surveys, compared with eleven such results in the last period. The highest MCI scores in the 2016-2017 year were found at the upper Timaru Stream (152 in summer, a new maximum) and upper Patea River (140 in spring and 150 in summer, a new maximum). Lowest MCI scores were found in the uppermost site in the Mangawhero (MCIs of 75 and 73) and both sites in the Mangati Stream (MCIs of 73 and 72 in summer)

In the spring survey, 97% of the sites had MCI values that were similar to or significantly better than historical medians (up from 91% in the previous year, although not all sites could be surveyed in spring 2016-2017). Of these, three sites had scores significantly higher than usual. In summer, 98% of the sites had MCI values that were similar to or significantly better than historical medians (95% in the previous year), and a significantly lower score was found at only 1 site (c.f. 3 in 2015-2016).

In terms of the Council's LTP commitment to the '*Protection of the life-supporting capacity of water, in-stream uses and values*', the measure for this activity is: '*Macroinvertebrate Community Index (MCI) values (a measure of freshwater community richness and composition) at at least 50 regionally representative sites*', and the target is '*the proportion of sites showing a trend (whether significant or indicative) of improvement in MCI against a base year of 1995 to exceed the proportion of sites showing decline over the same period'*.

The updated trend analysis shows that at 49 of the 57 sites (86%) for which trends can be calculated, MCI scores are improving. This is the highest number of sites ever found in this category. Surprisingly and pleasingly, the number of sites showing improvement continues to be maintained at the high levels that have been attained over recent years instead of beginning to decrease as might otherwise generally be expected once the benefits of interventions begin to become a matter of history.

Eight sites are indicating possible deterioration. The number of sites showing deterioration continues to reduce- it is down from 13 when trend analysis began in 2008. That is, the proportion of sites in the region showing a trend of improvement continues to exceed the proportion of sites showing declines, in an ever-increasing ratio (the ratio is now at greater than 6:1, up from less than 3:1 five years ago). In most cases where an apparent deterioration is indicated, the cause can be identified as natural headwater erosion events in the recent

past on the mountain. Recovery of ecological conditions in such circumstances in the most recent surveys is now becoming apparent (eg upper Manganui, upper Maketawa, and upper Katikara streams).

Applying a more rigorous statistical evaluation of trend data, the number of sites with a 'positive and very significant' trend since 1995 is 23, and there are a further 7 sites with a 'positive significant' trend, giving 30 sites now in either of the two positive categories of strong or very strong improving trends. In the first trend analysis (2006-2007 monitoring year), it was found that 'only' 13 sites were showing strong or very strong improving trends in ecological health at the time.

The latest result for the number of sites showing a significant or highly significant improvement or a positive direction of change is the best result ever recorded. That is, the number of sites in the Taranaki region with a statistically strong or very strong improvement evident is continuing to be maintained at record high levels. There are more than double the number of sites showing strong or very strong improvement as there were less than 10 years ago.

There is one ecological monitoring site in Taranaki that continues to show a significant negative trend, a site in the upper Katikara Stream that has been affected by natural headwater erosion events in the recent past on the mountain.

Reviewing the locations of sites showing improvement (Figure 1 below, which reproduces Figure 177 from the report), 3 of 12 upper or upper-mid catchment sites (25%), 16 of 22 mid catchment sites (73%) and 12 of 23 lower catchment sites (53%) are showing statistically significant improvement. Given that upper and upper-mid catchment sites, by virtue of their location, are subject to relatively little intervention activities that could improve their stream health, that particular result is not unexpected. However, what is encouraging from the perspectives of the Council and regional community, is the extent to which improvements in in-stream ecological health are becoming apparent throughout the full lengths of the region's catchments. This could be considered to be associated with the progressive implementation of programmes such as riparian management across the ring plain (refer agenda *item NIWA Study of riparian management and freshwater health, quality and swimmability in Taranaki*, Policy and Planning agenda 24 April 2018).

The analysis set out above relates to the 'direction of travel' for the region's streams and rivers. The associated question is that of how good (in terms of a comparison with how good a site could ever be reasonably expected to become) the current ecological status of each site is. In terms of the question 'what is the state of the ecological health of our streams?', the Council has developed means of calculating predictive scores for ringplain sites that are based on each of the altitude of each site, and/or its distance below the National Park boundary.

As noted above, as a stream descends, there are a range of influences (natural and human) that cause a reduction to some degree of MCI scores. The predictive modelling indicates for each site what the MCI 'should' be, if the site were to be as good as could be reasonably achieved.

A summary for all results for the 2016-2017 year is provided below, by percentage allocation into 'significantly lower', 'no significant difference', or 'significantly higher' scores than expected.

Season	Spring 2016			Summer 2017		
Actual vs Prediction	> 10 units lower	± 10 units	> 10 units higher	> 10 units lower	± 10 units	> 10 units higher
REC Distance	28 0	63 78	9 22	24 3	68 81	8 15

In general, the majority of sites were not significantly different to their predictive scores. In terms of predicted scores that are calculated based on distance from the National Park, MCI scores were more likely to be significantly higher than lower. The higher than expected scores are probably due to sites having improved since the distance predictive equations were created using data from 1981-2006. In terms of comparable MCI values nationwide, about a quarter of all sites in Taranaki (generally located in the mid and lower reaches of catchments) were below typical scores. It should be noted that in the 'distance' modelling, only stream that arise within the National Park are included; in the REC modelling, all sites are considered, including those on short-run streams arising low on the ring plain that do not have a significant spring source.

Variations in expected quality were more evident during the spring surveys than in summer. In the spring surveys, about a quarter of all sites had MCI scores that were much better than could have been reasonably anticipated based on distance from the Park. None had MCI scores that were much worse than predicted. In the summer surveys, results were somewhat more balanced between scores lower and higher than predicted, but there were still about five times as many sites with better scores than expected (based on distance), than there were with scores below expectations.

The streams and rivers with both the strongest statistical evidence of improvement ('there definitely is an improvement') and the greatest change in ecological state ('there is a definite improvement', of 20 MCI units or more) are:

- Kaupokonui Stream upstream of the Fonterra Kapuni factory
- Kaupokonui Stream upstream of STDC Kaponga WWTP
- Kaupokonui Stream upstream of Kapuni rail bridge
- Kurapete Stream
- Punehu Stream at SH45 (lower catchment)
- Kapoaiaia Stream at Wiremu Road
- Kapoaiaia Stream at Wataroa Road
- Mangati Stream within residential area, Bell Block.

In addition, it can be noted that two of the 6 Waingongoro sites are showing statistically highly significant positive trends. Both of these sites are located below the Eltham township. A review in each case of their patterns of change show periods of strong improvement after 2002 (coincident with the substantial removal of the effluent discharge from the Riverlands meatworks into the river) and again after 2009 (which is coincident with the removal of the discharge from the STDC Eltham wastewater treatment plant).

Seven sites show a significant improvement when assessed over the past 10 years. These are the Maketawa Stream at Tarata Road, Kurapete Stream upstream of Inglewood WWTPlant, the Waiokura Stream at Skeet Road, Huatoki Stream at Hadley Drive, lower Mangati Stream at Bell Block, Timaru Stream at Carrington Road, and Mangawhero Stream downstream of

Mangawharawhara Stream. The Katikara Stream at the beach site has shown significant deterioration over the same period.

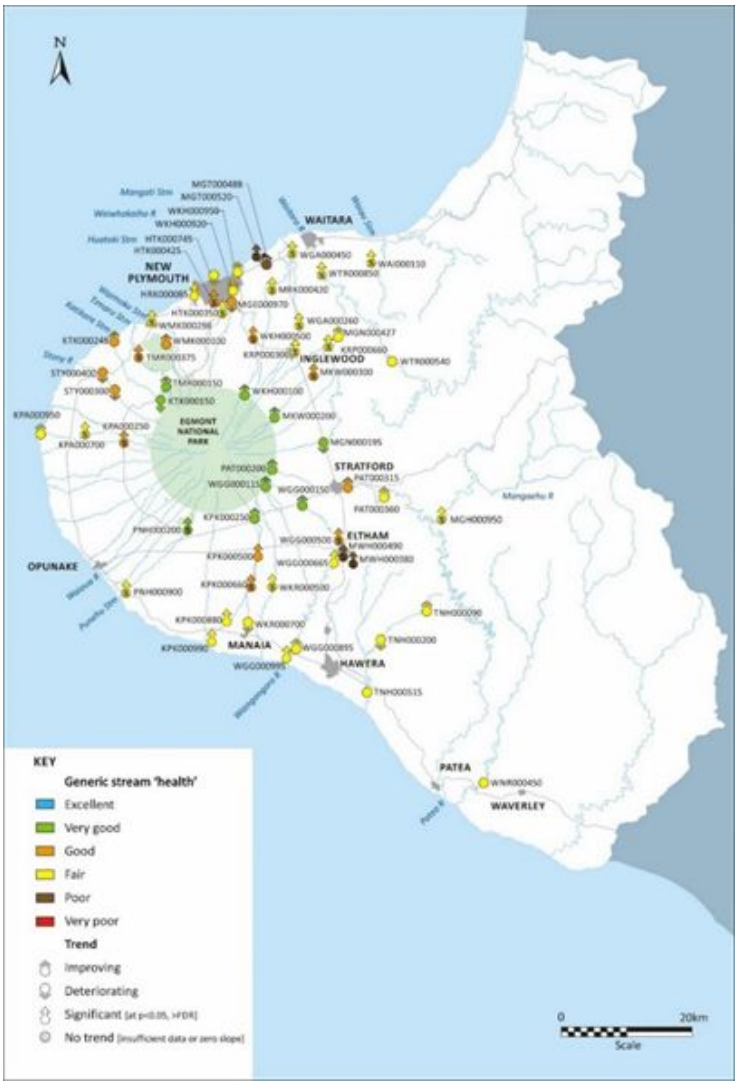

Figure 1: Generic biological health based on median MCI, and trends in biological quality for SEM sites, 1995-2017

Conclusions

In terms of iwi and other public awareness of stream ecological health, the Committee can note that through the Council's latest LTP submission process, maintenance of the Council's macroinvertebrate programme is supported. While Ngāti Mutunga requested additional monitoring within their rohe, the Council noted that it has recently added an additional site in north Taranaki to represent the Freshwater Management Unit covering this part of the region. The Council is exploring ways of expanding the monitoring network, whether by Council-based or community-based monitoring. Te Runanga o Ngāti Ruanui Trust supported the on-going management of water quality for future improvement, and the incorporation of culturally-based monitoring. While the Council has committed to developing appropriate indicators further, it is noted that stream health is a priority across

all parties, and macroinvertebrate monitoring gives effect to this priority. Te Korowai o Ngāruahine Trust and Te Kotahitanga o Te Atiawa likewise expressed an interest in and support for the Council's stream health monitoring.

In simple terms, the latest results of SEM MCI monitoring, conducted according to nationally recognised protocols, have seen an on-going firming of the trend of improvements being found regionally in respect of the LTP target of maintaining or enhancing regional in-stream ecological health (Figure 1). The Council is meeting its LTP and *Regional Fresh Water Plan for Taranaki* objectives. Over the long term, additional measures such as more complete stock exclusion from waterways, the maturing and extension of riparian planting, and continuing reductions in the number and improvements in the quality of discharges into waterways, should see further consequential gains in water quality and in in-stream ecological health across the region and in particular extending into the lowest reaches of the region's streams and rivers. Provision of this memorandum, together with subsequent information sheets that the Council prepares each year, will keep the regional community informed on fresh water quality.

The National Policy Statement for Freshwater (2014) includes national objectives and policies that the Council must give effect to over time. As amended in 2017, this policy framework explicitly includes a requirement to monitor macroinvertebrate communities as the prime metric for ecosystem health, which is in turn one of the two primary values that the NPS-FM assigns to freshwater systems that the Council must provide for and give effect to, so the Council's long term regional freshwater ecosystem quality monitoring continues to provide key foundational data for setting appropriate limits and methods of implementation, and for assessment purposes.

Decision-making considerations

Part 6 (Planning, decision-making and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the *Act*.

Financial considerations—LTP/Annual Plan

This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Legal considerations

This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Appendices/Attachments

Document 2000629: *Freshwater Macroinvertebrate Fauna Biological Monitoring Programme Annual State of the Environment Monitoring Report 2016-2017* Executive summary and Recommendations)

Executive summary

Section 35 of the Resource Management Act requires local authorities to undertake monitoring of the region's environment, including land, air, and fresh and marine water quality. The Taranaki Regional Council initiated the freshwater biological component of the State of Environment Monitoring (SEM) programme for Taranaki in the 1995-96 monitoring year. The macroinvertebrate component was separated from the microfloral component in the 2002-03 year. The latter programme was broadened to incorporate recently-developed techniques and is reported separately.

Freshwater macroinvertebrates are a range of aquatic species that have a crucial role in freshwater ecology and that respond to changes in water quality or hydrological patterns or habitat. While a grab sample of water collected from the waterbody will reveal water chemistry at the time of sampling, and thus give an indication of contemporaneous pressures on the ecology of the stream, the alternative of assessing the state of the freshwater communities themselves will show the cumulative influences of these factors over the recent past as well as being a primary indicator of whether a stream is healthy or otherwise. The Macroinvertebrate Community Index (MCI) is a New Zealand version of an approach that is used internationally. Each species found at a stream monitoring site is scored according to its sensitivity or tolerance, and the cumulative score then provides an index of stream health. The *Government's National Policy Statement for Freshwater Management 2017* requires every regional council to monitor and report on stream health using the MCI.

This report covers the 2016-2017 monitoring year. Biological surveys were performed in spring (October to December 2016) and summer (February to March 2017). Each seasonal survey assessed the macroinvertebrate communities at 59 sites in 26 rivers and streams. Two new sites were added in the 2015-2016 year, in the upper Waitara River and in the lower Whenuakura River, because of the need for the Council put in place adequate representative monitoring of the region's proposed Freshwater Management Units (as required by the National Policy Statement on Fresh Water).

The Hangatahua (Stony) River was selected as a river with high conservation value and the Maketawa Stream was selected for its regionally important recreational value. The Waitara, Manganui, Patea, Waiwhakaiho and the Mangaehu Rivers were chosen as examples of waterways with large catchments and multiple human impacts, arising in either the Egmont National Park or the eastern hill country. The Waingongoro River was included in the programme as a river under intensive usage with more recent wastes diversions out of the river, and the Waiongana Stream as a stream from which there is a major water abstraction (although not currently exercised). The Timaru, Mangaoraka, Waiokura (added in 2007) and Punehu Streams were included as streams within primary agricultural catchments. The Kaupokonui River, Mangorei Stream and Waimoku Stream were selected to monitor the progress of riparian planting in these catchments. These catchments had been targeted in management policies for riparian planting initiatives. The Katikara and Kapoaiaia streams are western Taranaki streams also targeted for riparian planting initiatives, and have been part of the monitoring programme since 2000. The Tangahoe River was included in 2007 to monitor land use changes in an eastern hill country catchment. The Kurapete Stream was added to the programme as an example of a small seepage ringplain stream where significant improvements to a major point source discharge have been implemented. The Waiau Stream is an example of a northern lowland catchment. The Mangawhero and Mangati Streams were selected as examples of small, degraded streams. The Huatoki Stream

was selected as an example of a stream influenced by urbanisation and also in part by riparian vegetation while the Herekawe Stream, on the western outskirts of the New Plymouth urban area (with a lengthy consent monitoring record), has been added in order to monitor the impact of relatively recent community walkway planting initiatives. The Whenuakura River was selected as a large river draining the eastern hill country.

During the 2016-2017 period, only 32 of the 59 sites could be sampled due to persistently high spring flows though all 59 sites were sampled during the summer period. For sites located in lower catchments the proportion of 'sensitive' taxa in the macroinvertebrate communities generally have been lower in summer than in spring, coincident with lower flows, higher water temperatures, less scouring, and increased smothering of habitats by more widespread algal growth within rivers and streams in summer. The median spring MCI score (99 units) was one unit lower than the median summer score (100 units), with the mean spring score 5 units higher. The seasonal difference in scores not ecologically or statistically significant. There was no data from 27 sites from the spring survey but this did not affect the spring median score as it was identical (99 units) to the long term spring median (1995-2017). While 14 sites had MCI scores that were higher in spring than in summer, there were actually more (15) that showed an increase in their summer scores.

The proportion of 'sensitive' taxa in the macroinvertebrate communities decreased down the length of the waterways, which was reflected in the deterioration in generic stream 'health' from 'very good' in the upper reaches to 'good' through to 'fair' in mid-reaches to 'fair' in the lower reaches.

A moderate number of sites (six sites) recorded new historical maximum MCI scores, while one site recorded a decrease in historical minimum score in the 2016-2017 period. Two of the six new maximum records and the one minimum record were from the two sites established in the 2015-2016 period and hence were of little comparative significance.

Evaluations of generic stream 'health' have been performed and assessments of current scores compared with predictive measures based on distance from the Egmont National Park boundary (a model based on regional data) and in relation to a River Environment Classification (REC) predictive model (which is based on national data). Generally there was good agreement between current scores and both of the predictive models, though the distance predictive model more closely matched current scores compared with the REC predictive model.

The trends through time have been evaluated and will continue to be assessed on an annual basis as the SEM programme continues. Taking into account the full historical record for each site, there were 57 sites with trend data (based on the complete monitoring record of a minimum of more than10 years' monitoring data).

Eight sites had indicative deteriorating trends, with only one of those trends being a statistically significant deterioration in MCI score (a result of headwater erosion effects inside the National Park). In contrast, forty-nine sites had indicative positive trends, with thirty of those sites having statistically significant improvements, all but two of which have also been of ecological importance. That is, not only is there confidence that the observed trends are

real, but the degree of change that has occurred in the state of the in-stream communities is substantial. In all, 31 sites had a statistically significant trend (after application of FDR tests[1]).

There was little evidence of trends in macroinvertebrate health at sites in the upper reaches of catchments, which generally already had good macroinvertebrate health, while over two-thirds of middle reach sites had significant improvement and approximately half the sites located in the lower reaches of catchments showed significant improvement. Generally, in lower catchment sites the macroinvertebrate communities tend to be 'tolerant' of the cumulative impacts of nutrient enrichment. Significant improvement of (predominantly 'fair') biological stream 'health' at the lower reach sites is unlikely to be detected until habitat improvements occur by way of substantial catchment-wide initiatives such as riparian planting and diversion of point source surface water dairy treatment ponds systems wastes discharges to land irrigation. (It is noted that the Council is promoting these interventions with implementation by the regional community).

Taking into account the most recent ten-year data set, there were ten sites showing significant improvements prior to FDR adjustment being applied, but none of these trends could still be deemed significant after FDR adjustment. This may be due to several factors. Firstly, trends have plateaued recently at some site, which may have been the result of riparian management initiatives having largely been completed in some catchments, or the effects of point source discharge removal having subsequently stabilised. Secondly, substrate instability and sedimentation caused by extensive headwater erosion events in recent years have affected the macroinvertebrate communities at upper sites in the Stony River (in particular), Katikara Stream, Maketawa Stream, Waiwhakaiho River, and Timaru Stream on occasions within this period. Most of these sites did continue to show recovery from these impacts during the current period. Thirdly, the smaller dataset has less power to support the assessment of differences being statistically significant within a background of natural fluctuations, even if real ecological improvements are occurring.

The recommendations for the 2017-2018 monitoring year provide for the freshwater biological component of the SEM monitoring to be maintained by way of the same macroinvertebrate faunal programme and for time trend reporting on the full data set and the most recent ten year dataset (to detect recent trends) to be performed annually.

[1] FDR= False Discovery Rate, one of several tests applied to the results to increase confidence in the results by eliminating apparent trends that are the results of co-incidence and random distributions rather than genuine change.

Recommendations for 2017-2018

It is recommended for 2017-2018:-

1. THAT the freshwater biological macroinvertebrate fauna component of the SEM programme be maintained in the 2017-2018 monitoring year by means of the same programme to that undertaken in 2016-2017;
2. THAT temporal trending of the macroinvertebrate faunal data continues to be updated on an annual basis.

Agenda Memorandum

Date 17 July 2018

Memorandum to
Chairperson and Members
Policy and Planning Committee

Subject: SEM Periphyton Monitoring Programme Report for 2016-2018

Approved by: GK Bedford, Director-Environment Quality

BG Chamberlain, Chief Executive

Document: 2080309

Purpose

The purpose of this memorandum is present to the Committee the latest report on the ecological health and state of streams and rivers in the Taranaki region, as measured by assessing periphyton during the 2016-2018 years. The programme is reported in *Freshwater Periphyton Monitoring Programme (Periphyton monitoring in relation to amenity values) State of Environment Monitoring Report 2016-2018.*

The Executive Summary and recommendations from the report are attached to this memorandum.

Executive summary

Section 35 of the Resource Management Act requires local authorities to undertake monitoring of the region's environment, including land, air, and fresh and marine water quality. The freshwater periphyton programme has been designed to monitor the presence, distribution, and characteristics of algae in Taranaki streams and rivers, especially if this reaches levels which may affect the instream values of these streams i.e. aesthetic values (contact recreation and amenity values) and biodiversity values. Periphyton provide much of the energy (food) for aquatic ecosystems, but given the wrong combination of conditions, periphyton can proliferate to a degree that degrades the system, forming large nuisance growths (either thick mats or long filamentous strands). The New Zealand Periphyton Guidelines provide a reference for the point at which growths of periphyton exceed the recreational guideline. Periphyton cover is deemed to have become unacceptably prolific when at least 30% of the bed is covered by strands of filamentous algae and/or at least 60% of the bed is covered by thick mats of algae.

The report notes that water, like all other natural resources, is considered by Maori to be a taonga to be valued, used with respect and passed on to future generations in as good or better condition than at present. In a physical sense, water is valued by hapu and whanau for the provision of sustenance through mahinga kai, or food resources eg, tuna (eel), piharau

(lamprey), kahawai, inanga and other whitebait species. These cultural, spiritual, and life-supporting values would be adversely affected by excessive periphyton growth.

The Taranaki Regional Council initiated a periphyton monitoring programme within its suite of the State of the Environment Monitoring (SEM) programmes for Taranaki, in the 2002-2003 monitoring year. The latest reports on the state of stream health and quality as measured by periphyton indicators is being presented today, covering the 2016-2018 period. It describes the results of the programme for the two monitoring years, and in addition provides an overall assessment (based on sixteen years of data) and identifies trends in the extent of periphyton cover at each site where present.

Twenty-one sites in ten representative catchments around the Taranaki region are selected for surveyed on four occasions during the two year period, generally in each spring and summer, according to consistent protocols including a minimum period after flow conditions that could scour and flush periphyton. In other words, sampling is conducted under 'worst case' conditions that allow nuisance periphyton to proliferate. Ten sites could not be surveyed in spring 2016, due to the levels and frequency of flooding at these ten sites.

Sites have been chosen to be representative of different catchment types found in the region, such as high conservation, riparian establishment, and major abstraction. Most of the rivers/streams in the programme have one upper site (ie less potential effect from human activities), and one or two lower sites (with various degrees of potential effect or influence). The results were interpreted to both provide a periphyton index score (PI) and to record exceedances of the recreational and aesthetic guidelines. For the PI, a higher value represents better in-stream conditions. The numerical index score is expressed in equivalent descriptive terms, ranging from 'very poor' through 'poor', 'moderate', and 'good' to 'very good' (the highest grading).

Chlorophyll *a* (the green pigment in algae) was used as a proxy for the amount of live periphyton biomass during the two summers. Guidelines for chlorophyll *a* have established by the Ministry for the Environment (Biggs, 2000). The National Objectives Framework (NOF) (MfE, 2014) also uses chlorophyll *a* to assign rivers and streams into bands of stream health categories. There is a Government-imposed requirement to ensure streams and rivers are above the 'D' band (chlorophyll *a* to be less than 200 mg/m^2) from 2025 onwards. The Council's long-established chlorophyll *a* sampling protocol differs from that established more recently for the NOF guideline, and therefore results cannot be directly translated to NOF bands.

Surveillance monitoring was also undertaken for the presence of didymo (an invasive alien species of periphyton) and for cyanobacteria (some forms of which can become toxic).

In the **2016-2018** period, out of 148 individual site surveys conducted (84 for each of thick mats and for filamentous algae), 137 complied with the MfE guidelines- a compliance rate of 93%. Thirteen of the 21 sites never had any breach during this period, while three sites had more than a single breach (out of the generally 8 surveys at each site): one site each on the Mangaehu (two breaches of the thick mat guideline), the Kapoaiaia, and the Punehu (both with two breaches of the filamentous guideline, one in each summer). In terms of seasonality, there was one breach in spring 2016, 5 in summer 2017, 2 in spring 2016, and 3 in summer 2018. All these results were very much in line with those of the previous two years.

Of the 21 individual sites, 11 had a median Periphyton Index score of 'very good' in the 2016-2018 period (cf 13 in both 2014-2016 and 2012-2014), 7 had a median score of 'good' (6 in 2014-2016 and 7 in 2012-2014), and 3 a score of 'moderate' (2 in 2014-2016). No sites received a lower median grading. During the same period, out of 74 individual ratings of state that could be assigned, 2 fell into the 'poor' category (3 in 2014-2016, 1 in 2012-2014); there were 13, or 11%, in the 'moderate' category (9 and 7); 16, or 22%, in the 'good' category (20% and 26%), and all remaining surveys (58%) found that periphyton condition was 'very good' (65% in both 2014-2016 and 2012-2014).

Long term periphyton trend analysis revealed that nine sites (about half) had indicative decreases for thick mats and 17 sites (almost all) had decreases for long filaments, although only two sites had statistically significant trends after FDR adjustment was applied (a rigorous test for statistical confidence). The two significant trends were at the upper Kapoaiaia and lower Patea River sites, both having significantly decreasing levels of long filamentous algae. No sites showed a statistically significant increase in either periphyton measure. It is noted that the lower Patea River site is just below the discharge point from the Stratford wastewater treatment plant, where recent improvements have been delivered.

Periphyton biomass levels as assessed by chlorophyll *a* showed significant variation among sites with a range from 1 to 375 mg/m^2 over the reported period. Four sites had values above the NOF guideline value (200 mg/m^2) in one of their two surveys, although no site exceeded the NOF limit in both surveys. Exceedance of the numerical limit in a single survey does not constitute a breach of the NOF standard as prescribed. Thirteen sites had values above the guideline to protect benthic biodiversity (50 mg/m^2) in one or other of the two summer surveys, although a majority of sites in each survey had values below the guideline.

No didymo has been found at any time at any site.

True upstream sites with little agriculture in their catchment generally have a low biomass and stable periphyton canopy throughout the year. Catchments with a proportion of their catchment used for agriculture are more likely to have periphyton growths at sites lower in the catchment during an average summer (not necessarily to a nuisance degree). The report notes that there has been generally an increase in riparian exclusion and planting implemented throughout the Taranaki region in the time since periphyton monitoring first began; and this may have led to the reduction in nuisance growths at the large number of sites where negative (reducing) trends for periphyton are apparent.

The report includes recommendations for the continuation of the programme.

Recommendations

That the Taranaki Regional Council:

1. receives this memorandum on the results of the Council's SEM programme monitoring periphyton, and the accompanying report *Freshwater Periphyton Monitoring Programme (Periphyton monitoring in relation to amenity values) State of Environment Monitoring Report 2016-2018 Technical Report 2018-7.*
2. adopts the specific report recommendations contained therein.

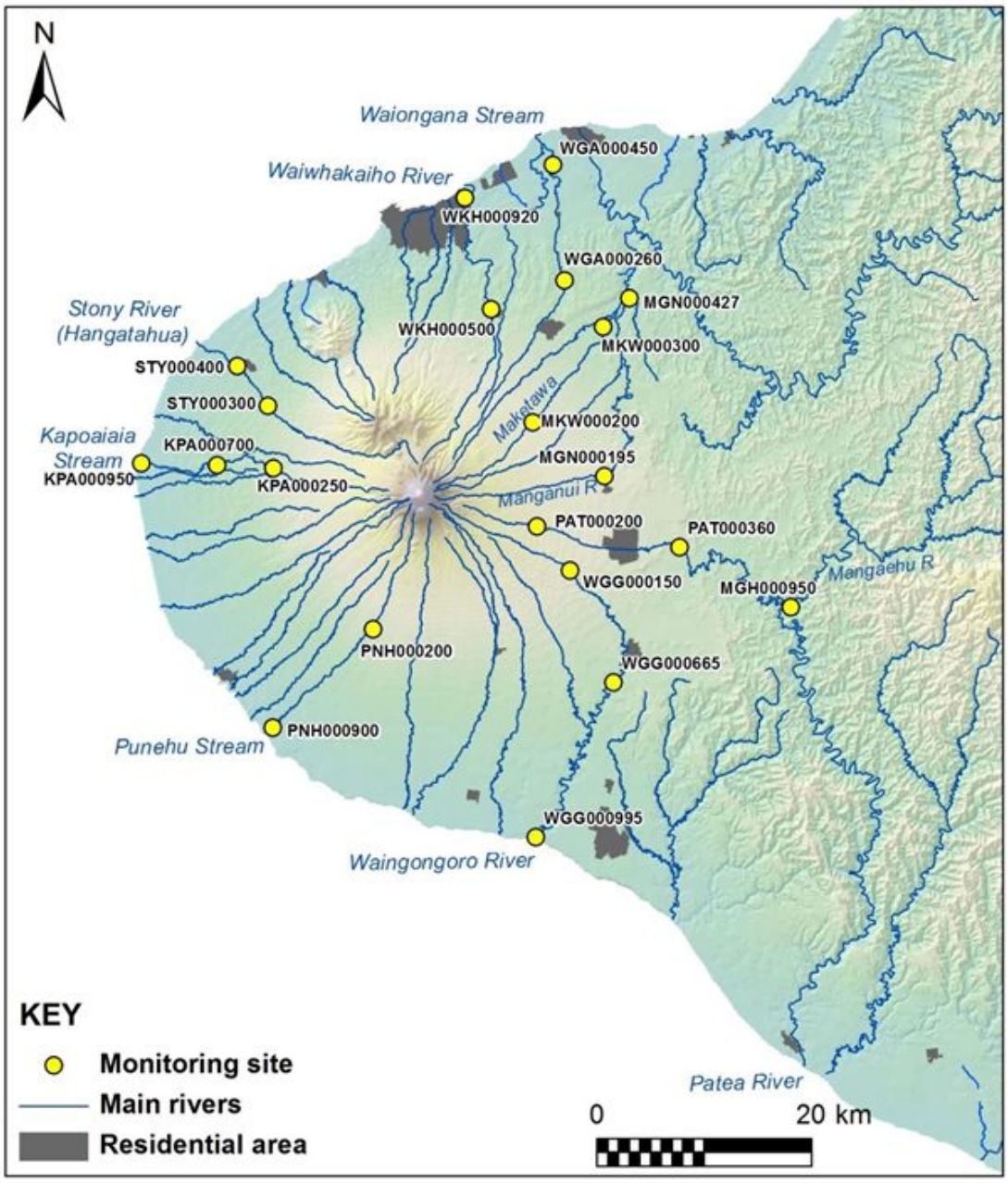

Figure 1: Periphyton sampling site locations (current programme)

Background

The Council's *Regional Fresh Water Plan for Taranaki (2001*) includes the following objectives:

Obj 3.1.2 *To maintain and enhance the natural, ecological and amenity values of rivers and streams of value in the region…*

Obj 3.1.4 *To safeguard the life-supporting capacity of water and aquatic ecosystems from the adverse effects of the use and development of fresh water*

Obj 3.1.5 *To maintain and enhance amenity values and the quality of the environment of Taranaki's rivers…*

The Council's Annual Plan for 2017-2018 contained a target for managing the algal state of the region's streams, as follows: '*Improvements in…algal cover, against a baseline of 1995 water quality, as applicable at 11 representative sites*'.

Section 35 of the Resource Management Act requires local authorities to undertake monitoring of the region's environment, including land, air, and fresh and marine water quality.

The Taranaki Regional Council initiated the periphyton monitoring programme within the Council's suite of the State of the Environment Monitoring (SEM) programmes for Taranaki in the 2002-2003 monitoring year. The freshwater periphyton programme has been designed to monitor the presence, nature, and distribution of algae in Taranaki streams and rivers with particular regard to the extent of proliferation which may affect the instream values of these streams i.e., aesthetic values (contact recreation and landscape values), biodiversity values, and those values linked to Maori culture and tradition. The programme is a continuing programme so as to test the effectiveness of regional water resources management policies. The most obvious of these is the progressive development of riparian planting in Taranaki, as shading of a stream may serve to limit periphyton growth and riparian planting may also filter runoff that is high in nutrients and sediment, which in turn may help reduce conditions conducive to the establishment of nuisance growths. Reductions in contaminant concentrations and mass loadings in point source discharges (whether agricultural or industrial) within a catchment may consequently improve water quality and limit the nutrients which allow nuisance periphyton to proliferate.

When managing rivers and streams for instream values, it is important to consider periphyton for two reasons:

1. Periphyton provides much of the energy (food) for the ecosystem.

2. Given the wrong conditions, periphyton can proliferate, forming large nuisance growths. Such growths interfere with human uses and degrade the habitat for other organisms.

The New Zealand Periphyton Guidelines provide a reference at which point growths of periphyton exceed the recreational guideline. This point is exceeded when at least 30% of the bed is covered by filamentous algae and/or at least 60% of the bed is covered by thick mats of algae. Additional guidelines or standards are now in place for chlorophyll *a* (the green pigment in algae). The *New Zealand Periphyton Guidelines* (2000) recommended a

maximum value of 50 mg/m^3 (monitored on the basis of scheduled rather than worst-case sampling) for the protection of benthic diversity, or 200 mg/m^3 to protect trout fisheries. The National Policy Statement for freshwater Management 2014 (amended 2017) sets a bottom line of 200 mg/m^3 (monitored on the basis of scheduled rather than worst-case sampling, with one or two exceedances allowed for each year).

Discussion

This report summarises the results of the programme for the monitoring period 2016-2018, and follows on from earlier reports covering up to the end of the 2016 monitoring period. Twenty-one sites were surveyed each year in ten catchments around the Taranaki region. Sites were chosen to be representative of different catchment types such as high conservation, riparian and major abstraction. In most cases, each river/stream has one upper site (where there is less potential effect from human activities), and one or two lower sites (with various degrees of potential effect). Sampling was undertaken generally twice each year, in spring (between September and December) and summer to late summer (between January and April), in accordance with protocols that required a minimum period since preceding freshes that may have served to reduce pre-existing periphyton growths. In other words, sampling is undertaken under the conditions that serve to promote a proliferation of periphyton- that is, a worst case circumstance. In some cases surveys had to be omitted because of the absence of suitable (low flow) conditions for the time being.

At each site, ten random assessments were made across the stream using a periphyton viewer. Periphyton cover on the stream bed within each square were estimated visually as a percentage cover on the substrate, as being of one of three types-thin film, mats, and/or filaments. The colour of the growth (brown, black, or green) was also recorded, as this provides information on the type and desirability of growths. Additionally, during the summer period periphyton samples were collected from ten rocks randomly selected at each site and levels of chlorophyll *a* pigment were analysed in a laboratory to determine viable periphyton biomass.

Information on the extent of coverage and the characteristics of the algae present is used to establish a periphyton index score (PI) as well as to determine whether the site exceeded the national recreational and aesthetic guidelines. The PI index is based on more information that just the percentage cover or whether the guidelines are exceeded.

While a periphyton index has been presented within national stream habitat assessment protocols (the 'SHMAK' PI), this has been found to not be suitable for characterising sites where periphyton communities are frequently affected either by scouring in floods, or by proliferation during low flow stable conditions, such as occurs in Taranaki. Therefore the Council has modified this PI methodology to generate its own index (the 'TRC PI'). In simple terms, a site clear of any algae will have a score of 10 (the maximum), and a site completely covered in filamentous green algae will have a score of 1 (the lowest possible score). While a site that has an exceedence of the periphyton guidelines could conceivably still have a reasonable PI score, even up to 8.2 (depending on the nature of the periphyton present, rather than its extent), a low TRC PI (somewhat at or below 6.0) will generally indicate undesirable growths are present to a significant, even if not at excessive levels. In descriptive terms, the categories are as follows:

Category ratings for TRC PI scores

Rating	TRC PI score
Very good	8-10
Good	6-8
Moderate	4-6
Poor	2-4
Very poor	0-2

An approximate scale for interpreting PI values is as follows:-

Score: 0 to 1.9
There are mainly long filamentous green algae at the site indicating that there is high to moderate enrichment. Such enrichment could be from enriched seepage/discharge, or could occur naturally in streams that have a high proportion of recent volcanic rocks (central North Island) in their catchments.

Score: 2 to 3.9
These communities suggest a moderate level of enrichment.

Score: 4 to 5.9
These communities suggest slight enrichment. Clean stones can result from recent abrasion by flood flows or intense grazing by invertebrates/insects that live in the gravels.

Score: 6 to 7.9
These communities are generally composed of species that are able to grow under moderate to low nutrient conditions. These communities also usually grow back first after a flood has removed previous growths, but may be out-grown by filamentous algae if nutrient levels are sufficiently high.

Score: 8 to 10
These communities usually signify low concentrations of nutrients and/or intensive grazing by invertebrates/insects that live among the gravels, or recent scouring.

In the **2016-2018** period, out of 148 individual site surveys conducted (84 for each of thick mats and for filamentous algae), 137 complied with the MfE guidelines- a compliance rate of 93%. In 2014-2016, the compliance rate had been 93.7%. Thirteen of the 21 sites never had any breach during 2016-2018 (14 in 2014-2016), while three sites had more than a single breach (out of the generally 8 surveys at each site): one site each on the Mangaehu (two breaches of the thick mat guideline), the Kapoaiaia, and the Punehu (both with two breaches of the filamentous guideline, one in each summer). In terms of seasonality, there was one breach in spring 2016, 5 in summer 2017, 2 in spring 2016, and 3 in summer 2018. All these results were very much in line with those of the previous two years.

For the TRC Periphyton Index, the median index value for 2016-2018 monitoring showed that eleven sites (52%) recorded a 'very good' rating (13 in 2014-2016), seven sites (33%) recorded a 'good' rating, and three sites (14%) recorded a 'moderate' rating. No sites received a lower median grading.

During the same period, out of 74 individual ratings of state that could be assigned, 2 fell into the 'poor' category (3 in 2014-2016, 1 in 2012-2014); there were 13, or 11%, in the 'moderate' category (9 and 7); 16, or 22%, in the 'good' category (20% and 26%), and all remaining surveys (58%) found that periphyton condition was 'very good' (65% in both

2014-2016 and 2012-2014). Only one site scored 'poor' gradings on individual surveys, compared with 3 in 2014-2016; the other 2 gradings at this site were both 'very good'.

Indicative and significant 16-year trends to summer 2018
Long term periphyton trend analysis revealed that for the majority of sites thick mats levels were fluctuating among sites and long filamentous algae levels were predominantly decreasing, although only two sites had statistically significant trends after FDR adjustment (a rigorous test for statistical confidence). Nine sites (about half) had decreases for thick mats and 17 sites (almost all) had decreases for long filaments. The two significant trends were at the upper Kapoaiaia and lower Patea River sites, both having decreasing levels of long filamentous algae. No sites showed a statistically significant increase in either periphyton measure.

Chlorophyll-a concentration measurements
The National Policy Statement for Fresh Water (2014) establishes attribute states (criteria) for the allowable concentration of chlorophyll-a, the pigment in periphyton. The attribute states and their associated numerical descriptions are: 'A' less than 50 mg chl-a/m^2; 'B' 50-120 mg chl-a/m^2; 'C' 120-200 mg chl-a/m^2 ; and 'D' (ie below the bottom line) more than 200 mg chl-a/m^2. Compliance is determined on the basis of samples collected monthly under 'random systematic' conditions ie on the same day of each month regardless of weather and flow conditions. Compliance is defined as having 1 or less samples each year containing more than 200 mg chl-a/m^2.

The Council has to date measured chlorophyll only once per year (summer), under worst case conditions ie when periphyton proliferation is at its most productive, rather than on a random basis. Therefore there can be no direct comparison made with the NOF criteria. However, a review of available chlorophyll-a data is still informative.

No site gave one than one result above 200 mg chl-a/m^2 when sampled under worst case conditions in the two summers. Ten sites (approximately half of all sites) had no results above 50 mg chl-a/m^2, and are effectively in the 'A' band. Three sites had no result above 120 mg chl-a/m^2, and are therefore effectively equivalent to the 'B' band. The remainder of the sites are effectively equivalent to 'C' grade.

Conclusions

Overall, sites located upstream in catchments had low levels of periphyton, while sites further downstream had higher levels of periphyton, which on infrequent occasions (assessed under conditions when proliferation was most likely to occur and to be at its greatest extent) breached guidelines. Correlation analysis was carried out to try and ascertain which environmental factors might be most closely associated with proliferation of periphyton. Results of this were inconclusive. Distance downstream from the National Park, or time since the last fresh, were both factors that were evident to some degree. While some strong correlations emerged for some surveys at some sites, these were not consistent across all sites or all surveys when higher levels of proliferation were found. It should also be borne in mind that correlation does not establish causation.

In summary, the weight of evidence from annual monitoring and trend analysis of worst-case conditions suggests that the state of the region's streams, as measured by periphyton biomass, is predominantly very good, and there is an on-going trend of improving in-stream health across the region's streams and rivers. It is noted that no comparison with the NPS-FM attribute for periphyton can yet be undertaken. The report notes that there has been

generally an increase in riparian exclusion and planting implemented throughout the Taranaki region in the time since periphyton monitoring first began; and this may have led to the reduction in nuisance growths at the large number of sites (81%) at which negative (reducing) trends for filamentous periphyton are apparent.

Thus, the Council and regional community are meeting the various LTP targets even more robustly on a year by year basis, and over the long term additional measures for maintaining and enhancing water quality, such as the riparian programme and exclusion of direct discharges of treated farm effluent to water, should see further and more robust gains in in-stream ecological health across the region.

Decision-making considerations

Part 6 (Planning, decision-making and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the *Act*.

Financial considerations—LTP/Annual Plan

This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Legal considerations

This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Appendices/Attachments

Document 2049992 (excerpts): *Freshwater Periphyton Monitoring Programme (Periphyton monitoring in relation to amenity values) State of Environment Monitoring Report 2016-2018 Technical Report 2018-7.*

Executive summary

Section 35 of the Resource Management Act requires local authorities to undertake monitoring of the region's environment, including land, air, and fresh and marine water quality. The Taranaki Regional Council began monitoring for nuisance periphyton in the 2002-2003 monitoring year. This report summarises the results of the State of the Environment periphyton programme for the monitoring period 2016-2018.

Periphyton is the layer of slime that can form on stream beds and on submerged objects. It consists of a mixture of algae and cyanobacteria that naturally occurs in rivers and streams. It plays a fundamental role in stream ecosystem functioning by utilising sunlight via photosynthesis to absorb nutrients and organic compounds for growth, and subsequently becoming a food source for invertebrates which in turn provide food for other organisms such as fish and birds. Nuisance periphyton in the form of prolific thick mats, pervasive long filaments or cyanobacteria can cause a range of issues such as streams becoming un-inviting for recreational users, anglers having difficulty fishing, streams closures due to cyanobacteria toxins and adverse impacts on stream ecology.

This freshwater periphyton programme has been designed to monitor for the presence and biomass of 'nuisance' algae in Taranaki streams and rivers at levels which may affect the instream values of these streams i.e., aesthetic values (contact recreation and landscape values), biodiversity values, and those values linked to Maori culture and tradition. To Maori, water is life, is linked to conception, and sustains the growth of crops, animals and people. Rivers represent the tipuna (ancestor) of the Tangata Whenua. Water and every river (awa) therefore has its own mana. Water also has its own mauri (life force) and wairua (spirituality). If the mauri or wairua of a waterbody is interfered with by way of pollution or desecration, then the spirit of the tipuna are affected and the waterbody will lose its vitality, its fruitfulness and its mana. Water, like all other natural resources, is considered by Maori to be a taonga to be valued, used with respect and passed on to future generations in as good or better condition than at present. In a physical sense, water is valued by hapu and whanau for the provision of sustenance through mahinga kai, or food resources eg, tuna (eel), piharau (lamprey), kahawai, inanga and other whitebait species. These values would be adversely affected by excessive periphyton growth.

Twenty-one sites are surveyed in ten rivers/streams around the Taranaki Region. Sites were chosen to be representative of different catchment types such as high conservation, agriculture, riparian and major abstraction. Most rivers or streams had one upper (mostly un-impacted) site, and one or two lower sites (with various degrees of land use impact). Periphyton surveys were scheduled for two times per year, spring (15 September to 31 December) and summer (1 January to 15 April). Sampling was always carried out after an extended period of low flow of at least ten days since a fresh of 3x median flow (i.e. after sufficient time for excessive growths to establish). At each site, ten random assessments were made across the stream using a periphyton viewer. Types of periphyton cover on the stream bed within each square were estimated visually as percentage coverage on the substrate; types being one of a range e.g. thin, medium and thick films of mats and short and long filaments. The colour of the growth (brown, black, or green) was also recorded. Additionally, during the summer period periphyton samples were collected from ten rocks randomly selected at each site and levels of chlorophyll *a* pigment were analysed in a laboratory to determine periphyton biomass.

The New Zealand Periphyton Guidelines, established by the Ministry for the Environment (Biggs, 2000), provide a reference at which point growths of periphyton exceed the recreational guideline. This point is exceeded when at least 30% of the bed is covered by filamentous algae and/or at least 60% of the bed is covered by thick mats of algae. A TRC specific periphyton index score derived from the standard periphyton index score (Biggs et al., 1998) was also calculated from the periphyton cover data and scores converted into one of five grades.

Chlorophyll *a* was used to estimate the amount of live periphyton biomass over two summers. Guidelines for chlorophyll *a* were established by the Ministry for the Environment (Biggs, 2000). The National Objectives Framework (NOF) (MfE, 2014) also uses chlorophyll *a* to assign bands to rivers and streams. There is a Government-imposed requirement to ensure streams and rivers are above the D band (chlorophyll *a* 200 mg/m^2) from 2025 onwards. The Council's long-established chlorophyll *a* sampling protocol differs from that established more recently for the NOF guideline and therefore results cannot be directly translated to NOF bands.

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the percentage cover of thick mats, and long filaments of periphyton for all sites and by testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

The results for the SEM nuisance periphyton programme during the 2016-2017 monitoring year showed that on one occasion at one site there was a breach of the thick mat guideline and on five occasions across four separate sites there was a breach of the long filaments guideline, out of a total of 64 site surveys. Ten sites could not be surveyed in spring 2016 due to high water levels. For the 2017-2018 monitoring year there were two occasions where there was a breach of the thick mat guidelines and three occasions where there was a breach of the long filaments guideline (Table 1), out of a total of 84 site surveys. No site failed more than one guideline in the 2017-2018 period. Two sites failed the thick mat guideline and six sites in total failed the long filamentous algae on one or more occasions during the two years under review. Out of the 168 surveys over the two years, 157 surveys (93%) found nuisance periphyton levels below guideline limits.

All rivers received a rating of at least 'moderate' for the TRC periphyton index score in all individual surveys except for the Kapoaiaia River at Wataroa Rd (a mid-catchment site), which had two surveys with 'poor' ratings out of 4 surveys.

For the TRC Periphyton Index, the median index value for 2016-2018 monitoring showed that eleven sites (52%) recorded a 'very good' rating, seven sites (33%) recorded a 'good' rating, and three sites (14%) recorded a 'moderate' rating.

No sites had cyanobacteria mats above 50% streambed coverage that would place a site in the 'Action' category and present a significant health hazard.

Table 1: Summary of SEM periphyton results for 2016-2018 monitoring period

River/Stream	Site	Distance from Nat Park (km)	Median TRC Periphyton Index	Trend		Periphyton cover		Periphyton biomass (chlorophyll *a* mg/m^2)	
				Thick mats	Long filaments	Thick mats	Long filaments	2017	2018
Hangatahua (Stony)	Mangatete Road	7.3	Very good	Increasing	Decreasing	3/3	3/3	16	1
	SH45	12.5	Very good	Decreasing	Decreasing	3/3	3/3	33	7
Kapoaiaia	Wiremu Road	5.7	Very good	Decreasing	Decreasing*	4/4	4/4	19	25
	Wataroa Road	13.5	Moderate	Decreasing	Decreasing	4/4	2/4$^+$	237^n	115$^+$
	Cape Egmont	25.2	Good	Decreasing	Decreasing	4/4	3/4$^+$	133$^+$	17
Maketawa	Derby Rd	2.3	Very good	Increasing	Increasing	3/3	3/3	3	3
	Tarata Road	15.5	Very good	Decreasing	Decreasing	3/3	3/3	25	132$^+$
Mangaehu	Raupuha Road	NA	Moderate	Increasing	Decreasing	2/4$^+$	4/4	375^n	89$^+$
Manganui	SH3	8.7	Very good	Decreasing	NA	3/3	3/3	5	3
	Bristol Road	37.9	Good	Increasing	Decreasing	3/3	3/3	90$^+$	NA
Patea	Barclay Road	1.9	Very good	Decreasing	Decreasing	4/4	4/4	5	5
	Skinner Road	19.2	Very good	Increasing	Decreasing*	4/4	4/4	29	117$^+$
Punehu	Wiremu Road	4.4	Very good	Increasing	Decreasing	4/4	4/4	45	1
	SH45	20.9	Good	Increasing	Decreasing	4/4	2/4$^+$	98$^+$	21
Waingongoro	Opunake Road	7.2	Very good	Decreasing	Decreasing	4/4	4/4	21	11
	Stuart Road	29.6	Very good	Increasing	Decreasing	4/4	4/4	152$^+$	167$^+$
	Ohawe Beach	66.6	Good	Increasing	Increasing	3/4$^+$	4/4	90$^+$	20
Waiongana	SH3a	16.1	Good	Decreasing	Decreasing	3/3	2/3$^+$	185$^+$	119$^+$
	Devon Road	31.2	Good	Increasing	Increasing	3/3	2/3$^+$	73$^+$	221^n
Waiwhakaiho	SH3 (Egmont Village)	10.6	Good	Increasing	Decreasing	3/3	2/3$^+$	46	186$^+$
	Constance St, NP	26.6	Moderate	Increasing	Decreasing	3/3	3/3	70$^+$	237^n

* Significant trend at $p<0.05$ after FDR adjustment, ^{n} above NOF standard, $^+$ exceeds Biggs, 2000 guideline

Periphyton biomass was in excess of the NOF standard (200 mg/m^2) at two sites for the summer 2017 surveys and another two sites for the summer 2018 survey (but see further on NOF compliance below), and was in excess of the guideline to protect benthic biodiversity (50 mg/m^2) at ten sites for the summer 2017 survey and nine sites for the summer 2018 surveys.

Periphyton biomass results generally reflected nuisance periphyton percentage cover levels and to a lesser extent TRC PI scores. There were four sites with chlorophyll *a* levels in exceedance of the NOF bottom line criterion but for each of the four sites only one of the two surveys was in exceedance. As noted above, these results do not mean that a 'D' NOF classification can be applied, as three years of systematically scheduled monthly data is required to produce a NOF rating, and therefore the site cannot be said to be compliant or non-compliant. Furthermore, the NOF protocol allows sites to have one sample per year for non-productive waterbodies (out of 12 surveys if the NOF procedure was used) above the 200 mg/m^2 standard without deeming the site's quality to be in non-compliance.

Long term periphyton trend analysis revealed that for the majority of sites thick mats levels were fluctuating among sites and long filamentous algae levels were predominantly decreasing, although only two sites had statistically significant trends after FDR adjustment (a rigorous test for statistical confidence). Nine sites (about half) had decreases for thick mats and 17 sites (almost all) had decreases for long filaments. The two significant trends were at the upper Kapoaiaia and lower Patea River sites, both having decreasing levels of long filamentous algae. No sites showed a statistically significant increase in either periphyton measure.

The data used for nuisance periphyton guidelines (thick algal mats and long filaments) overlaps with the periphyton index score but was potentially distinct from the periphyton biomass data as rocks viewed for periphyton cover are not necessarily, and probably unlikely, to be the same ones used to collect periphyton biomass. Therefore, even though ten replicates were used, results can potentially differ significantly between the two methods. Furthermore, periphyton coverage examines both live and dead periphyton while periphyton biomass uses chlorophyll *a* which is contained within live material only. Generally, ringplain streams and rivers closer to the Egmont National Park boundary had less periphyton than those further downstream. The majority of ringplain sites located further than 10 km from the National Park boundary and the Mangaehu River site had moderate to high levels of periphyton for at least one of the four surveys based on either periphyton coverage or biomass. A regression analysis also found a statistically significant correlation between distance from the park boundary and chlorophyll *a* levels for the summer 2018 survey. This indicates that sites located a reasonably distance from the National Park boundary or that have a substantial modified catchment above the site can potentially have problems with nuisance periphyton under certain conditions conducive to periphyton proliferation.

The difference between spring and summer surveys was not significant. Summer surveys often have considerably higher periphyton levels than spring surveys (e.g. TRC, 2014) but the average TRC PI score was within one unit for all four surveys (7.4-8.2 TRC PI). Average thick mat and long filamentous algae levels were within 1-2 percentage points between the spring the summer surveys which again indicated no seasonal difference in periphyton levels. There was a seasonal bias for breaches in guidelines with eight breaches occurring in summer against three breaches occurring in spring. However, it should be noted that in the

monitoring period under review, ten spring surveys could not be performed during the spring 2016 period due to high flows, which will slightly bias the relative results.

No *Didymosphenia geminata* was found for the monitoring period under review. Didymo, or 'rock snot', is a highly prolific and invasive diatom alage that forms blooms resembling dirty cotton wool. It has spread to nuisance proportions in a number of South Island high country streams and rivers.

Overall, the following conclusions can be made:

1. Generally, the monitored sites complied with nuisance periphyton guidelines, with 96% and 89% of surveys complying with the periphyton guideline for thick mats and long filaments respectively equating to an overall compliance rate of 93% for nuisance periphyton surveys.
2. 'Upstream sites' with little agriculture in their catchment had typically lower levels of periphyton compared with sites located further down the catchment that had nuisance periphyton levels which occasionally breached guideline limits.
3. Due to the number of variables involved (e.g. nutrients, light level, temperature, substrate type, time since last fresh, water clarity, level of invertebrate grazing etc) and interaction affects between variables it can be difficult to ascertain the main factors driving periphyton biomass.
4. The cumulative effects of agricultural discharges via point source or diffuse pollution, together with wider, less shaded stream widths and slower flow velocities, were probably the main cause of algae proliferation in 'downstream' catchment sites.
5. High flows can cause a reduction in periphyton growth but the degree of this effect is not consistent between streams.

From these conclusions, a number of recommendations are made in the report. Monitoring of the streams should continue as previously performed. The Council has also initiated a separate periphyton/chlorophyll *a* programme as per the NOF protocols, at sites considered representative of Freshwater Management Units.

In response to the invasion of *Didymosphenia geminata* in the South Island, it is also recommended that samples continue to be taken by the Council at selected sites for expert analysis.

Recommendations

1. THAT monitoring of the periphyton communities in the Stony, Maketawa, Manganui, Patea, Waiwhakaiho, Waingongoro, Punehu, Kapoaiaia, Waiongana and Mangaehu Rivers is continued for periphyton cover.
2. THAT in the 2018-2020 monitoring period, the Waiwhakaiho, Manganui, Patea, Waingongoro, Stony and Kaupokonui Rivers and Kapuni and Mangaoraka Streams are monitored for the invasive alga *Didymosphenia geminata*.
3. THAT the periphyton survey results are included in the next SEM 5 yearly state of environment report.
4. THAT programmes designed to limit nutrient input into Taranaki streams and rivers continue to be implemented such as riparian planting/fencing and disposal of dairy shed effluent to land in order to reduce periphyton levels in lowland streams and rivers in agriculturally dominated catchments.

Agenda Memorandum

Date 17 July 2018

Memorandum to
Chairperson and Members
Policy and Planning Meeting

Subject: **National Environmental Standards for Plantation Forestry in Taranaki**

Approved by: AD McLay, Director – Resource Management

BG Chamberlain, Chief Executive

Document: 2085433

Purpose

The purpose of this memorandum is to advise the Committee of the monitoring and enforcement activities to be undertaken of slash management by the Council in relation to the National Environmental Standards for Plantation Forestry (NES-PF). Interest had been shown at the previous meeting after the issues that arose in Gisborne with heavy rainfall causing flooding and slash movement into waterways damaging farmland and road infrastructure.

The same item was presented to the Consent s and Regulatory Committee this moring.

A power-point presentation on how the NES-PF would be applied will be provided at the meeting.

Executive summary

The National Environmental Standards for Plantation Forestry was introduced on 1 May 2018 by the Ministry for Primary Industries and are intended to provide a nationally consistent set of regulations to manage the environmental effects of plantation forestry activities. It contains 106 regulations and applies to forested areas above one hectare.

New Zealand has 1.7 million hectares of plantation forestry. Taranaki has 1.6 percent of this (29,000 hectares) and about 15,000 ha could be harvested in the next 6 years, depending on log prices.

In the majority of cases, the regulations will override the various council Resource Management Act plan provisions for forestry, including the Regional Fresh Water Plan for Taranaki and the Regional Soil Plan.

The Taranaki Regional Council has created a new position (Forestry Lead), in the Compliance Section, to undertake the necessary monitoring inspections and enforcement, where required, under the Council's Enforcement Policy (2017).

Recommendations

That the Taranaki Regional Council:

1. receives this memorandum;
2. notes the Council has employed a staff member to monitor the forestry industry and will recover the reasonable cost of this from the sector using the user pays provisions of the Long Term Plan;
3. notes the Council will monitor and where necessary enforce the provisions of the National Environmental Standard for Production Forestry and the Resource Management Act using its Enforcement Policy(2017);
4. notes, given the differences in catchment characteristics, forestry cover, harvesting methods and regulation, the issues with slash management experienced in Gisborne are unlikely to occur in Taranaki.

Background

The Ministry for Primary Industries and the Ministry for the Environment developed the National Environmental Standard jointly. It was gazetted in August 2017 with a delay in commencement to 1 May 2018 to enable councils and foresters to understand their responsibilities under the regulations and put in place processes to meet these responsibilities.

Foresters and councils have been supported in this process through a series of regional workshops. More than 600 foresters and council representatives throughout New Zealand attended these. A workshop was held in May in Stratford and attended by about 40 people. Those present recognised the need for appropriate regulation of the activity under the NES-PF and for there to a consistent regulatory approach for all operators to ensure high standards and minimal adverse environmental effects.

The National Environmental Standards for Plantation Forestry will be reviewed in 12 months to ensure they are being successfully implemented. The standards are based on existing good practice for the forestry industry and include risk assessment tools developed to manage the environmental impacts form forestry, covering issues of erosion, wilding pines and fish spawning. The benefits of these tools are that the restrictions on forestry activities are related to the environmental risk rather than the forestry operation.

In the past, the Council has undertaken some monitoring inspections on consented forestry activities, associated with earthworks, and enforcement action has been undertaken as required when non-compliances have been found. As the level of harvesting is increasing in the region it is appropriate to increase regulation.

The NES-PF allows the Council to recover the cost of monitoring permitted forestry activities.

Discussion

The NES-PF addresses the full forestry lifecycle. In the future under the NES regulation of forestry activities will be addressed under eight activities:

- Afforestation
- Pruning and thinning to waste
- Earthworks
- River crossings
- Forest quarrying
- Harvesting
- Mechanical land preparation
- Replanting.

Each of these activities will either require a consent or fall into the permitted activity category. The consents can be treated as controlled or restricted discretionary. Regardless of which category the activity falls into, the Taranaki Regional Council requires notification of the activity along with supporting information including Erosion Susceptibility, wilding tree risk calculation etc. Inspections will be undertaken by this council on both permitted activities and consented activities.

District councils will be able to monitor compliance with their responsibilities under the NES-PF.

Under the National Environmental Standards for Plantation Forestry more inspections will be completed, with pre, during and post inspections taking place where required. There will also be a focus on harvesting techniques in particular ground based harvesting on land where a cable hauler would be more appropriate.

Another area of focus will be on how sites are decommissioned, for example all tracks left with correct drainage and sediment controls, skid sites having slash pulled back from the edges and drainage installed. Emphasis will be placed on ensuring slash is not left in waterways (slash must now be outside the 5% AEP zone which is a one in 20 year flood).

The Council will target operators who have been and are currently operating without either a consent or not notifying us of permitted activity. During inspections undertaken on consented and notified sites we will find site operators that have not followed the requirements of the NES-PF, these sites will be dealt with on a case by case basis.

How big an issue is this for Taranaki?

Comparatively for Taranaki we are a relatively low risk compared to somewhere like Gisborne whose forestry land is predominantly on very large steep faces with deep seated erosion prone soils. Our biggest risk would be the big catchments like Waitotara. For most of inland Taranaki like east of Stratford, a large rainfall event would likely only effect the immediate downstream property from the forestry block and not make it any further, unless there were landslides/debris dams where impacts could be greater.

There are about 28,000 ha of forestry plantings above 1 ha in the region. In the next six years about 15,000 ha of mature trees could be harvested, but this will depend on log prices, as high prices can mean younger trees are harvested. Conversely, when prices are low owners

can leave the trees standing. Hence, it is difficult to accurately predict harvesting trends over time.

The plantations are spread throughout eastern Taranaki with large areas in the Tangahoe and Waitotora catchments. In Gisborne the plantations are more concentrated.

Given the differences in catchment characteristics, forestry cover and harvesting, the issues with slash management experienced in Gisborne are unlikely to occur in Taranaki. There is also more regulation of activities in Taranaki than in Gisborne.

In Gisborne a month's rainfall was received in 24 hours which is an extreme rainfall event.

There will be little the Council could do with an extreme rainfall event that occurs between harvesting and forest reestablishment as there may be slope failure, and debris entering waterways (causing debris dams and great impacts when these fail) and debris being captured by water above the 20 year flood level in the NES-PF. However, the Council will do everything it can under the NES and RMA to minimise environmental impacts. The NES also controls where you can plant trees with setbacks from neighbours, rivers, lakes and wetlands so slash will be less prone to being captured by high flow events.

What enforcement tools do we have?

If a non-compliance is identified, Warranted Officers in the TRC have the following options under the Council's Enforcement Policy (2018):

- An abatement notice can be served directing a person to cease work;
- An abatement notice can be served directing the person to undertake works to become compliant;
- An infringement notice or multiple infringement notices can be served if the non-compliance is serious enough or there is failure to comply with an abatement notice; and
- For extremely serious incidents or cases of significant environmental effects then a prosecution would be considered.

District Council vs Regional Council

District Councils require notification of works similar to the Regional Council. District Councils have responsibilities with issues such as planting near boundaries where neighbouring properties may be affected with issues such as shading, similarly alongside public roads. There are also setbacks for afforestation for papakainga and an urban area.

Decision-making considerations

Part 6 (Planning, decision-making and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the *Act*.

Financial considerations—LTP/Annual Plan

This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

MPI would have worked with other government departments to develop the NES-PF. There is limited consideration of specific iwi values in the NES-PF. (e.g. waahi tapu sites). As noted above district councils have responsibilities for planting separation distance from papakainga. All the regulations are aimed to minimise environmental effects of forestry so fulfil kaitiakitanga responsibilities.

Legal considerations

This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Agenda Memorandum

Date 17 July 2018

Memorandum to
Chairperson and Members
Policy and Planning Committee

Subject: Submission on Zero Carbon Bill

Approved by: AD McLay, Director – Resource Management

BG Chamberlain, Chief Executive

Document: 2080029

Purpose

The purpose of this memorandum is to introduce a draft submission on the Zero Carbon Bill and to recommend it be adopted by the Council.

Submissions close on 19 July 2018.

The draft submission is attached to this memorandum along with the discussion document *'Our Climate Your Say'* that sets out questions for feedback on the proposed Bill.

Executive summary

The introduction of a Zero Carbon Act was part of the Coalition Agreement that was generated when the new Government come to power in October 2017. It follows commitments made by New Zealand under the Paris Agreement signed in 2016 that aims to reach net zero emissions in the second half of this century.

In June 2018, the Ministry for the Environment released a document *'Our Climate Your Say'* that contained specific proposals for public feedback on a proposed Zero Carbon Bill. At the same time, the Ministry embarked on a nationwide series of public meetings throughout June and July 2018 designed to encourage as many New Zealanders as possible to have their say on the Bill.

The discussion document is clear that the primary objective of the Zero Carbon Bill is to create certainty about future interventions and it aims to do this by providing a long-term, stable policy environment with clear emissions targets and mechanisms to achieve this. The discussion document is also clear that the transition to a net zero emissions economy will need to be gradual, with a planned approach that ensures that emissions targets are carefully phased in and the impacts on jobs and livelihoods are minimised.

The draft submission comments on the sixteen questions contained in the discussion document. It supports a 2050 target being included in legislation but with provision for

staging over a number of years and for review and amendment of the targets in light of evolving technology and changes in costs and benefits, markets, land use trends etc.

It also offers qualified support for a target of net zero long-lived gases and stabilised short-lived gases (such as methane from agriculture) on the basis that the agricultural sector in New Zealand leads international best practice and there are currently very limited options at the farm scale to further mitigate greenhouse gas emissions. Further, in respect of carbon-based gases, to focus only on their emissions is to ignore the remainder of the closed carbon cycle that includes sequestration and methane reversion to carbon dioxide, for pastoral farming systems under steady-state conditions. To require mitigation would, on a global scale, encourage more inefficient agricultural producers to meet increasing demands for agricultural products. However, the submission points to further research on agricultural emissions which may mean that a target of stabilisation or even reductions by 2050 may be an appropriate long term goal.

The submission raises an alternative approach to agricultural emissions that may be worth exploring with the industry. This involves a cap on current animal numbers as a potentially effective means of limiting any further increases in greenhouse gas emissions. Some recent international research referenced in the submission offers support for such an approach.

The submission also comments on emissions budgets and the role and functions of the Climate Change Commission and supports adapting to the effects of climate change being included in the Bill.

The Government expects that a Zero Carbon Bill will be introduced to Parliament in October 2018 with a Zero Carbon Act coming into force in April 2019.

Recommendations

That the Taranaki Regional Council:

1. receives the memorandum '*Submission on Zero Carbon Bill*'; and
2. adopts the submission.

Background

The introduction of a Zero Carbon Act was part of the Coalition Agreement that saw the new Government come to power in October 2017. It follows commitments made by New Zealand under the Paris Agreement signed in 2016 that aims to reach net zero emissions in the second half of this century.

In June 2018, the Ministry for the Environment released a document *'Our Climate Your Say'* that contained specific proposals for public feedback on a proposed Zero Carbon Bill (see document attached). At the same time, the Ministry embarked on a nationwide series of public meetings throughout June and July 2018 designed to encourage as many New Zealanders as possible to have their say on the Bill.

The discussion document is clear that the primary objective of the Zero Carbon Bill is to create certainty. Its intention is to provide a long-term, stable policy environment with clear emissions targets and mechanisms to achieve this, and pan-party support. The discussion

document proposes that the Government sets a 2050 target in legislation now and proposes three options for what this target could look like:

- **net zero carbon dioxide:** reducing net carbon dioxide emissions to zero by 2050
- **net zero long-lived gases and stabilised short-lived gases:** long-lived gases to net zero by 2050, while also stabilising short-lived gases
- **net zero emissions:** net zero emissions across all greenhouse gases by 2050.

The discussion document is also clear that the transition to a net zero emissions economy will need to be gradual, with a planned approach that ensures that emissions targets are carefully phased in. An approach involving three emissions budgets of five years each (covering the next 15 years) is proposed. This is designed to ensure greater predictability (certainty), but also the ability to review budgets in light of technological and other changes.

The discussion document maintains that a planned transition over time gives us the best chance of minimising the impacts on jobs and livelihoods so that *'it is just and fair for all New Zealand communities and regions'* (discussion document page 11). This will require the Government to look carefully at the impacts on regions, workers and communities given the potential changes in the economy (there are several places in the submission where these matters are raised). Feedback is sought on the proposed emissions budgets and on Government responses to them.

Feedback is also sought on the role and functions and required expertise of the proposed Climate Change Commission and on whether adapting to the impacts of climate change should also be included in the Bill.

While there are risks and uncertainties involved in a move to a net zero emissions economy, the discussion document maintains that these can be managed effectively. There are also a number of potential benefits to New Zealand if the transition is managed carefully. There is the potential to build a high value economy that will benefit New Zealand in the long term. This is starting to happen now in energy and transport, and in agriculture but with the right encouragement, incentives and other supports in place New Zealand could gain significant advantages for example in developing new technologies, products and services.

There are also many potential co-benefits from a net zero emissions economy including environmental benefits, health benefits and reduced traffic congestion as well as opportunities for the Māori economy.

What will be important for the transition will be widespread political support and cross-sector agreement on the targets to be set and the means of achieving them. Effective mechanisms for dealing with the economic and social impacts of change, even if this is a planned, gradual process, will be needed. Many of these considerations will extend beyond the Zero Carbon Bill into other areas of the economy and society. For example, the Productivity Commission in its recent report *'Low emissions economy'* identified the core building blocks to a low emissions future. These included getting the emissions pricing right, creating laws and institutions that support stable policy (e.g. a Zero Carbon Act and a Climate Commission), supportive regulations and policies to address non-price barriers, encourage the transition and manage serious adverse impacts on lower-income households and affected business, and support for innovation and investment in low-emissions technology and infrastructure etc.

These will need to be agreed to and set in place if New Zealand is to transition successfully to a net zero emissions economy.

The submission

The discussion document seeks feedback on four broad areas associated with the Bill: the 2050 target; emissions budgets; the Climate Change Commission and adapting to the impacts of climate change.

The submission favours the option of a 2050 emissions reduction target being set in legislation now. This provides certainty and a clear target for New Zealand to work towards on climate change. However, the submission calls for the targets to be staged over a number of years and for these to be reviewed and amended as changes in science, technology and land use etc. occurs.

As to what sort of target should be set, the submission offers qualified support for a net zero long-lived gases by 2050 and stabilised short-lived gases (e.g. methane from agricultural sources). It is considered that this option offers the best mix of credible science, practical abatement interventions and lowest transition costs over the 30-year period to 2050. It does however, rely on further advances in research on agricultural mitigation technologies and on the uptake of these technologies by our trading competitors.

The submission suggests the possibility of an alternative approach to agriculture being brought into the New Zealand Emissions Trading Scheme (NZ ETS) under the options given. The submission notes that the NZ ETS relies on financial penalties as a means of changing behaviour but does not directly reduce emissions. It suggests exploring with the agricultural industry whether the imposition of a ceiling on current animal numbers is an effective means of limiting any further increases in greenhouse gas emissions from agriculture. This would involve farmers being able to trade in herd numbers without directly measuring emissions or trying to change emissions at the farm scale. It would recognise the closed loop movement of carbon within a pastoral animal husbandry system that is in equilibrium. Such an approach would have advantages of simplicity, accuracy and efficiency as well as low overall transition costs. Some recent international research on this matter is referenced in the submission.

Still on the issue of targets, the submission considers that New Zealand should be able to source some emissions reductions from overseas (as this would provide some flexibility in meeting our targets) and that the Bill should allow the 2050 target to be revised if circumstances change.

On the question of emissions budgets, the discussion paper proposes that a series of shorter-term emissions budgets be proposed as ‘stepping stones’ to guide progress towards the 2050 target. The submission agrees with this approach. Shorter-term budgets are necessary both to increase certainty for businesses about what needs to be done to meet the shorter-term horizon, and to inform a range of policy decisions that will need to be taken. The submission agrees that emissions budgets provide a good balance between signalling emissions reductions into the future while also allowing flexibility to deal with changing circumstances such as changes in the economy and in technology and science. A staged approach would also allow practicality to be progressively tested and established. It supports the proposed three emissions budgets of five years each with an option for the Government to be able to review the last two budgets.

The submission also supports having a list of matters contained in the Bill that must be taken into account by the Climate Change Commission and the Government when advising on and setting budgets and largely agrees with what is proposed in the discussion document. However, the submission suggests that the list of matters to be taken into account should also include the economic and social impacts on particular regions of New Zealand. The Bill should also require the Government to set out plans within a certain timeframe to achieve the emissions budgets.

On questions concerning the proposed Climate Change Commission itself, the submission supports the functions of the proposed Commission and that it should advise the Government on policy settings in the NZ ETS rather than being able to make decisions on these matters itself. When it comes to the expertise that should be on the Commission, the submission suggests two areas where change could be made, namely in areas relating to international trade and regional impacts.

The fourth and final area of feedback sought concerns whether the Bill should cover adapting to climate change. The submission supports the inclusion of a national adaptation plan in the Bill. The submission also supports in principle, the need for a specific adaptation reporting power. If such a power was included in the Bill and included obligations on local government, further discussions would be required as to what such reporting would cover, the timeframes for reporting and cost sharing arrangements.

In concluding, the submission emphasises the need for a number of operational, policy and institutional supports to be put in place around the Bill if it is to be successful in achieving its stated goals.

The Government expects that a Zero Carbon Bill will be introduced to Parliament in October 2018 with a Zero Carbon Act coming into force in April 2019.

Decision-making considerations

Part 6 (Planning, decision-making and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the *Act*.

Financial considerations—LTP/Annual Plan

This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Legal considerations

This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Attachments

Document 2081643: Discussion document: Our Climate Your Say
Document 2071566: Submission on Zero Carbon Bill

Discussion Document

Join the conversation...

Ministry for the Environment
Manatū Mō Te Taiao

This document may be cited as: Ministry for the Environment. 2018. *Our Climate Your Say: Consultation on the Zero Carbon Bill*. Wellington: Ministry for the Environment.

Published in June 2018 by the
Ministry for the Environment
Manatū Mō Te Taiao
PO Box 10362, Wellington 6143, New Zealand

ISBN: 978-1-98-852571-6 (print)
978-1-98-852570-9 (online)

Publication number: ME 1371

This document is available on the Ministry for the Environment website: www.mfe.govt.nz.

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How to use this document

You have a part to play in deciding how New Zealand responds to climate change.

Finding your way around the document

- We have produced a stand alone **Executive summary** that includes background information, a summary of the proposals in the Zero Carbon Bill and next steps.
- This summary is followed by the full consultation document, which contains three parts.

  Part one – Introduction

  – Outlines what climate change is, the impact it is having and our local and global context.

  Part two – Proposals for the Zero Carbon Bill

  – Sets out the proposals for the Bill, including the targets and the stepping stones to meet them, the Climate Change Commission and how we can plan to adapt.

  Part three – What happens next?

  – Contains information about the upcoming events, meetings and hui, and details the process for developing, finalising and implementing the Zero Carbon Bill.

To find more information

- Visit the Online Engagement Portal at http://www.mfe.govt.nz/have-your-say-zero-carbon.
- Ask the Zero Carbon Bill team at ZCB@mfe.govt.nz.
- Attend one of the events and hui held around the country and online.

Have your say on the Zero Carbon Bill

Please provide feedback by completing our submission form online, available at www.mfe.govt.nz/more/consultations.

Alternatively, you could download the submission form online (or request it from us) or write your own submission. Either email this submission to ZCB.Submissions@mfe.govt.nz (Microsoft Word document (2003 or later) or PDF) or post to Ministry for the Environment, PO Box 10362, Wellington, 6143.

In your submission include:

- your name or organisation name
- your email, or postal address.

Publishing and releasing submissions

All or part of any written submission (including names of submitters) may be published on the Ministry for the Environment's website, www.mfe.govt.nz. Unless you clearly specify otherwise in your submission, the Ministry will consider that you have consented to website posting of both your submission and your name.

Contents of submissions may be released to the public under the Official Information Act 1982 following requests to the Ministry for the Environment (including via email). Please advise if you have any objection to the release of any information contained in a submission, including commercially sensitive information, and in particular which part(s) you consider should be withheld, together with the reason(s) for withholding the information. We will take into account all such objections when responding to requests for copies of, and information on, submissions to this document under the Official Information Act.

The Privacy Act 1993 applies certain principles about the collection, use and disclosure of information about individuals by various agencies, including the Ministry for the Environment. It governs access by individuals to information about themselves held by agencies. Any personal information you supply to the Ministry in the course of making a submission will be used by the Ministry only in relation to the matters covered by this document. Please clearly indicate in your submission if you do not wish your name to be included in any summary of submissions that the Ministry may publish.

Message from the Minister

Over the past summer, many New Zealanders have experienced the changing climate in their everyday lives. The seas we swam in were warmer than anyone could remember. We had months of almost uninterrupted spectacular weather.

I say 'almost' because it was interrupted by a severe storm in January and two Pacific cyclones in February – Gita and Fehi. Roads were washed into the sea in the Coromandel, Auckland's Tamaki Drive was flooded (again) and Golden Bay saw huge landslides and damage to crops.

New Zealand has always had dramatic weather. But the frequency and the severity of storms, coastal and river flooding, droughts, and wildfires are increasing. These will continue to increase, as long as people continue to add large amounts of greenhouse gases into our atmosphere.

The costs to us are also increasing. We are seeing lost agricultural production, flood clean-up costs, sea-wall and road reconstruction, and so on. Insurance companies and banks are rethinking their risk profiles and premiums for coastal homes and businesses.

All of this sounds like a lot of bad news – but we now have many of the tools that we need to fix it. And, in doing so, we can grasp an extraordinary opportunity to upgrade our economy, not just to be 'clean and green' but also more productive, more resilient and better paid.

A new industrial revolution is taking place. This is happening, particularly in energy and transport, but also in every other sector of the economy, including agriculture.

Those leading the way are developing intellectual property, new technology and the products and services of the 'low-carbon economy'. Those that do not lead are letting the opportunity pass them by.

In New Zealand, investment has been held back by the lack of a clear position on climate change or any signal about the direction we want the economy to go in. Will we stick with our current reliance on traditional (and high pollution) technologies and products? Or will we commit to replacing those technologies with new, clean ones?

The Zero Carbon Bill is designed to create certainty. It is intended to provide a long-term and stable policy environment, with a clear emissions target and a guided pathway to get us there.

That certainty will drive investment in new industries and create new jobs to upgrade our economy. We have opportunities to increase our renewable electricity generation, plant more trees, invest in new technologies, continue our world-leading research into reducing emissions on our farms, and support the growing Māori economy.

The transition will affect every sector of the economy, but the change will be more far reaching in some than others. For that reason, we are absolutely committed that this transition will be planned, gradual and carefully phased in. We have had other transitions

before, which were not well managed and led to displacement and upheaval. For this to work, we need to make sure we bring everyone with us and leave no one behind.

Cast your mind back 30 years, to 1988. The internet did not exist, at least not in its current form. But try to imagine running your school or your farm or your bank without the internet today. It has transformed every aspect of the economy – and our lives. It has been disruptive, and it has also created tremendous opportunity and whole new industries.

A planned transition over time gives us the best chance of minimising the negative social and economic impacts of change so it is just and fair for people, communities and regions. The longer we leave our planning, the more abrupt and difficult change will be. We want to avoid that risk.

We are not starting from scratch. Nearly 10 years ago, the then Prime Minister Rt Hon John Key made a commitment to halve our emissions by the year 2050, and we have taken the first steps towards that.

But, in 2015, we, alongside almost all countries in the world, decided that the world should achieve net zero greenhouse gas emissions by the second half of this century through the Paris Agreement. This Government has committed to setting a net zero target for New Zealand to meet by 2050. We seek your views on what this target should look like during this consultation.

Setting a new long-term target will be a clear signal of our commitment to the Paris Agreement, including its collective goals and our own contribution to global action. Our implementation journey has begun. Many of New Zealand's largest businesses have already gone 'carbon neutral', and many others are working on it.

Now is the right time to set a target of net zero and put in place the institutions and the strategy to reach it. At its core, this is what the Zero Carbon Bill does.

With this challenge comes opportunity. Together, we can build a more sustainable economy that ensures New Zealanders can prosper.

I invite you to be part of the conversation.

Hon James Shaw
Minister for Climate Change

Executive summary

The Government is committed to acting on climate change. We want to build a more sustainable economy that is better for the environment, creates jobs and improves New Zealanders' lives. We also want to show global leadership by demonstrating to other countries that New Zealanders can be better off while taking action to reduce our impact on the climate.

Countries around the world emit greenhouse gases from activities like driving cars, farming, burning coal and deforestation. A big increase in human-made greenhouse gases has occurred in recent years, causing the global climate to change rapidly.

Each year, we are seeing more and more extreme weather events. Seas are rising. Our regions, businesses and communities have already seen costly damage and disruption. We are paying more to repair our roads and railways and to keep other vital infrastructure running. These costs will continue to increase over time.

In 2015, almost every nation decided to take action together to address climate change by adopting the Paris Agreement. It sets the world on the path to net zero emissions by the second half of the century. Net zero means the emissions we create are no greater than what is removed from the atmosphere, from things like forests soaking up carbon dioxide. Many countries are transitioning their economies and will continue to in the years to come. A number have set long-term emissions reduction targets, including the United Kingdom (UK), the European Union, Canada, Sweden and Norway. The global economy will look very different by 2050, as a result.

Although New Zealand's share of global emissions is very small (0.17 per cent), countries like us make up around 30 per cent of total emissions. New Zealand's per capita emissions are high, compared with similar economies in the Organisation for Economic Co-operation and Development (OECD).

The Zero Carbon Bill is an opportunity for New Zealand to decide how it delivers its part in the global effort while encouraging action by others. The Bill puts a new target in legislation that gives us certainty about our long-term goals. It creates the institutions to help us get there and to hold us to account. It can also put in place the plans we need to respond to the growing impacts of climate change. We want New Zealanders to help us decide the shape and form of this Bill.

Why we should take action

With action comes opportunity. By setting a long-term target, we will have time to adjust and to upgrade our economy. In 2011, New Zealand committed to reduce its emissions by 50 per cent below 1990 levels by 2050. Since then, we have ratified the Paris Agreement, which commits us to increasingly ambitious targets over time. Taking a fresh look at our 2050 target will bring us further in line with the Paris Agreement. A recent study from Westpac New Zealand found that taking early and planned action on climate change could save $30 billion by 2050, compared with taking delayed, then abrupt action later.[1]

[1] Westpac NZ (2018).

Over 30 years, New Zealand's economy will change, just as it has over the past 30 years. Taking action now means that we can:

- reduce the potential for sudden, drastic economic shocks
- gain an economic advantage as an early mover in emerging markets
- get the most from wider benefits like cleaner air and water and better health
- meet international commitments and encourage other countries to meet theirs.

This is our chance to build a high value economy that will hold us in good stead for the future. By upgrading our economy and preparing for the future, we can help make sure quality of life continues to improve for generations to come.

A move to a net zero emissions economy that is resilient to climate change will deliver health and environmental benefits. The air we breathe will be cleaner. More people catching buses and trains more often will reduce traffic congestion in our cities. Better insulation in homes for energy efficiency will reduce heating bills and lead to health cost savings and a higher quality of life because houses will be warmer, drier and healthier than they are now.

More forestry, in the right places, will improve the health of our birds, fish and plants. It will also improve water quality in our rivers and lakes and prevent erosion. Stronger climate action can also drive faster innovation as people find new solutions to old problems, and create new jobs.

Many Māori enterprises are involved in natural resource management including forestry, agriculture and fisheries. There will be opportunities for the Māori economy through the transition.

What the transition to net zero emissions could look like

There are plenty of ways we can take action. We can increase renewable electricity generation, plant more trees, invest in new technologies, shift our cars and trucks to electric and invest in public transport. We can also continue our world-leading research exploring how to reduce emissions on farms.

Change is not new. Our agriculture sector has responded to constant land use and other change over the past 70 years and, as a result, we are considered leading edge, globally.

Our economy is already dynamic and constantly adjusting to change. Jobs are continually created and lost. For some of us, the changes through the transition could be small or not noticeable – we could be driving vehicles powered by 100 per cent renewable electricity. For others, the changes could be bigger. The transition will affect how we travel, use land and what we produce and consume. Other countries, such as the UK, have shown that it is possible to reduce their emissions while growing their economy and maintaining a high standard of living.

It is uncertain how the future will unfold. We have used a range of studies to help us examine the impact of moving to a low-emissions economy. These can help us look ahead, but each has different strengths and weaknesses. Looking out to 2050 becomes less certain. The studies suggest changes will happen across all parts of our economy, including the following.

- As we reduce emissions, the economy will continue to grow but possibly less quickly. For example, if we make ambitious efforts to become a net zero emissions economy, gross

domestic product (GDP) is estimated to grow by 1.9 per cent every year[2]. This is compared with an estimate of 2.2 per cent every year if we did not take new measures to reduce emissions. It is highly unlikely that New Zealand will take no further action on climate change in the period to 2050, given the international commitment to the Paris Agreement.

- We will need to invest in innovation and plant a lot more trees, to ensure we maintain a strong economy over the coming decades.
- If we set a net zero emissions target – the most ambitious target – some sectors and industries could decline or change and new sectors will emerge, creating new jobs. Businesses with high emissions will face challenges if they do not reduce them. The make-up of the workforce in some regions could change as a result.
- Low income households are likely to be more affected financially. The Government is committed to supporting those disproportionately affected.

The economic analysis we commissioned highlights the costs of taking action. Recent analysis also suggests that limiting global warming to 1.5 degrees Celsius instead of 2 degrees Celsius by mid-century could lead to an increase in global GDP of 1.5 per cent to 2 per cent and avoids damages from climate change globally of around $11 trillion to $16 trillion.[3]

Commitment to a fair and inclusive transition

We want to avoid sudden changes, by planning early. A planned transition over time gives us the best chance of minimising the impact on our jobs and livelihoods so it is just and fair for all New Zealand communities and regions. The Government is committed to this. Incorporating te ao Māori (the Māori world view) and kaitiakitanga (the concept of guardianship) in our approach, as well as working with industry across the agriculture, forestry, energy, transport and waste sectors, will help to get the transition right.

This could include training and upskilling people into new low emissions jobs and managing the timing of when policies would take effect. The Government is already looking into what else we need to do to support vulnerable regions, workers and communities, given the potential changes in the economy. Preparing for the change, and investing in our progress will make the transition less disruptive.

What drives a smooth transition?

A recent report from the New Zealand Productivity Commission identifies the core building blocks to a low emissions future: emissions pricing, laws and institutions, regulations and policies, and the right innovation and investment settings.[4] New Zealand is already making progress on these. For example, New Zealand was one of the first countries in the world to set up an emissions trading scheme.

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2 Please see the appendix for the full report for more information on the studies used to assess the economic impacts.

3 Burke et al., 2018.
Note the avoided damages are calculated using a 3% discount rate, and mid-century refers to the period between years 2046 to 2065.

4 New Zealand Productivity Commission (2018).

The previous and current Parliamentary Commissioner for the Environment[5] and the Productivity Commission[6] recommend the Government sets out the laws and institutions for a low emissions and resilient future, as other countries have. The Zero Carbon Bill responds to these recommendations by proposing to:

- set targets to reduce our emissions
- introduce the stepping stones (or budgets) to reach these
- set up the institutions to provide independent, expert advice and hold governments to account
- better understand the risks and to plan for how we adapt to climate change.

What the Zero Carbon Bill could do

This Bill sets the long-term commitment to transition us to a low emissions, climate-resilient economy. It puts in place the core building blocks that will give certainty to New Zealanders that, no matter what government is in power, there will be a long-term approach to climate change that endures political cycles.

2050 target

A new 2050 target in the Bill would provide more certainty about the direction for the transition. This could help give businesses, households and local government a strong signal of the direction we are heading in as a country, and help people make confident choices about how to achieve our 2050 goal. Many other countries have already set ambitious long-term emissions reduction goals. The UK aims to reduce emissions by 80 per cent of 1990 levels by 2050. Canada is also aiming to reduce its emissions by 80 per cent in 2050 (relative to 2005 levels). The European Union's target is 80 to 95 per cent of 1990 levels by 2050. Norway, Portugal and Sweden are seeking to achieve neutrality, or near-neutrality, by 2050 or earlier.

We want to hear your views on which net zero target is the right one for New Zealand.

- **Net zero carbon dioxide by 2050:** this target would reduce net carbon dioxide emissions in New Zealand to zero by 2050 (but not other gases like methane or nitrous oxide, which predominantly come from agriculture).
- **Net zero long-lived gases and stabilised short-lived gases by 2050:** this target would reduce emissions of long-lived gases (including carbon dioxide and nitrous oxide) in New Zealand to net zero by 2050, while stabilising emissions of short-lived gases (including methane).
- **Net zero emissions by 2050:** this target would reduce net emissions across all greenhouse gases to zero by 2050.

Each target has different implications for our climate and economy. Modelling suggests that, under any target, there will be significant increases in new forest planting and emissions reductions in transport and energy, as well as changes in how we use our land.

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5 Parliamentary Commissioner for the Environment (2017) (2018).

6 New Zealand Productivity Commission (2018).

We want to hear your views on the role the Climate Change Commission could have in setting the target. This could allow us to get independent advice before setting a target in law.

It may be worth New Zealand considering buying international emissions reductions with high environmental integrity from other countries, to meet a portion of its target. Although this may be a cheaper option in the short term, it would mean less investment in reducing domestic emissions.

Emissions budgets

The year 2050 is a long way away. To give more predictability, emissions 'budgets' are a necessary part of the Bill, because they set out how much greenhouse gas we can emit over a period of time, for example, five or six years.

Several choices are available around how we design this system, and we want to hear your views. For example, the duration of each budget, how far in advance we set them, whether they can be revised and what happens if they are not met.

Climate Change Commission

We propose the Zero Carbon Bill establishes a new Climate Change Commission. This would provide independent, expert advice and support New Zealanders to hold successive governments to account for progress.

We propose the Climate Change Commission advises the Government on emissions budgets to reach the target, and we also have a choice to make around the specific role the Commission could have with the New Zealand Emissions Trading Scheme (NZ ETS).

The Interim Climate Change Committee has already been set up to work on how we manage agricultural emissions and how we get to 100 per cent renewable electricity. The interim committee will be leading these issues outside of this consultation process and will develop analysis and evidence on them. The new Climate Change Commission would advise the Government on these issues, once the Zero Carbon Bill passes into law.

Adapting to the impacts of climate change

Even if we can reduce greenhouse gases globally, some climate change is already locked in and we will need to adapt. The Bill could help decision-makers manage climate change risks in a systematic way. The Bill could require the Government to develop national adaptation plans that prioritise actions based on regular risk assessments. We also want to explore whether a targeted adaptation reporting power might be set up. This could see some organisations share information on their exposure to climate change risks.

Your feedback will help shape the Zero Carbon Bill

We welcome your feedback on the proposals contained in the consultation document, which will help inform further policy development and shape what will become the Zero Carbon Bill. Once the Bill has been introduced into Parliament a select committee process will follow, with a view to passing the Zero Carbon Act by mid-2019.

This will be followed by amendments to the Climate Change Response Act 2002, to strengthen the NZ ETS and help us implement the Paris Agreement. Public consultation on the NZ ETS will be undertaken through a separate process in August to September this year.

Part one: Introduction

SUMMARY

Our climate is already changing, and our economy needs to respond as part of a global transition to a net zero emissions, climate-resilient future. This will require a fundamental economic shift in New Zealand.

As we have seen from transitions in the past, such as the industrial and digital revolutions, economic transitions can create challenges – but also opportunities. Taking early action in the right areas is likely to avoid the need for more abrupt action later.

We are fully committed to the emissions reduction goals embodied in the Paris Agreement. As New Zealanders, we need to make decisions about how we transition our economy, how far and how fast we go, and how we do it in a way that is fair, just and timely.

This is not just about the next three years, or the next six, but a decision that affects our collective long-term futures. What we decide must endure political cycles, whilst enabling successive Governments to make policy choices within a robust, transparent and lasting framework.

The Zero Carbon Bill can deliver the long-term goal and direction, and set up the architecture to achieve a net zero emissions climate-resilient future. This is a critical conversation to have now, and we invite you to be part of it.

What is climate change?

The Earth's atmosphere is made up of a large amount of nitrogen (78 per cent), oxygen (21 per cent) and a small amount of greenhouse gases (including carbon dioxide, methane and nitrous oxide). Greenhouse gases trap warmth from the sun and make life on Earth possible. Without them, the surface of the planet would freeze. But increasing greenhouse gases in the atmosphere trap more heat and cause the climate to change.

Over the past 200 years, there has been a big increase in human-generated greenhouse gases from activities like burning fossil fuels, farming and cutting down forests.[7] The global climate is changing rapidly, compared with natural variations in the past. The world has already warmed about 1°C since 1900, and the increase in greenhouse gases is the main reason for this. The temperature will continue to rise and, if we do not dramatically curb emissions, the risks of harmful effects on people and ecosystems will increase.

Impact of climate change so far

We are already feeling the effects from a changing climate. In the past 100 years, seas have risen around 14 to 22 centimetres in New Zealand ports. More recently, we have suffered costly damage and disruption from coastal erosion, more frequent and severe weather events (flooding, droughts and wildfires) and damage to infrastructure and assets. This includes damage to sites of significance to Māori. Many Māori communities have ancestral ties to coastal areas with cultural heritage – marae, wāhi tapu and mahinga kai rohe.

[7] Trees act as a store or 'carbon sink' by absorbing or sequestering carbon dioxide over time through the process of photosynthesis. This means that, when areas are deforested, the carbon dioxide stored in those trees is released into the atmosphere.

The costs we face are continuing to rise. As an example, in the past 10 years, the cost of weather events to our transport network has risen from about $20 million per year to over $90 million per year.[8] The 2013 drought in the North Island cost the economy around $1.5 billion, and climate change will make droughts like this more likely.

Paris Agreement

In 2016, New Zealand signed and ratified the Paris Agreement. It sets out the international plan to put the world on track to avoiding dangerous climate change. It has been a game-changer: the world is now committed to a low emissions future.

The Paris Agreement says the world will:

- keep the increase in global average temperature to well below 2°C above pre-industrial levels, and pursue efforts to limit the temperature increase to 1.5°C, with an aim to reach peaking of global greenhouse gas emissions as soon as possible and to reach net zero emissions in the second half of the century
- enhance the ability of countries to adapt and reduce vulnerability to the adverse impacts of climate change
- make finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient economies.

Our first target under the Paris Agreement is to reduce greenhouse gas emissions to 30 per cent below 2005 levels by 2030 (11 per cent below 1990 levels).

The Paris Agreement sets out developed countries' roles in the transition and says they should 'continue taking the lead by undertaking economy-wide, absolute emission reduction targets'. More detailed rules are due to be finalised this year. As a small country, our influence lies in holding ourselves and other countries to account to meet international commitments. Taking action at home helps give us a mandate to encourage other countries to do the same.

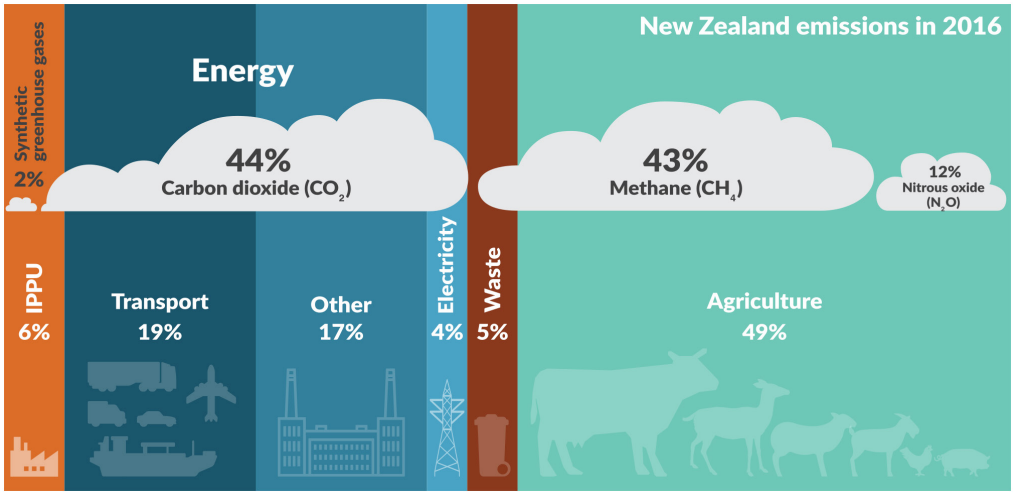
What do our emissions look like?

A large part of our economy is based on primary industries. Agriculture makes up nearly half of all emissions in New Zealand (figure 1). Its share of the national total is, on average, four times larger than for our OECD peers.

Most of New Zealand's electricity (about 80 per cent) is currently generated from renewable sources like wind and hydro. The Government has committed to making electricity 100 per cent renewable by 2035. We also have a sizeable forestry sector, which currently offsets about a third of our emissions.

[8] Ministry for the Environment (2017).

Figure 1: Emissions profile of New Zealand



Source: Ministry for the Environment. 2018b. *New Zealand Greenhouse Gas Inventory 1990–2016*. Wellington: Ministry for the Environment.

Note: Percentages may not add up to 100 per cent because they are rounded to the nearest per cent. IPPU stands for Industrial Processes and Product Use.

For more information on New Zealand's emissions profile, visit our website and look at the emissions inventory and emissions tracker.

Where are we starting from?

The Zero Carbon Bill will build on the progress New Zealand has already made on its international commitments and its Emissions Trading Scheme. It also builds on the steps many businesses and sectors have taken to reduce emissions and choices people are already making on how they get around and the products they buy.

Our towns and cities are contributing too. Regional and territorial authorities have a good understanding of how to adapt to climate change, and some are putting in place plans for creating low emissions communities. Government is working with iwi, communities and businesses to accelerate the transition. Many businesses have their own emissions reductions plans in place and are taking innovative steps to achieving their emissions reduction goals.

The Government's work to transition is already under way. Specific initiatives include:

- strengthening and improving the NZ ETS
- developing a land transport policy statement that supports investment in low emissions transport and urban design
- planting one billion trees
- establishing a Green Investment Fund, to stimulate new investment in low emissions industries
- continuing to develop practical solutions in the agriculture sector, where New Zealand is already a world leader, such as animal breeding and vaccines to reduce methane.

MĀORI AND IWI LEADERSHIP IN THE TRANSITION

> Toitū te Marae o Tāne, Toitū te Marae o Tangaroa, Toitū te Iwi – When land and water are sustained, the people will prosper.

There are opportunities for iwi and Māori-owned businesses to show leadership in the transition. Te ao Māori and kaitiakitanga underpin leadership that can drive positive change. There will be opportunities for Māori enterprises through the transition; however, there will also be challenges. For example, Te Ture Whenua Māori Act 1993 has implications for how land can be used and is governed.[9]

As an example of a leading iwi-run farm, Ngāi Tahu Farming applies advanced best-practice land and water use across the nearly 100,000 hectares of dairy, sheep and beef farms and forestry land that it manages in Te Waipounamu (South Island). It is focusing on reducing greenhouse gas emissions through collaborative research and on-farm practices including tree planting to create carbon sinks.

It has been able to reduce stock while improving productivity. Ngāi Tahu Farming General Manager Shane Kelly believes the agriculture sector will play an important part in New Zealand's shift to a net zero emissions economy, advocating a collaborative and staged process. Farmers are looking for direction and leadership, he says. 'We all want to look after our environment and we need to work collaboratively as a nation. It's a huge opportunity, the question is, how do we make this work together as a nation?'

[9] Note, Māori freehold land (which makes up 1.4 million hectares) has three unique characteristics. It comprises mainly small blocks with only a small proportion of arable land, it is subject to cultural importance to current and future generations, and it has individual, yet multiple owners.

Part two: Proposals

The transition will need to be deep and broad. We have choices around how far and how fast we go. For each choice we make, there will be opportunities and challenges as set out below.

OPPORTUNITIES:	CHALLENGES:
• reduce the potential for sudden, drastic economic shocks • get the most from the wider benefits in health and across the environment (eg, cleaner water and air) • avoid further damage caused by a changing climate (assuming the world continues to act in the same way) • drive faster innovation and productivity improvements • keep our small, export-led economy competitive • meet growing consumer demand for low emissions products and services • reduce sunk costs in infrastructure and other large-scale assets • benefit from mātauranga Māori (traditional knowledge) and te ao Māori through our Treaty of Waitangi partnership.	• the economy can continue to grow, possibly just not as quickly • significant changes to our energy, transport and agriculture sectors • some industries could experience decline while others emerge, with implications for jobs and regions • vulnerable communities could face a greater challenge • moving too early could affect the competitiveness of our trade-exposed businesses. This risks relocation of production to countries with less stringent climate change policies.

The Zero Carbon Bill aims to set the country's long-term commitment and provide transparency about what future policies we intend to use to achieve this. We are seeking your views on:

- the 2050 target
- emissions budgets
- the Climate Change Commission
- adapting to the impacts of climate change.

These core building blocks will give certainty to New Zealanders that, no matter what Government is in power, there will be a long-term approach that endures political cycles. Independent and expert institutions will keep Governments well advised and up to date on the science and help people hold politicians to account. This work will be guided by the following objectives:

- **sustainable and productive economy:** continuing to develop and diversify the economy, while limiting greenhouse gas emissions and responding to the impacts of climate change
- **global and local leadership:** leading at home and internationally, with an ambitious and clear goal that stimulates innovation and is the main way for New Zealand to influence the global climate action response
- **creating a just and inclusive society:** managing the pace of the transition, and supporting Māori, regions and communities affected by transitional policies and inequities, and those affected by the damaging impacts of climate change.

2050 Target

SUMMARY

The Zero Carbon Bill proposes a new long-term emissions reductions target.

Three main considerations are involved in setting a new target: the Paris Agreement, the science of short-lived and long-lived gases and the potential economic impacts of different targets.

We explore three target options that could replace our current target of 50 per cent reduction below 1990 levels by 2050:

- **net zero carbon dioxide:** reducing net carbon dioxide emissions to zero by 2050
- **net zero long-lived gases and stabilised short-lived gases:** reduce emissions of long-lived gases to net zero by 2050, while also stabilising emissions of short-lived gases
- **net zero emissions:** net zero emissions across all greenhouse gases.

This section outlines the possible implications of different targets; whether we should use emissions reductions from overseas, the potential role of a new Climate Change Commission in setting targets, and how we could include flexibility to meet our targets over time.

We are seeking your views on:

- what target we should set
- how New Zealand should meet its emissions reduction targets
- whether the target should be able to change.

Consultation questions on this proposal can be found at the end of this chapter. The full list of consultation questions can be found in the attached submissions form and online.

A new 2050 target

We propose introducing a new 2050 emissions reduction target through the Zero Carbon Bill. Putting a target in primary legislation would give it more prominence and discourage changes of ambition in response to short-term considerations.

Setting a new target would:

- provide an enduring, long-term signal to businesses, consumers and New Zealanders

- provide alignment to the Paris Agreement's global goal of reaching net zero emissions in the second half of the century
- help to inform our successive Nationally Determined Contributions[10] under the Paris Agreement
- signal to the world that New Zealand is playing its part in the global effort.

Setting the target in primary legislation would play an important role in:

- showing Parliament's long-term commitment to reducing emissions and provide clarity to New Zealanders about its policy objectives
- indicating the elevated priority level of the 2050 target (in relation to other Government considerations)
- discouraging changes of ambition in response to short-term considerations.

Setting targets is not new. New Zealand has already made commitments to reduce emissions to:

- 5 per cent below 1990 levels by 2020
- 11 per cent below 1990 levels by 2030 (or 30 per cent below 2005 levels by 2030)
- 50 per cent below 1990 levels by 2050.

Regardless of what decision is taken about a new 2050 target, the Government is still fully committed to implementing our Paris Agreement commitments and is focused on delivering our existing Nationally Determined Contribution by 2030.

All of the target options we consider are forms of net zero targets; they would all put New Zealand on a pathway to net zero emissions in the second half of this century. The difference between each option is the speed by which we would reach net zero emissions. The most ambitious target option we have considered, net zero emissions, would see us reach net zero emissions in 2050, whereas other options would put us on track to getting there in later years.

Setting the new 2050 target

Three main elements need to be considered when setting a new 2050 target:

- **the Paris Agreement**, because New Zealand has signed and ratified this global agreement
- **the science of short-lived and long-lived gases**, given the important differences between the impact of these gases on the climate
- **economic impacts**, meeting the different targets has implications for New Zealand's economy over the coming decades.

Paris Agreement

The Paris Agreement sets the gauge for international expectations around our efforts to reduce emissions over the long term.

[10] Nationally Determined Contributions are the efforts each country put forward under the Paris Agreement.

The headline emissions reduction objectives of the Paris Agreement are:

- "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels" – Article 2.1 (a)
- '[i]n order to achieve the long-term temperature goal set out in Article 2 […] to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century' – Article 4.1 (ie, achieving net zero emissions).

Any domestic action needs to be consistent with our commitment to the Paris Agreement goals. By honouring our commitments, we are better placed to encourage other countries to keep to theirs, including countries with much greater emissions than our own.

Science of different gases

Any target we set needs to be informed by the best available climate change science. Nearly half of New Zealand's greenhouse gas emissions come from agriculture, which means we need to pay particular attention to the scientific impact of short-lived gases like methane, which dominate agriculture's emissions.

SHORT-LIVED AND LONG-LIVED GASES

Short-lived gases like methane decay relatively rapidly in the atmosphere. They last for decades rather than centuries. This means global temperatures can be stabilised without necessarily reducing emissions of these gases to zero. We also have an opportunity to lower the impact even further by not only stabilising but also, where possible, reducing short-lived gases from our economy.

Long-lived gases like carbon dioxide either need to reduce entirely to zero or at least to the point where emissions can be balanced out by an equal amount of removals, for example, by planting new forests.

There are two scenarios where New Zealand's domestic emissions impact on global temperatures could be defined as zero.

- Reducing long-lived greenhouse gas emissions to zero and stabilising our short-lived gases, which would mean our domestic emissions would not contribute to any further increase in global temperatures.
- Reducing all greenhouse gas emissions to net zero, which would mean our domestic emissions would have no impact on the climate from that point forward.

Hypothetically, if both scenarios were applied worldwide then global temperatures would stabilise in each case, but they would stabilise at a lower temperature under the second scenario.

Economic outcomes

To meet these targets, we are likely to need changes to the way New Zealanders work, travel and consume. This means it is important for us to try to understand the range of potential economic outcomes. Further information is included below.

Options for a new climate change target for 2050

This section examines the following three potential outcomes from different 2050 target options that would supersede our current 2050 target.

- **Net zero carbon dioxide by 2050:** this target would reduce net carbon dioxide emissions in New Zealand to zero by 2050 (but not other gases like methane or nitrous oxide).
- **Net zero long-lived gases and stabilised short-lived gases by 2050:** this target would reduce emissions of long-lived gases (including carbon dioxide and nitrous oxide) in New Zealand to net zero by 2050, while stabilising emissions of short-lived gases (including methane).
- **Net zero emissions by 2050:** this target would reduce net emissions across all greenhouse gases to zero by 2050.

Table 1 provides further information on these three outcomes.

WHAT DOES 'NET' MEAN?

Gross emissions cover greenhouse gases from the parts of the economy that we traditionally think about as emitters – for example, cars, factories and livestock.

The term **net emissions** is normally used to describe gross emissions minus the emissions removed from the atmosphere through the impact of land use and forestry.

Different ways can be used to account for forests against our targets. Options include accounting for new forests only, as in our current target accounting, or including all forests, as reported in Ministry for the Environment's Greenhouse Gas Inventory.

Table 1: Economic and emissions outcomes of the options for the 2050 target

TARGETS	Net Zero Carbon	Net Zero Long-lived Gases and Stabilised Short-lived Gases	Net Zero Emissions
EMISSIONS	Net zero carbon dioxide emissions by 2050	Net zero long-lived gases by 2050, while also stabilising flow rate of short-lived gases	Net zero emissions (all gases) by 2050
LAND SECTOR	• Land-use outcomes more uncertain because targets not prescriptive for methane • Expanded forestry estate needed to offset CO_2/N_2O • Main driver of land-use change will be the level of ambition for methane reductions		• Major land use change needed to reduce or offset methane and CO_2/N_2O • Up to 10 per cent of New Zealand given over to new forest planting
ENERGY/ TRANSPORT	• Major changes in energy and transport sectors • EVs likely to make up to 95 per cent of the light vehicle fleet in 2050 • Industrial heat switches from fossil fuel to electricity and biomass • Any CO_2 emissions remaining in 2050 would need to be offset by new forest planting		
TECHNOLOGY OPTIONS	Target is focussed on CO_2, with many of the technologies that we will need already available	Technologies needed for both long-lived and short-lived gas emissions reductions, with limited ability to make trade-offs between progress on both of them	The high target ambition means that most, if not all, current and future technology options for emissions reductions will need to be adopted

Note: CO_2 = carbon dioxide; EVs = electric vehicles; N_2O = nitrous oxide.

Studying the economic impacts

We have looked at a series of models and other studies, to assess the implications for the New Zealand economy.[11] This work can give a general sense of the range of economic impacts of our target options. This includes how they might affect different sectors, regions and households.

These studies have been carried out by a range of sources, including independent external experts and government economists.

Under any of the 2050 target options, our economy can continue to grow, possibly just not as quickly as it might have done without any further climate action. Table 2 provides a summary of the economic opportunities and challenges that could result from further climate action.

To keep our economy growing, we would need to substantially expand our forest estate while continuing to innovate. Some households and sectors are likely to face higher costs and more disruption than others. The Government is committed to an approach that includes policies to support a fair and inclusive transition.

[11] See the appendix for more information on the studies used to assess the economic impacts.

Table 2: Summary of the economic opportunities and challenges

Opportunities	Challenges
We could see: • higher rates of innovation in sectors exposed to a higher emissions price, leading to an up-lift in productivity • new business opportunities in lower emissions sectors • less time wasted in traffic congestion and improved health from switches to public and active transport • health benefits from warmer and drier homes • if the rest of the world acts as well, reduced impact on our economy from climate change efforts.	We could face: • slower rates of economic growth as a result of higher emissions prices and other transition policies • competitiveness issues in trade-exposed emissions-intensive industries • decline in output and jobs for higher emissions sectors • slower rates of growth in household incomes .

Opportunities

Our research has explored the opportunities for stronger climate change policy to deliver wider positive effects. While opportunities are often more difficult to quantify than economic costs, many previous studies, from both New Zealand and overseas, have calculated substantial wider benefits of transitioning to a low emissions economy or estimated the scale of the problem.

These studies have informed the Ministry for the Environment paper on the co-benefits of emissions reductions, and the benefit to the New Zealand economy of avoiding damage caused by climate change. Examples from this paper are set out in table 3.

Table 3: Potential benefits of transitioning to a low emissions economy

Emissions reduction policy	Types of benefit	Estimated scale of benefit and/or problem	Strength of evidence
Energy efficiency/ home insulation	• Better health from drier warmer homes	Every $1 spent on the 'Warm Up New Zealand: Heat Smart' programme generates benefits of around $4. Retrofitting insulation can help deliver particularly strong health cost savings from at-risk groups (eg, children and the elderly). The emissions reduction benefits are relatively small.	Strong
Active transport (walking and cycling)	• Better health from more exercise and improved air quality • Reduced road traffic congestion	An investment of $630 million in infrastructure to support active transport could generate net benefits of $13 billion by 2050, mostly due to the health benefits from increased exercise. Human-caused air pollution can cost up to $4.3 billion each year, which includes costs from premature deaths, hospital visits and restricted activity days. Traffic congestion in Auckland costs $0.9	Strong

Emissions reduction policy	Types of benefit	Estimated scale of benefit and/or problem	Strength of evidence
		billion to $1.3 billion each year.	
Public transport	• Reduced road traffic congestion • Better health outcomes from improved air quality and fewer road accidents	The benefits from the existing passenger rail network in Wellington and Auckland are estimated at between $1.1 billion and $1.2 billion, almost all from reduced congestion. Safety and air quality benefits made more modest contributions.	Moderate
Forestry	• Improved freshwater quality • Reduced soil erosion • Improved biodiversity and species protection	Forestry can improve water quality, enhance biodiversity, reduce soil erosion, improve land use productivity and stimulate regional economic development. Nearly one million hectares of private land subject to moderate to extreme erosion are potentially well suited to afforestation. For example, the ecosystem value of each hectare of plantation forestry in the Ohiwa catchment was $5,600 per annum, over half of which is from improved water quality.	Moderate
Road freight to rail	• Reduced traffic congestion • Reduced road maintenance costs • Improved road safety	Estimated benefits of current rail freight are about $200 million per year from reduced congestion, $80 million per year from reduced maintenance costs and $60 million per year from safety.	Moderate
Use of electricity for home and industrial heat	• Better health from improved air quality	*See 'active transport' for scale of possible air pollution costs in New Zealand.* Heat generation from burning fossil fuels contributes to air pollution. This includes domestic coal burners as well as industrial coal-fired boilers.	Moderate
Electric vehicles	• Better health from improved air quality	*See 'active transport' for scale of air pollution costs in New Zealand*.	Moderate
Improved farm practices	• Improved freshwater quality	Reduced nitrogen use (eg, fertiliser) and improved pasture management could reduce nitrogen leaching into rivers by 13 per cent.	Weak

Modelling the impact across the economy

We have undertaken modelling to provide insights into the economic impacts of reaching different emissions reductions targets.

Overall, the modelling suggests the following.

- **The economy and household incomes will continue to grow but possibly not as quickly.** Achieving a net zero emissions target by 2050 could cause average GDP to grow less quickly, with the rate of growth depending on the target we aim for and how innovation in key emitting sectors develops.
- **A strong economy will require innovation and a lot of trees.** Emissions prices could be higher and growth rates lower if we do not plant enough trees or continue to innovate, or the impacts could be milder if we plant more trees or innovate faster.
- By 2050, per household national income would still have increased by 40 per cent, instead of 55 per cent. **Supporting lower income households will need to be part of our approach** – otherwise the impacts on these households could be disproportionate.
- The economic impacts could still be significant. **Some sectors may face a greater challenge, unless there are technical breakthroughs or support**, particularly those with high emissions and those competing in international markets and/or that have limited opportunities to reduce their emissions.
- **The difference in economic impact of moving from the current domestic target to a net zero emissions target is not substantial**. The annual growth rate could slow by about 0.2 per cent.

Two models have been commissioned

In an effort to gain insights into the economy-wide impacts of reaching different emissions reductions targets, we have used two different economic models developed by Vivid Economics (Vivid) and the New Zealand Institute of Economic Research (NZIER), respectively.

NZIER's model examines how emissions prices and economic growth might change for different emissions targets. **Vivid's model** looks at energy, land use and transport (without modelling interactions between them), and tells us the impact of meeting targets on emissions prices but not on economic growth. These emissions prices reflect the full cost of transitional policies rather than the price that industry will face. For example, if the Government invests in public transport, the prices industry will face could decrease.

NZIER's results

NZIER's modelling results span a wide range, due to varying assumptions about future innovation across energy, transport and agriculture.

For example, to meet net zero emissions, NZIER estimates an annual average emissions price in the range of $272 per tonne of carbon dioxide equivalent (CO_2-e) if we see innovation across energy, transport and agriculture, or $845 per tonne of CO_2-e if we expect innovation only in energy and transport.

NZIER also reports on the macroeconomic impacts (for example, GDP growth rates) of targets. Table 4 shows a range of results for meeting the current 2050 target, and other more ambitious targets under varying assumptions about innovation.

Table 4: NZIER's average economic growth across scenarios and targets

	'Do nothing baseline'	Assume innovation in agriculture only, above the baseline			Assume innovation in energy and transport only, above the baseline		Assume innovation in energy, transport and agriculture, above the baseline		
Target (at 2050)	**–**	**50%**	**75%**	**Net zero**	**50%**	**Net zero**	**50%**	**75%**	**Net zero**
Average annual GDP growth rate over 2017–50	2.2%	1.8%	1.6%	1.6%	1.7%	1.5%	2.1%	1.9%	1.9%
Average GDP per year over 2017–50, $ billion	$386	$367	$359	$357	$359	$349	$377	$371	$370

Source: NZIER

Note: '50%' represents both net zero carbon and the current 2050 target; '75%' is a proxy for net zero long-lived gases and stabilised short-lived gases. A 75% reduction on 1990 levels by 2050 has been used as it approximates an outcome where long-lived gases have been reduced to net zero in 2050 and short-lived gases from agriculture have been reduced by 45% from 1990 levels by 2050; Net zero is net zero

The analysis by NZIER suggests that GDP will continue to grow but will be in the range of 10 per cent to 22 per cent less in 2050, compared with taking no further action on climate change. However, it is highly unlikely we would take no further action on climate change in the period to 2050, given our current domestic target and our international commitment to the Paris Agreement.

The full range of modelled outcomes will be released as part of the Zero Carbon Bill's consultation process.

Vivid's results

Vivid's modelling gave us emissions prices only and not the wider effects on the economy. To meet net zero emissions, Vivid estimates an annual average emissions price over 2018 to 2050 as $76 to $100 per tonne CO_2-e, which is significantly lower than the NZIER results indicate.

We can infer that, at the emissions prices Vivid suggests necessary to meet the targets, the impact on economic growth would be milder than the NZIER results indicate.

Limitations and assumptions

Each study gives us different insights. The NZIER study examines the impacts on the economy as a whole, so we can see how the economy might change in response to different targets. It helps us consider how technological innovation and different rates of forestry might affect the total cost of the different targets.

The NZIER numbers, especially those that derive from assuming little innovation in agriculture, are at the top of the range of modelled impacts. It can also be argued that the NZIER figures may be overestimates of the economic impacts because it is difficult to assess the responses of households and businesses to changes in the economy. The NZIER modelling shows much greater ranges of results as we widen variation in the innovation assumptions.

Vivid's model may result in underestimates because its modelling does not consider the flow-on effects across the whole economy.

Neither model includes many of the benefits set out above of taking action on climate change, such as the wider co-benefits, or the potential benefit of avoiding damage to the economy caused by a changing climate, if the rest of the world acts too.

Modelling results change, depending on how they are designed and assumptions are made about the future.[12] This means that, while modelling gives us a reasonable view through to 2030, beyond that the picture becomes less certain. Looking back both at the changes in technology and shifts in our economy over the past three decades shows that we can expect huge changes between now and 2050. This means modelling out to 2050 is stretching the models used to their limits.

Modelling has limitations, and the economy-wide results should be read with care. While the models will estimate changes, they cannot perfectly predict exact changes in technology or changes in the economy as sectors grow or decline. Overall, modelling can help by indicating general trends and the relative differences in impacts from setting different targets.

Target comparisons

Given the difference in modelling approaches across Vivid and NZIER, and the range of scenarios considered, we think it is plausible that the relative costs and benefits of transition may fall somewhere in between the Vivid and NZIER results.

The results presented in table 5 reflect a sample of modelling results that assume more innovation across agriculture, energy and transport, and substantial forest planting – driven by climate change policies.

The assumptions used can be found in the appendix. The NZIER model builds on assumptions used by Vivid.

[12] See the appendix for more information on modelling assumptions.

Table 5: A sample of modelling results on economic growth and emissions prices under 2050 target options, wide innovation scenario

		Net zero carbon	Net zero long-lived gases and stabilised short-lived gases	Net zero emissions
	Assumed forestry sequestration	25 mt	35 mt	50 mt
Economy-wide impact	GDP growth rate[13] (%)	2.1%	1.9%	1.9%
	Absolute change compared with current domestic target	–	↓0.1%	↓0.2%
	Absolute change compared with 'do nothing' baseline[14]	↓0.2%	↓0.3%	↓0.3%
	GDP[15] ($ billion)	$381	$374	$373
	Percentage change compared with current domestic target	–	↓1.7%	↓2.1%
	Percentage change compared with 'do nothing' baseline[14]	↓2.3%	↓4.0%	↓4.4%
Household impact	Per household GNDI[16] ($ thousand)	$228	$224	$223
	Percentage change compared with 2018 GNDI	↑21.8%	↑19.7%	↑19.3%
	Percentage change compared with current domestic target	–	↓1.7%	↓2.1%
	Percentage change compared with 'do nothing' baseline[14]	↓2.3%	↓4.0%	↓4.3%
Strength of climate action	Transition cost ('emissions prices')[17] ($ per tCO_2-e)	$109	$243	$272
	Absolute change compared with current domestic target	–	↑$134	↑$163

Source: Based on work by NZIER, 2018.
Note: GDP = gross domestic product; GNDI = gross national disposable income; mt = megatonnes; N/A = not applicable; tCO_2-e = tonnes carbon dioxide equivalent.

[13] GDP growth rate reflects the annual average GDP growth rate over the period 2018 to 2050.

[14] The 'do nothing' baseline has been constructed by NZIER based on Treasury's economic projections and emissions information provided by government agencies. This baseline's emissions projections are higher than those published in the most recent government projections, and this difference means the model could be over-stating the emissions reductions needed to meet each target, and so the impacts on the economy could be milder than modelled. The most recent government emissions projections were not finalised in time to feed into this modelling study but will provide the basis for continued modelling of the transition to low emissions.

[15] GDP reflects gross domestic product as an annual average over the period 2018 to 2050. Note, GDP in 2018 is approximately $269 billion.

[16] Per household GNDI reflects the gross national disposable income divided by number of households as an annual average over the period 2018 to 2050. Note, per household GNDI in 2018 is $187,000. Note also that GNDI is a measure of the total income of New Zealand residents from domestic production and from net income flows with the rest of the world.

[17] Emissions prices are annual averages over the period 2018 to 2050. The emissions price reflects the economy-wide average cost to reduce a tonne of CO_2-e to meet a given target. They do not necessarily represent a forecast for the price of New Zealand Units in the NZ ETS.

Some sectors will face harder choices than others

The transition to low emissions will create bigger challenges for some sectors than for others. The sectors that are likely to face harder choices will be those that have high emissions, compete in international markets and/or have limited opportunities to reduce their emissions. Emissions-intensive sectors (eg, sheep and beef farming, dairy processing and petrochemical processing) could be more negatively affected than less emissions-intensive sectors (eg, retail services).

Land owners' decisions about how to respond to future climate change policies will have an important effect on the make-up of primary industries and rural communities. The modelling so far suggests that big increases in forestry will be required to meet any of the possible emissions reduction targets. For the strongest target we have assessed, net zero emissions, our modelling suggests that new forest planting could need to cover as much as 10 per cent of New Zealand's land area.[18] As the Productivity Commission points out, this scale of land use change would be comparable to the scale of the changes we have experienced in land use over the past 30 years, even if the types of changes are different.[19]

Farmers and land owners could also make a choice to convert to lower emissions land uses such as horticulture, or seek higher profits from forestry. Farmers have shown their ability to make productivity improvements over the previous decades, and we expect this trend to continue.

Impacts on households and supporting lower income households

Modelling shows the impact of domestic climate action would be felt more strongly by lower income households, because a higher proportion of their spending is on products and services that are likely to increase in cost as we reduce emissions across the economy.

Our modelling suggests the households that are in the lowest 20 per cent bracket for income may be more than twice as affected, on a relative basis, than those households with an average income. The Government has a number of tools it could choose to use to compensate affected households for higher costs, such as tax or welfare measures.

The uneven distribution of costs across different households is an important part of the reason for taking a planned approach to ensure a just and fair transition.

Economic impacts for Māori

While we have not specifically modelled the impacts on Māori businesses or households, our response to climate change will affect Māori enterprises, particularly in the forestry, agriculture and fisheries industries, and workers in some areas. In addition, modelling shows that vulnerable households will be more affected, and a proportion of these will be Māori. Government is committed to ensuring a fair and inclusive transition, and Māori households will need to be considered.

Many Māori and iwi-run organisations and businesses already practise kaitiakitanga and are actively thinking about how to be sustainable. Being ahead of the curve in reducing emissions

[18] Currently, over 35 per cent of New Zealand's land area is covered by forests. This amounts to 9.9 million hectares.

[19] New Zealand Productivity Commission (2018).

and building resilience will see new business opportunities emerge for Māori and pave the way for others to follow, including broadening the Government's thinking for how the transition might be managed.

It is also important to consider the unique characteristics, governance and collective ownership of Māori land, Māori aspirations, cultural values, and rights under the Treaty of Waitangi in facilitating the adoption and implementation of climate change opportunities.

WHAT DOES STRONG CLIMATE ACTION MEAN FOR ME, IN TERMS OF COSTS?

A transition to a low emissions economy will require strong climate change action. This creates transition costs for businesses and New Zealanders. These costs can be represented in terms of emissions prices. There is huge uncertainty about how much emissions prices would need to increase to reach a net zero emissions economy, but these prices could range between $76 and $845 per tonne of carbon dioxide equivalent (CO_2-e) as annual averages. These emissions prices reflect the full cost of transitional policies rather than the price industry will face. For example, if Government invests in public transport, the prices industry face could decrease.

Businesses could pass on all or part of the transition costs they face through the prices they charge households. For example, a litre of petrol produces 2.3 kilograms of carbon dioxide. This means the price of a litre of petrol at the pump could increase by about 23 cents for every $100 per tonne of CO_2-e. This increase in petrol prices could result in some households deciding to replace their petrol car with an electric vehicle, which would cost less to run.

What this may mean for target choices

As indicated above, modelling and economic analysis gives us only a general sense of the trends and the impacts of target options. It shows that, in all cases, planting substantial new areas of trees to sequester carbon, supporting innovation and being deliberate about the journey to support economic prosperity and our communities will be important. We should also not lose sight of the fact that doing nothing comes with its own risks, as does delaying embarking on the journey.

An important result from the NZIER modelling is that, if we hold firm on all other assumptions including how industries innovate, then the difference to the economy of meeting more ambitious targets does not appear large. But if we have assumptions about different levels of innovation then there would be larger differences in growth rates.

The economic analysis should best be considered alongside other important considerations, such as our international standing and aspirations for leadership globally, and the brand our businesses are able to project internationally. We will also want to consider how actions we take to reduce domestic emissions also support other outcomes, such as improved housing, health or waterways.

Many of the economic effects of the transition to 2050 will be felt slowly over time. The Government wants to plan well, to avoid unexpected shocks.

Using emissions reductions from overseas

The Government is committed to ambitious climate change action at home and to transitioning the New Zealand economy to net zero emissions over the coming decades. This is consistent with the Paris Agreement.

Depending on how far and how fast we decide to transition, we may require technology that does not become available, or is not cost effective to purchase, until nearer 2050. The Paris Agreement recognises that countries may choose to cooperate to meet their climate change commitments. Having the option to purchase emissions reductions from overseas may provide us with flexibility in meeting targets.[20] It might allow us to meet ambitious climate change targets at a reduced cost.

This could be a cheaper option in the short term. However, it could mean less investment in upgrading New Zealand's economy to reduce emissions, and we would have to keep purchasing emissions reductions from overseas until we reduced emissions in New Zealand.

The extent to which the use of international emissions reductions lowers the economic cost of meeting our 2050 target depends strongly on the price at which reductions with high environmental integrity might be able to be purchased.

Our modelling can help us understand the reduction in economic cost that could be achieved if international emissions reductions were available at lower emissions prices than our domestic price. For example, in a hypothetical scenario, where the price of international emissions reductions is assumed to be $150 per tonne CO_2-e in 2050 (in 2018 dollars), and we assume there is no limit on the supply of international units, then the economic cost of meeting the net zero emissions target would be roughly halved.

International carbon markets

We seek your views on the extent to which international emissions reductions could play a role in helping New Zealand to meet its climate change targets. We would need to evaluate the relative cost of the emissions reductions available overseas and those available in New Zealand. If international carbon markets are used in the future, this type of cooperation would need to satisfy a number of criteria. For example, the Government would want to be satisfied that:

1. the credits and/or units are genuine and have environmental integrity (that is, the emissions reductions are real)
2. we will maintain substantive domestic progress towards our transition to our chosen emissions reduction target
3. it makes economic sense
4. we can do it in a way that maintains a steadily rising domestic carbon price, so that incentives stay in place for domestic reduction options, like forestry.

Under the Kyoto Protocol, international carbon markets were problematic. There was an oversupply of cheap units as well as issues with the environmental integrity of some. There was also no cap on the amount of international units that could be surrendered by participants in the NZ ETS. Later this year, we will be consulting on changes to the NZ ETS that help to

[20] These could be referred to as 'carbon credits' or 'international units'.

safeguard its integrity, if international carbon markets are used in the future. An important part of these changes will be the introduction of a volume limit on the use of international units within the NZ ETS. This limit will allow us to manage the impact of any international use on our domestic market and ensure that incentives to make domestic emissions reductions are retained.

The Government is involved in a number of international efforts to ensure the environmental integrity of international carbon markets in the future. This includes negotiations through the United Nations Framework Convention on Climate Change, providing leadership to establish the 'Ministerial Declaration on Carbon Markets' and a range of other initiatives.

How we set the target

Potential role for the Climate Change Commission

We seek your views on the role a new Climate Change Commission could have in setting the 2050 target. The Parliamentary Commissioner for the Environment has suggested that the target could be set in a two-stage process. First, the Government could set a more general statement of ambition in the Bill, in line with the collective global ambition set out in the Paris Agreement. Then, the Climate Change Commission could advise, within a defined timeframe, on the specific target consistent with the statement of ambition. A less specific target in the Zero Carbon Bill itself could both allow more time for a decision about the target to be made as well as potentially providing more flexibility on future emissions budgets. This would mean the process of setting the specific target would be longer than under the other options.

A 2050 target could change over time

We seek your views on whether the Bill should allow the target to be revised. This could be in response to significant changes to the economy, our understanding of the science, the technology available or to take into account what the rest of the world is doing. Being able to review the target would allow the Government the opportunity to adjust the target to respond to unforeseen and significant events under predetermined conditions. The downside of being able to review the target is that it might provide less certainty about what is expected from different sectors. Legislation can provide a mechanism to revisit the target and it could also provide guidance or restrictions on what conditions would need to be met for a change to be made, as well as the extent to which it could be adjusted. This should maintain the Government's commitment to the long-term goal while offering a process for transparent and well-signalled review.

The proposed Climate Change Commission could have a role in advising the Government on revisions to the target. See the Climate Change Commission for more detail.

QUESTIONS

1 What process should the Government use to set a new emissions reduction target in legislation?

Pick one:

- the Government sets a 2050 target in legislation now
- the Government sets a goal to reach net zero emissions by the second half of the century, and the Climate Change Commission advises on the specific target for the Government to set later.

2 If the Government sets a 2050 target now, which is the best target for New Zealand?

Pick one:

- net zero carbon dioxide: Reducing net carbon dioxide emissions to zero by 2050
- net zero long-lived gases and stabilised short-lived gases: Long-lived gases to net zero by 2050, while also stabilising short-lived gases
- net zero emissions: Net zero emissions across all greenhouse gases by 2050.

3 How should New Zealand meet its targets?

Pick one:

- domestic emissions reductions only (including from new forest planting)
- domestic emissions reductions (including from new forest planting) and using some emissions reductions from overseas (international carbon units) that have strong environmental safeguards.

4 Should the Zero Carbon Bill allow the target to be revised if circumstances change?

Emissions budgets

SUMMARY

The Zero Carbon Bill will establish how we do emissions budgets.

Emissions budgets can act as stepping stones to guide progress towards our 2050 target.

- An 'emissions budget' is a quantity of emissions allowed over a period of time.
- Emissions budgets could be set 10–15 years in advance, with each budget specifying emissions for a five-year period.
- Future budgets could be revised to allow for changes in the economy and technology.
- When setting budgets, a range of considerations would need to be made.

We seek your views on:

- timeframes over which budgets should be set
- whether these budgets should be able to be reviewed
- whether you agree with the list of considerations that need to be made when setting budgets.

Consultation questions on this proposal can be found at the end of this chapter. The full list of consultation questions can be found in the attached submissions form and online.

What are emissions budgets?

Emissions budgets describe a quantity of emissions allowed over a defined period (for example, five or six years). We have used budgets before through the Kyoto Protocol and under the Paris Agreement.

Emissions budgets are a necessary tool to set out the shorter-term steps that need to be taken to reach our 2050 target. They can:

- increase predictability for businesses and New Zealanders about what is needed over a shorter-term horizon
- inform a wide range of policy decisions, including the allocation of units within the NZ ETS.

Emissions budgets provide a good balance between signalling the emissions reduction path far enough into the future, while also allowing flexibility to deal with changing circumstances. Allowing flexibility in the path we take to reduce emissions is essential to cope with changes, such as much higher (or lower) costs for reducing emissions than we anticipated.

The Government does not consider that other options (such as setting a fixed, straight-line reduction pathway in legislation) provide enough flexibility to adjust to changes in our economy, and in technology and science.

Design choices for emissions budgets

There are several important design choices to consider for emissions budgets. The first is the length of each budget, second is how far into the future budgets are set. The third is whether they should be able to be revised.

Length of each budget

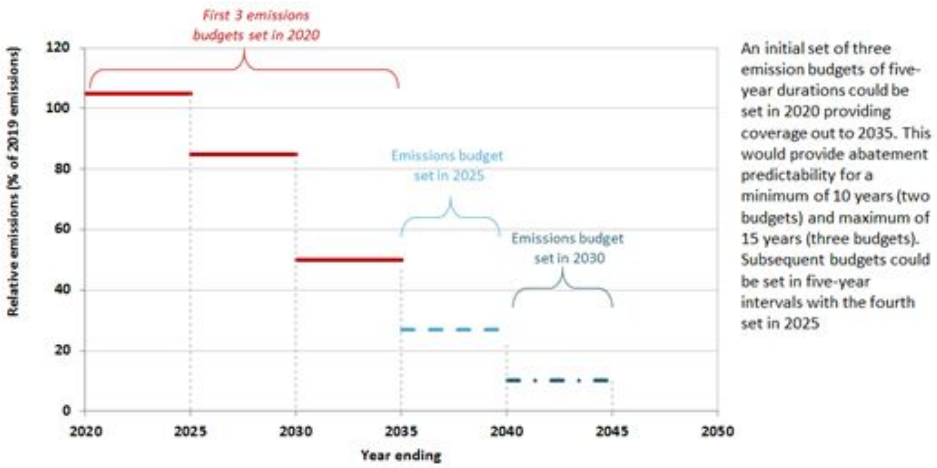
We propose that the length of each budget should be five years because it provides greater predictability for businesses and communities while remaining flexible for the future. It would also have lower administrative costs and align with our Nationally Determined Contributions under the Paris Agreement.

When deciding, we need to consider that too short a period provides less predictability for businesses and communities and too long a period requires decisions to be made today on very uncertain information. There are other ways to do this. The Parliamentary Commissioner for the Environment recently recommended New Zealand set a six-yearly budget with a three-year review of the policies implemented by the Government. This is designed to line up with our electoral cycle.

How far into the future budgets are set

We propose that three emissions budgets of five years each be in place at any given time (figure 2). This would mean we have a minimum 'look-ahead' timeframe of between 10 years and 15 years. We think this is a good balance between improving predictability and remaining flexible to changes in the future. These timeframes may help to depoliticise the budget-setting process because the Government of the day would not be able to set or influence the budget for its own political term.

Figure 2: Possible approach to emissions budgets (three five-year budgets)



Revising emissions budgets

We propose that the Government should be able to alter the last emissions budget (that is, the budget that is the furthest into the future). The advantage of this approach is that each Government would have a say in setting future emissions budgets. However, it could also make future emissions budgets less predictable for New Zealand businesses.

We also welcome your views on whether the second emissions budget in the sequence should be able to be reviewed under exceptional circumstances (eg, following a natural disaster) and adjusted within a specified range.

What should be taken into account when setting emissions budgets

We seek your views on what the Climate Change Commission and the Government should take into account when advising on and setting emissions budgets. This includes important factors such as economic and social circumstances. These considerations aim to help make the process robust and balanced. Details on the proposed considerations are set out in the Climate Change Commission section below.

Other design choices of emissions budgets

Monitoring emissions budgets: we propose that a brief annual report is produced to show how New Zealand is tracking towards the emissions budgets. This could be based on New Zealand's Greenhouse Gas Inventory, which provides tier one data (which meets international statistical obligations).

Banking or borrowing from one emissions budget to the next: we propose introducing a small amount of flexibility into each emissions budget. A threshold could be set where a budget could be considered as being met.

Aligning emissions budgets with the NZ ETS: the emissions budgets and the NZ ETS can easily be designed to be compatible. We are making improvements to the scheme that will give the Government the tools to align the volume of units[21] in the NZ ETS with our emissions budgets.

Aligning emissions budgets with international commitments: domestic emissions budgets and budgets used to account for Nationally Determined Contributions, under the Paris Agreement, have different purposes. Therefore, they do not need to be exactly the same.[22] The accounting for both our Nationally Determined Contributions and for our domestic emissions budgets will need to be robust, transparent and aligned with international norms and clearly communicated to our international partners.

Government response

Budgets alone will not achieve our targets. We will also need to implement policies to reduce emissions. We propose that the Bill requires the Government to publish a plan to meet future emissions budgets. The plan would provide a longer term strategy for the economy and society to support the transition.

Developing a longer term strategy for a low emissions economy was recommended by the Productivity Commission in its draft final report.[23] It is also consistent with the Paris Agreement, which has an expectation that we formulate a long term low greenhouse gas emissions development strategy. Having this in place promotes international cooperation and indicates we are following a rules-based system globally.

There are choices about how we require the Government to prepare and publish its plans and policies. We propose that, in response to each emissions budget, the Government publishes:

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21 A small amount of other emissions are not accounted for under the NZ ETS and will need to be factored into setting emissions budget amounts and New Zealand Unit limits.

22 The Parliamentary Commissioner for the Environment noted this in its March 2018 report *A Zero Carbon Act for New Zealand*, and we strongly agree with this.

23 New Zealand Productivity Commission (2018).

- a 10 to 15 year outlook on the choices for our transition pathway
- specific policies within sectors to reduce emissions and achieve the emissions budget (for example, incentives to support low emissions alternatives, like energy efficiency standards)
- other actions we need to take (eg, supporting investment in low emissions sectors and funding for research)
- how we address challenges faced by vulnerable communities and sectors, to ensure a just transition.

We are proposing that the Government must publish its plan within a set timeframe after each emissions budget has been announced.

QUESTIONS

5 The Government proposes that three emissions budgets of five years each (ie, covering the next 15 years) be in place at any given time. Do you agree with this proposal?

6 Should the Government be able to alter the last emissions budget (ie, furthest into the future)?

Pick one:

- yes, each incoming Government should have the option to review the third budget in the sequence
- yes, the third emissions budget should be able to be changed, but only when the subsequent budget is set
- no, emissions budgets should not be able to be changed.

7 Should the Government have the ability to review and adjust the second emissions budget within a specific range under exceptional circumstances?

8 Do you agree with the considerations we propose that the Government and the Climate Change Commission take into account when advising on and setting budgets?

GOVERNMENT RESPONSE

9 Should the Zero Carbon Bill require Governments to set out plans within a certain timeframe to achieve the emissions budgets?

10 What are the most important issues for the Government to consider in setting plans to meet budgets? For example, who do we need to work with, what else needs to be considered?

Climate Change Commission

SUMMARY

The Zero Carbon Bill establishes a new Climate Change Commission (the Commission) to provide independent expert advice and to support New Zealanders to hold Governments to account towards progress.

- There is a spectrum of roles that the Climate Change Commission could take, from advisory through to decision-making.
- We propose it would have an advisory role in providing advice on:
  - the level of emissions budgets
  - areas of the economy to focus on when achieving emissions budgets
  - issues related to climate change as requested.
- We propose it would have a role in monitoring New Zealand's progress towards emissions budgets and reducing the risks of climate change.
- It could play different roles with respect to the New Zealand Emissions Trading Scheme (NZ ETS), from advisory through to decision-making.
- It could advise on the upper limit of use of international emissions reductions.

We seek your views on:

- the proposed set of core functions for the Climate Change Commission and its role in respect of the NZ ETS
- what matters it should consider or take into account when undertaking its work
- what expertise commissioners need.

Consultation questions on this proposal can be found at the end of this chapter. The full list of consultation questions can be found in the attached submissions form and online.

Institutions to support transition

Why set up a Climate Change Commission?

New Zealanders need confidence that climate change policies will remain stable and that our pathway to the long-term target will stay broadly consistent. We think that a Climate Change Commission would be the best institution to show that New Zealand is on track and to help people hold Governments to account.

Climate change is a long-term problem yet decisions are needed now on how we address it. There is a strong case for insulating the policy-making process from short-term political pressures. Establishing a climate change commission would provide ongoing, independent expert advice to the Government on how we make the transition.

Other countries have already established independent institutions to provide advice to Government.[24] Both the former and current Parliamentary Commissioners for the

[24] These include Australia, Denmark, Finland, Ireland, Sweden and the United Kingdom.

Environment and the Productivity Commission have recommended an institution like this should be established in New Zealand.

For the Climate Change Commission to be successful and become a trusted and stable part of New Zealand's government institutions, it would need:

- political consensus for its work underpinned by widespread community and business support
- stable and ongoing funding
- a credible expert board of commissioners, appointed through a robust and transparent process
- a capable secretariat with access to good quality data from across government.

CASE STUDY: THE UNITED KINGDOM MODEL

The United Kingdom's Climate Change Committee (the UK Committee) is a highly regarded model internationally, and both the Parliamentary Commissioner for the Environment and the New Zealand Productivity Commission have provided advice to the Government on how the UK approach could be applied in New Zealand.

The UK Committee is made up of a chair and five to eight other members with expertise in climate change science, technology, economics, policy and business. Its primary role is to advise on the level of carbon budgets as well as related matters, such as the extent to which domestic reductions and international credits should be relied on to achieve each budget, which sectors of the economy offer particular opportunities for emissions reductions, and advice on the most cost-effective route to achieving budgets.

The UK Committee also has a sub-committee dedicated to the role of adapting to climate change.

What role could the Climate Change Commission have?

We propose the Climate Change Commission has an advisory rather than a decision-making role. This creates a new channel of independent expert advice and strikes a good balance between providing additional accountability, while ensuring Governments are able to make decisions based on their own priorities.

The decisions that we will need to take on climate change policy will have a broad impact on New Zealanders. Determining the right role for the Climate Change Commission will depend on balancing how much power and independence we give to appointed commissioners compared with democratically accountable bodies (ie, the Government).

Currently, decisions on climate change policy are made by the Government with the support of advice from officials. New laws, and changes to existing laws, are subject to the parliamentary process, providing important checks and balances.

Too much power could make a Climate Change Commission more at risk of being removed by future parliaments, if those Governments in power do not like what it is doing. However, if not enough weight and attention is given to the Commission's recommendations, this could reduce its effectiveness. Both the Parliamentary Commissioner for the Environment and the Productivity Commission have recommended New Zealand establish a Climate Change

Commission based on the example of the UK Committee. This would be an advisory role, with mechanisms built in to hold government to account, as described in table 6.

Table 6: Possible options for the role of a Climate Change Commission

	Advantages	Disadvantages
Advisory only Provides expert advice, but the Government is not obliged in a strong way to respond to recommendations. (Similar to the Parliamentary Commissioner for the Environment.)	Provides an additional source of expert independent advice on climate change issues.	Not likely to give strong additional accountability for Government to New Zealanders, because there is no requirement to publicly respond to advice.
Advisory, with mechanisms built in to hold Government to account Government must publicly respond to, and provide rationale when it deviates from, the Commission's advice. (Similar to the UK Committee – with strong requirement to develop policies within a specified timeframe.)	Creates a sound source of advice from an independent commission and a hurdle for Government to deviate from that advice. Maintains the Government's ability to make decisions on policy and to trade off outcomes across the economy and society.	The commitment to the long-term goal under this option is not as strong as the decision-making option.
Decision-making The Climate Change Commission makes decisions or sets policy under its own authority at arm's length from Government. (Similar to our Commerce Commission.) Note, no other countries have a Commission with a decision-making role.	Creates a very strong commitment to the long-term goal by delegating decisions to an independent authority.	Decisions on climate change policy require trade-offs against a range of outcomes. Delegating decisions to an independent authority risks making progress on climate outcomes while neglecting other social and economic outcomes. Delegating too much power could risk susceptibility to changes by future parliaments. This could damage its stability.

Advisory and monitoring functions

We propose the Climate Change Commission could have advisory and monitoring functions on the following:

- **emissions budgets:** advise on the most appropriate level and composition of emissions budgets and monitor our progress towards achieving these budgets
- **independent expert advice:** provide independent advice on areas of the economy to focus on and achieve emissions budgets, and what is important to consider in getting there
- **2050 target:** periodic check-in on the target level, in light of changes in technology as well as accounting for what the rest of the world is doing. It could also advise the Government on the most appropriate level for the 2050 target. See the section 2050 target in part two for more details
- **adaptation:** monitor New Zealand's progress towards addressing the risks posed by climate change. Publish a report setting out progress towards delivering the national adaptation plan
- **international emissions reductions:** advise on the extent to which international emissions reductions should be used towards our targets.

The Climate Change Commission's role in the New Zealand Emissions Trading Scheme

We seek your views on the Climate Change Commission's role in the operation of the NZ ETS. The NZ ETS is a well-established tool that puts a price on emissions and supports New Zealand to meet its climate change targets.

The most recent review of the NZ ETS found that the current settings create significant regulatory uncertainty. If the Climate Change Commission had either an advisory or decision-making role on the NZ ETS, it may help provide greater policy stability and predictability. This could result in more consistent long-term signals to business to invest in low emissions technologies and forestry.

The Commission could have an advisory role on the NZ ETS. This view is supported by two recent reports. The Productivity Commission's draft report on a low emissions future suggested a Climate Change Commission could make recommendations on unit supply in the NZ ETS, based on evidence, for the Government of the day to adopt, modify or reject.

> 'The Productivity Commission agrees that it is not appropriate for a Climate Commission to have decision-making powers. New Zealand's transition to a low-emissions economy will have profound and widespread impacts, and require the weighing of a range of economic, environmental, social and foreign policy considerations… no government has so far been willing, or deemed it prudent, to transfer decision-rights on climate change mitigation matters to an independent body'.[25]

In addition, the Parliamentary Commissioner for the Environment's report *A Zero Carbon Act for New Zealand: Revisiting Stepping Stones to Paris and Beyond* recommended that unit supply in the NZ ETS should be determined by the Government as part of its policy implementation responsibilities.

> 'Instead of giving the Commission a decision-making role, the Zero Carbon Act could require the Commission to provide advice prior to any change a Government might seek to make to ETS settings'.[26]

Another option is for the Climate Change Commission to have a decision-making role with respect to the NZ ETS, such as the overall level of units supplied into the NZ ETS. This is likely to result in a highly independent NZ ETS, with a very clear role in reducing emissions. The Climate Change Commission's decisions may also have the following outcomes:

- determining the overall cost to our economy of meeting our target
- setting the maximum emissions prices for NZ ETS businesses
- determining the emissions cost exposure for our emissions intensive and trade-exposed industries.

These outcomes have implications for the emissions costs for businesses and households, the overall functioning of the New Zealand carbon market and on public finances. This may result in the Climate Change Commission having decision-making powers that have traditionally been associated with Government. This would need to be balanced with the advantages of the NZ ETS being managed with a high level of independence, to support New Zealand to meet its climate change targets.

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[25] New Zealand Productivity Commission (2018), p 186.

[26] Parliamentary Commissioner for the Environment (2018), p 29.

WHAT THE NEW ZEALAND EMISSIONS TRADING SCHEME DOES

The NZ ETS puts a price on greenhouse gas emissions by issuing a restricted volume of permits to emit into the market. The NZ ETS requires all sectors of New Zealand's economy to report on their emissions and, with the exception of emissions from agriculture,[27] to purchase and surrender emissions units to the Government for those emissions.

This creates a financial incentive for businesses to invest in technologies and practices that reduce emissions. It also encourages forest planting by allowing eligible foresters to earn New Zealand Units (NZUs) as their trees grow and absorb carbon dioxide.

The NZ ETS was reviewed in 2015/16. There was a clear call from stakeholders to improve the stability and predictability of the scheme. As a result, the Government has made in-principle decisions on a package of four proposals to improve the operation of the NZ ETS in the 2020s. The in-principle decisions are expected to be implemented in 2019, following further policy development and consultation later in 2018.

The in-principle decisions include: introducing auctioning of units, to align the NZ ETS to our climate change targets; limiting participants' use of international units when the NZ ETS reopens to international carbon markets, developing a different price ceiling to eventually replace the current $25 per tonne carbon dioxide equivalent fixed-price option, and coordinating decisions on the supply settings in the NZ ETS over a rolling five-year period.

Design choices for a new Climate Change Commission

What the Climate Change Commission could consider when undertaking its work

It is important the Climate Change Commission undertakes all of its proposed functions in a transparent and predictable way. To do this, we propose that it be required to consider a number of factors set out in legislation. The Government should also have to follow these same factors when setting emissions budgets. The UK's Climate Change Act 2008 offers a useful precedent for what matters its Climate Change Committee should take into account when undertaking its work. These include:

- scientific knowledge about climate change
- technology relevant to climate change
- economic circumstances and, in particular, the likely impact of the decision on the economy and the competitiveness of particular sectors of the economy
- fiscal circumstances and, in particular, the likely impact of the decision on taxation, public spending and public borrowing
- social circumstances and, in particular, the likely impact of the decision on fuel poverty
- energy policy and, in particular, the likely impact of the decision on energy supplies and the carbon and energy intensity of the economy.

These considerations will help inform judgements on the level of emissions budgets and the pace of our economic transition. In New Zealand, we will need to take into account our own circumstances. This includes our obligations under the Treaty of Waitangi.

[27] Methane and nitrous oxide.

The Commission could also consider the three government objectives for climate change policy: sustainable economy, global and local leadership and creating a just and inclusive society.

Implications for the Government on the Climate Change Commission's role and functions

The Zero Carbon Bill will propose new requirements on the Government to respond to the reports of the Climate Change Commission. Where it provides advice, such as on the emissions budgets, the Government would be required to take this into account and issue a public report in response. Where the Government's actions differ from the advice of the Climate Change Commission, these reports should outline why.

Where the Climate Change Commission has monitoring functions, the Government would also be required to publicly respond to the monitoring report. Requiring the Government to do this within a timeframe of six to twelve months would provide additional accountability.

This accountability is important so New Zealanders can see how Governments are planning for and addressing climate change issues.

What expertise could the Climate Change Commission have?

We seek your views on the range of expertise that the commissioners could have.

The UK Committee consists of a chair plus five to eight committee members and an adaptation sub-committee with five members. The members have a high level of standing in society and are sector experts rather than representatives of particular stakeholder groups.

We consider our Commission should have similar credibility and the following essential expertise:

- climate change policy (including emissions trading)
- resource economics and impacts (including social impacts, labour markets and distribution)
- te Tiriti o Waitangi, te reo me ona tikanga Māori and Māori interests
- climate and environmental science including mātauranga Māori
- experience with addressing adaptation challenges like planning, insurance and local government
- risk management
- engineering and/or infrastructure
- community engagement and communications.

Desirable, but non-essential, expertise could include:

- business competitiveness
- knowledge of the public and private innovation and technology development system.

Including the expertise needed in the Commission in the Zero Carbon Bill aligns with the UK approach[28] and the recommendation of our Parliamentary Commissioner for the Environment.[29]

QUESTIONS

11 The Government has proposed that the Climate Change Commission advises on and monitors New Zealand's progress towards its goals. Do you agree with these proposed functions?

12 What role do you think the Climate Change Commission could have in relation to the New Zealand Emissions Trading Scheme (NZ ETS)?

Pick one:

- advising the Government on policy settings in the NZ ETS
- makes decisions itself, in respect of the number of units available in the NZ ETS.

13 The Government has proposed that Climate Change Commissioners need to have a range of essential and desirable expertise. Do you agree with the proposed expertise?

Adapting to the impacts of climate change

SUMMARY

The Zero Carbon Bill can help New Zealand adapt to the impacts of climate change.

- Historical emissions have already changed our climate.
- Even with successful reduction of greenhouse gases, we will need to adapt to the impacts of climate change.
- New Zealand is already incurring costly damage to its assets and infrastructure, and the resilience of its people and communities is being challenged.

We propose that the Zero Carbon Bill includes the following adaptation provisions, to help decision-makers manage climate change risks in a systematic way:

- a national climate change risk assessment
- a national adaptation plan
- regular review of progress towards implementing the national adaptation plan
- an adaptation reporting power.

We seek your views on:

- the scope, scale and content of the national climate change risk assessment and national adaptation plan
- the respective roles of central government and the Climate Change Commission for each of the adaptation provisions
- how an adaptation reporting power should be used and who it should apply to.

Consultation questions on this proposal can be found at the end of this chapter. The full list of consultation questions can be found in the attached submissions form and online

[28] See the UK's Climate Change Act 2008: www.legislation.gov.uk/ ukpga/2008/27/schedule/1.

[29] Parliamentary Commissioner for the Environment (2017).

Increasing our resilience

Regardless of what level of ambition we set in the Zero Carbon Bill, our climate will continue to change over the coming decades. This is because some climate change is already locked in from historic emissions, and we will need to adapt to this.

As a result, we will face risks from rising sea levels and extreme weather and from slow changes to our ecosystems and biodiversity, including our animals, plants and soils that underpin not only the primary sector but also human health.

The costs from climate change are already high and growing. For example, in the past 10 years, the cost of weather events to our transport network has increased from about $20 million per year to over $90 million per year.[30] Reports from the Parliamentary Commissioner for the Environment indicate that the cost of replacing every building within half a metre[31] of the average high tide mark[32] could be $3 billion and within 1.5 metres as much as $19 to 20 billion.[33]

We are committed under the Paris Agreement to plan for and take action on climate change adaptation. In 2016, the Climate Change Adaptation Technical Working Group was set up to provide advice on adapting to the impacts of climate change while sustainably growing our economy. Two reports have now been released,[34] with the most recent identifying a series of actions New Zealand should take to increase resilience and adapt to the changing climate.

This section considers possible tools that could be used to help us adapt to climate change.

Creating the right environment for adaptation

At the moment, the way we respond and adapt to climate change impacts is not well coordinated. Many of the risks, impacts and actions to adapt are dealt with across a number of different legislative and regulatory regimes.

There are gaps in our information. We have some knowledge about the impact of sea level rise on our coastlines and communities but even less about the impact rising temperatures will have on our natural systems. We do not know what unwanted plants and animals might arrive and thrive as a result, or the impact of ongoing extreme weather events on production in the primary sector. There is more work to do to understand the possible impacts on our health, biodiversity and culture over time.

The Zero Carbon Bill could include requirements in law that we understand the risks and have a plan to manage them. Setting up the right tools for decision-makers would help us consider the risks to the whole of society and the economy. We could also introduce ways to encourage or require some organisations to share more information on their exposure to climate change risks.

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30 Ministry for the Environment (2017).

31 The mid-range projected sea-level rise over the next 50 years is about 30 centimetres, and could vary between 20 centimetres and 50 centimetres. Note in the past 100 years, seas have risen around 14–22 centimetres in New Zealand ports.

32 Defined as the mean high water springs.

33 Parliamentary Commissioner for the Environment (2015), p 89.

34 Available at: www.mfe.govt.nz/publications/climate-change/adapting-climate-change-new-zealand-stocktake-report-climate-change.

If we introduce, through primary legislation, a way to assess risks and create a plan to adapt, we can take a broad view and ensure the right settings are in place to respond. This includes how we respond to different needs in different communities around New Zealand. We propose that the Zero Carbon Bill includes the following provisions:

- a national climate change risk assessment
- a national adaptation plan
- regular review of progress towards implementing the national adaptation plan
- an adaptation reporting power.

A national climate change risk assessment

Climate change exacerbates existing risks and creates new risks.[35] Many councils and communities are already dealing with some of these.

At the moment, our actions to adapt are ad hoc and we cannot measure our effectiveness. To address this, we propose introducing a compulsory national climate change risk assessment that is updated regularly.

The Climate Change Adaptation Technical Working Group has recommended that this type of assessment is a priority. If we can get a better understanding of which areas and communities are the most exposed and vulnerable to risks, we can ensure we are taking the most effective actions to address these.

Our first step is determining what the risks are for people, infrastructure, the natural environment and the economy. This information needs to be accessible and standardised to help decision-makers, including iwi and hapū, communities, transport and infrastructure sectors, private sector firms, and central and local government.

A risk assessment would need to align with and inform other risk work by the Government. It could provide valuable information to the National Security System and the Ministry for Civil Defence and Emergency Management and other interested agencies. The proposed national climate change risk assessment would:

- identify risks to New Zealand that arise from, or are worsened by climate change
- provide the necessary evidence to improve how we communicate current and future risks and opportunities
- provide a foundation for investment and decision-making, and guide future work
- inform development of a national adaptation plan
- inform planning and actions to minimise the cost of future climate-related disaster response and recovery
- contribute to an approach across all sectors to help stimulate action in a systematic way
- provide accessible and standardised information for decision-making.

Placing this requirement in primary legislation means future risk assessments continue to take a broad view across the economy and society and there will be continuity over time, creating a more stable policy environment.

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[35] IPCC (2014).

A national climate change risk assessment would be publicly available, updated at five-yearly intervals and the Climate Change Commission would hold responsibility for this.

While the Commission is being set up, central government could initiate the first risk assessment, with future assessments falling under the responsibility of the Climate Change Commission. Future assessments could include information obtained from the adaptation reporting power, if developed (see below).

National adaptation plan

Climate change adaptation is not currently integrated into many central government agency objectives. This means legislation and regulatory frameworks and policies around long-term planning are not well aligned. This makes it difficult for local government, businesses and communities to proactively organise themselves and take action.

To date, most action taken to adapt to climate change has been reactive. In the case of local government, responses to climate damage are paid for out of maintenance funds. With clear direction, local government and others would have more certainty. This would mean they could plan funding for ongoing climate change-related impacts.

We propose introducing a way to have a planned response to climate change risks. This would provide a national approach to prioritising adaptation action. Given the long-term nature of adaptation, and the breadth and potential scale of the issue, a national adaptation plan would:

- identify priority actions for addressing risk, as identified in the climate change risk assessment, including assisting and prioritising vulnerable people and regions
- be based on strong scientific evidence, provide robust information and raise awareness of climate change risks
- help clarify roles and responsibilities on climate change adaptation across different pieces of legislation, different sectors of society, and determine who needs to act on what and when
- be aligned with the work of the Ministry of Civil Defence and Emergency Management, including the need for community and individual resilience
- be designed to deal with changing risks and encourage proactive planning in a comprehensive way
- aim to integrate climate change risk into decision-making
- recognise the importance of coordination, collaboration, cooperation and partnerships between central government and other levels of government, and across sectors and society and including iwi and hapū
- recognise the importance of monitoring and evaluating progress towards enhanced resilience
- be designed to look for and take advantage of opportunities for adaptation.

We propose that the Government, rather than the Climate Change Commission, holds responsibility for the national adaptation plan. To address local challenges, we would develop the plan with local government and other stakeholders. The plan should be updated at five-yearly intervals, to synchronise with the five-yearly climate change risk assessment process.

We would require ongoing evaluation of how the national adaptation plan is being implemented. This will ensure the plan endures and that it leads to effective adaptation action. We recommend that the Climate Change Commission reviews how the national adaptation plan is being implemented at the mid-point of each five-year cycle. The outcomes of each review could be used to update the next iteration of the plan.

Exploring potential for an adaptation reporting power

We want to explore whether the Government should introduce an adaptation reporting power. At the moment, we do not have a clear picture of what action is being taken as part of risk management processes by organisations.[36]

We think we could get a better picture of our risks and opportunities if we could get more information from organisations that own public infrastructure or deliver public services. We want to hear your views on whether we should explore this further. The type of considerations we could have are:

- the value of having a targeted and specific reporting obligation from organisations
- who this would apply to, for example, organisations such as Crown entities or state-owned enterprises, local and central government or private companies that provide public services like energy and transport services, including rail
- what the choices are around such a power being voluntary, or included in legislation and mandatory
- what such reporting should cover, for example, how ready organisations are to respond to risks and opportunities.

There are likely to be some benefits from this approach. Organisations would be better informed and more prepared to mitigate or manage risks that have been identified. The reports would reveal how prepared organisations are. They would help the Government design supportive policies and to ensure that the regulatory environment encourages adaptation.

Experience in the UK has found that mandatory reporting delivers a higher standard of reports, as well as complete coverage from the required organisations, providing a better understanding of the adaptation action being taken.

However, it would also bring administrative and compliance costs to both organisations and to the Government.

QUESTIONS

14 Do you think the Zero Carbon Bill should cover adapting to climate change?

15 The Government has proposed a number of new functions to help us adapt to climate change. Do you agree with the proposed functions?

16 Should we explore setting up a targeted adaptation reporting power that could see some organisations share information on their exposure to climate change risks?

[36] These organisations all have different governance arrangements, some are constituted under specific legislation, some will be Crown entities, some private companies, some publicly listed companies.

Part three: Next steps

The Zero Carbon Bill proposes to create the necessary enduring institutional architecture to meet New Zealand's long-term emissions reduction goals and build resilience to the impacts of climate change. The Zero Carbon Bill will not get us through the transition by itself. We also need to continue with a strong emissions pricing regime through the NZ ETS, develop regulation and policy in areas to complement emissions pricing, and support innovation and investment in low emissions technologies.

The Government has a number of existing initiatives alongside the Zero Carbon Bill, including:

- strengthening and improving the NZ ETS
- developing a land transport policy strategy that supports investment in low emissions transport and urban design
- planting one billion trees
- establishing a Green Investment Fund to stimulate new investment in low carbon industries.

Our towns and cities are also contributing. Regional and territorial authorities are improving their understanding of how to adapt to climate change and are putting in place plans for low emissions communities. Government is working with iwi, communities and businesses to accelerate the transition. For example, it has worked with the dairy sector to develop the 'Dairy Action for Climate Change', helping farmers reduce emissions over time. The Low Emissions Roadmap with Fonterra is helping large energy users transition off fossil fuels and onto renewable energy sources.

Your feedback

Your specific feedback on the proposals contained in this document will help inform further policy development and shape what will become the Zero Carbon Bill. Final policy decisions are expected to be made later this year.

Amendments to the Climate Change Response Act 2002 will follow to strengthen the NZ ETS (in line with changes made through the Zero Carbon Act) and give effect to our international obligations under the Paris Agreement.

Appendix

Mitigation opportunities in key sectors where emissions reductions are possible

Energy	The energy sector is experiencing rapid technological innovation and will play a huge role in the transition. For example: Electric vehicles (EVs) are already economic over the lifetime of the car and we can expect EV uptake will substantially reduce emissions. Hydrogen fuel cell vehicles might also play a role, and/or advanced biofuels and similar technologies, particularly for moving freight. Industrial process heat (eg, milk and meat processing) holds potential to improve energy efficiency and switch to much lower emission fuels, such as woody biomass or electricity. Wind and geothermal are currently the lowest-cost electricity generation options in New Zealand. We still have extensive high-quality untapped renewable energy resources. Energy efficiency improvements from the use of residential LED lighting and industrial scale plant modifications can reduce emissions directly or help lower costs of using cleaner energy sources.
Agriculture	A methane vaccine is under development to mitigate on-farm emissions in the dairy, sheep and beef sectors. Research and development may give rise to material on-farm abatement opportunities in the future. Land use change to lower-emitting uses will likely be needed to achieve material emissions reductions from agriculture.
Forestry	Increasing our forested land area will play a huge role in soaking up more emissions, both commercial plantation forests and permanent native forests. Forestry helps buy us time until other technological developments or options become available, but we will need continued emissions reductions post 2050 – beyond planting more trees – to maintain a low-emissions economy.
Industrial processes	Efficiency gains in industrial processes (eg, steel, cement, fertiliser) will help because there are currently a limited number of available technology options. Industrial sectors that use other high greenhouse gas warming potential products (such as refrigerants) have viable alternatives and improved management practices that can markedly reduce their impacts.
Waste	Waste can be a valuable resource, for example, Palmerston North's waste treatment plant's anaerobic digestion of organic waste creates renewable methane used to generate electricity.[37]

[37] Available at: www.bioenergy.org.nz/documents/resource/Reports/Going-greener-PNCC.pdf.

ABOUT THE ECONOMIC MODELLING

A multi-method economic analysis approach is under way because no one approach can give the whole picture. This combines bottom-up cost modelling, whole-of-economy modelling and research on specific impacts, to build an understanding of both the challenges and upsides of new targets for 2050. The studies include:

- bottom-up and linked sector modelling building on rural land use and energy sector models to indicate transition pathways and emissions prices from 2030–50 to meet different target options. The different range of pathways developed drive the transitions via higher emissions pricing, by sectoral shifts or significant technological change within existing economic structures (Vivid Economics, Concept and Motu Economic and Public Policy Research, 2018)
- whole-of-economy computable general equilibrium (CGE) modelling to determine emissions prices and the gross domestic product impact of different targets. The assumptions on emissions reductions options are, where possible, aligned with the Vivid modelling[38]
- economic analysis of the impact of stronger climate action on innovation and competitiveness within the New Zealand context (Sense Partners), as well as related international evidence
- the co-benefits of emissions reductions, and the benefit to the New Zealand economy of avoiding damages caused by climate change.

This and future material will be published on the Ministry for the Environment website as it is finalised. This is part of building a clearer picture and evidence base over time to support future decisions and the advice of entities such as the Climate Change Commission, once it is established.

Other externally commissioned reports are also relevant. For example, Westpac NZ commissioned a report from EY (and Vivid) to determine the benefit to the economy of acting sooner rather than later. This report was based on a limited range of scenarios and included an assumption about the introduction of agriculture to the NZ ETS from 2020.

ASSUMPTIONS UNDERLYING NZIER'S MODELLING OF EMISSIONS

The NZIER model builds on assumptions used by Vivid and includes scenarios where:

- a baseline assuming current policy settings remains, sets energy efficiency and technological change assumptions based on today's rates, electric vehicles increase to make up 65 per cent of the light vehicle fleet by 2050 based on pricing considerations alone, other countries act consistently with the Paris Agreement, which they also signed, agricultural emissions remain unpriced and no international units are used
- faster energy innovation occurs, driven by higher emissions prices and transitional policies that double the baseline energy efficiency trends across all industries and provide a shift to 98 per cent renewable energy by 2035 with the remaining 2 per cent used being gas-fired generation in dry years only
- faster transport innovation occurs, driven by higher emissions prices and transitional policies that increase electric vehicle uptake to 95 per cent of the light vehicle fleet and 50 per cent of the heavy vehicle fleet by 2050

[38] NZIER (2018).

ASSUMPTIONS UNDERLYING NZIER'S MODELLING OF EMISSIONS

- faster agricultural innovation occurs, this sees a one-off innovation of a methane vaccine introduced in 2030 being adopted across all farms, which reduces dairy emissions by 30 per cent and sheep and beef emissions by 20 per cent. A reduction in global demand for dairy (11 per cent fall in 2050 output from 2015 levels) and sheep and beef (15 per cent fall) is experienced as consumer preferences shift towards lower emissions intensive foodstuffs, such as synthetic meats.

These assumptions define the scenarios of mitigations deemed possible, and so, after assuming these things happen, the models then calculate the emissions prices necessary to meet a given target. The faster innovations can be turned on and off to see the impact of changing technology in different sectors, if meeting different targets.

The models do not include everything that might happen in the future: they do not allow for unforeseen technologies to ever take us beyond the faster innovation rates. For example, recent developments in breeding lower emissions sheep and other voluntary measures that we are already seeing on farm and by businesses.

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Submissions form

We seek your feedback on the specific proposals in the Zero Carbon Bill.

2050 target

1. What process should the Government use to set a new emissions reduction target in legislation?

   Pick one:

   - the Government sets a 2050 target in legislation now
   - the Government sets a goal to reach net zero emissions by the second half of the century, and the Climate Change Commission advises on the specific target for the Government to set later.

   Optional comment

2. If the Government sets a 2050 target now, which is the best target for New Zealand?

   Pick one:

   - **net zero carbon dioxide:** Reducing net carbon dioxide emissions to zero by 2050
   - **net zero long-lived gases and stabilised short-lived gases:** Long-lived gases to net zero by 2050, while also stabilising short-lived gases
   - **net zero emissions:** Net zero emissions across all greenhouse gases by 2050.

   Optional comment

3. How should New Zealand meet its targets?

   Pick one:

   - domestic emissions reductions only (including from new forest planting)
   - domestic emissions reductions (including from new forest planting) and using some emissions reductions from overseas (international carbon units) that have strong environmental safeguards.

   Optional comment

4. Should the Zero Carbon Bill allow the 2050 target to be revised if circumstances change?

   Pick one:

   - yes
   - no.

   Optional comment

Emissions budgets

5. The Government proposes that three emissions budgets of five years each (ie, covering the next 15 years) be in place at any given time. Do you agree with this proposal?

   Pick one:

   - yes
   - no.

   Optional comment

6. Should the Government be able to alter the last emissions budget (ie, furthest into the future)?

   Pick one:

   - yes, each incoming Government should have the option to review the third budget in the sequence
   - yes, the third emissions budget should be able to be changed, but only when the subsequent budget is set
   - no, emissions budgets should not be able to be changed.

   Optional comment

7. Should the Government have the ability to review and adjust the second emissions budget within a specific range under exceptional circumstances?

   Pick one:

   - yes
   - no.

Optional comment

8. Do you agree with the considerations we propose that the Government and the Climate Change Commission take into account when advising on and setting budgets?

   Pick one:

   - yes
   - no.

Optional comment

Government response

9. Should the Zero Carbon Bill require Governments to set out plans within a certain timeframe to achieve the emissions budgets?

   Pick one:

   - yes
   - no.

Optional comment

10. What are the most important issues for the Government to consider in setting plans to meet budgets? For example, who do we need to work with, what else needs to be considered?

Comment

Climate Change Commission

11. The Government has proposed that the Climate Change Commission advises on and monitors New Zealand's progress towards its goals. Do you agree with these functions?

    Pick one:

    - yes
    - no.

    Optional comment

12. What role do you think the Climate Change Commission should have in relation to the New Zealand Emissions Trading Scheme (NZ ETS)?

    Pick one:

    - advising the Government on policy settings in the NZ ETS
    - makes decisions itself, in respect of the number of units available in the NZ ETS.

    Optional comment

13. The Government has proposed that Climate Change Commissioners need to have a range of essential and desirable expertise. Do you agree with the proposed expertise?

    Pick one:

    - yes
    - no.

    Optional comment

Adapting to the impacts of climate change

14. Do you think the Zero Carbon Bill should cover adapting to climate change?

    Pick one:

    - yes
    - no

    Optional comment

15. The Government has proposed a number of new functions to help us adapt to climate change. Do you agree with the proposed functions?

    Pick one:

    - yes
    - no.

    Optional comment

16. Should we explore setting up a targeted adaptation reporting power that could see some organisations share information on their exposure to climate change risks?

    Pick one:

    - yes
    - no.

    Optional comment

17 July 2018
Document: 2071566

Ministry for the Environment
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Submission on Zero Carbon Bill

Introduction

The Taranaki Regional Council (the Council) thanks the Ministry for the Environment for the opportunity to make a submission on specific proposals for the Zero Carbon Bill as outlined in the Ministry' discussion document *'Our Climate Your Say!'*

The Council makes this submission in recognition of the purpose of local government set out in the Local Government Act 2002, and the role, status, powers and principles under that Act relating to local authorities. In particular, the Council's comments are made in recognition of its:

- functions and responsibilities under the Local Government Act 2002 and the Resource Management Act 1991; and
- its regional advocacy responsibilities whereby the Council represents the Taranaki region on matters of regional significance or concern.

The Council has also been guided by its Mission Statement *'To work for a thriving and prosperous Taranaki'* across all of its various functions, roles and responsibilities, in making this submission.

In making this submission the Council has provided feedback on the sixteen questions (organised under four topic headings) contained in the discussion document. Where a question presents options or choices to be selected, this is indicated by a ✓ next to the preferred option.

2050 target

1. *What process should the Government use to set a new emissions reduction target in legislation?*

   Pick one:

   ✓ *the Government sets a 2050 target in legislation now*

- *the Government sets a goal to reach a net zero emissions target by the second half of the century, and the Climate Change Commission advises on the specific target for the Government to set later.*

Optional comment

The setting of an emissions reduction target(s) in legislation would provide certainty and a clear direction for New Zealand to work towards on climate change.

The targets could be staged over a number of years. This would provide shorter term goals to be achieved. This offers the significant advantage of allowing for evolving scientifically robust measurements of sources and magnitudes of emissions from various sectors or at microcosmic scale, the fruits of ongoing research into options for mitigation and their effectiveness and cost-benefit, and market, land–use, and cultural adjustment. Provision should be made in the law for review and amendment of the targets.

2. *If the Government sets a 2050 target now, which is the best target for New Zealand?*

Pick one:

- *net zero carbon dioxide: reducing net carbon dioxide emissions to zero by 2015*
- ✓ *net zero long-lived gases and stabilised short-lived gases: long-lived gases to net zero by 2050, while also stabilising short-lived gases*
- *net zero emissions across all greenhouse gases by 2050.*

Optional comment

All three options will be challenging for New Zealand to achieve by 2050. It will need widespread political support and buy-in from across New Zealand and all sectors of the economy.

The transition to a low emissions economy will not be without cost and disruption and will need to be carefully managed. The Council agrees with statements in the discussion document by the Minister for Climate Change that the transition must '*be planned, gradual and carefully phased in*' (discussion document page 7) and that it will be important to minimise the negative social and economic impacts of change *'so it is just and fair for people, communities and regions*' (discussion document, page 8). There will likely be job losses in high carbon-emitting industries and increases in transport and electricity prices for example, that will have national and regional economic and social consequences. Mechanisms will need to be put in place to address these as part of a planned and gradual transition.

Of the three options presented the Council offers qualified support for a target of net zero long-lived gases and stabilised short-lived gases such as methane from agricultural sources. The Council holds that this option offer the best mix of credible science, practical abatement interventions, and lowest transition costs.

However, the agricultural sector currently has very limited options at the farm scale to further mitigate greenhouse gas emissions below existing levels, other than abandonment of production. Critically, the Council notes there is no credible means of even accurately assessing agricultural emissions at either the farm scale or the sector scale; universal mitigations will not only inevitably be unfair but will penalise the emissions-efficient producer; and farm-scale emission accountability will be grossly inaccurate and will misrepresent the contribution of this sector.

In its submission to the Productivity Commission's *Low emissions economy* draft report, the Council submitted that the entry of agriculture in to the NZ ETS should be delayed until such time as proven mitigation options are available and adopted by our trade competitors. We noted that when looking across all the greenhouse gas emitting sectors in New Zealand, agriculture is leading international best practice in greenhouse gas mitigation whereas other sectors are not. If New Zealand was to commit to stabilising short-lived gases by 2050 (or more particularly a net zero emissions target across all greenhouse gas emissions), we could, on a global scale, be promoting more inefficient agricultural producers to meet increasing demands for agricultural produce, at the expense of our own more efficient agricultural sector.

Given that agriculture is a significant earner of export income for New Zealand and is sensitive to movements in international markets, we would need to be certain of the efficacy of mitigation options and that these were also being applied by our trade competitors.

However, the Council is aware that further research on agricultural mitigation technologies offer some promising leads so that specifically stabilising emissions by 2050 may therefore also be an appropriate target. This will need to be reviewed in light of technological advances and the position of our trading competitors on this issue.

Including agricultural emissions in the target in some form will provide an incentive for further work to be done on mitigation options.

However, the Council considers there is scope for exploring an alternative approach to greenhouse gas emissions from agriculture. This involves working together with the industry to explore the imposition of a ceiling upon current animal numbers as an effective and meaningful means of imposing a ceiling on any further increases in greenhouse gas emissions from the animal husbandry sector. On the face of it, such an approach offers the attractions of simplicity, accuracy, low transition costs, and effectiveness.

The first point is that inclusion of an NZ ETS financial imposition upon pastoral agricultural emissions (no matter how calculated) is actually <u>not</u> a means of reducing emissions. It is simply a disincentive to be a farmer. No matter how much a farmer pays in an ETS, the emissions from his/her farm remain unchanged for the time being. The theory is that the financial imposition will subsequently motivate the farmer to change practices. The fallacy in that argument is that it is most unlikely that a tool such as OVERSEER will provide an adequately accurate representation of emission reduction at the farm scale to compensate the farmer for their efforts and

mitigation interventions, and thus to reward the behaviour (setting aside the whole question of whether the technology yet exists to mitigate emissions on the farm). Also, any reduction in (net national) emissions can only come about if the raised ETS payment is spent on forestry or other effective emissions-capturing or reducing technology. Whereas a cap on the total number of farm animals instantly stabilizes emissions and hence their warming potential; and further, the possibility of more production through increased productivity by the farmer, achievable through measures such as better grasses or breeding of more efficient animals, inevitably and directly means fewer emissions (better conversion of intake carbon to milk/meat/body condition instead of to loss as methane), so the motivation to the farmer is for more production and more profit without ETS penalty AND has immediate co-benefits for reduced emissions.

A cap on animals caps emissions whereas an ETS imposition only generates revenue; its effect upon emissions remains uncertain. A farmer could well decide to pay the ETS tax and not bother reducing emissions (after all, he's just paid for the privilege of emitting, so why shouldn't he, just as an owner of a gas-guzzler could well decide to pay a higher petrol price rather than downsize engine capacity).

As long as the national herd is held constant, farmers would want and would need to be able to trade herd numbers. The benefits of such an approach is that it has integrity because it recognises the closed loop movement of carbon within a pastoral animal husbandry system that is at equilibrium; it does not require any attempt at directly measuring emissions or changing emissions at the farm scale; it will immediately drive more efficient utilisation of fertiliser and feed and more efficient conversion of intake into product, and it will promote a reduction in stock intensity (with wider environmental benefits) by promoting per animal productivity over per hectare productivity.

We note and endorse the recent commentary and report by Professor Dave Frame, director of the Victoria University-based New Zealand Climate Change Research Institute. He notes The Intergovernmental Panel on Climate Change (IPCC)'s first report, in 1990, suggested a "simple approach [to measuring the contribution to climate change of different gases] … to illustrate the difficulties inherent in the concept".

"That approach ended up sticking - it's a classic case of path-dependence, really,"

"But the way we do it masks some important differences between long-lived gases and short-lived gases."

Frame has stated that difference mattered for countries with large agriculture sectors - and not only developed nations like New Zealand, but also developing ones.

A just-published study co-authored by Frame and colleagues from Victoria, Oxford University and the University of Reading in Britain, and Norway's Centre for International Climate and Environmental Research, has drawn on a simple but well-tested climate model and accompanying range of emissions scenarios.

Frame said the study mainly showed the way methane was currently accounted for - by using the idea of CO2 equivalence - exaggerated the long-term effects of methane on the climate.

"We think we have a better way of making this comparison, that uses the same basic principles used today, but applies them differently to take account of the fact that methane has a vigorous heating effect, but is short-lived, while CO2 has a weaker but near-permanent effect on temperatures," Frame said.

"Basically, CO2 is a stock pollutant that accumulates in the atmosphere, but methane is a flow pollutant that disappears about a decade after emissions occur."

Frame argued that the current approach of comparing the gases posed a risk of prompting to target methane emissions instead of carbon dioxide. "If we make trade-offs that favour reductions in agricultural methane instead of fossil carbon, then we will be making a mistake from a climate change perspective"

The Council also notes the reported comments of Professor Ralph Sims, director of Massey University's Centre for Energy Research, that choosing to stabilise methane levels rather than reducing them to zero would take pressure off the farming sector, at a time when research to date had yielded only small opportunities to cut levels.

Methane also enters the atmosphere from sources such as coal mines, natural gas fields and pipelines, which NASA recently confirmed were the main culprits behind mysterious methane increases in the atmosphere over the past decade.

Professor Sims noted that if the methane was bio-based, it could be argued that the resulting CO2 after methane break-down was recycled back through the growing pasture; but if it was fossil-based methane, then the resulting CO2 was no different from that released from fossil fuel combustion, and therefore represented additional warming potential.

3. *How should New Zealand meet its targets?*

Pick one:

- *domestic emissions reductions only (including from new forest planting)*
- ✓ *domestic emissions reductions (including from new forest planting) and using some emissions reductions from overseas (international carbon units) that have strong environmental safeguards.*

Optional comment

The option of using some emissions reductions from overseas provides New Zealand with flexibility in meeting our targets. The Council considers that this is important when dealing with uncertainty over long time periods and questions of when for example, technology becomes available and at what cost. It could mean we could meet our targets at lower cost than if we relied only on reducing domestic emissions and could therefore ease the transition to a low-emissions economy. It also means that NZ is not solely reliant upon domestic planting as a means of mitigation (given that this measure is unavoidably short-term and limited, given space for planting is not inexhaustible).

4. *Should the Zero Carbon Bill allow the 2050 target to be revised if circumstances change?*

   Pick one:

   - ✓ *Yes*
   - *No*

   Optional comment

   See response to Q1, 2 and 3.

Emissions budgets

5. *The Government proposes that three emissions budgets of five years each (i.e. covering the next 15 years) be in place at any given time. Do you agree with this proposal?*

   Pick one:

   - ✓ *Yes*
   - *No*

   Optional comment

   A five year timeframe for each emissions budget provides a degree of certainty for business while retaining flexibility for any changes that might arise in future for example as a result of evolving/emerging technology, land use change, or policy review. A 15 year timeframe for setting the overall emissions budget appears to the Council to be a good balance between what is predictable and retaining flexibility to respond to changes in circumstances.

   The Council agrees that these timeframes may help to 'depoliticise' the budget-setting process.

6. *Should the Government be able to alter the last emissions budget (i.e. furthest into the future)?*

   Pick one:

   - ✓ *Yes, each incoming Government should have the option to review the third budget in the sequence*
   - *Yes, the third emissions budget should be able to be changed, but only when the subsequent budget is set*
   - *No, emissions budgets should not be able to be changed.*

   Optional comment

   The Council considers that this option allows an incoming Government latitude to amend the third emissions budget in line with its stated policy and evolving technology/reshaping of land use due to other drivers.

A publically available report should be required to be prepared to outline the reasons for the change, and the change itself be subject to public comment and submission.

7. *Should the Government have the ability to review and adjust the second emissions budget within a specific range under exceptional circumstances?*

   Pick one:

   - ✓ *Yes*
   - *No*

   Optional comment

   The Council agrees that the second budget should also be able to be reviewed but the circumstances under which this may occur will need further consideration. Limiting a review to when there are 'exceptional circumstances' may commit New Zealand to unrealistic or impractical targets for a number of years before a budget can be changed. There will also be arguments and disagreements about what are or are not 'exceptional circumstances' and this term would need to be clearly defined if this option was favoured.

8. *Do you agree with the considerations we propose that the Government and the Climate Change Commission take into account when advising on and setting budgets?*

   Pick one:

   - ✓ *Yes*
   - *No*

   Optional comment

   The Council agrees with the list of considerations on page 44 of the discussion document as to the matters to be taken into account by the Climate Change Commission and the Government when advising on and setting budgets. Having in law, a list of matters to be taken into account in advising and setting budgets increases public accountability for the decisions made. It will also ensure that the process is balanced and robust. Taking into account economic and social circumstances and impacts etc. will be critical for making informed judgements on emissions budgets and the rate of our economic transition to a net zero emissions economy.

   The Council considers that the list of matters to be taken into account should include any economic and social impacts on particular regions of New Zealand. This recognises that some regions may be more severely impacted than others and that additional support measures might be needed for those regions.
   The Council considers that the list of matters should also include our obligations under the Treaty of Waitangi.

9. *Should the Zero Carbon Bill require Governments to set out plans within a certain timeframe to achieve the emissions budgets?*

   Pick one:

   - ✓ *Yes*
   - *No*

   Optional comment

   The Council considers that the Zero Carbon Bill should require the Government to prepare and publish plans or policies on how we propose to meet future emissions budgets.

   In the Productivity Commission's draft report on a '*Low-emissions economy*', this was recommended as a necessary step to ensure other supporting regulations and policies were in place to enable targets to be met. These policies were around supporting the creation and use of mitigation technologies, assisting behaviour change by businesses and households and managing risks.

   The Council also supports the proposal that the Zero Carbon Bill require the Government to publish its plans within a set timeframe after each emissions budget has been announced.

10. *What are the most important issues for the Government to consider in setting plans to meet budgets? For example, who do we need to work with, what else needs to be considered?*

    Comment

    Major considerations are the impacts on the New Zealand economy and on New Zealand society which are linked to the rate of transition and to our state of technology on climate change. Flexibility in setting targets and regular review of budgets will be required along with plans about how we intend to meet budgets.

    It is vital for reasons of both credibility and effectiveness, that the proven practicality of individual plan targets be considered, especially for specific sectors and activities.

    Consideration of impacts on regions and communities at a sub-national or regional scale will be essential as will measures designed to alleviate those impacts.

    This suggests a wide range of interests to be considered in setting plans to meet budgets.

    As far as regional or local community input is concerned, the Council recommends the involvement of local government, regional development agencies, iwi, chambers of commerce, locally based business interests, locally organised sector groups (e.g. Federated Farmers), local NGOs, and community groups (volunteer agencies, aged concern groups etc.).

Climate Change Commission

11. *The Government has proposed that the Climate Change Commission advises on and monitors New Zealand's progress towards its goals. Do you agree with these functions?*

    Pick One:

    - ✓ *Yes*
    - *No*

    Optional comment

    The Council agrees with proposals that the Climate Change Commission advises on and monitors New Zealand's progress towards its goals. Where it provides advice, the Government should also be required to take this advice into account and issue a public report in response. Where the Government's actions differ from the advice received from the Climate Change Commission, these reports should outline why.

    Where the Climate Change Commission has monitoring functions, the Government should also be required to publically respond to the monitoring report.

    The Council suggests that a timeframe of up to six months be provided for the Government to respond.

12. *What role do you think the Climate Change Commission should have in relation to the New Zealand Emissions Trading Scheme (NZ ETS)?*

    Pick One:

    - ✓ *Advising the Government on policy settings in the NZ ETS*
    - *Makes decisions itself, in respect of the number of units available in the NZ ETS*

    Optional comment

    The Council considers that the Climate Change Commission should have an advisory role on the NZ ETS. The Council considers that it is not appropriate for the Commission to have decision-making powers. The move to a low-emissions economy under the NZ ETS will have widespread economic, social, and environmental impacts and the Council maintains that the weighing up of these impacts and making decisions on them is the proper role of an elected Government.

13. *The Government has proposed that Climate Change Commissioners need to have a range of essential and desirable expertise. Do you agree with the proposed expertise?*

    Pick one:

    - ✓ *Yes*
    - *No*

Optional comment

The Council's response to this question is a qualified 'yes'. The Council agrees that the expertise needed for the Climate Change Commission should be included in the Zero Carbon Bill. It is possible that more than one area of expertise listed on page 45 of the discussion document could be found in a single member.

The Council considers that the two areas of expertise listed as 'desirable, but non-essential' i.e. business competitiveness and knowledge of the public and private innovation and technology development system, could well be considered essential areas of expertise. New Zealand is fundamentally a trading nation and located in the South Pacific, has high costs associated with reaching its international markets. Knowledge of business competitiveness will be a useful addition to the expertise of the Commission when advising the Government on the NZ ETS and emissions budgets etc.

Innovation and technology development was highlighted by the Productivity Commission in its *Low-emission economy* draft report as being fundamental to achieving its overall emission targets. Again, the Council considers that this area could well be considered to be essential expertise on the Commission.

In relation to the business competitiveness area of expertise referred to above, the Council suggests that this area of expertise be amended as follows:

- *Business competitiveness, <u>including knowledge, expertise or experience in international trade</u>* (added words underlined).

As previously indicated, New Zealand is a trading nation so skills in business competitiveness and international trade would be a useful addition to the Commission's expertise.

The Council considers that knowledge of or expertise in regional impacts of national policy would also be an important area of expertise for the Commission. Perhaps the second bullet point on page 45 of the discussion document could be expanded to read:

- *Resource economics and impacts (including social impacts, labour markets and distribution <u>and regional impacts</u>)* (added words underlined).

Adapting to the impacts of climate change

14. *Do you think the Zero Carbon Bill should cover adapting to climate change?*

Pick one:

- ✓ *Yes*
- *No*

Optional comment

The Council was represented at the workshop in Wellington on 4 May 2018, organised by the Deep South Challenge, and headed up *'Climate adaptation ambassadors workshop: Steering research through to policy and action'*. One of the main conclusions to come out of the workshop was that there was a need for national guidance in the form of a national adaptation strategy or plan to integrate and coordinate efforts towards a common goal on adapting to the effects of climate change.

The Council considers that a national adaptation plan is essential and that it would be appropriate if this formed part of the Zero Carbon Bill. Mitigation and adaptation are part of the same climate change challenge for New Zealand and it makes sense for both to be addressed in an integrated and comprehensive way in legislation.

15. *The Government has proposed a number of new functions to help us adapt to climate change. Do you agree with the proposed functions?*

Pick one:

- ✓ *Yes*
- *No*

Optional comment

The Council agrees with the proposed functions which include a national climate change risk assessment, a national adaptation plan, regular review of progress towards implementing the national adaptation plan and an adaptation reporting power.

These functions should also be included in legislation. This will help ensure that risks from climate change and long-term planning to deal with those risks are well aligned and regularly updated which will in turn, create a more stable policy environment.

16. *Should we explore setting up a targeted adaptation reporting power that could see some organisations share information on their exposure to climate change risks?*

Pick one:

- ✓ *Yes*
- *No*

Optional comment

The Council supports in principle the need for a specific adaptation reporting power. If this was a mandatory requirement it would provide a clearer picture of what action was being undertaken across New Zealand to mitigate the effects of climate change, and what gaps thereby remain to be addressed, including the ability to identify critical vulnerabilities.

If it was decided to introduce an adaptation reporting power, local government should be included as one of the reporting parties. However, further discussions would be required as to what such reporting would cover, the timeframes for reporting and cost sharing arrangements.

Conclusions

The Taranaki Regional Council again thanks the Ministry for the Environment for the opportunity to comment on proposals for a Zero Carbon Bill.

To be effective, a Zero Carbon Bill will need widespread political support and buy-in from across New Zealand and all sectors of the economy. Without that support and buy-in we will not achieve progress on climate change.

Achieving our targets on climate change will also require clear long-term goals to be established and a carefully phased in, gradual process of transition to achieving them. This will require action outside of the Zero Carbon Bill in areas of operational, policy and institutional supports to ensure an integrated and coordinated approach to climate change in New Zealand.

Yours faithfully

B G Chamberlain
Chief Executive

Agenda Memorandum

Date 17 July 2018

Memorandum to
Chairperson and Members
Policy and Planning Committee

Subject: **Mana Whakahono a Rohe (Iwi relationship agreements) MFE guidance and update on relationship discussions**

Approved by: A D McLay, Director – Resource Management

B G Chamberlain, Chief Executive

Document: 2039206

Purpose

The purpose of this memorandum is introduce a recent report by Ministry for the Environment (MFE) and Pou Taiao- Iwi leaders group on the development of Mana Whakahono a Rohe (iwi relationship agreements) under the Resource Management Act (RMA) and update Members about work undertaken to date on developing such agreements.

A link to the MFE website and full report is attached for Members' reference - http://www.mfe.govt.nz/rma/manawhakahono.

This item has also been presented to the Consents and Regulatory Committee given it addresses policy and consents matters.

Executive summary

- The *Resource Management Act 1991* (RMA) was amended in 2017 to provide for Mana Whakahono a Rohe (Iwi relationships) agreements between local authorities and iwi/hapu. As a result these are limited to RMA operational matters and not Local Government Act or other statutory matters ;
- The intent of the legislation is to enhance and formalise Māori participation in RMA resource management and decision making processes;
- A Guide to developing such agreements has recently been prepared by MFE and Pou Taiao- Iwi leaders group and provides some useful guidance the Council is following;
- The Council and other council's in the region have met with iwi representatives and Ministry for the Environment officials to discuss and explore options for pan iwi/council approaches to Mana Whakahono a Rohe agreements;
- The Taranaki iwi chairs forum is also engaging with the Mayoral Forum on possible pan council/iwi approaches;

- Initial discussions to date with two, of the eight iwi of Taranaki, have been reasonably positive and constructive in terms of identifying issues and seeking possible solutions.

Recommendations

That the Taranaki Regional Council:

1. receives the memorandum on the Mana Whakahono a Rohe (Iwi relationships) Guide;
2. notes the Guide and the MFE workshop provided some useful material to assist the Council and Iwi in the development of a successful relationship agreement;
3. notes the Council along with the other councils, within the region and beyond, have begun informal discussions with Te Kaahui o Rauru representatives and also with Te Korowai o Ngāruahine Trust representatives on developing a Mana Whakahono a Rohe agreement;
4. notes the discussions with the two iwi have been reasonably positive and constructive in terms of identifying issues that can be addressed and seeking possible solutions for these issues; and
5. notes the Taranaki iwi chairs forum is also engaging with the Mayoral Forum on possible pan council/iwi approaches.

Background

The report notes while the RMA has had some successes in tangata whenua participation, other times there has been disappointment and frustration at their inability to meaningfully engage in RMA processes and have influence over how resources are managed.

Setting clear performance expectations through a Mana Whakahono a Rohe (Mana Whakahono) for both tangata whenua and local authorities will help resolve these frustrations and common complaints such as, local authorities failing to consult adequately or a lack of responsiveness from tangata whenua.

A Mana Whakahono is a binding statutory arrangement that provides for a more structured relationship under the RMA between iwi authorities, hapu and a local authority.

The intent of Mana Whakahono is to improve working relationships between tangata whenua (through their iwi authority or hapu) and local authorities, to enhance Maori participation in RMA resource management and decision making processes.

Legal Requirement

The RMA, Section 58M: sets out the purpose of a Mana Whakahono a Rohe. It states:

Section 58M: Purpose of Mana Whakahono a Rohe

The purpose of a Mana Whakahono a Rohe is-

(a) to provide a mechanism for iwi authorities and local authorities to discuss, agree and record ways in which tangata whenua may, through their iwi authorities participate in resource management and decision making processes under the RMA; and

(b) to assist local authorities to comply with their statutory duties under the RMA, including through the implementation of sections 6(e), 7(a), and 8:

In relation to sections 6(e), 7(a) and 8, the following apply:

- Section 6(e) declares the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, wāhi tapu, and other taonga as a matter of national importance and requires all persons exercising functions and powers under the RMA to recognise and provide for it, as a matter of national importance.
- Section 7(a) requires all persons exercising functions and powers under the RMA when managing the use, development, and protection of natural and physical resources to have particular regard to kaitiakitanga.
- Section 8 imported the principles of the Treaty of Waitangi and provides that in achieving the purpose of the RMA, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).

In making plan and consent decisions the Council must consider all the matters in Part II (sections 6-8) of the RMA according to the statutory direction given in each of the sections. Under section 6(e) the Council must recognise and provide for the matters listed as a matter of national importance while under section 7(a) the Council is required to have particular regard to kaitiakitanga. Under section 8 the Council is required to take into account the principles of the Treaty of Waitangi. Within each section, all matters are treated equally according to the circumstances or facts of each particular case or decision and no one matter is more significant than another.

In terms of a Mana Whakahono a Rohe the RMA provides for a Mana Whakahono a Rohe to be entered into between:

- an iwi authority and a local authority / local authorities;
- a combination of iwi authorities and a local authority / local authorities;
- a combination of an iwi authority / iwi authorities and hapu, and a local authority or local authorities;
- a hapu and a local authority (if initiated by the local authority);
- a combination of hapu and local authorities (if initiated by the local authorities).

Under the RMA an iwi authority (authorities jointly) may initiate a Mana Whakahono a Rohe with a local authority or authorities any time except 90 days before a local body election, and the local authority or authorities must respond to the invitation from an iwi authority or authorities and convene a hui within 60 days of receiving the invitation. A local authority may also initiate a Mana Whakahono a Rohe with an iwi authority or with hapu. Collectively the parties must conclude a Mana Whakahono a Rohe within 18 months unless otherwise agreed. The key focus is around iwi input to operational matters with plans and resource consents.

Work to date

The Council and Horizons Regional Council, Wanganui District Council, South Taranaki District Council have met with Te Kaahui o Rauru representatives and agreed to work together on an agreement to formalise and enhance current relationships and set clear performance expectations on RMA processes and decision making. Discussions have been underway since mid-March.

The Council with the South Taranaki District Council, Stratford District and New Plymouth District Council have also met with representatives from Te Korowai o Ngāruahine Trust for preliminary discussions towards achieving a similar agreement. Discussions started in June 2018.

Discussions with the two iwi have been reasonably positive and constructive in terms of identifying issues that can be addressed and seeking possible solutions for these issues.

Council staff recently attended a regional forum meeting with iwi representatives and officials from the Ministry for the Environment and other Government Agencies where we were provided with a presentation on the development of the Mana Whakahono provisions by Tina Porou from the Pou Taiao iwi leaders group and a presentation from the Independent Maori Statutory Board advisors to the Auckland Council, on iwi involvement in the RMA in Auckland City. Both were useful and it was stressed informal discussions should be held before formally initiating a Mana Whakahono a Rohe agreement. This approach is being applied by the two iwi in their discussions with the Councils.

The Taranaki iwi chairs forum and the Mayoral Forum have met recently to discuss possible pan council/iwi approaches.

Hence progress is being made and closer understandings and relationships are being developed. A key matter arising has been the scope of matters that can be addressed in a relationship agreement. The matters are limited to RMA operational matters and not Local Government Act or other statutory matters.

There should be benefits to the Council, iwi and consent applicants (resource users) if efficient and effective processes and systems can be developed that avoid duplication and increase certainty for all concerned.

Decision-making considerations

Part 6 (Planning, decision-making, and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the *Act*.

Financial considerations—LTP/Annual Plan

This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

See above.

Legal considerations

This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Agenda Memorandum

Date 17 July 2018

Memorandum to
Chairperson and Members
Policy and Planning Committee

Subject: Key Native Ecosystems programme mid-year update 2018

Approved by: S R Hall, Director - Operations

B G Chamberlain, Chief Executive

Document: 2056625

Purpose

The purpose of this memorandum is to present for Members' information an update on the identification of thirteen new Key Native Ecosystem (KNE) sites.

Executive summary

- The Council's *Biodiversity Strategy for the Taranaki Regional Council* ('the Biodiversity Strategy') sets out four strategic priorities, one of which relates to the Council focusing on protecting KNEs on privately owned land.
- KNEs refer to terrestrial (land) areas identified by the Taranaki Regional Council as having regionally significant ecological values and that are targeted for protection.
- The Council's protection of KNEs is ongoing. Officers work with interested landowners, including iwi, and community groups to promote the voluntary protection and enhancement of ecological values associated with the sites.
- All landowners can seek an assessment of their particular site for potential involvement in the KNE programme. When these opportunities arise, new sites are assessed in relation to their regional significance, and/or existing information and databases updated.
- Protection of KNEs is part of the Council's **non-regulatory** work. Protection is implemented through the preparation and implementation of biodiversity plans, the provision of environmental enhancement grant funding, and/or assisting with pest and weed control.
- Council officers have recently investigated a further thirteen sites as noted in this memorandum and recommend they be adopted as a KNE. All the sites have been assessed as significant in accordance with criteria set out in the *Regional Policy Statement for Taranaki* (2010), i.e. rarity and distinctiveness, representativeness or ecological context.

- The ongoing identification and assessment of sites with potentially regionally significant indigenous biodiversity values has resulted in 25 new sites being identified as KNEs in the 2017/2018 financial year.
- As at 17 July 2018, the Council has identified 265 KNEs (covering approximately 122,489 hectares), which includes conservation land. Of the 289,000 hectares of indigenous vegetation in the region, approximately 64,000 hectares is in private ownership. A total of 212 of the KNE sites (covering approximately 12,575 hectares), are partially or completely privately owned, representing almost 20% of the targeted vegetation. KNE sites target the most vulnerable and at risk types of indigenous vegetation and do not cover all indigenous vegetation types. The thirteen sites referred to in this memorandum comprise 455 ha.

Recommendations

That the Taranaki Regional Council:

1. receives this memorandum and the attached inventory sheets for Chris Jury Forest & Wetlands; Pirinoa; Hall's Bush; Lowe East Block; Lowe North Block; Sextus Family Reserve; Swanepoel KNE; Donald QEII; The Totaras; Todd Energy – Tikorangi Road East Farm; Peter and Margaret Atkinson; David and Raewyn Lusk and Paritutu / Centennial Park.
2. notes that the aforementioned sites have indigenous biodiversity values of regional significance and should be identified as Key Native Ecosystems.

Background

To assist it in giving effect to its statutory functions for indigenous biodiversity under the Resource Management Act 1991, the Council has recently reviewed and adopted the *Biodiversity Strategy for the Taranaki Regional Council* ('the Biodiversity Strategy'). The Biodiversity Strategy sets out four strategic priorities, one of which relates to the Council focusing on protecting KNEs on privately owned land.

The Council's management approach is to work with interested landowners and community groups, through provision of a property planning service and other assistance, in order to promote the voluntary protection and enhancement of ecological values associated with these sites. The identification of KNEs is ongoing. All landowners can seek an assessment of their particular site for potential involvement in the KNE programme. When these opportunities arise, new sites are assessed in relation to their regional significance, and/or existing information and databases updated.

Council officers have recently investigated thirteen sites and recommend they be adopted as a KNE. The candidate sites are: Chris Jury Forest & Wetlands; Pirinoa; Hall's Bush; Lowe East Block; Lowe North Block; Sextus Family Reserve; Swanepoel KNE; Donald QEII; The Totaras; Todd Energy – Tikorangi Road East Farm; Peter and Margaret Atkinson; David and Raewyn Lusk and Paritutu / Centennial Park. All these sites have been assessed as significant in accordance with criteria set out in the *Regional Policy Statement for Taranaki* (2010), i.e. rarity and distinctiveness, representativeness or ecological context. Copies of the inventory sheets for the new sites are **attached** to this item.

KNE site inventory process

As at 17 July 2018, the Council has identified 265 KNEs (covering approximately 122,489 hectares), which includes conservation land. Of the 289,000 hectares of indigenous vegetation in the region, approximately 64,000 hectares is in private ownership. A total of 212 of the KNE sites (covering approximately 12,575 hectares), are partially or completely privately owned, representing almost 20% of the targeted vegetation. KNE sites target the most vulnerable and at risk types of indigenous vegetation and do not cover all indigenous vegetation types. The twelve sites referred to in this memorandum comprise 455 ha.

Identification of a site as a KNE does not have any extra bearing on the rules or controls that already apply to such sites in regional or district council plans. Identification of sites is undertaken by the Council to focus its **non-regulatory** efforts to work with and support landowners to protect biodiversity values on their land. Protection is implemented through the preparation and implementation of biodiversity plans, the provision of environmental enhancement grant funding, and/or assisting land occupiers and/or care groups with pest and weed control.

The *2018–2028 Long Term Plan* includes, amongst other things, a target to maintain and regularly update the Council's Inventory of KNEs. Council officers have recently investigated and consulted with landowners to identify another thirteen sites as KNEs. These new sites mean that 25 KNE sites have been identified and assessed as regionally significant in the 2017/2018 year.

Decision-making considerations

Part 6 (Planning, decision-making, and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the Act.

Financial considerations—LTP/Annual Plan

This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991,* the *Local Government Official Information and Meetings Act 1987*, and the *Biosecurity Act 1993*.

Iwi considerations

This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Legal considerations

This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Appendices/Attachments

Document No. 2032156; 2032143; 2044467; 2049109; 2053111; 2052730; 2052718; 2044800; 2057792; 2049017; 2057652; 2057661; 2060307

Paritutu Centennial Park

At a glance

TRC Reference: BD/9624

Ecological District: Egmont

Land Tenure: District

Area(ha): 14.8

GPS: 1688530X & 5676028Y

Habitat: Coastal/Forest Remnant

Bioclimatic Zone: Coastal

Ecosystem Type: CL6: Hebe, whararikí flaxland/ rockland

WF13: Tawa, kohekohe, rewarewa, hinau, podocarp forest

WF5: Tōtara, kānuka, broadleaved forest[Dune forest]

LENZ: D2.1b Chronically threatened

National: Priority 1 – Threatened Land Environment

Priority 4 – Threatened Species

Priority 2 – Sand Dunes and Wetlands

Regional: Representative ecosystem type

Potential KNE

Regional Ecosystem Loss: Acutely Threatened <10% left

At risk 20-30% left

Protection Status: Local Government

Catchment: Herekawe (388)

General Description

Paritutu Centennial Park runs from Paritutu rock in the north to the Herekawe stream in the south. Paritutu is the tallest part of the rim of an old volcano and has been damaged in the past by attempts to quarry rock for the construction of the nearby port. Vegetation at the site is a mix of remnant coastal forest and scrub which has been heavily modified in the past. Re-vegetation plantings have been carried out and have introduced some non-local native species which have naturalised in the area including puka (*Meryta sinclairii*) and coastal mahoe (*Melicytus novae-zelandiae*). A distinct form of *Corokia cotoneaster* is found on the slopes of Paritutu and is known as "Paritutu korokio". Goldstripe gecko are found at the site and individuals from other areas have been released near the base of Paritutu in the past. The area provides important connectivity to the Nga Motu / Sugar Loaf Islands which are home to threatened plants, NZ fur seal and significant seabird colonies.

Ecological Features

Flora

Vegetation at the site is a mix of remnant coastal forest and scrub which has been heavily modified in the past. The main canopy of the coastal forest is now dominated by non-local native coastal tree species karo, pohutakawa and puka (*Meryta sinclairii*). A distinct form of Corokia cotoneaster is found on the slopes of Paritutu and is known as "Paritutu korokio". The original ecosystem types are assumed to be a mix of hebe/whararikí scrub, tawa, kohekohe forest and totara, kanuka, dune forest.

Fauna

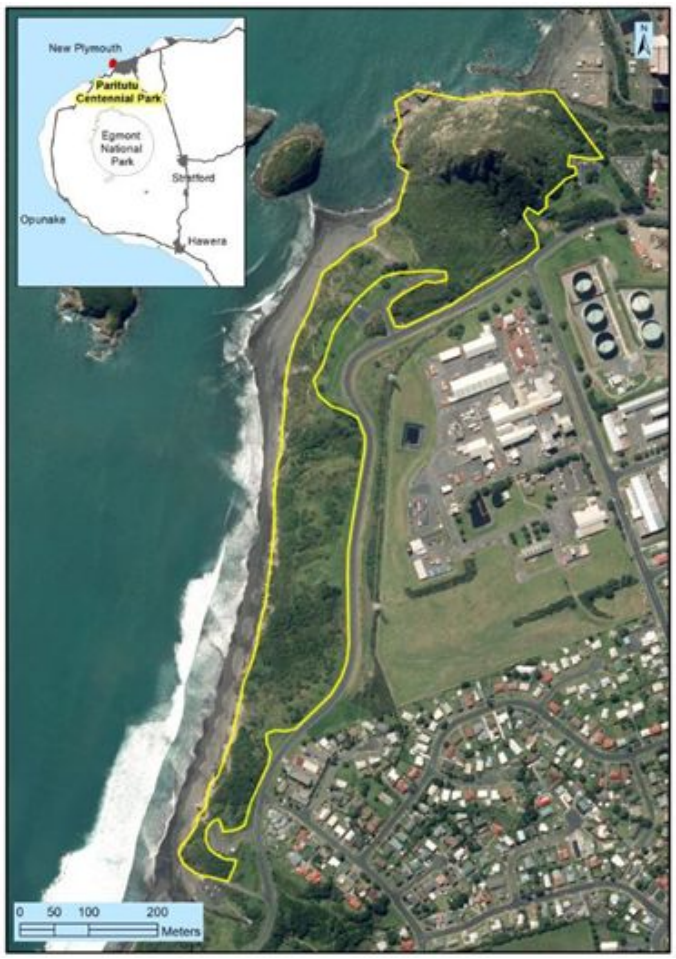
Birds present are typical of the outskirts of urban New Plymouth with a large proportion of exotic species. There are a range of seabirds that nest on the nearby Nga Motu / Sugar Loaf Islands including red billed gulls, diving petrels, grey faced petrels and fluttering shearwaters. It is likely that these species will be prospecting for nearby breeding grounds on the mainland and with sufficient predator control new seabird colonies could establish at this site. Little penguin and New Zealand fur seal currently already use the area. Goldstripe gecko are present at the site and individuals from other areas have been released here in the past. Copper skinks are also present.

Ecological Values

Rarity and Distinctiveness - Medium	Contains core habitat for the 'at risk' little penguin and the 'at risk' goldstripe gecko. The site also has a significant population of a distinct form of Corokia cotoneaster known as 'Paritutu korokio'.
Ecological context - High	Provides additional habitat and significant connectivity with the Nga Motu / Sugar Loaf Islands and other Key Native Ecosystems in this area such as Tank Farm Ponds, Barrett Lake Scenic Reserve and Omata Bush KNEs.
Representativeness - High	Contains indigenous vegetation on land classified as a Chronically Threatened (D2.1b) LENZ environment. Also contains an area that has been identified as a priority representative area for management in Taranaki (Top 30% Representative Ecosystem sites).
Sustainability - Positive	Key ecological processes still influence the site and with appropriate management, it can remain resilient to existing or potential threats.

Other Management Issues

Predators - High	Possums, cats, mustelids, hedgehogs and rodents
Weeds - High	Boneseed, Pampas, gorse, boxthorn, wilding pines, agapanthus, woolly nightshade and kahili ginger.
Habitat Modification - Low	The site is protected as a NPDC reserve, Vulnerable to erosion from the sea.



The Totaras

At a glance

TRC Reference: BD/9613
Ecological District: Matemateaonga
Land Tenure: Private
Area(ha): 401
GPS: 1724236X & 5632198Y

Habitat: Forest Remnant
Bioclimatic Zone: Lowland
Ecosystem Type: MF7.3: Tawa, pukatea, podocarp forest

LENZ: F1.1b Not threatened
National: Priority 4 – Threatened Species
Regional: Potential KNE
Close proximity to a representative ecosystem site
Regional Ecosystem Loss: At risk 20-30% left
Catchment: Tangahoe (348)

General Description

The Totaras KNE is located approximately 12 km east of Eltham and lies in the Tangahoe stream catchment and Matemateaonga Ecological District. The Totaras area is of large size (401ha) and is mainly made up of regenerating native forest species with a dominant canopy of tree ferns and low stature natives with emerging larger trees becoming more evident. The Totaras site is less than 500 meters from the iconic Lake Rotokare Scenic Reserve fenced sanctuary and provides spill over habitat from the sanctuary and good connectivity to other indigenous habitats in this area.

Ecological Features

Flora

The vegetation of the site is regenerating native bush with a canopy dominated by tree ferns, mahoe, rangiora, lancewood and manuka. In some areas a more mature canopy is establishing and is comprised of tawa, rewarewa, miro, kamahi, totara and rimu. In the wetter areas kahikatea and pukatea are more common. The regenerating canopy has a high proportion of native vines climbing over it with NZ passionfruit, NZ jasmine, bush lawyer and supplejack. The understory is comprised of a range of ferns and shrub species including kanono and coprosma rhamnoides.

Fauna

The site has a wide range of native birds which is very likely being bolstered by the overflow of birds spilling out over the fence from the Rotokare Scenic Reserve. North island brown kiwi are present in low numbers. NZ falcon have been recorded from the site along with North island robin, tui, bellbird, tomtit, kereru, grey warbler, silvereye and fantail. Good habitat exists for native reptiles including epiphytes, loose bark, abundant foliage, leaf litter and forest ground cover. The 'at risk' goldstripe gecko has been recorded at the nearby Rotokare Scenic Reserve and is likely present at this site also. Long tailed bats have been recorded at the site. The site will contain a diverse range of invertebrates which may include notable species such as peripatus. The site contains a number of tributaries to the Makino stream in the Tangahoe river catchment which will likely contain banded kokopu and longfin eels.

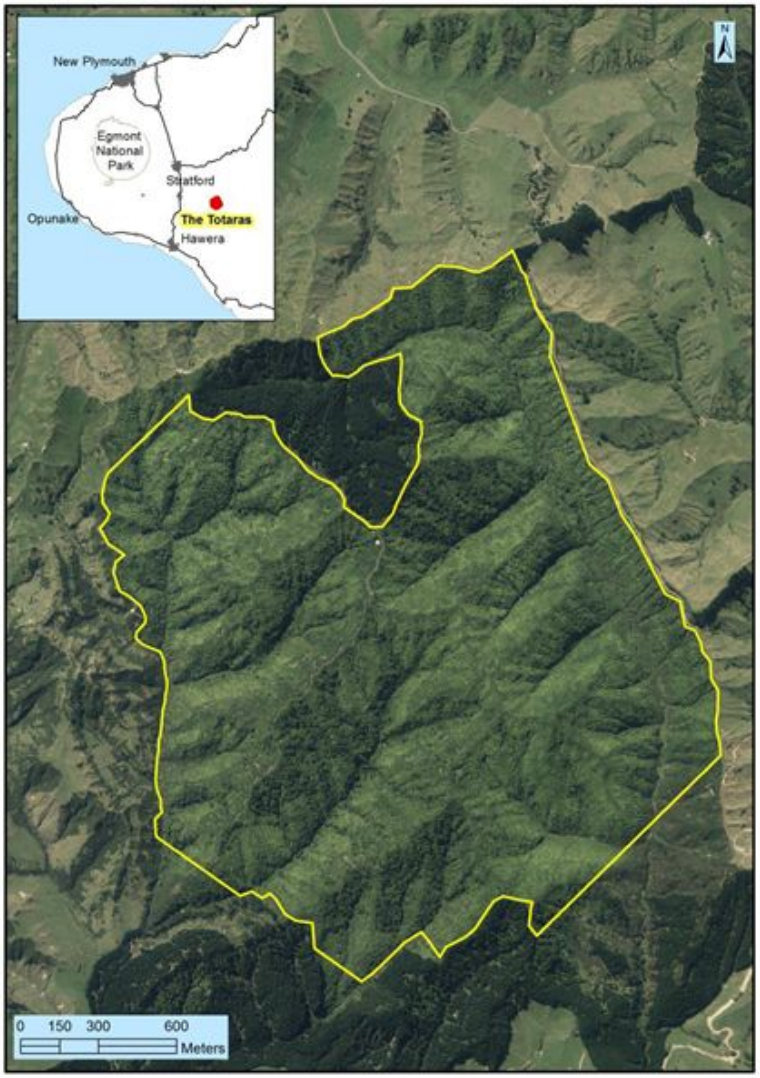
Ecological Values

Ecological context - High	Provides good connectivity and size to ecological restoration projects in this area.
Rarity and Distinctiveness - High	Contains and provides core habitat for the 'Threatened' North Island brown kiwi, New Zealand falcon and long-tailed bat. Provides additional core habitat for spill over of other notable species from the Lake Rotokare predator fenced reserve.

Representativeness - Medium	Contains indigenous vegetation in an area classed as 'Not Threatened' (F1.1b). The site is close to an area that has been identified as a priority representative area for management in Taranaki (Top 30% Representative Ecosystem type). The vegetation in the Totatras block is regenerating well and over time will revert to mature native forest once typical in that area.

Other Management Issues

Weeds - Low	The site has few problem pest plants. Gorse and pampas are a problem encroaching onto access tracks.
Predators - High	Predators including rodents, mustelids, possums, feral cats and hedgehogs will be having an impact on native species at the site. Pest animal control at the site is coordinated by the South Taranaki branch of Forest and Bird. Current control is targeting mustelids, rats, feral cats and possums.
Habitat Modification - Low	The landowners are looking to legally protect the site by registering a QEII trust covenant on the site.



David & Raewyn Lusk

At a glance

TRC Reference: BD/9603

Ecological District: Egmont

Land Tenure: Private

Area(ha): 1

GPS: 1692480X & 5670785Y

Habitat: Forest Remnant

Bioclimatic Zone: Semi-Coastal

Ecosystem Type: WF13: Tawa, kohekohe, rewarewa, hinau, podocarp forest

LENZ:	F5.2a Acutely threatened
National:	Priority 1 – Threatened Land Environment
Regional:	Potential KNE
Regional Ecosystem Loss:	Chronically threatened 10-20% left
Protection Status:	QEII Covenant
Catchment:	Huatoki (389)

General Description

The site is located on the south west fringe of New Plymouth in the Egmont Ecological District and Huatoki Stream catchment. The site is comprised of an east facing slope 1 ha in size. The edges of the remnant are regenerating native forest and tree ferns. The main slope is mainly a remnant of cutover old forest with a good canopy cover and undergrowth. The site provides good connectivity to other Key Native Ecosystems in the area including the Huatoki Scenic Reserve, McQuoid QII, McGlashan Bush and the Ratapihipihi Scenic Reserve.

Ecological Features

Flora

The main canopy of the old forest area is dominated by puriri, pukatea, tawa, rimu and rewarewa. The lower canopy is dominated by mahoe, pigeonwood and tree ferns. A good mix of seedlings and saplings are present including kawakawa, mapou, pigeonwood and coprosmas. A variety of native ferns dominate the groundcover including the notable Deparia petersenii subsp. congrua which is listed as 'Regionally Distinctive'. The area is classified as an 'Acutely Threatened' land environment (F5.2b). Native vegetation in these areas is rare and important for species threatened by habitat loss.

Fauna

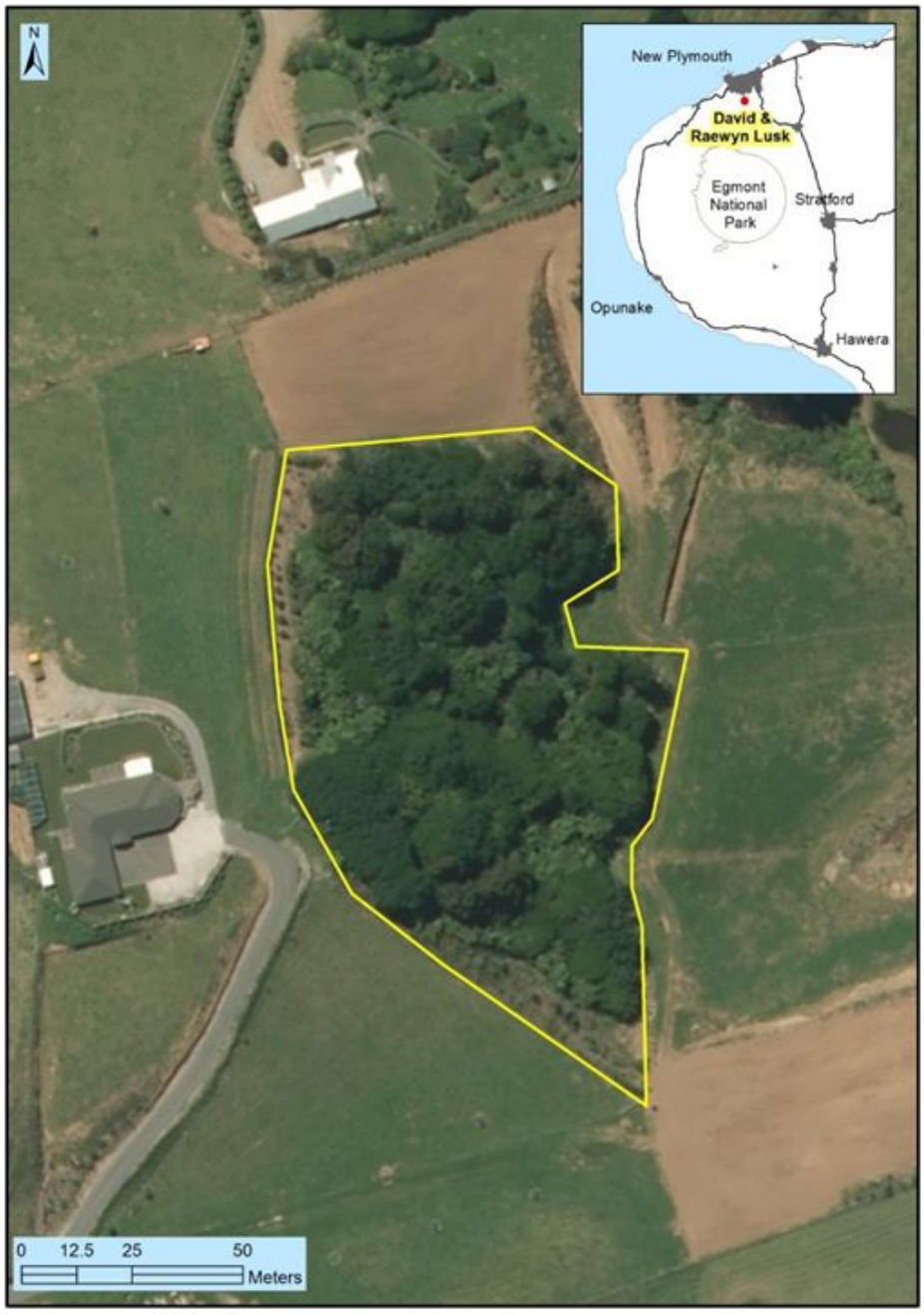
The site provides a small forest habitat for native birds such as tui, kereru, fantail, grey warbler, shining cuckoo and morepork. Good habitat exists for native reptiles and invertebrates which will include notable species.

Ecological Values

Sustainability - Positive	In good vegetative condition. Key ecological processes still influence the site. Under appropriate management, it can remain resilient to existing or potential threats.
Ecological context - High	The site provides good connectivity to other Key Native Ecosystems in the area including the Huatoki Scenic Reserve, McQuoid QII, Omata Bush, McGlashan Bush and the Ratapihipihi Scenic Reserve.
Representativeness - High	Contains indigenous vegetation on 'Acutely Threatened' (F5.2a) LENZ land environment.
Rarity and Distinctiveness - Medium	Contains the 'Regionally Distinctive' fern Deparia petersenii subsp. congrua.

Other Management Issues

Weeds - Medium	Woolly nightshade is the main pest plant issue at the site. There is also a small patch of tradescantia.
Predators - Medium	Rodents, mustelids, possums, cats and hedgehogs will be impacting on fauna values at the site.
Habitat Modification - Low	The site is in the process of being legally protected with a QEII covenant.
Herbivores - Medium	Fence upgrades on the northern side of the site are needed to ensure that stock are excluded from the site.



Peter and Margaret Atkinson

At a glance

TRC Reference: BD/9610

Ecological District: Egmont

Land Tenure: Private

Area(ha): 1.9

GPS: 1690360X & 5670012Y

Habitat: Forest Remnant

Bioclimatic Zone: Semi-Coastal

Ecosystem Type: WF13: Tawa, kohekohe, rewarewa, hinau, podocarp forest

LENZ: F5.2b Acutely threatened

National: Priority 1 – Threatened Land Environment

Regional: Potential KNE

Regional Ecosystem Loss: Chronically threatened 10-20% left

Catchment: Huatoki (389)

General Description

The site is a 1.9ha remnant of semi-coastal forest with a canopy dominated by tawa, rewarewa, rimu and pukatea. The ecosystem type is classified as WF13, tawa, kohekohe, rewarewa, hinau, podocarp forest. The remnant is part of a larger area of indigenous and exotic forest that is contiguous with the Ratapihipihi scenic reserve. The remnant is an example of cutover old forest with a reasonable canopy cover and regenerating undergrowth. The site borders the Upper Mangaotuku KNE and provides good connectivity to other Key Native Ecosystems in the area including Berridge twin bush, Omata Bush, Barrett Lake Scenic Reserve and the Ratapihipihi Scenic Reserve.

Ecological Features

Flora

The main canopy of the remnant is dominated by pukatea, tawa, rimu and rewarewa. The lower canopy is dominated by mahoe, pigeonwood, tree ferns and young nikau. A good mix of seedlings and saplings are present including kawakawa, mapou, pigeonwood and coprosmas. A variety of native ferns are also present in the groundcover. The area is classified as an 'Acutely Threatened' land environment (F5.2b). The ecosystem type is classified as WF13, Tawa, kohekohe, rewarewa, hinau, podocarp forest.

Fauna

Bird life in the remnant is fairly typical for the margin of the New Plymouth urban area. Tui are common and other native birds are present such as kereru, fantail, and grey warbler. Good habitat exists for native reptiles including epiphytes, loose bark, abundant foliage, leaf litter and forest ground cover. A small stream runs through the remnant and there is habitat for native fish. The site will contain a diverse range of invertebrates which may include notable species such as peripatus.

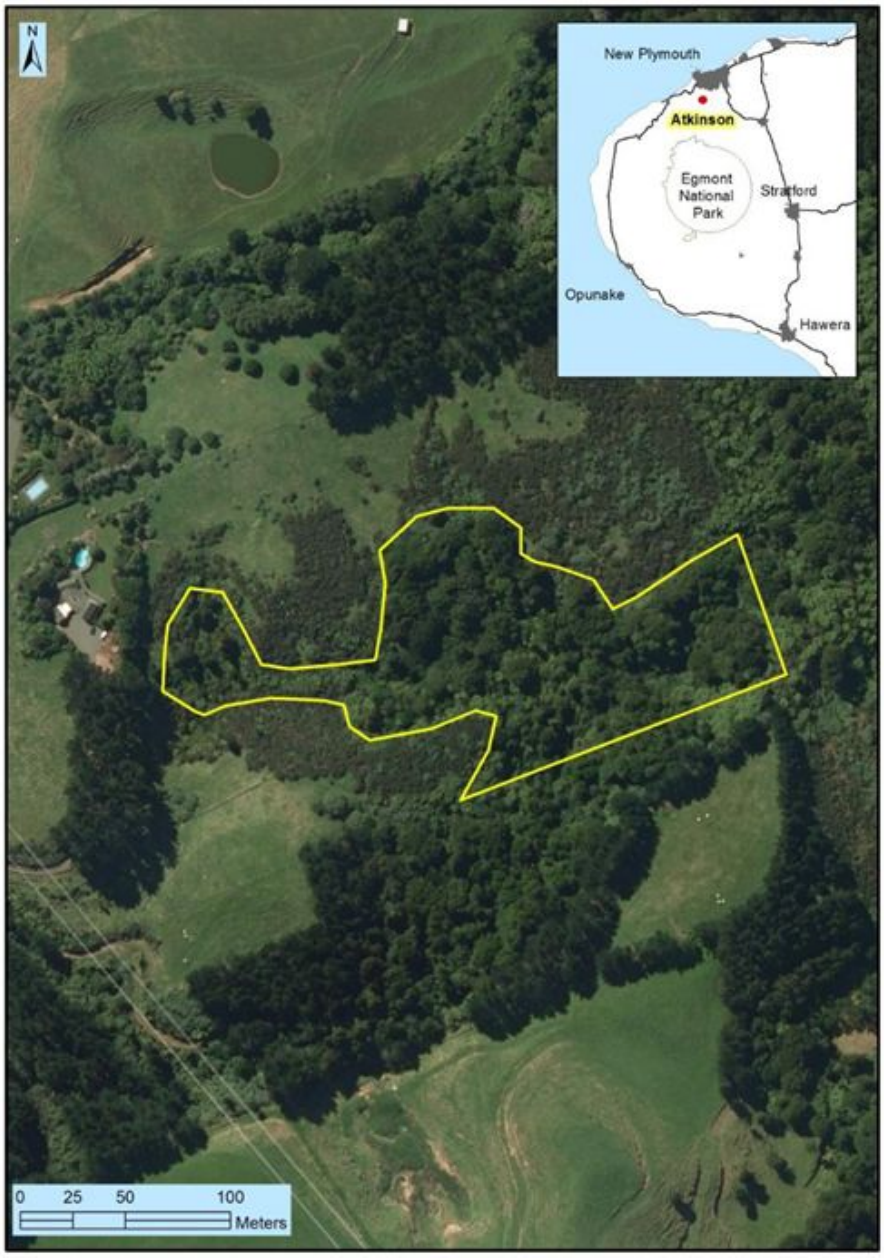
Ecological Values

Representativeness - High	The ecosystem type is WF13, Tawa, kohekohe, rewarewa, hinau, podocarp forest which is classified as 'Chronically Threatened'. Over 80% of this type of forest has been lost in the Taranaki region.
Rarity and Distinctiveness - Medium	The 'at risk' king fern is present at the site. The Mangaotuku steam also provides habitat for the 'regionally distinctive' banded kokopu.
Ecological context - High	The site provides important connectivity with other KNE's in the area and is part of the largest block of tall stature vegetation on the western outskirts of New Plymouth. The site is directly adjacent to the Upper Mangaotuku KNE.

Sustainability - Positive	Key ecological processes still influence the site and with appropriate management, it can remain resilient to existing or potential threats.

Other Management Issues

Weeds - High	There are very few weed issues in the more mature areas of the remnant. There are challenging weeds present in the regenerating areas. Weeds include woolly nightshade, brush wattle and gorse.
Predators - High	Possums, cats, mustelids, hedgehogs and rats.
Habitat Modification - Low	The landowner is working with the QEII trust to establish a covenant on the site.



Sextus Family Reserve 5/06/376

At a glance

TRC Reference: BD/9580
Ecological District: Egmont
Land Tenure: Private
Area(ha): 2.2
GPS: 1717553X & 5642891Y

Habitat: Forest Remnant/Wetland
Bioclimatic Zone: Lowland
Ecosystem Type: MF7.3: Tawa, pukatea, podocarp forest

LENZ:	F7.2a At risk
National:	Priority 2 – Sand Dunes and Wetlands
Regional:	Potential KNE
	Close proximity to a representative ecosystem site
Regional Ecosystem Loss:	At risk 20-30% left
Protection Status:	QEII Covenant
Catchment:	Patea (343)

General Description

The Sextus Family Reserve forest remnant is privately owned land and is located approximately 7kms east of Stratford in central Taranaki. The 2ha forest remnant lies in the Egmont Ecological District and Patea River catchment. The forest is situated on a river terrace and old oxbow on the side of the Patea river with steep slopes leading up to flat dairy paddocks. The forest canopy is dominated by kahikatea with mahoe, totara and pigeonwood present. The forest is located 500m from and on the same property as Toko wetland KNE, providing habitat and connectivity for native biodiversity.

Ecological Features

Flora

The old forest area of the forest canopy is dominated by kahikatea. The understory is recovering and includes kawakawa, kanono, pigeonwood, mahoe, totara and tree ferns. Native ferns are well established and dominate the ground cover. Rank grass dominates the groundcover in the open areas on the stream boundary where natives including lemonwood have been planted.

Fauna

A moderate number of native birds were observed including kereru, grey warbler, silver eye, kingfisher and fantail. Good habitat exists for mudfish and the site is connected by waterways to known mudfish locations. Good habitat exists for native reptiles including dense vegetation, epiphytes, loose bark, leaf litter, logs and ground cover. A cave weta was found under a rotting log and the habitat will contain a diverse range of terrestrial invertebrates.

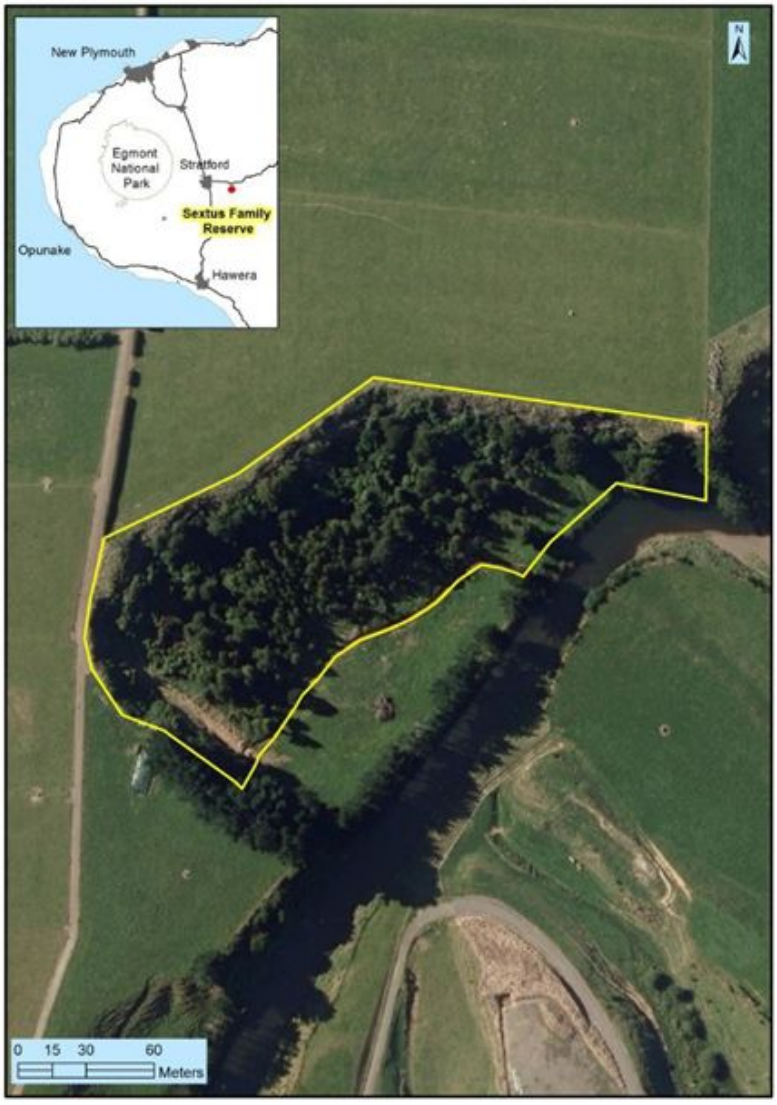
Ecological Values

Ecological context - High	The bush remnant provides important connectivity in a highly fragmented landscape to nearby priority biodiversity sites (500m south east from the Toko Wetland KNE and within a 4kms radius of 3 other QEII sites).
Rarity and Distinctiveness - Medium	Contains good habitat for notable priority species such as the Regionally Distinctive swamp maire and native reptiles and invertebrates.
Representativeness - Medium	Contains vegetation on 'At Risk' LENZ environment (F7.2a) and is a remnant of a regionally At Risk ecosystem type (MF7.3 Tawa, kahikatea, podocarp forest).

Sustainability - Positive	In relatively good vegetative condition. Key ecological processes still influence the site. Under appropriate management it can remain resilient to existing or potential threats.

Other Management Issues

Habitat Modification - Medium	Drains on south and eastern boundaries
Herbivores - Medium	Stock fencing in place. There is a history of occasional goat and deer grazing in the remnant as they move along the river boundary.
Possum Self-help	The forest remnant is within the self help possum control area and receives control in the form of phil proof bait stations serviced with brodifacoum.
Predators - Medium	Predators including rodents, mustelids, possums, feral cats and hedgehogs will be having an impact on native species at the site.
Weeds - High	Large coverage of old mans beard in parts of the canopy and expanding. Tradescantia is present on the forest floor in some places.



SWANEPOEL KNE

At a glance

TRC Reference: BD/9622

Ecological District: Egmont

Land Tenure: Private

Area(ha): 2.45

GPS: 1704796X & 5679337Y

Habitat: Forest Remnant

Bioclimatic Zone: Semi-Coastal

Ecosystem Type: WF13: Tawa, kohekohe, rewarewa, hinau, podocarp forest

LENZ:	F5.2b Acutely threatened
National:	Priority 1 – Threatened Land Environment
Regional:	Potential KNE
Regional Ecosystem Loss:	Chronically threatened 10-20% left
Catchment:	Waiongana (394)

General Description

The Swanepoel forest remnant is privately owned land and is located near Waitara approximately 4kms east of Bell Bock in north Taranaki. The 2.45ha forest remnant lies in the Egmont Ecological District and Waiongana River catchment. The forest is situated on flat terrain in an area which has undergone drainage. The forest canopy is dominated by puriri with occasional pukatea, rimu and mahoe. The forest provides habitat and connectivity in an area where such remnants are not common.

Ecological Features

Flora

The forest canopy is dominated by puriri, with pukatea, pigeonwood and kohekohe present. The understory is recovering well and includes kawakawa, karaka, tawa, rimu, mahoe and mapou. Native ferns are well established with jointed fern abundant. Tradescantia dominates the groundcover in open areas including a large area where giant reed has been eradicated.

Fauna

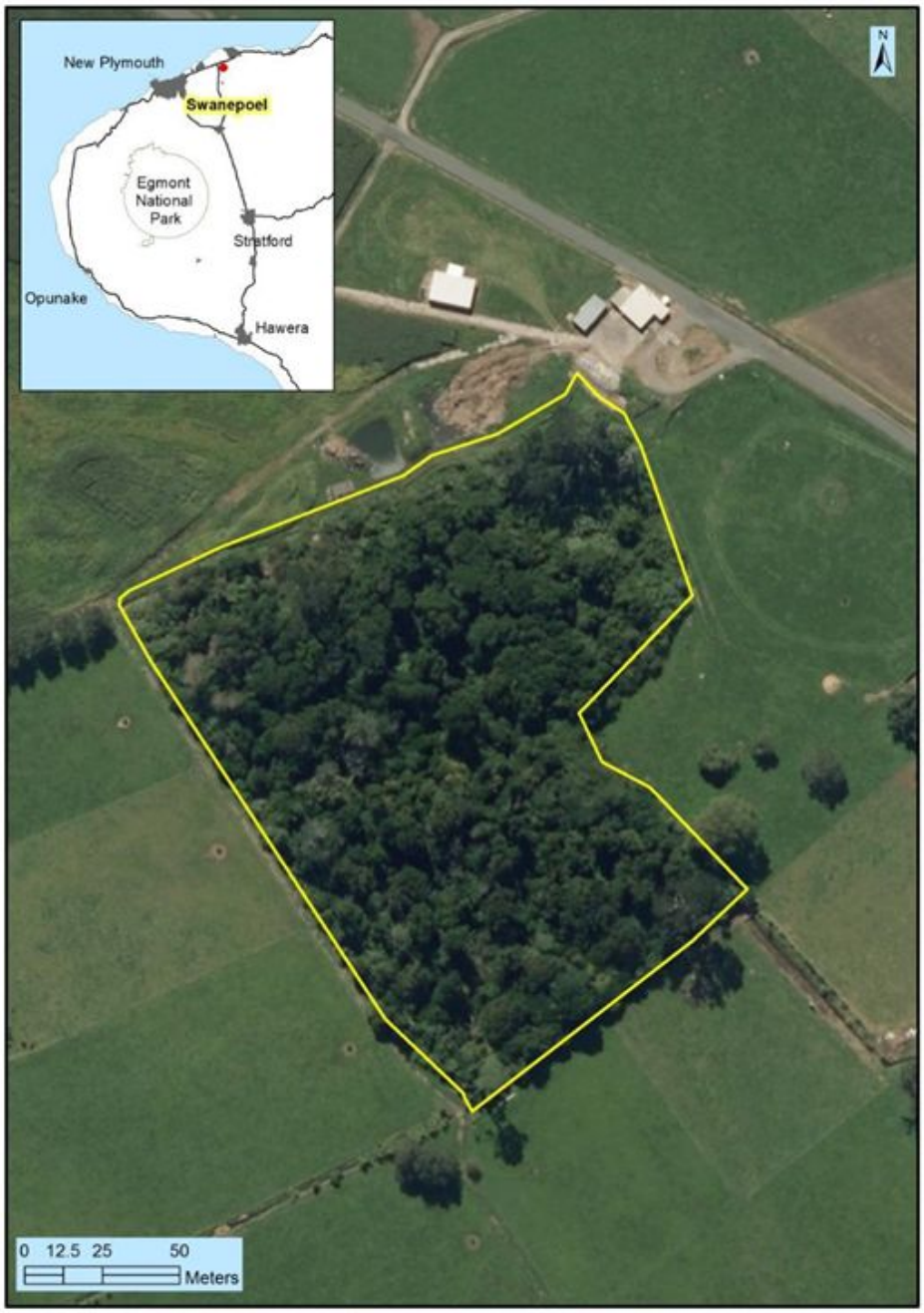
A moderate number of native birds were observed including fantail, tui, grey warbler and kingfisher. Good habitat exists for native reptiles including dense vegetation, epiphytes, loose bark, leaf litter, logs and ground cover.

Ecological Values

Ecological Context - Medium	Although the site is just over 2 ha it provides native habitat in a area where such fragments are lacking.
Rarity and Distinctiveness - Medium	Contains good habitat for notable priority species such as native reptiles and invertebrates.
Sustainability - Positive	Although there are several weed species with extensive coverage on the southern boundary, the northern side of the remnant remains in relatively good vegetative condition. The interior contains Tradescantia, however, overall the site has good potential to remain resilient to existing or potential threats under appropriate management.
Representativeness - High	Contains vegetation on an 'Acutely Threatened' LENZ environment (F5.2b) and is a remnant of a Chronically Threatened ecosystem type (WF13) that is now very rare in Taranaki.

Other Management Issues

Habitat Modification - Medium	Drains on boundary have drained this former wetland
Herbivores - Low	Stock proof, low amount of possum sign
Possum Self-help	Within possum self help area
Predators - Medium	Predators including rodents, mustelids, possums, feral cats and hedgehogs will be having an impact on native species at the site.
Weeds - High	Tradescantia common in interior, large grape vine and elaeagnus present in eastern boundary



Chris Jury Forest and Wetlands

At a glance

TRC Reference: BD/9605

Ecological District: Egmont

Land Tenure: Private

Area(ha): 3.4

GPS: 1712892X & 5678107Y

Habitat: Forest Remnant/Wetland

Bioclimatic Zone: Semi-Coastal

Ecosystem Type: WF13: Tawa, kohekohe, rewarewa, hinau, podocarp forest

LENZ:	F5.2b Acutely threatened
National:	Priority 1 – Threatened Land Environment
	Priority 4 – Threatened Species
Regional:	Key Native Ecosystem
Regional Ecosystem Loss:	Chronically threatened 10-20% left
Catchment:	Waiau (397)

General Description

The Chris Jury Forest and Wetlands site is located on private land off Otaraoa Road, 6 km south-east of Waitara. The site lies in the Egmont Ecological District and Waiau stream catchment. The area is comprised of a small (1.1ha) semi-coastal forest remnant on the Waiau stream margin and approximately 2.3ha of manmade wetlands with established buffer vegetation. The forest remnant is in good condition with a dense mixed canopy and understory and the wetlands are well established and also in good condition. Notable species present include the 'Regionally Distinctive' swamp maire and 'At Risk' giant kokopu and longfin eel.

Ecological Features

Flora

The forest remnant canopy is dominated by tawa and pukatea with occasional titoki, rewarewa, white maire, pigeonwood and mahoe. Puriri and kohekohe are also present although are mainly younger trees or saplings. Notably, a small stand of swamp maire is present on a wet southern margin of the forest. The understory is dominated by kawakawa and coprosma with a mix of other species present including pigeonwood, mahoe and tree ferns. Ground cover, climbers and epiphytes are common. Other notable flora species may be present including Tawhirikaro.

Fauna

Native birds present include kereru, tui, bellbird, shining cuckoo, grey warbler, fantail, kingfisher and morepork. The Waiau stream on the forest margin contains freshwater crayfish, giant kokopu and longfin eels and may contain other notable freshwater fish such as banded kokopu. There is very good habitat for a range of other notable native species including reptiles and invertebrates.

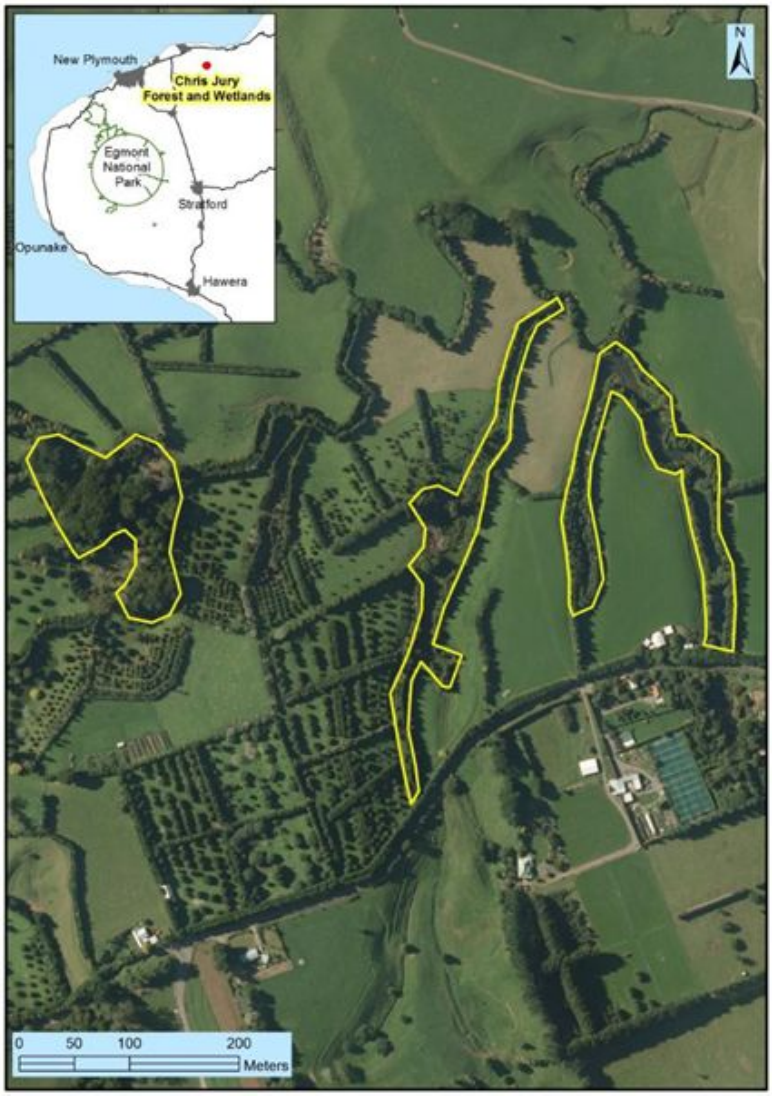
Ecological Values

Ecological context - High	Enhances connectivity between fragmented indigenous habitats in this area including Bushy Park and Tikorangi Whiteheads KNE.
Rarity and Distinctiveness - Medium	Contains the 'Regionally Distinctive' swamp maire and 'At Risk' giant kokopu and longfin eel. Provides habitat for and likely to contain other notable species including reptiles and other notable native fish.
Representativeness - High	Contains vegetation on 'Acutely Threatened' land environment (F5.2b) and is a remnant of an ecosystem type (WF13: Tawa, kohekohe, rewarewa, hinau, podocarp forest) considered 'Chronically Threatened' as less than 20% remains in the region.

Sustainability - Positive	In very good vegetative condition and likely to remain resilient to existing or potential threats.

Other Management Issues

Habitat Modification - Medium	Currently mostly fenced and in good condition apart from an area on the south stream margin. Potential medium risk from stock breach and human modification.
Herbivores - Medium	Potential threat from cattle if fences were breached.
Predators - Medium	Predators including rodents, mustelids, possums, feral cats and hedgehogs will be having an impact on native species at the site.
Weeds - High	The landowner has undertaken a sustained weed control program and weed threats are currently low. Potential weed threats will be high and will an ongoing risk at this site.
Possum Self-help	The site is outside the current possum self-help program boundary although receives occasional possum control by the landowners. High possum numbers have the potential to impact on forest health.



Todd Energy - Tikorangi Road East Farm

At a glance

TRC Reference: BD/9611

Ecological District: Egmont

Land Tenure: Private

Area(ha): 3.5

GPS: 1713011X & 5677293Y

Habitat: Forest Remnant

Bioclimatic Zone: Semi-Coastal

Ecosystem Type: WF13: Tawa, kohekohe, rewarewa, hinau, podocarp forest

LENZ:	F5.2a Acutely threatened
	F5.2b Acutely threatened
National:	Priority 1 – Threatened Land Environment
Regional:	Potential KNE
Regional Ecosystem Loss:	Chronically threatened 10-20% left
Catchment:	Waiau (397)

General Description

The site is located on Tikorangi road east approximately 8km south east of Waitara and is comprised of five small forest remnants in the Waiau stream catchment totaling an area of 3.5 ha. The site is located in the Egmont ecological district. All the remnants are examples of lowland semi coastal forest with a canopy dominated by tawa, kohekohe, rewarewa, with some rimu and puriri. The site provides good connectivity to other Key Native Ecosystems in the area including the Bushy park, Tikorangi Whithead, and Mangahewa KNE's.

Ecological Features

Flora

The canopy of the site is dominated by tawa, kohekohe, rewarewa, with some rimu and puriri. The canopy is mainly intact and the understory is in reasonable condition where stock are excluded. Pukatea (Laurelia novaezelandiae) is a common canopy component in the poorly drained gullies. The 'at risk' King fern is present in areas that stock have been excluded from. The site also contains the 'regionally distinctive' fern Deparia petersenii subsp. congrua.

Fauna

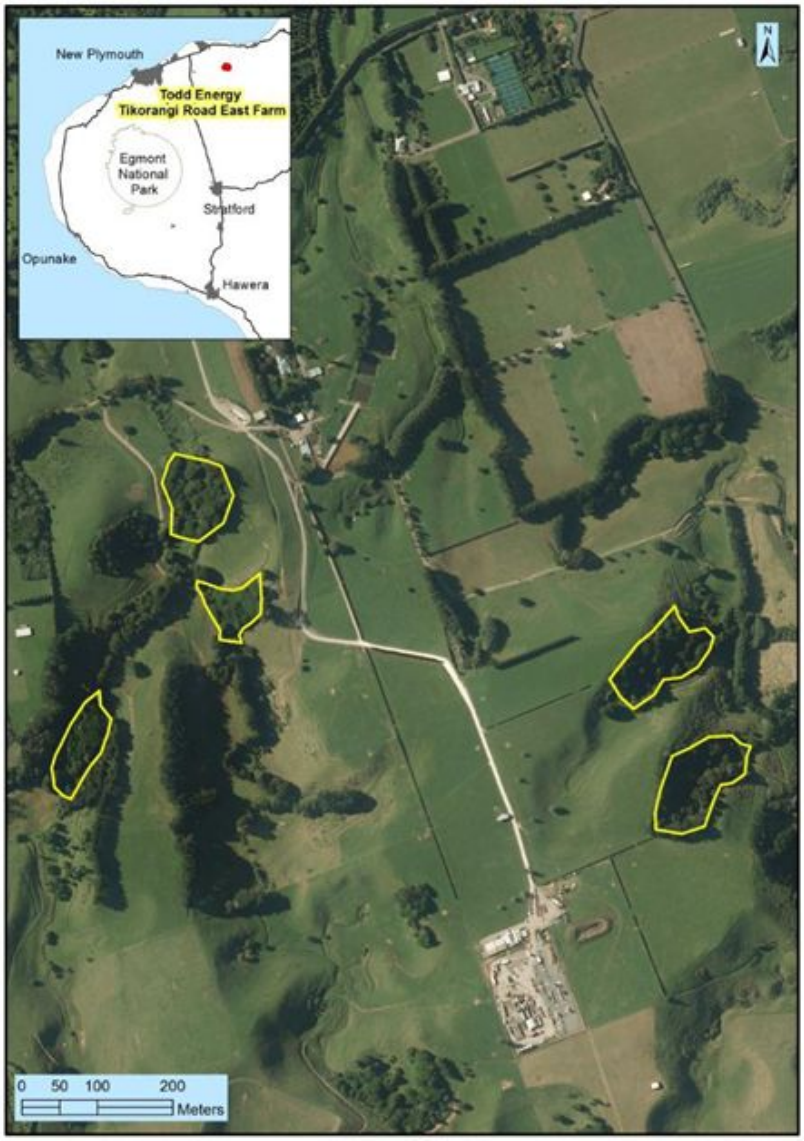
Native birds found at the site include tui, kingfisher, grey warbler and fantail. Good habitat exists for native reptiles including epiphytes, loose bark, abundant foliage, leaf litter and forest ground cover. Good habitat for native freshwater fish exists in a tributary of the Waiau stream which runs through the site. Banded kokopu are likely present and a spotlight survey could be carried out to identify native fish values.

Ecological Values

Ecological Context - Medium	Provides additional habitat and greater connectivity with other Key Native Ecosystems in this area such as the Bushy Park, Mangahewa and Tikorangi Whitehead KNE's.
Representativeness - High	Contains indigenous vegetation type classified as an 'Acutely Threatened' (F5.2b) LENZ environment.
Rarity and Distinctiveness - Medium	The 'at risk' King fern is present in areas that stock have been excluded from. The site also contains the 'regionally distinctive' fern Deparia petersenii subsp. congrua.
Sustainability - Positive	Key ecological processes still influence the site. Under appropriate management, it can remain resilient to existing or potential threats.

Other Management Issues

Weeds - High	Woolly nightshade, wandering willy and banana passionfruit are having an impact on the condition of the remnants and control of these species would greatly benefit the remnants.
Predators - High	Invasive animal species such as possums, rats, feral cats and mustelids will be impacting the flora and fauna of the bush remnants.
Herbivores - High	Stock are getting through the fences at some of the remnants and upgrading the fences to a stock proof condition would greatly benefit the site.
Habitat Modification - Low	Todd energy are working with the QEII Trust to covenant the bush remnants.



Donald QEII

At a glance

TRC Reference: BD/9612

Ecological District: Egmont

Land Tenure: Private

Area(ha): 1.2

GPS: 1686508X & 5672240Y

Habitat: Forest Remnant/Wetland

Bioclimatic Zone: Semi-Coastal

Ecosystem Type: WF13: Tawa, kohekohe, rewarewa, hinau, podocarp forest

LENZ: F5.2b Acutely threatened

National: Priority 1 – Threatened Land Environment

Priority 2 – Sand Dunes and Wetlands

Regional: Potential KNE

Regional Ecosystem Loss: Chronically threatened 10-20% left

Protection Status: QEII Covenant

Catchment: Wairere (387)

General Description

Donald KNE consists of a 1.2ha semi-coastal forest and wetland at the head of small gully system of the Wairere Stream catchment. This site is an excellent example of semi-coastal kohekohe forest and contains jointed fern, a notable flora species for Taranaki. Forest remnants like this are under-represented in Taranaki owing to widespread clearance for agriculture and urban development. Donald QEII is in close proximity to other Key Native Ecosystems such as Tapuae coastal strip, Berridge twin bush, Woodside and Omata School.

Ecological Features

Flora

The main canopy of the remnant is dominated by kohekohe, rewarewa, pukatea, rata and puriri. A number of other plant species are also present in the sub canopy including karaka, mamaku, kawakawa, pigeonwood, various coprosmas, silver fern/ponga and mahoe.

Fauna

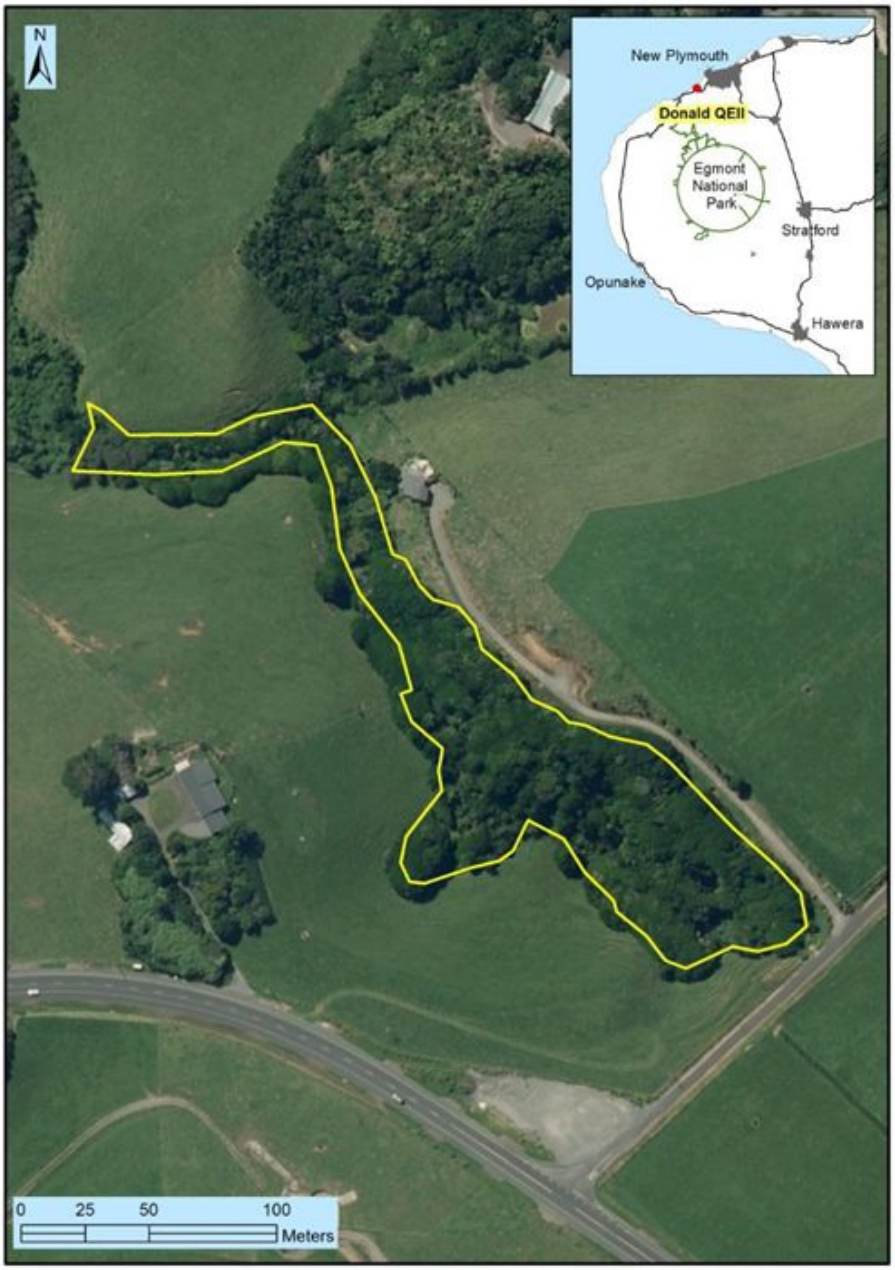
Native birdlife recorded in and around the site include the New Zealand pigeon, tui, grey warbler, fantail, silvereye and sacred kingfisher. Good habitat exists for reptiles which may include notable species. Longfin eel seen in stream flowing through the site.

Ecological Values

Ecological Context - Medium	Provides habitat for specific indigenous species and is in close proximity to other Key Native Ecosystems in the area, including Woodside, Berridge twin bush, Tapuae Coastal strip and Te wawa wetland.
Representativeness - High	Contains vegetation on a land environment classified as 'Acutely Threatened' (F5.2b) and is valuable as a remnant of a greatly reduced ecosystem type within the region.
Rarity and Distinctiveness - Medium	Provides habitat for the regionally distinctive jointed fern (Arthropteris tenella).
Sustainability - Positive	Key ecological processes still influence the site and with appropriate management, it can remain resilient to existing or potential threats.

Other Management Issues

Weeds - High	Control of high risk species required for Tradescantia, woolly nightshade, Japanese spindle tree, wattle and convolvulus.
Possum Self-help	Site is in the possum Self Help programme.
Predators - High	Predator control required to help reduce rats, hedgehogs and mustelids at the site.
Habitat Modification - Low	Protected by QEII covenant conditions.



Lowe North Block

At a glance

TRC Reference: BD/9617

Ecological District: North Taranaki

Land Tenure: Private

Area(ha): 12.2

GPS: 1732796X & 5657824Y

Habitat: Forest Remnant

Bioclimatic Zone: Lowland

Ecosystem Type: MF7.2: Rata, tawa, kamahi, podocarp forest

MF7.3: Tawa, pukatea, podocarp forest

National: Priority 4 – Threatened Species

Regional: Close proximity to a representative ecosystem site

Key Native Ecosystem

Regional Ecosystem Loss: Less reduced >50% left

Catchment: Waitara (395)

General Description

The Lowe North forest remnant is privately owned land and is located near Kiore approximately 25kms north east of Stratford in central Taranaki. The 12.2ha forest remnant lies in the North Taranaki Ecological District and Waitara River catchment. The forest is situated on the upper slopes of a north west facing valley leading down to the Matau Road. The forest canopy is dominated by tawa with occasional pukatea, miro and rimu. The forest is attached to a wider area of forest on the adjacent property and is nearby to a site considered as a priority area for management.

Ecological Features

Flora

The forest canopy is dominated by tawa with occasional pukatea, miro, rimu, titoki and rewarewa. The understory is sparse in places and is dominated by pigeonwood, mahoe, coprosma and tree ferns. Ground cover is sparse in places and climbers and epiphytes are fairly common.

Fauna

Notable native birds present include the 'Threatened' North Island brown kiwi and 'At Risk' North Island robin and whitehead. Other native birds present include kereru, tui, bellbird, silvereye, grey warbler, fantail, tomtit, kingfisher and morepork. Also notable is the presence of the 'Threatened' long-tailed bat. There is very good habitat for a range of other notable native species including reptiles and invertebrates.

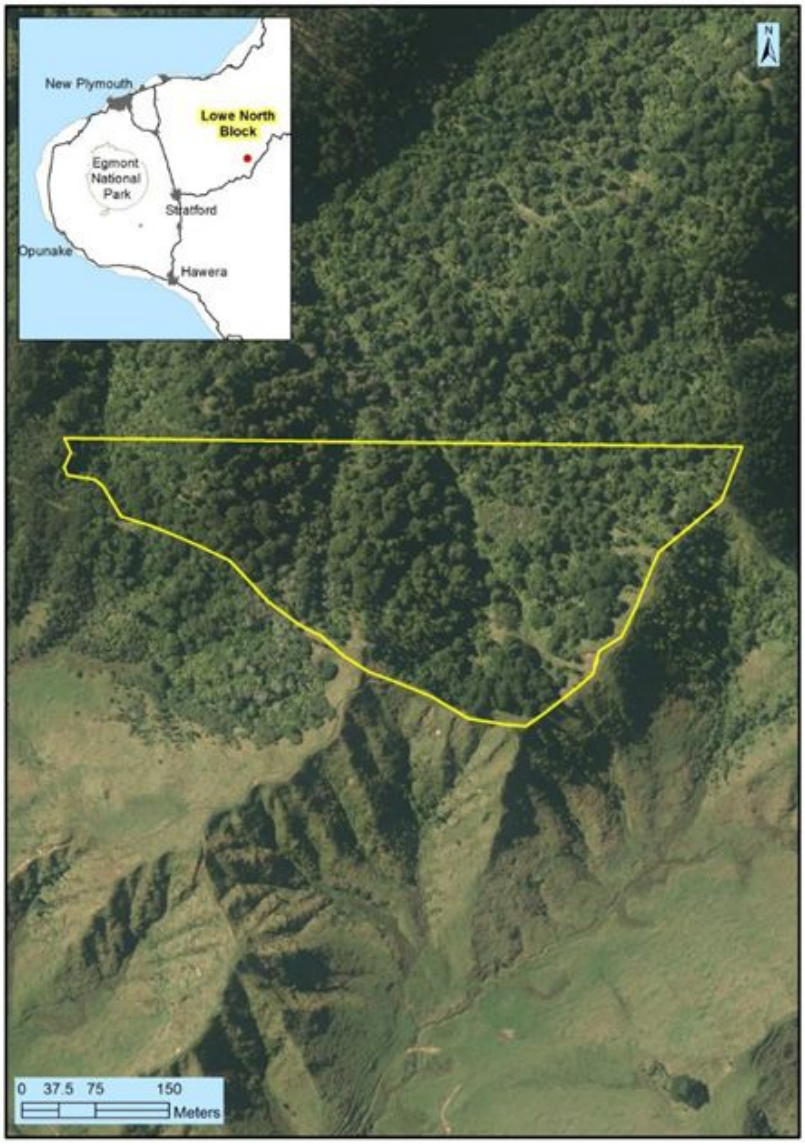
Ecological Values

Ecological context - High	Enhances connectivity between fragmented indigenous habitats in this area including nearby remnants on this property and nearby KNE's such as the Te Wera wetlands. Close to priority brown kiwi management areas.
Rarity and Distinctiveness - High	Contains notable species such as the 'Threatened' North Island brown kiwi and long-tailed bat. Also contains the 'At Risk' North Island robin and whitehead. Provides habitat for and also likely to contain other notable species including reptiles and invertebrates.
Representativeness - Medium	Similar to and close to a remnant of a native forest ecosystem (MF7.2: Rata, tawa, kamahi, podocarp forest) that has been identified as a priority representative area for management in Taranaki (Top 30% Representative Ecosystem type).

Sustainability - Positive	In relatively good vegetative condition and likely to continue to improve when fenced and especially if goats were held at reduced levels.

Other Management Issues

Habitat Modification - Low	The habitat is vulnerable to modification although there are no immediate threats.
Herbivores - High	Stock and occasional feral goats have had an impact on areas of the forest understory and ground cover typical in this area. Goats and possums will remain a high threat.
Predators - Medium	Predators including rodents, mustelids, possums, feral cats and hedgehogs will be having an impact on native species at the site.
Weeds - Low	Currently a low threat at this site with occasional pasture weed species.
Possum Self-help	The site is outside the current possum self-help program boundary although receives occasional possum control by the landowner. High possum numbers have the potential to impact on forest health.



Lowe East Block

At a glance

TRC Reference: BD/9616
Ecological District: Matemateaonga
Land Tenure: Private
Area(ha): 5.4
GPS: 1733739X & 5656751Y

Habitat: Forest Remnant
Bioclimatic Zone: Lowland
Ecosystem Type: MF7.2: Rata, tawa, kamahi, podocarp forest

LENZ: F1.1d Not threatened
National: Priority 4 – Threatened Species
Regional: Key Native Ecosystem
Representative ecosystem type
Regional Ecosystem Loss: Less reduced >50% left
Protection Status: Memorandum of Encumbrance
Catchment: Patea (343)
Waitara (395)

General Description

The Lowe East forest remnant is privately owned land and is located near Kiore approximately 25kms north east of Stratford in central Taranaki. The 5.4ha forest remnant lies in the Matemateaonga Ecological District and Patea River catchment. The forest is situated on a hill top and hill slopes and is generally south and west facing. The forest canopy is dominated by tawa with occasional pukatea, miro and rimu. The forest is attached to a wider area of forest on the adjacent property and is considered a priority area for management in Taranaki.

Ecological Features

Flora

The forest canopy is dominated by tawa with occasional pukatea, miro, rimu, titoki and rewarewa. The understory is sparse in places and is dominated by pigeonwood, mahoe, coprosma and tree ferns. Ground cover is sparse in places and climbers and epiphytes are fairly common.

Fauna

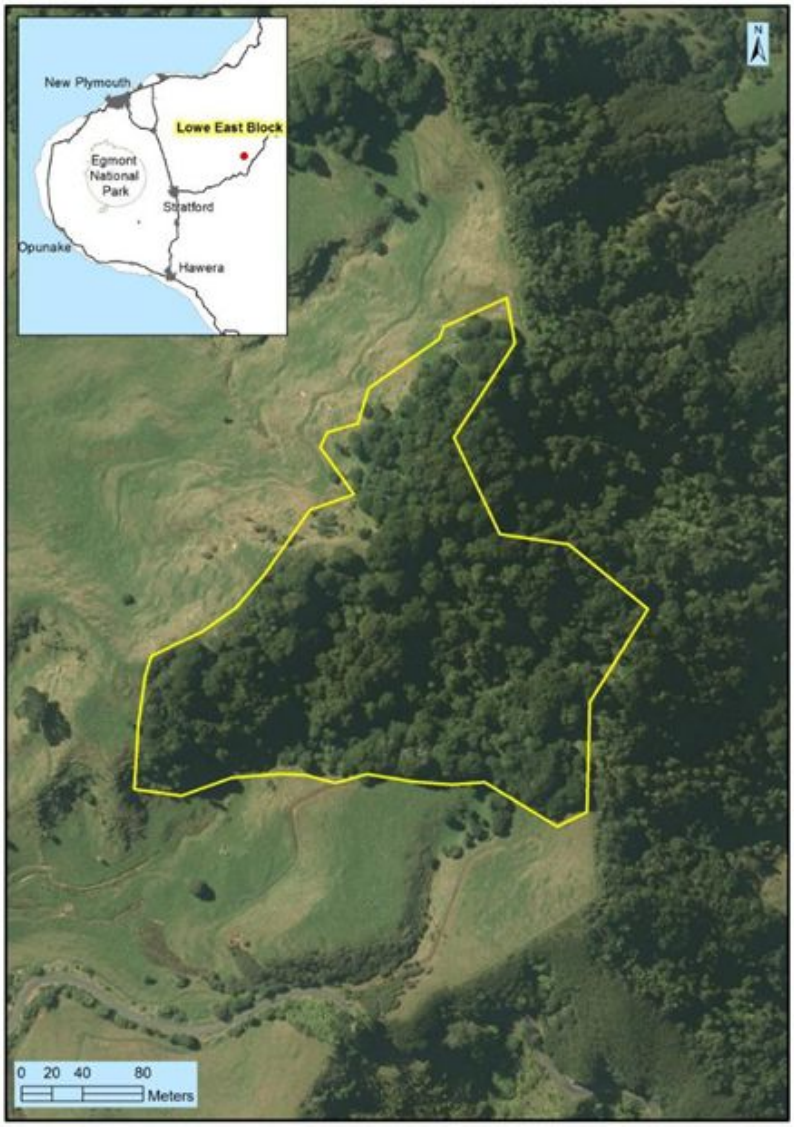
Native birds present include North Island robin, kereru, tui, bellbird, silvereye, grey warbler, fantail, tomtit, kingfisher and morepork. The presence of the 'Threatened' long-tailed bat is notable for the site. A very small stream in the forest and a small man made pond is present on the buffer which may contain longfin eels and freshwater crayfish. There is very good habitat for a range of other notable native species including reptiles and invertebrates.

Ecological Values

Ecological context - High	Enhances connectivity between fragmented indigenous habitats in this area including nearby remnants on this property and nearby KNE's such as the Te Wera wetlands. Close to priority brown kiwi management areas.
Rarity and Distinctiveness - Medium	Contains the 'Threatened' long-tailed bat and 'At Risk' North Island robin. Provides habitat for and likely to contain other notable species including reptiles and invertebrates.
Representativeness - High	A remnant of a native forest ecosystem (MF7.2: Rata, tawa, kamahi, podocarp forest) that has been identified as a priority representative area for management in Taranaki (Top 30% Representative Ecosystem type).
Sustainability - Positive	In relatively good vegetative condition and likely to continue to improve especially if goats were held at reduced levels.

Other Management Issues

Habitat Modification - Low	The habitat is vulnerable to modification although there are no immediate threats.
Herbivores - High	Stock and occasional feral goats have had an impact on areas of the forest understory and ground cover although the site has some recovery since stock have been excluded. Goats and possums remain a high threat.
Predators - Medium	Predators including rodents, mustelids, possums, feral cats and hedgehogs will be having an impact on native species at the site.
Weeds - Low	Currently a low threat at this site with occasional burdock and pasture weed species.
Possum Self-help	The site is outside the current possum self-help program boundary although receives occasional possum control by the landowner. High possum numbers have the potential to impact on forest health.



Hall's Bush

At a glance

TRC Reference: BD/9620

Ecological District: Egmont

Land Tenure: Private

Area(ha): 4.8

GPS: 1696071X & 5664240Y

Habitat: Forest Remnant

Bioclimatic Zone: Lowland

Ecosystem Type: MF7.2: Rata, tawa, kamahi, podocarp forest

LENZ: F5.2a Acutely threatened

National: Priority 1 – Threatened Land Environment

Regional: Key Native Ecosystem

Regional Ecosystem Loss: Less reduced >50% left

Catchment: Waiwhakaiho (392)

General Description

The Hall's Bush forest remnant is located 3.4kms from Egmont Village and is located in the Egmont Ecological District and Waiwhakaiho River catchment. Hall's Bush consists of a small (4.8ha) cutover lowland forest remnant dominated by tawa and is situated on flat land next to Albert Road. Notable species present include the 'Regionally Distinctive' swamp maire. Other notable species may be present including freshwater fish and reptiles. The site provides connectivity with other forest remnants, habitat corridors and Key Native Ecosystems in the area.

Ecological Features

Flora

The forest remnant canopy is dominated by tawa with occasional pukatea, rewarewa, pigeonwood and mahoe. Notably, occasional swamp maire saplings are present in the understory which is dominated by kanono, pigeonwood, mahoe and tree ferns. Ground cover, climbers and epiphytes are common.

Fauna

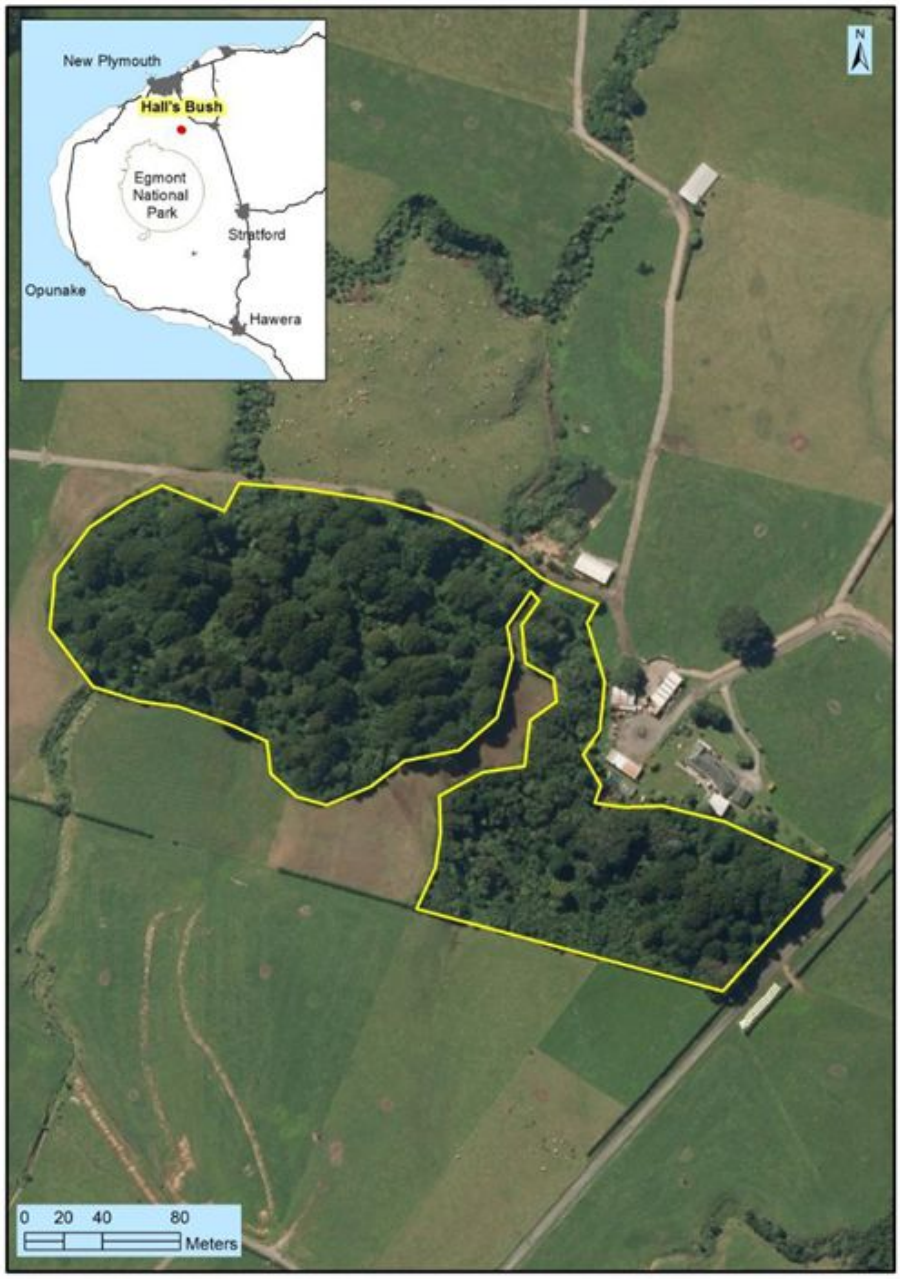
Native birds present include kereru, tui, grey warbler, fantail, silvereye, kingfisher and pukeko. A small stream is present and is likely to contain notable freshwater fish such as kokopu and longfin eels. There is very good habitat for a range of other notable native species including reptiles and invertebrates.

Ecological Values

Ecological Context - Medium	Enhances connectivity between fragmented indigenous habitats in this area including nearby riparian habitats and more distant Korito Heights and the Alfred Road Wetland.
Rarity and Distinctiveness - Medium	Contains the 'Regionally Distinctive' swamp maire and likely to contain other notable species including notable native fish and reptiles.
Representativeness - High	Contains vegetation on 'Acutely Threatened' land environment (F5.2a) and is a remnant of an ecosystem type (MF7-2: Rata, Tawa, Kamahi, podocarp forest) considered 'Less Reduced'.
Sustainability - Positive	In good vegetative condition and likely to remain resilient to existing or potential threats.

Other Management Issues

Habitat Modification - Medium	Currently fenced and in good condition. Potential risk from stock breach and human modification.
Herbivores - Medium	Currently low although potential threat from cattle if fences were breached or canopy browse if possum numbers became high.
Possum Self-help	The site lies in the possum self-help area and receives possum control as part of the program.
Predators - Medium	Predators including rodents, mustelids, possums, feral cats and hedgehogs will be having an impact on native species at the site.
Weeds - High	Localised infestations of weeds such as tradescantia, barberry and blackberry are present as at the site.



Pirinoa

At a glance

TRC Reference: BD/9615

Ecological District: Egmont

Land Tenure: Private

Area(ha): 1.3

GPS: 1710821X & 5660523Y

Habitat: Forest Remnant

Bioclimatic Zone: Lowland

Ecosystem Type: MF7.3: Tawa, pukatea, podocarp forest

WF8: Kahikatea, pukatea forest

LENZ: C1.1a Chronically threatened

F5.2a Acutely threatened

National: Priority 1 – Threatened Land Environment

Regional: Key Native Ecosystem

Close to a representative ecosystem type

Regional Ecosystem Loss: Acutely Threatened <10% left

Chronically threatened 10-20% left

Protection Status: QEII Covenant

Catchment: Waitara (395)

General Description

The Pirinoa site is located on privately owned land 7.5 km south east of Inglewood and lies in the Egmont Ecological District and Waitara River catchment. The Pirinoa site comprises a small (1.3 ha) QEII covenanted area of lowland tawa and swamp forest located close to the Manganui River off Ngaro Road. The remnant is loosely connected to other riparian vegetation along the Manganui River and provides greater connectivity to other priority sites in the area such as Tariki Bush, Maketawa Stream Forests and Dravitzki QEII covenants on Salisbury Road.

Ecological Features

Flora

The high canopy at Pirinoa is dominated by tawa with occasional kahikatea, rimu and miro. The understory is intact and includes species such as kanono, pigeonwood, mahoe and turepo. Native ferns are well established and include shining spleenwort, sickle spleenwort, hen and chicken fern etc. Green mistletoe (Pirinoa) and swamp maire (both Regionally Distinctive) are present and are notable for this site.

Fauna

Birds are generally in moderate to low numbers in the area and include kereru, tui, bellbird, fantail, grey warbler, silvereye and morepork. A range of exotic species are also present. Good habitat exists for native reptiles including dense vegetation, epiphytes, loose bark, leaf litter, logs and ground cover. Native notable reptile species may be present such as the goldstripe gecko, forest gecko, striped skink and ornate skink. The habitat will contain a very diverse range of terrestrial invertebrates likely including notable species such as peripatus. A small stream is present which may contain notable native fish species such as banded kokopu.

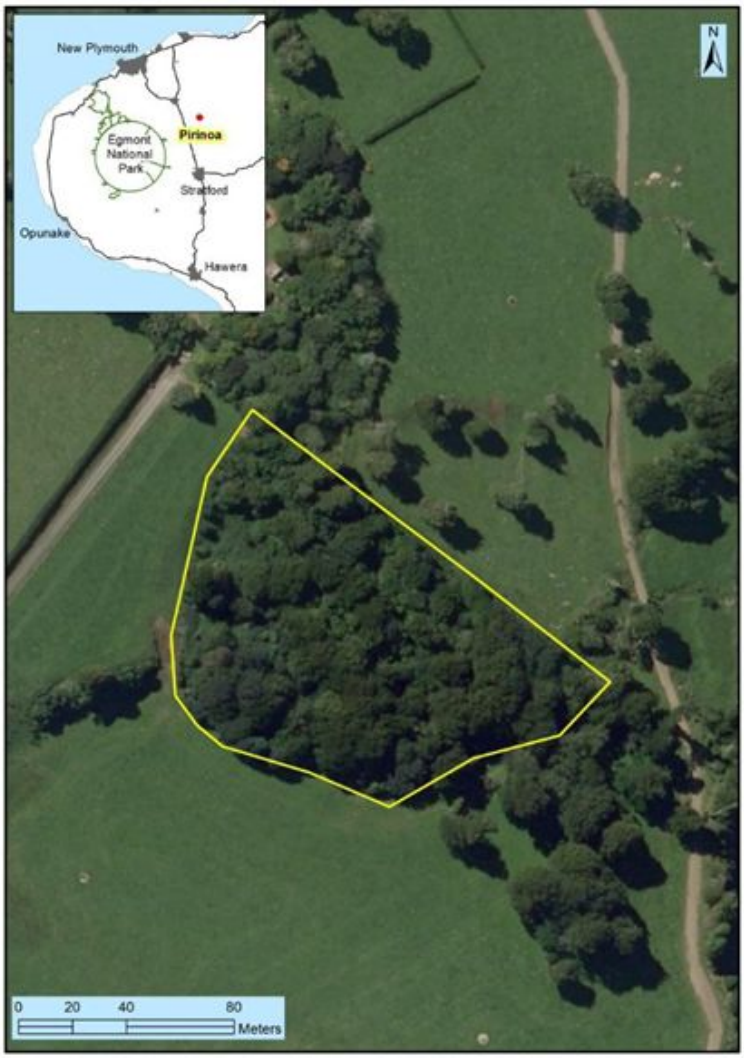
Ecological Values

Ecological Context - Medium	Provides greater connectivity to other priority sites in the area such as Tariki Bush, Maketawa Stream Forests and Dravitzki QEII covenants on Salisbury Road.
Rarity and Distinctiveness - Low	Contains the 'Regionally Distinctive' green mistletoe and swamp maire and likely to contain other notable species.

Representativeness - High	Contains indigenous vegetation on F5.2a ('Acutely Threatened') and C1.1a ('Chronically Threatened') LENZ environments. The forest type is also particularly rare in Taranaki with less than 10% of this type of forest remaining in the region. Close to a representative ecosystem type.
Sustainability - Positive	In good vegetative condition. Key ecological processes still influence the site. Under appropriate management, it can remain resilient to existing or potential threats.

Other Management Issues

Habitat Modification - Low	Currently fenced and in good condition Potential risk from stock breach and human modification.
Herbivores - High	Currently low although potential threat from cattle if fences were breached or canopy browse if possum numbers became high.
Possum Self-help	The site lies in the possum self-help area and receives possum control as part of the program.
Predators - Medium	Predators including rodents, mustelids, possums, feral cats and hedgehogs will be having an impact on native species at the site.
Weeds - Medium	Sycamore and tradescantia can have long-tern impacts on small forest remnants and are present at this site.



Whakataka te hau

Karakia to open and close meetings

Whakataka te hau ki te uru	Cease the winds from the west
Whakataka te hau ki tonga	Cease the winds from the south
Kia mākinakina ki uta	Let the breeze blow over the land
Kia mātaratara ki tai	Let the breeze blow over the ocean
Kia hī ake ana te atakura	Let the red-tipped dawn come with a sharpened air
He tio, he huka, he hauhu	A touch of frost, a promise of glorious day
Tūturu o whiti whakamaua kia tina.	Let there be certainty
Tina!	Secure it!
Hui ē! Tāiki ē!	Draw together! Affirm!

Nau mai e ngā hua

Karakia for kai

Nau mai e ngā hua	Welcome the gifts of food
o te wao	from the sacred forests
o te ngakina	from the cultivated gardens
o te wai tai	from the sea
o te wai Māori	from the fresh waters
Nā Tāne	The food of Tāne
Nā Rongo	of Rongo
Nā Tangaroa	of Tangaroa
Nā Maru	of Maru
Ko Ranginui e tū iho nei	I acknowledge Ranginui above and
Ko Papatūānuku e takoto ake nei	Papatūānuku below
Tūturu o whti whakamaua kia	Let there be certainty
tina	Secure it!
Tina! Hui e! Taiki e!	Draw together! Affirm!