Taranaki Regional Council

AGENDA
Policy & Planning

Tuesday 21 November 2023, 10.30am

Policy and Planning Committee

21 November 2023 10:30 AM

Agenda Topic — Page

Taranaki Regional Council

AGENDA Policy & Planning

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 te 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 whiti whakamaua kia	Let there be certainty
tina	Secure it!
Tina! Hui e! Taiki e!	Draw together! Affirm!

Taranaki Regional Council

AGENDA Policy & Planning

Date 21 November 2023

Subject: Policy and Planning Committee Minutes – 10 October 2023

Approved by: A D McLay, Director - Resource Management

S J Ruru, Chief Executive

Document: 3223103

Recommendations

That the Taranaki Regional Council:

a) 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 10 October 2023

b) notes the recommendations therein were adopted by the Taranaki Regional Council on Tuesday 31 October 2023.

Matters arising

Appendices/Attachments

Document 3213047: Minutes Policy and Planning – 10 October 2023.

Taranaki Regional Council

MINUTES
Policy & Planning

Date 10 October 2023

Venue: Taranaki Regional Council Boardroom, 47 Cloten Road, Stratford

Document: 3213047

Present		B J Bigham	Chairperson
		D M Cram	
		D H McIntyre	
		A L Jamieson	
		C L Littlewood	*(ex officio - zoom)*
		N W Walker	*(ex officio)*
		E Bailey	Iwi Representative *(zoom)*
		P Moeahu	Iwi Representative
		M Ritai	Iwi Representative *(zoom)*
		C Filbee	South Taranaki District Council
		G Boyde	Stratford District Council
		L Gibbs	Federated Farmers *joined meeting at 10.38*
Attending	Mr	S J Ruru	Chief Executive
	Mr	A D McLay	Director - Resource Management
	Ms	A J Matthews	Director – Environment Quality
	Mr	D R Harrison	Director - Operations
	Ms	L Hawkins	Planning Manager
	Mr	F Kiddle	Strategy lead
	Miss	A Smith	Science Communications Advisor
	Mr	F Kiddle	Strategy Lead *(zoom)*
	Mrs	M Jones	Governance Administrator

The meeting opened with a group Karakia at 10.30am.

Apologies: Were received and sustained from, Committee Chair - C S Williamson, S W Hughes and B Haque.

Jamieson/walker

1. Confirmation of Minutes Policy and Planning Committee 29 August 2023

Resolved

That the Taranaki Regional Council:

a) took as read and confirmed the minutes of the Policy and Planning Committee of the Taranaki Regional Council held at 10.30 on 29 August 2023 at Taranaki Regional Council 47 Cloten Road Stratford

b) noted the recommendations therein were adopted by the Taranaki Regional Council on Tuesday 19 September 2023.

Jamieson/Cram

2. Freshwater Implementation Report

2.1 Ms L Hawkins spoke to the memorandum to provide the Committee with an update of the Freshwater Implementation programme and the key elements that will be worked on moving forward.

Resolved

That the Taranaki Regional Council:

a) received the October 2023 update on the freshwater implementation programme.

Walker/Filbee

3. NPS-FM Amendments to the Regional Fresh Water Plan for Taranaki

3.1 Ms L Hawkins spoke to the memorandum to provide an update on the required changes and amendments to the Regional Freshwater Plan for Taranaki.

Resolved

That the Taranaki Regional Council:

a) received this Memorandum entitled *Amendments to the Regional Fresh Water Plan for Taranaki;*

b) noted amendments made to the *National Policy Statement for Freshwater Management* 2020 by the Government

c) noted the implementation requirements for the regional council associated with the NPS-FM including the insertion of transitional provisions to the Regional Freshwater Plan

d) noted amendments made to the Regional Fresh Water Plan for consistency with the NPS-FM and to fix formatting and minor errors

e) noted the public notification requirements (appendix 1) associated with the necessary amendments required by the NPS-FM via s.55(2) and s.55(2A) of the Resource Management Act 1991.

Boyde/McIntyre

4. Proposed National Policy Statement for Natural Hazards Decision Making 2023 Submission

4.1 Ms L Hawkins spoke to the Memorandum to inform members on the submission for the proposed requirements for managing natural hazards.

Resolved

That the Taranaki Regional Council:

a) received the memorandum titled *Proposed National Policy Statement for Natural Hazards Decision Making 2023 Submission*

b) endorsed the approach to prepare a high level submission, covering those points contained in this memo, on the draft National Policy Statement for Natural Hazards Decision Making by the due date of 13 November 2023

c) determined that this decision be recognised as not significant in terms of section 76 of the *Local Government Act 2002*

d) determined that it has complied with the decision-making provisions of the *Local Government Act 2002* to the extent necessary in relation to this decision; and in accordance with section 79 of the Act, determined that it does not require further information, further assessment of options or further analysis of costs and benefits, or advantages and disadvantages prior to making a decision on this matter.

Boyde/Walker

5. Biodiversity Credit System Submission

5.1 Mr F Kiddle – Strategy Lead, spoke to the Memorandum to update the committee on the submission process, noting that his will be quite a lengthy process.

5.2 The motion was passed to leave this paper on the table and delegate authority to Mr S J Ruru – Chief Executive to approve the amended submission that is to be lodged by 3 November.

Resolved

That the Taranaki Regional Council:

a) received the memorandum *Biodiversity Credit system Submission*

b) delegated authority to Mr S J Ruru - Chief Executive to approve the amended submission that is to be lodged by 3 November

c) noted the formal submission be presented at the next Policy and Planning meeting scheduled for 21 November.

Cram/McIntyre

6. Consultation on Advancing New Zealand's Energy Transition

6.1 Ms F Kiddle – Strategy Lead, spoke to the memorandum to provide the committee with an update on the submission process so far.

Resolved

That the Taranaki Regional Council:

a) received the memorandum Consultation on advancing New Zealand's energy transition

b) endorsed the submission in Attachment One on the *Regional Hydrogen Transition draft technical design paper*

c) noted a joint regional submission on the full package of consultation documents for approval by Mayoral Forum is being prepared

d) noted the areas for consideration in drafting this submission set out in this memo

e) determined that this decision be recognised as not significant in terms of section 76 of the *Local Government Act 2002*

f) determined that it has complied with the decision-making provisions of the *Local Government Act 2002* to the extent necessary in relation to this decision; and in accordance with section 79 of the Act, determines that it does not require further information, further assessment of options or further analysis of costs and benefits, or advantages and disadvantages prior to making a decision on this matter.

McIntyre/Jamieson

There being no further business the Committee Chairperson, B J Bigham, declared the meeting of the Policy and Planning Committee closed with karakia at 11.47am.

Policy and Planning Chairperson: ____

B J Bigham

Taranaki Regional Council

MEMORANDUM
Policy & Planning

Date	21 November 2023
Subject:	**Freshwater Implementation Report November 2023**
Approved by:	A D McLay, Director - Resource Management
	S J Ruru, Chief Executive
Document:	3222571

Purpose

1. The purpose of this memorandum is to provide the Committee with a Freshwater Implementation project update.

Executive summary

2. Set out in the memorandum is an update on the progress of implementing the Essential Freshwater package from central government. The memorandum focusses on the key tasks undertaken since the previous Committee meeting, and identifies risks associated with the project and achievement of the project timeframes.
3. The attached report focusses on the key streams of work associated with the essential freshwater package. This being policy development, implementation of the Freshwater Farm Plans (FWFP) regulations and the communications and engagement timeline.

Recommendation

That the Taranaki Regional Council:

a) receives the November 2023 update on the freshwater implementation programme.

Background

4. This memorandum updates members on progress in implementing the Essential Freshwater Package. An implementation programme was previously presented to, and approved by the Committee. This report provides an overview on the progress of the work programme, specifically focussing on the previous 6 weeks and those ahead. It provides an opportunity for discussions relating to progress and risks identified.

Discussion

5. The attached report (attachment 1) provides a high level overview of the progress made in the past 6 weeks since the last Committee meeting, and those tasks to be undertaken

in the coming 6 weeks. It also identifies risks associated with the programme, and a copy of the high level engagement strategy.

6. Key discussion points are included in this covering memorandum to draw Members attention to key areas of work.

Consultation update

7. Over the past 6 weeks consultation on key elements of the programme has been the main focus of both policy and science staff. This engagement process focussed on key elements of the National Objectives Framework (NOF) from the National Policy Statement for Freshwater (NPS-FM). The consultation period ran from 25 September to 27 October (5 weeks) and focussed on the following concepts of the NOF process:

   7.1. Te Mana o Te Wai objective

   7.2. Freshwater visions for Freshwater Management Units (FMU)

   7.3. Values and environmental outcomes

   7.4. Environmental actions and attribute identification.

8. A series of detailed discussion documents and scientific technical memos were prepared for each FMU to support the consultation process.

9. The consultation period included an online survey and a series of face to face workshops (four Special Interest Group sessions and six community sessions). The table below summarises the number of responses received during the consultation period.

	No. submissions or responses
Online survey	144
Bespoke written submissions	5
Social media	6
Total	155

10. Information from the face to face meetings was collected through facilitated discussions and commentary written by participants on printouts. Therefore it is not reflected in the table above. Special interest group workshops were attended by approximately 50 people representing around 40 organisations. Public meetings were attended by approximately 35 people. Across all response channels thousands of individual pieces of feedback were gathered (approx. 7,488 for the online survey alone).

11. The opportunity to participate in the survey or attend meetings was communicated across a range of channels and reached approximately 50,000 people as shown in the table below. Note that the reach number is cumulative across channels and accordingly includes duplicates where individuals saw messages on more than one channel.

	Message reach
Website	2,301
Email	10,299
Social media	13,353
Advertising (Farming First)	25,000
TOTAL*	50,953

12. Staff are now working through all the feedback received and a detailed analysis is being undertaken ahead of determining the refinement to the NOF. Whilst this work is at a preliminary stage, and may change as the analysis is completed, the following high level themes through the feedback can be identified.

- Broad support from survey respondents for the draft Te Mana O Te Wai objective with 74% of those who responded strongly or somewhat agreeing with the objective. Feedback from special interest groups was more mixed with several issues identified by these groups as requiring further thought by Council.
- Broad support for the draft planning principles for determining target attribute states, with 75% of survey respondents somewhat or strongly agreeing with proposed principals.
- Feedback from community meetings and special interest groups indicates high levels of agreement for the draft visions for each FMU, although many suggestions have been made to improve and refine the draft. Data from the online survey has yet to be processed.
- Environmental outcomes survey and workshop data has yet to be processed and indicative findings are unable to be presented at the time of writing this report.

13. A report will be prepared summarising the feedback received and will include analysis and identification of actions required to update provisions. This report will be provided to members of the Committee in December 2023.

14. Staff will utilise the feedback received to progress with the NOF and the region wide provision development for the Freshwater and Land Plan. The next steps will focus on setting target attribute states (TAS) that will lead to the development of appropriate environmental actions and limit setting. The next stage for engagement with the community is planned for March / April 2024. This stage will be heavily focussed on a face to face approach to take interested persons through draft plan provisions and NOF targets and limits.

<u>Working with iwi</u>

15. Concurrent with the broader community engagement, a number of meetings over the past 6 weeks have been undertaken with Ngā iwi o Taranaki Pou Taiao. These discussions have focussed on the TMOTW objective and the steps of NOF. To better facilitate ongoing collaboration, online MIRO boards have been set up which support FMU by FMU consideration by each iwi, at the same time as a collaborative approach across the whole framework. This work is ongoing and initial feedback is currently being finalised by iwi and will be considered as part of the next steps to refine the draft provisions.

16. Ongoing work and a meeting schedule has been set up with Pou Taiao over coming months to continue conversations as the science and policy framework develop. Engagement with hāpu continues to focus on those who have previously indicated a desire to provide input. This being said the approach to hāpu has again been revisited with recent conversations with iwi resulting in planning for additional reach-out to hāpu.

Financial considerations—LTP/Annual Plan

17. 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

18. 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

19. 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.

Community considerations

20. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

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

Appendices/Attachments

Document 3222231: Freshwater Implementation Project Report - November 2023.

Taranaki Regional Council

Freshwater Implementation Project Report to Policy & Planning Committee

November 2023

	Progress in the last six weeks	Key tasks in the coming six weeks	Risks
National Policy Statement for Freshwater Management	• Consultation period for draft NOF consultation running until 27 October – face to face meetings and an online component. • Continued conversations with Ngā iwi o Taranaki. Pou Taiao agreement focussing on conversation around what it means to give effect to TMOTW through rule development. Direct engagement with iwi and hapu focussing on the draft NOF development. • Refining attribute identification for all values, including conversation with iwi to identify attributes, particularly around Mahinga Kai. Additional attributes are being scoped to measure progress towards achieving environmental outcomes for non-compulsory values such as natural form and character, and fishing. • Planning and commencing overall Target Attribute State process with science leads, initial focus on compulsory attributes. • Begin drafting of region wide objective, policies and rule framework. • Review/finalise the nutrient SCAMP mitigations memo, lake water quality modelling report and threatened species report. • Interviews with farm owners and operators and industry bodies across the region to inform the economic assessment report. • Participation in regional sector response to implementing the RM reform consent duration package with has immediate effect (see paper to the Ops and Regs October Committee). Correspondence to consent holders underway. • The science team is continuing to build its evidence base for informing the target and limit setting process. This involves simulating a range of possible scenarios relating to different water allocation regimes and contaminant load reduction measures.	• Analysis of feedback received during consultation period. Set direction for updates required, working alongside Pou Taiao position. • Finalise attribute identification for all values. Pou Taiao position focussing on Māori freshwater values. • Commence work on identifying Target Attribute State setting with science leads, initial focus on the compulsory attributes. Develop tech memos setting TAS by Christmas for core attributes. • Continue interviews with farm owners and operators and industry bodies across the region to inform the economic assessment report. • Continue discussions with Pukerangiora, Otaraua and Manukorihi hapū in Waitara on Mana o te Wai hui. • Continued conversations with Ngā iwi o Taranaki focussing on refinement of TMOTW and NOF process. Pou Taiao agreement focussing on conversation around what it means to give effect to TMOTW through rule development. Seeking direct engagement with iwi and hapu focussing on the draft NOF development. • Continue drafting of region wide objective, policies and rule framework. • Further refinement work for *E.coli* model continues including stage 3 mitigations.	• Medium risk – Partnership with iwi. Risk that the timeframes, complexity of issues and the need to be working in an agile manner to develop the policy framework will impact on the partnership approach being fostered. Amendments to the Pou Taiao Agreement including the setting up of a steering committee mitigate this risk. • Medium risk – participation in the community engagement is low. Mitigated through continued promotion of process, community meetings switched to being held at various locations, targeted engagement with industry groups to lessen the load on individuals. • Medium risk – potential change to direction of the NPSFM with the new government.
Freshwater Farm Plans	• Continued working group discussions to set project plan and implementation. • Engage with Assure Quality with regard to setting up training module requirements.	• Development of framework for CCCV for freshwater farm plans (FWFP), including meeting with Pou Taiao at the end of the November to discuss framework and approach to work with iwi and hāpu. Update will be provide to the FW Steering Group in December. • Communication strategy for FWFP underway. • Finalise contract with Assure Quality with regard to training modules.	• Medium risk – potential change to direction of FWFP regulations with the new government. Impact is likely to be on timing of requirements.

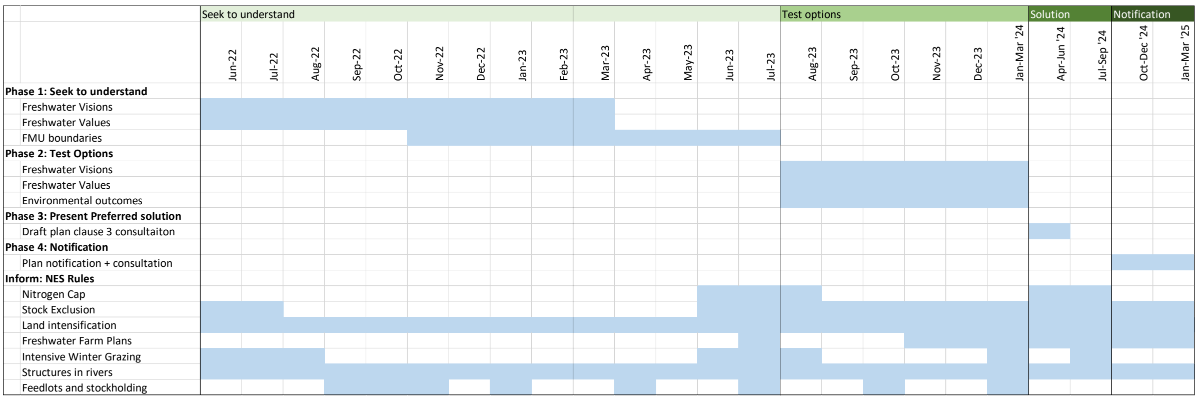
Engagement and Communication Strategy (Policy Development)

Set out below is a high level summary of the engagement approach and timing for key components supporting the policy development. Also noted is a high level timeline for key communications and engagement activity. Note this engagement plan does not including Council working with their tangata whenua partners, this process is subject to an alternative approach led with the Pou Taiao and Council's Iwi communications advisor.

Phase	Stage	What	Who	Timing*
Phase 1	**Seek to understand** Focus: gathering info from audiences about what's important to them	This phase has covered seeking input on a variety of high level freshwater matters including visions for Freshwater in Taranaki, identification of values for freshwater management and feedback on the proposed FMU boundaries. Input has been sought through a variety of mediums including online surveys, social pinpoint, face to face meetings and drop-in sessions (ie Stratford A&P show).	Community and special interest groups.	Apr 2021 to Mar 2023
Phase 2	**Test options** Focus: building and discussion on options that meet the region's wants and needs	There are two key steps in this process: 1. Testing the building blocks of the National Objectives Framework. A discussion document for each FMU is being prepared and will cover visions, values, baselines and environmental outcomes. 2. Testing limits and targets. Continuing to build the National Objectives Framework, this step will present options for the limits and targets for the new plan. This phase will also likely include region wide policy framework discussions.	1. Community – via online consultation opportunity. Special interest groups including industry bodies, catchment groups, government agencies, district councils, environmental NGOs – via workshop discussions. 2. Community and special interest groups. A series of face to face meetings around the region and opportunity for online feedback.	Aug 2023 to Mar 2024
Phase 3	**Present preferred solution** Focus: presentation of best options (draft plan)	A draft plan will be complied and through requirements of the RMA an opportunity for written feedback provided.	Clause 3 – listed in the RMA, and special interest groups.	Mid 2024
Phase 4	**Notification: Public submissions** Focus: formal communication relating to Plan notification	The Freshwater components of the NRP must be notified by December 2024. Once notified all interested parties will have the opportunity formally submit written submissions on the notified plan.	All interested parties.	End 2024 for notification. Submission period early 2025.

* Note the timing is indicative only, as a full programme review is currently being undertaken.

Essential Freshwater Engagement Strategy timeline



MEMORANDUM
Policy & Planning

Date	21 November 2023
Subject:	**Taranaki State of the Environment Lakes Monitoring Programme**
Approved by:	AJ Matthews, Director - Environment Quality
	S J Ruru, Chief Executive
Document:	3220915

Purpose

1. The purpose of this memorandum is to provide the Committee with an overview of the new state of the environment lakes monitoring programme; the current state of health of the region's lakes; and the next steps in our implementation of the National Policy Statement for Freshwater Management 2020 (NPS-FM) in relation to lakes.
2. Included in this overview is a summary of three technical reports, copies of which accompany this memorandum and will be made available on the Council's website:
   - *Modelled national objectives framework attributes for Taranaki lakes and recommendations for baseline sampling,* prepared by Cawthron Institute;
   - *LakeSPI assessment of four Taranaki lakes,* prepared by NIWA; and
   - *LakeSPI assessment of three Taranaki lakes,* prepared by NIWA.

Executive summary

3. The NPS-FM requires the monitoring and assessment of regionally representative lakes, focusing on several water quality and ecological indicators or "attributes" that are set out in the National Objectives Framework (NOF). These attributes are used to inform how well different freshwater values are being provided for, including (but not limited to) ecosystem health, human contact, threatened species, and mahinga kai.
4. Prior to 2022, monitoring focussed on a single lake, Lake Rotorangi, undertaken for compliance monitoring purposes. In response to the requirements of the NPS-FM, a regional state of the environment lakes monitoring programme has been developed and implemented. Six lakes are now monitored on a monthly basis as part of the programme.
5. In addition to monthly water quality monitoring, the NPS-FM also requires regular surveys of lake submerged plants (macrophytes) as an indicator of ecosystem health. During 2021 and 2023, NIWA was commissioned to assess native and invasive plants in seven Taranaki lakes. Of the seven lakes surveyed, six lakes were found to be in high or

moderate condition, above the national bottom line. One lake, Lake Herengawe, was found to be in poor condition and failed to achieve the national bottom line for both the native and invasive indices.

6. Under the NPS-FM, regional councils are required to identify "baseline states", the point from which water quality and ecosystem health must be maintained or improved. To provide an assessment of lake health, we commissioned Cawthron Institute, to determine the baseline state for lakes throughout the region. This report revealed that many of Taranaki's lakes are likely to fall below the "national bottom line", meaning they are considered to be degraded and in poor health. Overall, 78% of lakes were predicted to fail to achieve the bottom line for at least one attribute, with more than 50% of lakes likely to fail the lake-bottom dissolved oxygen attribute. A predicted 72% failed chlorophyll-*a* (a measurement of algae), while 54% failed for total phosphorus and 61% for total nitrogen.

7. There are a number of further steps required to implement the NPS-FM requirements for lakes, which are outlined further in this memorandum. The reports by Cawthron and NIWA also set out further steps to improve the effectiveness and accuracy of the results we gain from our monitoring programme, as well as expand on the information we gather.

Recommendations

That the Taranaki Regional Council:

a) receives the memorandum Taranaki State of the Environment Lakes Monitoring Programme

b) notes the findings and recommendations therein.

Background

8. Lakes and wetlands support a diverse array of plants and animals, some of them rare and threatened. In Taranaki, lakes such as Rotokare and Rotomanu are popular spots for picnicking, fishing, swimming and boating. Highly valued by Māori, lakes and wetlands also provide traditional food sources – known as mahinga kai.

9. Lakes can be classified by how they are formed (geomorphic lake types) and by the mixing pattern of the water and how they are connected to the sea. Of the 37 named lakes and lagoons in Taranaki, eight are artificial, being the product of either quarrying or damming. The rest have formed through natural processes. These include a number of coastal dune lakes, along with volcanic, riverine and landslide lakes. The majority of these natural lakes are found in South Taranaki.

10. Prior to 2022, lake monitoring focused solely on Lake Rotorangi. Lake Rotorangi is an artificial lake used for hydroelectric generation. Monitoring was primarily undertaken for compliance with resource consents associated with the Pātea hydroelectric power scheme. Water quality monitoring of Lake Rotorangi began in 1988 and is conducted four times a year at two established sites. Macrophyte surveys are also conducted every three years to track the abundance and species of invasive plants in the lake.

11. The NPS-FM requires monitoring and assessment of regionally representative lakes against a number of attributes. These include phytoplankton, total nitrogen, total phosphorus, dissolved oxygen and lake submerged plant indicators.

12. To meet the requirements of the NPS-FM, a state of environment lakes monitoring programme was developed during 2021/2022. Criteria based on size (>1 ha), degree of modification, and suitable access were applied to further refine the lakes, after which 17 lakes were short-listed for further investigation.

13. In total, six naturally formed lakes (Table 1) were finally selected to be included in the programme, in addition to continuing the long-term monitoring of Lake Rotorangi. While these lakes are broadly representative of the different lakes types found throughout the region, not all Freshwater Management Units (FMUs) are included in the programme. For example, there are no lakes in the Waitara FMU, and the only lake in the Pātea FMU, Lake Rotorangi, is not included in the monthly monitoring programme. This is because appropriate lakes were unable to be identified in these FMUs. Our lakes monitoring programme was peer reviewed in 2022 by NIWA (de Winton *et al*., 2022b), with a number of changes adopted based on the recommendations made.

Table 1 Monitored lakes in the Taranaki region for the state of the environment programme including location, FENZ classification, maximum depth (m) and area (ha).

Proposed FMU	Lake	Easting	Northing	FENZ Classification	TRC estimated max depth (m)	Area (ha)
Southern Hill Country	Lake Rotokare	1721453	5631971	Mild, shallow, small	11	16
	Lake Waikare	1754873	5607388	Warm, moderately shallow, small	19	7.4
Coastal Terraces	Lake Herengawe	1740432	5593938	Warm, moderately shallow, small	4.6	14
	Lake Kaikura	1720486	5604553	Warm, shallow, very small	4.5	5.9
Pātea	Lake Rotorangi	1735037	5621609	Mild, deep, large	60	630
Volcanic Ringplain	Barrett Lagoon	1690018	5672617	N/A	6.2	4
Northern Hill Country	Lake Rotokawau	1748508	5692929	Warm, shallow, very small	12	1.4

14. In addition to monitoring water quality, the NPS-FM also requires councils to undertake monitoring of native and invasive lake submerged plants using a method known as Lake Submerged Plant Indicators (LakeSPI). This surveying approach requires divers to assess the presence of different aquatic plants (macrophytes), which in turn is used to

assess lake ecosystem health under the NOF. Surveying is required at least every five years to track changes over time. LakeSPI surveys have now been undertaken by NIWA in seven of the regions lakes, with the findings documented in two reports, both of which accompany this agenda memorandum.

15. While there is currently limited available information on the health of many of the region's lakes, we are able to estimate their likely state utilising national modelling. To provide an assessment of lake health, we commissioned Cawthron Institute to predict the current state of health of lakes throughout Taranaki. Full details can be found in the report *Modelled national objectives framework attributes for Taranaki lakes and recommendations for baseline sampling* which accompanies this agenda memorandum.

Discussion

State of environment lakes monitoring

16. All six monitored lakes are sampled at the beginning of each month. This monitoring includes taking samples at the deepest part of the lake and completing vertical profiling of temperature, dissolved oxygen, conductivity, pH and turbidity. These measurements are taken with an “aquatroll”, a specialised piece of equipment, at the surface (0.2 m) and then every 0.5 m from then until the lake bottom. At the deepest point we also take a secchi disk measurement, which indicates the clarity of the water. Water samples are taken at the surface (~0.2 m), the epilimnion (top layer), and the hypolimnion (bottom layer) which are shown in Figure 1. These water samples are analysed for different properties depending on the depth of the sample including:

- **Surface:** Turbidity, pH, electrical conductivity, total suspended solids, and *E. coli*
- **Epilimnion:** The abovementioned properties, excluding *E. coli*, from the surface water, chlorophyll-*a*, and nutrient samples (total nitrogen, total ammonia, nitrite, nitrate, nitrate + nitrite, total Kjeldahl nitrogen, dissolved reactive phosphorus, total dissolved phosphorus, dissolved organic phosphorus, total phosphorus)
- **Hypolimnion:** The same properties as the epilimnion, excluding chlorophyll-*a*.

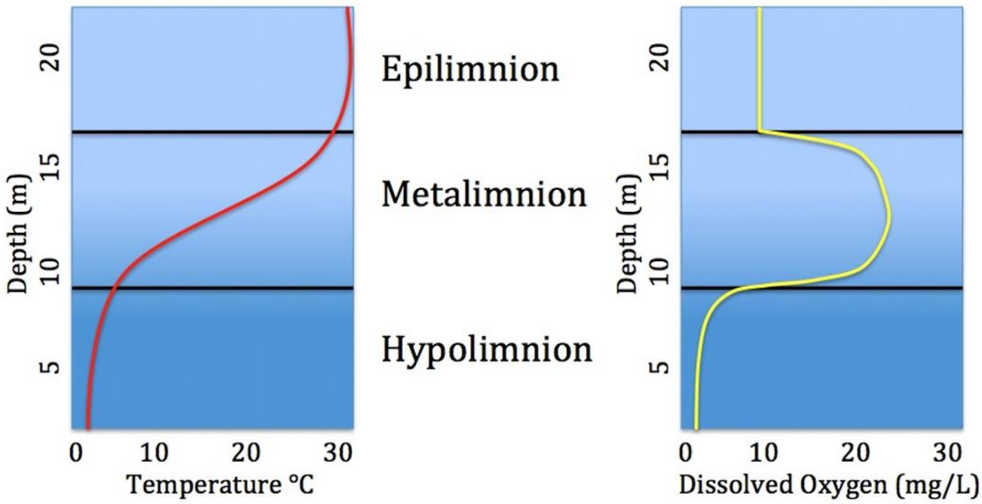


Figure 1 Depth profiles and temperature and dissolved oxygen in relation to the epilimnion and hypolimnion (Source: aquaticfieldcourse2013 on Wordpress.com).

17. The NPS-FM sets out the requirements for monitoring and assessment of lake water quality and ecosystem health. Attributes monitored as part of our state of environment lakes monitoring programme, as required by the NPS-FM, are described in Table 2.

Table 2 Freshwater attributes for lakes as set out in the National Objectives Framework of the NPS-FM.

Attribute	Description
Planktonic Cyanobacteria	Planktonic cyanobacteria can be found floating in the water column in lakes. Cyanobacteria are naturally occurring and at low levels do not present a risk however, some cyanobacteria can produce cyanotoxins which can be detrimental to the health of people and animals (including lake fauna). At certain times of year, increases in the abundance of cyanobacteria can result in algal "blooms" when cyanobacteria can pose a risk, particularly to animals and humans.
Total Nitrogen	Nitrogen is an essential nutrient for plant and algal growth. However, elevated levels contribute to excessive growth and can result in negative ecological effects. Nitrogen can be present in water in several forms (nitrate, nitrite, ammoniacal nitrogen and organic nitrogen). Total nitrogen includes all forms of nitrogen. It is important to note that if a sample is analysed for total nitrogen, it will also include any nitrogen that is not bioavailable for organisms (this is also relevant for total phosphorus). The most common sources of nitrogen include leaching and run-off from agriculture and horticulture or from industrial or wastewater discharges.
Total Phosphorus	Total phosphorus is a measure of all forms of phosphorus in the water, including dissolved and particulate, organic and inorganic. Phosphorus is naturally present in water and essential for plant growth; however, like nitrogen, excess phosphorus can encourage the nuisance growth of algae and macrophytes and can degrade ecosystems. While phosphorus is naturally elevated in our region's soils due to the volcanic geology, fertiliser application along with the discharge of domestic and animal waste, contributes to elevated levels of phosphorus in freshwater. Much of the phosphorus in lakes is a legacy of erosion caused by land development activities such as native vegetation clearance and fertiliser application.
Dissolved Oxygen	This includes the mid-hypolimnetic dissolved oxygen (which is the bottom layer of lakes that are stratified) and lake-bottom dissolved oxygen (which is measured 1 m above the sediment surface). Dissolved oxygen is critical to all aquatic life within a lake ecosystem. Oxygen can enter water by diffusion from the atmosphere, aeration of the water through surface turbulence, and as a product of photosynthesis. The oxygen content of water decreases as nutrients and organic materials increase. Excessive plant and algae growth and decomposition in response to

Attribute	Description
	increasing nutrients in waterways can also significantly affect the amount of dissolved oxygen available (Goodwin & Young, 2022).
Lake Submerged Plant Indicators (LakeSPI)	Indices that include both native and invasive macrophytes. Macrophytes are a good indicator of lake health and are a reasonably stable property we can measure that produces accurate results. Since macrophyte communities can be heavily impacted by catchment activities which result in increased sediment and nutrient loading, large changes in submerged plant indices can provide a useful indication of these pressures (de Winton *et al.*, 2022). These surveys can also identify potential invasions of pest plants in Taranaki. This allows us to take quick action, as needed, to slow or stop the spread to nearby waterways.
Ammonia (toxicity)	Ammoniacal nitrogen (NH_4-N), also called 'ammonium', is the concentration of nitrogen present as either ammonia (NH_3) or ammonium (NH_4) in water. The balance between ammonia and ammonium depends on the pH and temperature of the water. Ammoniacal forms of nitrogen enter waterways such as lakes primarily through point source discharges, such as raw sewage or dairy shed effluent. At high concentrations, ammonia and nitrate can be toxic to aquatic life.
Phytoplankton	Phytoplankton include algae and cyanobacteria that float in the water column and can produce oxygen through photosynthesis. All phytoplankton contain chlorophyll-*a* (chl-*a*) which can be used to assess the amount of algae in a lake, measured as phytoplankton biomass. The amount of phytoplankton in a lake is often closely linked with the amount of nutrient enrichment and biological productivity of a lake ecosystem (referred to as the trophic state).
Escherichia coli (E. coli)	*E. coli* is an indicator of faecal contamination, which can coincide with other harmful bacteria and viruses.

LakeSPI

18. Surveying of submerged plant indicators present in seven Taranaki lakes was commissioned in 2021 and 2023. Currently, all six monitored lakes have been assessed by NIWA, along with one additional lake, Lake Mangawhio. The results of these surveys are provided in two reports (de Winton *et al.*, 2022a; David *et al.*, 2023) which outline the estimated Native Condition Index, Invasive Impact Index, and overall LakeSPI Index. For the LakeSPI Index and the Native Condition Index, higher scores represent better ecological health whilst for the Invasive Impact Index the reverse is true (Tables 3 and 4).

Table 3 The categories of lake condition based on the overall LakeSPI Index score (adapted from de Winton *et al.*, 2022a).

LakeSPI Index Score	LakesSPI Category
>75%	Excellent

>50-75%	High
>20-50%	Moderate
0-20%	Poor
0%	Non-vegetated

Table 4 National Objectives Framework attribute table for LakeSPI indices. Native Condition Index and Invasive Impact Index attribute bands from the NPS-FM (2020, Appendix 2B, Tables 11 and 12).

Attribute Band	Native Condition Index	Invasive Impact Index
A	>75%	0
B	>50 and ≤ 75%	>1 and ≤25%
C	≥20 and ≤50%	>25 and ≤90%
National Bottom Line	20%	90%
D	<20%	>90%

19. All surveyed lakes within Taranaki were found to be above the national bottom line, with the exception of Lake Herengawe. Lakes in high condition included Lakes Kaikura, Rotokawau and Waikare; while those in moderate condition included Lakes Rotokare, Mangawhio and Barrett Lagoon. LakeSPI indices ranged from 13% (Lake Herengawe) to 74% (Lake Rotokawau). The native condition scores of the lakes range from 11% to 52%, while the invasive impact scores ranged from 0% to 95%. Results are shown in Table 5.

Table 5 LakeSPI Index, Native Condition Index and Invasive Impact Index results for all surveyed lakes (de Winton *et al*., 2022a; David *et al*., 2023).

Lake	Date completed	LakeSPI Index (%)	Native Condition Index (%)	Invasive Impact Index (%)
Kaikura	01/12/2021	66	52	19
Rotokare	30-31/11/2021	33	37	64
Mangawhio	02/12/2021	21	28	79
Rotokawau	21/09/23	74	52	0
Waikare	19/09/23	52	32	0
Barrett Lagoon	20/09/2023	23	23	85
Herengawe	18/09/2023	13	11	95

20. Observations of each lake were made during each survey, including:

- **Lake Kaikura** is part of a protected wetland complex and supports regionally and national rare flora and fauna. The surrounding catchment is predominantly agriculture (Lakes380, 2023). Lake Kaikura had scores that reflected dominance of native plants, with minimal invasive species but had relatively low macrophyte diversity (number and abundance of different species).

- **Lake Rotokare** is located in the Rotokare Scenic Reserve. The lake is popular for boating in the summer, making it vulnerable to transfer of pest plants and fish. From historic sediment samples, there is evidence that algal levels have always been elevated, but have increased in the past century, possibly due to the introduction of red finned perch (*Perca fluviatus*), which are pervasive predators that deplete zooplankton, with less grazing pressure on algae, this can result in an increase of algae (Lakes380, 2023). Lake Rotokare was assigned band C for both NPS-FM attributes due to the widespread invasive *Lagarosiphon major*, herein referred to as lagarosiphon. Despite the abundance of lagarosiphon, there were still areas that acted as a stronghold for native plants, which prevented a lower grade below the national bottom line.
- **Lake Mangawhio** is located in a relatively unmodified catchment, with moderate to steep hill country with flanking tawa-podocarp forest and with associated wetland areas. Lake Mangawhio was placed above the national bottom line for the two NPS-FM attributes. The placement in band C, rather than a higher category, was largely due to lagarosiphon and the presence of *Ceratophyllum demersum*, commonly referred to as “hornwort”. It was noted that the steep-sided lake and sediment instability could be a contributing factor for restricting the habitat for submerged vegetation.
- **Lake Rotokawau** is surrounded mostly by native forest, with the wider area being predominantly pasture (Lakes380, 2023). Lake Mangawhio had a Native Condition Index that fell within band B and an Invasive Impact Index within band A. This was attributed to the absence of invasive plants.
- **Lake Waikare** is located on private property, surrounded predominately by pine plantation, with the west of the lake being surrounded by a large area of native bush identified as a significant natural area. The lake and its surrounding wetland area supports important fauna and flora (Lakes380, 2023). Lake Waikare achieved band A for the Invasive Impact Index, and band C for the Native Condition Index. The Invasive Index grade was due to the lack of invasive plants. However, the Native Condition Index only achieved band B due to a lack of diversity and shallow growing depth of macrophytes. This occurred due to limited light penetration, which was a result of high turbidity (low clarity) in the lake.
- **Barrett Lagoon** is located in an urban area, mostly surrounded by the native bush of Barrett Domain, with pasture on the margins of the south of the lake (Lakes380, 2023). Barrett Lagoon had attributes that fell within band C. Although there was a widespread abundance of invasive plants, including egeria (*Egeria densa*), lagarosiphon, and the presence of introduced waterlily (*Nymphaea* hybrid), there was also a presence of several native plant species.
- **Lake Herengawe** is a small coastal dune lake surrounded by lowland swamp. The surrounding catchment is highly modified pasture, often up to the lake edge (Lakes380, 2023). Lake Herengawe was the only monitored Taranaki lake to fall below the national bottom line, which occurred for both NPS-FM attributes. This result is attributed to the widespread invasive vegetation, including hornwort, egeria, and lagarosiphon.

21. LakeSPI surveys are required every five years. In time, further surveys will provide an overall picture of the ecological health of other Taranaki lakes.

Current (baseline) state of health of Taranaki lakes

22. The NPS-FM requires monitoring and assessment of regionally representative lakes against a number of attributes in the NOF. A key step in the NOF process is to identify "baseline states" for each attribute set out in the NPS-FM. The baseline state provides the reference point from which we must either maintain or improve the state of a particular freshwater attribute. Where a baseline state fails to achieve a prescribed 'national bottom line', action must be taken to achieve the target state identified by the council and community. Work is currently underway to set target attribute states for freshwater in Taranaki.

23. Where councils do not hold data or information about an attribute, they must use the best available information. We were able to determine baseline states based on three different data sources. These included:

    - Data sourced from our regional state of the environment lake monitoring programme (noting that this is a preliminary dataset, from May 2023 onwards).
    - Modelled estimates of baseline state from Cawthron (Schallenberg *et al.*, 2023) for each of the six newly monitored state of environment lakes, as well as 61 other Taranaki lakes. Modelling utilised Sediment Bacterial Indices (SBI), derived from sediment core information that was gathered through the national Lakes380 programme. With 256 lakes now surveyed throughout New Zealand (including eight in Taranaki), this dataset is considered highly representative and, therefore, is a good indication of the baseline attributes of our lakes.
    - Modelled lake water quality commissioned by MfE and developed by Snelder *et al.* (2022), who combined monitored water quality variables with catchment and land-use data for New Zealand. It is important to note that the SBI modelling (above) does not accurately estimate ammonia and cyanobacterial biovolume. Therefore this MfE model provides a better estimate for those attributes (Schallenberg *et al.*, 2023).

24. From these datasets, we were able to derive the baseline state of different NOF attributes for all six monitored lakes (Table 6), as well as lakes across the wider region.

Table 6 The NOF attribute bands received for six lakes included in the SOE programme (Lake Rotokawau, Barrett Lagoon, Lake Rotokare, Lake Kaikura, Lake Herengawe, Lake Waikare), including: TRC = measured data; SBI = modelled data (Schallenberg *et al.*, 2023); MfE = modelled data (Snelder *et al.*, 2022); and BAS = the overall site-based baseline assessment. Table adapted from Zieltjes and McElroy, 2023.

	Total nitrogen (annual median)				Ammonia (toxicity) (annual median)			Chlorophyll-*a* (annual median and maximum)			
	SBI	MfE	TRC	BAS	MfE	TRC	BAS	SBI	MfE	TRC	BAS
Lake Rotokawau	D	D	B	C	A	B	B	D	D	D	D
Barrett Lagoon	D	D	D	D	A	B	B	D	D	B	C
Lake Rotokare	D	B	C	C	A	A	A	C	B	D	D
Lake Kaikura	C	D	D	D	A	A	A	D	C	B	C
Lake Herengawe	D	D	D	D	A	A	A	D	D	D	D
Lake Waikare	C	B	C	C	A	A	A	C	B	C	C

	Total phosphorus (annual median)				Ammonia (toxicity) (annual 95th percentile)			Dissolved Oxygen	
	SBI	MfE	TRC	BAS	MfE	TRC	BAS	TRC Bottom	TRC Hypolimnion
Lake Rotokawau	D	C	B	C	B	B	B	D	D
Barrett Lagoon	D	D	B	C	C	B	B	D	N/A
Lake Rotokare	C	B	C	D	A	B	B	D	D
Lake Kaikura	D	D	C	C	B	B	B	C	N/A
Lake Herengawe	D	D	C	C	B	A	B	A	N/A
Lake Waikare	C	B	D	D	A	B	B	D	D

25. All of our six monitored state of the environment lakes have at least one attribute within band D, i.e. below the national bottom line (Table 7). The only attribute that has not fallen below the national bottom line for our six lakes is ammonia, for both the annual median and the 95th percentile.

Table 7 Summary of monitored lakes with NOF attribute baseline grades below the national bottom line.

	Lake Rotokawau	Barrett Lagoon	Lake Rotokare	Lake Kaikura	Lake Herengawe	Lake Waikare	Total
Total nitrogen		D		D	D		3
Total phosphorus			D			D	2
Chl-*a*	D		D		D		3
Ammonia (toxicity)							0
Ammonia (toxicity)							0
Lake-bottom DO	D	D	D			D	4
Mid-hypolim DO	D		D			D	3
Total	3	2	4	1	2	3	

26. Schallenberg *et al*. (2023) estimated that over half of the lakes in the Taranaki Region (based on a subsample of 36) have a high risk of depleted lake bottom dissolved oxygen and may be below the national bottom line. Based on the SBI modelling, 78% of Taranaki lakes are estimated to fail the bottom line for at least one attribute. An estimated 72% fail for chl-a, 54% fail for total phosphorus, and 61% are predicted to fail total nitrogen. Only 15 out of the 67 lakes included in the modelling assessment are estimated not to fail the bottom line for any attributes. Only one lake was estimated to achieve the A or B bands for all attributes. This was Lake Dive, located in a largely unmodified catchment within Te Papa-Kura-o-Taranaki on Taranaki Maunga.

27. The SBI and MfE models produced similar results; however, compared to the MfE models, the SBI model estimated that an additional 11 lakes failed the chl-*a* bottom line, that four more lakes failed total phosphorus, and one more lake failed total nitrogen. The SBI and MfE modelled results were noticeably different in only four lakes, and Schallenberg *et al*. stated that for three of these, the MfE models were likely inaccurate.

28. It is important to note that due to the limited available data, the identified baselines are considered preliminary and have a high level of uncertainty. This increased uncertainty was taken into account when setting baseline grades, with the modelled estimates considered together with the limited monitoring dataset to support the overall grading.

Next steps

29. Next steps in the NOF process include setting target states, and identifying management options and actions to achieve these. This is being undertaken, taking into consideration the views of iwi/hapū, community groups and stakeholders, including information gathered through recent community engagement sessions.
30. Monitoring of taonga species and mahinga kai will need to be developed in partnership with the relevant iwi and hapū, with some iwi and hapū already expressing interest in undertaking or participating in such monitoring. We are actively exploring opportunities to include iwi/hapū in state of environment monitoring monitoring programmes, and improving communication around these. This is a work in progress.
31. We will need to identify any limits on resource use that will improve lake water quality and ecosystem health in relation to the attributes outlined in Appendix 2A of the NPS-FM (phytoplankton, total nitrogen, total phosphorus, ammonia, *E. coli*, and cyanobacteria), and include these limits in our regional plan. This may also require new and more restrictive conditions on resource consents.
32. For the attributes listed in Appendix 2B of the NPS-FM including, native and invasive submerged plants, and dissolved oxygen (lake-bottom and mid-hypolimnetic), we will also need to develop action plans. We may also identify limits on resource use that will impact these attributes and include them in our regional plan, and we may also impose conditions on resource consents.
33. As we continue monitoring, we will need to keep our baseline attributes in mind. This is because the monitoring data that we used to set the preliminary baseline attributes only included a limited data set. Further monitoring may reveal differences that come with seasonal variation. Therefore, the current draft baseline attributes could change.
34. Cawthron has identified several lakes that are recommended for point sampling due to the high probability that they will fall below the national bottom line (based on SBI), and some lakes that have been highlighted for sampling due to the modelling being identified as potentially inaccurate (Schallenberg *et al.*, 2023). The report includes a recommendation of one-off sampling of up to 31 lakes, to validate the model predictions used to identify the preliminary baseline attributes.
35. Further information will be necessary to develop lake management and/or remediation plans. This information could include:
    - Lake capture zone delineation, to identify the source of overland and groundwater flow paths.
    - Lake bathymetric surveys to estimate lake volumes and confirm the deepest point within lakes for sampling.
    - Nutrient budgets to account for sources and sinks of nutrients, as well as nutrient cycling and sequestration.
    - Pest fish surveys and/or eDNA sampling would assist in the identification of native and introduced species in lakes.

36. This knowledge base will be developed in time, as resourcing permits. Our immediate focus remains on the ongoing collection of water quality and ecosystem health data and information to ensure baseline and target state information is well-placed to inform the next stage in the NPS-FM process.

Financial considerations—LTP/Annual Plan

37. 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

38. 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

39. 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.

Community considerations

40. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

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

References

Blackmore K. 2021. *Proposed State of the Environment Lakes Monitoring Programme*. Taranaki Regional Council Document #2910341. Taranaki Regional Council.

David S. 2023. *LakeSPI assessment of four Taranaki lakes*. Prepared for Taranaki Regional Council October 2023. NIWA.

de Winton M, Elcock S, Taumoepeau A. 2022a. *LakeSPI assessment of three Taranaki lakes*. Prepared for Taranaki Regional Council January 2022. NIWA.

de Winton M, Verburg P, Milne J. 2022b. *Review of proposed lake monitoring programme for the Taranaki Region*. Wellington. NIWA.

Lakes 380. 2023. [online] Available at: https://lakes380.com /. [Accessed 5 October 2020].

McElroy T, Zieltjes B. 2023. *Technical Memorandum - Draft Baseline State for Escherichia coli and Cyanobacteria (Planktonic) in Taranaki Rivers and Lakes*. Taranaki Regional Council Document #3201369. Taranaki Regional Council.

Ministry for the Environment. 2020. *National Policy Statement for Freshwater Management 2020*. Ministry for the Environment publication ME1720, February 2023.

Shallenberg L, Pearman J, Vandergoes M, Wood S. 2023. *Modelled national objectives framework attributes for Taranaki lakes and recommendations for baseline sampling*. Cawthron report 3946. Prepared for Taranaki Regional Council. Nelson: Cawthron Institute.

Snelder T, Fraser C, Whitehead A. 2022. *Spatial modelling of Lake water quality state incorporating monitoring data for the period 2016 to 2020*. Christchurch: Land Water People. Report No. 2021-15. Prepared for Ministry for the Environment.

Zieltjes B, McElroy T. 2023. *Technical memorandum – Lakes (trophic state)*. Taranaki Regional Council Document #3192882. Taranaki Regional Council.

Appendices/Attachments

Document 3217053: LakeSPI assessment of four Taranaki lakes.

Document 2974507: LakeSPI assessment of three Taranaki lakes.

Document 3221379: Modelled national objectives framework attributes for Taranaki lakes and recommendations for baseline sampling.

LakeSPI assessment of four Taranaki lakes

Prepared for Taranaki Regional Council
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Contents

Tables

Figures

1 Introduction

Taranaki Regional Council (TRC) is responsible for managing Taranaki's waterbodies including 89 lakes over 1 ha in size, as per the Department of Conversation's Freshwater Ecosystems geo-database[1]. The National Policy Statement for Freshwater Management 2020 (NPS-FM 2020) directs TRC to set new objectives, policies, and limits for water management at a local level[2]. The region's Long-Term Plan 2021-2031 has a focus on implementing the new national policy statement for freshwater management (NPS-FM) and seeks to maintain and enhance indigenous biodiversity in the Taranaki catchments and waterbodies[3].

Indigenous freshwater ecosystems in lakes are threatened by impacts from invasive weeds, and also land use changes such as agricultural intensification that caused increased nutrient and sediment loading to waterbodies. The LakeSPI survey method allows lake managers to assess and report on the status of lakes at an individual, regional, or national level; monitor changes in a lake or group of lakes over time and prioritise lake management initiatives accordingly (e.g., protection, monitoring, weed surveillance). The NPS-FM 2020 lists component indices of LakeSPI, Native Condition Index and Invasive Impact Index, as new ecosystem health attributes with national bottom lines. It is envisaged that these new attributes will provide a way to improve how lake ecosystem health is measured and managed.

In December 2021, TRC commissioned NIWA to survey Lakes Kaikura, Mangawhio and Rotokare using the LakeSPI method for the first time in the Taranaki region. This year, TRC commissioned surveys for a further four lakes: Lakes Herengawe, Waikare, Rotokare, also known as Barrett Lagoon, and Rotokawau.

This report provides detailed results and observations for the latest LakeSPI surveys undertaken in September 2023 in Lake Herengawe, Lake Waikare, Barrett Lagoon (Rotokare), and Lake Rotokawau. The Appendices include a national status ranking for all seven Taranaki Region lakes (Appendix A), as well as a list of recorded aquatic plant species per surveyed lake in 2023 (Appendix B).

[1] Freshwater Ecosystems geo-database (doc.govt.nz)
[2] National Policy Statement for Freshwater Management 2020 Amended February 2023 | Ministry for the Environment
[3] 2021/2031 Long-Term Plan (trc.govt.nz)https://www.trc.govt.nz/assets/Documents/Plans-policies/LTP2021/LTP2021-web.pdf

2 Method

2.1 LakeSPI

LakeSPI is a bioassessment tool that uses Submerged Plant Indicators (SPI) for assessing the ecological condition of New Zealand lakes and for monitoring changes in lakes. Key assumptions of the LakeSPI method are that native plant species and high plant diversity represents healthier lakes or better lake condition, while invasive plants are ranked for undesirability based on their displacement potential and degree of measured ecological impact (Clayton and Edwards 2006, de Winton et al. 2012).
Features of aquatic vegetation structure and composition are used to generate three LakeSPI indices:

- 'Native Condition Index' – This captures the native character of vegetation in a lake based on diversity and extent of indigenous plant communities. A higher score means healthier, deeper, diverse submerged vegetation.
- 'Invasive Impact Index' – This captures the invasive character of vegetation in a lake based on the degree of impact by invasive weed species. A higher score means more impact from exotic species, which is often undesirable.
- 'LakeSPI Index' – This is a synthesis of components from both the native condition and invasive impact condition of a lake and provides an overall indication of lake condition. The higher the score the better the condition.

Because lakes have differing physical characteristics that can influence the extent and type of submerged vegetation, each of the LakeSPI indices are expressed in this report as a percentage of a lake's maximum (i.e., 100%) scoring potential. Scoring potential reflects the maximum depth of the lake to normalise the results from very different types of lakes. In lakes where submerged vegetation cover does not exceed 10% at the majority of sites, LakeSPI indices default to 0%. A lake scoring full points for all LakeSPI indicator criteria would result in a LakeSPI Index of 100%, a Native Condition Index of 100% and an Invasive Impact Index of 0%.

A complete description of measured characteristics is given in the technical report and user manual at https://lakespi.niwa.co.nz/. The LakeSPI method is supported by a web-reporting service found at https://lakespi.niwa.co.nz/ where scores for lakes assessed to date can be searched and displayed. This secure and freely accessible data repository allows agencies to compare lake scores with other lakes regionally and nationally as required.

2.2 Survey approach

At each lake, NIWA established five baseline sites, chosen to be representative of the lake vegetation and allowing full extent of vegetation depth development, away from local influences such as stream inflows. Along each profile, scuba divers recorded relevant vegetation characteristics on data sheets, including measures of diversity from the presence of key plant communities, the depth extent of vegetation and the degree of impact by invasive weed species (if present). A full description of the vegetation features that are assessed for the LakeSPI method is found in the technical report and user manual on the web-reporting pages https://lakespi.niwa.co.nz. Observations were entered into the NIWA LakeSPI database, which calculates the three LakeSPI indices.

Although identification to species level is not required for all plants assessed by LakeSPI, NIWA has additionally listed all plant species recorded within the lakes in Appendix B.

2.3 Reporting

2.3.1 LakeSPI condition categories

For ease of reporting results, five lake condition categories (Table 1) are used to provide a description of a lakes status at the time of a survey. These categories are allocated according to the LakeSPI Index score:

Table 1: Five categories of lake condition based on LakeSPI Index score.

LakeSPI Index score	LakeSPI Category
>75%	Excellent
>50-75%	High
>20-50%	Moderate
>0-20%	Poor
0%	Non-vegetated

2.3.2 National Policy Statement for Freshwater Management

The NPS-FM has included two LakeSPI indices as attributes in its National Objectives Framework (NOF) that require action plans (NPS-FM, 2020). Attribute bands are related to Native Condition Index and Invasive Impact Index values as shown in Table 2. Any lake that falls below the national bottom line is considered degraded and may require TRC to prepare a time-based action plan to achieve a target status. If the current state is below the national bottom line due to natural processes (e.g., naturally non-vegetated geothermal or peat lakes), a target attribute state below the national bottom line may be set. Currently, the Ministry for the Environment state that the Native Condition Index and Invasive Impact Index should be assessed every three years. Although, NIWA has previously recommended five yearly surveys, with more frequent surveys suggested if large changes in ecological condition are detected (e.g., pressure from land-use intensification or new invasive weed species incursions).

Table 2: National Objectives Framework attribute table for LakeSPI indices. Native Condition Index and Invasive Impact Index attribute bands from the NPS-FM (2020).

Attribute band	Native Condition Index	Invasive Impact Index
A	>75%	0%
B	>50 and ≥75%	>1 and ≤25%
C	≥20 and ≤50%	>25 and ≤90%
National bottom line	20%	90%
D	<20%	>90%

2.3.3 Lake Summary

For each lake, a summary table lists:

- The LakeSPI category of ecological condition for the lake.
- National ranking for the surveyed lake, based on position for LakeSPI Index out of all lakes surveyed (i.e., 276 ranks for 342 surveyed lakes).
- Attribute bands for Native Condition Index and Invasive Impact Index under the NPSFM (2020).
- Lake maximum depth established during the current survey or previously available.
- Maximum depth of vegetation recorded during the current survey.

3 Results

The following pages detail the observations and results of the LakeSPI surveys undertaken in Lake Herengawe, Lake Waikare, Barrett Lagoon (Rotokare), and Lake Rotokawau in September 2023. Figure 1provides an overview of the lake locations within the Taranaki Region, while Table 3 presents the LakeSPI results for each lake in order of their LakeSPI Index scores, with the indices presented as a percentage of maximum scoring potential.

Figure 1: Map of Taranaki Region Lakes surveyed in September 2023 including their LakeSPI Condition category.

Table 3: Summary of current LakeSPI indices for the four surveyed Taranaki lakes.

Lake	LakeSPI Survey date	LakeSPI Index (%)	Native Condition Index (%)	Invasive Impact Index (%)	Lake Condition Category
Rotokawau	21/09/2023	73.6%	51.7%	0.0%	High
Waikare	19/09/2023	52.1%	32.1%	0.0%	High
Barrett Lagoon	20/09/2023	23.0%	23.0%	84.4%	Moderate
Herengawe	18/09/2023	12.6%	10.7%	94.8%	Poor

3.1 Lake Herengawe

Lake Summary

Lake condition: Poor

Lake ranking: 255th

Attribute Bands
Native Condition Index: D
Invasive Impact Index: D

Lake maximum depth: 5.0 m

Max depth of vegetation: 4.1 m

Lake Herengawe, a coastal dune lake in south Taranaki, was categorised in a poor ecological condition with a LakeSPI index of 12.6% (Figure 2). This result reflected the high impact (94.8%) by invasive vegetation throughout the lake, including *Ceratophyllum demersum, Egeria densa*, and *Lagarosiphon major*. Both the Native Condition Index (11%) and the Invasive Impact Index (95%) fall into the D attribute bands, which leaves Lake Herengawe's ecological condition below the national bottom line based on the NPS-FM (2020) (Table 2).

Lake Herengawe Submerged Plant Indicators

Survey Date	Status	LakeSPI %	Native Condition %	Invasive Impact %
September 2023	Poor	12.6%	10.7%	94.8%

Figure 2: LakeSPI results for Lake Herengawe. LakeSPI Indices expressed as a percentage of lake maximum potential.

The submerged vegetation (Figure 3) at all five LakeSPI sites was dominated by the invasive weed *Ceratophyllum demersum* (hornwort), which grew densely to a maximum height of 3 m and commonly formed 75-100% cover. *Egeria densa* was recorded at four of the five surveyed sites to a maximum depth of 4.1 m and with a maximum height of 2.5 m. Patches of *Lagarosiphon major* with a cover of 1-5% and a maximum height of 0.4 m were located to a depth of 3.4 m at one LakeSPI site.

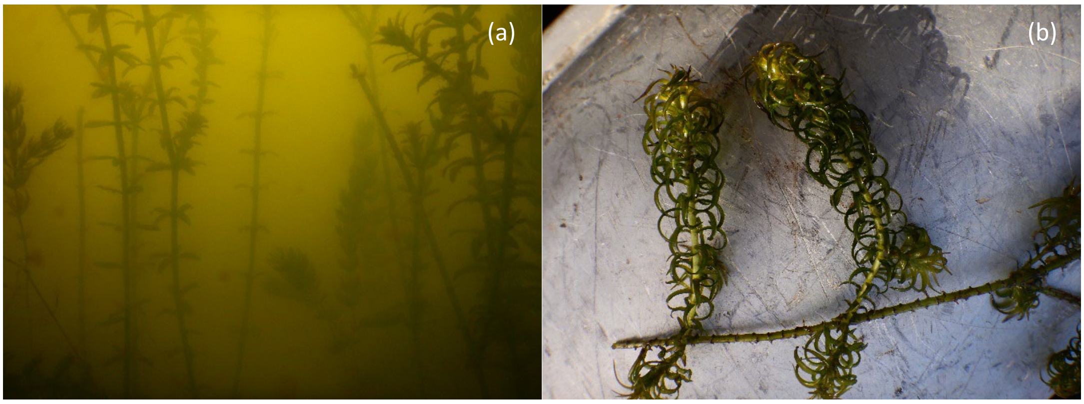


Figure 3: (a) dense bed of *Ceratophyllum demersum* and *Egeria densa* (b) with some *Lagarosiphon major* also recorded.

Native submerged vascular plants were present in the shallow areas down to 1.5m depth. The native pondweed *Potamogeton ochreatus* formed a low cover (≤5%) at one LakeSPI site between depths of 1.0 to 1.5 m, reaching a maximum, surface-reaching, height of 1.5 m. The native milfoil *Myriophyllum triphyllum* was recorded at two survey sites in Lake Herengawe. The depth range for milfoil was limited to 0.3 – 1.0 m with a sparse cover of ≤5% and a maximum plant height of 0.4 m.

Emergents at the water edge were identified as *Typha orientalis* (raupō) and *Schoenoplectus* spp., growing at moderate covers (6-25%) and emergent from maximum depths of 1.4 m. *Isolepis prolifera* was recorded at only one LakeSPI site , but reached a maximum cover of ≥96% at depths between 0 – 0.2 m. Lake Herengawe is not fully fenced, and cattle grazing to the lake edge, as observed during fieldwork, had damaged the marginal vegetation of the waterbody (Figure 4).

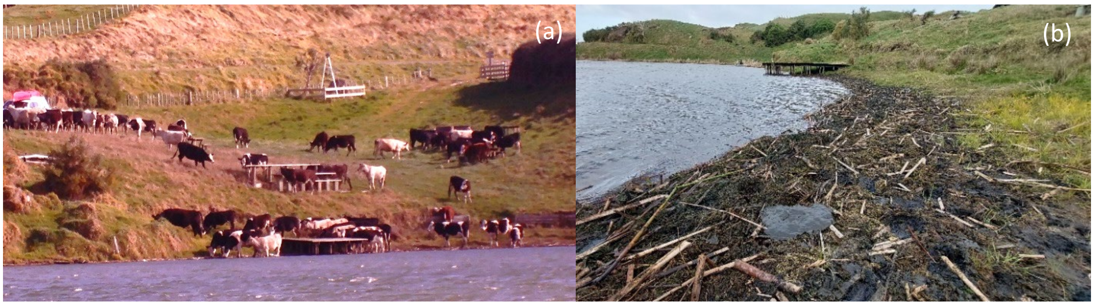


Figure 4: (a) Cattle access in Lake Herengawe; (b) discharged waste and trampled water edge at Lake Herengawe.

3.2 Lake Waikare

Lake Summary

Lake condition: High

Lake ranking: 129th

Attribute Bands
Native Condition Index: C
Invasive Impact Index: A

Lake maximum depth: 18.9 m

Max depth of vegetation: 3.4 m

With a LakeSPI Index of 52.1%, Lake Waikare was categorised as a high ecological condition (Figure 5). While the Native Condition Index is relatively low at 32.1% and scores an attribute band C, due to shallow growing depth and lack of plant diversity, the absence of invasive weeds, results in an Invasive Impact Index of 0% and A band (Table 2).

Lake Waikare Submerged Plant Indicators

Survey Date	Status	LakeSPI %	Native Condition %	Invasive Impact %
September 2023	High	52.1%	32.1%	0.0%

Figure 5: LakeSPI results for Lake Waikare. LakeSPI Indices expressed as a percentage of lake maximum potential.

Native pondweed (*Potamogeton ochreatus*) was the overall dominant submerged plant in Lake Waikare. Average pondweed cover was described as 26-50%, and the plant was growing only within a narrow depth band from 1.0 to 3.4 m and to a maximum height of 1.8 m. The limited light available at depth in highly turbid lake appeared to restrain plants from growing any deeper. Large freshwater sponges were growing attached to the pondweed (Figure 6). Under the Kahikatea tree at the eastern arm of the lake, a charophyte meadow (*Chara australis)* was present in a shallow, sheltered bay at 1.2 m. Low covers (≤5%) of *Myriophyllum triphyllum* were located at a single survey site at 0.5 m depth.

Although Lake Waikare is located next to a recently harvested forestry block, the northern half of the lake is surrounded by dense, native bush (Figure 6). The vegetation at the southern half of the lake margin predominantly comprised raupō *(Typha orientalis)* at 76-95% cover, reaching a maximum depth of 1.5 m. Also, *Carex secta* fringed the lake edge at 6-25% cover, followed by water purslane (*Ludwigia palustris*), water forget-me-not (*Myosotis laxa*), and sparse occurrences of *Bolboschoenus fluviatilis* (Table A-4). Average low covers (1-5%) of the native *Azolla rubra*, as well as the duckweed *Lemna minor* were present within the raupō.

Figure 6: (a) Northern shore, Lake Waikare; (b) Freshwater sponge growing on *Potamogeton ochreatus*; (c) *Chara australis* from 1.2 m depth on the rake at Site E.

Due to extreme turbidity, the visibility was too low for scuba diving. Therefore, the LakeSPI survey was conducted with rake throws from the canoe (Figure 6).

The bathymetry of Lake Waikare steep from the lake edge, as expected for this deep lake (19 m). The limited photic zone resulted in a narrow littoral zone for submerged plants to grow around the lake edge and therefore left a relatively large area in the single deep (18.9m) basin unvegetated. The northern margin was steepest, and additional rake throws at non-LakeSPI sites revealed deep areas located within 0.5 m of the shore that were non-vegetated. In the southern half, emergent plants such as raupō have occupied a wide range of the shallow margin of the lake.

3.3 Lake Rotokare / Barrett Lagoon

Lake Summary

Lake condition: Moderate

Lake ranking: 222nd

Attribute Bands
Native Condition Index: C
Invasive Impact Index: C

Lake maximum depth: 5.7 m

Max depth of vegetation: 5.2 m

A LakeSPI Index of 23% indicated a moderate condition for Lake Rotokare, also known as Barrett Lagoon, in 2023 (Figure 7), despite the widespread presence of invasive weeds such as *Egeria densa* and *Lagarosiphon major*. The lake scored in the C band for both the Native Condition Index (23%) as well as for the Invasive Impact Index (85%) under the NPS-FM (2020), which placed this lake above the national bottom line (Table 2).

Barrett Lagoon Submerged Plant Indicators

Survey Date	Status	LakeSPI %	Native Condition %	Invasive Impact %
September 2023	Moderate	23.0%	23.0%	84.4%

Figure 7: LakeSPI results for Rotokare/Barrett Lagoon. LakeSPI Indices expressed as a percentage of lake maximum potential.

The invasive weed egeria (*Egeria densa*) occupied most of the lake basin (≥96%) to the maximum depth of 5.2 m. It formed a dense, closed canopy by growing to a maximum height of 3.5 m (Figure 8). Freshwater sponges were common, growing along the egeria stems. The second invasive weed recorded at all five LakeSPI sites in the Barrett Lagoon was lagarosiphon (*Lagarosiphon major*). Lagarosiphon formed low to moderate (up to 75%) covers at depths ranging between 0.5 and 1.5 m, and growing to a maximum height of 0.8 m. An introduced waterlily (*Nymphaea* hybrid) was found at two of the five LakeSPI sites in shallow water depths up to 0.5 m at an average cover of 51-75% (Figure 8).

The native plant community in the Barrett Lagoon included pondweeds and charophytes. Only low covers of *Potamogeton cheesemanii* (up to 25%) and *Potamogeton ochreatus* (≤5%) were present at a single site, in a depth range between 0.5 and 1.0 m. Charophyte meadows (≥75% cover) occurred at four LakeSPI sites at a maximum depth of 1.5 m, in which *Chara australis,* as well as *Nitella* sp. aff. *cristata* occurred with higher covers of *Chara fibrosa* (Figure 8; Table A-4). The native emergent *Eleocharis sphacelata* was only recorded at low covers (1-5%) at one of the LakeSPI sites.

Figure 8: **(a) *Nymphaea* hybrid; (b) Charophyte meadow at 1 m depth; (c) 3.5 m high *Egeria densa* was dominant in Barrett Lagoon; (d) *Lagarosiphon major* infestation at a maximum depth of 1.5 m.**

3.4 Lake Rotokawau

Lake Summary

Lake condition: High

Lake ranking: 52nd

Attribute Bands
Native Condition Index: B
Invasive Impact Index: A

Lake maximum depth: 11.9 m

Max depth of vegetation: 4.8 m

A LakeSPI Index of 73.6 % placed Lake Rotokawau in the High category for LakeSPI (Figure 9). The Native Condition Index scored at 51.7%, and fell into the attribute band B, due to the limited biodiversity of submerged plants, however the absence of invasive weeds leads to an Invasive Impact Index of 0% and attribute band A, categorising Lake Rotokawau as a high-status condition lake as per LakeSPI Indices (Table 1) and well above the national bottom line after NPS-FM (2020) (Table 2).

Lake Rotokawau Submerged Plant Indicators

Survey Date	Status	LakeSPI %	Native Condition %	Invasive Impact %
September 2023	High	73.6%	51.7%	0.0%

Figure 9: LakeSPI results for Lake Rotokawau. LakeSPI Indices expressed as a percentage of lake maximum potential.

The exclusively native submerged vegetation was dominated by high covers (≥76%) of *Potamogeton ochreatus*, growing up to 3.4 m tall (Figure 10). The pondweed was recorded between depths of 0.5 to 4.8 m throughout Lake Rotokawau. Charophyte meadows (>75% cover) were located on all five survey sites, to a depth of down to 1.6 m (Figure 10). These meadows consisted solely of *Nitella* sp. aff. *cristata*, which grew at lower density covers of 51-75% down to a maximum depth of 2.4 m.

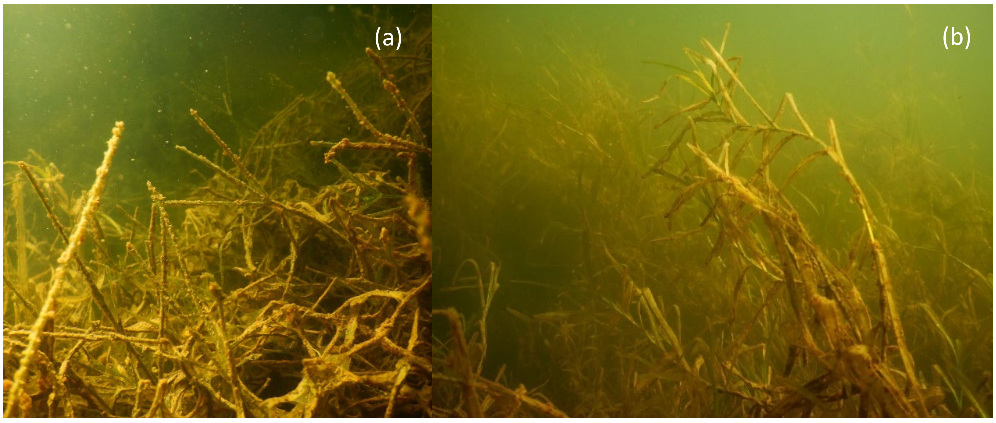


Figure 10: (a) *Nitella sp. aff. cristata meadow at 1.5 m depth;* (b) native blunt pondweed *Potamogeton ochreatus* dominated the vegetation.

Lake Rotokawau is surrounded by native forests, which prevented the growth of emergent vegetation on two of the LakeSPI sites. The remaining surveyed margins were fringed with moderate covers of raupō (*Typha orientalis*)*, Isolepis prolifera*, spike rushes (*Eleocharis acuta, Eleocharis sphacelata*)*,* as well as *Centella uniflora* and spearwort (*Ranunculus flammula*) (Figure 11).

Figure 11: (a) Native forests surrounding Lake Rotokawau; (b) emergent plants at the southern side of the lake; (c) Spike rush (*Eleocharis sphacelata*) at the lake margin; (d) spearwort (*Ranunculus flammula*) in the shallows.

4 Acknowledgements

Many thanks to Adele Bittner from TRC for providing detailed access information for each lake and for joining us with Abby and Alice at Lake Waikare. Further thanks go to Aleki Taumoepeau and Iñigo Zabarte-Maeztu (NIWA) for field support.

5 References

Clayton, J., Edwards, T. (2006) Aquatic plants as environmental indicators of ecological condition in New Zealand lakes. *Hydrobiologia* 570: 147–151.

de Winton, M.D., Clayton J.S., Edwards T. (2012) Incorporating invasive weeds into a plant indicator method (LakeSPI) to assess lake ecological condition. *Hydrobiologia* 691: 47-58.

NPS-FM (2020) National Policy Statement for Freshwater Management 2020. https://consult.environment.govt.nz/freshwater/npsfm-and-nesf-exposure-draft/)

Appendix A National Status of Taranaki Region Lakes

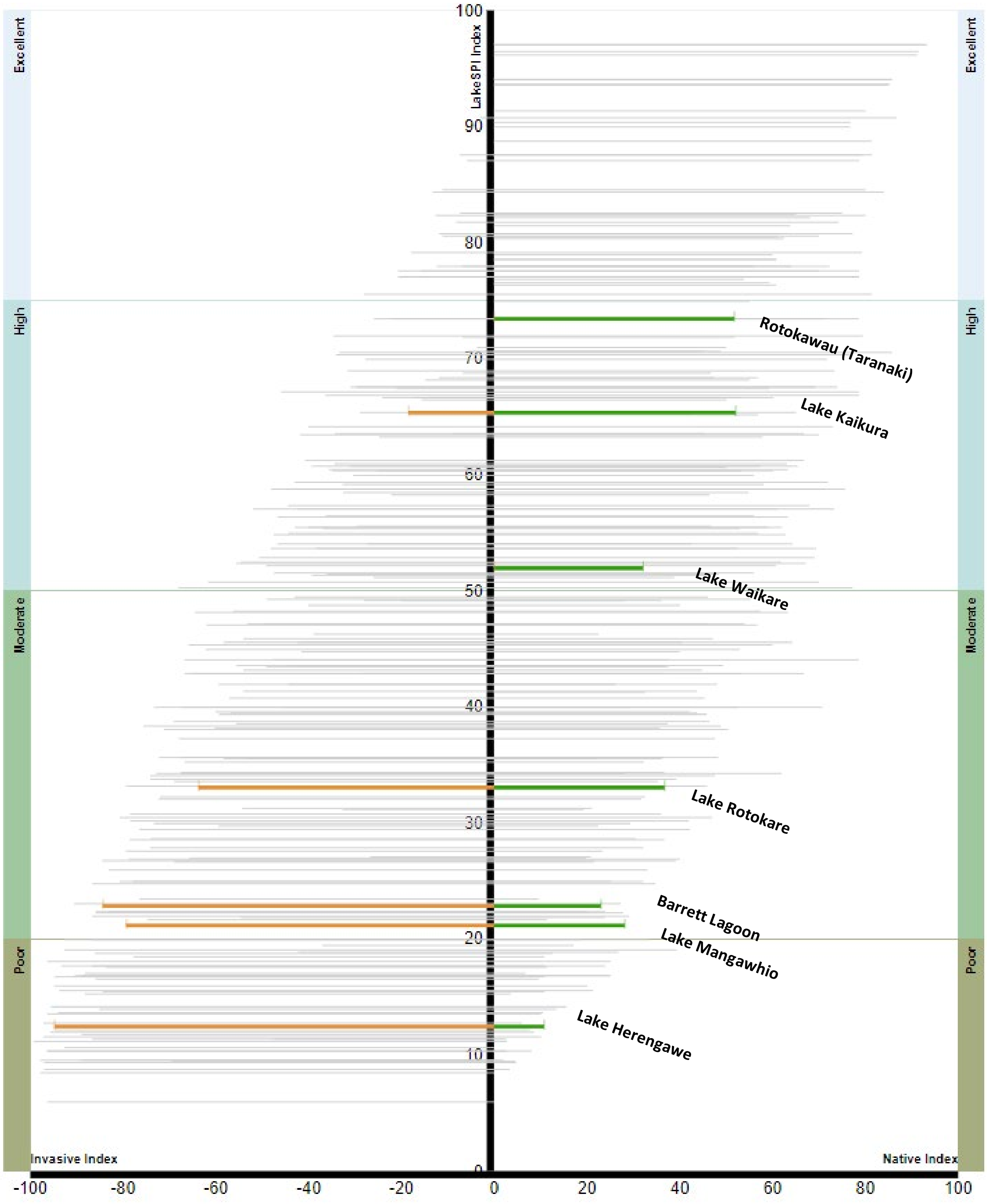


Figure A-12: LakeSPI Indices on the latest results of all 342 NZ lakes assessed under LakeSPI (grey), showing the scores for the Taranaki region lakes as an orange/green line. LakeSPI scores are plotted on the vertical axis, with the Native Condition Index plotted on the right-hand horizontal axis, and the Invasive Impact Index on the left hand to show the negative influence on the LakeSPI score.

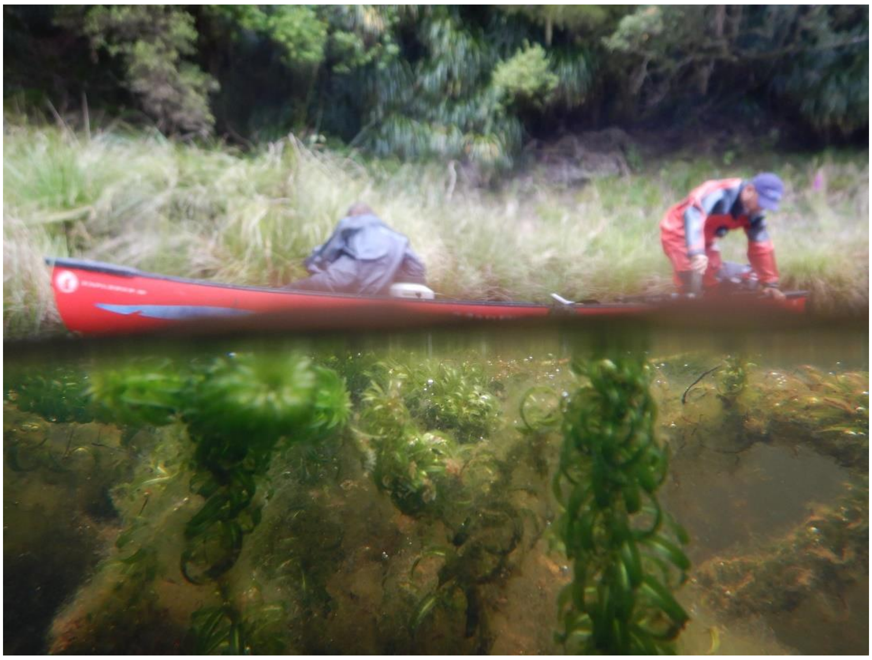
Appendix B Table of aquatic plant species records

Table A-4: Aquatic plant species recorded in the Taranaki lakes in 2023.

Species	Herengawe	Waikare	Barrett Lagoon	Rotokawau
Emergents				
Bolboschoenus fluviatilis		✓		
Carex secta		✓		
Eleocharis acuta				✓
Eleocharis sphacelata			✓	✓
Isolepis prolifera	✓			✓
Ludwigia palustris		✓		
Myosotis laxa subsp. caespitosa		✓		
Ranunculus flammula				✓
Schoenoplectus	✓			
Typha orientalis	✓	✓		✓
Surface floaters				
Azolla rubra		✓		
Lemna minor		✓		
**Nymphaea* hybrid			✓	
Tall vascular plants				
**Ceratophyllum demersum*	✓			
**Egeria densa*	✓		✓	
**Lagarosiphon major*	✓		✓	
Myriophyllum triphyllum	✓	✓		
Potamogeton cheesemanii			✓	
Potamogeton ochreatus	✓	✓	✓	✓
Charophytes				
Chara australis		✓	✓	
Chara fibrosa			✓	
Nitella sp. aff. *cristata*			✓	✓

*Invasive plants

LakeSPI assessment of three Taranaki Lakes



Prepared for Taranaki Regional Council

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Climate, Freshwater & Ocean Science

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Quality Assurance Statement		
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	Approved for release by:	Michael Bruce

Caption for front page: Shoreline of Lake Mangawhio showing submerged canopy of *Lagarosiphon major* and NIWA survey team observing shallow vegetation (Photo, Mary de Winton, NIWA).

Contents

Figures

Executive summary

Taranaki Regional Council (TRC) engaged NIWA to survey three priority lakes (Lakes Kaikura, Mangawhio and Rotokare) using LakeSPI (Lake Submerged Plant Indicators) in 2021. These lakes are the first in the region to be assessed using LakeSPI. Results from the LakeSPI surveys can contribute to regional State of Environment reporting and assist TRC in meeting their responsibilities under the National Policy Statement for Freshwater Management (NPS-FM). Specifically, component indices from LakeSPI have been adopted as new ecosystem health attributes with national bottom lines under the NPS-FM (2020) Three bands (A-C) above a national bottom line indicate acceptable ecosystem health and a lower D band may signal the need for actions to reverse lake degradation.

LakeSPI surveys were completed over November-December 2021. Features of aquatic vegetation structure and composition were recorded and entered to the NIWA LakeSPI database, which calculates a Native Condition Index, an Invasive Impact Index and an overall LakeSPI Index. Indices are expressed as percentages. A higher LakeSPI and Native Condition Index denotes better lake ecological condition and higher Invasive Impact Index denotes poorer Lake Condition. Theoretically, a pristine lake with diverse native submerged vegetation, unimpacted by human activities or invasive species, would score a LakeSPI Index of 100%, a Native Condition Index of 100% and an Invasive Impact Index of 0%.

Lake Kaikura had a LakeSPI Index of 66%, falling into the ‘High’ category for lake ecological condition. This result reflected dominance by native submerged plants but vegetation of relatively limited biodiversity, and minimal impact by non-native weeds. Lake Kaikura ranked 70th nationally for ecological condition (for 257 rank positions over 323 surveyed lakes). Under the NPS-FM, a Native Condition Index of 52% and low Invasive Impact Index of 19% placed Lake Kaikura within the B band for both attributes.

A LakeSPI Index of 21% placed Lake Mangawhio into the ‘Moderate’ category of ecological condition. The depth development of submerged vegetation was restricted and the invasive weeds *Lagarosiphon major*, and to a lesser extent *Ceratophyllum demersum*, had a large influence on the structure and diversity of the lake vegetation. Lake Mangawhio ranked 212th for ecological condition nationally. A Native Condition Index of 28% and an Invasive Impact Index of 79% places Lake Mangawhio in the C band for both attributes.

Lake Rotokare recorded a LakeSPI Index of 33%, placing the lake into the ‘Moderate’ category of lake ecological condition. This result reflected the areas of native submerged vegetation that have persisted despite the widespread presence of the invasive alien weed *Lagarosiphon major*. The lake ranked 176th for ecological condition nationally. The Native Condition Index of 37% and Invasive Impact Index of 64% places Lake Rotokare into the C band according to NPS-FM attributes.

The three Taranaki lakes were assessed as having Moderate to High ecological condition according to LakeSPI. The main apparent impacting factor influencing lake condition for all lakes appeared to be water quality, with maximum submerged vegetation depth limited to between 3 to 4.2 m depth due to light limitation. Weed invasion was a major impact factor for Lakes Mangawhio and Rotokare, but Lake Kaikura was amongst the relatively few lakes nationally without substantial modification of the submerged littoral vegetation by invasive weeds.

All three Taranaki Lakes were above the National Bottom Line that indicates an acceptable condition for the attributes *submerged plants (native) and submerged plants (invasive species)* according to the NPS-FM (2020).

Recommendations arising from the report are:

- Increasing the number of lakes surveyed by LakeSPI to 10-12 to enable sufficient regional representation of lake ecological condition.
- Developing a schedule of LakeSPI surveys for prioritised lakes.
- Including a resurvey of Lake Mangawhio after 3-5 years to gauge possible submerged vegetation recovery following past perturbations.
- Undertaking ongoing annual surveillance for new submerged weed incursions at access points and key areas for spread in the surveyed lakes not currently dominated by invasive plant species, and other valued Taranaki lakes.
- Including more specific surveillance for hornwort at Lake Rotokare for a further 2 years on account of the reported sighting in 2021.
- Continuing biosecurity advocacy at Lake Rotokare on account of high-risk activities for pest transfer.
- Updating Ngāti Ruanui and landowners on the current status of Lake Kaikura, biosecurity risk and precautions that can be undertaken.
- Holding conversations between agencies to gauge support for lake management goals towards a return to a native vegetated condition at Lake Rotokare by scoping use of the herbicide endothall for aquatic weed eradication, used elsewhere as restoration tool.

1 Introduction

Taranaki Region has 89 lakes over 1 ha in size according to the Freshwater Ecosystems of New Zealand geo-database[1]. The Regional Fresh Water Plan for Taranaki Region[2] recognises the value of freshwater resources, including lakes, and that ongoing State of Environment (SOE) monitoring will enable the Taranaki Regional Council (TRC) to assess the effectiveness of the Plan. TRC are currently implementing the National Policy Statement for Freshwater Management (NPS-FM) in a staged programme of key projects[3]. As part of ongoing work, TRC has identified priority lakes for survey using LakeSPI as Lakes Kaikura, Mangawhio and Rotokare. These lakes are the first in the Region to be assessed using LakeSPI.

LakeSPI is a bioassessment method that uses the degree of development by native submerged plants, and level of impact by non-native, invasive weeds to indicate a lakes ecological condition. Specifically, components indices from LakeSPI have been adopted as new ecosystem health attributes with national bottom lines under the NPS-FM (2020)[4]. Assessment results from LakeSPI surveys will contribute to regional SOE reporting and assist TRC in meeting their responsibilities under the NPS-FM.

LakeSPI is based on the premise that submerged plants are useful indicators of lake condition. For example, plants are easy to observe, sample or identify as they are macroscopic and perennial in nature, and are predominantly rooted or anchored to the bed of lakes (non-motile). This is in contrast with other lake biota that can be highly mobile (e.g., fish) or otherwise be difficult to sample, measure or identify.

Submerged plants, which are predominantly perennial, also effectively integrate environmental conditions that support plant growth over an extended period of time prior to survey, such as water transparency. Other physio-chemical methods (e.g., Secchi disc measures), may change markedly over short time periods and require frequent measurements throughout the year.

In some lakes, the littoral zone (lake margin to maximum plant depth) can have quite different water quality compared to the open water (pelagic or lake centre) condition. Given the importance of the littoral zone to the overall ecological state and recreational value of many lakes it is important to monitor the ecological well-being and biological functioning of the littoral zone where submerged plants dominate.

Increased sediment and nutrient loading from catchment activities, and displacement of native vegetation by invasive alien plant species or other freshwater pest impacts are major influences on lake ecology and condition. The submerged plant metrics that are measured and the indicators used in LakeSPI provide a useful means of assessing these impacts.

This report summarises the methods used (Section 3) provides LakeSPI results for each lake (Section 4), and a brief discussion of results. A wider discussion (Section 5) places the Taranaki lakes within a national picture with a total of 323 lakes with LakeSPI results. Finally, a series of recommendations are made (Section 6).

[1] *Freshwater Ecosystems of New Zealand: Freshwater (doc.govt.nz)*
[2] *v3-Public_Regional_Fresh_Water_Plan_as_amended_March_2021.PDF (trc.govt.nz)*
[3] *Progressive Implementation Programme for the National Policy Statement for Freshwater Management (trc.govt.nz)*
[4] *National Policy Statement for Freshwater Management 2020 (environment.govt.nz)*

2 Study Lakes

The three lakes are located in south Taranaki Region (Table 1), with Lake Kaikura being <1 km from the sea and Lake Mangawhio and Rotokare being inland, within hilly country (Taranaki Regional Council 2006) between 100 to 200 m in elevation (Figure 1).

Table 1: Lake name FENZ lake identification number, origin type and map co-ordinates (New Zealand Map Grid) for the three lakes surveyed for this report.

Lake name	FENZ #	Type	Easting (NZMG)	Easting (NZMG)
Kaikura	15795	Dune	2630574	6166404
Mangawhio	16224	Landslide	2663907	6171040
Rotokare	7512	Landslide	2631465	6193896

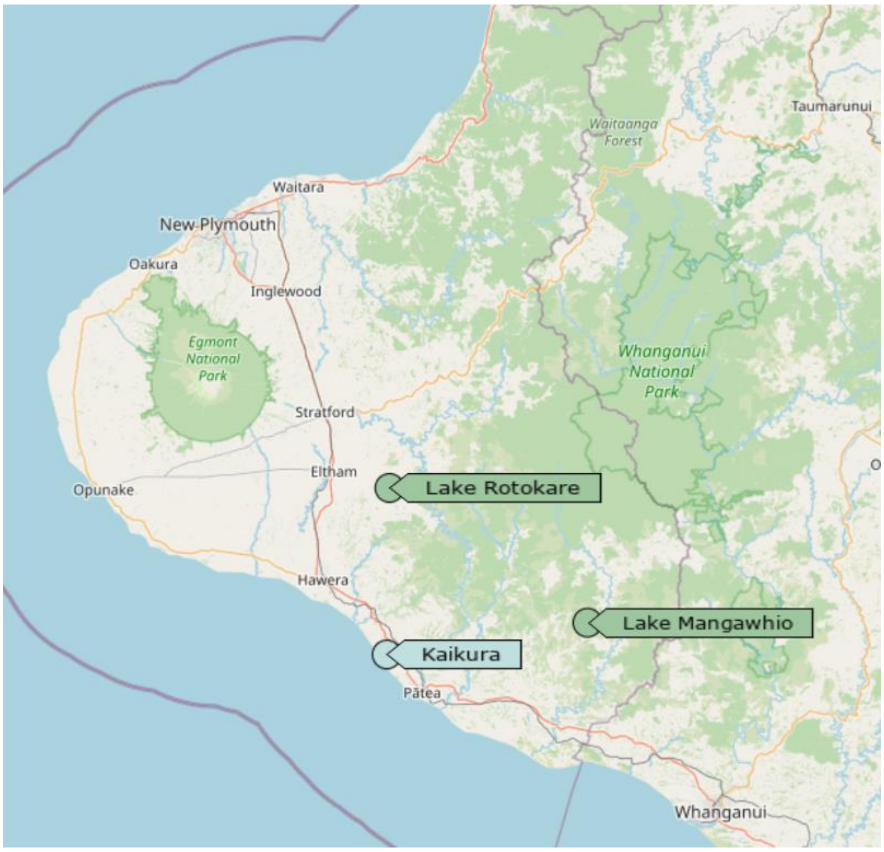

Figure 1: Map showing location of the three Taranaki lakes surveyed using LakeSPI.

3 Methods

3.1 LakeSPI

LakeSPI is a management tool that uses Submerged Plant Indicators (SPI) for assessing the ecological condition of New Zealand lakes and for monitoring changes in lakes. Key assumptions of the LakeSPI method are that native plant species and high plant diversity represents healthier lakes or better lake condition, while invasive plants are ranked for undesirability based on their displacement potential and degree of measured ecological impact (Clayton and Edwards 2006, de Winton et al. 2012).

Features of aquatic vegetation structure and composition are used to generate three LakeSPI indices:

- 'Native Condition Index' – This captures the native character of vegetation in a lake based on diversity and extent of indigenous plant communities. A higher score means healthier, deeper, diverse submerged vegetation.
- 'Invasive Impact Index' – This captures the invasive character of vegetation in a lake based on the degree of impact by invasive weed species. A higher score means more impact from exotic species, which is often undesirable.
- 'LakeSPI Index' – This is a synthesis of components from both the native condition and invasive impact condition of a lake and provides an overall indication of lake condition. The higher the score the better the condition.

Because lakes have differing physical characteristics that can influence the extent and type of submerged vegetation, each of the LakeSPI indices are expressed in this report as a percentage of a lake's maximum (i.e., 100%) scoring potential. Scoring potential reflects the maximum depth of the lake to normalise the results from very different types of lakes. In lakes where submerged vegetation cover does not exceed 10% at the majority of sites, LakeSPI indices default to 0%. A lake scoring full points for all LakeSPI indicator criteria would result in a LakeSPI Index of 100%, a Native Condition Index of 100% and an Invasive Impact Index of 0%.

A complete description of measured characteristics is given in the technical report and user manual at LakeSPI (niwa.co.nz). The LakeSPI method is supported by a web-reporting service found at LakeSPI (niwa.co.nz) where scores for lakes assessed to date can be searched and displayed. This secure and freely-accessible data repository allows agencies to compare lake scores with other lakes regionally and nationally as required.

3.2 Survey approach

At each lake, NIWA established five baseline sites, chosen to be representative of the lake vegetation and allowing full extent of vegetation depth development, away from local influences such as stream inflows. Appendix A documents site locations as maps and GPS references.

Along each transect, scuba/snorkel divers recorded relevant vegetation characteristics on data sheets, including measures of diversity from the presence of key plant communities, the depth extent of vegetation and the degree of impact by invasive weed species (if present). A full description of the vegetation features that are assessed for the LakeSPI method is found in the technical report and user manual on the web-reporting pages (LakeSPI (niwa.co.nz)).

Observations were entered into the NIWA LakeSPI database, which calculates the three LakeSPI indices.

Although identification to species level is not required for all plants assessed by LakeSPI, NIWA has additionally recorded all plant species recorded within the lakes in Appendix B.

3.3 Reporting

3.3.1 LakeSPI condition categories

For ease of reporting results, five lake condition categories (Table 2) are used to provide a description of a lakes status at the time of a survey. These categories are allocated according to the LakeSPI Index score:

Table 2: Five categories of lake condition based on LakeSPI Index score.

LakeSPI Index score	LakeSPI Category
>75%	Excellent
>50-75%	High
>20-50%	Moderate
>0-20%	Poor
0%	Non-vegetated

3.3.2 National Policy Statement for Freshwater Management

The NPS-FM has included two LakeSPI indices as attributes in its National Objectives Framework (NOF) that require action plans (NPS-FM 2020, Appendix 2B, Tables 11 and 12). Attribute bands are related to Native Condition Index and Invasive Impact Index values as shown in Table 3. Any lake that falls below the national bottom line is considered degraded and may require TRC to prepare a time-based action plan to achieve a target status. If the current state is below the national bottom line due to natural processes (e.g., naturally non-vegetated geothermal or peat lakes), a target attribute state below the national bottom line may be set. Currently, the Ministry for the Environment state that the Native Condition Index should be assessed every three years, whereas Invasive Impact Index should be assessed annually. Although, NIWA has previously recommended five yearly surveys, with more frequent surveys suggested if large changes in ecological condition are detected (e.g., pressure from land-use intensification or new invasive weed species incursions).

Table 3: National Objectives Framework attribute table for LakeSPI indices. Native Condition Index and Invasive Impact Index attribute bands from the NPS-FM (2020, Appendix 2B, Tables 11 and 12).

Attribute band	Native Condition Index	Invasive Impact Index
A	>75%	0
B	>50 and ≤75%	>1 and ≤25%
C	≥20 and ≤50%	>25 and ≤90%
National bottom line	20%	90%
D	<20%	>90%

3.3.3 Lake Summary

For each lake, a summary table lists:

- The LakeSPI category of ecological condition for the lake.
- National ranking for the surveyed lake, based on position for LakeSPI Index out of all lakes surveyed (i.e., 257 ranks for 323 surveyed lakes).
- Attribute bands for Native Condition Index and Invasive Impact Index under the NPS-FM (2020).
- Lake maximum depth established during the current survey or previously available.
- Maximum depth of vegetation recorded during the current survey.

4 Results

Table 4 presents LakeSPI results for each lake in order of their LakeSPI Index scores, with the indices presented as a percentage of maximum scoring potential. In the following section the lakes are discussed in alphabetical order.

Table 4: Summary of current LakeSPI indices for three Taranaki lakes in order of their condition.

Lake	LakeSPI Survey date	LakeSPI Index (%)	Native Condition Index (%)	Invasive Impact Index (%)	Lake Condition Category
Kaikura	01/12/2021	66	52	19	High
Rotokare	30-31/11/2021	33	37	64	Moderate
Mangawhio	02/12/2021	21	28	79	

4.1 Lake Kaikura

4.1.1 Results

Lake Summary

Lake condition:	High
Lake ranking:	70th
Attribute Bands	
Native Condition Index:	B
Invasive Impact Index:	B
Lake maximum depth:	5.1 m
Max depth of vegetation:	3.7 m

Lake Kaikura Submerged Plant Indicators

Survey Date	Status	LakeSPI %	Native Condition %	Invasive Impact %
December 2021	High	65.5%	52.0%	18.5%

Figure 2: LakeSPI results for Lake Kaikura. LakeSPI Indices expressed as a percentage of lake maximum potential.

With an overall LakeSPI Index of 66%, Lake Kaikura falls within the 'High' category for lake ecological condition (Figure 2). This score reflected a Native Condition Index of 52% based on dominance by native submerged plants, but with vegetation of relatively limited biodiversity. Therefore, the lake falls within the B band for Native Condition Index as an attribute under the NPS-FM (2020). The low Invasive Impact Index of 19% is based on minimal impact by non-native weeds and the lake falls within the B band for Invasive Impact Index under the NPS-FM (2020).

The submerged vegetation was almost completely dominated by the native blunt pondweed, *Potamogeton ochreatus* (Figure 3). This plant was found between 0.4 and 3.7 m depth at typical covers greater than 50% and up to >95%. This native pondweed was recorded up to 2.5 m tall but was more commonly 1 to 2 m in height and did not form surface-reaching, fruiting beds at the time of the survey. The only other native submerged plant was the milfoil, *Myriophyllum triphyllum*, which was recorded at low covers (≤5%) and limited heights (0.4 m tall) between 1 and 1.5 m depth at one site only.

The only non-native submerged plant recorded was curled pondweed, *Potamogeton crispus* (Figure 3), which was present in the shallows (0.4 to 1.5 m) at three sites, at typically low covers (≤25%) and heights (≤0.5 m).

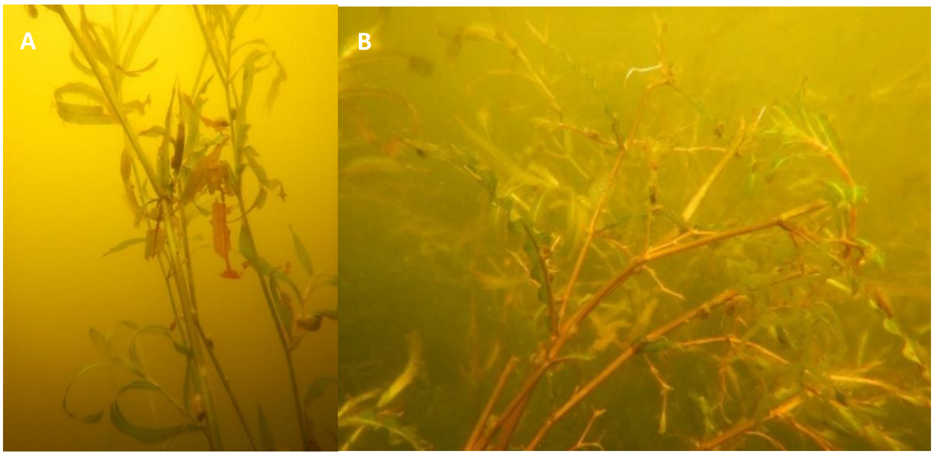

Figure 3: Lake Kaikura submerged macrophytes. A) native blunt pondweed *Potamogeton ochreatus* dominated the vegetation, and B) curled pondweed *Potamogeton crispus* was the only alien submerged weed species seen.

Native emergent plants fringed most of the lake margin (Figure 4) predominantly comprised raupō (*Typha orientalis*) and kuawa (*Schoenoplectus tabernaemontani*).

Figure 4: Emergent vegetation at the shallow margins of Lake Kaikura. Raupō (*Typha orientalis*) commonly fringed the margins to depths of between 0.4 to 1.2 m depth.

Other observations included unusually large numbers of the alien 'ear pond snail' (*Radix auricularia*) which appeared to be grazing on pondweed leaves (Figure 5). A bloom of small water fleas (*Daphnia* sp.) was observed in the eastern arm of the lake.

During the survey, it was noted that high covers (up to >95%) of filamentous-green algae occupied the surface of sediments wherever plant cover was lower (Figure 5). This alga was recorded to 3.2 m depth but was found usually shallower to 1.5 to 2 m depth. The algae appeared to be dominated by species in the genus *Ulva*, which are usually associated with brackish-water habitats. Also noted was a member of the red algae genus, *Compsopogon hookeri*, growing epiphytically on pondweed stems.

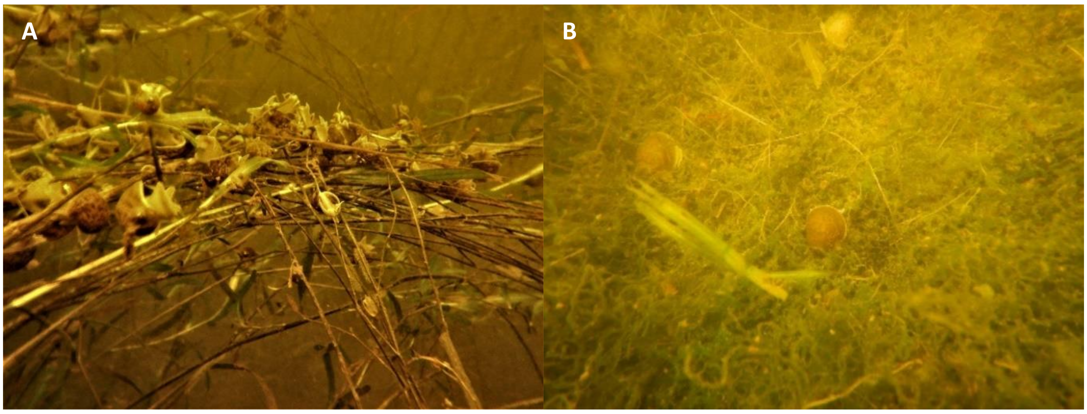

Figure 5: Lake Kaikura observations. A) an unusually abundant population of the alien ear pond snail (*Radix auricularia*) and B) high covers of a filamentous benthic alga (*Ulva* spp.).

4.1.2 Discussion

Lake Kaikura falls within the B band for both of the LakeSPI Indices as attributes under the NPS-FM (2020). These results indicate the lake has a high ecological condition, native submerged plant communities are largely intact, and invasive plants having only a minor impact on native vegetation.

The 'High' ecological condition based on the LakeSPI Index of 66% recorded for Lake Kaikura reflects the predominantly native character of the submerged vegetation. Nevertheless, survey results revealed that some expected components of a native lake vegetation were missing or scarce. Milfoils (*Myriophyllum* species) were only recorded at one site. Milfoil species are often present at lakes which have areas of amphibious turf created by moderate disturbance in wetlands, such as waterfowl loafing areas or water inflow sites, as well as extending as submerged plants into shallow depths. Also absent were members of characean algae (*Chara* or *Nitella* genera). Characean algae are obligate submerged species that often form an understory to native pondweeds and may extend deeper than vascular plants where water clarity permits.

It may be that these native vegetation components will develop and increase in area over time, following the relatively recent retirement and enhancement of riparian margins and other catchment initiatives that are likely to improve water quality. Although the deepest point of the lake recorded during NIWA's survey (using hydroacoustics) was c. 4.9 m, the deepest submerged plant record was limited to 3.7 m depth. A large area of the deeper lake might be colonised by submerged plants if future water clarity improves.

The only alien invasive weed recorded was *Potamogeton crispus*, which was not widespread or abundant. This species is commonly spread from seed by waterfowl. It has a lower invasive ranking (usually lesser impacts) than vegetatively reproducing submerged weeds such as hornwort (*Ceratophyllum demersum*), egeria (*Egeria densa*) or lagarosiphon (*Lagarosiphon major*) that are reliant on human activities for spread.

The introduction of any of the latter species on contaminated boats or equipment would pose a significant threat to the ecology and utility of the Lake Kaikura, and hornwort would present the greatest threat to the lake. Likewise, the introduction of pest fish may have consequences for water quality and lake ecology. Ngāti Ruanui and signatories of the Dwyer, Stevenson/Le Prou, Schrider covenant[5] for Lake Kaikura should be appraised of the lake's status and risks. In particular, landowners providing access to Lake Kaikura should be aware of these risks and the steps necessary to reduce freshwater pest introductions (e.g., Check, Clean, Dry principles). Recreational equipment used in water (e.g., vessels, trailers and fishing equipment) commercial or recreational tuna (eel) fishing and drainage machinery are well known vectors and pathways for the spread of freshwater pests to new lakes.

The record for ear pond snail (*Radix auricularia*) in Lake Kaikura was unusual as its dispersal is thought to be enhanced by human activities such as aquaria releases (Champion et al. 2020), which seem unlikely for Lake Kaikura due to its currently restricted access, but may have been introduced to Lake Kaikura by equipment contaminated with snail eggs. Ear pond snail records have increased substantially since 2015, when wild populations were previously confined to scattered sites in Bay of Plenty, Auckland and Canterbury (Winterborn 2021). Hawkes Bay (Lake Tutira) and Taranaki sites (Lakes Kaikura and Rotokare) represent new regions for the snails' distribution that have been recorded in the past year (2021 NIWA unpublished records). Very abundant populations of ear pond snails have been seen elsewhere, but the consequences for plants and lake ecology are not known.

Early limnological descriptions for the group of dune lakes around Waverley (Oturi, Herengawe, Waiau, Okoia and 'Brewer') were undertaken in 1949 (Cunningham et al. 1953). As these lakes are just 20 km distance from Lake Kaikura, they provide some insights into likely early vegetation and water quality conditions. At this time *Potamogeton ochreatus* or *Potamogeton* species were recorded at depths of >2 m (Waiau) to between 4 and 6 m depth (Oturi, Herengawe) according to mapped bathymetry and vegetation distribution. A *Chara* species was also recorded to up to 4 m in Lake Herengawe. The only non-native aquatic plant species recorded by Cunningham et al. (1953) was *Ottelia ovalifolia*. Emergent plant species included widespread *Typha orientalis* and mixtures of *Schoenoplectus tabernaemontani* (as 'scirpus'), *Machaerina articulata* (as 'cladium') and *Eleocharis* spp. in Lake Herengawe. Lake Kaikura has a similar vegetation composition to these early descriptions, although vegetation did not grow as deeply in this lake.

[5] FINAL-PDF-OS-85.pdf (qeiinationaltrust.org.nz)

4.2 Lake Mangawhio

4.2.1 Results

Lake Summary

Lake condition:	Moderate
Lake ranking:	212th
Attribute Bands	
Native Condition Index:	C
Invasive Impact Index:	C
Lake maximum depth:	15.6 m
Max depth of vegetation:	3 m

Lake Mangawhio Submerged Plant Indicators

Survey Date	Status	LakeSPI %	Native Condition %	Invasive Impact %
December 2021	Moderate	21.3%	28.1%	79.3%

Figure 6: LakeSPI results for Lake Mangawhio. LakeSPI Indices expressed as a percentage of lake maximum potential.

A LakeSPI Index of 21% (Figure 6) placed Lake Mangawhio into the Moderate category for LakeSPI. This result reflected the rather limited depth extent for submerged vegetation (to just 1/5th of the lakes depth) and dominance by the invasive weed lagarosiphon (*Lagarosiphon major*). An Invasive Impact Index of 79% falls within a C band under the NPS-FM (2020) and indicates lagarosiphon was a large influence on the structure and diversity of the lake vegetation. The Native Condition Index of 28% shows elements of the native submerged vegetation remain and the lake is allocated a C band under the NPS-FM (2020).

Lagarosiphon was present at all surveyed sites and was also observed more widely as a narrow band of surface-reaching weed bed close to the lake margin (Figure 7) around almost all the perimeter of the lake. Lagarosiphon was recorded between 0.1 and 3 m depth at >50% cover, but high cover (>95%) surface-reaching weed beds were only present to 1.5 m depth.

Two additional invasive submerged weeds present were hornwort (*Ceratophyllum demersum*) and curled pondweed (*Potamogeton crispus*). Although hornwort was widespread in Lake Mangawhio (four out of five LakeSPI surveyed sites and all other checked shoreline locations), it was generally found at low covers (<25%) within the dense lagarosiphon weed beds. Only at one survey site did hornwort form higher covers (average 51-75% and up to 76-95%) between 0.5 to 2.9 m, the widest recorded depth range for this weed of the five transect sites. At the same site, hornwort grew to the maximum recorded height of 1 m (Figure 8). *Potamogeton crispus* and the non-native weed *Ottelia ovalifolia* were uncommon in the lake, and several patches of the non-native water lily *Nymphaea alba* (or hybrid) were present near the outflow.

Figure 7: **The invasive weed *Lagarosiphon major* at Lake Mangawhio.** A) narrow surface-reaching beds at the lake margin, B) plants adjacent to sprawling marginal emergent plants at the steep lake margins.

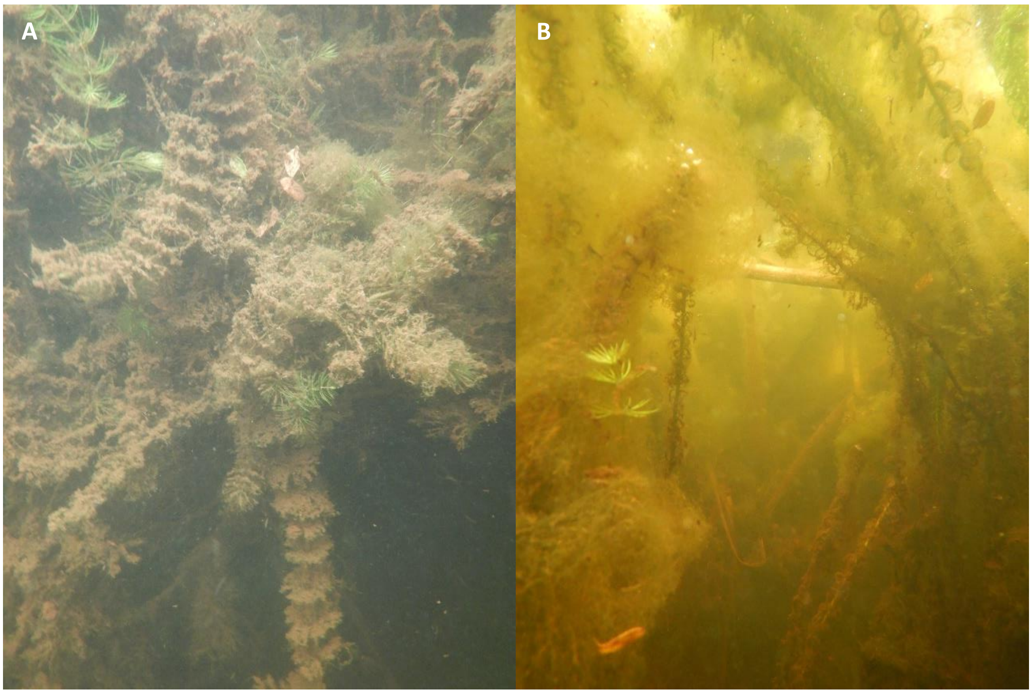

Figure 8: **Hornwort (*Ceratophyllum demersum*) in Lake Mangawhio.** A) high covers formed at only at one survey site, where it also grew up to 1 m in height, B) hornwort was usually present at low covers within the lagarosiphon weed bed.

The native blunt pondweed *Potamogeton ochreatus* was recorded at all sites at low covers of ≤25% (average ≤5%). Scattered plants of blunt pondweed extended throughout the dense lagarosiphon weed bed and into deeper water to 2.9 m depth (Figure 9A). Native characean algae, *Chara australis* and *Nitella* sp. aff. *cristata*, formed localised areas of high cover (≥75%) at most sites, immediately deeper than the dense lagarosiphon (Figure 9B and C). Frequently, these characean algal growths were supported on thin silt layers on top of the numerous sunken tree branches and stumps found in this lake, where lagarosiphon would not be able to anchor and grow.

Figure 9: **Native vegetation in Lake Mangawhio.** Native vegetation comprised A) sparce growths of blunt pondweed (*Potamogeton ochreatus*), together with B) the characean algae *Nitella* sp. aff. *cristata* (see arrows) and C) *Chara australis* with orange male fruiting bodies.

The presence of filamentous algae was commonly observed within the lagarosiphon canopy and coating deeper plants, especially at the northern inflow.

4.2.2 Discussion

Lake Mangawhio scored within the C band for both the Native Condition Index and Invasive Condition Index as attributes under the NPS-FM (2020), with neither Index being close to the national bottom line values (Table 3). These results indicate the lake is in a moderate ecological condition, native submerged plant communities are moderately impacted and invasive plants having a moderate to high impact on native vegetation. The Native Condition Index exceeds the national bottom line of 20% by 8% and the Invasive Impact Index shows a 11% buffer below the acceptable score of 90%.

The lake has a lower LakeSPI Index (21%) than might be expected for a lake in a relatively natural catchment, comprising moderate to steep hill country with flanking tawa-podocarp forest and with associated wetland areas. The depth that submerged plants grew down to (3 m) suggests that water clarity is strongly limiting, although the steep-sided lake and sediment instability could be a contributing factor for restricting the habitat for submerged vegetation. In addition, the lake vegetation was dominated by invasive weeds, primarily lagarosiphon but also hornwort, two of the worst submerged freshwater weeds in New Zealand.

The lake was formed by landslide estimated at some 1300 years BP (Page et al. 2015), evidenced by the drowned forest present within the lake. Lake Mangawhio subsequently underwent a large perturbation in mid-2015, when a significant rain event resulted in a c. 6 m drop in level following massive erosion of the outlet (Page et al. 2015). It appears that this level reduction has contributed to the steep-sided nature of this lake, as the gently sloping littoral areas at the heads of the valley arms were drained and are now land or wetlands. The lake also appeared to be highly turbid after the weather event (Page et al. 2015). It is also unclear how further land damage and past exotic forest/scrub clearance might have impacted the lake. Filamentous algal growths in the lake are suggestive of legacy sources or catchment loads of nutrients entering the lake.

It appears that lagarosiphon and hornwort have been present in the lake for some years given their complete distribution around the lakeshore. Lagarosiphon was the dominant species within the submerged vegetation. Hornwort also contributed to the high Invasive Impact Index because it is the highest ranked invasive plant present according to weed risk assessments (Champion et al. 2010). Hornwort appears to be disadvantaged relative to lagarosiphon in this lake, potentially because the latter has no root system for anchorage and would be easily dislodged and dispersed down the steep littoral slope to depths where it would not receive sufficient light to survive. Therefore, hornwort does not appear to pose additional significant threat to lake ecology under current conditions. The other non-native submerged weeds *Potamogeton crispus* and *Ottelia ovalifolia* are spread as seed by waterfowl, and the water lily, which must have been intentionally planted, are considered to be more minor with lesser impacts on lake ecology. Contaminated plantings of ornamental water plants are one means of accidental introductions for other weeds and a possible vector for hornwort and/or lagarosiphon.

Native submerged plants present at the lake comprised common species of a pondweed and characeans that are widely found in freshwater systems. These species have been largely displaced from shallow areas of the lake (≤1.5 m) by lagarosiphon weed beds.

4.3 Lake Rotokare

4.3.1 Results

Lake Summary

Lake condition:	Moderate
Lake ranking:	176th
Attribute Bands	
Native Condition Index:	C
Invasive Impact Index:	C
Lake maximum depth:	11 m
Max depth of vegetation:	4.2 m

Lake Rotokare Submerged Plant Indicators

Survey Date	Status	LakeSPI %	Native Condition %	Invasive Impact %
November 2021	Moderate	33.2%	36.7%	63.7%

Figure 10: LakeSPI results for Lake Rotokare. LakeSPI Indices expressed as a percentage of lake maximum potential.

A LakeSPI Index of 33% (Figure 10) places Lake Rotokare in the Moderate category of lake ecological condition. This result reflected the proportion of native submerged vegetation that has persisted despite the widespread presence of the invasive alien weed lagarosiphon (*Lagarosiphon major*). The lake scored in the C band for both the Native Condition Index (37%) and for the Invasive Impact Index (64%) according to attributes under the NPS-FM (2020) (Table 3).

Lagarosiphon was recorded at all sites over a depth range of 1 to 3.2 m. It commonly formed a surface-reaching bed along the lake margins (Figure 11) to depths of up to 2.6 m. Although the tall (1.5 to 3.2 m in height) lagarosiphon colonies created a high cover canopy at the lake surface (Figure 11), occupation at the bed of the lake was typically between 6-50% and up to 51-75. Lagarosiphon colonies in Lake Rotokare did not grow densely as is typical in other waterbodies and the older, lower plant stems were frequently defoliated due to grazing by aquatic caterpillars of the native moth *Hygraula nitens* (Figure 12). This open lagarosiphon growth often allowed the growth of characean algae as an understory.

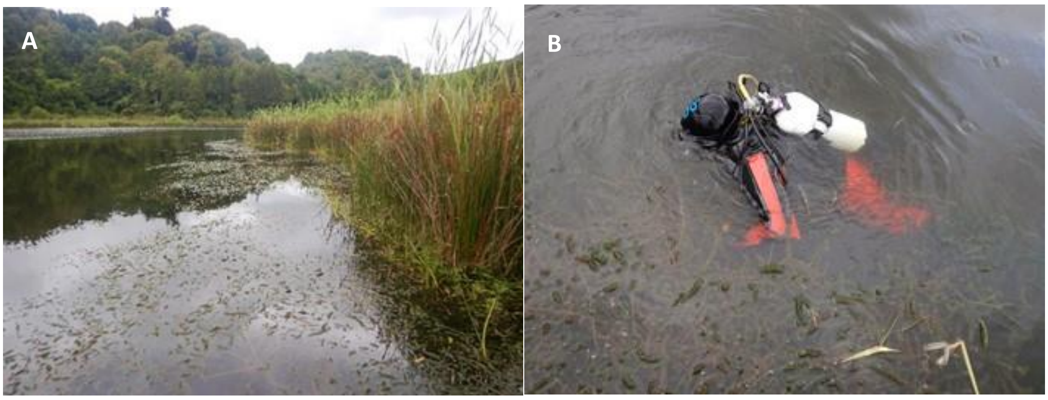

Figure 11: ***Lagarosiphon major* at the shoreline of Lake Rotokare.** A) a narrow strip of surface-reaching weed beds along the lake margins, B) a relatively dense canopy at the water surface.

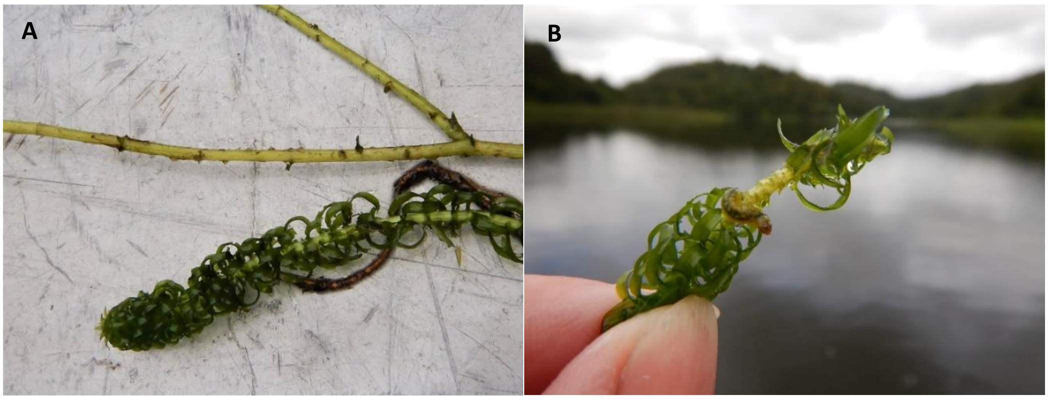

Figure 12: **Lagarosiphon grazing damage from the moth *Hygraula nitens*.** A) defoliation of the older lower stems but new basal growth showed little damage and B) a caterpillar with local grazing damage on a canopy shoot section.

The native characean alga *Nitella* sp. aff. *cristata* (Figure 13) formed high cover (>75%) 'meadows' across the deeper littoral zone, starting below the surface-reaching lagarosiphon weed beds and extending into deeper water at all sites. The deeper cut-off for these meadows was very abrupt, with bare sediment beyond showing pock marks of fish disturbance. *Nitella* sp. aff. *cristata* had an overall depth range of 1.5 to 4.2 m depth and grew unusually tall at 0.9 to 1.5 m in height. Another characean alga, *Chara australis* (Figure 13), was also very common in shallow water between 1 to 3 m depth.

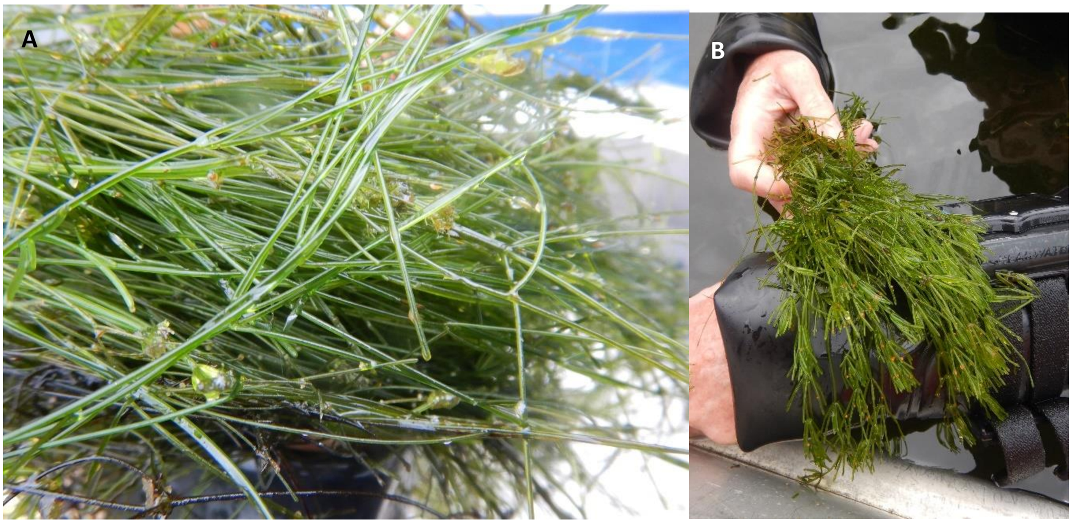

Figure 13: Native characean algae recorded at Lake Rotokare. A) *Nitella* sp. aff. *cristata* and B) *Chara australis* bearing orange fruiting bodies.

Submerged vegetation did not grow in shallow lake areas <1 m because the dense marginal emergent vegetation 'rafted' out over these shallow margins (Figure 11), with heavily shaded open water beneath the floating emergent root zone. Emergent plants were dominated by raupō (*Typha orientalis*) and *Machaerina articulata*.

The native pondweed *Potamogeton ochreatus* was observed as uncommon at the lake margin, seen outside of the surveyed sites, and was often heavily grazed by caterpillars. Also recorded was the small native floating plants *Azolla rubra* and duckweed *Lemna disperma*. Despite a wide littoral search for hornwort (*Ceratophyllum demersum*) simultaneous with this LakeSPI survey, the presence of this weed species has not been confirmed since its record of a fragment removed in February 2021 (no specimen or photos seen by NIWA).

4.3.2 Discussion

Lake Rotokare falls within the C-band for the attribute Native Condition Index and Invasive Impact Index under the NPS-FM (2020). Together these results indicate the lake has a moderate ecological condition, native submerged plant communities are moderately impacted, and invasive plants are having a moderate to high impact on native vegetation. Neither LakeSPI Indices approached the national bottom line, with the Native Condition Index nearly double the bottom line of 20% and a 26% buffer between the Invasive Impact Index and the bottom line for acceptable weed impact of 90%.

Lagarosiphon has been present in the lake since at least the early 1980's (de Winton et al. 2009). This weed did not exhibit maximum potential extent at Lake Rotokare, elsewhere being capable of growing to 6.6 m depth (Coffey and Wah 1988) and forming surface reaching beds from 5 m depth (Clayton et al. 1989). It seems likely that water clarity and subsequent light penetration restrict the depth development of lagarosiphon in Lake Rotokare. Although grazing impacts by *Hygraula nitens* were noted on the lagarosiphon in late November 2021, lagarosiphon growth was already outstripping grazing and this insect is unlikely to provide a large supressing influence on weed beds.

Water clarity would also exert a strong control on the maximum depth for characean meadows in Lake Rotokare, as characean algae are capable of extending to over 30 m in highly transparent lakes (Schwarz et al. 2000). Notable for Lake Rotokare, are the regular summer cyanobacterial blooms, such as that encountered during the late November LakeSPI survey where the bloom was concentrated in the surface 2.5 m layer and water clarity was improved in deeper water. Other layers of water with different clarity are possible, with black colouration to the water below the thermocline (where temperature changes >1°C occurred over 1 m depth) at 7 m reported in the past (Hicks et al. 2013),and being associated with low oxygen concentrations. Measurements of photosynthetically active radiation in the lake in February 2019, during a cyanobacterial bloom, showed the 1% light extinction depth was 3.42 m (Smith 2018), similar to the maximum depth of the charophyte meadows at between 3.4 and 4.2 m depth.

Abundant populations of perch (*Perca fluviatilis*) sampled in 2013 were thought to have a detrimental impact on the ecology of Lake Rotokare (Hicks et al. 2013) and high densities of this species were later confirmed from Lake Rotokare in 2017-18 (Smith et al. 2018). NIWA divers noted pitting of the sediment surface beyond the depth limit of vegetation, which is often associated with benthivorus fish feeding, but the deeper characean meadows did not appear to have been disturbed.

Lake Rotokare is open to power boating from December to April, provided that water quality conditions are suitable for water contact. Non-powered boats are allowed year-round. This recreational use does open the lake up to risk of accidental introductions of invasive pests that are associated with human movements. The Lake Rotokare Scenic Reserve Trust are aware of the risk, precautions have been undertaken in the form of signage and the Trust are proactive on biosecurity awareness amongst visitors.

Of highest risk to the current lake littoral ecology are the invasive weeds hornwort and egeria (*Egeria densa*). Both these weeds are present in nearby Lake Rotorangi, which is also a destination for recreational boating, having good vehicle access and multiple boat ramps. A hornwort record from Lake Rotokare in February 2021 raises the possibility that this weed has already established in that lake, although a delimitation survey simultaneous with the LakeSPI survey could not detect any established beds or fragments under the poor water clarity (algal bloom) at the time. However, we cannot rule out the presence of hornwort in the lake and recommend further surveillance effort (see Section 6).

Also of note was the observation of the non-native ear pond snail (*Radix auricularia*) during NIWA's 2021 survey of Lake Rotokare (see Section 4.1. for more species information). This species was not amongst five molluscs recorded from sampling of the lake up to 2017 (Smith 2018), which indicates its potentially recent introduction in this lake.

5 Discussion

5.1 Current condition

The three surveyed lakes in the Taranaki Region fell into categories of Moderate to High and spanned LakeSPI Index values of 21 to 66% (Table 5). The surveyed lakes have been further grouped based on the main apparent impacting factor influencing the score (Table 5). Impact factors include 'weed' invasion (Invasive Impact Index ≥ 60%), or vegetation development limited by 'water quality' (WQ).

Lake Kaikura is currently categorised in High condition, which generally indicates a well-developed diverse native plant community and/or limited impacts from invasive species. Lakes Rotokare and Mangawhio were categorised in Moderate condition, reflecting differing degrees of impact from invasive weeds and/or restricted development of native plant communities. The limited depth extent of submerged vegetation in all three lakes (maximum plant depth 3 to 4.2 m) suggests water transparency and light penetration restrict plant development and further littoral extension is possible in all lakes if water quality improves.

Table 5: Summary of current LakeSPI results for assessed lakes. Listed is overall condition category, an indication of main impact factor on scores (weed or water quality- WQ), and invasive weed history.

Lake	LakeSPI Index (%)	Overall Condition	Impact factor	Worst weed present	First record of worst weed
Kaikura	66	High	WQ	*P. crispus*	2021 – first survey
Rotokare	33	Moderate	WQ/ Weed	Lagarosiphon	Pre 1980
Mangawhio	21	Moderate	WQ/ Weed	Hornwort	2021 – first survey

5.2 Invasive weed status

All three lakes recorded invasive aquatic weeds with Invasive Impact Indices ranging from 19 to 79%. Submerged weeds confirmed or likely to be present from Taranaki Region are ranked under the LakeSPI method in the following order from worst to least invasive, based on 'weediness' (Champion and Clayton 2000):

Hornwort > egeria > lagarosiphon > elodea (*Elodea canadensis*) > alien bladderwort (*Utricularia gibba*) = curled pondweed > water buttercup (*Ranunculus trichophyllus*) = *Juncus bulbosus*.

In the case of Lake Kaikura, the only invasive submerged weed recorded was curled pondweed. This weed has been present in the dune lakes of the west coast in neighbouring Manawatū-Whanganui Region since at least the 1970's (Kelly 1978), being first recorded as naturalised in Fielding in 1940 (Healy and Edgar 1980). Curled pondweed is a seed producing species that is spread by waterfowl and is less likely to cause major invasion problems in lakes than human spread weeds. In Lake Kaikura, curled pondweed was patchy in nature and co-existed with native vegetation, therefore having only a minor impact.

Invasive Impact Indices for Lakes Rotokare (64%) and Mangawhio (79%) indicate a relatively high impact of invasive weeds on the native vegetation. In the case of Lake Rotokare, lagarosiphon has been established for over 40 years but has not invaded to its full potential and an understory of native vegetation was often associated with its weed beds. In contrast, lagarosiphon had a greater impact in Lake Mangawhio, dominating the shallow submerged vegetation. Lake Mangawhio also recorded the widespread distribution of hornwort, which contributed to the higher Invasive Impact Index. Nevertheless, it does not appear that hornwort is likely to expand substantially under current lake conditions.

5.3 National comparisons

5.3.1 LakeSPI

While the sample of Taranaki lakes is too small to compare regional results with results nationally, Figure 14 shows the overall composition of lake condition category for the LakeSPI Index for 323 lakes. The surveyed Taranaki lakes fall into the two largest category groups nationally, Moderate and High.

Figure 15 shows the position of the three Taranaki Lakes relative to LakeSPI Indices for 323 lakes nationally. The rankings for Taranaki Lakes at 70/257 for Lake Kaikura places it within the top 30% of lakes nationally. Lake Rotokare at 176/257 lies within the lower 33% and Lake Mangawhio at 212/257 falls within the lower 20% of lakes nationally.

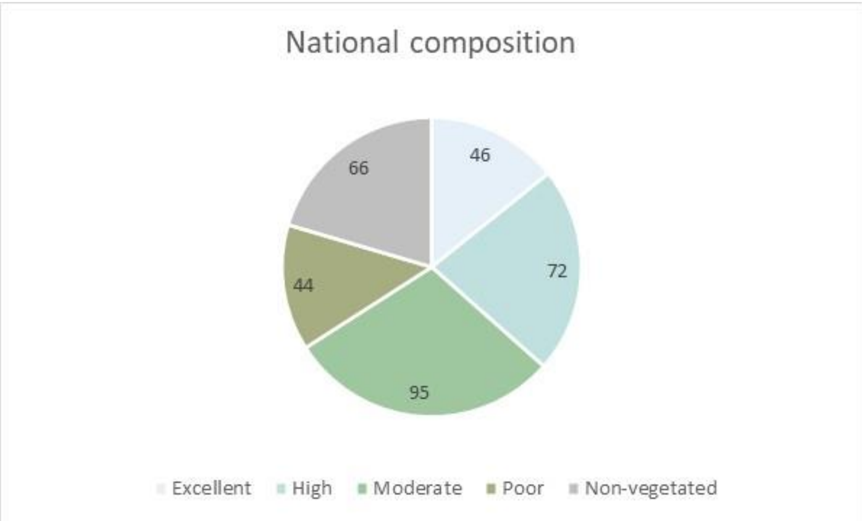

Figure 14: Proportion of lakes that fall into each of five categories of LakeSPI Index for lakes nationally (323). Number of lakes assessed shown in each sector.

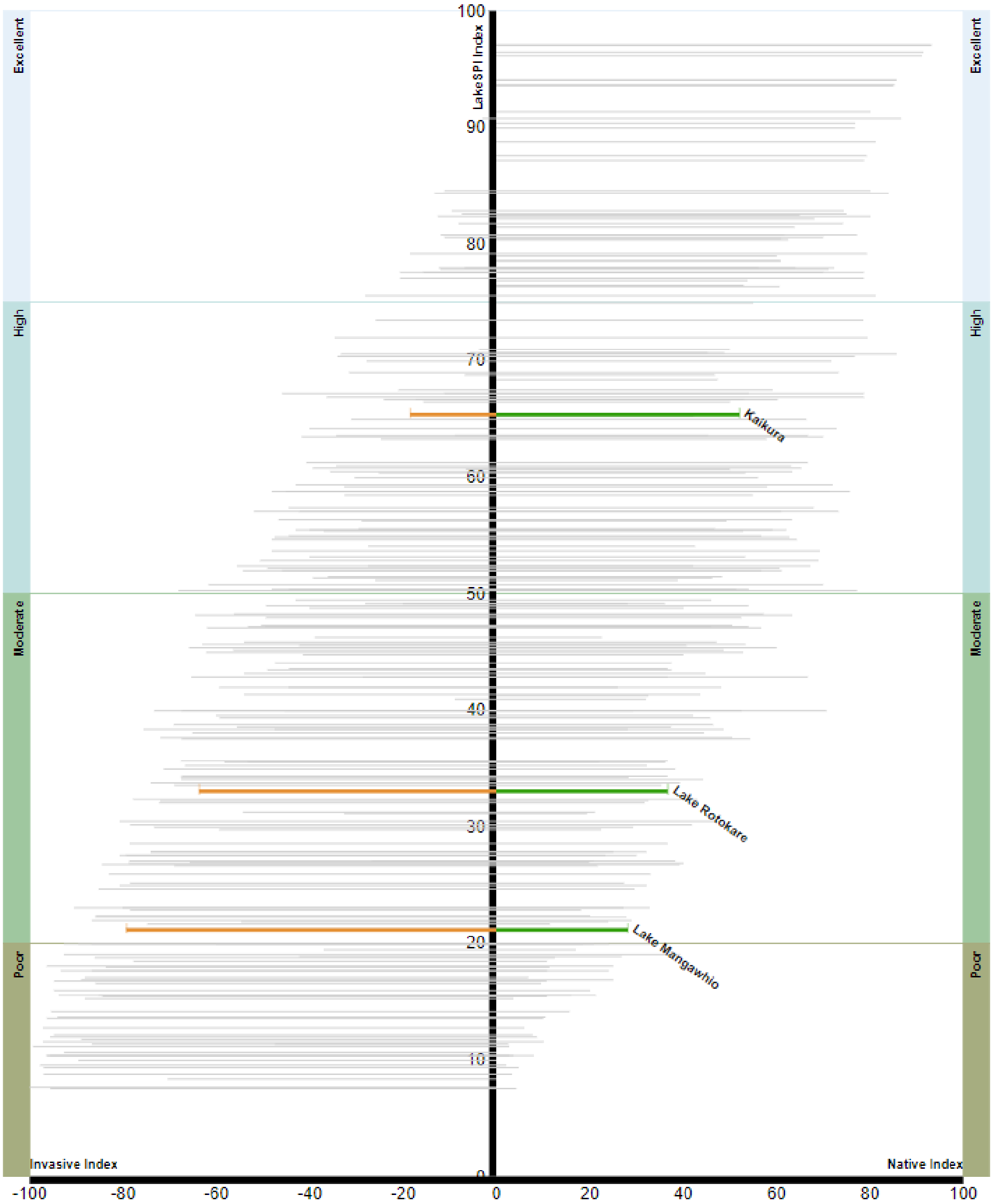

Figure 15: LakeSPI Indices based on the latest results of 323 lakes in grey, showing the scores for the lakes of the Taranaki Region as an orange/green line. LakeSPI scores are plotted on the vertical axis, with the Native Condition Index plotted on the right-hand horizontal axis, and the Invasive Impact Index on the left hand to show the negative influence on the LakeSPI score.

5.3.2 NPS-FM

According to the NPS-FM (2020), the attribute *submerged plants (native)* that uses the Native Condition Index places Lake Kaikura into the B band and Lakes Mangawhio and Rotokare into the C band. The attribute *submerged plants (invasive species)* that uses the Invasive Condition Index also places Lake Kaikura into the B band and Lakes Mangawhio and Rotokare into the C band. All lakes are therefore above the national bottom line.

The current frequency distribution of lakes nationally into attribute bands is shown in Figure 16. Lake Kaikura is included within a relatively small group of lakes within the B band for Invasive Impact Index (Figure 16). This illustrates that the lake is one of the limited number of lakes nationally without substantial modification of the littoral vegetation by invasive weeds (A and B lakes). The D band for Invasive Impact Index represents highly invaded systems where non-native weeds have replaced all indigenous submerged plants.

Bands B and C for Native Condition Index, which represent the Taranaki lakes, incorporate a large proportion of lakes nationally (Figure 16). Non-vegetated lakes, the lowest ecological condition represented in LakeSPI, represent 20% of surveyed lakes nationally and are incorporated within the D band for Native Condition Index. The remainder of lakes in the D band for Native Condition Index are usually heavily impacted by poor water quality or native vegetation has been displaced by freshwater pests.

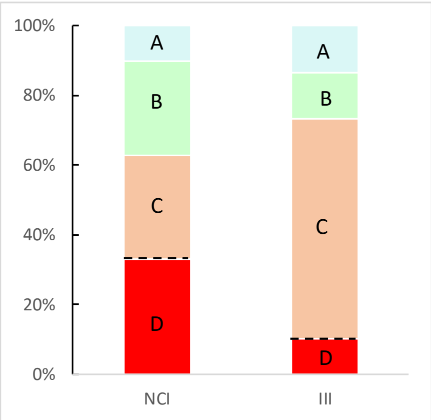

Figure 16: Proportion of lakes nationally in each attribute band (A - D) for Native Condition Index (NCI) and Invasive Impact Index (III). Black dotted line indicates the national bottom line. Number of assessed lakes is 323 for NCI (non-vegetated lakes included in group D) and 256 for III (non-vegetated lakes excluded).

6 Recommendations

- For sufficient regional representation of lake ecological condition using LakeSPI, we suggest a minimum sample size of 10 to 12 representative lakes be surveyed in the wider Taranaki Region.
- It is recommended that a schedule for LakeSPI surveys be developed by Taranaki Regional Council staff, with priorities based on representativeness, perceived lake value, stability and known threats to the lake.
- For Lake Mangawhio, a further assessment of aquatic plant composition and development after 3 to 5 years would show if lake water quality conditions are moving toward support of a more extensive submerged vegetation.
- An ongoing surveillance programme is suggested for additional aquatic weed incursions at these and additional valued Taranaki lakes, focusing on hornwort, lagarosiphon, egeria and *Elodea canadensis* at access areas/boat ramp and areas that fragments are likely to accumulate, on an annual basis late in summer.
- Specific surveillance for hornwort at Lake Rotokare is recommended in the form of a visual search by boat of the lake margins in the south-eastern arm, checking the lagarosiphon canopy and marginal vegetation for drift hornwort fragments on a 6-monthly to yearly frequency for a further two years (2022 and 2023).
- At Lake Rotokare, clear, high impact messaging for Check, Clean, Dry should continue to be prominently displayed and ways considered to reduce signage ‘fatigue’.
- Ngāti Ruanui and landowners providing access to Lake Kaikura should be aware of the lakes’ current status, the biosecurity risks to this status and the steps necessary to reduce freshwater pest introductions (e.g., Check, Clean, Dry principles). This should include drainage machinery use as a vector of aquatic weeds.
- We recommend conversations between agencies regarding the desired status of the submerged vegetation of Lake Rotokare and assessing support for a return to a native vegetated condition. Evidence is growing for the use of the herbicide endothall as a restoration tool in New Zealand lakes by achieving aquatic weed eradication.

7 Acknowledgements

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8 References

Champion, P., Rowe, D., Smith, B., Kilroy, C., de Winton, M. Wells, R., Wadhwa, S., Fear, A. (2020) Freshwater invasive species of New Zealand 2020. https://niwa.co.nz/sites/niwa.co.nz/files/Freshwater invasive species of New Zealand 2020_0.pdf

Champion, P.D., Hofstra, D.E., Clayton, J.S. (2010). Nipping aquatic plant invasions in the bud – weed risk assessment and the trade. *Hydrobiolog*ia 656: 167-172.

Clayton, J.S., de Winton, M., Wells, R.D.S., Tanner, C.C., Miller, S.T., Evans-McLeod, D. (1989). The aquatic vegetation of 15 Rotorua lakes. Aquatic Plants Section. Ministry of Agriculture and Fisheries. Pp 101.

Coffey, B.T., Wah, C.K. (1988) Pressure inhibition of anchorage-root production in *Lagarosiphon major* (Ridl.) Moss: a possible determinant of its depth range. *Aquatic Botany*, 29: 289–301.

Cunningham, B.T., Moar, N.T., Torrie, A.W., Parr, P.J. (1953) A survey of the western coastal dune lakes of the North Island. *Australian Journal of Marine and Freshwater Research,* 4: 343–386.

de Winton, M., Champion, P., Clayton, J., Wells, R. (2009) Spread and status of seven submerged pest plants in New Zealand lakes. *New Zealand Journal of Marine & Freshwater Research*, 43: 547–561.

de Winton, M.D., Clayton J.S., Edwards T. (2012) Incorporating invasive weeds into a plant indicator method (LakeSPI) to assess lake ecological condition. *Hydrobiologia* 691: 47-58.

Healy, A.J., Edgar, E. (1980). Flora of New Zealand 3: Adventive cyperaceous, petalous and spathaceous monocotyledons. Government Printer, Wellington. 220.

Hicks, B.J., Bell, D.G., Duggan, I.C., Wood, S. A., Tempero, G.W. (2013). Aquatic ecology of Lake Rotokare, Taranaki, and options for restoration. ERI report 14. Report prepared for the Rotokare Scenic Reserve Trust. Environmental Research Institute, The University of Waikato.

Kelly, D. (1978) A plant distribution survey of twelve coastal lakes. Prepared for the Rangitikei-Whanganui Catchment Board and Regional Water Board. Massey University: 28.

Page, M.J., Rosser, B.J., Townsend, D.B., Carey, J.M., Ries, W.F. (2015) Reconnaissance report on landsliding caused by the 19-20 June 2015 rainstorm in the Taranaki-Wanganui-Manawatu region. GNS Science Report 2015/47.

Redekop, P., Gross, E.M., Nuttens, A., Hofstra, D.E., Clayton, J.S., Hussner, A. (2018) *Hygraula nitens*, the only native aquatic caterpillar in New Zealand, prefers feeding on an alien submerged plant. *Hydrobiologia*, 812: 13–25.

Schwarz, A-M., Howard-Williams, C., Clayton J. (2000) Analysis of relationships between maximum depth limits of aquatic plants and underwater light in 63 New Zealand lakes. *New Zealand Journal of Marine and Freshwater Research*, 34: 157-174.

Smith, D. (2018) The aquatic ecology of Lake Rotokare. Unpublished MSc thesis. The aquatic ecology of Lake Rotokare (waikato.ac.nz)

Taranaki Regional Council (2006) Key Native Ecosystems. Inventory of sites with indigenous biodiversity values of regional significance. Document No. 2676. Key Native Ecosystems - Inventory of sites with indigenous biodiversity values (trc.govt.nz), Key Native Ecosystems - Inventory of sites with indigenous biodiversity values (trc.govt.nz)

Winterbourn, M. (2021) Guide to the freshwater Mollusca of New Zealand (fully revised February 2021) (PDF) Guide to the freshwater Mollusca of New Zealand (fully revised February 2021) (researchgate.net)

Appendix A Lake survey sites

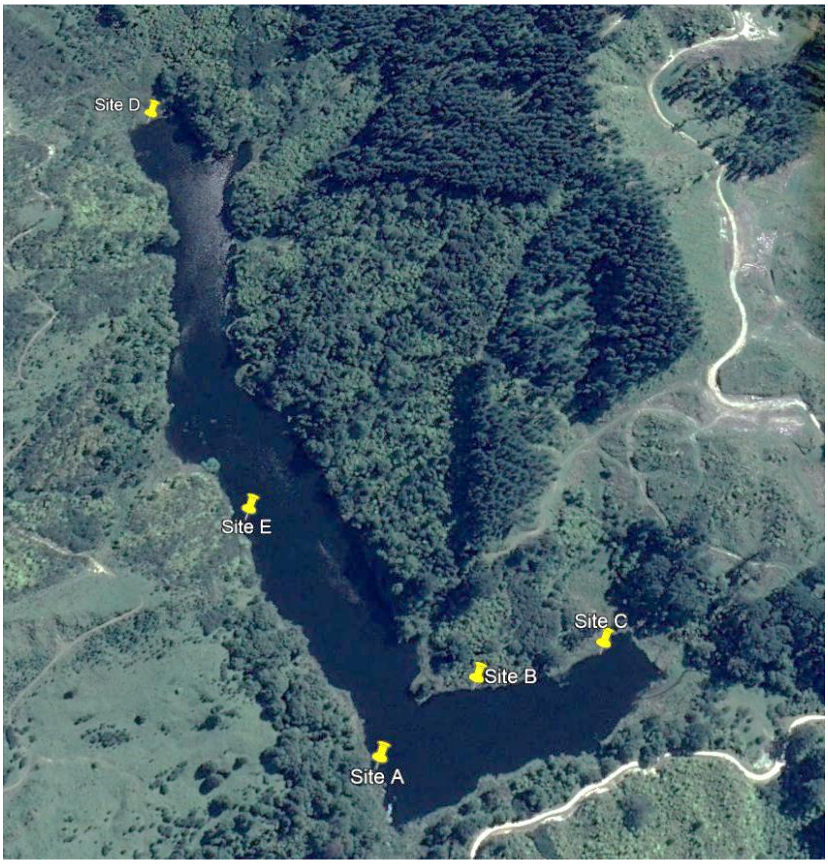
Appendix Table 1: Shoreline Grid references (NZMG) for five survey sites in Lake Kaikura.

Site	Northing	Easting
A	6166205	2630626
B	6166281	2630426
C	6166417	2630527
D	6166312	2630561
E	6166363	2630496

Appendix Figure 1: Map of the five survey sites at Lake Kaikura.

Appendix Table 2: Shoreline Grid references (NZMG) for five survey sites in Lake Mangawhio.

Site	Northing	Easting
A	6170780	2663945
B	6170846	2664025E
C	6170875	2664133E
D	6171432	2663706
E	6171004	2663826



Appendix Figure 2: Map of the five survey sites at Lake Mangawhio.

Appendix Table 3: Shoreline Grid references (NZMG) for five survey sites in Lake Rotokare.

Site	Northing	Easting
A	6193750	2631508
B	6193664	2631657
C	6193657	2631408
D	6193662	2631136
E	6193779	2631326
F	6194251	2631462

Appendix Figure 3: Map of the five survey sites at Lake Rotokare.

Appendix B Species list

Appendix Table 4: Submerged aquatic plant species recorded for three lakes in the Taranaki Region based on LakeSPI surveys. * denotes non-native.

Species	Kaikura	Mangawhio	Rotokare
Tall vascular plants			
*Ceratophyllum demersum**		✓	
*Lagarosiphon major**		✓	✓
Myriophyllum triphyllum	✓		
*Ottelia ovalifolia**		✓	
*Potamogeton crispus**	✓	✓	
Potamogeton ochreatus	✓	✓	✓
Charophytes			
Chara australis		✓	✓
Nitella sp. aff. *cristata*		✓	✓
Floating plants			
Azolla rubra			✓
Lemna disperma	✓		✓
Emergents			
Carex secta	✓	✓	
Isolepis prolifera		✓	
Juncus sp.		✓	
*Ludwigia palustris**		✓	
*Ludwigia peploides**		✓	
Machaerina articulata			✓
Myosotis laxa subsp. *caespitosa**	✓		
Persicaria decipiens	✓	✓	
Salix sp.*			✓
Schoenoplectus tabernaemontani	✓		
Typha orientalis	✓	✓	✓

CAWTHRON

REPORT NO. 3946

MODELLED NATIONAL OBJECTIVES FRAMEWORK ATTRIBUTES FOR TARANAKI LAKES AND RECOMMENDATIONS FOR BASELINE SAMPLING

MODELLED NATIONAL OBJECTIVES FRAMEWORK ATTRIBUTES FOR TARANAKI LAKES AND RECOMMENDATIONS FOR BASELINE SAMPLING

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EXECUTIVE SUMMARY

The Taranaki Region has 86 lakes listed in the Freshwater Ecosystems of New Zealand (FENZ) database, one of which has substantial historical monitoring data. Taranaki Regional Council (TRC) recently established a new State of the Environment monitoring plan and is now monitoring six lakes in the region at monthly intervals. However, the health and state of most lakes in the region are not well known.

The National Policy Statement for Freshwater Management (NPS-FM 2020) provides guidelines whereby regional councils must 'maintain or improve' water quality in their regions. Included in this document is the National Objectives Framework (NOF), which categorises attributes relating to lake ecosystem health; chlorophyll-*a* (Chl-*a*), total nitrogen (TN), total phosphorus (TP), NH_4-N toxicity, dissolved oxygen (DO) concentration, macrophytes, and human contact (cyanobacterial biovolume and *Escherichia coli*) into four bands (A–D) with a specified national bottom line for each attribute. If a lake fails the bottom line for a national compulsory attribute (D-band for: Chl-*a*, TN, TP, DO, macrophytes and cyanobacteria, C-band for NH_4-N), action must be taken to improve water quality in that lake to at least the national bottom line.

In the absence of substantial long-term lake monitoring data, spatial modelling of lake attributes can provide a regional-scale snapshot of water quality and inform the selection and prioritisation of lakes for further sampling and monitoring. To predict the attribute state of lakes across the Taranaki Region, TRC commissioned the Cawthron Institute to:

- Undertake a review of lakes in the Taranaki Region as identified in the FENZ database to confirm lake identification and status (i.e. whether the lake is still present), and the geomorphic category of each lake.
- Develop a model using data from the national Our lakes' health: past, present, future (Lakes380; www.lakes380.com) programme to estimate current TN, TP and Chl-*a* concentrations for Taranaki lakes and compare the model data with existing modelled data available from the Ministry for the Environment (MfE).
- Provide a summary of the available MfE modelled data on NH_4-N and cyanobacterial biovolumes for the Taranaki Region.
- Use expert opinion to identify lakes where it is likely that the spatial models are not providing accurate predictions.
- Identify lakes in the Taranaki Region that are likely to be failing the national bottom line for lake bottom DO and mid-hypolimnetic DO.
- Suggest an approach for selecting lakes that should be prioritised for single point sampling to provide more baseline data for TRC and include general recommendations on lakes that should be prioritised for protection and restoration.

Our review of Taranaki lakes identified 19 waterbodies listed in the FENZ database that do not meet the FENZ definition of a lake (i.e. open water ≥ 1 ha in surface area). These lakes

were removed from the analysis presented in this report. In addition, we identified at least 17 lakes in the region that are not currently included in the FENZ database, illustrating the need for a comprehensive survey to identify all lakes.

MfE has modelled water quality attribute states for lakes across Aotearoa New Zealand. However, data from a limited number of lakes have been used to inform the models, meaning they are not representative of all lakes in Aotearoa New Zealand. In this study, we developed Sediment Bacterial Indices (SBIs) for Chl-*a*, TN and TP using data from a highly representative sub-set of 256 lakes, collected as part of the Lakes380 programme. This was compared with MfE modelled data for the same attributes.

The SBI modelling predicts that 78% of lakes in the Taranaki Region fail the bottom line for at least one attribute, while individually 72% fail for Chl-*a*, 54% fail for TP and 61% fail for TN. Only 15 lakes are predicted not to fail any attribute; however, of these lakes, 14 have at least one attribute estimated to be in a C-band, suggesting these lakes are still degraded. The SBI models produced similar results to the MfE modelling; however, in comparison to the MfE models, the SBI predicted 11 more lakes failed the bottom line for Chl-*a,* four more lakes failed for TP and one more lake failed for TN. The SBI and MfE modelled results were noticeably different in only four lakes, and for three of these, the MfE models were likely to be inaccurate.

The SBI modelling approach cannot be used to accurately estimate NH_4-N and cyanobacterial biovolume, therefore MfE models were explored for these attributes. The models developed for annual and maximum NH_4-N toxicity were deemed unsatisfactory by the developer, while the cyanobacterial biovolume model predicted that only 8% of lakes fail for that attribute. However, we believe the cyanobacterial model is under predicting the number of lakes that fail this NOF attribute. When a lake is eutrophic or higher, there is a high likelihood that it will experience a prolonged cyanobacterial bloom, especially during summer and autumn. When the national model for cyanobacterial biovolume was developed, there was only data for 37 lakes across Aotearoa New Zealand. We recommend that data on cyanobacterial biovolume is collected for all monitored lakes to improve knowledge on this attribute. The SBI modelling predicted that only one lake in the region (Lake Dive) scored in the A- or B-bands for all attributes. This lake is on Mount Taranaki and has a largely unmodified catchment.

We estimate that over half of the lakes in the Taranaki Region (n = 36) are at high risk of having depleted lake bottom DO and may fail the national bottom line for this attribute. For this estimation, we chose lakes that had a modelled SBI-Chl-*a* concentration in the C- or D-band and a depth greater than 15 m (based on FENZ data). We believe that the number of lakes with depleted DO is probably higher, as profiles from two shallow lakes also showed DO depletion and one shallow lake (Barrett Lagoon) experienced anoxia.

Management actions will be required to restore the lakes to a state above the national bottom line. We suggest that lakes predicted to fail, or that are close to failing, the national bottom line are prioritised for single point sampling. Due to the high number of lakes in the region predicted to have at least one attribute in the C- or D-band, we used a clustering method to help guide the selection of representative lakes. We recommend:

- Single point sampling should be undertaken at prioritised lakes (e.g. one in each of the 27 clusters identified, and an additional four lakes for which modelling results may be inaccurate) to validate the model predictions and provide information on the current conditions of the lakes and possible drivers of degradation. This information can then be used to help inform the development of a robust monitoring or research plan.
- Based on the above modelling and single time point sampling, robust management and / or monitoring plans are developed to allow the collection of data to inform the accurate assignment of NOF bands. Where possible, data collected should also provide additional information that will help guide management plans for lake protection or restoration.

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1. INTRODUCTION

The Taranaki Region of Aotearoa New Zealand has 86 lakes according to the Freshwater Ecosystems of New Zealand (FENZ) database. The lakes cover a wide diversity of geomorphic types, including beach and coastal lagoons, dune, riverine, landslide and wetland lakes, along with constructed reservoirs and dams (Leathwick et al. 2010). Many of these lakes have been impacted by multiple stressors, including water level fluctuations, nutrient and sediment run-off, introductions of non-native species, and climate change.

The National Policy Statement for Freshwater Management (NPS-FM 2020) and the embedded National Objectives Framework (NOF) were implemented to halt the degradation of freshwater quality by providing a mechanism to control diffuse pollution. The NPS-FM requires regional and unitary councils to ‘maintain or improve’ water quality across ‘freshwater management units’ (FMUs). Councils are required to monitor and develop plans to improve waterbodies in their jurisdiction to the national bottom-line standards or above (MfE 2020).

The standards used to assess lake ecosystem health are defined by thresholds of total nitrogen (TN), total phosphorus (TP), chlorophyll-*a* (Chl-*a*), ammonia (NH_4-N) toxicity and dissolved oxygen (DO), along with invasive and native LakeSPI (Lake Submerged Plant Index) as outlined in the NOF. Additionally, cyanobacterial biovolume (as an indication of potentially toxic cyanobacteria) and *Escherichia coli* (*E. coli*) are included as human contact attributes. If a lake falls into the C-band for ammonia toxicity or the D-band for TP, TN, Chl-*a* and cyanobacteria (Table 1), then actions are required to shift it out of these bands, which will likely involve management or restoration plans and a significant investment in resources. The water quality of lakes placed in other bands must also be maintained or improved (MfE 2020). Information on the current state of lake attributes is required to achieve these outcomes. Ideally this information should be obtained from a robust monitoring programme; however, this is challenging in regions with a large number of unmonitored lakes.

Table 1. National bottom-line thresholds for lake ecosystem health and human contact attributes outlined in the National Policy Statement for Freshwater Management (MfE 2020). Chl-*a* = chlorophyll-*a*, TN = total nitrogen, TP = total phosphorus, NH_4-N = ammonia, and DO = dissolved oxygen. Note: *Escherichia coli* is a human contact attribute requiring sampling at primary contact sites; however, this attribute was not included here as it was outside the scope of this report.

Attribute	**Attribute (unit)**	**National bottom line**		**Bands failing bottom line**
Lake ecosystem health attribute				
Phytoplankton	Chl-*a* (mg/m^3)	Annual median 12	Annual maximum 60	D
Total nitrogen	TN (mg/m^3)	Seasonally stratified and brackish (annual median) 750	Polymictic (annual median) 800	D
Total phosphorus	TP (mg/m^3)	Annual median 50		D
Ammonia toxicity	NH_4-N (mg/L)	Annual median 0.24	Annual 95th percentile 0.4	C
Lake bottom dissolved oxygen	DO (mg/L)	Measured or estimated annual minimum 0.5		D
Mid-hypolimnetic dissolved oxygen	DO (mg/L)	Measured or estimated annual median 4.0		D
Human contact attributes				
Planktonic cyanobacteria	Biovolume (mm^3/L)	All cyanobacteria 80th percentile[1] 10	Potentially toxic cyanobacteria 80th percentile[1] 1.8	D

Determining which lakes in the Taranaki Region fall below the national bottom line would require intensive sampling of each lake for at least 1 year to provide the required annual median, minimum, maximum or percentile values (Table 1). This would be very costly, resource intensive and unachievable in the near future. In the absence of substantial monitoring data for all lakes in the region, spatial modelling can

[1] The NOF requires that 80th percentile values are calculated from a minimum of 12 samples collected over 3 years.

be used to provide a regional-scale estimate of current NOF bands for lake attributes and guide the prioritisation of lakes for sampling and further research. However, insufficient data for some attributes may mean robust modelling is not possible.

Between 2022 and 2023, both the Ministry for the Environment (MfE) and the Lakes380 team separately undertook spatial modelling of lake water quality in Aotearoa New Zealand. MfE used available monitoring data provided by regional councils, whereas the Lakes380 team supplemented monitoring data with single point surface sediment samples collected from a wider range of lakes sampled as part of their research programme.

To assist with the estimation of NOF ecosystem health and human contact attribute states for lakes in the Taranaki Region, the Cawthron Institute was commissioned to:

- Undertake a review of lakes in the Taranaki Region as identified in the FENZ database to confirm lake identification and status (i.e. whether the lake is still present), and the geomorphic category of each lake.
- Develop a model using Lakes380 data to estimate current bands for annual median TN, TP, and Chl-*a* for Taranaki lakes and compare the data with existing modelled data available from MfE.
- Provide a summary of the available MfE modelled data on NH_4-N and cyanobacterial biovolume for the Taranaki Region.
- Use expert opinion to identify lakes where spatial models appear to inaccurately predict attribute bands.
- Identify lakes in the Taranaki Region that are likely to be failing the national bottom line for lake bottom DO and mid-hypolimnetic DO.
- Suggest an approach for selecting lakes that should be prioritised for single time point sampling to provide more baseline data for TRC as well as provide recommendations on lakes that should be prioritised for protection and restoration.

In addition to the introduction (Section 1), this report is written in five sections. These sections cover:

Section 2: *Summary of data available for Taranaki lakes*. A review of FENZ lakes in the Taranaki Region, removing those that were incorrectly assigned or no longer meet the definition of a lake (i.e. ≥ 1 ha of open water). A high-level summary of monitoring and other data for lakes in the Taranaki Region is provided to explain the need for the modelling work. These data are also compared to the modelled outputs in Section 3.

Section 3: *Spatial modelling*. The methods and results from the Lakes380 spatial modelling are presented. Modelling of NH_4-N and cyanobacterial biovolumes was not possible using these data and, as an alternative, spatially modelled data from MfE are presented. The Lakes380 modelling data are also compared with MfE modelled data and other sampled data available from TRC.

Section 4: *Dissolved oxygen*. A method for estimating which lakes likely fail the national bottom line for bottom-water DO concentrations is provided, along with a list of the lakes likely to fail using this approach.

Section 5: *Identifying lakes for additional sampling*. A clustering approach is used to identify lakes where additional single point sampling should be undertaken.

Section 6: *Potential actions or interventions to maintain or improve the health of Taranaki lakes.* An overview of potential actions for maintaining or improving the health of Taranaki lakes is provided along with recommendations on how palaeolimnological data collected as part of the Lakes380 programme can be used to inform lake restoration and management in the region.

2. REVIEW AND SUMMARY OF DATA AVAILABLE FOR TARANAKI LAKES

2.1. Review of lakes in the Taranaki Region

2.1.1. Introduction

The FENZ database is a set of spatial data layers describing the environmental and biological patterns of freshwater ecosystems in Aotearoa New Zealand (Leathwick et al. 2010). The database was designed to provide consistent national coverage of information about freshwater ecosystems, including their geographical locations and their physical and biological attributes. The spatial locations of lakes were largely identified using data from the 1:50,000 topographic map series for Aotearoa New Zealand and imposing a lower size limit of 1 ha. Given the challenges with assigning lakes at a national scale, and changes in the landscape since FENZ was developed, it is likely that some lakes have been either misidentified or subsequently drained or modified. Additionally, the classification of lake geomorphic type may not have been accurate for all lakes. A review of individual lakes is required to confirm lake presence and correct classification.

2.1.2. Methods

We evaluated the 86 lakes identified by FENZ in the Taranaki Region through a visual assessment using Takiwā Lakes (www.takiwa.co; www.lernz.co.nz/tools-and-resources/takiwa-lakes) and the FENZ lake ID (LID), which was entered into the search function.

We determined:

- Whether the lake was greater than 1 ha of open water (the FENZ definition of a lake) based on satellite imagery in Takiwā. Lake size was measured in Google Earth™ using the polygon measurement tool, and historical (2007–2022) satellite imagery was assessed to identify historical lake sizes for those lakes near the threshold.
- If the lake geomorphic class had been correctly identified based on lake morphology and landscape features as defined using the categories in the FENZ database: beach / coastal (B), wind / dune (W), riverine (R), swamp / wetland (S), landslide / landslip (L), glacial (G), dam / reservoir (D), and volcanic (V).

2.1.3. Results

FENZ lists a total of 86 lakes in the Taranaki Region. Of the 86 lakes, 19 did not meet the criteria of having an open water area greater than or equal to 1 ha in the region and, therefore, should no longer be classified as lakes. Images of these waterbodies, hereafter referred to as declassified lakes, are provided in Appendix 1. These declassified lakes include open waters less than 1 ha in surface area, oxidation ponds and river reaches. The 67 confirmed lakes have been used for the remainder of this report.

Our analysis also found five lakes that are not accurately represented in the FENZ database (Appendix 2). These include lakes for which the size and / or shape is incorrect and requires updating. While outside the scope of this study, we have also confirmed the presence of 17 lakes missing from the FENZ database that were previously identified by TRC (Appendix 3). However, we note that an extensive investigation was not undertaken, and it is likely that there are more unidentified lakes in the region. A detailed study using up-to-date satellite imagery is required to identify all current lakes.

Our review found that lake geomorphic classification was likely inaccurate for 15 lakes, including Kaikura, Waikirikiri Lagoon, Taumaha, Nowells Lakes, Rotomanu, Waipu Lagoons and Rotokare. We have proposed updated geomorphic classes for these lakes in Appendix 4.

2.2. Summary of data available for Taranaki lakes

Rotorangi is the longest artificial lake in Aotearoa New Zealand and was formed as part of the Patea River hydroelectricity scheme in 1984 (TRC 2022). This lake has the longest historical monitoring records in the region, including TN, NH_4-N, nitrite nitrogen, nitrate nitrogen, total Kjeldahl nitrogen, Chl-*a*, TP, dissolved reactive phosphorus (DRP), suspended solids and Secchi disc depth dating back to 1984. Monitoring of this lake is guided by resource consent requirements.

Eight lakes in Taranaki were sampled as part of the Lakes380 programme in October 2019 (Figure 1; Table 2). Water, surface sediment and sediment core samples were collected. The water and surface sediment samples were analysed for a suite of nutrients including TN, nitrite nitrogen, nitrate nitrogen, ammoniacal nitrogen, TP, DRP, dissolved organic carbon (DOC) and inorganic carbon (DIC), Chl-*a*, trace metals and environmental DNA (eDNA). Conductivity, temperature and DO profiles were also taken at each lake. A selection of the sediment cores are being analysed using a range of techniques to explore if, how and why the lakes have changed over the past approximately 1,000 years.

Fifteen lakes were sampled by TRC between July and September 2021 as part of a scoping project that aimed to identify lakes to include in a more representative lake monitoring programme (Table 2; Blakemore 2021c). Water quality parameters – including Chl-*a* and Secchi disc depth – and a suite of nutrients – including TN and TP – were measured, providing some single point data for these lakes. Six of the lakes were then chosen for the regional State of the Environment (SoE) monitoring programme, which began in early 2023. Temperature and DO profiles were also measured from seven lakes in the region at least once to provide information on bottom water oxygenation.

Potentially toxic planktonic cyanobacteria and *E. coli* have been routinely monitored in Rotokare, Rotomanu, Lake Ratapiko and Lake Opunake since 2014 and Lake Ngangana since 2021 as part of the 'Can I Swim Here?' campaign. Eight other lakes in the region have been sampled for cyanobacteria at least once since 2017 (Figure 1; Table 2). These samples are mostly collected from lake shore sites and not mid-lake sites.

Figure 1. Lakes in the Taranaki Region that have existing data on water quality for ecosystem health or human contact. Data collected by Taranaki Regional Council (black) and / or the Lakes380 team (blue).

Aquatic macrophyte surveys have been undertaken on Rotorangi since 1986, and they show the continual dominance of *Egeria densa* and *Lagarosiphon major* in this lake and the introduction of the invasive hornwort *Ceratophyllum demersum* in 2012 (Blakemore 2021a). Further macrophyte surveys using the LakeSPI protocol were carried out in Lake Kaikura, Lake Mangawhio and Rotokare in 2021. The results suggested the lakes were of moderate to high ecological health (de Winton et al. 2022). The report noted that water quality, in particular light limitation, was likely impacting the macrophyte ecology in all lakes, along with the presence of non-native species (de Winton et al. 2022).

Table 2. Lakes in the Taranaki Region with data on either water quality (WQ) or contact recreation. SoE = State of the Environment, DO = dissolved oxygen.

Lake name	Monitoring undertaken	Notes
Rotorangi	Cyanobacteria (2014–2023), Macrophytes (1986–2021, including LakeSPI in 2021), Routine monitoring of WQ, DO and contact recreation (1994–2023)	Currently routinely monitored (quarterly)
Rotokare	Cyanobacteria (2014–2023), LakeSPI (2021), Lakes380 (2019), WQ and contact recreation (2007–2023), DO profiles (2023), SoE WQ (from 2023)	Currently routinely monitored (SoE) from March 2023
Rotomanu	Cyanobacteria (2014–2023), WQ and contact recreation (1995–2023)	
Ratapiko	Cyanobacteria (2014–2023), WQ and contact recreation (2005–2023)	
Opunake	Cyanobacteria (2014–2023), WQ and contact recreation (1993–2023)	
Ngangana	Cyanobacteria (2017–2023)	
Herengawe	Cyanobacteria (2022–2023), Lakes380 (2019), WQ and contact recreational sampling (2021–2023), DO profiles (2023), SoE WQ (from 2023)	Currently routinely monitored (SoE) from April 2023
Taumaha	Cyanobacteria (2021), Organic contaminants and WQ (2019–2022)	
Waiau	Lakes380 (2019), WQ and contact recreation (2021)	
Oturi	Lakes380 (2019), WQ and contact recreation (2021)	

Lake name	Monitoring undertaken	Notes
Okoia	WQ and contact recreation (2021)	
Tapaurau Lagoon	WQ and contact recreation (2021)	
Nowells Lake (East)	WQ and contact recreation (2021)	
Kaikura	Cyanobacteria (2023), LakeSPI (2021), Lakes380 (2019), WQ (2021 and 2023), DO profiles (2023), SoE WQ (from 2023)	Currently routinely monitored (SoE) from April 2023
Umutekai	WQ and contact recreation (2021)	
Barrett Lagoon	WQ (2021–2023), DO profiles (2022), SoE WQ (from 2023)	Currently routinely monitored (SoE) from April 2023
Waikare	Cyanobacteria (2023), Lakes380 (2019), WQ (2023), DO profiles (2023), SoE WQ (from 2023)	Currently routinely monitored (SoE) from March 2023
Moumahaki	Lakes380 (2019), WQ and contact recreation (2021)	
LID: 16202	Lakes380 (2019)	
Mangamahoe	Field WQ (1991)	
Mangawhio	Field WQ and contact recreation (2021), LakeSPI (2021)	
Rotokawau	WQ and contact recreation (2021–2023), DO profiles (2023), SoE WQ (from 2023)	Currently routinely monitored (SoE) from May 2023
Waipu Lagoons	WQ and contact recreation (2021)	

Relevant data from the lakes outlined in Table 2 are compared to outputs of the spatial modelling in Section 3. To enable a comparison with NOF attributes, annual median epilimnion values of Chl-*a*, TP, TN and NH_4-N were calculated when there were at least three samples within a 1-year period. Annual 95th percentile NH_4-N concentrations were used when there were at least three samples within a 1-year period; however, we note that these will only provide very rough estimates of 95th percentile concentrations. Cyanobacterial biovolume samples were calculated as 80th percentiles of at least 12 samples collected over a 3-year period.

3. SPATIAL MODELLING OF NATIONAL OBJECTIVES ATTRIBUTES

Spatial models are developed using measured data from a range of representative lakes. The measured parameters can then be modelled in other lakes using available data on lake characteristics and catchment land use. In this report, we utilise data from three different spatial modelling approaches (Table 3).

Table 3. Spatial modelling methods used to estimate lake attributes. Data from these methods are incorporated in this report. Chl-*a* = chlorophyll-a, TN = total nitrogen, TP = total phosphorus, NH_4-N = ammonia.

Model method	**Source**	**Attributes**	**Model predictor categories**
Sediment Bacterial Index using Lakes380 data. Statistical modelling method: Extreme Boosting.	This report, but based on the approach described in Wood et al. (2023)	• TN • TP • Chl-*a*	• Lake characteristics • Catchment • Climate and flow • Land use
Spatial modelling of lake water quality state (2016–2020). Statistical modelling method: Random Forest.	MfE, Snelder et al. (2022)	• TN • TP • Chl-*a* • NH_4-N	• Lake characteristics • Catchment • Climate and flow • Geology • Land cover • Land use
Strategic assessment of New Zealand's freshwaters for recreational use: a human health perspective. Statistical modelling method: Random Forest.	MfE, Snelder et al. (2016)	• Cyanobacterial biovolume	• Geography and topography • Climate and flow • Geology • Land cover

3.1. Spatial modelling of total phosphorus, total nitrogen and chlorophyll-*a* using Lakes380 data and a Sediment Bacterial Index

3.1.1. Introduction

As part of the Lakes380 programme, an approach known as the Sediment Bacterial Trophic Index (SBTI; Pearman et al. 2022) was developed. This infers the trophic state of a lake based on different indicator bacteria present in lake surface sediment. While water samples are temporally variable due to climate conditions and seasonality, surface sediments provide a time-integrated representation of the within-lake conditions and organisms, as well as those in the catchment (Schallenberg and Kalff 1993). The SBTI uses 16S ribosomal RNA gene (16S rRNA) metabarcoding to characterise the bacterial community, from which key indicator bacteria are identified and the index calculated. During its development, the SBTI was compared to the Trophic Level Index 3 (TLI) for 96 monitored lakes, which showed the SBTI and TLI were strongly correlated (R^2 = 0.842, P < 0.001; Pearman et al. 2022).

The Lakes380 team then used this approach to measure SBTI in a highly representative sub-set of 256 lakes, and a statistical approach known as extreme boosting was used to predict the SBTI for all lakes in Aotearoa New Zealand (Wood et al. 2023). A similar approach, using a different statistical method has been developed for MfE using available lake water quality data in the recent Aotearoa 2022 report (MfE 2022). However, MfE acknowledge the limitations of the dataset used to develop the models: data from lakes in many parts of the country are absent, and there is an over-representation of lakes in low elevations with warmer climates and an under-representation of those in high altitudes with colder climates. These limitations likely introduce over- or under-predictions of attributes.

In this report, we adapted the SBTI approach used by Pearman et al. (2022) to estimate a Sediment Bacterial Index (SBI) for Chl-*a* (SBI-Chl-*a*), TN (SBI-TN) and TP (SBI-TP). Extreme boosting was then used to predict the SBIs for lakes in Aotearoa New Zealand. This report focuses on the data for the Taranaki Region. It is important to note that this model produces estimates of SBIs rather than estimates of the attributes themselves.

3.1.2. Methods

A detailed description of the methods used is given in Pearman et al. (2022) and Wood et al. (2023).

Determining the Sediment Bacterial Index for each attribute

Lake surface sediment samples were collected from 256 naturally occurring lakes in Aotearoa New Zealand. Lakes were carefully selected to be highly representative of all lakes in the country (by region and lake type) and to cross multiple environmental gradients. Sediment bacterial communities from these lakes were characterised using 16S rRNA metabarcoding, from which key indicator bacteria associated with different attribute concentrations and NOF bands (A–D) were identified and the attribute-specific SBI calculated for each lake. The lake-specific SBI for each attribute was then compared with measured annual median attribute concentrations in 96 lakes for which these data were available.

Modelling the Sediment Bacterial Index for each attribute across all Taranaki lakes

To predict SBI for those lakes where it could not be calculated, we developed a modelling approach using machine learning. We tested six different models (Random Forest, Linear Model, Support Vector Machine, Boosted Regression Tree, Neural Networks and Extreme Boosting). We selected extreme boosting because it had the highest mean R^2, the lowest root mean squared deviation (RMSE) and the lowest mean absolute error (MAE) of the evaluated approaches (Table 4). A detailed description of the statistical steps used is given in Wood et al. (2023). The SBI-Chl-*a*, SBI-TN and SBI-TP were determined for all lakes in Aotearoa New Zealand. We then selected the data on lakes in the Taranaki Region to use in this report. The values are predicted median values to match the national bottom-line measurements for these attributes (Table 1).

Table 4. Model statistics for the Sediment Bacterial Index using Extreme Boosted regression models for total phosphorus (TP), total nitrogen (TN) and chlorophyll-*a* (Chl-*a*). R^2 = coefficient of determination, RMSE = root mean squared error, MAE = mean absolute error.

	TP (mg/m^3)			**TN** (mg/m^3)			**Chl-*a*** (mg/m^3)		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
R^2	0.68	0.58	0.72	0.69	0.58	0.79	0.51	0.37	0.67
RMSE	19.25	17.18	21.42	246.66	216.32	292.5	7.67	5.99	8.63
MAE	14.36	12.3	15.9	176.38	150.51	208.48	5.34	4.27	6.15

The model included selected lake characteristics obtained from the FENZ database (Table 5) and land-use characteristics from the catchments of each lake (Land Cover Database Version 5 2020). Seven broad groupings were used for the analysis:

- Native forest (a combination of Broadleaved Indigenous Hardwoods and Indigenous Forest)
- Native vegetation (Alpine Grass / Herbfield, Fernland, Flaxland, Manuka and / or Kanuka, Matagouri or Grey Scrub, Sub Alpine Shrubland and Tall Tussock Grassland)
- Non-native vegetation (Deciduous Hardwoods, Depleted Grassland, Gorse and / or Broom, Mixed Exotic Shrubland, Orchard, Vineyard or Other Perennial Crop and Short-rotation Cropland)
- Forestry (Exotic Forest and Forest – Harvested)
- High production grassland (HPG; agricultural grassland with a high stock density)
- Low production grassland (LPG; agricultural grassland with a low stock density)
- Other (Gravel or Rock, Herbaceous Saline Vegetation, Landslide, Permanent Snow and Ice, Sand or Gravel and Surface Mine or Dump)

Table 5. Lake characteristics selected from the Freshwater Ecosystems of New Zealand database for inclusion in the Sediment Bacterial Index models.

Lake characteristics	Unit
Max. depth	m
Lake area	ha
Lake elevation	m
Catchment slope	degrees
Catchment area	ha
Summer solar radiation	$MJ/m^2/day$
Summer temperature	degrees
Mean wind	metres/second
Catchment flow	m^3/sec
Catchment phosphorus	Categorical 1–5
Catchment calcium	Categorical 1–4
Catchment particle size	Categorical 1–5
Distance to coast	km
Residence time	years

Using the SBI approach, we were unable to accurately model NH_4-N or cyanobacterial biovolumes due to a lack of robust data in the Lakes380 programme on these parameters. The sections below provide a summary of modelling that has been undertaken for these parameters as part of several MfE commissioned studies.

3.2. Spatial modelling of total phosphorus, total nitrogen and chlorophyll-*a* and ammonia undertaken by Ministry for the Environment

MfE commissioned a study that aimed to estimate the values and resulting NOF bands of eight lake attributes including Chl-*a*, TN, TP, NH_4-N[2], Secchi disc depth, *E. coli* and TLI using data from the period 2016–2020 (Snelder et al. 2022). Random Forest (RF) models were created to estimate the attribute state for 3,821 lakes in Aotearoa New Zealand based on water quality monitoring data[3] (Snelder et al. 2022). The models varied in their performance based on the attribute modelled (Table 6). Of

[2] The NPS-FM 2020 requires that NH_4-N data is pH adjusted, therefore adjusted NH_4-N was used when developing the model.

[3] The number of lakes used to develop the models varied from 54 to 124 depending on the attribute modelled.

note was the unsatisfactory performance of the median and annual maximum NH_4-N models; therefore caution should be taken when using modelled NH_4-N data.

Table 6. Performance and ratings of the water quality models from Snelder et al. (2022); performance ratings are based on Moriasi et al. (2015). N = number of lakes, R^2 = coefficient of determination of observation versus predictions, NSE = Nash-Sutcliffe efficiency, PBIAS = percent bias, RMSD = root mean square deviation. Modified from Snelder et al. (2022).

Attribute	N	R^2	NSE	PBIAS	RMSD	Rating
Total nitrogen (median) (mg/m^3)	124	0.78	0.77	3.66	0.23	Very good
Total phosphorus (median) (mg/m^3)	124	0.62	0.62	0.44	0.35	Good
NH_4-N (median) (mg/L)	80	0.31	0.31	0.74	0.35	Unsatisfactory
NH_4-N (maximum) (mg/L)	80	0.29	0.29	0.71	0.55	Unsatisfactory
Chlorophyll-*a* (median) (mg/m^3)	124	0.45	0.45	-0.82	0.41	Satisfactory

3.3. Spatial modelling of cyanobacterial biovolume undertaken by Ministry for the Environment

In 2016, MfE commissioned a report to estimate the state of freshwaters in Aotearoa New Zealand from a human health perspective (Snelder et al. 2016). This study used quarterly SoE measurements of Chl-*a*, TN, TP, Secchi disc depth and TLI from up to 99 lakes sampled between 2009 and 2013, along with concurrent observations of cyanobacterial biovolume, Chl-*a*, TN, TP, and Secchi disc depth data for 37 lakes. This was because suitable cyanobacterial biovolume data was only available for 37 lakes. Site median values of water quality variables were combined with catchment and land-use data to predict these variables for all lakes in Aotearoa New Zealand. The values were then used as new data in a cyanobacterial biovolume multiple linear regression equation to estimate cyanobacterial biovolume for all lakes, based on the water quality predictors. The spatial water quality attribute models were rated to have satisfactory to good performance according to Snelder et al. (2016). The most accurate model for cyanobacterial biovolume included Chl-*a*, TP and Secchi disc depth and had an R^2 of 0.64 (Snelder et al. 2016).

3.4. Results – comparison of spatial modelling data

The NOF threshold values for TN are different depending on whether the lake is seasonally stratified and brackish, or polymictic (MfE 2020; Table 1). Given that the mixing regimes for most lakes in this region are unknown, in this report we have used the slightly lower threshold value of 750 mg/m^3 (for seasonally stratified and brackish lakes) as a conservative estimate when referring to the TN bands.

3.4.1. Sediment bacterial indices

Sediment Bacterial Indices were developed for the Chl-a, TN and TP attributes using surface sediment bacterial data from 96 monitored lakes in Aotearoa New Zealand. When the SBI model outputs were compared to measured annual median Chl-a, TN and TP concentrations, significant relationships were observed (Chl-*a*: R^2 = 0.49, P < 0.001, TN: R^2 = 0.61, P < 0.001, and TP: R^2 = 0.61, P < 0.001; Figure 2). However, while the models were able to confidently predict whether an attribute would be in a D-band, the predictive ability for values within this band was poor. This is because the weights used in the formula are based on the proportion of indicators for the NOF bands and the values in the monitored lakes. These weights set a limit when all indicators are for a particular NOF band, and they produce a maximum limit on the scale when 100% of the indicators are from NOF D-band. This results in lakes being characterised as being in NOF D-band, but the very high values predicted are inaccurate. Nevertheless, lakes that had a measured annual median of Chl-*a*, TN and TP in the D-band were correctly predicted as being within this band using the SBI approach, except for one lake where the TN was underpredicted by the model, placing it in the C category.

In bands A, B and C, the models show less variance, although they tended to predict higher attribute concentrations and therefore occasionally placed attributes into the D-band. This was particularly notable for TP (Figure 2C).

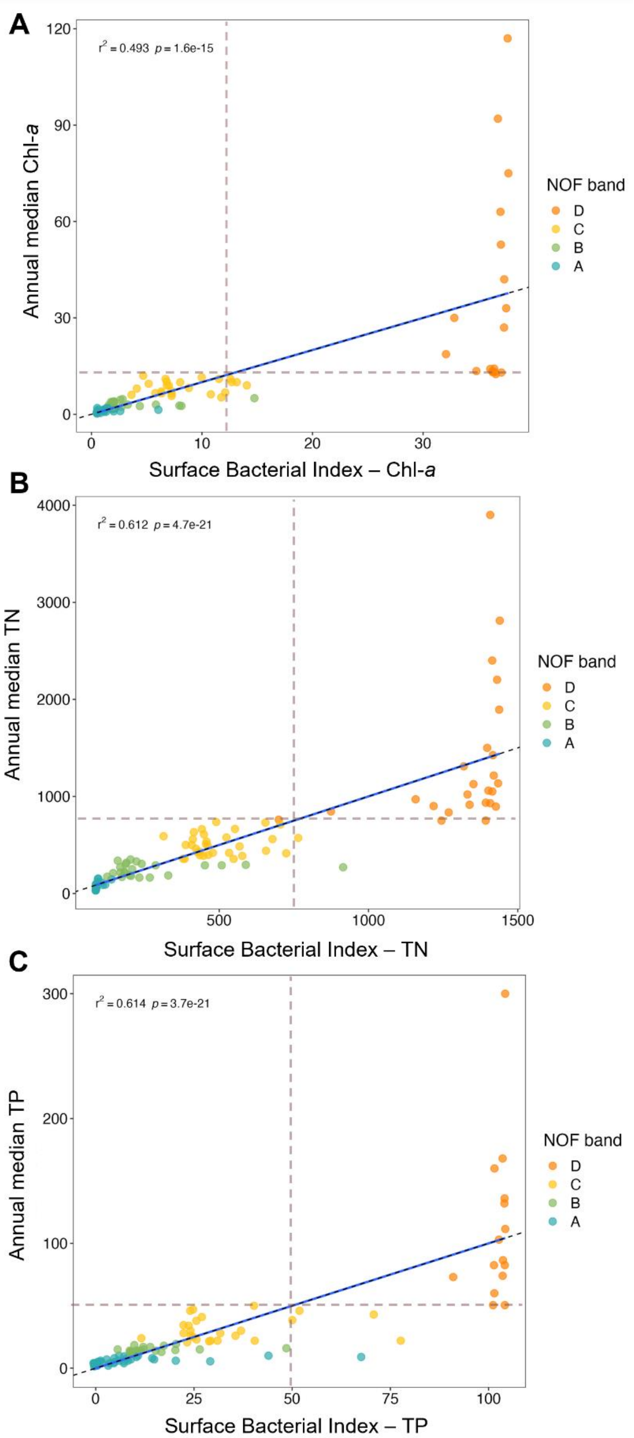

Figure 2. The relationship between measured annual median attribute concentration and Sediment Bacterial Index (SBI) modelled attribute concentration for 96 lakes in Aotearoa New Zealand. Attributes are: A) chlorophyll-*a* (Chl-*a*), B) total nitrogen (TN), and C) total phosphorus (TP). Lakes are coloured by the National Objectives Framework (NOF) banding for each attribute based on their measured annual median concentrations. The brown dashed lines indicate the national bottom line for that attribute.

Based on the SBI indices calculated for the 96 lakes with monitoring data, we used 16S rRNA metabarcoding data from 256 lakes nationwide to predict their SBI for each attribute (Chl-*a*, TN and TP), eight of which were in the Taranaki Region. The SBI models indicated that six of the eight lakes failed the national bottom line for at least one of the three modelled attributes (Table 7). Five of the eight lakes were estimated to fail the bottom line for both TN and TP, while four of those were also estimated to fail on Chl-*a*.

Table 7. Sediment Bacterial Indices for annual median chlorophyll-*a* (SBI-Chl-*a*), annual median total nitrogen (SBI-TN) and annual median total phosphorus (SBI-TP) measured in eight lakes in the Taranaki Region. Cells are coloured by the National Objectives Framework band related to the attribute: orange = D-band, yellow = C-band, green = B-band, and blue = A-band.

LID	Lake name	SBI-Chl-*a* (mg/m^3)	SBI-TN (mg/m^3)	SBI-TP (mg/m^3)
15795	Kaikura	8.7	612	40
15902	Herengawe	25.8	1,300	75
16222	Waikare	1.4	579	46
7512	Rotokare	10.9	808	50
16131	Moumahaki	16.2	943	64
15907	Waiau	40.1	1,603	96
15904	Oturi	18.6	1,012	49
16202		2	560	42

Modelling sediment bacterial indices for chlorophyll-*a*, total nitrogen and total phosphorus across all Taranaki lakes

Attributes were then modelled using the SBI-Chl-*a* (Figure 3), SBI-TP (Figure 4) and SBI-TN (Figure 5) for all lakes in the Taranaki Region, after removal of declassified lakes identified in Section 2.1.

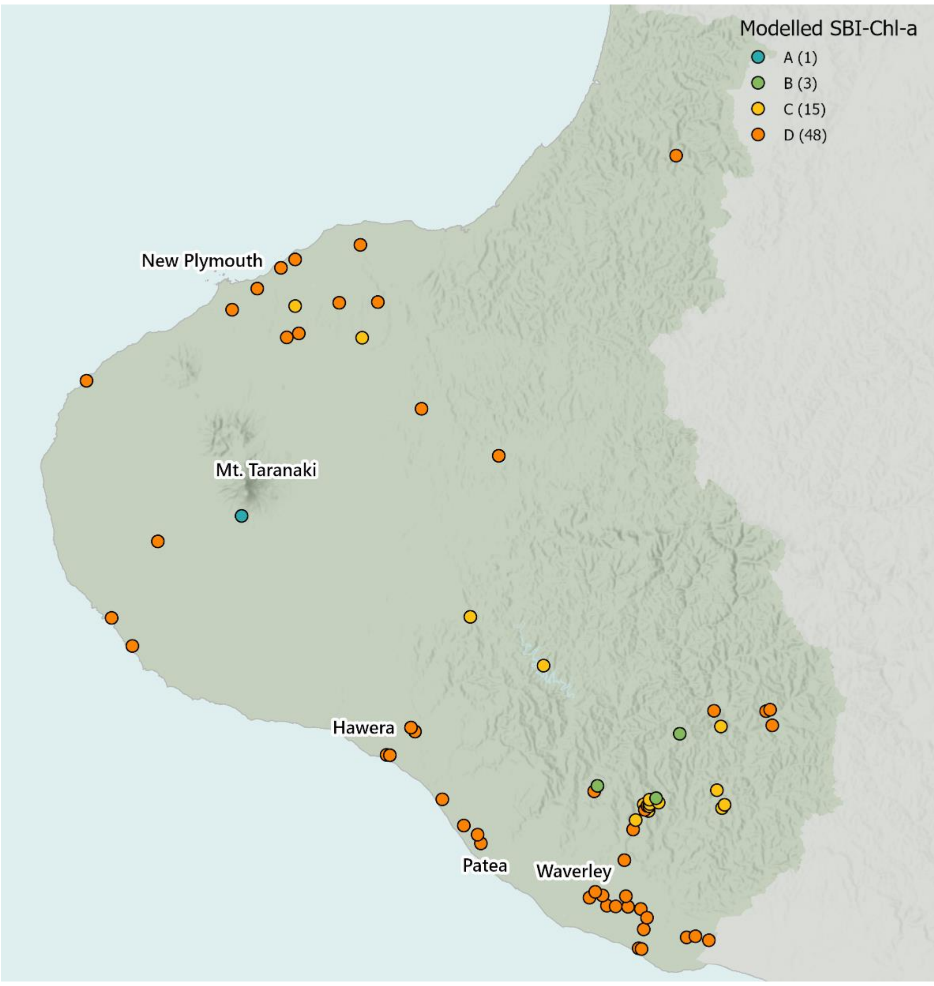

Figure 3. Map of lakes in the Taranaki Region (*n* = 67), coloured by their modelled chlorophyll-*a* (SBI-Chl-*a*) National Objectives Framework bands. Numbers in parentheses indicate the number of lakes in that band.

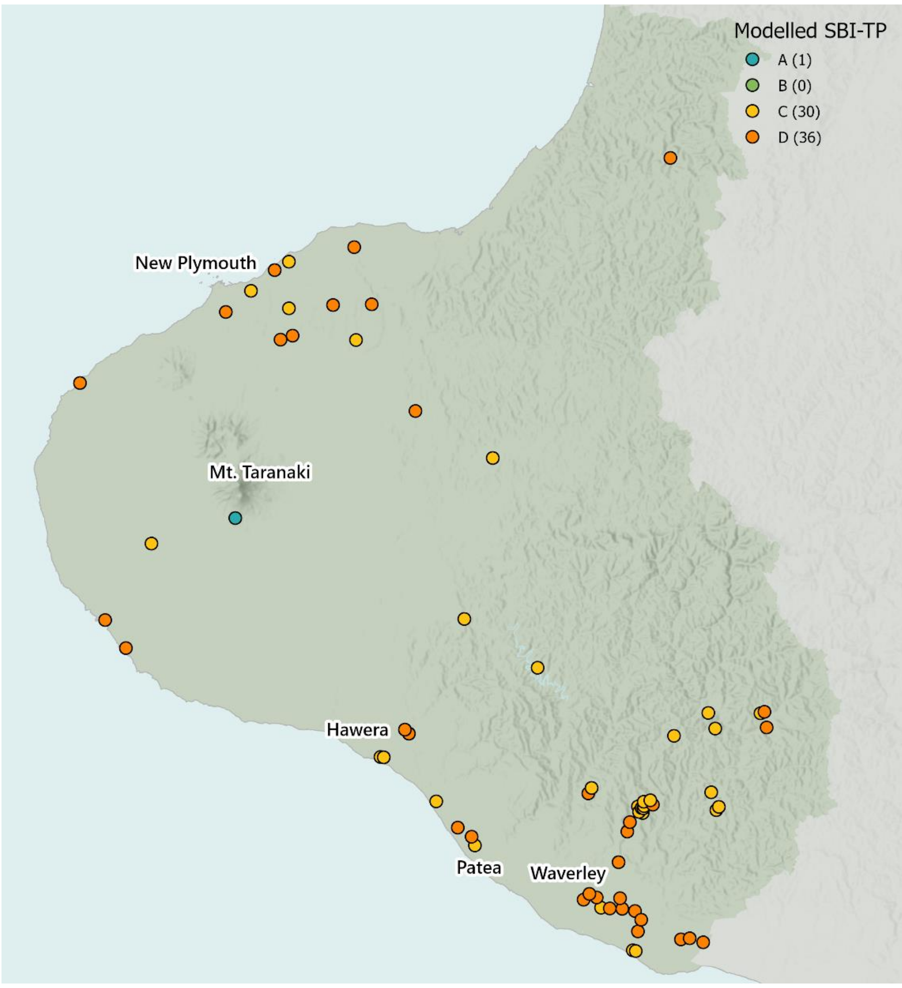

Figure 4. Map of lakes in the Taranaki Region (n = 67), coloured by their modelled total phosphorus (SBI-TP) National Objectives Framework bands. Numbers in parentheses indicate the number of lakes in that band.

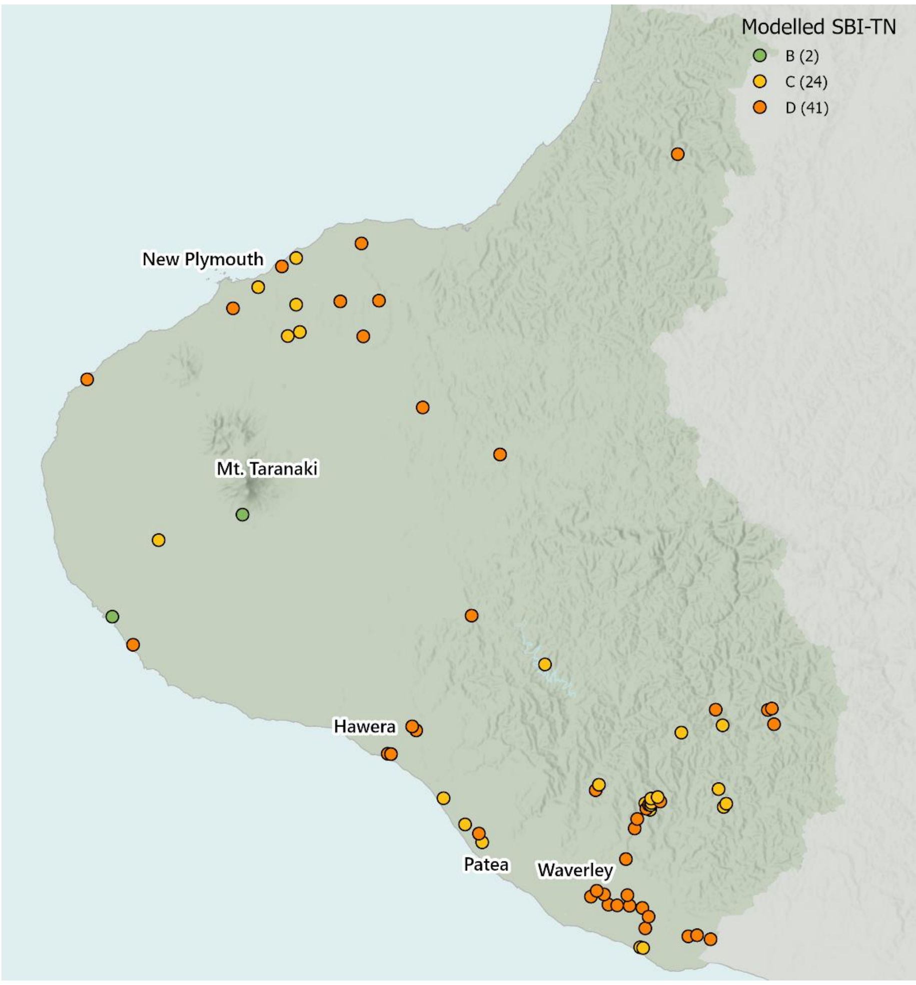

Figure 5. Map of lakes in the Taranaki Region (*n* = 67), coloured by their modelled total nitrogen (SBI-TN) National Objectives Framework bands. Numbers in parentheses indicate the number of lakes in that band.

A comparison of measured (using sediment indicator bacteria) and modelled (using lake, catchment, and land-use characteristics) SBI attributes for the eight lakes in which the SBIs were measured showed the two approaches generally produced similar values (Table 8). Four of the eight lakes were placed into the same bands using measured and modelled SBI-Chl-*a*, while three were placed into adjacent bands (Table 8). All eight lakes were placed into the same NOF band for both measured and modelled SBI-TN. Five of the eight lakes were placed in the same band using the measured and modelled SBI-TP. The most notable differences in measured and modelled values were the SBI-Chl-*a* values for lakes Waikare and LID: 16202, where modelled estimates were in the C-band, though the SBI calculations placed them in the A-band.

Table 8. Measured Sediment Bacterial Index (SBI) attributes : annual median chlorophyll-*a* (Chl-*a*, mg/m^3), annual median total phosphorus (TP, mg/m^3) and annual median total nitrogen (TN, mg/m^3), compared with modelled SBI outputs for eight lakes in the Taranaki Region. Values are coloured by the National Objectives Framework (NOF) banding related to the attribute: orange = D-band, yellow = C-band, green = B-band, and blue = A-band.

LID	Lake name	Meas. SBI-Chl-*a* (mg/m^3)	Mod. SBI-Chl-*a* (mg/m^3)	Meas. SBI-TP (mg/m^3)	Mod. SBI-TP (mg/m^3)	Meas. SBI-TN (mg/m^3)	Mod. SBI-TN (mg/m^3)
15795	Kaikura	8.7	15.9	40	67	612	595
15902	Herengawe	25.8	22.3	75	76	1,300	1,204
16222	Waikare	1.4	6.8	46	42	579	480
7512	Rotokare	10.9	7.4	50	41	808	1,041
16131	Moumahaki	16.2	11	64	51	943	945
15907	Waiau	40.1	26.8	96	86	1,603	1,302
15904	Oturi	18.6	17.8	49	68	1,012	1,051
16202		1.9	6.7	42	36	560	575

The results of region-wide SBI-Chl-*a*, SBI-TN and SBI-TP modelling are presented in Table 10.

3.4.2. Sediment Bacterial Index and MfE spatial modelling results

SBI and MfE modelling suggested that 55% to 72% of lakes in the Taranaki Region fail the national bottom line for Chl-*a* (Table 9). Between 48% to 54% are estimated to fail for TP, and 60% to 61% for TN. No lakes in the Taranaki Region are estimated to fail the bottom line for annual median NH_4-N toxicity according to the MfE models, with modelled annual median NH_4-N values in the A-band for all lakes. The MfE model estimates 16% of lakes fail the national bottom line for annual maximum NH_4-N toxicity (i.e. are in the C-band), while 79% of lakes are estimated in the B-band, and 5% of lakes in the A-band (Table 9). However, we note the unsatisfactory model performance for both the median and maximum NH_4-N models (Table 6). An estimated 8% of lakes fail the bottom line for cyanobacterial biovolume, while 10% are placed in the C-band, 46% in the B-band, and 36% in the A-band.

Table 9. The number and percentage of lakes (*n* = 67) in the Taranaki Region in each National Objectives Framework (NOF) bands according to Sediment Bacterial Index (SBI) and Ministry for the Environment (MfE) modelling of annual median chlorophyll-*a* (Chl-*a*), annual median total phosphorus (TP), annual median total nitrogen (TN), annual median and maximum[4] ammonia concentration (NH_4-N),[5] and 80th percentile cyanobacterial biovolume.

		NOF Band			
		A	B	C	D
SBI-Chl-*a*	# of lakes	1	3	15	48
	% of lakes	2%	4%	22%	72%
MfE Chl-*a*	# of lakes	0	7	23	37
	% of lakes	0%	11%	34%	55%
SBI-TP	# of lakes	1	0	30	36
	% of lakes	2%	0%	44%	54%
MfE TP	# of lakes	0	10	25	32
	% of lakes	0%	15%	37%	48%
SBI-TN	# of lakes	0	2	24	41
	% of lakes	0%	3%	36%	61%
MfE TN	# of lakes	0	6	21	40
	% of lakes	0%	9%	31%	60%
MfE NH_4-N median	# of lakes	67	0	0	0
	% of lakes	100%	0%	0%	0%
MfE NH_4-N maximum[4]	# of lakes	3	53	11	0
	% of lakes	5%	79%	16%	0%
MfE 80th percentile cyanobacterial biovolume	# of lakes	24	31	7	5
	% of lakes	36%	46%	10%	8%

Using the SBI modelled Chl-*a*, TP and TN, only 15 lakes in the region are predicted not to fail the bottom line for any of the modelled attributes, while 52 lakes (78% of lakes) fail for at least one of the following: Chl-*a*, TP, TN or cyanobacterial biovolume. Only one lake (Lake Dive) is estimated to be in bands A or B for all attributes (Table 9).

[4] Note that the NPS-FM 2020 uses 95th percentile annual NH_4-N instead of annual maximum concentration, but the MfE modelled data are annual maximums.

[5] Caution should be taken when interpreting the NH_4-N data, as the performance of the models was 'unsatisfactory' (Table 6).

The modelled SBI placed more lakes into the D-band than the MfE models. This was particularly noticeable for Chl-*a* and TP (Figure 6). The SBI modelled Chl-*a* placed 11 more lakes into the D-band than the MfE modelled values, while more lakes were placed into B- and C-bands using the MfE model (Figure 6). Four more lakes were placed into the D-band using the SBI-TP than the MfE TP model, while one more lake was placed in the D-band using the SBI-TN than the MfE model predicted. No lakes in the Taranaki Region were placed into the A-band for Chl-*a* according to MfE modelling, while one lake (Lake Dive) was in the A-band according to the SBI model.

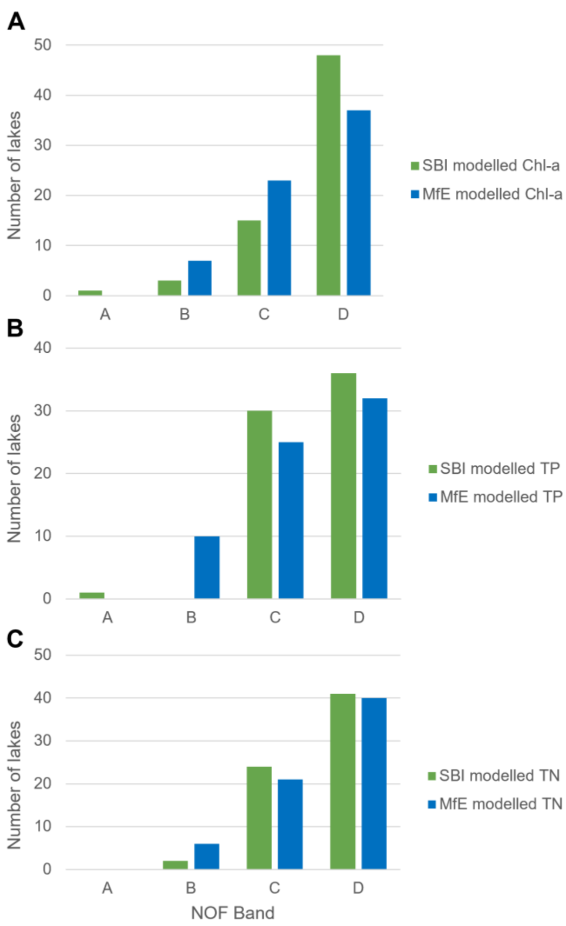

Figure 6. Comparison of the number of lakes in each National Objectives Framework (NOF) band for (A) annual median chlorophyll-*a* (Chl-*a*), (B) annual median total phosphorus (TP), and (C) annual median total nitrogen (TN) using Sediment Bacterial Index (SBI) modelled attributes (green bars) and Ministry for the Environment (MfE) modelled attributes (blue bars).

The SBI and MfE data for all lakes in the Taranaki Region are provided in Table 10. Monitoring and single time point data are also included for comparison.

Table 10. Measured and modelled values of annual median chlorophyll-*a* (Chl-*a*), annual median total phosphorus (TP), annual median total nitrogen (TN), annual median and maximum pH-adjusted ammonia (NH_4-N)[6,7] and 80th percentile cyanobacterial biovolume (Cyanobacteria) for 67 lakes in the Taranaki Region. Bacterial Index (SBI) measurements (meas.) for Chl-*a*, TP and TN are given where available, and modelled estimated (mod.) given for remaining lakes. Ministry for the Environment (MfE) modelled data is provided for Chl-*a*, TP, TN (for comparison with SBI modelled data), NH_4-N and cyanobacterial biovolume. Annual median measurements of Chl-*a*, TP, TN, NH_4-N and 95th percentile concentrations of NH_4-N are provided for seven lakes (six SoE lakes and Rotorangi) sampled by Taranaki Regional Council (TRC) in 2022–2023, which had at least three samples over a 1-year period. Single spot-sample measurements are provided for 12 other lakes sampled by TRC in 2021, along with spot-sample measurements for eight lakes collected by the Lakes380 team (L380) in October 2019. Potentially toxic cyanobacterial biovolumes are provided as 80th percentile values calculated from at least 12 samples collected by TRC between March 2020 and March 2023. Values are coloured by the National Objectives Framework (NOF) band related to the attribute, as specified in the National Policy Statement for Freshwater Management: orange = D-band, yellow = C-band, green = B-band, and blue = A-band.

		Chlorophyll-*a* (mg/m³)					Total phosphorus (mg/m³)					Total nitrogen (mg/m³)					NH_4-N-toxicity (mg/L)				Cyanobacteria (mm³/L)	
LID	Lake name	TRC Chl-*a*	L380 spot Chl-*a*	Meas. SBI-Chl-*a*	Mod. SBI-Chl-*a*	MfE mod. Chl-*a*	TRC TP	L380 spot TP	Meas. SBI-TP	Mod. SBI-TP	MfE mod. TP	TRC TN	L380 spot TN	Meas. SBI-TN	Mod. SBI-TN	MfE mod. TN	MfE mod. Annual Median	TRC Annual Median	TRC Annual 95th percentile	MfE mod. Annual Max.	MfE mod. Cyano. Biovol.	TRC Cyano. Biovol.
16202			58*	1.97	6.7	5.1		55*	42	36	16		570*	560	575	488	0.005			0.089	0.1	
16131	Moumahaki	12.4*	11*	16.2	11	3.8	34*	52*	64	51	16	400*	5000*	943	945	341	0.004			0.055	0.395	
15904	Oturi	70*	7.4*	18.6	17.8	13.3	43*	110*	49	68	72	870*	1300*	1012	1051	1046	0.014			0.403	0.35	
15907	Waiau	50*	3.9*	40.1	26.8	12	57*	120*	96	86	96	2600*	7400*	1603	1302	1422	0.017			0.413	0.679	
15795	Kaikura	4.7**	18*	8.7	15.9	9.3	26**	100*	40	67	119	4000**	1200*	612	595	1390	0.016	0.01**	0.04**	0.287	0.414	
15902	Herengawe	24**	21*	25.8	22.3	14.1	29**	87*	74.6	76	105	1100**	760*	1300	1204	1407	0.014	< 0.01**	< 0.01**	0.38	0.76	0.17
16222	Waikare	5.2**	7.9*	1.4	6.8	4.6	48**	56*	46	42	17	455**	620*	579	480	342	0.004	< 0.01**	0.04**	0.048	0.212	
7512	Rotokare	30**	40*	10.9	7.4	4.1	46**	54*	50	41	16	400**	580*	808	1041	275	0.003	< 0.01**	0.01**	0.045	0.576	2.70
20893	Barrett Lagoon	3**			16.7	18	16**			53	51	1460**			786	947	0.016	0.02**	0.05**	0.532	0.478	
7445	Rotokawau	13.5**			21.6	16.6	12**			71	39	235**			1036	782	0.008	0.02**	0.04**	0.161	0.821	
7506	Rotorangi (L2)	3.6			11.6	4.9	24			38	34	665			367	490	0.011			0.096	0.74	< 0.01

[6] Caution should be taken when interpreting these data, as the performance of the models was 'unsatisfactory'. (Table 6).
[7] Note that the C-band for NH_4-N fails the national bottom line.
* Single spot-sample measurement, not an annual median. Caution must be taken when interpreting these data as single point samples are not necessarily representative of annual conditions.
** Calculated from at least three samples, but rarely covering a full year. The samples may therefore not be representative of annual medians or percentiles and should be interpreted with caution.

		Chlorophyll-*a* (mg/m^3)					Total phosphorus (mg/m^3)					Total nitrogen (mg/m^3)					NH_4-N-toxicity (mg/L)				Cyanobacteria (mm^3/L)	
LID	Lake name	TRC Chl-*a*	L380 spot Chl-*a*	Meas. SBI-Chl-*a*	Mod. SBI-Chl-*a*	MfE mod. Chl-*a*	TRC TP	L380 spot TP	Meas. SBI-TP	Mod. SBI-TP	MfE mod. TP	TRC TN	L380 spot TN	Meas. SBI-TN	Mod. SBI-TN	MfE mod. TN	MfE mod. Annual Median	TRC Annual Median	TRC Annual 95th percentile	MfE mod. Annual Max.	MfE mod. Cyano. Biovol.	TRC Cyano. Biovol.
20771	Umutekai	1.2*			9.8	15	19*			42	47	680*			674	750	0.015			0.277	1.98	
20904	Rotomanu	6.2*			22.6	8.6	24*			78	80	320*			1087	599	0.009			0.17	0.901	0.12
16224	Mangawhio	5.6*			6.5	4	36*			38	15	450*			460	316	0.004			0.048	0.131	
15842	Nowells Lakes (East)	7.3*			13.8	8.9	31*			47	43	760*			845	1107	0.011			0.255	1.342	
20959	Waipu lagoon	8.9*			17.8	15.4	15*			38	54	810*			513	990	0.019			0.448	0.634	
15886	Tapuarau Lagoon	20*			12.8	5.4	28*			32	24	470*			542	457	0.007			0.127	2.95	
15898	Okoia	37*			22	12.4	42*			94	138	2200*			1272	1382	0.015			0.41	0.834	
15823	Taumaha	90*			14.9	12.1	54*			39	62	1060*			566	1211	0.018			0.434	0.308	
16392	Ratapiko	< 0.6*			15.5	10.9	17*			69	100	420*			1075	1010	0.014			0.501	0.442	< 0.01
13309					15.4	15.7				47	56				653	1192	0.019			0.384	0.843	
13311					14.1	13.9				60	72				838	1201	0.014			0.491	0.871	
15792					31.2	8.8				99	65				1195	1085	0.014			0.308	2.522	
15840					15.7	9.3				47	41				887	1145	0.013			0.261	0.823	
15854					15	13				71	78				1057	1332	0.019			0.393	0.885	
15855					12.9	12.4				68	67				979	1300	0.019			0.4	0.582	
15890					12.2	5.4				30	23				360	432	0.007			0.116	2.795	
15896					18.3	12.3				59	51				781	1067	0.013			0.281	0.754	
15900					15.3	16				49	67				836	1335	0.017			0.389	0.693	
15906					19.1	14.8				77	90				1274	1117	0.012			0.36	0.607	
15909					13.9	13				60	53				987	1287	0.017			0.377	0.73	
15926	Waikato				16.5	12.5				69	86				1099	1377	0.017			0.254	0.98	
15937					18.6	15.8				70	68				808	1149	0.016			0.397	1.571	
15943					18.6	15.9				64	88				769	1191	0.018			0.403	0.673	
15947					22.5	13.7				86	76				1006	1263	0.014			0.241	1.58	
16060					15.9	15.6				80	60				985	1034	0.014			0.378	0.885	

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		Chlorophyll-*a* (mg/m^3)					Total phosphorus (mg/m^3)					Total nitrogen (mg/m^3)					NH_4-N-toxicity (mg/L)				Cyanobacteria (mm^3/L)	
LID	Lake name	TRC Chl-*a*	L380 spot Chl-*a*	Meas. SBI-Chl-*a*	Mod. SBI-Chl-*a*	MfE mod. Chl-*a*	TRC TP	L380 spot TP	Meas. SBI-TP	Mod. SBI-TP	MfE mod. TP	TRC TN	L380 spot TN	Meas. SBI-TN	Mod. SBI-TN	MfE mod. TN	MfE mod. Annual Median	TRC Annual Median	TRC Annual 95th percentile	MfE mod. Annual Max.	MfE mod. Cyano. Biovol.	TRC Cyano. Biovol.
16091					19.5	15.1				68	82				995	1169	0.013			0.597	1.636	
16123					12.9	5.6				65	19				849	386	0.004			0.066	0.464	
16159					20.3	14.8				58	47				835	788	0.009			0.217	0.396	
16163					4.2	6.5				30	23				450	500	0.006			0.123	0.261	
16165					5.7	9.2				27	27				554	390	0.004			0.083	0.406	
16190					10.2	7.1				37	23				647	465	0.005			0.098	0.235	
16193					21.3	15.4				49	47				869	702	0.012			0.253	0.187	
16196					13.8	15.4				50	48				775	870	0.012			0.245	0.607	
16197					9.5	6.1				33	21				638	426	0.005			0.071	0.54	
16213					8.8	6				36	21				638	389	0.005			0.068	0.228	
16214					7.7	5.3				32	18				520	373	0.005			0.062	0.378	
16215					9.8	12.8				51	30				931	590	0.006			0.156	0.479	
16219					2.1	12.7				40	28				647	537	0.006			0.178	0.354	
16233					3.1	8.6				35	24				534	416	0.005			0.109	0.246	
16237					6.1	4.4				27	15				413	304	0.003			0.05	0.077	
16246					21.2	12.4				57	35				1183	1006	0.015			0.246	0.315	
16269					22.6	14.3				74	56				791	931	0.014			0.308	1.363	
16280	Opunake				19	12.1				50	34				339	629	0.008			0.164	0.744	9.68
16288					13.8	12.8				46	33				651	581	0.009			0.203	0.516	
16325	Lake Dive				< 0.6	4.2				1	19				248	313	0.004			0.057	0.69	
16442					20	11.9				45	34				884	731	0.01			0.339	0.78	
16502					17.1	11.7				49	31				971	879	0.014			0.226	0.359	
16505					16	11				52	27				951	840	0.014			0.22	0.59	
16591					13	13.1				45	58				790	901	0.015			0.385	0.138	
20749					19.3	12.1				65	43				646	870	0.012			0.361	0.737	
20767					8.5	15.3				46	56				869	1004	0.016			0.383	0.681	

		Chlorophyll-*a* (mg/m^3)					Total phosphorus (mg/m^3)					Total nitrogen (mg/m^3)					NH_4-N-toxicity (mg/L)				Cyanobacteria (mm^3/L)	
LID	Lake name	TRC Chl-*a*	L380 spot Chl-*a*	Meas. SBI-Chl-*a*	Mod. SBI-Chl-*a*	MfE mod. Chl-*a*	TRC TP	L380 spot TP	Meas. SBI-TP	Mod. SBI-TP	MfE mod. TP	TRC TN	L380 spot TN	Meas. SBI-TN	Mod. SBI-TN	MfE mod. TN	MfE mod. Annual Median	TRC Annual Median	TRC Annual 95th percentile	MfE mod. Annual Max.	MfE mod. Cyano. Biovol.	TRC Cyano. Biovol.
20880	Mangamahoe				18.9	12.3				55	100				719	1161	0.015			0.668	0.631	
20899					18.8	6.2				36	19				619	388	0.006			0.071	0.878	
20919					16.2	16.6				67	54				822	946	0.014			0.353	1.067	
20943					12.4	14.9				51	59				825	880	0.012			0.278	1.042	
20969					23.9	11.5				102	113				1082	1159	0.012			0.365	2.577	

3.5. Discussion – modelled attributes for Taranaki lakes

Linear regression analysis of the SBI models against measured annual median concentrations confirmed that the models accurately predicted all lakes within the D-band; however, we caution against interpreting the numerical values predicted for these lakes due to the high variation and reduced predictive ability for lakes within this band. Similarly, the model was often unable to accurately differentiate between the higher bands (i.e. A, B, C), and we caution against using the individual attribute values predicted by the models.

A large proportion of lakes in the Taranaki Region are estimated to fail the bottom line for Chl-*a*, TP or TN, with 70% of lakes failing at least one attribute according to MfE modelling, and 78% failing according to SBI modelling. Chl-*a* was the attribute responsible for most failures, with 72% of lakes failing the bottom line using the SBI-Chl-*a* model. According to the SBI-TP and SBI-TN models, 54% and 61% of lakes fail the bottom line for TP and TN, respectively. This is not surprising, as these attributes tend to be highly correlated. Using the SBI models, 9 lakes failed only one attribute, while 13 lakes failed for two attributes and 30 failed for all three SBI attributes.

Eight percent of lakes are estimated to fail the bottom line for cyanobacterial biovolume. However, we believe the cyanobacterial model is under predicting the number of lakes that fail this NOF attribute. When a lake is eutrophic or higher, there is a high likelihood that it will experience a prolonged cyanobacterial bloom, especially during summer and autumn. When the national model for cyanobacterial biovolume was developed, there were only data for 37 lakes across Aotearoa New Zealand (Snelder et al. 2016). We recommend that data on cyanobacterial biovolume are collected for all monitored lakes to improve knowledge on this attribute.

No lakes in the Taranaki Region are predicted to fail for annual median NH_4-N toxicity; however, 16% are predicted to fail for annual maximum NH_4-N toxicity, suggesting that, in some lakes, events may occur that temporarily increase ammonia levels to near toxic concentrations. However, the NOF requires annual 95th percentile values not annual maximums, so the number of lakes predicted to fail may be lower. We note that caution should be used when interpreting these model outputs, as the model was rated ‘unsatisfactory’ (Table 6).

Three of the six lakes currently monitored by TRC as part of the regional SoE programme (Herengawe, Barrett Lagoon, Rotokawau) are predicted to fail the bottom line for Chl-*a*, TN and TP based on the SBI modelling approach, while Kaikura is predicted to fail for both Chl-*a* and TP. Similarly, Herengawe and Barrett Lagoon are predicted to fail for all three attributes using the MfE modelling approach, while Kaikura is predicted to fail for TP and TN, and Rotokawau for Chl-*a* and TN. The monitoring undertaken by TRC to date suggests that Herengawe fails the bottom line for Chl-*a* and TN, while Rotokare and Rotokawau fail for Chl-*a* and Barrett Lagoon for

TN. However, the monitoring samples analysed only cover autumn and winter seasons and are therefore not representative of annual medians. These numbers are expected to increase with the inclusion of sampling over warmer summer months.

3.5.1. Exploring lakes where modelled values may be inaccurate

Measured versus modelled Sediment Bacterial Index

SBI's have been both measured and modelled for eight lakes in the Taranaki Region. Overall, both the measured and modelled SBI-Chl-*a* estimates found four of the eight lakes (50%) fail the bottom line. Similarly, both the measured SBI-TN and modelled SBI-TN predict that five of the eight lakes (63%) fail the bottom line for TN. For TP, the measured SBI-TP estimated four lakes would fail (50%), while the modelled SBI-TP estimated five (63%). Overall, the measured and modelled SBI attribute values were similar, particularly in terms of the proportion of lakes failing the bottom line. However, two lakes (Waikare and LID: 16202) were measured as A-band for Chl-*a* using the SBI, while the modelled SBI-Chl-*a* predictions placed both lakes in the C-band.

Sediment Bacterial Index modelled attributes versus MfE modelled attributes

Both modelling methods produced similar results, and if lakes were not placed into the same bands using both methods, they were usually placed into adjacent bands. This outcome is not surprising given the model inputs for both are largely based on the same lake, catchment and land-use characteristics. However, the SBI model was developed using a larger number of lakes and thus represented greater geographic areas and environmental gradients.

There are a few instances where the modelled bands differ substantially between the two methods. Two lakes (LIDs: 16219 and 16163) were modelled in the B-band for Chl-*a* using the SBI model and in the C- and D-bands using the MfE models. These lakes have modified catchments and are modelled in the C-band for TN and TP. Satellite imagery suggests low water clarity and potential cyanobacterial blooms; therefore, it is likely the SBI model is underpredicting for Chl-*a* (Figure 7). However, for Lake Moumahaki, SBI modelling predicted Chl-*a*, TN and TP to be in the C- and D-bands, while MfE models suggested these were in the B-band. Satellite imagery suggests the lake clarity can be low, potentially aligning with the timing of forestry deforestation in the catchment (Figure 7). Lake ID: 16123 had MfE modelled attributes in the B- and C-bands, while SBI attributes were placed in the D-band. The catchment land use is predominantly grassland and native forest. While no obvious algal blooms were observed on Google Earth™ images, we suggest further sampling at this lake to confirm appropriate banding.

Figure 7. Lakes in the Taranaki Region for which Sediment Bacterial Index (SBI) modelled and MfE modelled values differed substantially. Lake ID is provided for each lake, along with the National Objectives Framework band the lakes were placed in by the two methods. The red line in the bottom left figure is the lake catchment outline. Image sources: Google Earth™ and Takiwā (takiwa.co).

4. AN APPROACH TO IDENTIFIY LAKES THAT MIGHT HAVE LOW BOTTOM WATER AND MID-HYPOLIMNETIC OXYGEN CONCENTRATIONS

The NPS-FM sets bottom-line thresholds for annual minimum lake bottom and mid-hypolimnetic DO concentrations of 0.5 mg/L and 4.0 mg/L, respectively. The bottom line for lake bottom DO must be met in all lakes, while the mid-hypolimnetic DO bottom line must be met in seasonally stratifying lakes (MfE 2020). The rationale for this is that if oxygen concentrations in lake bottom waters decline below 0.5 mg/L, the anoxic conditions are likely to result in nutrient release from lake sediments, while low oxygen (< 4 mg/L) in the hypolimnion creates an inhospitable environment for fish seeking refuge from high epilimnion temperatures during summer. Single low-oxygen events can create long-lasting effects, e.g. nutrient release or fish kills.

Ideally, continuous or regular (i.e. at least monthly) DO profiles should be taken in lakes, as deeper lakes are more likely to stratify in summer and stratification regimes can change seasonally. Only seven of the 67 lakes in the Taranaki Region have oxygen profiles (Figure 8), meaning 60 lakes have no data on bottom water DO concentrations or stratification characteristics. Of those with data, only Rotorangi has been profiled regularly and includes summer profiles.

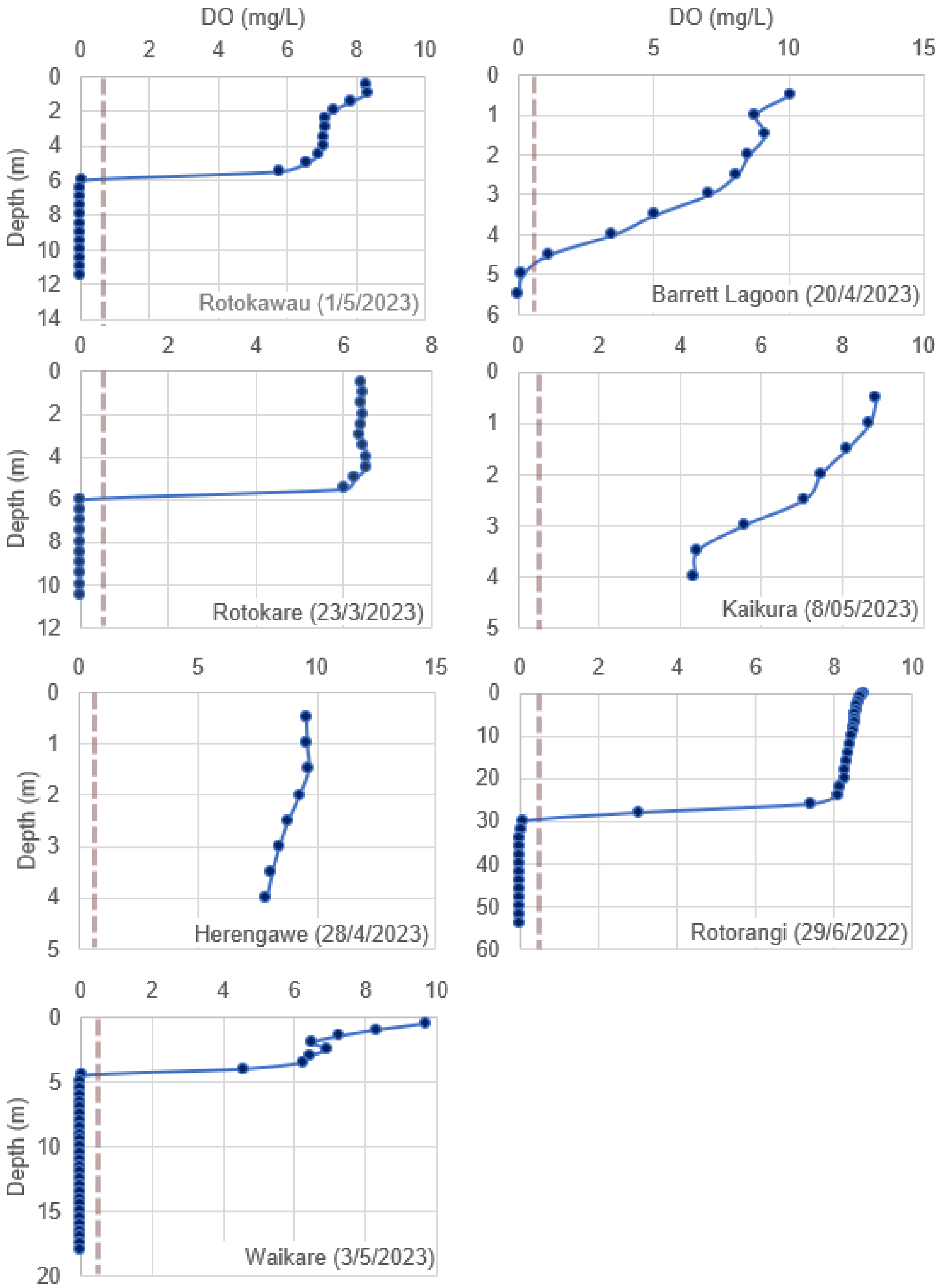

Figure 8. Dissolved oxygen (DO) profiles taken from seven lakes in the Taranaki Region The dotted line indicates the National Objectives Framework bottom line for lake bottom DO concentration. Data supplied by Taranaki Regional Council.

Based on the profiles available, five of the seven lakes experienced bottom water anoxia, i.e. < 0.5 mg/L of DO sampled < 1 m above the sediment surface (Table 11).

Three shallow lakes (Rotokare, Rotokawau and Barrett Lagoon) experienced lake bottom anoxia, which is surprising given the lakes are < 15 m deep. Two other shallow lakes (Herengawe and Kaikura) did not fail the bottom line; however, Kaikura experienced oxygen-depleted bottom waters. Given that the profiles for Barrett Lagoon, Rotokawau and Kaikura were taken in April and May 2023, it is likely that more intense stratification and lower bottom water DO may occur in these lakes over summer. These results highlight that even relatively shallow lakes in the region can experience depleted DO in their bottom waters.

Table 11. Bottom water dissolved oxygen (DO) and mid-hypolimnetic DO for eight lakes in the Taranaki Region that have measured oxygen profiles. If more than two profiles were available, the most recent was used as well as the most recent profile from summer. Cells are coloured by their corresponding National Objectives Framework band: orange = D-band, yellow = C-band, green = B-band, and blue = A-band.

Lake name	Date profiled	Max depth (m)	Bottom water DO conc. (mg/L)
Rotokawau	23/02/2023	11.9	0
	01/02/2023	11.9	0
Barrett Lagoon	20/04/2023	5.7	0
	02/05/2023	5.7	3.8
Rotokare	23/03/2023	11	0
	02/05/2023	11	0
Kaikura	05/04/2023	4.5	10.7
	08/05/2023	4.5	4.4
Herengawe	16/09/2022	3.9	8.7
	28/04/2023	3.9	7.9
Waikare	16/03/2023	18.9	0
	03/05/2023	18.9	0
Rotorangi	25/02/2021	55	0
	29/06/2022	55	0

To identify lakes that might be at risk of experiencing bottom water anoxia, we suggest using lake maximum depth (as an indicator of stratification) along with measured or modelled Chl-*a* concentration. We estimate that if a lake stratifies in summer and has high productivity (i.e. high Chl-*a*), it is likely to encounter anoxic bottom waters and therefore fail the national bottom line for that attribute. The rationale for this is that stratified lakes have limited transfer of nutrients and dissolved and particulate material, often leading to a nutrient-rich but light-limited hypolimnion (MacIntyre et al. 1999). In addition, oxygen is restricted from reaching this denser, bottom layer (Wetzel 1983). If stratified lakes are highly productive, indicated by high Chl-*a* concentrations (C- or D-band), high rates of respiration followed by decomposition are likely to occur, further depleting oxygen in the hypolimnion. Therefore, we suggest these lakes are likely to experience bottom water anoxia and may be in the D-band for bottom water DO.

To determine whether a lake is likely to stratify, we used lake maximum depth as an indicator. Where lake mixing dynamics are unknown, lakes with a depth greater than 15 m can be categorised as likely to be seasonally stratified (Verburg 2012), although we note that shallower lakes may also stratify in certain circumstances. Due to the scarcity of data, we used lake maximum depths taken from the FENZ database; however, manually measured depths were used when available. Many of the lake depths provided in FENZ are incorrect (Wood et al. 2022), making it very challenging to accurately identify lakes at high risk of experiencing anoxia.

To estimate Chl-*a* concentration and the corresponding NOF band, we used the SBI-Chl-*a* modelled values from Section 3.1. As noted above for Barret Lagoon, Rotokawau, Rotokare and Kaikura, shallow lakes may also experience depleted DO, we therefore stress that the approach presented here should only be used to identify lakes that are most at risk from anoxia. Accurately predicting or modelling which lakes will experience anoxia is not possible with the limited data available.

Measuring mid-hypolimnetic DO requires knowledge of the thermocline depth at the time of sampling, as this is temporally variable. Given the limited information available on physical lake characteristics such as mixing in Taranaki lakes, it is difficult to estimate the mid-hypolimnetic oxygen concentration for each lake. However, lakes that stratify and are in the D-band for bottom water DO are also likely to fail the mid-hypolimnetic DO bottom line. As shown in Figure 8, four of the five lakes experiencing bottom water anoxia experience anoxic or near-anoxic conditions throughout the majority of the hypolimnion. We suggest that until more data is gathered on thermocline depths, lakes experiencing bottom water anoxia could be estimated to also fail mid-hypolimnetic DO.

4.1.1. Results

Using the approach outlined above, 33 lakes were identified as at high risk of experiencing depleted DO levels in bottom waters (Table 12). Three shallow lakes (Barrett Lagoon, Rotokare and Rotokawau), which are less than 15 m maximum depth, were also added because measured oxygen profiles from March to May 2023 (Table 11) indicated anoxic bottom waters.

Table 12. Lakes in the Taranaki Region identified as at high risk of experiencing dissolved oxygen depletion. Maximum lake depths from FENZ are used where measured maximum depths are lacking. Max = maximum, SBI-Chl-*a* = Modelled Sediment Bacterial Index data for chlorophyll-*a.* Concentrations are coloured by their corresponding National Objectives Framework band: orange = D-band, yellow = C-band

LID	Lake name	FENZ Lake max. depth (m)	Measured max. depth (m)	SBI-Chl-*a* (mg/m^3)
16165		22.0		5.7
16237		21.2		6.1
16224	Mangawhio	17.2		6.5
16202		21.9	15.8	6.7
16222	Waikare	23.8	18.9	6.8
7512	Rotokare	24	11	7.4
16214		23.5		7.7
20767		21.3		8.5
16213		21.7		8.8
16197		17.8		9.5
16215		22.0		9.8
16190		20.9		10.2
16131	Moumahaki	37.3	26	11.0
7506	Rotorangi	161.4	55	11.6
20943		21.2		12.4
15855		18.2		12.9
16123		23.2		12.9
16591		21.3		13.0
16288		22.6		13.8
15842	Nowells Lake (south)	18.2		13.8
16196		23.9		13.8
15823	Taumaha	16.3		14.9
15854		19.9		15.0
16392	Ratapiko	37.9		15.5
16060		15.6		15.9
16505		24.2		16.0
15926	Waikato	17.1		16.5
20893	Barrett Lagoon	16.2	5.7	16.7
16502		22.4		17.1
20880	Mangamahoe	23.9		18.9
16091		22.8		19.5
16442		23.1		20.0
16159		17.2		20.3
16246		22.9		21.2
7445	Rotokawau	8.8	11.9	21.6
15947		20.6		22.5

4.1.2. Discussion

Over half of the lakes (*n* = 36) in the Taranaki Region might experience depleted DO in their bottom waters. Of these, 28 are already estimated to fail the national bottom line for at least one other modelled attribute (TP, TN, NH_4-N or cyanobacteria). We strongly recommend that DO profiles or, ideally, continuous monitoring DO sensors are used to explore the accuracy of these estimates. These data would also help to refine future DO modelling endeavours.

A major caveat in the approach used above is the reliance on FENZ modelled maximum lake depths. We have noted, through analyses in other regions, that FENZ lake maximum depths can be highly inaccurate. In the Taranaki Region, the FENZ database suggests 40 lakes have a maximum depth greater than 15 m. Eight of these have been manually measured, of which four were found to be less than 15 m. Not only were these lake depths wrongly classified in the FENZ database, but they were also overestimated by an average of 22 m, which is significant when determining lake mixing and hydrodynamics. We believe that the number of lakes greater than 15 m deep in the Taranaki Region will be lower than indicated in FENZ.

We also note that some lakes less than 15 m deep can experience hypoxia in the bottom waters, often as a result of nutrient and / or organic matter enrichment or reduced water circulation (Souchu et al. 1998; Hsieh et al. 2021). These lakes likely have high nutrient inputs and are generally in a poor ecological state. An example of this is Barrett Lagoon (maximum depth 5.7 m), which experienced bottom water anoxia in April 2023 (Table 11). While three shallow lakes were included in our prediction based on available knowledge, similar shallow lakes without existing data will have been missed.

5. PRIORITISING LAKES FOR BASELINE SAMPLING

Single point sampling is recommended to validate the attribute SBI modelling predictions, particularly for lakes or groups of lakes that may have been predicted inaccurately or where management actions are likely to be required. A single point surface sediment sample can be used to assess the sediment bacterial communities from which the SBI can be measured and validated against the modelled results provided in this report. Single point sampling can also provide baseline information on lake characteristics, water quality and biodiversity, as well as indicate stressors that might be leading to degradation. This sampling does not meet any national standards, and once this initial information has been collated, a selection of the lakes should be considered for further sampling and monitoring.

5.1. Prioritisation approach

We suggest that lakes predicted to fail the national bottom line for NPS-FM attributes, or that are close to failing, should be prioritised for single point sampling. Further management actions will likely be required to restore these lakes to at least the national bottom line. At these sites, it is essential that the modelled attribute predictions are confirmed via surface sediment samples prior to investing resources in management plans. The collection of information on variables such as biodiversity and internal nutrient cycling will also help guide any future management decisions. In addition, we suggest single point sampling is prioritised at lakes for which one of the two modelling approaches may be inaccurate, i.e. the four lakes identified in Section 3.5.1.

5.1.1. Cluster analysis

Sediment Bacterial Index and MfE modelling suggests that 78% and 70% of lakes, respectively, likely fail the NPS-FM bottom line for at least one NOF attribute. Given these two models predict a similar proportion of highly degraded lakes, it is likely that the majority of lakes in the region will require plans to ensure they do not fail the national bottom line. These estimates are based on modelling designed to provide a broad, region-scale snapshot of lake health, and there are caveats that become particularly significant when viewed at an individual lake level. Therefore, sampling should be undertaken to validate or support the modelled attribute predictions.

Due to the large number of lakes estimated to be placed in a C- or D-band for at least one attribute, and the significant budget required to comprehensively sample each lake, we used a clustering approach (described in Box 1 below) to identify groups of lakes with similar features. Lakes were placed into representative clusters based on their spatial location, geomorphic type, catchment land use and lake area. The rationale is that one lake from each cluster could then be targeted for further sampling, followed by the development of an appropriate management plan. This approach could then be applied to other lakes in the cluster without the need for in-depth sampling at each lake. We note that a simple yet critical piece of information that is missing for many lakes in the region is depth measurement. Most lake depth data in FENZ are modelled, and in our experience these data can be highly inaccurate; therefore, we have excluded lake depth from the cluster analysis. Collecting accurate depth information for as many lakes as possible and including the data in the clustering analysis would further improve this method.

Box 1. Methods used for clustering analysis

The clustering was undertaken for all lakes in the Taranaki Region. Previous studies that have explored eutrophication in Aotearoa New Zealand have identified land use and lake area as some of the key drivers, e.g. Pearman et al. (2022). Lake depth is also important; however, due to the inaccuracy of lake maximum depths estimated in the FENZ database, we have not included this variable. Moran's Eigenvector Maps (MEMs) were created and used as spatial variables. The R package *geosphere* (Hijmans 2022) was used to calculate the distance between two lakes. These distances were used to calculate the MEMs using the *dbmem* package and the *adespatial* package (Dray et al. 2023). The calculated MEMs were combined with six catchment land-use categories (high production exotic grassland, low production exotic grassland, forestry, native forest, urban and other) and lake area in a data frame, and a distance matrix was constructed with the *gower* method in the cluster package (Maechler et al. 2022). Clustering was undertaken with the *hclust* function in base R. Clustering threshold was set to 0.2 and plotted in *ggplot2* (Wickham 2016).

The cluster analysis identified 27 lake clusters at a threshold of 0.2 (Figure 9). TRC has already collected single point samples from 16 of the 27 clusters identified. However, not all of those lakes were sampled over a summer period, meaning the single point samples are unlikely to capture the highest Chl-*a* and cyanobacterial levels those lakes may experience.

We suggest that one lake from each cluster is sampled in accordance with our single point sampling recommendations outlined in Section 5.2. In addition, we recommend that Lake Moumahaki and LIDs: 16123, 16163 and 16219 be sampled regardless of their cluster, as the SBI and MfE models were not in agreement for attributes in these lakes. In total, we recommend single point sampling of 31 lakes. Choosing which lakes to sample from each cluster can be guided by cultural, community or recreation values, or may be based on lakes that have pre-existing data.

We suggest one of two different approaches to select lakes from each cluster:

1) Resample lakes with previous single point samples to collect more information. This sampling would provide baseline summer data, as well as fill data gaps such as lake depth, and allow the collection of eDNA biodiversity samples, or
2) Sample new lakes from all clusters, increasing the number of lakes with some level of baseline information.

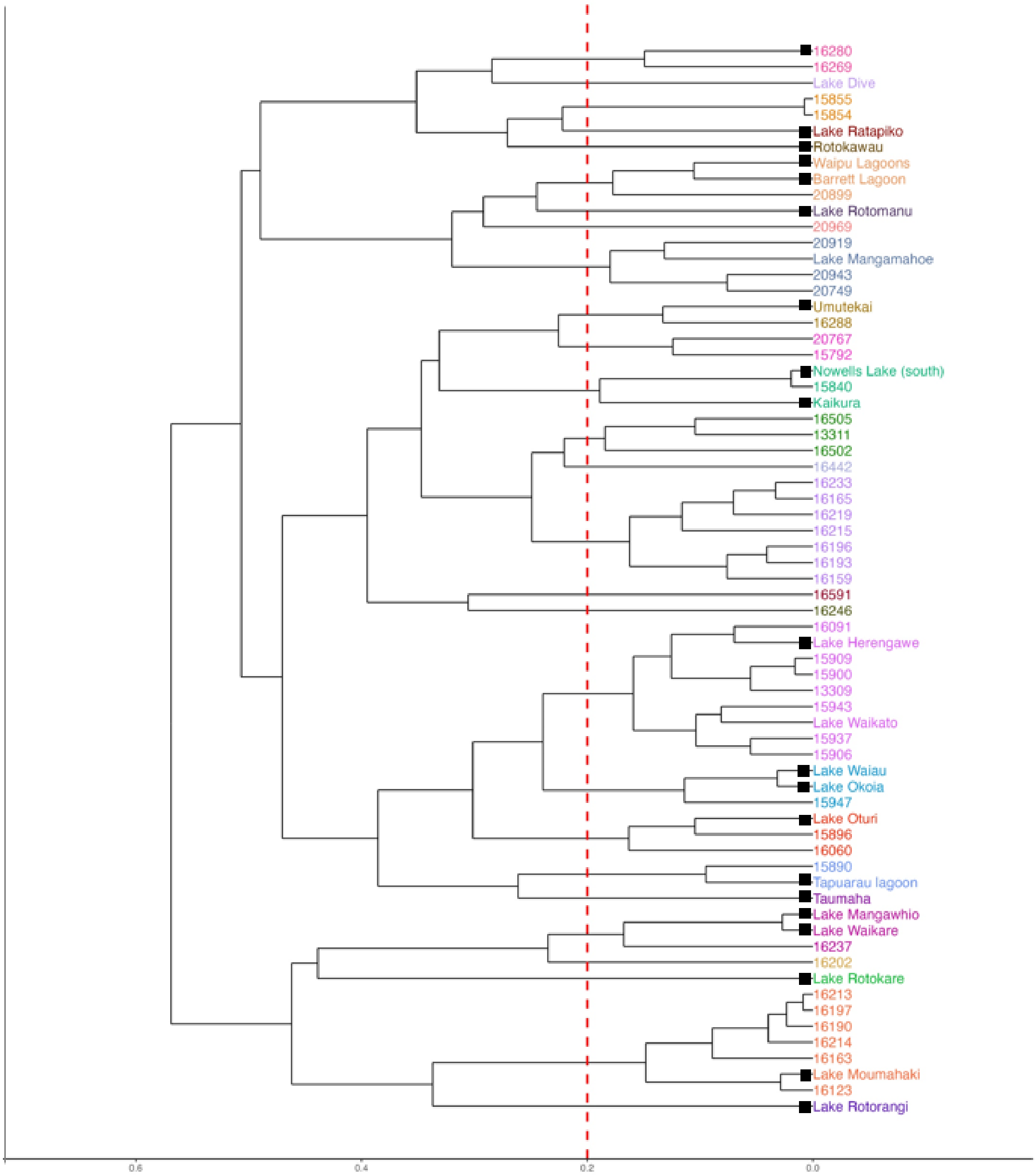

Figure 9. Dendrogram showing the results of the cluster analysis for all lakes in the Taranaki Region. Colours represent different clusters. Clustering was based on lake area, geomorphic class, catchment land use and spatial distance. Black squares indicate lakes for which Taranaki Regional Council has already collected at least one single point sample. The clustering threshold was set to 0.2 (the red dashed line on the plot).

5.2. Recommended single point sampling protocols

The surveys and sampling we recommend are listed below. The aim is that this sampling can be undertaken in a single day within 4–5 hours, with 2–3 lakes being sampled per day. Based on our preliminary assessment of access to most lakes in this region, it will be necessary to have a light (likely inflatable) boat. It is recommended that this sampling be undertaken in summer when there is a higher likelihood of capturing important events such as stratification and potential algal blooms.

Lake and access survey

- At each lake, a side-scan sonar should be used to profile the lake’s bathymetry / cross section. This will also identify the deepest point and determine if aquatic macrophytes are present in the lake and how deep they go.
- Perform a Conductivity Temperature Depth (CTD) cast (if deeper than 2 m). If the sampling is undertaken during summer, this will establish if stratification (and possibly anoxia) is likely. It is important to note this depends on conducting the cast in the mid-summer stratification period, and for polymictic lakes, short-term stratification events may be missed.
- General information about the lake should also be gathered, e.g. accessibility, current usage / values, and types of vegetation adjacent to the lake. These data may assist with later prioritisation.

Sampling – mid-lake / deepest point

- Water sample (2 L) from the surface mixed layer and hypolimnion for DRP, nitrate, nitrite, TN, TP, total Kjeldahl nitrogen, total suspended solids, volatile suspended solids and Chl-*a*.
- A surface sediment sample from the deepest point to determine the SBI-Chl-*a*, SBI-TN and SBI-TP.
- Water samples for DNA analysis of taonga species and biodiversity (see the following section for more information).
- Surface sediments for geochemistry and phosphorus fractionation. This will indicate the pool of potentially mobilisable phosphorus available for internal recycling. Samples should be collected from at least three locations, as these can be pooled for analysis. Lake trophic level can also be estimated from the sediment geochemistry (Waters et al. 2023) or by using the SBTI as described in Pearman et al. (2022).

Environmental DNA sampling and analysis

Environmental DNA (eDNA) is the traces of DNA that are left behind as living things pass through water, air or soil. Molecular techniques capable of targeting eDNA are now widely used in environmental research and are increasingly being incorporated into monitoring programmes worldwide.

The main advantages with these approaches are increased sensitivity, faster sampling times and in many cases, cost-effectiveness relative to traditional approaches. However, there are important caveats that do need to be considered, for example, the data are not quantitative and robust validation is required to avoid false positives and negatives. We also note that there are still some barriers to robust implementation in lakes, e.g. more knowledge is needed to understand the level of sampling effort required, and reference databases are lacking for some taxa. However, eDNA approaches offer significant potential as tools to provide an inventory of biodiversity across many lakes.

If the proposed lakes are small, we suggest taking triplicate 2-L water samples at three sites within a lake. We are still exploring the best / most effective methods for eDNA sampling in lakes, and it is likely that this advice will be updated. Post filtering, the triplicates could be combined to reduce analysis costs. We suggest the following analyses are undertaken: (1) metabarcoding – to determine fish community composition (the assay also detects birds and mammals), macrophytes (the assay also detects terrestrial plants), and a general eukaryote assay, and (2) targeted assays using droplet digital PCR for kākahi (freshwater mussel) and tuna (eel).

6. POTENTIAL ACTIONS OR INTERVENTIONS TO MAINTAIN OR IMPROVE THE HEALTH OF TARANAKI LAKES

The modelling results from this report predict that many lakes in the Taranaki Region are degraded and fail the national bottom line for at least one NOF attribute. Lakes that fail or are close to failing the national bottom line will require management or restoration actions to halt degradation and improve water quality. The development of management plans requires knowledge of the individual stressors impacting each lake. In Aotearoa New Zealand, diffuse pollution from pastoral farming, altered hydrology and connectivity, and the establishment of invasive species have been identified as major threats to lake health (Hamilton 2016). Climate change, including rising water temperatures, extended stratification periods and increased severe weather events are also likely to act synergistically with these stressors and have negative impacts on lake health. Appropriate management and restoration efforts require a thorough understanding of how these and other drivers influence individual lakes.

Short-term targeted sampling programmes can be put in place to determine the drivers of degradation in lakes. These can include targeted eDNA methods to detect invasive species, catchment modelling to inform the likely magnitude of external nutrient loads, and surface sediment analysis to determine the extent of sedimentation and the internal or legacy nutrient load. The *Lake Managers Handbook: Land Water Interactions* (MfE 2002) outlines a number of methods to quantify how catchment land-use activities affect lake ecosystems and describes catchment-lake processes, providing insight into source-control measures and the development of action plans.

Once the causes of degradation are understood, restoration will require individual approaches for each lake that acknowledge the foodweb structure and the presence of invasive species (Hamilton et al. 2016). In most cases, external and internal nutrients are likely to be the key drivers. A suite of restoration approaches are available that target reducing external loads including, for example, riparian planting, changing the land-use management practice or in-lake strategies such as weed harvesting, sediment capping, floating wetlands, phosphorus inactivation (alum) and oxygenation / destratification techniques (Hamilton 2019). Table 13 provides examples of mitigation / restoration techniques that have been applied in Aotearoa New Zealand. A full review of these is beyond the scope of this report and we refer readers to Hamilton et al. (2018).

Table 13. Examples of lake restoration techniques applied in Aotearoa New Zealand. Modified from Hamilton et al (2018).

Stressor	Mitigation	How it works
Multiple	Inflow diversion	Diverts nutrient-rich lake inflows directly to the lake outflow.
Nitrogen and phosphorus	Weed harvesting	Removes nutrients assimilated in excess weed growth.
Multiple	Hypolimnetic siphoning	Removes poor-quality bottom water of stratified lakes.
Multiple	Dredging	Removes nutrients and sediments from the lakebed.
Phosphorus (and nitrogen secondarily)	Sediment capping	Provides a capping layer to decrease nutrient releases from lakebed sediments.
Multiple	Increased flushing rate	Creates sufficient through flow to physically remove phytoplankton and / or reduce nutrients.
Phosphorus and sediment	Wave barriers	Reduces resuspension of sediments and nutrients in shallow lakes.
Nitrogen (primarily) and phosphorus	Floating wetlands	Uses wetland plants to take up nutrients.
Phosphorus	Phosphorus inactivation or flocculation	Uses chemicals (e.g. aluminium sulphate) to 'lock up' dissolved phosphorus in lakes via adsorption and precipitation processes.
Phosphorus (secondarily nitrogen, phytoplankton)	Oxygenation, destratification, or mixing propellers	Pumps air to the bottom of lakes to decrease redox-mediated nutrient releases.

6.1. Using palaeolimnological data to inform management or restoration actions

Palaeolimnology is a scientific discipline that investigates the history and past conditions of lakes and their catchments by studying sediment cores. It provides insights into long-term environmental changes, including shifts in water quality and aquatic communities, and human impacts on lake ecosystems. It can be useful for establishing the reference condition (i.e. prehuman condition) of lakes and their catchments and for investigating the timing and rate of change in water quality, the key drivers of changes in water quality, natural variability, and the impact of natural and anthropogenic perturbations.

As part of the Lakes380 programme, sediment cores were collected from eight lakes in the Taranaki Region. Detailed analysis is underway on the sediment cores from Rotokare and Kaikura. The study on Rotokare is focusing on the effect of perch on water quality and cyanobacterial blooms, and the Kaikura work investigates the impact of land-use intensification on lake health. Some analysis has been undertaken on the cores from Lakes Moumahaki and Waikare. No analysis has been undertaken on the sediment cores from the other four lakes (Herengawe, Oturi, Waiau and 15929).

A suite of different analyses can be undertaken depending on the specific question/s of interest. Table 14 provides an overview of the types of analysis that have been undertaken on sediment cores as part of the Lakes380 programme.

Table 14. Description of a range of information that can be obtain from the analysis of sediment cores. These proxies have all been routinely used as part of the Lakes380 programme.

Proxy (method)	**Information provided**
Age model	Provides dates associated with each layer of the sediment core. This is determined using radiocarbon (^{14}C), ^{210}Lead analysis and pollen data.
Pollen	Indicates changes in catchment and in-lake vegetation, and provides high-level data that can be used to assess the timing of different human occupation periods. The presence of charcoal can be used to provide evidence of burning in the catchment / region.
ITRAX scanning Entire core is scanned	Indications of shifts in lake geochemistry, productivity and catchment erosion. Manganese (Mn) relative concentrations normalised to iron (Fe) as a proxy for past lake redox conditions.
Hyperspectral scanning Entire core is scanned	Shifts in chlorophyll-*a* concentrations.
Diatoms	Indicates changes in water quality and other parameters such as depth and light availability.
Cadmium	A proxy for fertiliser application on land surrounding the lake. Cadmium is found in phosphate rocks, which are used to make fertilisers such as superphosphate.
Lead	A proxy for increases in population or urbanisation close to a lake. The lead is likely sourced from leaded petrol, which was phased out in Aotearoa New Zealand in 1996.
Environmental DNA of microbial communities (diversity and function)	Changes in bacterial communities related to shifts in water quality and shifts in three functions (denitrification, dissimilatory nitrate reduction to ammonia, and sulphate reduction).
Environmental DNA – biodiversity	Provides insights into changes in biodiversity in the lake and the land around the lake.

7. CONCLUSIONS AND RECOMMENDATIONS

- Our review of Taranaki lakes found that 19 lakes currently listed in FENZ are no longer lakes and should be removed from TRC databases.
- At least 17 lakes were identified in the Taranaki Region which are not included in the FENZ database. Given we did not perform an exhaustive review, this number is likely to be higher. A comprehensive survey of lakes in the region using up to date satellite imagery is required to accurately determine the number of lakes present.
- Our modelling suggests that 78% of lakes in the Taranaki Region fail the bottom line for at least one attribute, while 72% fail for Chl-*a*, 54% fail for TP and 61% fail for TN, individually.
- Only 15 lakes are predicted not to fail on any attribute; however, 14 of these lakes have at least one attribute estimated to be in a C-band, suggesting these lakes are still degraded.
- The SBI models estimating annual median Chl-*a*, TN and TP showed general agreement with MfE models for the same attributes. However, the SBI models predicted a slightly higher proportion of lakes were placed in D-bands for Chl-*a* TP and TN.
- No lakes are predicted to fail the bottom line for annual median NH_4-N toxicity, while 16% are estimated to fail for annual maximum NH_4-N toxicity, although these model estimates are annual maximums while the NPS-FM requires annual 95th percentiles. However, the performance of the models used for the NH_4-N predictions is unsatisfactory, and these should be interpreted with caution.
- Eight percent of lakes are predicted to fail the bottom line for cyanobacterial biovolume.
- We expect that over half of lakes (n = 36) in the Taranaki Region are likely to fail the bottom line for lake bottom DO.

Given that most lakes in the Taranaki Region are predicted to be in a highly degraded state, it is likely that management actions will be required to restore the lakes to at least the national bottom line. We suggest that lakes predicted to fail, or that are close to failing, the national bottom line should be prioritised for single point sampling. Because of the high number of lakes in the Taranaki Region that fall into this category, we used a clustering approach to group similar lakes based on their geomorphic type, spatial location, catchment land use and lake area. We also recommend that Lake Moumahaki and LIDs: 16123, 16163 and 16219 be sampled regardless of their cluster, as the modelling for these lakes was identified as potentially inaccurate.

In total, we recommend single point sampling of 31 lakes to validate the model predictions to provide information on the current conditions of the lakes and to identify possible drivers of degradation. Based on the above modelling and single point sampling, robust monitoring plans should be developed to allow the collection of data as required to inform the accurate assignment of NOF bands (i.e. annual medians for Chl-*a*, TN and TP, NH_4-N, annual 95th percentiles for NH_4-N, and 3-yearly 80th percentiles for cyanobacteria). Where possible, data collected should also provide additional information that will help guide management plans for lake protection or restoration.

Revitalisation of lakes requires accurate information on the drivers of degradation. The most likely reasons for degradation are diffuse pollution, hydrological or habitat modification, internal nutrient cycling, and the introduction of non-native species. The single point sampling will provide some initial data on internal nutrient cycling and non-native species, and this could be coupled with external nutrient load models developed from the Catchment Land Use for Environmental Sustainability (CLUES) model (Semadeni-Davies et al. 2020), or other catchment models. These data, in concert with routine water quality sampling, would inform the development of management and restoration plans.

8. ACKNOWLEDGEMENTS

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9. REFERENCES

Blakemore K. 2020. A review of regional lakes monitoring. Memorandum to Taranaki Regional Council. Document number: 2525572.

Blakemore K. 2021a. Aquatic macrophyte survey of Lake Rotorangi, April 2021. Prepared for Taranaki Regional Council. Document number: 2763233.

Blakemore K. 2021b. Proposed state of the environment lakes monitoring programme. Memorandum to Taranaki Regional Council. Document number: 2910341.

Blakemore K. 2021c. Recommendations of lakes suitable for inclusion in a long term monitoring programme. Memorandum to Taranaki Regional Council. Document number: 2887094.

de Winton M, Elcock S, Taumoepeau A. 2022. LakeSPI assessment of three Taranaki lakes. Hamilton: National Institute of Water & Atmospheric Research. Prepared for Taranaki Regional Council.

Dray S, Bauman D, Blanchet G, Borcard D, Clappe S, Guenard G, Jombart T, Larocque G, Legendre P, Madi N, et al. 2023. adespatial: Multivariate Multiscale Spatial Analysis. https://CRAN.R-project.org/package=adespatial

Hamilton DP. 2019. Review of relevant New Zealand and international lake water quality remediation science. ARI report No. 2019/002 to bay of Plenty Regional Council. Australian Rivers Institute, Griffith University, Brisbane.

Hamilton DP, Collier KJ, Howard-Williams C. 2016. Lake restoration in New Zealand. Ecological Management and Restoration. 17(3):191-199.

Hamilton DP, Collier KJ, Quinn JM, Howard-Williams C. 2018. Lake restoration handbook: a New Zealand perspective. Cham, Switzerland: Springer International Publishing.

Hijmans R. 2022. geosphere: spherical trigonometry. https://CRAN.R-project.org/package=geosphere

Hsieh H-H, Chuang M-H, Shih Y-Y, Weerakkody WS, Huang W-J, Hung C-C, Muller FLL, Ranatunga RRMKP, Wijethunga DS. 2021. Eutrophication and hypoxia in tropical Negombo Lagoon, Sri Lanka. Frontiers in Marine Science. 8.

Land Cover Database Version 5. 2020. [accessed 12 June 2022]. https://lris.scinfo.org.nz/layer/104400-lcdb-v50-land-cover-database-version-50-mainland-new-zealand/

Leathwick J, West D, Chadderton L, Gerbeaux P, Kelly D, Robertson J, Brown D, Chadderton W, Ausseil A. 2010. Freshwater Ecosystems of New Zealand (FENZ) Geodatabase: user guide. Department of Conservation. http://tools.envirolink.govt.nz/assets/Uploads/FENZ-Leathwick-et-al-2010-FENZ-User-Guide-Version-One.pdf

MacIntyre S, Flynn KM, Jellison R, Romero JR. 1999. Boundary mixing and nutrient fluxes in Mono Lake, California. Limnology and Oceanography. 44(3):512–529.

Maechler M, Rousseeuw P, Struyf A, Hubert M, Hornik K. 2022. cluster: Cluster Analysis Basics and Extensions. https://CRAN.R-project.org/package=cluster

[MfE] Ministry for the Environment. 2002. Lake manager's handbook: land water interactions. Wellington: Ministry for the Environment.

[MfE] Ministry for the Environment. 2020. National Policy Statement for Freshwater Management 2020. Wellington: Ministry for the Environment.

[MfE] Ministry for the Environment. 2022. Environment Aotearoa 2022. Wellington: Ministry for the Environment.

Moriasi DN, Gitau MW, Pai N, Daggupati P. 2015. Hydrologic and Water Quality Models: Performance Measures and Evaluation Criteria. Transactions of the ASABE 58:1763–1785.

Pearman JK, Wood SA, Vandergoes MJ, Atalah J, Waters S, Adamson J, Thomson-Laing G, Thompson L, Howarth JD, Hamilton DP, et al. 2022. A bacterial index to estimate lake trophic level: National scale validation. Science of the Total Environment. 812:152385.

Schallenberg M, Kalff J. 1993. The ecology of sediment bacteria in lakes and comparisons with other aquatic ecosystems. Ecology. 74(3):919–934.

Semadeni-Davies A, Jones-Todd C, Srinivasan MS, Muirhead R, Elliott A, Shankar U, Tanner C. 2020. CLUES model calibration and its implications for estimating contaminant attenuation. Agricultural Water Management. 228:105853.

Snelder T, Fraser C, Whitehead A. 2022. Spatial modelling of lake water quality state incorporating monitoring data for the period 2016 to 2020. Christchurch: Land Water People. Report No. 2021-15. Prepared for Ministry for the Environment.

Snelder T, Wood SA, Atalah J. 2016. Strategic assessment of New Zealand's freshwaters for recreational use: a human health perspective. Christchurch: Land Water People. Prepared for Ministry for the Environment.

Souchu P, Gasc A, Collos Y, Vaquer A, Tournier H, Bibent B, Deslous-Paoli J-M. 1998. Biogeochemical aspects of bottom anoxia in a Mediterranean lagoon (Thau, France). Marine Ecology Progress Series. 164:135–146.

[TRC] Taranaki Regional Council. 2022. Our place: Taranaki state of environment 2022. Stratford, Taranaki: Taranaki Regional Council.

Verburg P. 2012. Classification and objective bands for monitored lakes. Hamilton: National Institute of Water & Atmospheric Research. Prepared for Ministry for the Environment.

Waters S, Atalah J, Thompson L, Thomson-Laing G, Pearman JK, Puddick J, Howarth JD, Reyes L, Vandergoes MJ, Wood SA. 2023. It's all in the mud – the use of sediment geochemistry to estimate contemporary water quality in lakes. Applied Geochemistry. 153:105667.

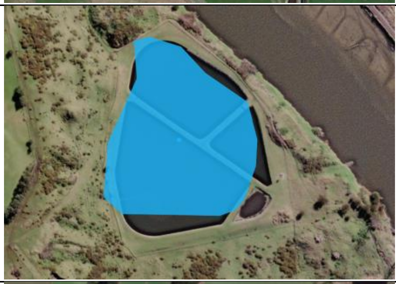
Wetzel RG. 1983. Limnology. Philadelphia: Saunders College Publishing.

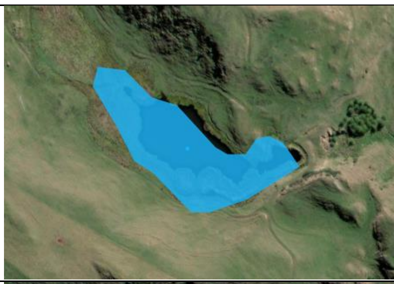
Wickham H. 2016. ggplot2: elegant graphics for data analysis. https://ggplot2.tidyverse.org.

Wood SA, Hampton H, Vandergoes MJ, Pearman JK. 2022. Lakes in the Manawatū-Whanganui region: an in-depth review and assessment, with recommendations for future action. Nelson: Cawthron Institute. Cawthron Report No. 3793. Prepared for Horizons Regional Council.

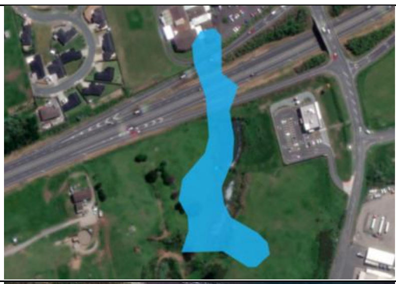
Wood SA, Vandergoes MJ, Atalah J, Waters S, Adamson J, Tibby J. [forthcoming 2023]. National scale mapping of lake trophic state and vulnerability in Aotearoa New Zealand. Inland Waters.

APPENDIX 1. Images of lakes requiring declassification in the Taranaki Region due to not meeting the definition of a lake.

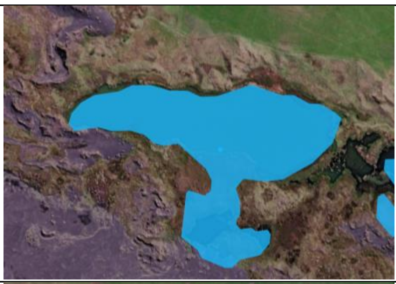
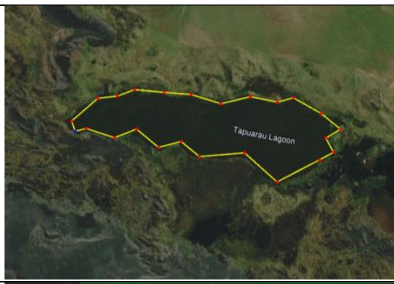
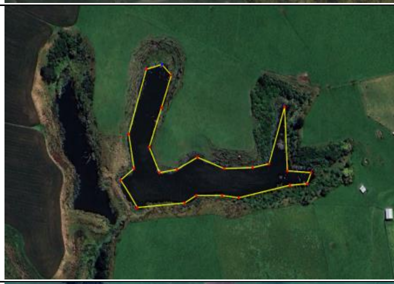
FENZ Lake ID	FENZ lake image	Current lake image	Comments
15884			Lake does not exist, dry (windfarm)
15942			Lake does not exist, dry
16025			Patea oxidation ponds
16080			Lake does not exist, dry
16088			Lake does not exist, dry

16110			Lake <1 ha (0.69 ha), has not been 1 ha since 2012
16113			Lake < 1 ha (0.7 ha), has not been 1 ha since at least 2007
16235			Lake does not exist, dry
16267			Lake < 1 ha (0.75 ha), old river stretch has been separated
16377			Lake does not exist, it is a river

16491 Lake Rotok-ohu			Lake does not exist, dry
16647			Lake < 1 ha, wetland?
20772			Lake does not exist, dry
20776			Lake < 1 ha (0.67 ha)
20910			Lake does not exist, dry

20958			Lake does not exist, < 1 ha, wrong size / shape
20961			Lake does not exist, dry
13328			Lake divided, < 1 ha
21099			Lake outside of Taranaki Regional boundary

APPENDIX 2. Lakes in the FENZ database that require updating due to size or morphology.

FENZ Lake ID	FENZ lake polygon	Google Earth™ lake image	Comments
15886			Lake (4.5 ha) is smaller than stated in FENZ (6.5 ha)
15909			Lake different shape to that identified in FENZ. Size = 1.6 ha, left lake is separate and not included
15926			Lake (8.3 ha) often larger than specified in FENZ (4.9ha)
20893 Barrett Lagoon			Lake (5 ha) is bigger than stated in FENZ(2.9 ha)
20969 Lake Cowley			Lake (15.5 ha) is bigger than stated in FENZ (6.6 ha)

APPENDIX 3. Waterbodies identified by Taranaki Regional Council as potential lakes. These are not listed in the FENZ database but confirmed here as meeting the FENZ definition of a lake (≥ 1 ha open water).

Lake polygon	Coordinates	Size
	-39.217648 174.280096	1.1 ha
	-39.778493 174.51128	1.1 ha
	-39.038644 174.110395	1 ha
	-39.798591 174.651114	1.1 ha
	-39.723857 174.432902	1.1 ha

	-39.753549 174.636833	1 ha
	-39.689947 174.412617	1.1 ha
	-39.679409 174.397704	1.4 ha
	-39.328866 174.521504	2 ha
	-39.093654 174.013511	2.3 ha

	-39.786983 174.653066	1.6 ha
	-39.574985 174.209621	2.8 ha
	-39.81699 174.713258	2.9 ha
	-39.760398 174.557232	2.9 ha
	-39.5916 174.2251	3.6 ha

	-39.820596 174.600247	3.6 ha
	-39.0133 174.2445 Lake Ngangana	7.3 ha

APPENDIX 4. Updated geomorphic classification for 15 lakes in the Taranaki Region where the FENZ geomorphic classification is likely inaccurate.

Lake ID (LID)	Lake name	FENZ Geo. Class	Updated Geo. Class
13311		S	R
15792	Waikirikiri Lagoon / Komene Lagoon	S	B
15795	Lake Kaikura	B	R
15823	Lake Taumaha	S	W
15840	Nowell's Lakes W	B	R
15842	Nowell's Lakes E	B	R
15890		W	S
15909		W	D
16237		L	S
16442		D	S
16505		S	L
16591		W	R
20904	Lake Rotomanu	B	D
20959	Waipu Lagoons	B	S
7512	Lake Rotokare	V	L

Taranaki Regional Council

MEMORANDUM
Policy & Planning

Date 21 November 2023

Subject: **Prioritisation of Freshwater and Land Plan Development**

Approved by: A D McLay, Director - Resource Management

S J Ruru, Chief Executive

Document: 3221980

Purpose

1. The purpose of this memorandum is to seek endorsement of a proposal to prioritise development of a Freshwater and Land Plan and to revisit remaining parts of the broader resource management policy work programme post December 2024.

Executive summary

2. Council's existing policy work programme is to develop a Natural Resources (NRP), a process which combines existing resource management documents – Regional Policy Statement (RPS) and Regional Plans Water, Soil and Air into one integrated document.
3. Work has been progressing on drafting the Natural Resources Plan (NRP), with particular effort in development of new freshwater planning provisions to meet the requirements of the National Policy Statement for Freshwater Management (NPS-FM) including the statutory requirement to notify a new water plan by December 2024.
4. In recent months a number drivers have come into play, which necessitate a review of the NRP programme. This review has resulted in the proposal to prioritise the freshwater components and revisit the remainder of the work programme at a later stage. This paper sets out those drivers and considers the implications associated with this option. Two options are presented for the consideration of the Committee, with the recommended option being to prioritise freshwater and de-prioritise the remaining parts of the NRP, until after December 2024. This will result in the development of a new Freshwater and Land Plan and associated freshwater updates to the RPS.
5. Due to there being some uncertainly associated with a number of drivers, including potential impacts resulting from a change of Government, it is recommended that the remaining policy development programme be re-assessed and reported to the Committee in April 2025.

Recommendations

That the Taranaki Regional Council:

a) receives the memorandum *Prioritisation of Freshwater and Land plan development*

b) notes that there is a high level of uncertainty in relation to the future direction of resource management reform and the current national policy environment at present

c) notes that staff expect that greater clarity around this environment will emerge over the next year

d) agree that development of new freshwater planning provisions needs to remain a high priority for Council

e) endorses the proposal to prioritise the development of the Freshwater and Land Plan for notification in December 2024 and **defer** further work on development of the Natural Resources Plan until post December 2024

f) directs staff to review the approach that Council might use to advance resource management policy development and report back with a recommended way forward in April 2025

g) determines that this decision be recognised as not significant in terms of section 76 of the *Local Government Act 2002.*

h) determines that it has complied with the decision-making provisions of the *Local Government Act 2002* to the extent necessary in relation to this decision; and in accordance with section 79 of the Act, determines that it does not require further information, further assessment of options or further analysis of costs and benefits, or advantages and disadvantages prior to making a decision on this matter.

Background

Natural Resources Plan development

6. Council's current resource management policy approach is centred around development of a new NRP to replace the existing RPS and Regional Plans for Water, Soil and Air. Note the Regional Coastal Plan is not included in the development of the NRP as it has recently been made operative (September 2023) following a comprehensive review process.

7. The approach to develop a combined NRP would enable the development of one integrated plan that was capable of meeting the existing national policy and planning standard obligations. It would also provide a 'one stop shop' for plan users in that it would cover all aspects of the environment except for the coast.

8. Work has been progressing on the development of the NRP, with a number of sections currently in early draft, for some time. Over the past 12 months, however, a more intensive focus has been placed on freshwater policy development given the strategic significance of this area, its complexity and the extent of change needed. In this regard it is noted that the current Water Plan is now over twenty years old.

9. With the exception of freshwater, the policy development progress undertaken to date has been largely focussed internally. There has been limited engagement with tangata whenua, the community and other interested parties on matters outside of freshwater. This reflects both the complexity of the freshwater area, the extent of change occurring in the broader policy environment and capacity constraints for tangata whenua, external stakeholders and Council.

10. The fact that extensive external engagement has not occurred to date and the limited timeframe between now and December 2024 means that there is simply not the time to

have the level of tangata whenua and stakeholder engagement on non-freshwater issues that is appropriate.

11. The partnership with tangata whenua is particularly important given the very specific obligations that Council has to extensively involve them in its policy development processes. There are, however, resourcing constraints for Iwi in being able to engage on multiple policy fronts given the multiple demands on their time from both local government, a range of other stakeholders and their own work programmes.
12. If Council were to continue with development of the NRP then the only practical approach will be to focus on seeking feedback on first drafts, rather than input at early stages of policy development. An exception to this approach would be needed in relation to the Integrated Management and Tangata Whenua chapters. These will need a close working relationship with, and direction from tangata whenua. These sections of the NRP have not progressed to date due to the focus of both Council and Iwi on freshwater.

<u>Resource Management Reforms and Government Policy</u>

13. Over the last five years central government have progressed a wide ranging resource management reform process. This has seen the passage of a new Spatial Planning Act 2023 and Natural and Built Environment Act 2023 in August. In addition a number of changes have been made to central government policy direction as reflected in national policy statements and national environmental standards.
14. The two new Acts, the Spatial Planning Act (SPA) and the Natural and Built Environment Act (NBEA), set up a number new processes and requirements for managing natural resources, including a requirement for the development of new Spatial Planning and Natural and Built Environment plans for each region over the next eleven years.
15. To facilitate the transition process, the Ministry for the Environment (MfE) had been in discussions with a handful of regions, including Taranaki, about an opportunity to be part of the first tranche region implementation process. This would have seen Taranaki receiving support to advance development of a regional spatial strategy in 2024.
16. The scoping work to consider this opportunity has been led by Te Aranga on behalf of the four Taranaki councils and Ngā iwi o Taranaki. It is overseen by a Steering Committee with representatives from both local government and iwi.
17. Following the election of a new government in October it is expected that the new resource management legislation will be repealed, with the Resource Management Act 1991 continuing to apply until new legislation can be introduced towards the end of 2026. It is also expected that there will be a number of changes made to the existing national policy environment including the NPS-FM and new National Policy Statement on Indigenous Biodiversity (NPS-IB).
18. At the time of writing this report, there is a level of uncertainty about the final shape of the new coalition government. This means that there is uncertainty about the policy changes that they might seek to implement and what these changes might mean for Council. Some guidance is available from the pre-election policy statements released by the individual parties but these positions could change during coalition negotiations and/or once the government is formed and receives further advice on their proposed changes.
19. Once a new government is formed, it is likely that it will take several months for formal decisions, and the legislative and policy changes needed to reflect those decisions, to be

made. In the interim, the current legislative and policy framework remains in place and Council needs to make decisions about how to progress the review of its key resource management planning documents.

Issues

20. The approach to develop a NRP for notification in December 2024 has been impacted by recent resource management (RM) reform decisions, changing central government requirements, and the capacity of Council, iwi and the community to undertake the level of policy development and engagement required given the significance of the changes proposed.
21. To recognise these factors while also ensuring that Council can continue to make progress it is proposed that Council prioritise the development of a new Freshwater and Land Plan and defer development of other major resource management policy until post December 2024.

Discussion

22. A number of Council's current resource management planning documents, particularly the Regional Water Plan which was adopted in 2001, are dated and need to be replaced to ensure that they reflect current planning requirements.
23. While work is being progressed to address this challenge via a new NRP this work has now reached the point where it is considered appropriate for Council to review the current approach and consider whether it remains appropriate.
24. Key factors that need to be considered in undertaking such a review include:
    - RM reforms – Taranaki is progressing work to enable it to consider whether it should be a tranche one region should the Spatial Planning Act 2023 and Natural and Built Environment Act 2023 remain in place. Even if the Spatial Planning Act is repealed there is an argument that Taranaki should consider advancing development of a regional spatial plan to ensure that it can address a number of the regional development challenges affecting the region within a broader strategic context. These challenges include energy transition issues, natural hazards and growth planning.
    - Central Government requirements – while it is likely that there will be changes to the current national policy settings following the recent elections it is not expected that there will be a great deal of clarity about what these changes are and what they might mean for several months. In the interim Council needs to continue to make progress with the most immediate/important obligations, which is primarily the development of a new freshwater planning provisions.
    - Capacity and resourcing constraints - of Council, tangata whenua, the community and interested parties to meaningfully be involved in a robust policy development process. There are significant practical limitations on the resourcing that is available to progress the required policy work programmes. It is therefore important that the available resource be focussed on the highest priority areas.
    - Fiscal constraints – there is significant financial pressure on central and local government as well as communities at present. This pressure means that it is important that Council ensure that it is getting good value from the work it does do

including not progressing work where there is a level of uncertainty as to whether it will be useful in the future.

Age of Plans

25. If Taranaki was a tranche one region this could see initial policy development work on a new regional spatial strategy commencing in late 2024 or early 2025. This would likely result in the region having a fully operative RSS and NBE plan by 2031/2032. For the interim period the Council would continue to operate under its existing RMA planning framework.
26. Continuing with the current NRP development programme will overlap with the likely timeframe of the new system. The NRP would likely become operative in 2026 /2027 (though this is dependent on hearing and environment court processes). This would result in their being updated policy direction for the region being put in place whilst the RSS and NBE Plans are being developed. This will likely have resource implications with Council, tangata whenua, the community and interested parties needing to participate in two overlapping policy processes.
27. Prioritising Freshwater components and revisiting the remainder of the policy direction after December 2024 will ensure that there is updated freshwater policy direction in place ahead of any new system, whether that is the RSS/NBE regime or a new regime that might be introduced by the new government, being implemented.
28. The timing of the remaining policy update work is less clear, as to some degree it is dependent on future government decisions on the future of the two new Acts and/or its replacement legislation.
29. However, regardless of central government direction, work could progress on region wide policy development, which could be incorporated into either a new Regional Policy Statement (RPS) or Regional Spatial Strategy, from early 2025 onwards. Should this not be in the form of an RSS, then RPS policy development could be progressed with the aim to notify a new stand-alone RPS in 2026.
30. There is a risk associated with Council's aging plans remaining in place for longer, should the full NRP not be progressed at this time. However, investing further in developing new RMA plans when further change is likely to occur in the not too distant future is not efficient. Consideration of this impact on the Council, iwi, community and interested parties should be part of the discussion.
31. Any of the existing work which has already been drafted in relation to the wider policy development will be able to be picked up as part of and inform any future process, whether that be under the RMA or the new legislation.

Plan Integration

32. The benefit of undertaking the development of a NRP is to manage natural resources in an integrated manner. As Council does not currently operate with a combined plan, the approach to develop such a plan needs to be taken as a complete programme.
33. Prioritising the development of a new freshwater and land plan will result in the review of the freshwater components of the existing RPS and the existing Water and Soil Regional Plans to create a new standalone Freshwater and Land Regional Plan and updated freshwater components of the RPS.
34. The process of revisiting the remaining components of the existing policy development programme post December 2024 will result in separate reviews and updates to the RPS

and the Air Quality Regional Plan. Updates to these plans would be done as standalone plans.

35. To revisit a combined NRP approach at this later stage, when the new Freshwater and Land Plan and freshwater components of the RPS are operative, potentially re-opens these elements to challenge. This would not be desirable given the significant resourcing and input of council, tangata whenua, community and interested parties during the development of the freshwater components.

<u>Central Government Requirements</u>

36. The development of the NRP has, in part, been driven by the desire to ensure that Council can give effect to central government policy direction. Some of these have timeframes attached to them, which the NRP process could meet.

37. The most pressing implication is the requirement to have a Planning Standard Compliant RPS and implementation of the NPS-FM by the end of 2024. Given the age and structure of the existing RPS, this is not a straight-forward process and cannot be achieved without a full review and re-draft. This requirement would be met if the NRPS programme continued. The remaining central government requirements all have delivery timing across the next 7-8 years and will need to be addressed in that timeframe.

<u>Appropriate Engagement Processes</u>

38. The development of the NRP to date has included limited opportunity for external engagement. Further engagement can be built into the development of the NRP on the existing programme, however this will be extremely minimal and will focus on consultation drafts of the NRP.

39. The opportunity to explore options through policy development will be limited, with the exception of freshwater. This approach is likely to receive criticism from interested parties and the community. It also poses a procedural risk to Council. Progressing with the NRP programme to meet the December 2024 notification requirement will not result in good practice when it comes to engagement in policy development.

<u>Partnership with Iwi</u>

40. Staff have been working with tangata whenua in relation to freshwater over the past 12 months. This is a complex, time and resource demanding process for both Council and tangata whenua.

41. In recent discussions, and in the context of the RM reforms and existing policy development programme, concern has been expressed by Iwi in relation to the resource requirements to participate in additional policy development processes beyond freshwater. Iwi simply do not have the resource available to participate and engage in a meaningful way in such a large regional policy programme within the December 2024 timeframe.

42. The lack of proper and desired involvement of iwi in the NRP development poses a risk to Council in upholding its treaty responsibilities broadly and the more specific requirements within individual NPSs. Both a procedural and relationship risk to the continued building of the partnership with iwi is likely to result if the full NRP policy development is progressed.

Options

43. Council has a choice of either continuing with the NRP development programme as it stands, or to prioritise the development of a new Freshwater and Land plan to enable the implementation of the NPS-FM.

Option one - Continue with NRP development

44. This option sees Council continuing with its NRP development on the existing programme to notify by the end of 2024. A summary of the benefits and risks associated with this option are set out below:

44.1. Benefits

- Achieves central government timeframe and directions in the National Planning Standards and NPSs.
- Replaces Council's individual plans with an integrated NRP.
- Delivers existing Annual Plan work programme and will update all plans ahead of moving into the new system, although they may not be fully operative.

44.2. Risks

- Approach is not supported by iwi and involvement in policy development will be limited, posing procedural and partnership development risk.
- Engagement and consultation with the community and interested parties will be limited and poses a procedural risk.
- Programme will see two separate hearings processes needing to be managed in parallel with the freshwater process being managed by the Chief Freshwater Commissioner and the non-freshwater aspects being managed by a Council appointed hearings panel. This compresses the cost to Council of the hearings process across a shorter timeframe.
- Programme post notification (hearings and environment court processes) is likely to overlap with RM reform processes. This will add pressure to the capacity of Council staff to participate and contribute to the early stages of policy development in the new system. There is also a flow on effect to iwi, community and interested parties having to participate in two processes.
- Capacity constraints of Council are heightened and it would struggle to meet the complex and comprehensive requirements of implementing the NPS-FM along with those requirements of developing a complete NRP. This may jeopardise the delivery of the whole project by December 2024, and hence Council may be unable to meet its legislative requirements under the NPSFM.

Option two – Prioritisation of the Freshwater and Land Plan development

45. This option would see Council prioritising the development of the Freshwater and Land Plan and revisiting the remaining policy aspects post December 2024. The progression of those other policy components could be undertaken either through separate reviews of the existing regional policy statements and plans from 2025, or through developing the new policy framework as required by new legislation.

46. Regardless of the approach adopted, under this option staff will take the opportunity to work on components of the wider work programme as they can, but the focus will remain on Freshwater.

47. A summary of the benefits and risks associated with this option are set out below:

47.1. Benefits:

- Allow for Council resourcing to focus on implementing freshwater components, including engagement processes with the tangata whenua, the community and interested parties. This aligns with the capacity of Council to deliver the NPS-FM requirement of notification in December 2024.
- Supports the partnership with iwi by enabling time and resourcing to focus on policy development as it relates to freshwater. This can be achieved without compromising input into other areas of policy development. This is not only important to develop the partnership with iwi but also to support a robust policy development process.
- It spreads the costs and risks associated with the hearings panel processes over time and in a way in which integration of the freshwater and other aspects of the plans can be more easily managed.
- Provides time for the scoping work for the RM reform to be undertaken and for a more considered approach to continuing policy development across the whole region to be developed. The consideration of spatial planning and how we best undertake policy development as a region is supported by all Taranaki councils and Ngā Iwi o Taranaki, regardless of whether the scoping work formally continues or not. Further, in the case of the RPS only Stratford District Council would benefit from updated direction to inform their future District Plan review.
- Allows time for the new government to determine the changes that they might make to the current resource management legislation and national policy framework. This approach will also allow time for Council to consider the implications of these changes and how they might best be implemented.

47.2. Risks:

- Prioritising just the freshwater components will likely result in a combined plan approach being unable to be achieved. However, an integrated approach to the management of resources will still be achieved through the development of a standalone regional policy statement and regional plans.
- Will not meet the requirements of the Planning Standards to have the RPS compliant by the end of 2024. The Planning standards are largely an administrative requirement, and although there is the potential for procedural challenge for not meeting this requirement, it is considered less of a risk than not meeting the NPS-FM requirements of freshwater notification by the end of 2024.
- The Council would need to 'live with' its existing ageing plans, with the exception of freshwater and the coast. Depending on the outcome of any changes brought about by the new government for the new system, work could begin on the remaining components of the policy programme in 2025.
- Prioritising Freshwater and de-prioritising the other components of the NRP does not remove the risk of an overlap of policy development processes under the RMA and the new system. But it will better spread the policy development work load for all involved.

48. Although Option two is not without risks, it is considered the most appropriate option by staff. It will enable resourcing and engagement with iwi, community and interested

parties to focus on freshwater, will allow time for the discussions and investigations into the RM reforms to take place and will meet central government requirements with the exception of the Planning Standards for the RPS component.

49. Option two will result in priority given to freshwater process over the next 12 months, but post December 2024 a broader policy focus can be resumed. Given the level of uncertainty that surrounds the context of the RM reform, staff will review this approach in April 2024. This will allow for consideration of the completed RM reform scoping study to MfE and also any implications that may arise from a change in government direction. At this stage a more detailed future work programme for policy development can be undertaken and presented to the committee.

Significance

50. The decision does not trigger the TRC Significance and Engagement Policy. Targeted consultation and engagement of the region will be undertake on relevant policy development, the recommended option considers the ability of iwi and community to participate meaningfully in the processes of the broader NRP.

Financial considerations—LTP/Annual Plan

51. This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates, although this will delay the notification of the full NRP and as such future policy development processes will need to budgeted for in future LTP discussions. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

52. 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

53. 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.

54. Through the RM Steering Committee, discussion with iwi members has identified support for bringing the contents of this paper to Committee for consideration.

Community considerations

55. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

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

MEMORANDUM
Policy & Planning

Date	21 November 2023
Subject:	**Science Report Card 2023: Can I Swim Here?**
Approved by:	AJ Matthews, Director - Environment Quality
	S J Ruru, Chief Executive
Document:	3215808

Purpose

1. The purpose of this memorandum is to provide the Committee with an overview of the results from the 2022/2023 'Can I Swim Here?' recreational water quality monitoring programme, and present the associated science report card.
2. A copy of the report card accompanies this memorandum, and will be made available on our website.

Executive summary

3. Every summer, we work closely with district councils and Te Whatu Ora to advise the public on whether water quality in our rivers, lakes and beaches is suitable for swimming and recreation. This monitoring is a requirement of councils across the country, and is delivered as the Can I Swim Here? programme.
4. A summary report card has been developed in order to improve engagement and reach a wider audience. This format complements our technical reporting, and the five-yearly State of the Environment report (recently published in 2022). Our intention is to publish this report card at the completion of each summer bathing season, with a more detailed technical report published every two to three years to align with our new state of environment reporting cycle (currently in development).
5. This report card presents the results of coastal and freshwater monitoring of popular recreation spots across the region. Between 1 November 2022 and 31 March 2023, the Council undertook weekly water quality monitoring at 40 swimming spots across the region, including 22 rivers and lakes, and 18 beaches.
6. Water quality at the region's beaches was suitable for swimming most of the time, with 341 of 394 (87%) of enterococci samples deemed suitable for swimming at the time of sampling. Fitzroy Beach had the best water quality out of all monitored beaches.
7. For rivers and lakes, 243 of 484 (50%) of *E. coli* samples taken from freshwater recreational sites indicated that water quality was suitable for swimming at the time of sampling. Te Henui Stream at the coast continued to have high *E. coli* levels throughout the season, with permanent health warnings remaining in place at this site.

8. At river sites, 55 out of 99 (56%) of benthic cyanobacteria surveys found that monitored rivers were suitable for swimming. In lakes, planktonic cyanobacteria levels were suitable for swimming on 65% of sampling occasions. Lakes Opunake and Rotokare were unsuitable for swimming on the majority of sampling occasions.
9. An assessment of long-term *E. coli* and planktonic cyanobacteria monitoring data was carried out, in accordance with the National Policy Statement for Freshwater Management 2020 (NPS-FM). The assessment found that only two out of 22 (9%) monitored freshwater swim spots were graded excellent, while the remaining 20 sites (91%) were graded poor. Five out of 7 (71%) monitored lakes were graded excellent with regards to planktonic cyanobacteria, and the remaining 2 (29%) were graded poor.

Recommendations

That the Taranaki Regional Council:

a) <u>receives</u> the *Science Report Card 2023: Can I Swim Here?*

b) <u>notes</u> that monitoring for the 2023/2024 season is now underway.

Background

10. Every summer between November and March, we work with the three district councils and Te Whatu Ora to advise the public on whether water quality in our rivers, lakes and beaches is suitable for swimming and recreation.
11. Prior to November 2021, recreational water quality samples were collected during fine weather. Sampling now occurs weekly regardless of weather conditions. This change brings the monitoring programme into line with new national policy requirements and provides our community with greater awareness of suitability of rivers, lakes and beaches for swimming and recreating during a range of weather conditions.
12. Although elevated numbers of faecal bacteria can be present in waterways during fine conditions, these numbers typically worsen during and after heavy rainfall, when faecal contamination enters waterbodies through run-off or via stormwater. Livestock, birds, dogs and even humans are among the many potential sources of faecal contaminants that can affect recreational water quality.
13. The previous dry weather monitoring approach helped to characterise recreational water quality around the region during fine conditions when people are more likely to swim. However, we know that some people across Taranaki are still getting in the water during wet weather (or soon after), so it is important to collect data during those conditions too.
14. The way in which monitoring results are shared with the public has also evolved in recent years, with online reporting now playing an important and effective role in keeping the public up to date. The Can I Swim Here? module[1] on the LAWA (Land, Air, Water Aotearoa) website displays the weekly monitoring results for every region in New Zealand.
15. A summary report card has been developed to provide an overview of the programme, accompanied with a brief summary of the results. Where applicable, results are

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[1] Found at www.lawa.org.nz/explore-data/swimming/

presented alongside relevant standards or guideline values in order to provide an assessment of environmental state. The intent of these report cards is to ensure they are suitable for a non-technical audience in order to improve community engagement and understanding.

Discussion

16. This report card presents the results of coastal and freshwater monitoring of popular recreation spots across the region. Between 1 November 2022 and 31 March 2023, the Council undertook weekly water quality monitoring at 40 swimming spots across the region, including 22 rivers and lakes, and 18 beaches.

17. Weekly water samples were collected, with the freshwater sites tested for *Escherichia coli (E. coli)* and marine sites tested for enterococci. These bacteria are indicators of the presence of faecal contamination in the water and associated disease-causing pathogens. Cyanobacteria (potentially toxic algae) were also monitored every two weeks at selected river and lake sites.

18. Monitoring results were assessed against the Microbiological Water Quality Guidelines (MfE and MoH, 2003) and Cyanobacteria Interim Guidelines (MfE, MoH, 2009) in order to assess whether water quality was suitable for swimming and other watersports. Both sets of guidelines follow a risk based traffic light system. Green being suitable for swimming, to amber indicating caution advised, and red indicating a site is unsuitable for swimming.

19. During the 2022/2023 season, 243 of 484 (50%) of samples taken from freshwater recreational sites indicated that water quality was suitable for swimming at the time of sampling. *E. coli* numbers were elevated to cautionary levels based on 100 (21%) samples, while conditions were unsuitable for swimming at the time of sampling based on 141 (29%) samples. Lake Rotorangi at the dam had the best water quality out of all of the monitored sites, while Te Henui Stream mouth had the poorest water quality with permanent health warnings remaining in place at this site.

20. At popular beach sites, 341 of 394 (87%) of samples indicated that water quality was suitable for swimming at the time of sampling. Enterococci numbers exceeded the cautionary guideline in 22 (6%) samples. For 31 (8%) samples, water quality was unsuitable for swimming. Fitzroy Beach had the best water quality out of all monitored beaches, while Waitara West Beach was unsuitable for swimming most often.

21. For benthic cyanobacteria, 55 out of 99 (56%) surveys found that the monitored rivers were suitable for swimming. Cyanobacteria reached cautionary levels during 35 (35%) surveys, and conditions were deemed to be unsuitable for swimming during 9 (9%) surveys. Benthic cyanobacteria levels remained low at the Manganui River and Te Henui Stream sites throughout the summer period, whereas the Waiwhakaiho River at Merriland's Domain was unsuitable for swimming on 5 of 18 (28%) occasions.

22. In lakes, planktonic cyanobacteria levels were suitable for swimming on 57 out of 88 (65%) sampling occasions. Cyanobacteria levels were elevated to cautionary levels during 4 (5%) surveys, and conditions were unsuitable for swimming during 27 (31%) surveys. Cyanobacteria levels were suitable for swimming in Lakes Ratapiko, Rotorangi and Herengawe over the entire summer, whereas Lakes Opunake and Rotokare were unsuitable for swimming on 17 of 18 (95%) sampling occasions, and 8 of 14 (60%) sampling occasions, respectively.

23. An assessment of long-term grades found that only 2 out of 22 (9%) monitored freshwater swim spots were graded excellent with respect to *E. coli*; Lake Rotorangi and Lake Heregawe. The remaining 20 sites (91%) were graded poor. Five out of 7 (71%) swimming lakes were graded excellent with regards to planktonic cyanobacteria. Two lakes (29%) were graded poor; Lake Rotokare and Lake Opunake.
24. Under the NPS-FM, sites that have been graded poor are considered to be below the national bottom line; a minimum standard below which action is required to deliver water quality improvements. With regards to *E. coli* at swim spots, councils are required to work with communities to develop action plans for achieving these improvements. We must also work towards reducing levels of *E. coli* and occurrences of planktonic cyanobacteria by setting enforceable rules and limits.
25. The 2023-2024 Can I Swim Here? monitoring season in now underway, with the first round of samples collected on 7 November. Weekly results will be published on the LAWA website.

Financial considerations—LTP/Annual Plan

26. 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

27. 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

28. 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.

Community considerations

29. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

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

References

Ministry for the Environment. 2003. *Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas*. Wellington.

Ministry for the Environment and Ministry of Health. 2009. *Cyanobacteria in Recreational Fresh Waters – Interim Guidelines*. Wellington.

Appendices/Attachments

Document 3222856: Science Report Card 2023: Can I Swim Here?

Can I Swim Here?

In order to check whether it's safe to swim during the summer months, Taranaki Regional Council monitors water quality at 40 swimming spots across the region from November to March.

Weekly water samples are collected from rivers, lakes and beaches, with the freshwater sites tested for *Escherichia coli (E. coli)* and marine sites tested for enterococci. These bacteria are indicators of the presence of faecal contamination in the water and associated disease-causing pathogens.

The Council also monitors potentially toxic algae, or cyanobacteria, every fortnight at a subset of these sites.

The Microbiological Water Quality and Cyanobacteria Guidelines help us to assess whether water quality is suitable for swimming and other watersports. Each week, monitoring results are assessed using a traffic light system *(Figure 1)*. The Council works with district councils and Te Whatu Ora to inform the public when it's safe to swim.

Figure 1: Quick guide to the traffic light system used for the weekly assessment of sites.

Weekly monitoring results, long-term grades and permanent health warnings for Taranaki are updated online https://www.lawa.org.nz/explore-data/swimming. Further information regarding faecal indicator bacteria and cyanobacteria can also be found on the LAWA website.

Escherichia coli results (rivers and lakes)

Escherichia coli (*E. coli*) are an indicator of faecal contamination in freshwater. Although not always disease-causing, *E. coli* are often found alongside other harmful pathogens that can make people sick, and are therefore a useful measure of the suitability of rivers and lakes for recreation. *E. coli* greater than 260 *E. coli*/100mL indicates an elevated risk to human health and caution is advised. Above 550 *E. coli* /100mL freshwater sites are considered unsuitable for swimming.

Figure 2: Guideline values for swimming and recreation at freshwater sites.

During the 2022-2023 season, 243 (50%) samples taken from freshwater recreational sites indicated that water quality was suitable for swimming at the time of sampling. *E. coli* numbers were elevated to cautionary levels based on 100 (21%) samples, while conditions were unsuitable for swimming at the time of sampling based on 141 (29%) samples *(Figure 3)*.

Lake Rotorangi at the dam had the best water quality out of all of the monitored sites, while Te Henui Stream mouth had the poorest water quality; with permanent health warnings remaining in place at this site. Other locations with permanent health warnings and rāhui can be found on the website.

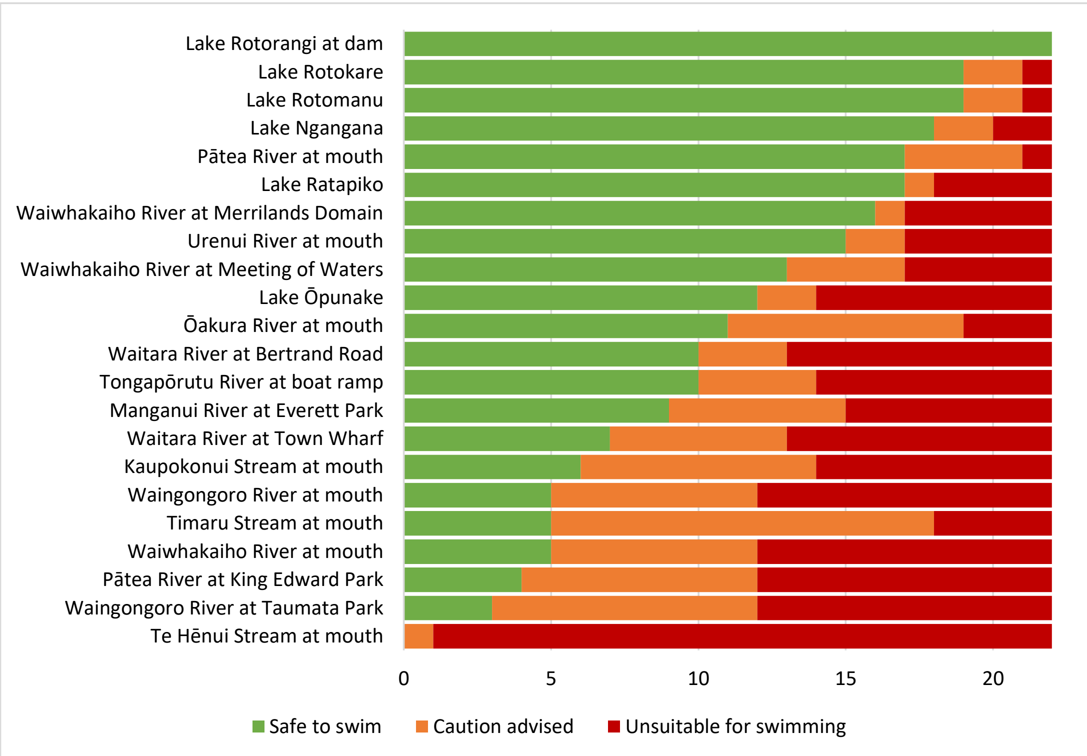

Figure 3: Results of weekly E. coli assessments at freshwater sites for the 2022/2023 season.

Enterococci results (beaches)

Enterococci bacteria are an indicator for faecal contamination in marine waters. Similar to *E. coli*, enterococci are often found alongside other harmful pathogens that can make people sick. However, enterococci can persist longer in saltwater and are therefore a better measure of human health risk.

Figure 4: Guideline values for swimming and recreation at marine and coastal sites.

During 2022-23, 341 (87%) samples taken at marine sites indicated that water quality was suitable for swimming at the time of sampling. Enterococci numbers were elevated above the cautionary guideline in 22 (6%) samples. For 31 (8%) samples water quality conditions were unsuitable for swimming ([Figure 5](#))[1]. Fitzroy Beach had the best water quality out of all monitored beaches during the 2022-23 season.

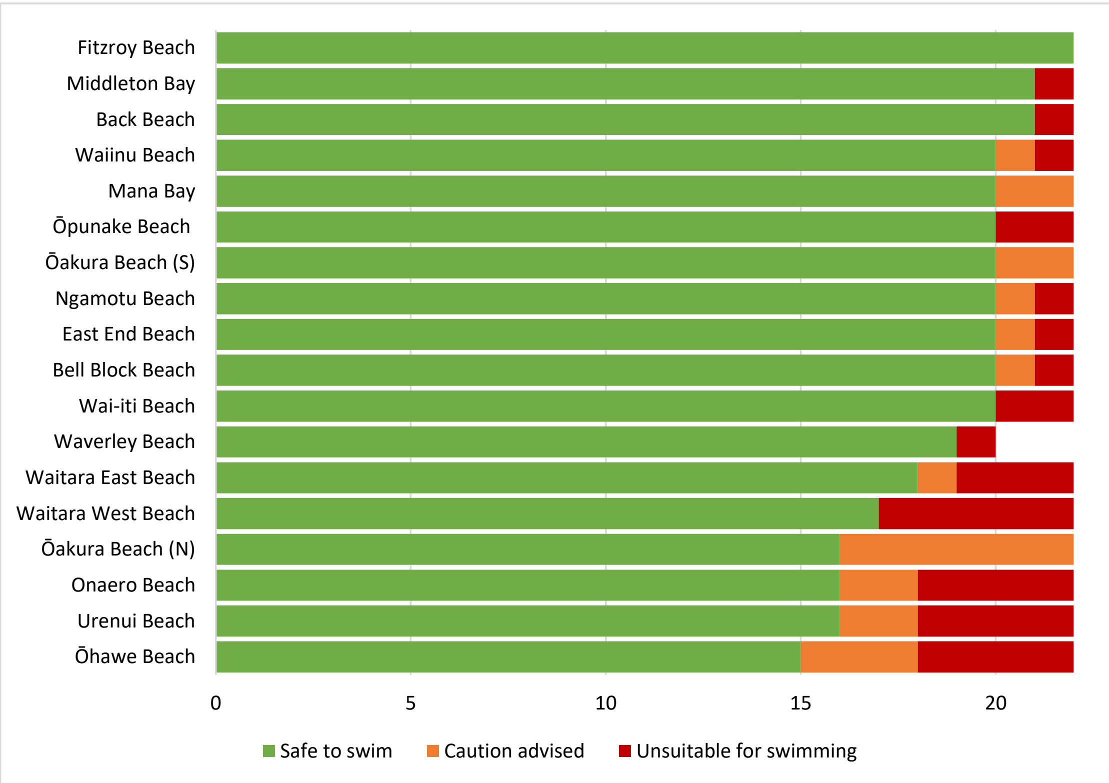

Figure 5: Results of weekly enterococci assessments at marine sites for the 2022/2023 season.

[1] The Council adopted a more precautionary approach than what's set out in the Microbiological Water Quality guidelines by categorising swimming spots as being unsuitable for swimming following a single exceedance of the 280 enterococci threshold, rather than two consecutive exceedances.

Cyanobacteria results (lakes and rivers)

Cyanobacteria exists naturally in freshwater, growing on the rocks of a river bed (benthic) or floating and drifting in lakes (planktonic). During the summer months, increased water temperature, reduced rainfall and increased daylight hours provide ideal conditions for cyanobacteria to grow, sometimes resulting in algal blooms. When in bloom, cyanobacteria can produce toxins at concentrations that pose a risk to the health of people and animals entering the water.

During the 2022-2023 season, 55 (56%) benthic cyanobacteria surveys found that the monitored rivers were suitable for swimming. Cyanobacteria were elevated to cautionary levels during 35 (35%) surveys, and conditions were deemed to be unsuitable for swimming during 9 (9%) surveys.

Benthic cyanobacteria levels remained low at the Manganui River and Te Hēnui Stream sites throughout the summer period, whereas the Waiwhakaiho River at Merrilands Domain was unsuitable for swimming on 5 (28%) occasions.

In lakes, planktonic cyanobacteria levels were suitable for swimming on 57 (65%) sampling occasions. Cyanobacteria were elevated to a cautionary status during 4 (5%) surveys, and conditions were unsuitable for swimming during 27 (31%) surveys. Levels were suitable for swimming in Lakes Ratapiko, Rotorangi and Herengawe over the entire summer, whereas Lakes Ōpunake and Rotokare were unsuitable for swimming on 17 (95%) and 8 (60%) sampling occasions respectively.

Figure 6: Guideline values for benthic cyanobacteria in rivers. Conditions may also be unsuitable for swimming where there are detaching mats and/or exposed mats along the river's edge, even if overall coverage is low.

Figure 7: Guideline values for planktonic cyanobacteria in lakes.

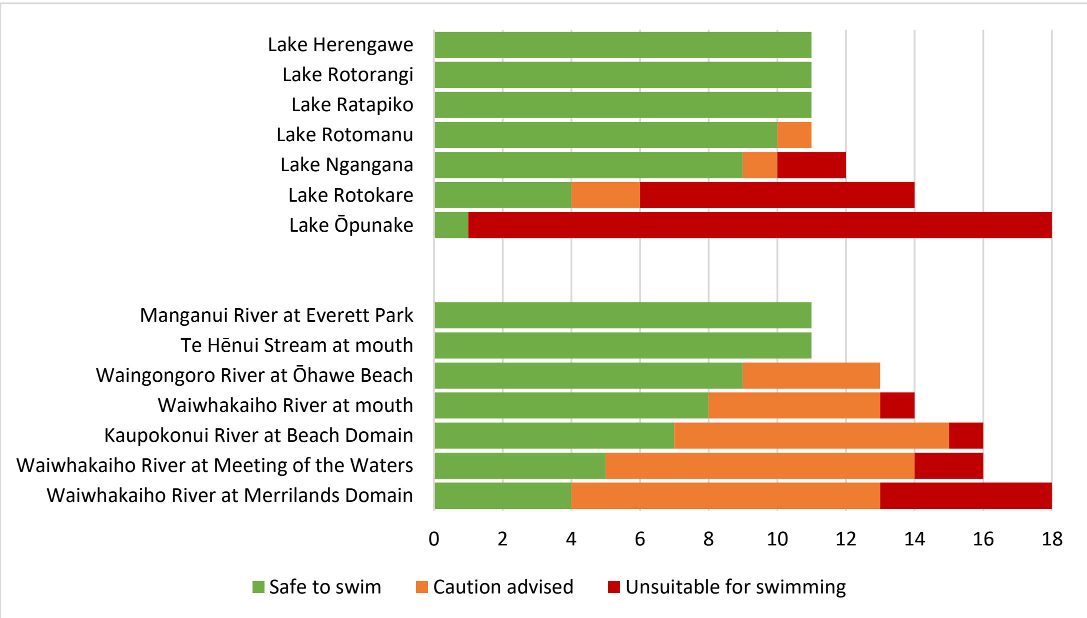

Figure 8: Results of cyanobacteria assessments at rivers and lakes during the 2022/2023 season (sites were visited more frequently where results were elevated).

National freshwater policy

Under the National Policy Statement for Freshwater Management 2020 (NPS-FM), regional councils are required to assess the overall suitability of swim spots based on the likelihood of someone getting sick. These requirements specifically relate to the risk associated with *E. coli* and planktonic cyanobacteria, and are based on long-term statistical grades. For *E. coli*, the 95th percentile of monitoring results is the statistical criteria used to indicate the likelihood of a site experiencing elevated bacteria levels. For planktonic cyanobacteria, the 80th percentile is used.

Because the Council recently changed the way it collects samples to align with national requirements, *E. coli* data is only available for the last two years (or one year for some sites), rather than five years which is preferable. Therefore, the *E. coli* grades should be treated as an interim assessment for the time being.

Only 2 (10%) monitored freshwater swim spots were graded excellent with respect to *E. coli*; Lake Rotorangi and Lake Herengawe. The remaining 20 (90%) sites were graded poor. Five (71%) swimming lakes were graded excellent with regards to planktonic cyanobacteria. Two (29%) were graded poor; Lake Rotokare and Lake Ōpunake.

Under the NPS-FM, sites that have been graded poor are considered to be below the national bottom line; a minimum standard below which action is required to deliver water quality improvements. With regards to *E. coli* at swim spots, regional councils are required to work with communities to develop action plans for achieving these improvements. We must also work towards reducing levels of *E. coli* and occurrences of planktonic cyanobacteria by setting enforceable rules and limits. The Council is currently working on this by engaging with the community to develop a new Freshwater Plan, which must be notified by December 2024.

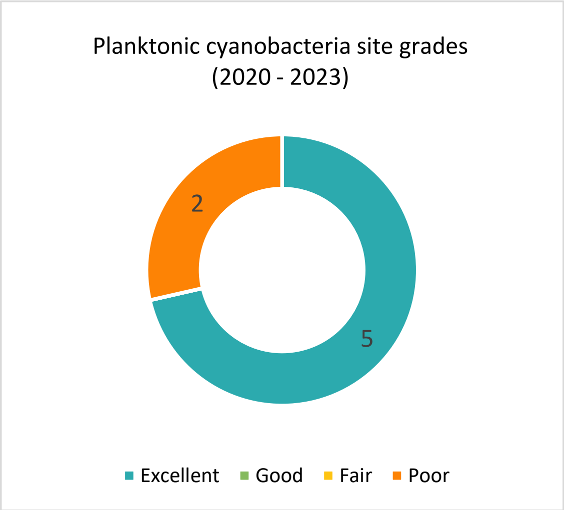

Figure 9: Planktonic cyanobacteria site grades, 2020-2023.

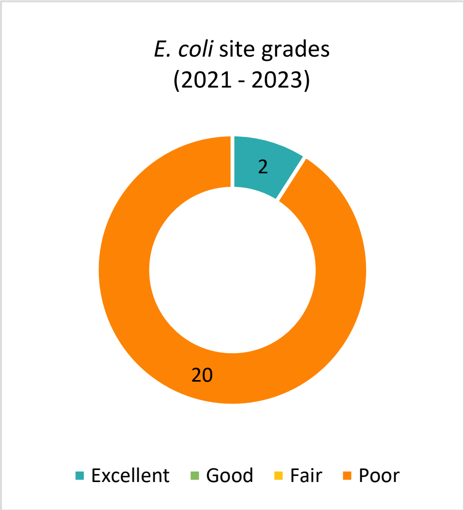

Figure 10: E. coli site grades, 2021-2023.

Things to consider before going for a swim

- Avoid swimming for at least 3 days after heavy or prolonged rain, even for sites that have good water quality. Heavy rain can cause surface run-off which washes pollutants and animal faeces from land into rivers, lakes and the ocean which can make them temporarily unsafe for swimming.
- Follow the advice of warning signs and don't swim if the water is murky or smells unpleasant. It is best to wait until it clears before taking a dip.
- Check the water quality information for the site.
- Know how to spot potentially toxic algae in rivers or lakes so you can avoid it.
- Avoid swimming near potential sources of contamination such as flocks of birds, stormwater or wastewater outlets.

For more information on the Can I Swim Here? monitoring programme, including test results and current health warnings and, go to www.trc.govt.nz/can-i-swim-here/.

MEMORANDUM
Policy & Planning

Date 21 November 2023

Subject: **Soil quality in the Taranaki Region 2022: current status, comparison with 2017, and temporal analysis**

Approved by: A J Matthews, Director - Environment Quality

S J Ruru, Chief Executive

Document: 3204115

Purpose

1. The purpose of this memorandum is to provide the Committee with an overview of the findings of a recent report commissioned by Taranaki Regional Council *Soil quality in the Taranaki Region 2022: current status, comparison with 2017, and temporal analysis* by Manaaki Whenua Landcare Research. A copy of the report accompanies this memorandum, and is available on the Council's website.
2. This item will be accompanied by a brief presentation.

Executive summary

3. The Council has been monitoring soil quality in the region since 1995, with sampling undertaken approximately every five years. Sampling was most recently undertaken by Council officers between October and December 2022, with analysis and reporting completed by Manaaki Whenua - Landcare Research.
4. The Taranaki soil quality monitoring programme comprises 20 sites with varying land uses including three plantation forest sites, eight dairy pasture sites, five drystock pasture sites (pasture grazed predominantly by sheep and beef), two cropping/market garden sites, and two indigenous forest sites.
5. Soil quality was assessed against recommended targets derived for specific land use and soil orders using key soil quality indicators including: total carbon (C) and total nitrogen (N), anaerobically mineralisable nitrogen (AMN), pH, Olsen P, bulk density, and macroporosity. Total cadmium (Cd) was also assessed. Microbial biomass carbon, soil respiration, and bioavailable Cd were not assessed against targets as there are none recommended in New Zealand.
6. Total carbon, AMN and bulk density returned results within the target values across all assessed sites. The soil quality indicators of concern noted in this report were total N, Olsen P concentrations, and air-filled porosity (macroporosity (–10kPa)). Soil issues associated with macroporosity and high levels of phosphorus and/or nitrogen at

sampling sites reflects the land use and management dedicated to intensive productivity and soil quality characteristics found in Taranaki.

7. Land management practices including appropriate nutrient budgets, soil testing for soil fertility or soil quality, appropriate fertiliser and effluent application rates and fertiliser types can help minimise the likelihood of high nutrient concentrations in soils and therefore runoff, thus reducing potential impacts on receiving aquatic environments.

8. Low macroporosity, as found for most dairy and drystock sites in this report, is often the result of soil compaction and is likely the result of high stocking rates, grazing when soil is too wet, and use of heavy machinery. Improving macroporosity can help to improve pasture or crop yield and help reduce nutrient loading in runoff through increased nutrient uptake by plants, and increasing drainage flow. To improve macroporosity, management techniques should be considered such as using stand-off pads, limiting traffic and stocking on paddocks especially in wet conditions, and the addition of organic matter.

9. Higher concentrations of Cd may arise from excess use of phosphate fertilisers and can have consequences for human and animal health. Forestry and indigenous forest soils had the lowest Cd concentrations, suggesting the elevated Cd levels found in intensively managed soils had originated from the application of phosphate fertiliser containing elevated levels of Cd. At three dairy sites and one drystock site, total Cd exceeded the recommended Tier 1 trigger value (0.6 mg kg-1), requiring more active management of soil cadmium. The concentration of total Cd at several sites was below the Tier 1 trigger value, which is considered to be acceptable, but above 0.5 mg kg–1 and nearing the Tier 1 trigger value.

10. Because of the limited number of data points available, the results from reports prior to this 2022 report were not able to undergo statistical trend assessments. This is therefore the first soil quality report in which temporal trends have been reported.

11. There was evidence that the temporal trend across the sampling events between 1997 and 2022 was significant for four indicators: total Cd, AMN, microbial biomass C, and macroporosity (–5 kPa). For all soil properties with a significant temporal trend, the annual rate of change was low. The reduction in total Cd over the five surveys is likely to be beneficial to soil quality, while the remaining trends are indicative of declining soil quality.

12. Despite evidence of long-term trends, a comparison between the two most recent surveys (2022 and 2017) concluded that, with the exception of microbial biomass C and basal respiration, there was no evidence that the results were statistically different. This reflects that some indicators tend to have high variability, or that little has changed in the last five years and that any management practices recently implemented have not significantly altered the key soil indicators between these sampling dates.

13. The report sets out a number of recommendations including:

    - The soil-quality monitoring programme continues to resample existing sites in order to determine the extent and direction of any changes since originally sampled.
    - The Council considers activities to educate land managers on practices to protect the environment including the current recommendations on reducing Olsen P concentrations and soil compaction.
    - Soil classification and soil pit examination for detailed soil descriptions should be conducted by an experienced pedologist for newer sites where this work has not

already been completed. This work could be done in association with future S-map mapping work or preferably as a new project.

- Measurements including microbial biomass C, basal respiration and bioavailable Cd, which are not recommended in the National Environmental Monitoring Standards (NEMS), could be discontinued, possibly in favour of other more relevant soil quality indicators, e.g., hot water carbon.

14. The next soil quality monitoring sampling is due to be carried out October-December 2027.

Recommendations

That the Taranaki Regional Council:

a) receives the memorandum *Soil quality in the Taranaki Region 2022: current status, comparison with 2017, and temporal analysis* and presentation

b) notes the recommendations of the authors and officers regarding future work.

Background

15. Soil quality monitoring is undertaken by most regional councils, including Taranaki Regional Council, as part of State of Environment (SoE) monitoring. Monitoring provides valuable information on soil functioning under different land uses and the impacts of soil use on the environment.

16. Soil health is important for maximising the productive capacity of farms and minimising the impacts of land use on the environment. This is particularly important for topsoil, the most nutrient-rich part of the soil. Poor soil health affects the quality of surrounding waterways through increasing sediment and nutrient run-off. Our use of land and soil requires careful management to maintain soil health and prevent soil-related issues – including erosion, excess nutrients and contamination.

17. In New Zealand, soil quality data generally indicates soil issues associated with low/poor macroporosity and high levels of phosphorus and/or nitrogen. Compacted soil may restrict drainage and plant growth, lower soil health and can contribute to harmful impacts on aquatic environments by contributing to increased surface runoff and erosion. Excess phosphorus and nitrogen can enter nearby surface water or groundwater through runoff or leaching and negatively affect water quality.

Soil quality monitoring in Taranaki

18. The Council has been monitoring soil quality on different soils and land uses in the region since 1995. From 1996 to 2001, 46 sites in the region were characterised as part of the nationwide '500 Soils Project' soil quality assessment programme. Future resampling efforts were intended to determine whether soil quality was changing. In 2007-2008, the Council resampled 18 of the previously characterised sites, and included two new sites with 'low intervention' indigenous forest land use to contrast with the previously sampled higher intensity dairy and arable land uses. The 20 sites sampled in 2007 were resampled in 2012, 2017 and 2022 with a few instances of sites being replacement due to sampling and access issues.

19. Because of the limited number of data points available, the results from reports prior to this 2022 report were not able to undergo statistical trend assessments. This is therefore the first soil quality report in which temporal trends have been reported.

20. To assess the physical soil properties at each site, three intact soil cores were collected at equal intervals along a 50 metre transect using steel rings (10 cm diameter × 7.5 cm depth). Composite soil samples of 2.5 cm diameter were collected every 2 m along the same transect at a soil depth of 0–10 cm, in order to assess soil chemistry.
21. Samples were assessed for physical condition, chemical fertility, trace elements, organic matter and microbial health indicators, with results compared against optimal ranges. Soil quality indicators investigated in this report, along with soil quality information provided by the indicator, and an explanation of the importance of the measurement is provided in the table below:

Indicator property	Soil quality indicator	Soil quality information provided by indicator	Why is the measure important?
Chemical	Total C content	Organic matter status	Organic matter helps soils retain moisture and nutrients and gives good soil structure for water movement and root growth.
	Total N content	Approximates organic N reserves (the vast majority of N in the soil)	Nitrogen (N) is an essential nutrient for plants, although when in excess, nitrogen can leach into water. Excess nitrogen in the form of nitrate can be harmful to freshwater ecosystems as well as impact human health by contaminating drinking water sources.
	Anaerobically mineralisable N (AMN)	Organic N that can be readily mineralised into a plant available form	Not all the organic matter N can be used by plants; soil organisms change the N to forms that plants can use. Anaerobic mineralisable nitrogen gives a measure of how much organic N is potentially available to the plants and the activity of the organisms.
	pH	Acidity or alkalinity	Most plants and soil animals have an optimum pH range for growth. Indigenous species are generally tolerant of acid conditions but introduced pasture and crop species require a more alkaline soil.

	Olsen P	Plant available phosphate	Phosphorus (P) is an essential nutrient for plants. Many soils in New Zealand require P applications for agricultural use. However, excessive P levels can increase loss to waterways, contributing to adverse effects on freshwater ecosystems.
Biological properties	Microbial biomass C	Biomass of living microbes in soil	Microbial biomass (bacteria and fungi) is a measure of the mass of the living component of soil organic matter. The microbial biomass decompose plant and animal residues and soil organic matter to release carbon dioxide and plant available nutrients.
	Soil respiration	Total respiratory activity of aerobic soil microorganisms	Soil respiration reflects the capacity of soil to sustain plant growth and soil microbes.
Physical properties	Dry bulk density	Compaction, volumetric conversions	Compacted soils will not allow water or air to penetrate, do not drain easily, and restrict root growth.
	Air filled porosity (–10 kPa tension), which can be referred to as macroporosity	Soil compaction, root environment, aeration	Macropores are important for air penetration into soil and are the first pores to collapse when soil is compacted. For comparison with the 2017 resampled sites, the air-filled porosity measurement was used.
	Macroporosity (–5 kPa tension)a	Soil compaction, root environment, aeration	For comparison of sites over time, the –5 kPa macroporosity measurement was used because the –10 kPa air-filled porosity measurement was not calculated for samples from 1998 to 2000.

22. Analysis of cadmium (Cd) concentrations was also undertaken. Cadmium is a naturally occurring heavy metal found in low concentrations in the environment. It occurs naturally in phosphate rock, the main ingredient for superphosphate fertiliser, which is used to improve plant growth. Ongoing use of phosphate-based fertilisers can lead to a build-up of cadmium in soils, which can cause health problems for people at high concentrations. High Cd loads can be caused by historically high rates of fertiliser

application to allophanic soils, and/or from phosphorus fertilisers contaminated with high Cd concentrations.

Discussion

23. The soil quality indicators for the current 2022 survey were compared with target values derived for specific land use and soil orders from the Land Monitoring Forum (Hill & Sparling 2009) using information from Mackay et al. (2013) and as discussed in Cavanagh et al. (unpubl. data). Of the 20 monitoring sites, the two 'indigenous vegetation' sites were excluded from the target range assessments as soil quality target values are not available for this land use. Therefore only the remaining 18 sites were assessed against target values as described in the following paragraph. Soil microbial biomass carbon, soil respiration, and bioavailable Cd were not assessed as part of this report as there are no recommendations for targets or guidelines for these indicators in New Zealand.
24. For cadmium, the 'Tiered Fertiliser Management System' has five cadmium level tiers, with Tier 0 representing soil Cd that lies within the range of natural background levels. The soil 'trigger' values for Tiers 1, 2, 3 and 4: are 0.6, 1.0, 1.4 and 1.8 mg Cd/ kg soil, respectively (Fertiliser Association 2019). More active management of soil cadmium loading from phosphate fertilisers is introduced when soil concentrations are above 0.6 mg Cd/kg, Tier 1.
25. Physical soil condition assessments were based on dry bulk density, and air-filled porosity (referred to as macroporosity at –10 kPa). Chemical and biochemical characteristics were determined based on total carbon, total nitrogen, anaerobically mineralisable N, Olsen P, and soil pH. Additional assessments of soil biological functioning were based on soil microbial biomass carbon and soil respiration measurements. Soil cadmium was analysed as total and bioavailable Cd fractions. Macroporosity (measured using –5 kPa tension) is also included in this report, as earlier surveys only measured –5 kPa (i.e. not –10 kPa). However, macroporosity (when measured using –5 kPa tension) was not formally assessed in this report, as the Land Monitoring Forum only uses the–10 kPa macroporosity measurement (Hill & Sparling 2009).

Soil quality state and trends

26. Excluding the two indigenous forest sites, two out of the remaining 18 sites (11%) were within the target range for physical, chemical, and total Cd soil quality indicators. The land use at these two sites was forestry and dairy. There were 12 sites assessed (67%) that had two or more indicators that did not meet the associated soil and/or land use target range, and five sites (28%), that had three or more indicators that did not meet the associated soil and/or the land use target range. These five sites were all under dairy land use. The soil indicators total N, Olsen P and total Cd that were outside target ranges/ guidelines were all above the recommended maximum limit for the soil and/ or land use, with one exception. One site had a pH value outside the recommended target range, which also occurred for this site during the 2017 survey. Macroporosity values were below target ranges for 11 sites (61%).
27. A trend of decreasing macroporosity (–5 kPa) suggests that overall soil compaction is occurring. It also suggests soil compaction is not being ameliorated by natural processes that can occur such as through plant root and soil fauna activity, soil cracking and drying, etc. (e.g. Drewry et al. 2004). Low macroporosity as found for most dairy and drystock sites in this report is likely the result of high stocking rates, grazing when soil is

too wet, and use of heavy machinery (Hu et al. 2021; Ministry for the Environment & Stats NZ 2021). Improving macroporosity can help to improve pasture or crop yield (Drewry et al. 2008). Improving macroporosity can also help reduce nutrient loading through increased nutrient uptake by plants, and by decreasing nutrient run-off through increased drainage flow. To improve macroporosity, management techniques should be considered such as using stand-off pads, limiting traffic and stocking on paddocks especially in wet conditions, and the addition of organic matter.

28. Olsen P values were higher than targets at half of the sites, with several sites having concentrations well beyond the soil quality targets and industry agronomic guidelines. These results suggest that management to mitigate high Olsen P concentrations should be encouraged. Management practices including appropriate nutrient budgets, soil testing for soil fertility or soil quality, appropriate fertiliser selection and effluent application rates can all help minimise the likelihood of high nutrient concentrations in soils. Manaaki Whenua – Landcare Research has produced a series of soil health factsheets, for farmers and regional councils etc. including advice regarding soil nutrient management and reducing the impacts of soil pugging and compaction (https://www.landcareresearch.co.nz/publications/soil-horizons/soil-horizons-articles/soil-health-factsheets/).

29. The observed trend in decreasing Cd levels could indicate changes in practices such as reducing the amount of phosphate fertiliser applied, efforts by industry to reduce Cd content in fertiliser products, or a combination of these. However, there was no evidence in the trend analysis that there had been a change in Olsen P concentrations in either direction over the five samplings. In addition to applied fertiliser, there can be other sources of P which may maintain or increase soil P concentrations, such as supplements and effluent.

30. The application rate and type of phosphate fertiliser used should be monitored and managed to avoid further soil Cd contamination. Management guidelines and further information for farmers are provided by 'The Tiered Fertiliser Management System' (Fertiliser Association 2019). More information on Cd in the cropping sector and some educational resources can be found on the Ministry for Primary Industries website (https://www.mpi.govt.nz/dmsdocument/41244-Guide-Managing-cadmium-in-food-crops-in-New-Zealand).

31. There was evidence that the temporal trend across the sampling events between 1997 and 2022 was significant for four indicators: total Cd, AMN, microbial biomass C, and macroporosity (–5 kPa). For all soil properties with a significant temporal trend, the annual rate of change was low. A reduction in total Cd over the five surveys is likely to be beneficial to soil quality, while the remaining trends are indicative of declining soil quality.

32. Despite evidence of long-term trends, a comparison between the two most recent surveys (2022 and 2017) concluded that, with the exception of microbial biomass C and basal respiration, there was no evidence that the results were statistically different. This reflects that some indicators tend to have high variability, or that little has changed in the last five years and that any management practices recently implemented have not significantly altered the key soil indicators between these sampling dates.

Recommendations and next steps

33. The report sets out a number of recommendations including:

- The soil-quality monitoring programme continues to resample existing sites in order to determine the extent and direction of any changes since originally sampled.
- The Council considers activities to educate land managers on practices to protect the environment including the current recommendations on reducing Olsen P concentrations and soil compaction.
- Soil classification and soil pit examination for detailed soil descriptions should be conducted by an experienced pedologist for newer sites where this work has not already been completed. This work could possibly be done in association with future S-map mapping work or preferably as a new project.
- Measurements including microbial biomass C, basal respiration and bioavailable Cd, which are not recommended in the National Environmental Monitoring Standards (NEMS), could be discontinued, possibly in favour of other more relevant soil quality indicators, e.g., hot water carbon.

34. The next soil quality monitoring sampling is due to be carried out October-December 2027.

Financial considerations—LTP/Annual Plan

35. 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

36. 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

37. 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.

Community considerations

38. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

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

Appendices/Attachments

Document 3204120: Soil quality in the Taranaki Region 2022

Manaaki Whenua
Landcare Research

Soil quality in the Taranaki Region 2022: current status, comparison with 2017, and temporal analysis

Prepared for: Taranaki Regional Council

June 2023

Soil quality in the Taranaki Region 2022: current status, comparison with 2017, and temporal analysis

Contract Report: LC4297

John Drewry, Allycia Van de Laar, Stephen McNeill

Manaaki Whenua – Landcare Research

Reviewed by:	*Approved for release by:*
Hadee Thompson-Morrison Land Scientist – Environmental Contaminants Manaaki Whenua – Landcare Research	John Triantafilis Portfolio Leader – Managing Land & Water Manaaki Whenua – Landcare Research

Contents

Summary

Project and client

- Taranaki Regional Council (TRC) has been monitoring soil quality on soils and land uses in the region. The council participated in the '500 Soils Project' soil quality assessment programme, where sites were sampled during 1999 to 2001.
- Since then, 20 monitoring sites have been resampled in 2007, 2012, 2017, and – for this project – in 2022. Taranaki Regional Council land resources staff collected the soil samples. Manaaki Whenua – Landcare Research (MWLR) was contracted to supply sampling equipment, undertake laboratory soil analyses, and provide an interpretive report.

Objectives

- Complete laboratory analyses on soil samples for soil biological indicators (microbial biomass carbon and basal respiration), soil chemical (total and bioavailable cadmium (Cd), total carbon (C) and total nitrogen (N), anaerobically mineralisable N, pH, Olsen phosphorus (P)) and physical properties (bulk density, air-filled porosity (–10 kPa) and macroporosity (–5 kPa)).
- Complete statistical analysis to compare 2017 and 2022 samplings and for temporal trends over five samplings where data are available.
- Provide a report on results and recommendations.

Methods

- The established sites were sampled by TRC staff and soil samples provided to MWLR.
- Laboratory analyses were conducted by MWLR in their Hamilton Soil Physics laboratory and Environmental Chemistry laboratory in Palmerston North.
- Sampling data prior to 2022 was available from MWLR archives. We noticed an error in archived data for one sampling, so we checked the data for 2017, 2012, 2007, against our original MWLR laboratory results reports, and used the original MWLR laboratory results in the analysis for this report. The original MWLR laboratory results sheets for these dates also had additional data that we used in this report. Laboratory data for checking pre-2007 results were not available.
- In addition, we used the checked original MWLR laboratory results, because using laboratory units (including gravimetric ones) is more in line with current practice, is more robust, and avoids other issues as explained in the main report.
- Soil quality was assessed against recommended targets using the key soil quality indicators: total C and total N, anaerobically mineralisable N (AMN), pH, Olsen P, bulk density, and macroporosity. Total Cd was also assessed. Microbial biomass carbon, soil respiration, and bioavailable Cd were not assessed against targets as there are none recommended in New Zealand.
- Of the 20 monitoring sites, we have excluded the two 'indigenous vegetation' sites from the assessment against target values, as soil quality target values are not available for this land use. There were 18 sites assessed against targets.

- The values for the sampling years 2017 and 2022 were compared by carrying out an unpaired *t*-test.
- A statistical trend analysis over the five samplings was conducted. A Generalised Additive Model (GAM) was applied to each soil indicator, with a random effect for each site, and a fixed effect for the number of 52-week-long years since the beginning of 2009 was used as a convenient reference point because more soil indicators were available from then, but dates can be earlier than this. All models except that for pH have the response modelled as a Gamma with a log transformation. This analysis was different from earlier client reports but provided a robust method for these data.

Results

- Across the region, for all the physical, chemical, and total Cd soil quality indicators, only two sites out of 18 sites in the target value assessment (11%) had all soil indicators within the target range.
- There were 11 out of 18 sites that were assessed (61%) that had two or more soil physical and chemical indicators (i.e. excluding total Cd) that did not meet the target range.
- When total Cd was also included, there were 12 out of 18 sites assessed (67%) that had two or more soil physical, chemical and total Cd indicators that did not meet the target range, while five out of 18 sites assessed (28%) had three or more soil indicators that did not meet the target range. These five sites were all under dairy land use.
- Air-filled porosity (macroporosity –10 kPa) values were below target ranges for 11 out of 18 sites (61%), indicating soil compaction is occurring. Olsen P values were higher than targets in nine sites (50%), and several sites had very high values. Four sites out of the 18 assessed (22%) had total Cd values above the recommended Tiered Fertiliser Management System (TFMS) Tier 1 trigger value of 0.6 mg Cd/kg soil).
- There was no evidence that the key soil quality values from 2017 and 2022 were different, but microbial biomass carbon had decreased, while basal respiration increased.
- There was evidence that the temporal trend across five samplings (where available) was significant ($P < 0.05$) for total Cd, AMN, microbial biomass carbon, and macroporosity (–5 kPa). For these properties with a significant temporal trend, the slope was negative, indicating the values are reducing.

Conclusions

- Several soil indicators showed good soil quality, and all sites had C, AMN and bulk density within the target values; most had pH values within targets.
- The soil quality indicators of concern were total N, Olsen P, and air-filled porosity (i.e. macroporosity (–10kPa)).
- When total Cd was also included, there were five out of 18 sites (28%), which were dairy sites, that had three or more soil physical, chemical, and total Cd indicators that did not meet the target range.

- Air-filled porosity (macroporosity –10 kPa) values were below target ranges for many sites, indicating soil compaction is occurring. Olsen P values were higher than targets in half of the 18 sites assessed against targets, with several having very high values, indicating that management to mitigate these high Olsen P concentrations should be encouraged.
- There was no evidence that the key soil quality values from 2017 and 2022 were different.
- The temporal trend across samplings was significant for total Cd, AMN, microbial biomass carbon, and macroporosity (–5 kPa), and that the values are reducing, but the annual rate of change is quite small. A reduction in total Cd is considered positive for soil quality. A reduction in microbial biomass carbon and macroporosity is considered a decline in soil quality.

Recommendations

We recommend the following to TRC.

- The soil quality monitoring programme of resampling existing sites continues in order to determine the extent and direction of any changes since sites were originally sampled.
- TRC considers activities to educate land managers on practices to protect the environment including the current recommendations on reducing soil Olsen P concentrations and to improve soil compaction.
- If several newer sites added by TRC have not had soil classification and soil pit examination for detailed soil descriptions conducted by an experienced pedologist, this work should be undertaken, possibly in association with future S-map mapping work, or separately.
- TRC should consider if the future measurement of microbial biomass carbon, basal respiration and bioavailable Cd is warranted.

1 Introduction

1.1 Background

Taranaki Regional Council (TRC) has been monitoring soil quality on different soils and land uses in the Taranaki Region since 1995. The council participated in the '500 Soils Project' soil quality assessment programme from 1996 to 2001 (Sparling et al. 2001a, b).

As part of the 500 Soils Project, a standard set of sampling methods, as well as physical, chemical and biological soil properties, were identified to assess soil quality, particularly for State of the Environment and regional council reporting (Hill & Sparling 2009). These sampling methods and soil quality indicators were adopted for use in the soil quality monitoring programme. The programme also contributes data to national reporting of soil quality (e.g. Ministry for the Environment & Stats NZ 2021).

To determine whether soil quality was changing, it was originally intended the sites should be resampled at a future date, typically, 3–10 years later, depending on the land use. In 2007, the council decided to resample some sites previously characterised from 1996 to 2001, over 2007–2008, and included new sites with 'low intervention' to contrast with the higher intensity dairy and arable land uses. The sites sampled in 2007 were resampled in 2012, 2017 and 2022. Further details are available in Stevenson and Laubscher (2018). One new site was added between 2017 and 2022 samplings.

For the 2022 sampling, TRC land resources staff collected the soil samples. MWLR was contracted to complete soil analyses and provide an interpretive report.

1.2 Objectives

- Complete laboratory analyses on soil samples for soil biological indicators (microbial biomass carbon (C) and respiration), soil chemical (total and bioavailable cadmium, total C and total N, anaerobically mineralisable N, pH, Olsen P) and physical properties (bulk density, air filled porosity (–10 kPa) and macroporosity (–5 kPa)).
- Complete statistical analysis to compare 2017 and 2022 samplings and include temporal trends over five samplings where data are available.
- Provide a report on findings and recommendations.

2 Monitoring network and site details

The Taranaki soil quality monitoring programme monitors 20 sites on soils across the region under different land uses (Figure 1). Land uses include dairying, cropping, drystock, horticulture, exotic forestry, and indigenous vegetation (Table 1).

Site codes, soil type, soil classification, and land use of the 20 monitoring sites sampled in 2017 and 2022 are presented in Table 1. Soil orders at the sites comprise 14 Allophanic soils, two Brown, three Gley, and one Recent Soil.

The monitoring sites comprise three plantation forests, eight dairy pastures, five drystock pastures (pasture grazed predominantly by sheep and beef), two cropping/market garden sites, and two indigenous forest sites. In 2017, two new drystock sites (SOL000191 and SOL000192) were added to replace two existing sites (SOL000144, SOL000145) where sampling was no longer practical. Since the 2017, one of the new drystock sites (SOL000191) has been replaced with another drystock site (SOL010012).

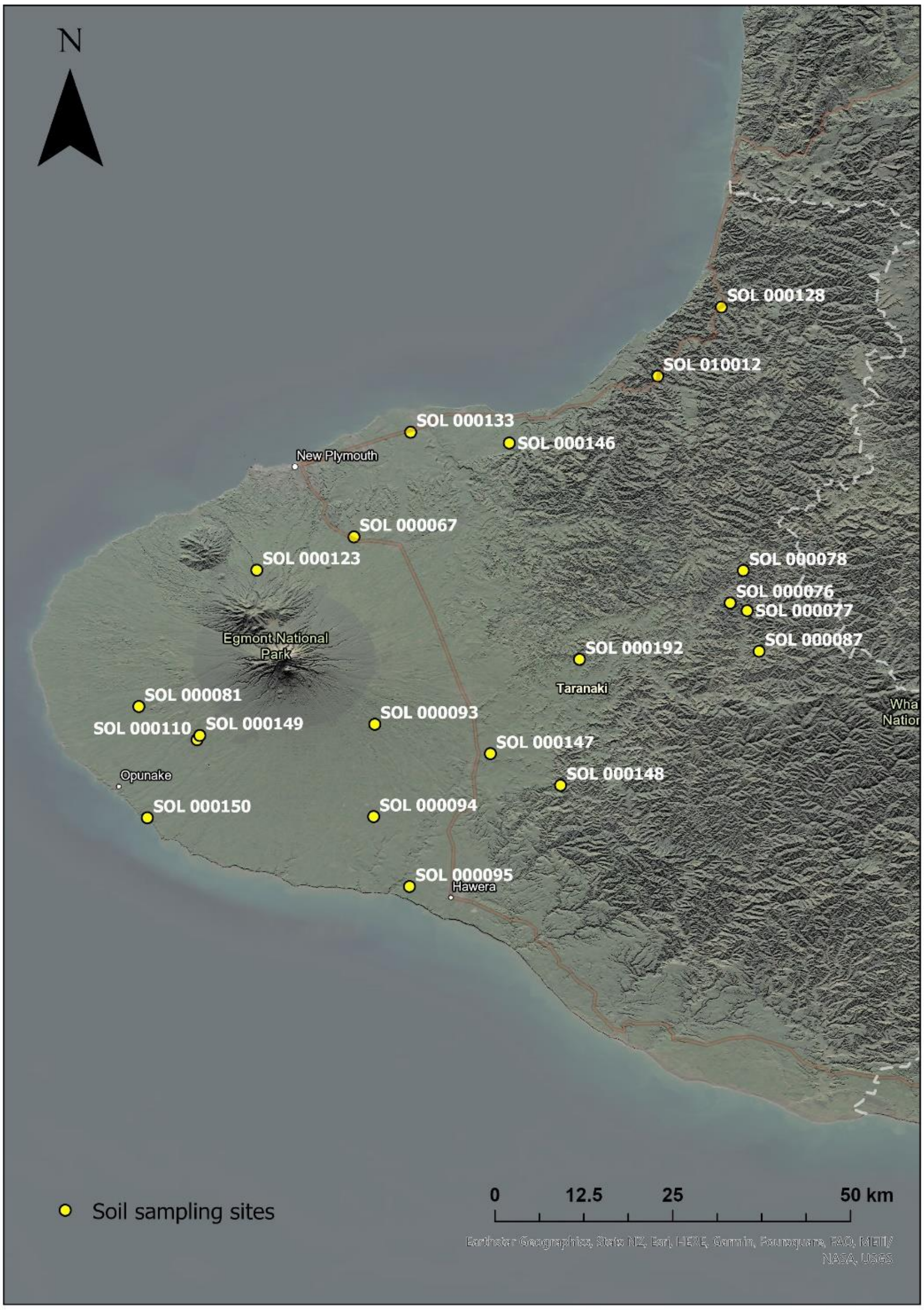

Figure 1. Location map showing sites in Taranaki Region sampled in 2022. Map constructed using ArcGIS with overlying data layers created by MWLR.

Table 1. Site codes, soil type, soil classification, and current land use of sites (*n* = 20) sampled in 2022 compared with 2017. Detailed archived soil classification and soil profile descriptions are available from Sparling and Stevenson (2008) and Sparling et al. (2001b).

TRC code	Soil type or map unit	Soil classification	Land use in 2017	Land use in 2022
SOL 000067	Sandy clay loam	Typic Orthic Allophanic Soil	Drystock	Market garden
SOL 000076	New Plymouth brown loam	Typic Orthic Allophanic Soil	Forestry	Forestry
SOL 000077	New Plymouth brown loam	Typic Orthic Allophanic Soil	Forestry	Forestry
SOL 000078	Whangamomona fine sandy loam steepland soil	Typic Orthic Recent Soil	Forestry	Forestry
SOL 000081	Pihama silt loam	Mottled Orthic Allophanic Soil	Dairy	Dairy
SOL 000087	New Plymouth brown loam	Typic Orthic Allophanic Soil	Drystock	Drystock
SOL 000093	Egmont Brown loam	Typic Orthic Allophanic Soil	Dairy	Dairy
SOL 000094	New Plymouth brown loam	Typic Orthic Allophanic Soil	Dairy	Cropping[a] & Dairy
SOL 000095	Egmont Black loam	Typic Orthic Allophanic Soil	Dairy	Dairy
SOL 000110[b]	Hangatahua sandy loam	Acidic Allophanic Brown Soil	Dairy	Dairy
SOL 000123[b]	Patua sandy loam	Typic Orthic Allophanic Soil	Drystock	Drystock
SOL 000128	Kaikarangi silt loam	Typic Recent Gley Soil	Drystock	Drystock
SOL 000133	New Plymouth black silt loam	Typic Orthic Allophanic Soil	Crop/Hort	Crop/Hort
SOL 000146	New Plymouth black loam	Typic Orthic Allophanic Soil	Crop/Hort	Dairy
SOL 000147	Moutoa humic clay	Acid recent Gley Soil	Dairy	Dairy
SOL 000148	Whangamonona complex	Typic Orthic Allophanic Soil	Indigenous	Indigenous
SOL 000149	Tekiri-Punehu association	Typic Perch-Gley Allophanic Soil	Indigenous	Indigenous
SOL 000150	Foxton black sand	Typic Sandy Brown Soil	Dairy	Dairy
SOL 000192	Stratford fine sandy loam	Typic Orthic Allophanic soil	Drystock	Drystock
SOL 010012	Kairanga silt loam and clay loam	Typic Orthic Gley Soil	Drystock/ Dairy	Drystock

[a]Maize crop present in the paddock adjacent to the sampling site. Site treated predominately as dairy.

[b]National Soils Database (NSD) sites – SOL000110 is NSD site SB09318 and SOL000123 is NSD site SB10086.

3 Methods

Most of the methodologies have been described in earlier reports (Sparling et al. 2001a, b; Sparling & Stevenson 2008; Stevenson & Laubscher 2018) so only brief details are given here. Table 2 gives a summary of the soil indicators analysed, and the analytical methods.

3.1 Soil sampling

Taranaki Regional Council field staff collected soil samples during late 2022. Steel rings (10 cm diameter × 7.5 cm depth) were supplied to TRC staff to collect intact cores for soil physical measurements. Composite soil chemistry samples of 2.5 cm diameter were collected every 2 m along a 50 m transect at a 0–10 cm soil depth. The soil samples for chemical characteristics (except cadmium (Cd)) and biological analyses were analysed at Manaaki Whenua – Landcare Research's Environmental Chemistry Laboratory at Palmerston North. Samples for total cadmium were sent to Hill Laboratories for analysis. Soil physical analyses were completed at Manaaki Whenua –Landcare Research's Soil Physics Laboratory in Hamilton. Where necessary, samples were stored at 5°C.

3.2 Soil quality measurements and assessment

Seven primary soil properties were measured to assess soil quality (Table 2). Chemical and biochemical characteristics were assessed using total carbon (TC), total nitrogen (TN), anaerobically mineralisable N (AMN), Olsen P, and soil pH.

Soil physical condition was assessed from the dry bulk density (BD), and air-filled porosity (measured using –10 kPa tension, which can be referred to as macroporosity at –10 kPa). Macroporosity (measured using –5 kPa tension) is also included in this report, as sometimes in earlier samplings only –5 kPa was measured (i.e. not –10 kPa). Macroporosity (when measured using –5 kPa tension) was not formally assessed in this report, as the Land Monitoring Forum (LMF) only uses the measurement to mean macroporosity at –10 kPa (Hill & Sparling 2009).

Additional measurements for soil biological functioning were made for soil microbial biomass carbon (C) and soil respiration. Soil cadmium was analysed as total and bioavailable Cd fractions. Soil microbial biomass carbon, soil respiration, and bioavailable Cd were not assessed as part of this report as there are no recommendations for targets or guidelines for these indicators in New Zealand.

3.3 Analyses

3.3.1 Chemical and biochemical properties

Total C and N were determined by dry combustion of air-dried, finely ground soils using a Leco 2000 CNS analyser (LECO Corporation, St. Joseph, USA). Olsen P concentration was determined by extracting <2 mm air-dry soils for 30 min with 0.5 M $NaHCO_3$ at pH 8.5 (Olsen et al. 1954) and measuring the PO_4^{3-} concentration by the molybdenum blue method. Soil pH was measured in water using glass electrodes and a 1:2.5 soil-to-water ratio (Blakemore et al. 1987). Anaerobically mineralisable N (AMN) was estimated by the anaerobic (waterlogged) incubation method; the increase in inorganic N concentration (expressed as NH_4^+ under anaerobic conditions) was measured after incubation for 7 days at 40°C and extraction in 2M KCl (Keeney & Bremner 1966).

Table 2. Indicators used for soil quality.

Indicators	Soil Quality Information	Method
Chemical properties		
Total C content	Organic matter status	Dry combustion, CHN Analyser
Total N content	Approximates organic N reserves (the vast majority of N in the soil)	Dry combustion, CHN Analyser
Anaerobically mineralisable N (AMN)	Organic N that can be readily mineralised to a plant available form	Waterlogged incubation at 40°C for 7 days
pH	Acidity or alkalinity	Glass electrode pH meter, 1:2.5 in water
Olsen P	Plant available phosphate	Bicarbonate extraction, molybdenum blue method
Biological properties		
Microbial biomass C	Biomass of living microbes in soil	Fumigation-extraction
Soil respiration	Total respiratory activity of aerobic soil microorganisms	CO2-efflux in confined chamber
Physical properties		
Dry bulk density	Compaction, volumetric conversions	Intact soil cores
Air filled porosity (–10 kPa tension), which can be referred to as macroporosity[a]	Soil compaction, root environment, aeration	Pressure plates (–10 kPa tension)
Macroporosity (–5 kPa tension)[a]	Soil compaction, root environment, aeration	Pressure plates (–5 kPa tension)

[a] Air-filled porosity (measured using –10 kPa tension, can be referred to as macroporosity at –10 kPa, including by the Land Monitoring Forum). Note that macroporosity (measured using –5 kPa tension) is also included in this report.

As additional analyses, total available Cd was analysed after a nitric/hydrochloric acid digest (US EPA method 200.2), and bioavailable Cd from a 0.01 M calcium nitrate extraction (McLaren et al. 2005). Extractions were performed at the MWLR laboratory, but samples were analysed by ICP-MS at Hill Laboratories. According to Stevenson and Laubscher (2008), total Cd analyses for previous reports (pre-2007) had used slightly different extraction methods (i.e. nitric acid/peroxide digest; Kovacs et al. 2000), but in consultation with TRC, it was decided at that time, to use the standard US EPA method as that is the mostly widely used method internationally.

3.3.2 Physical properties

Macroporosity and air-filled porosity were determined by drainage on pressure plates at – 5 and –10 kPa respectively (Klute 1986). For comparison with the 2017 resampled sites, the air-filled porosity measurement was used. For comparison of those sites over time, the –5 kPa macroporosity measurement was also used because the –10 kPa air-filled porosity measurement was not calculated for samples from 1998 to 2000. Dry bulk density was measured on a subsampled core dried at 105°C (Klute 1986). Air-filled porosity was calculated as described by Klute (1986). Further method details are available on the MWLR website (Manaaki Whenua Landcare Research 2023a, 2023b).

3.4 Statistics and data presentation

Soil quality data were expressed on a weight/weight (gravimetric) basis for chemistry and biochemistry indicators, or as presented by the laboratory. Gravimetric reporting was preferred because the original target values were expressed on a gravimetric basis. In addition, changes over time can often be more easily observed in gravimetric data because changes in bulk density can either amplify or dampen changes. This issue is discussed further in Drewry et al. (2021).

Sampling data from before 2022 was available from the MWLR archives. We noticed an error in archived data for one sampling, so we checked the data for 2017, 2012, 2007, against our original MWLR laboratory results' reports and used the original MWLR laboratory results in the analysis for this report. The original MWLR laboratory results sheets for those dates also had additional data that we also used in this report. Laboratory data for checking pre-2007 results were not available.

The soil quality indicators for the current 2022 sampling were compared with target values derived for specific land use and soil orders from the LMF, and subsequent reports. Target values are presented in Appendix 3 as Table A3.1. Of the 20 monitoring sites, we have excluded the two 'indigenous vegetation' sites from that component of the assessment as soil quality target values are not available for this land use. So, there were 18 sites assessed against targets.

For the temporal analysis, a Generalised Additive Model (GAM) was applied to each soil indicator, with a random effect for each site and a fixed effect for the number of 52-week-long years since the beginning of 2009. The year 2009 was used as a convenient reference point because more soil indicators were available from then, but dates can be earlier than this. All models except that for pH have the response modelled as a Gamma with a log transformation. The probability value for the trend analysis is for a null hypothesis of a temporal trend different from zero (positive or negative). Small values ($P < 0.05$) provide evidence that that the true temporal trend is different from zero.

For each soil indicator, the values for the sampling years 2017 and 2022 were compared by carrying out an unpaired *t*-test using the null hypothesis that the values in each year were the same. The P value from this unpaired *t*-test is for a null hypothesis of a mean difference different from zero. Small values ($P < 0.05$) provide evidence that that the true difference between 2017 and 2022 values is different from zero; in other words, that the values for 2017 and 2022 are different.

Note that the *t*-test and temporal analysis did not consider the removal of any outliers. There are some outliers for specific dates and properties, and they are potential candidates for pruning. However, removing outliers should only be considered if the value is considered anomalous after a careful inspection of the values.

For calculations, where samples were below detection limit, half the detection limit was used. The statistical analysis was conducted using R version 4.2.0 (R Core Team 2022).

4 Results

4.1 2022 sampling compared with targets or guidelines

Results from the 2022 sampling laboratory analyses are presented in Tables 3, 4 and 5. Detailed soil quality laboratory results are presented in Appendices 1 and 2.

Results for each soil quality indicator are compared against the suggested target ranges reported in Hill and Sparling (2009) if available, or with more recent targets presented in Appendix 3. For example, AMN targets were adapted from the LMF manual (Hill & Sparling 2009) using information from Mackay et al. (2013) and as discussed in Cavanagh et al. (unpubl. data). Further information on targets including Olsen P is shown in Table A3.1 in Appendix 3. 'Indigenous vegetation' sites are not included in the target value assessments, so there were only 18 sites assessed against targets.

Across the region, for all the physical, chemical, and total Cd soil quality indicators, 2 sites (SOL 000076 & SOL 000150) out of 18 sites in the target value assessment (11%) had all soil indicators within the soil and/or the land use target range (Tables 3 and 4).

There were 11 out of 18 sites that were assessed (61%) that had two or more soil physical and chemical indicators (i.e. excluding total Cd) that did not meet the soil and/or the land use target range (Table 3).

When total Cd was also included, there were 12 out of 18 sites assessed (67%) that had two or more soil physical, chemical and total Cd indicators) that did not meet the soil and/or the land use target range (Tables 3 and 4). When total Cd was also included, there were five out of 18 sites in the target value assessment (28%) had three or more soil physical, chemical, and total Cd indicators that did not meet the soil and/or the land use target range (Tables 3 and 4). These five sites were all under dairy land use and consisted of three Allophanic, one Gley and one Brown soil. The sites with the most soil indicators outside target ranges were SOL 000094 and SOL 000095.

The soil indicators total N, Olsen P and total Cd that were outside target ranges/guidelines were, except for one, all above the recommended maximum for the soil and/or the land use. Air-filled porosity (macroporosity –10 kPa) values were outside target ranges for 11 out of 18 sites (61%). In all 11 instances, the values were below the soil and/or the land use target range. Similar to the 2017 sampling, site SOL 000087 had a lower pH than the recommend target range. This was the only site with a pH value outside the recommended target range.

Four sites (SOL 000123, SOL 000094, SOL 000095, & SOL 000081) out of the 18 assessed against targets (22%) had total Cd values above the Tiered Fertiliser Management System (TFMS; see section 5.1) Tier 1 trigger value (0.6 mg kg^{-1}) but below the Tier 2 trigger value (1.0 mg kg^{-1}). Sites under forestry had the lowest total Cd values (<0.10 mg kg^{-1}). Despite being below the Tier 1 trigger value, several sites (SOL 000093, SOL 000110, SOL 000146 & SOL 000147) were above 0.5 mg kg^{-1}, and nearing the Tier 1 trigger value.

The results for soil respiration and microbial biomass were not assessed against targets or guidelines (Table 5).

Table 3. Key soil quality chemical, biochemical and physical characteristics of TRC soils sampled in 2022. Items in orange are below the target range, and blue above the target range. 'Indigenous vegetation' sites are not included in the target value assessments, so there were only 18 sites assessed against targets.

TRC code	Soil Order	Land use	pH	Total C (%)	Total N (%)	AMN (mg kg^{-1})	Olsen P (mg kg^{-1})	Bulk density (t/m^{-3})	Air-filled porosity (i.e. macroporosity) (–10kPa) (%, v/v)
SOL 000067	Allophanic	Market Garden	5.6	6.1	0.55	148	122	0.88	10.4
SOL 000076	Allophanic	Forestry	5.4	8.6	0.59	154	6	0.78	21.5
SOL 000077	Allophanic	Forestry	5.0	14.5	0.96	159	5	0.49	29.4
SOL 000078[a]	Recent	Forestry	5.2	7.6	0.42	73	4	0.76	23.7
SOL 000081	Allophanic	Dairy	6.1	13.4	1.29	203	32	0.57	8.9
SOL 000087[a]	Allophanic	Drystock	4.9	4.1	0.37	108	20	1.07	5.5
SOL 000093	Allophanic	Dairy	6.0	10.1	0.99	196	57	0.67	15.1
SOL 000094	Allophanic	Cropping & Dairy	5.6	9.1	0.99	182	78	0.93	4.8
SOL 000095	Allophanic	Dairy	6.0	9.7	0.97	219	51	0.85	5.2
SOL 000110	Brown	Dairy	5.6	8.2	0.73	171	62	0.80	7.4
SOL 000123	Allophanic	Drystock	5.5	15.1	1.16	305	29	0.51	12.0
SOL 000128	Gley	Drystock	5.0	5.0	0.52	155	57	0.86	3.3
SOL 000133	Allophanic	Crop/Hort	6.6	7.6	0.73	57	88	0.95	6.6
SOL 000146	Allophanic	Dairy	5.8	9.2	0.92	173	41	0.86	4.9
SOL 000147	Gley	Dairy	5.6	17.3	1.12	163	63	0.71	4.3
SOL 000148[a]	Allophanic	Indigenous	5.9	10.7	0.88	263	8	0.56	21.6
SOL 000149	Allophanic	Indigenous	5.8	18.5	1.35	443	6	0.33	29.4
SOL 000150	Brown	Dairy	6.0	3.4	0.32	104	33	1.27	27.8
SOL 000192[a]	Allophanic	Drystock	5.5	5.4	0.49	119	94	0.99	6.4
SOL 010012	Gley	Drystock	5.4	4.7	0.48	133	27	0.87	9.6

[a]Land classified as hill country – Olsen P (hill country) indicator value used for assessing the non-indigenous vegetation site where applicable.

Units: µg g^{-1} used in some earlier reports are equivalent to mg kg^{-1}.

Table 4. Total and bioavailable cadmium (Cd) from sites sampled in 2022. Items in blue are above the Tier 1 trigger value for total Cd (0.6 mg kg^{-1}).

TRC Code	Land use	Total Cd (mg kg^{-1})	Bio-available Cd (mg kg^{-1})
SOL 000067	Market Garden	0.26	0.015
SOL 000076	Forestry	0.08	<0.006
SOL 000077	Forestry	0.07	0.007
SOL 000078	Forestry	0.05	<0.006
SOL 000081	Dairy	0.85	0.006
SOL 000087	Drystock	0.16	0.028
SOL 000093	Dairy	0.56	0.009
SOL 000094	Cropping & Dairy	0.69	0.013
SOL 000095	Dairy	0.70	<0.006
SOL 000110	Dairy	0.55	0.015
SOL 000123	Drystock	0.62	0.017
SOL 000128	Drystock	0.31	0.031
SOL 000133	Crop/Hort	0.57	<0.006
SOL 000146	Dairy	0.52	<0.006
SOL 000147	Dairy	0.58	0.014
SOL 000148	Indigenous	0.16	<0.006
SOL 000149	Indigenous	0.17	<0.006
SOL 000150	Dairy	0.07	<0.006
SOL 000192	Drystock	0.30	0.012
SOL 010012	Drystock	0.16	0.008

Table 5. Soil respiration and microbial biomass on a gravimetric basis for TRC soils sampled in 2022.

TRC code	Land Use	Microbial biomass C (mg kg^{-1})	Basal respiration (μgC g^{-1} h^{-1})
SOL 000067	Market Garden	375	1.51
SOL 000076	Forestry	735	1.16
SOL 000077	Forestry	924	2.23
SOL 000078	Forestry	514	0.73
SOL 000081	Dairy	1479	3.39
SOL 000087	Drystock	503	0.72
SOL 000093	Dairy	1509	2.36
SOL 000094	Cropping & Dairy	847	1.49
SOL 000095	Dairy	999	2.35
SOL 000110	Dairy	870	1.99
SOL 000123	Drystock	1795	2.82
SOL 000128	Drystock	1193	1.84
SOL 000133	Crop/Hort	261	0.43
SOL 000146	Dairy	408	1.26
SOL 000147	Dairy	652	1.91
SOL 000148	Indigenous	990	2.49
SOL 000149	Indigenous	1726	4.66
SOL 000150	Dairy	393	1.21
SOL 000192	Drystock	706	1.04
SOL 010012	Drystock	897	1.43

4.2 2022 sampling compared with 2017 sampling

Table 6 shows a summary of the comparison between 2017 and 2022 values. It is important to note that the differences include all values available for 2017 and 2022, and the comparison is unpaired between samples at sites.

For most properties in Table 6, there was no evidence to suggest that the values from 2017 and 2022 were different (i.e. $P > 0.05$). Mean microbial biomass and basal respiration were the only two soil indicators with a $P < 0.05$, suggesting a statistically significant difference between 2017 and 2022 samplings for those parameters.

Table 6. Comparison of 2017 and 2022 values. The *P* value is for a null hypothesis of a mean difference different from zero. SD is standard deviation. Note: Summary analysis does not have any outliers removed.

Soil indicator	Mean (2017)	SD (2017)	Mean (2022)	SD (2022)	*P* value
Total Cd (mg kg^{-1})	0.40	0.289	0.37	0.256	0.72
Bioavailable Cd (mg kg^{-1})	0.01	0.008	0.01	0.008	0.62
Total C (%)	9.8	3.699	9.4	4.381	0.80
Total N (%)	0.82	0.262	0.79	0.316	0.79
AMN (mg kg^{-1})	182	83.42	176	85.88	0.83
pH	5.47	0.399	5.62	0.424	0.23
Olsen P (mg kg^{-1})	50	43.23	44	33.57	0.63
Microbial biomass C (mg kg^{-1})	1553	748.4	889	453.8	<0.05
Basal respiration (μgC g^{-1} h^{-1})	1.13	0.508	1.85	1.005	<0.05
Bulk density (t/m^3)	0.72	0.200	0.78	0.243	0.33
Air-filled porosity (i.e. macroporosity –10 kPa) (%, v/v)	12.4	9.501	12.9	9.624	0.83
Macroporosity (–5 kPa, %, v/v)	8.9	8.493	9.5	8.512	0.76

4.3 Statistical trends across five samplings

Figures 2 to 13 show trend plots of individual soil properties over time. The raw results of the generalised additive model (GAM) statistical temporal analyses can be found in Appendix 4 as Table A4.1, presented in log-transformed units.

There was evidence (Appendix 4 Table A4.1) that the temporal trend across up to five different year samplings was significant ($P < 0.05$) for four indicators: total Cd, AMN, microbial biomass C, and macroporosity (–5 kPa). For all soil properties with a significant temporal trend, the slope was negative, and this is summarised in Table 7. For all the other soil indicators analysed in the GAM, there were no significant temporal trends observed. In Table 7, the estimated median rate of change in the soil indicator value and the rate of change (per year) are in the units of the soil indicator (i.e. not log-transformed as in Table A4.1). These temporal predictions are estimated over all sites as at 31 December 2022, accounting for 52-week years.

Table 7. Summary of models fitted to the Taranaki soil quality data where the rate of change in the soil indicator value is considered highly significant. The SE is the standard of error of the estimate of the median rate of change in the soil indicator value (estimated as at 31 Dec 2022).

Soil indicator	Median rate of change in the soil indicator value (estimated as at 31 Dec 2022)[a]	Standard error	Annual change
Total Cd (mg kg^{-1})	0.30985	0.07621	-0.008311
AMN (mg kg^{-1})	0.00829	0.00138	-0.000071
Microbial biomass C (mg kg^{-1})	8.62876	0.78778	-0.014831
Macroporosity (%, v/v) (–5 kPa)	0.90731	0.11276	-0.001300

[a] Note: Median rate of change in the soil indicator value was estimated over all sites as at 31 December 2022. In all cases, the estimated changes are in the units of the soil indicator (i.e., not log-transformed).

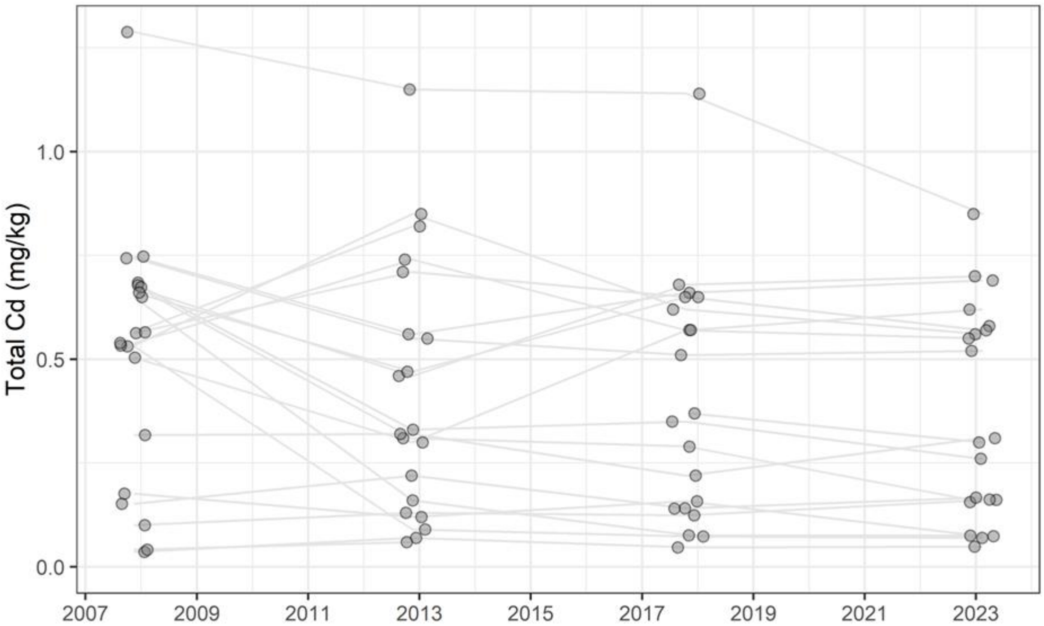

Figure 2. Trends in total Cd (mg kg^{-1}) for the Taranaki region from 2007 to 2022. The markers indicate the values, which are jittered slightly to make their positions clearer. The light grey lines connect points from the same site over time.

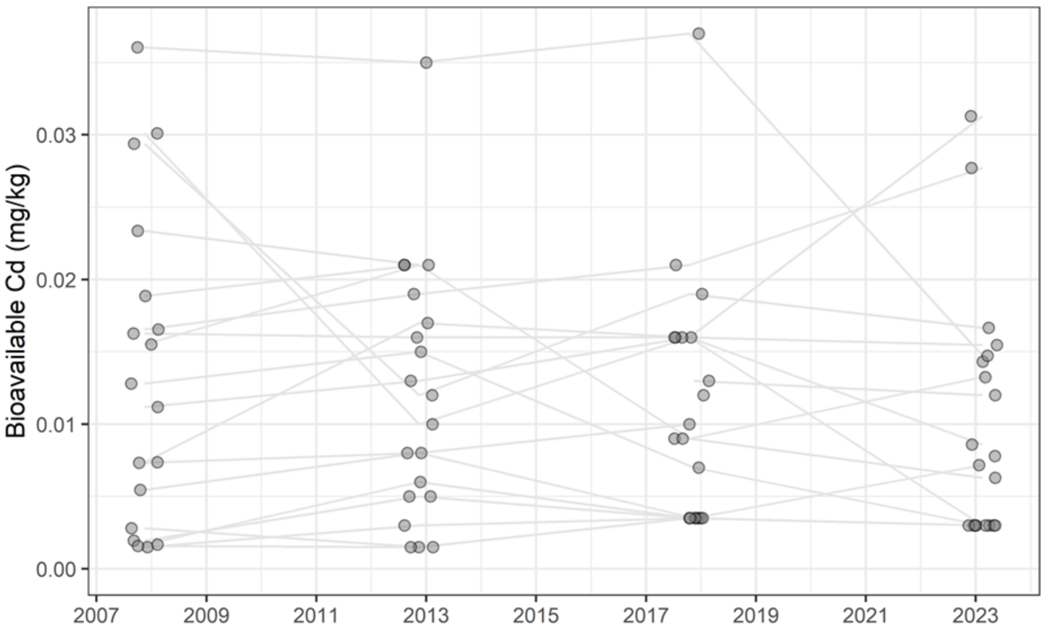

Figure 3. Trends in bioavailable Cd (mg kg^{-1}) for the Taranaki region from 2007 to 2022. The markers indicate the values, which are jittered slightly to make their positions clearer. The light grey lines connect points from the same site over time.

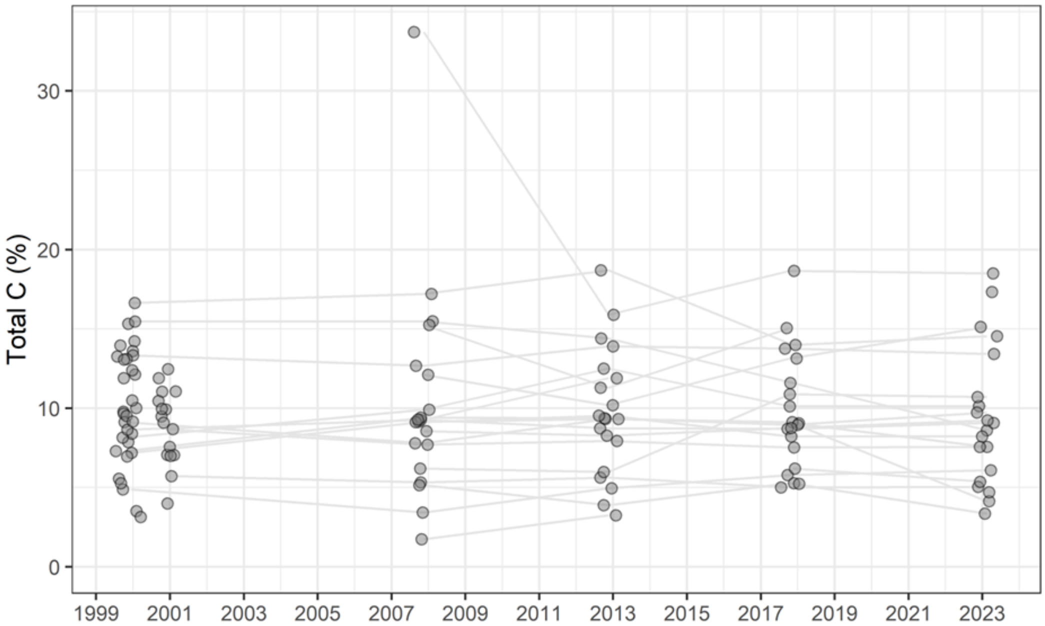

Figure 4. Trends in total carbon (%) for the Taranaki region from 1999 to 2022. The markers indicate the values, which are jittered slightly to make their positions clearer. The light grey lines connect points from the same site over time.

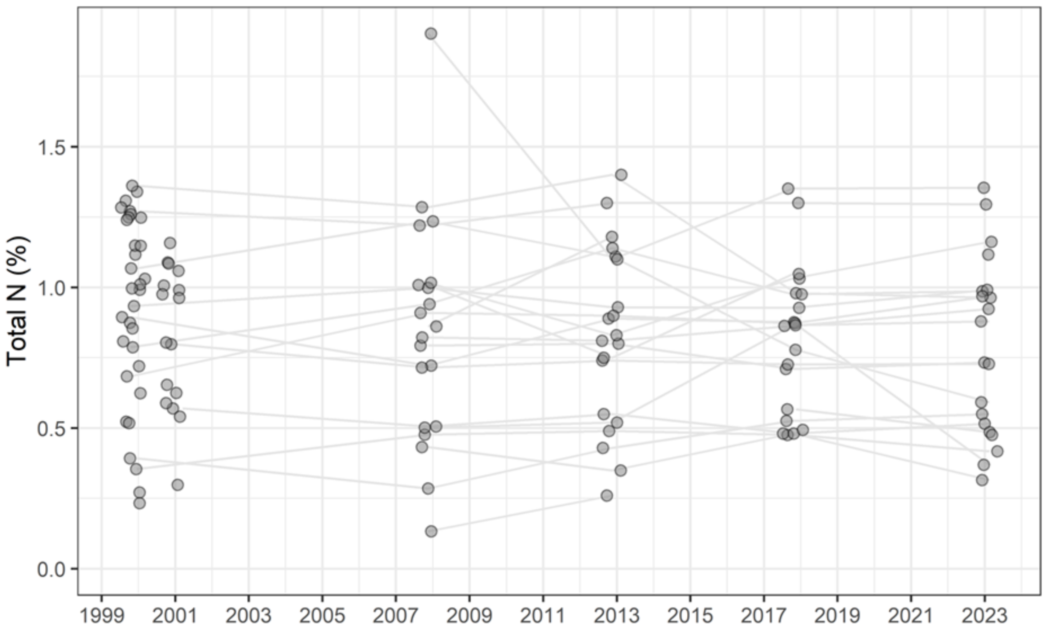

Figure 5. Trends in total nitrogen (%) for the Taranaki region from 1999 to 2022. The markers indicate the values, which are jittered slightly to make their positions clearer. The light grey lines connect points from the same site over time.

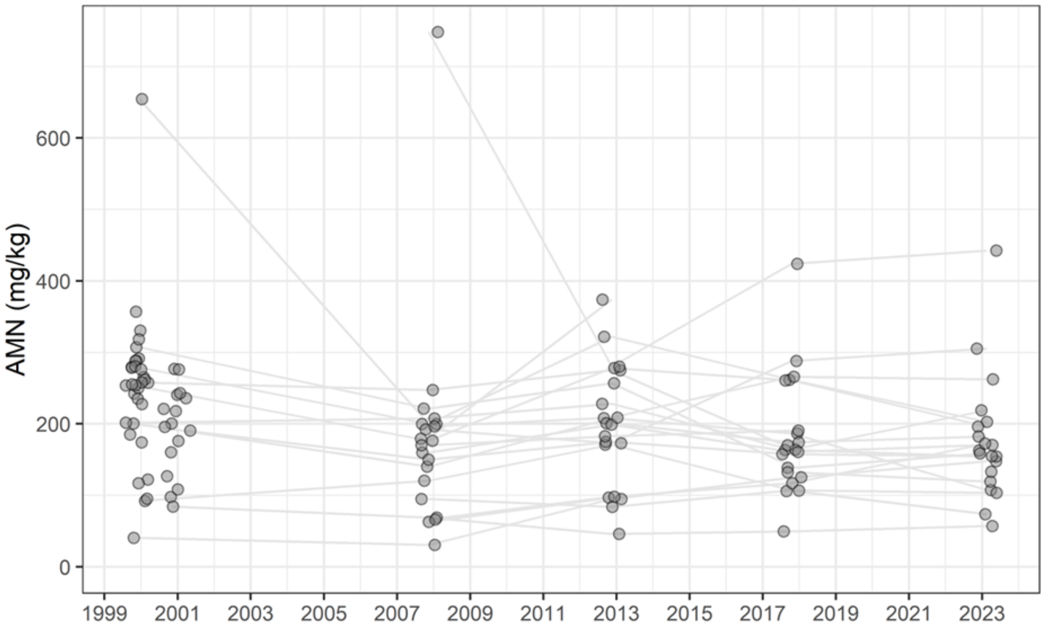

Figure 6. Trends in anaerobically mineralisable nitrogen (mg kg^{-1}) for the Taranaki region from 1999 to 2022. The markers indicate the values, which are jittered slightly to make their positions clearer. The light grey lines connect points from the same site over time.

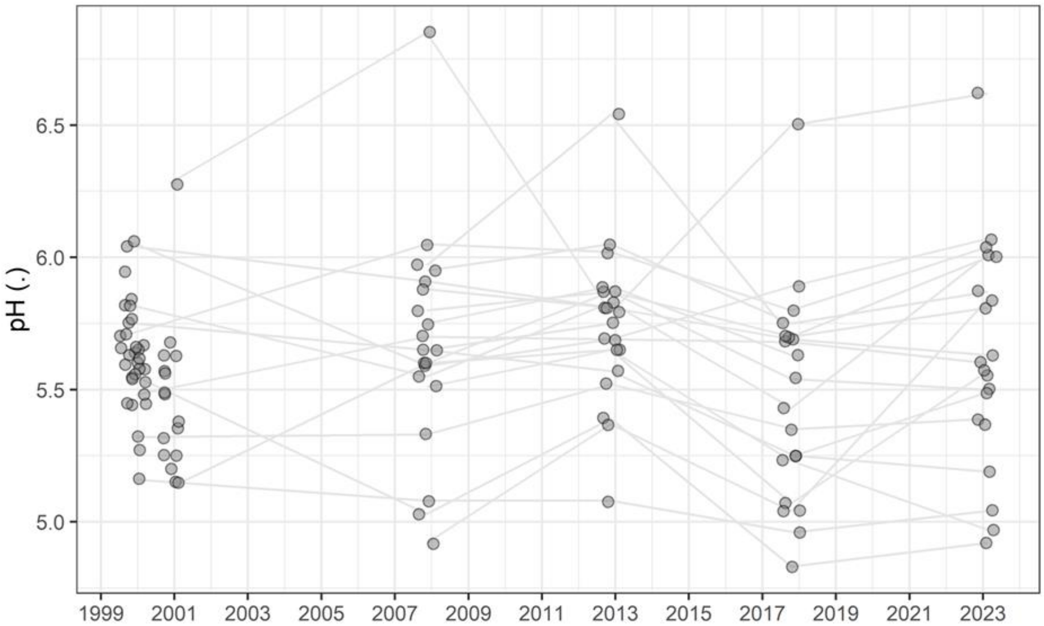

Figure 7. Trends in pH for the Taranaki region from 1999 to 2022. The markers indicate the values, which are jittered slightly to make their positions clearer. The light grey lines connect points from the same site over time.

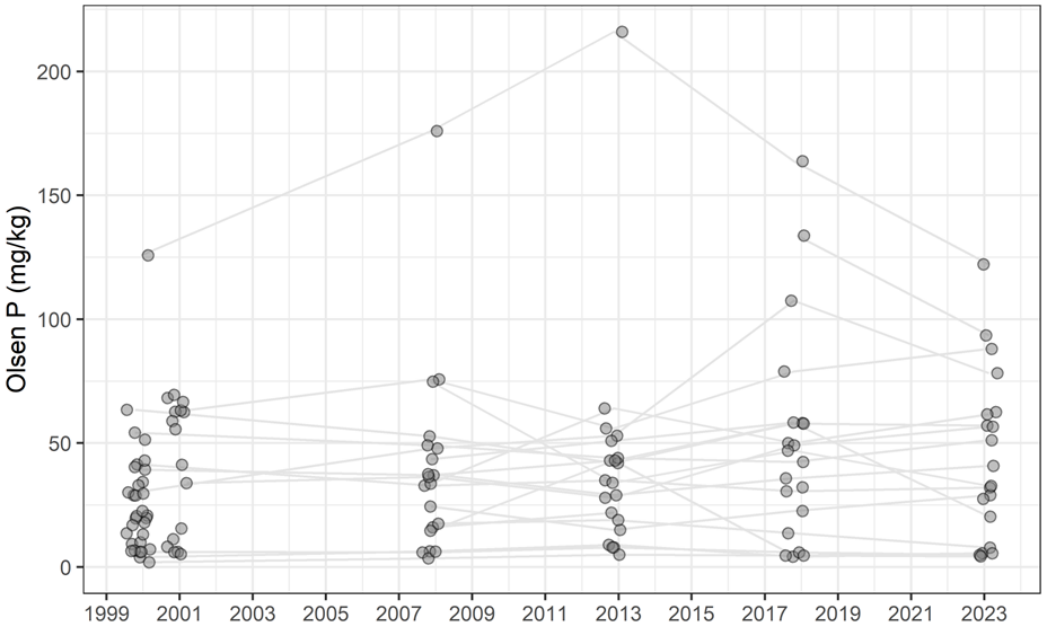

Figure 8. Trends in Olsen P (mg kg^{-1}) for the Taranaki region from 1999 to 2022. The markers indicate the values, which are jittered slightly to make their positions clearer. The light grey lines connect points from the same site over time.

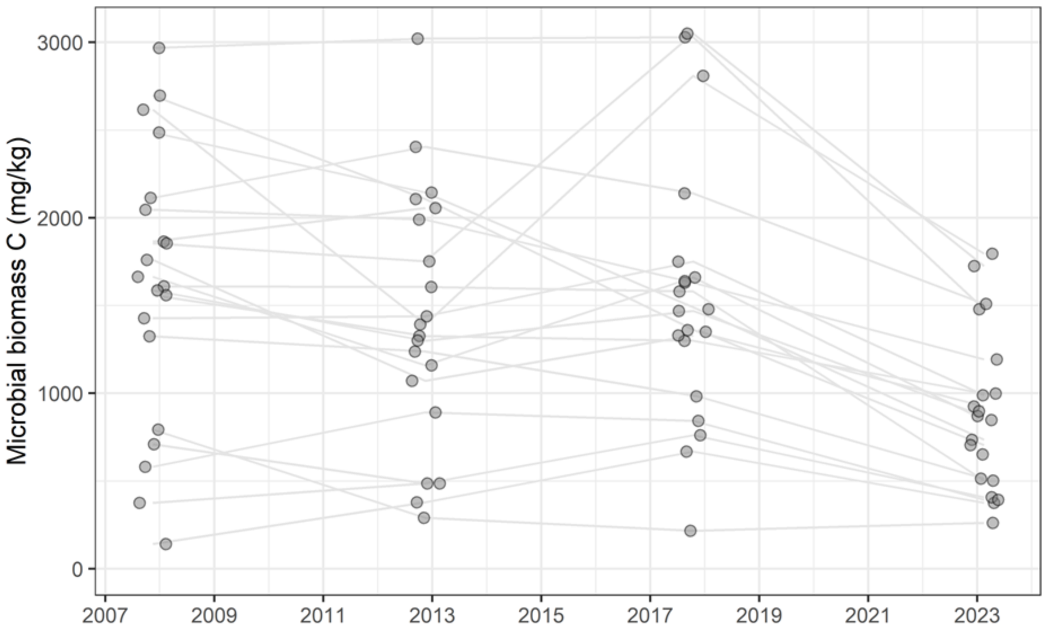

Figure 9. Trends in microbial biomass carbon (mg kg^{-1}) for the Taranaki region from 2007 to 2022. The markers indicate the values, which are jittered slightly to make their positions clearer. The light grey lines connect points from the same site over time.

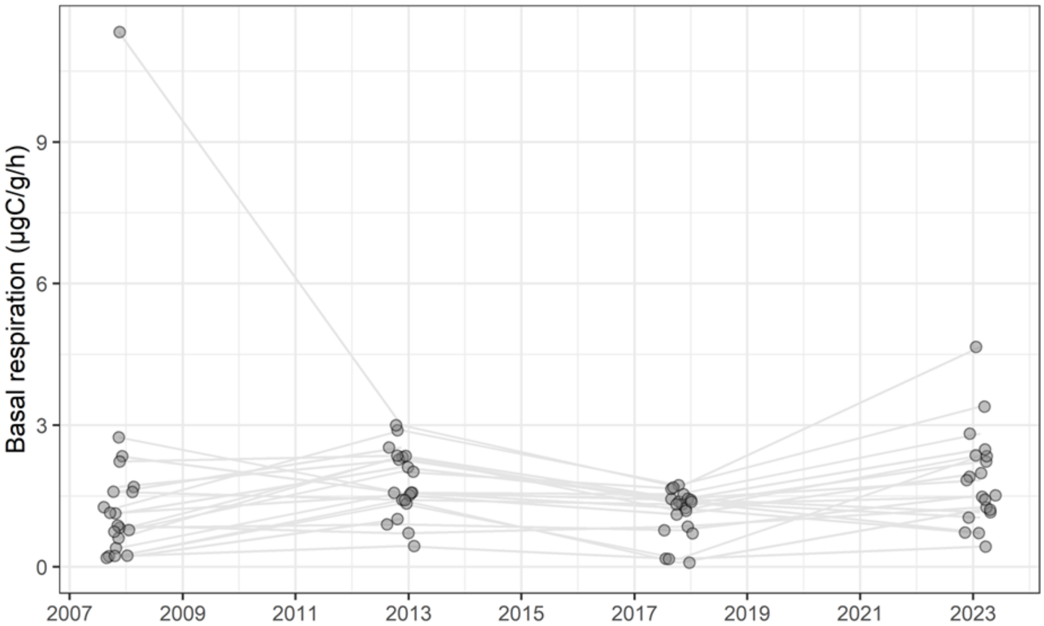

Figure 10. Trends in basal respiration (µgC g^{-1} h^{-1}) for the Taranaki region from 2007 to 2022. The markers indicate the values, which are jittered slightly to make their positions clearer. The light grey lines connect points from the same site over time.

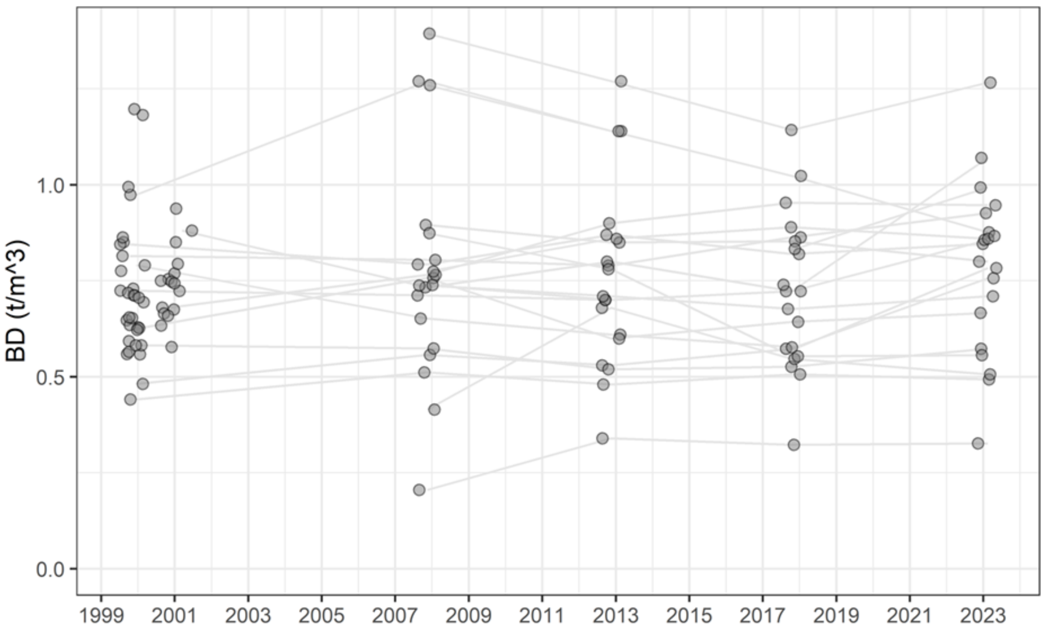

Figure 11. Trends in dry bulk density (t m^{-3}) for the Taranaki region from 1999 to 2022. The markers indicate the values, which are jittered slightly to make their positions clearer. The light grey lines connect points from the same site over time.

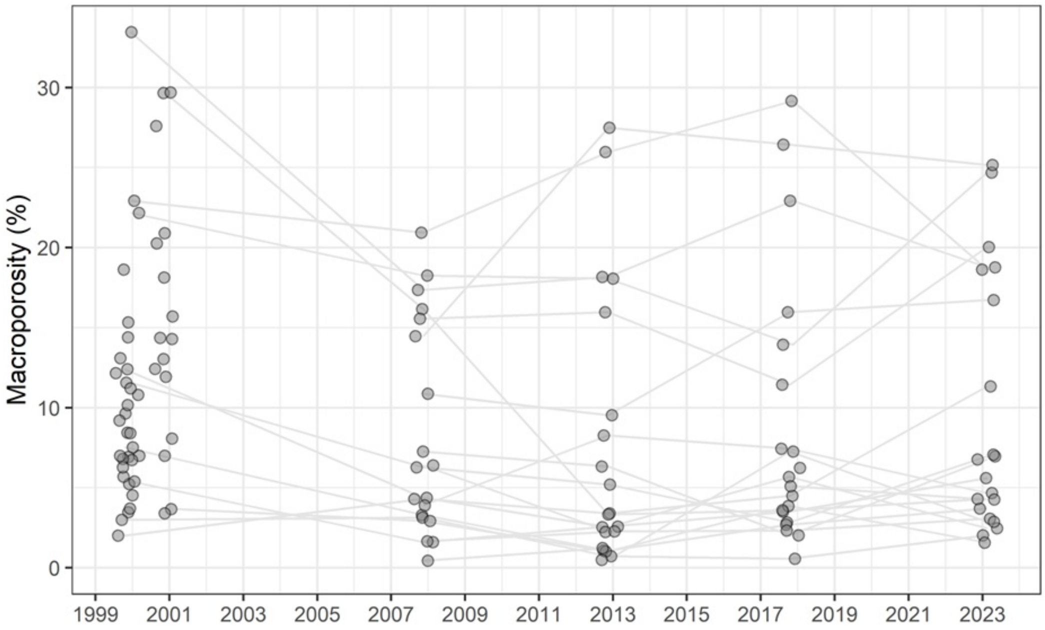

Figure 12. Trends in macroporosity (-5 kPa, %, v/v) for the Taranaki region from 1999 to 2022. The markers indicate the values, which are jittered slightly to make their positions clearer. The light grey lines connect points from the same site over time.

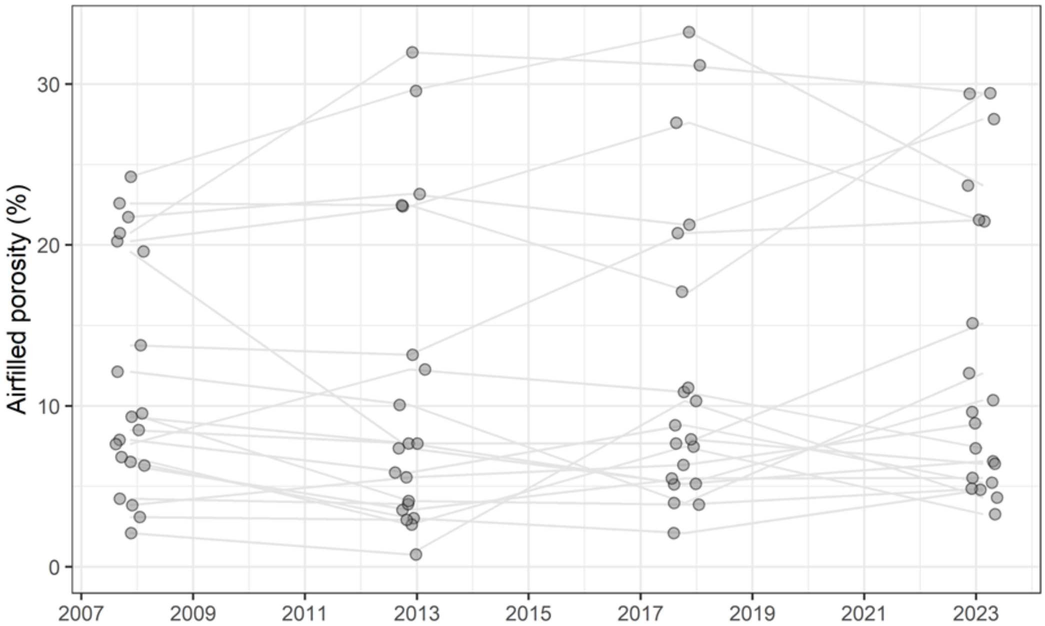

Figure 13. Trends in air-filled porosity (–10 kPa, %, v/v) for the Taranaki region from 2007 to 2022. The markers indicate the values, which are jittered slightly to make their positions clearer. The light grey lines connect points from the same site over time.

5 Discussion

5.1 2022 sampling compared with targets or guidelines

Around New Zealand, national environmental reporting of soil quality data indicates soil issues around macroporosity and high levels of phosphorus and/or nitrogen (Ministry for the Environment & Stats NZ 2021). This is reflected in the current set of land-use and soil quality characteristics for the Taranaki Region.

As observed in previous samplings, Olsen P and total N concentrations were high for many of the sampling sites. Several sites had very high Olsen P – well beyond the soil quality targets in Appendix 3 (Table A3.1), and industry agronomic guidelines (e.g. Roberts & Morton 2009). Excess nutrients can enter nearby waterways or groundwater through leaching or surface runoff and negatively affect water quality. Management practices including appropriate nutrient budgets, soil testing for soil fertility or soil quality, using appropriate fertiliser and effluent application rates and fertiliser types can help minimise the likelihood of occurrences of high nutrient concentrations.

Low macroporosity, as found in this data set, is often the result of soil compaction. Compacted soil contributes issues for restricted drainage, plant growth and overall lower soil health. Low macroporosity as found for most dairy and drystock sites in this data set, is probably the result of high stocking rates, grazing when soil is too wet, and use of heavy machinery etc. (Hu et al. 2021; Ministry for the Environment & Stats NZ 2021). Improving macroporosity can help to improve pasture or crop yield (Drewry et al. 2008). Improving macroporosity can also help reduce high nutrient loads through increased nutrient uptake by plants, and by decreasing nutrient run-off through increased drainage flow.

To improve macroporosity, management techniques should be considered such as using stand-off pads, limiting traffic and stocking on paddocks especially in wet conditions, and the addition of organic matter. Manaaki Whenua – Landcare Research has produced a series of soil health factsheets, for farmers and regional councils etc. including ones advising on management of soil nutrients and reducing the impacts of soil pugging and compaction (see Drewry et al. 2022a, 2022b).

The 'Tiered Fertiliser Management System' has five cadmium level tiers, with Tier 0 representing soil Cd that lie within the range of natural background levels. The Tier 1 soil 'trigger' value is 0.6 mg Cd/kg soil (Fertiliser Association 2019). Above the value of 0.6 mg Cd/kg, more active management of soil cadmium loading from phosphate fertilisers is introduced. The soil 'trigger' values for Tiers 1, 2, 3 and 4: are 0.6, 1.0, 1.4 and 1.8 mg Cd/kg soil, respectively, were selected during the TFMS development as key national Cd management values (Fertiliser Association 2019).

Total Cd was above the recommend Tier 1 trigger value (0.6 mg kg^{-1}) for three dairy and one drystock sampling sites. Forestry and indigenous forest soils had the lowest Cd concentrations, suggesting the elevated levels in intensively managed soils have originated from this natural contaminant in phosphate fertiliser. High Cd loads can be caused by the historically high fertiliser application rates to Allophanic soils, and/or from fertilisers with high Cd concentrations (Abraham 2018). The application rate and type of phosphate fertiliser used should be monitored and managed to avoid further soil contamination. Management guidelines and further information for farmers are provided by 'The Tiered Fertiliser Management System' (Fertiliser Association 2019).

As mentioned previously, total Cd was above 0.5 mg kg^{-1} but below the 0.6 mg kg^{-1} trigger value for several sites. One of these sites was under cropping land use (SOL 00133) and another was a dairy site that that was adjacent to land under cropping (SOL 000094). The concentration of Cd at these sites is currently considered to be acceptable. However, they are nearing the Tier 1 trigger value. Higher concentrations of Cd at these sites can have consequences for human and animal health. More information on Cd in the cropping sector and some educational resources can be found on the Ministry for Primary Industries website (Ministry for Primary Industries 2023).

5.2 2022 sampling compared with 2017 sampling

The comparison between the 2022 and 2017 samplings concluded that, with the exception of microbial biomass C and basal respiration, there was no evidence that the samplings were statistically different. This suggests that some indicators tend to have high variability, (as evidenced by the large standard deviations in Table 6), or little has changed in the last five years, or that any implemented management practices have not changed the key soil indicators between these sampling dates.

5.3 Statistical trends across five samplings

There was evidence that the temporal trend across the five samplings was significant for Total Cd, AMN, microbial biomass C, and macroporosity (–5 kPa), and that the slope was negative, indicating a reduction in the soil quality indicators. However, from the results (Table 7), the annual rate of change is quite small.

A reduction in Total Cd over the five samplings is likely to be beneficial to soil quality. It could indicate changes in practices such as reducing the amount of phosphate fertiliser applied, efforts by industry to reduce Cd content in fertiliser products, or a combination of these – as explained in Abraham (2018). However, there was no evidence in our trend analysis that Olsen P concentrations had reduced or increased over the five samplings. There can be other sources of P which may increase soil P concentrations, such as supplements and effluent, not just applied fertiliser.

For macroporosity (–5 kPa), a reduction suggests that overall soil compaction is still occurring, with soil quality declining. It also suggests it is not being ameliorated by natural processes that can occur such as through plant root and soil fauna activity, soil cracking and drying etc (e.g. Drewry et al. 2004).

5.4 General discussion

During preparation of this report, it became unclear whether several newer sites added by TRC had had soil classification and soil profile descriptions conducted by an experienced pedologist. If this has not been done for newer sites (i.e. sites added since the 500 Soils Project), we recommend this work be undertaken, possibly in association with future S-map mapping work. Earlier sites established around 2000 (such as in the 500 Soils Project) have soil profile descriptions available in Sparling & Stevenson (2008) and Sparling et al. (2001b).

Several measurements made including bioavailable Cd and basal respiration, are not generally undertaken by other councils in the LMF, and are not recommended in the National Environmental Monitoring Standards (NEMS 2022). Taranaki Regional Council staff may wish to consider if these should be discontinued, possibly in favour of other more relevant soil quality indicators being used by more councils, e.g. hot water carbon.

6 Conclusions

Our overall conclusions from our analysis are listed below.

- Several soil indicators showed good soil quality as all sites had total carbon, AMN and bulk density results within the target values; most had pH values within targets. Note that the two ‘indigenous vegetation’ sites were not included in the target assessment.
- The soil quality indicators of concern were total N, Olsen P concentrations, and air-filled porosity (macroporosity (–10kPa)).
- When total Cd was also included, there were five out of 18 sites (28%) which were dairy sites, that had three or more soil physical, chemical, and total Cd indicators that did not meet the soil and/or the land use target range.
- Air-filled porosity (macroporosity –10 kPa) values were below target ranges for many sites, indicating soil compaction is occurring. Olsen P values were higher than targets in half of the sites, with several having very high values, indicating that management to mitigate these high Olsen P concentrations should be encouraged.
- There was no evidence to suggest that the key soil quality values from 2017 and 2022 were different, but microbial biomass C had decreased, while basal respiration increased.
- There was evidence that the temporal trend across five samplings (where available) was significant for total Cd, AMN, microbial biomass C, and macroporosity (–5 kPa), and that the values are reducing. A reduction in total Cd is considered positive for soil quality. A reduction in microbial biomass C and macroporosity is considered a decline in soil quality. The annual rate of change or the four indicators is quite small.

7 Recommendations

We recommend the following to TRC.

- The soil-quality monitoring programme of resampling existing sites continues in order to determine the extent and direction of any changes since originally sampled.
- Taranaki Regional Council considers activities to educate land managers on practices to protect the environment including the current recommendations on reducing Olsen P concentrations and soil compaction.
- If several newer sites added by the council have not had soil classification and soil pit examination for detailed soil descriptions conducted by an experienced pedologist, then this work should be undertaken, possibly in association with future S-map mapping work or preferably as a new project.
- Measurements including microbial biomass C, basal respiration and bioavailable Cd, which are not recommended in the National Environmental Monitoring Standards (NEMS), could be discontinued, possibly in favour of other more relevant soil quality indicators, e.g., hot water carbon.

8 Acknowledgements

Soil physical analyses were completed by the Soil Physics Laboratory, Manaaki Whenua – Landcare Research, Hamilton; soil chemical analyses were completed by the Environmental Chemistry Laboratory, Palmerston North. Emily McKay contributed to the site map and hill country identification. We thank Helen O'Leary for editing and Kate Boardman for formatting the report.

9 References

Abraham E 2018. Cadmium in New Zealand agricultural soils. New Zealand Journal of Agricultural Research 63(2): 202–219.

Blakemore LC, Searle PL, Daly BK 1987. Methods for chemical analysis of soils. New Zealand Soil Bureau Scientific Report No. 80. 103 p.

Cavanagh JE, Harmsworth G 2022. Exploring the implementation of ecological soil guideline values for soil contaminants. Envirolink Grant: 2214-MLDC162 Manaaki Whenua – Landcare Research Contract Report: LC4128. 64 p.

Drewry JJ, Cameron KC, Buchan GD 2008. Pasture yield and soil physical property responses to soil compaction from treading and grazing: a review. Australian Journal of Soil Research 46(3): 237–256.

Drewry JJ, Cavanagh JE, McNeill SJ, Stevenson BA, Gordon DA, Taylor MD 2021. Long-term monitoring of soil quality and trace elements to evaluate land use effects and temporal change in the Wellington region, New Zealand. Geoderma Regional 25(1): e00383. https://doi.org/0.1016/j.geodrs.2021.e00383.

Drewry JJ, Paton RJ, Monaghan RM 2004. Soil compaction and recovery cycle on a Southland dairy farm: implications for soil monitoring. Australian Journal of Soil Research 42(7): 851–856.

Drewry J, Stevenson B, Kannemeyer R. 2022a. Soil health factsheet: reducing compaction & pugging. Manaaki Whenua Landcare Research. Retrieved 28 October 2022 from: https://www.landcareresearch.co.nz/discover-our-research/land/soil-and-ecosystem-health/soil-health-and-resilience/publications/

Drewry J, Stevenson B, Kannemeyer R. 2022b. Soil health factsheet: soil nutrients. Manaaki Whenua Landcare Research. Retrieved 28 October 2022 from: https://www.landcareresearch.co.nz/discover-our-research/land/soil-and-ecosystem-health/soil-health-and-resilience/publications/

Fertiliser Association 2019. Tiered fertiliser management system for soil cadmium. Wellington, Fertiliser Association of New Zealand.13 p.

Hill RB, Sparling GP 2009. Soil quality monitoring. In: Land and soil monitoring: A guide for SoE and regional council reporting. Hamilton, Land Monitoring Forum. Pp. 27–88.

Hu W, Drewry JJ, Beare M, Eger A, Müller K 2021. Compaction-induced soil structural degradation affects productivity and environmental outcomes: a review and New Zealand case study Geoderma 395(1–2): 115035. https://doi.org/10.1016/j.geoderma.2021.115035

Keeney DR, Bremner JM 1966. Comparison and evaluation of laboratory methods of obtaining an index of soil nitrogen availability. Agronomy Journal 58: 498–503.

Klute A 1986. Water retention laboratory methods. In: Klute A ed. Methods of soil analysis Part 1: physical and mineralogical methods. 2nd edn. Madison WI, Soil Science Society of America. Pp. 635–632.

Kovacs B, Prokisch J, Gyori Z, Kovacs AB, Palencsar A 2000. Studies on soil sample preparation for inductively coupled plasma atomic emission spectrometry analysis. Communications in Soil and Plant Analysis 31: 1949–1963.

Mackay, A, Dominati E, Taylor M. 2013. Soil quality indicators: the next generation. AgResearch Client Report RE500/2012/025 prepared for the Land Monitoring Forum. 155 p.

Mackay AD, Simcock R, Sparling GP, Vogler I, Francis G 2006. Macroporosity. Internal SLURI report. Hamilton, AgResearch. 19 p.

Ministry of Agriculture and Forestry 2011. Cadmium and New Zealand agriculture and horticulture: A strategy for long term risk management. A report prepared by the Cadmium Working Group for the Chief Executives Environmental Forum MAF Technical Paper No 2011/02. Wellington, Ministry of Agriculture and Forestry. 27 p.

McLaren RG, Clucas LM, Taylor MD 2005. Leaching of macronutrients and metals from undisturbed soils treated with metal-spiked sewage sludge. 3: Distribution of residual metals. Australian Journal of Soil Research 43: 159–170.

Ministry for the Environment and Stats NZ 2021. Our Land 2021. New Zealand's Environmental Reporting Series Publication number: ME 1555. 61 p.

Ministry for Primary Industries 2023. Cadmium research. Retrieved 14 June 2023 from: https://www.mpi.govt.nz/funding-rural-support/environment-and-natural-resources/land-and-soil-health/cadmium-research/

Manaaki Whenua – Landcare Research 2023a. Laboratory tests. Retrieved 15 February 2023 from: https://www.landcareresearch.co.nz/partner-with-us/laboratories-and-diagnostics/soil-physics-laboratory/laboratory-tests/

Manaaki Whenua – Landcare Research 2023b. Soil testing. Retrieved 15 February 2023 from: https://www.landcareresearch.co.nz/partner-with-us/laboratories-and-diagnostics/environmental-chemistry-laboratory/soil-testing/

NEMS 2022. National Environmental Monitoring Standard. Soil quality and trace elements. Sampling, measuring, and managing soil quality and trace element data. Version 1.0.0. National Environmental Monitoring Standard. Wellington, Ministry for the Environment. 48 p.

Olsen SR, Cole CV, Watanabe FS, Dean LA 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. US Department of Agriculture Circular 939. Washington DC, US Department of Agriculture. 19 p.

Roberts AHC, Morton JD 2009. Fertiliser use on New Zealand dairy farms. Revised edition ed. Auckland, New Zealand Fertiliser Manufacturers' Research Association. 52 p.

R Core Team 2022. R: a language and environment for statistical computing. Version 4.2.0. Vienna, R Foundation for Statistical Computing. https://www.R-project.org/

Sparling GP, Rijkse W, Wilde RH, van der Weerden T, Beare MH, Francis GS 2001a. Implementing soil quality indicators for land: research report for 1999/2000. Landcare Research Contract Report LC0001/059.

Sparling GP, Rijkse W, Wilde RH, van der Weerden T, Beare MH, Francis GS 2001b. Implementing soil quality indicators for land: research report for 2000–2001 and final report for MfE Project Number 5089. Landcare Research Contract Report LC0102/015. 386 p.

Sparling GP, Stevenson BA 2008. Soil quality in Taranaki Region: characteristics of new sites, and current status of previously sampled sites. Landcare Research Contract Report LC0708/096. 64 p.

Stevenson B, Laubscher N. 2018. Soil quality in the Taranaki Region 2017: current status and comparison with previous samplings. Manaaki Whenua – Landcare Research Contract Report: LC3175. 39 p.

Appendix 1 – Soil chemistry and biochemistry data

Environmental Chemistry Laboratory

Analytical Report – Soils

Manaaki Whenua – Landcare Research
Riddet Rd, Massey University Campus,
Private Bag 11052, Palmerston North 4442
Phone: +64 6 353 4800

Manaaki Whenua
Landcare Research

Job number: LJ22049

Date received: 11 & 25 November & 1 December 2022

Customer: John Drewry, Manaaki Whenua – Landcare Research
Private Bag 11052, Palmerston North 4442

Date reported: 5 May 2023

Notes: Field moist soil testing could not be started in the recommended timeframe so results should be used with caution. Samples were stored in the coolstore until analysis could be undertaken.

Samples were dried and ground between the 13th and 20th February 2023.

Total cadmium analyses were subcontracted to Hill Laboratories. 0.01M calcium nitrate extractions were carried out in the EC Lab and extracts sent to Hill Laboratories for analysis.

A lower sample weight was used for M22/5260 for KCl extractable N, anaerobically mineralisable N and basal respiration testing due to the low density of the sample.

N E Foster

Ngaire Foster, Laboratory Manager

The laboratory is accredited by International Accreditation New Zealand. The tests reported herein have been carried out in accordance with its terms of accreditation, except for the tests marked *, which are not accredited. Results are expressed on an oven-dry (105°C) basis unless stated otherwise. Details of method codes are available online at http://www.landcareresearch.co.nz/resources/laboratories/environmental-chemistry-laboratory/services. Results apply to the samples as received, not necessarily the bulk from which they were drawn, as the lab was not responsible for sampling from the bulk. This report may not be reproduced, except in full, without the consent of the signatory.

ACCREDITED IANZ TESTING LABORATORY

Job number: LJ22049

Date reported: 5 May 2023

Manaaki Whenua Landcare Research

Client ID	Sample number	Water content as received (method 104(ii)) (% dry wt)	Estimated water holding capacity (method 104(iii)) (% dry wt)	Air dry soil water content (calculation)* (%)	pH (2:5 water) (method 106(i))	Organic C (method 114) (%)	Total N (method 114) (%)	C/N ratio (calculation)*
Testing start date		16/11/2022	17/11/2022	1/03/2023	24/02/2023	20/02/2023	20/02/2023	
Testing end date		6/12/2022	19/01/2023	2/03/2023	2/03/2023	3/03/2023	3/03/2023	
Accreditation status		accredited	accredited	non-accredited	accredited	accredited	accredited	non-accredited
SOL 000081 Dairy farm	M22/5254	97	191	10.2	6.1	13.4	1.29	10
SOL 000093 Dairy farm	M22/5255	67	152	5.2	6.0	10.1	0.99	10
SOL 000094 Dairy farm	M22/5256	45	112	7.1	5.6	9.07	0.99	9
SOL 000095 Dairy farm	M22/5257	53	125	6.7	6.0	9.72	0.97	10
SOL 000110 Dairy farm	M22/5258	55	120	4.3	5.6	8.22	0.73	11
SOL 000128 Beef pasture	M22/5259	57	126	3.1	5.0	5.04	0.52	10
SOL 000149 Regen forest	M22/5260	185	320	8.3	5.8	18.5	1.35	14
SOL 010012	M22/5261	57	114	3.2	5.4	4.71	0.48	10
SOL 000067 Market garden/horse pasture	M22/5408	63	126	6.8	5.6	6.10	0.55	11
SOL 000123 Lamb pasture	M22/5409	131	184	7.3	5.5	15.1	1.16	13
SOL 000133	M22/5410	55	108	12.5	6.6	7.57	0.73	10
SOL 000146	M22/5411	65	135	13.6	5.8	9.23	0.92	10
SOL 0000147 Dairy farm	M22/5412	83	181	11.2	5.6	17.3	1.12	16
SOL 000150	M22/5413	13	57	1.3	6.0	3.36	0.32	11
SOL 000076 Forestry	M22/5730	88	177	8.5	5.4	8.61	0.59	15
SOL 000077 Forestry	M22/5731	103	220	9.8	5.0	14.5	0.96	15
SOL 000078 Forestry	M22/5732	66	133	5.0	5.2	7.56	0.42	18
SOL 000087 Pasture	M22/5733	57	115	3.3	4.9	4.14	0.37	11
SOL 000148 (Forest (Native)	M22/5734	108	203	5.3	5.9	10.7	0.88	12
SOL 000192 Pasture	M22/5735	52	120	2.9	5.5	5.36	0.49	11

Job number: LJ22049

Date reported: 5 May 2023

Manaaki Whenua Landcare Research

Client ID	Sample number	KCl-extractable NO_3-N (method 118) (mg/kg)	KCl-extractable NH_4-N (method 118) (mg/kg)	Anaerobic mineralisable-N (method 120) (mg/kg)	Olsen P (method 124) (mg/kg)	0.01M $Ca(NO_3)_2$-extractable Cd (method 154)* mg/kg	Microbial biomass carbon (method 174) (mg/kg)	Basal respiration (method 172)* µgC/g/h	Total cadmium (subcontracted) mg/kg
Testing start date		6/12/2022	6/12/2022	6/12/2022	20/03/2023	27/02/2023	23/11/2022	28/11/2022	2/03/2023
Testing end date		16/12/2022	16/12/2022	16/12/2022	21/03/2023	8/03/2023	2/02/2023	16/03/2023	8/03/2023
Accreditation status		accredited	accredited	accredited	accredited	non-accredited	accredited	non-accredited	subcontracted
SOL 000081 Dairy farm	M22/5254	31	2	203	32	0.006	1479	3.39	0.85
SOL 000093 Dairy farm	M22/5255	39	2	196	57	0.009	1509	2.36	0.56
SOL 000094 Dairy farm	M22/5256	80	1	182	78	0.013	847	1.49	0.69
SOL 000095 Dairy farm	M22/5257	40	2	219	51	<0.006	999	2.35	0.70
SOL 000110 Dairy farm	M22/5258	38	2	171	62	0.015	870	1.99	0.55
SOL 000128 Beef pasture	M22/5259	24	13	155	57	0.031	1193	1.84	0.31
SOL 000149 Regen forest	M22/5260	57	2	443	6	<0.006	1726	4.66	0.167
SOL 010012	M22/5261	27	7	133	27	0.008	897	1.43	0.162
SOL 000067 Market garden/horse pasture	M22/5408	4	3	148	122	0.015	375	1.51	0.26
SOL 000123 Lamb pasture	M22/5409	18	16	305	29	0.017	1795	2.82	0.62
SOL 000133	M22/5410	18	0	57	88	<0.006	261	0.43	0.57
SOL 000146	M22/5411	61	1	173	41	<0.006	408	1.26	0.52
SOL 0000147 Dairy farm	M22/5412	19	1	163	63	0.014	652	1.91	0.58
SOL 000150	M22/5413	8	2	104	33	<0.006	393	1.21	0.074
SOL 000076 Forestry	M22/5730	6	2	154	6	<0.006	735	1.16	0.075
SOL 000077 Forestry	M22/5731	7	2	159	5	0.007	924	2.23	0.070
SOL 000078 Forestry	M22/5732	6	33	73	4	<0.006	514	0.73	0.049
SOL 000087 Pasture	M22/5733	8	4	108	20	0.028	503	0.72	0.156
SOL 000148 (Forest (Native)	M22/5734	22	2	263	8	<0.006	990	2.49	0.161
SOL 000192 Pasture	M22/5735	8	3	119	94	0.012	706	1.04	0.30

Appendix 2 – Soil physics data

Moisture Release & Solid/Void Characterisation

Project Name:	Taranaki Regional Council Soil Quality Monitoring 2022
Contact Name:	Brian Levine & Chris Vicars
Job Number:	PRJ959
Date:	06/03/2023

Lab Number	Client ID	Sampled Liner Number	Lab Liner Number	Initial Water Content (%, w/w)	Dry Bulk Density (t/m^3)	Particle Density (t/m^3)	Total Porosity (%, v/v)	Macro Porosity (%, v/v)	Air Filled Porosity (%, v/v)	Vol. WC 5kPa (%, v/v)	Vol. WC 10kPa (%, v/v)
HP10967a	SOL000067 - 0m	1148	900	74.3	0.82	2.59	68.5	6.5	10.0	62.0	58.5
HP10967b	SOL000067 - 25m	1597	901	64.8	0.89	2.60	65.6	6.3	9.5	59.3	56.1
HP10967c	SOL000067 - 50m	1203	902	59.9	0.92	2.58	64.6	8.1	11.6	56.5	53.0
HP10968a	SOL000081 - 0m	1110	903	103.2	0.59	2.29	74.1	5.0	8.5	69.1	65.7
HP10968b	SOL000081 - 25m	1551	904	108.5	0.56	2.28	75.5	7.0	10.4	68.4	65.1
HP10968c	SOL000081 - 50m	1027	905	117.7	0.57	2.24	74.6	4.8	7.9	69.9	66.7
HP10969a	SOL000093 - 0m	1197	906	70.1	0.73	2.36	69.2	9.7	13.9	59.5	55.3
HP10969b	SOL000093 - 24m	1012	907	81.3	0.68	2.34	70.8	8.4	11.4	62.4	59.4
HP10969c	SOL000093 - 50m	1211	908	92.3	0.59	2.39	75.1	15.9	20.1	59.2	55.0
HP10970a	SOL000094 - 0m	1028	909	47.3	0.94	2.41	61.0	2.4	5.1	58.6	56.0
HP10970b	SOL000094 - 25m	1600	910	48.2	0.92	2.41	61.9	1.2	3.8	60.7	58.1
HP10970c	SOL000094 - 50m	1120	911	46.1	0.92	2.46	62.6	2.5	5.5	60.1	57.1

Lab Number	Client ID	Sampled Liner Number	Lab Liner Number	Initial Water Content (%, w/w)	Dry Bulk Density (t/m^3)	Particle Density (t/m^3)	Total Porosity (%, v/v)	Macro Porosity (%, v/v)	Air Filled Porosity (%, v/v)	Vol. WC 5kPa (%, v/v)	Vol. WC 10kPa (%, v/v)
HP10971a	SOL000095 - 0m	1261	912	58.0	0.88	2.45	64.1	2.0	4.1	62.1	60.0
HP10971b	SOL000095 - 25m	1302	913	57.8	0.81	2.39	65.9	2.3	5.9	63.6	60.0
HP10971c	SOL000095 - 50m	1075	914	54.2	0.85	2.45	65.1	3.1	5.7	62.0	59.4
HP10972a	SOL000110 - 0m	1321	915	75.3	0.74	2.41	69.2	7.5	10.9	61.8	58.3
HP10972b	SOL000110 - 25m	1288	916	65.0	0.83	2.40	65.4	6.0	8.7	59.4	56.7
HP10972c	SOL000110 - 50m	1368	917	65.1	0.83	2.40	65.3	< 1	2.5	65.4	62.8
HP10973a	SOL000123 - 0m	1178	918	106.8	0.63	2.28	72.6	4.4	9.1	68.2	63.5
HP10973b	SOL000123 - 25m	1177	919	151.1	0.48	2.22	78.6	7.2	11.6	71.4	67.1
HP10973c	SOL000123 - 50m	1297	920	185.7	0.41	2.08	80.5	8.7	15.4	71.8	65.1
HP10974a	SOL000128 - 0m	1144	921	67.3	0.87	2.50	65.4	< 1	2.3	65.2	63.0
HP10974b	SOL000128 - 25m	1089	922	62.4	0.92	2.56	64.2	2.4	4.5	61.9	59.7
HP10974c	SOL000128 - 50m	1009	923	79.4	0.78	2.46	68.4	1.8	3.0	66.6	65.3
HP10975a	SOL000133 - 0m	1211	924	55.2	0.96	2.55	62.5	4.1	6.7	58.4	55.8
HP10975b	SOL000133 - 25m	1262	925	57.6	0.95	2.54	62.6	3.9	5.7	58.7	56.9
HP10975c	SOL000133 - 50m	1583	926	59.5	0.93	2.55	63.6	4.9	7.3	58.7	56.3
HP10976a	SOL000146 - 0m	1073	927	65.8	0.89	2.46	63.8	2.0	3.8	61.8	60.1
HP10976b	SOL000146 - 25m	1176	928	74.5	0.82	2.44	66.3	2.2	3.5	64.1	62.8
HP10976c	SOL000146 - 50m	1829	929	63.4	0.87	2.43	64.2	5.0	7.3	59.2	56.8
HP10977a	SOL000147 - 0m	1828	930	87.7	0.73	2.21	66.9	< 1	1.5	66.6	65.4
HP10977b	SOL000147 - 25m	1252	931	91.4	0.69	2.14	67.8	2.1	3.4	65.6	64.4
HP10977c	SOL000147 - 50m	1295	932	76.9	0.71	2.18	67.4	6.0	8.0	61.5	59.4

Lab Number	Client ID	Sampled Liner Number	Lab Liner Number	Initial Water Content (%, w/w)	Dry Bulk Density (t/m^3)	Particle Density (t/m^3)	Total Porosity (%, v/v)	Macro Porosity (%, v/v)	Air Filled Porosity (%, v/v)	Vol. WC 5kPa (%, v/v)	Vol. WC 10kPa (%, v/v)
HP10978a	SOL000148 - 0m	1182	933	82.9	0.57	2.44	76.8	22.0	26.9	54.8	49.9
HP10978b	SOL000148 - 25m	1528	934	94.1	0.53	2.42	78.2	22.4	27.0	55.8	51.2
HP10978c	SOL000148 - 50m	1163	935	127.8	0.57	2.52	77.2	5.8	10.8	71.5	66.5
HP10979a	SOL000149 - 0m	1334	936	154.6	0.37	2.30	84.1	28.5	33.0	55.7	51.1
HP10979b	SOL000149 - 25m	1066	937	231.0	0.28	2.32	87.8	23.3	27.7	64.5	60.1
HP10979c	SOL000149 - 50m	1017	938	184.2	0.33	2.29	85.6	23.7	27.6	61.9	58.0
HP10980a	SOL000150 - 0m	1395	939	12.8	1.29	2.98	56.8	18.3	26.5	38.4	30.3
HP10980b	SOL000150 - 25m	1523	940	9.3	1.41	3.09	54.4	28.5	35.1	25.9	19.3
HP10980c	SOL000150 - 50m	1356	941	21.6	1.10	2.84	61.3	13.3	21.9	48.0	39.4
HP10981a	SOL010012	1592	942	76.2	0.74	2.53	70.6	9.3	12.4	61.3	58.2
HP10981b	SOL010012	1630	943	44.4	1.08	2.59	58.1	5.5	7.6	52.6	50.5
HP10981c	SOL010012	1232	944	77.2	0.78	2.50	69.0	6.4	8.9	62.6	60.0
HP10982a	SOL000076 - 0m	1602	945	35.6	1.12	2.70	58.4	15.9	18.2	42.5	40.2
HP10982b	SOL000076 - 25m	1065	946	84.1	0.62	2.51	75.2	19.4	22.6	55.8	52.6
HP10982c	SOL000076 - 50m	1199	947	85.6	0.61	2.46	75.1	21.0	23.6	54.1	51.4
HP10983a	SOL000077 - 0m	1539	948	94.0	0.54	2.45	78.0	27.4	32.6	50.5	45.4
HP10983b	SOL000077 - 25m	1029	949	113.1	0.52	2.26	77.1	16.3	19.7	60.8	57.3
HP10983c	SOL000077 - 50m	1006	950	101.8	0.42	2.13	80.3	30.4	35.9	49.9	44.4
HP10984a	SOL000078 - 0m	1115	951	101.9	0.57	2.40	76.3	14.1	21.4	62.2	54.9
HP10984b	SOL000078 - 25m	1614	953	69.4	0.64	2.42	73.7	25.7	29.9	48.0	43.8
HP10984c	SOL000078 - 50m	1405	954	38.3	1.06	2.60	59.4	16.1	19.8	43.2	39.6

Lab Number	Client ID	Sampled Liner Number	Lab Liner Number	Initial Water Content (%, w/w)	Dry Bulk Density (t/m^3)	Particle Density (t/m^3)	Total Porosity (%, v/v)	Macro Porosity (%, v/v)	Air Filled Porosity (%, v/v)	Vol. WC 5kPa (%, v/v)	Vol. WC 10kPa (%, v/v)
HP10985a	SOL000087 - 0m	1837	955	82.6	0.75	2.36	68.2	3.9	6.6	64.3	61.6
HP10985b	SOL000087 - 25m	1662	956	34.9	1.34	2.64	49.1	1.3	2.3	47.9	46.8
HP10985c	SOL000087 - 45m	1042	957	45.7	1.12	2.66	57.7	5.9	7.7	51.8	50.0
HP10986a	SOL000192 - 0m	1210	958	64.2	0.89	2.48	64.1	3.7	6.4	60.5	57.7
HP10986b	SOL000192 - 25m	1727	959	41.5	1.13	2.56	55.9	5.6	7.5	50.3	48.3
HP10986c	SOL000192 - 50m	1378	960	60.2	0.96	2.54	62.4	3.5	5.3	58.9	57.1

Notes: Macro-porosity cited here is determined between total porosity and tension of -5 kPa, for consistency with the National Soils Database of New Zealand (NSD).

Macroporosity figures and air-filled porosity marked as < 1 indicate instances (HP10972c, HP10974a, HP10977a) where the sample was right on the limit of the methodology capability.

Air-filled porosity cited here is determined between total porosity and tension of -10 kPa. This can be referred to as Macro-porosity.

It is important to be aware what tension has been used, particularly when data is compared with historical or NSD data.

Analyst Allycia van de Laar

Checked by: John Claydon, Laboratory Manager

Date: 06/03/2023

Appendix 3 – Target and cadmium guideline values

Table A3.1. Target and cadmium guideline values used to compare soil quality in this report.

Indicator	Unit	Land use system: Cropping	Pasture	Forestry	Horticulture	Reference
		Target range				
Bulk density	(Mg m^{-3})	0.4–1.4 for Pallic and Recent Soils 0.3–1.3 for Allophanic Soils 0.7–1.4 for all other soils				1
Macroporosity (–10 kPa)	(% v v^{-1})	10–30	10–30	10–30	10–30	2, 4
pH (all soils except Organic)		5–7.6	5–6.6	3.5–7.6	5–7.6	1
Total carbon	(%)	>3 for Allophanic Soils. >2 for Semi-arid, Pallic and Recent Soils. >2.5 for other soils				1
Total N	(%)	exclusion	0.25–0.7	0.1–0.7	exclusion	1
AMN	(mg kg^{-1})	>20	>50	>20	>20	1, 2
Olsen P (Volcanic; ie Allophanic soils)	(mg kg^{-1})	20–50	20–50		20–50	2
Olsen P (Sedimentary and Organic soils; i.e. Recent, Brown, Gley etc soils)	(mg kg^{-1})	20–40	20–40		20–40	2
Olsen P (Raw sands and Podzols with low AEC; i.e. some Recent soils)	(mg kg^{-1})	5	5		5	2
Olsen P (Raw sands and Podzols with medium and above AEC; i.e. some Recent soils)	(mg kg^{-1})	15–25	15–25		15–25	2
Olsen P (hill country)	(mg kg^{-1})	15–20	15–20		15–20	2
Olsen P (all soils)	(mg kg^{-1})			5–30		2
		Guideline values				
Total Cd		TFMS 'Tier 0' up to 0.6 mg kg^{-1}, and 'Tier 1' from 0.6 to 1.0 mg kg^{-1} [a]				3, 6
		If a food crop, and Cd is high, then Eco-SGV of 1.5 mg kg^{-1} [b]				5

Notes: Pasture target includes dairy and drystock. Macroporosity at –10 kPa. Olsen P units were not clearly identified in Mackay *et al.* (2013), but Hill and Sparling (2009) state mg kg^{-1} should be used, plus mg kg^{-1} are the units used from our MWLR laboratory measurement.

AEC: Anion exchange capacity.

[a] TFMS: Tiered Fertiliser Management System. The TFMS has five cadmium level tiers, with Tier 0 representing soil cadmium that lies within the

range of natural background levels. The Tier 1 soil 'trigger' value (0.6 mg Cd/kg soil) was selected as the 99th percentile of the background soil concentrations (Fertiliser Association 2019).

[b] Soil Cd concentrations to ensure compliance of food crops with food standards may differ

Macroporosity (at –10 kPa) adapted from Hill and Sparling (2009), after lower target changed to 10% following Mackay et al. (2006) and as discussed in Cavanagh et al. (2023).

AMN target adapted from Hill and Sparling (2009) using information from Mackay et al. (2013) as discussed in Cavanagh et al. (2023).

References: 1, Hill and Sparling (2009); 2, Mackay et al. (2013); 3, Ministry of Agriculture and Forestry (2011); 4, Mackay et al. (2006); 5 Cavanagh and Harmsworth (2022), (using 95% protection level for ecological receptors for regional council state of the environment monitoring); 6, Fertiliser Association (2019)

For microbial biomass C, basal respiration and bioavailable cadmium, there are no targets or guidelines recommended.

Appendix 4 – Temporal trend analysis: Generalised Additive Model

Table A4.1. Summary of models fitted to the Taranaki soil quality data, including the 2022 results. The model in each case is a generalised additive model (GAM). The soil indicator is modelled as a Gamma distribution and a log-link for all indicators except pH. For pH, the soil indicator is modelled as a Gaussian distribution. Therefore, the values in the table should be interpreted as log-transformed values, or a linear value for pH. Bold values show the instances where (*P* <0.05).

Soil indicator	Intercept	Intercept SE	Years	Years SE	Years p-value	R^2
Total Cd (mg/kg)	**-1.0025**	**0.1854**	**-0.026793**	**0.008623**	**0.003**	**77**
Bioavailable Cd (mg/kg)	-4.681	0.163	-0.00857	0.008952	0.34	64
Total C (%)	2.1821	0.0549	-0.001719	0.002584	0.51	74
Total N (%)	-0.2375	0.0551	-0.001432	0.002587	0.58	78
AMN (mg/kg)	**5.2375**	**0.0547**	**-0.009051**	**0.003774**	**0.019**	**56**
pH (.)	5.5734	0.038	-0.002349	0.002794	0.4	59
Olsen P (mg/kg)	3.2137	0.1143	0.006274	0.004959	0.21	81
Microbial biomass C (mg/kg)	**7.2438**	**0.1119**	**-0.032841**	**0.006185**	**< 0.001**	**72**
Basal respiration (µgC/g/h)	0.2355	0.1247	0.013996	0.010679	0.19	27
BD (t/m^3)	-0.3073	0.033	0.002504	0.001737	0.15	80
Air-filled porosity (%, v/v)	2.2034	0.1406	0.003144	0.007903	0.69	83
Macroporosity (%, v/v)	**2.0287**	**0.0941**	**-0.018717**	**0.006381**	**0.004**	**67**

Note: All models except that for pH have the response modelled as a Gamma with a log link transformation, so the values above should be exponentiated for those cases to get the intercept value and the coefficient for the date since 2009. For example, for Cd the intercept in linear space is exp(-1.002) = 0.367. Similarly, the coefficient for the number of 52-week years since 2009 is exp(-0.027) = 0.974.

MEMORANDUM
Policy & Planning

Date	21 November 2023
Subject:	**Dangerous Dams Policy Consultation**
Approved by:	A D McLay, Director - Resource Management
	S J Ruru, Chief Executive
Document:	3221418

Purpose

1. To enable the Taranaki Regional Council (the Council) to adopt its *Policy on Dangerous Dams, Earthquake-Prone Dams and Flood-Prone Dams* (Dangerous Dams Policy) ahead of the legislated deadline of 13 May 2024.

Executive summary

2. The Council must adopt a Dangerous Dams Policy before 13 May 2024. The *Building Act 2004* requires the use of the special consultative procedure set out in section 83 of the *Local Government Act 2002* for adoption of this policy.
3. Council officers have prepared a draft Dangerous Dams Policy and statement of proposal based on a model policy prepared by Te Uru Kahika – the regional sector's umbrella organisation. The policy clearly sets out the principles and priorities the Council will apply in implementing the policy; how the Council will keep information, work with dam owners, and take or direct action; and how the policy applies to heritage dams.
4. Consultation will be open from 11 December 2023 to 19 February 2024. Any submitters who want to be heard will have the opportunity as part of the 2 April 2024 Ordinary Meeting. Subject to any required amendments, the policy will then be adopted.

Recommendations

That the Taranaki Regional Council:

a) <u>receives</u> this memorandum titled *Dangerous Dams Policy Consultation*

b) <u>adopts</u> the statement of proposal on the *Policy on Dangerous Dams, Earthquake-Prone Dams and Flood-Prone Dams* pursuant to sections 161 and 162 of the *Building Act 2004* set out in Attachment One

c) <u>approves</u> that a summary of the statement of proposal will not be prepared given that the policy will likely only be of interest to a small group of stakeholders who have a good level of knowledge about the issues involved

d) agrees to release the Statement of Proposal for the completion of the special consultative procedure and the approval of the *Policy on Dangerous Dams, Earthquake-Prone Dams and Flood-Prone Dams* on 11 December 2023 with submissions closing on 19 February 2024

e) determines that this decision be recognised as not significant in terms of section 76 of the *Local Government Act 2002*

f) determines that it has complied with the decision-making provisions of the *Local Government Act 2002* to the extent necessary in relation to this decision; and in accordance with section 79 of the Act, determines that it does not require further information, further assessment of options or further analysis of costs and benefits, or advantages and disadvantages prior to making a decision on this matter.

Background

5. The *Building Act 2004* (the Act) manages building consent requirements for dam construction and the requirements to ensure their ongoing safety. Along with the other regional councils in the North Island, the Council has delegated its building consent processing and inspection functions for dams to the Waikato Regional Council. Regarding dam safety responsibilities in the Act, the Council:
   - must maintain a register of all dams in its district;
   - must administer and monitor the dam safety process;
   - must have a dangerous dams policy that is reviewed every five years; and
   - is given a range of powers to act if a dam poses an imminent risk to public safety.
6. However, all Council functions except the powers to act, were awaiting regulations to provide key definitions before they became operative. The *Building (Dam Safety) Regulations 2022* (the Regulations) now look set to come into force on 13 May 2024.
7. By 13 May 2024, Council needs to update its Dangerous Dams Policy. The Act requires use of the special consultative procedure set out in the *Local Government Act 2002* (refer Attachment Two) to update a dangerous dams policy. The policy must set out:
   - the approach Council will take in performing its dam related functions;
   - the Council's priorities in performing those functions; and
   - how the policy will apply to heritage dams.
8. The Council last reviewed its Dangerous Dams Policy in 2011. Further review of this policy was put on hold as the Government was exploring dam safety regulation under the *Resource Management Act 1991*. The Government has since reverted to using the *Building Act 2002*, resulting in the 2022 Regulations.
9. Working collaboratively, Te Uru Kahika – the regional sector's umbrella organisation – has prepared a model dangerous dams policy for use across councils. The sector is also working together to determine best practice administrative and compliance procedures for implementing the Regulations more widely.

Issues

10. Council is required to adopt a Dangerous Dams Policy that is compliant with the *Building Act 2004*. This policy must go through the special consultative procedure.

Discussion

11. Council officers consider the model policy prepared by Te Uru Kahika is appropriate for Taranaki. The Policy is better tailored to the Regulations than the Council's 2011 policy. It also clearly sets out the principles and priorities the Council will apply in implementing the policy; how the Council will keep information, work with dam owners, and take or direct action; and how the policy applies to heritage dams.
12. Using the model policy, a statement of proposal is included in Attachment One. The proposed timeline for the full consultation process is:
    - 21 November 2023: The Council adopts the statement of proposal.
    - 11 December 2023: The statement of proposal is open for consultation.
    - 19 February 2024: Consultation closes.
    - 2 April 2024: The Council hears submissions on the policy as part of the Ordinary Meeting. The Council considers submissions and, if necessary, amends the Dangerous Dams Policy prior to adoption.
13. A summary of the statement of proposal is not required. The overall policy is concise and not overly technical. Council also does not expect significant public interest in the consultation process. Those who do submit will also likely be dam owners, who will be familiar with the wider regulatory environment.
14. Beyond the Dangerous Dams Policy, council Officers are updating internal administrative and compliance procedures for the dam safety process ahead of 13 May 2024. Officers will also review the current dam register (refer Attachment Three).

Options

15. Council is required, under the *Building Act 2004*, to have a *policy on dangerous dams, earthquake-prone dams and flood-prone dams.* The Act requires the use of the special consultative procedure in adopting this policy and the process must be completed ahead of 13 May 2024. The last scheduled Ordinary Meeting before this date is 2 April 2024. Hence, the only reasonably practicable option is for Council to proceed with consultation on the policy as proposed.

Significance

16. This decision is not considered significant in terms of the Significance and Engagement Policy. Adoption of the Dangerous Dams Policy is a statutory requirement. Public and community views will be received through the special consultative process.

Financial considerations—LTP/Annual Plan

17. 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

18. The proposed policy will, if adopted, replace the existing Dangerous Dams Policy that was adopted in 2011.

Iwi considerations

19. 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.

20. Iwi have not been specifically consulted in relation to this policy during its development. They will, however, be able to lodge a submission should they choose.

Community considerations

21. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum. In particular, the community would expect the Council to meet its legislative obligation to adopt a policy on this issue.

Legal considerations

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

Appendices/Attachments

Document 3220398: Statement of Proposal TRC Dangerous Dams Policy 2024

Document 3221461: Requirements of section 83 of the Local Government Act 2002

Document 3221471: Summary of classifiable dams in Taranaki

STATEMENT OF PROPOSAL

POLICY ON DANGEROUS DAMS, EARTHQUAKE-PRONE DAMS AND FLOOD-PRONE DAMS

PURSUANT TO SECTIONS 161 AND 162

BUILDING ACT 2004

The Taranaki Regional Council (the Council) is developing its *Policy on Dangerous Dams, Earthquake-Prone Dams and Flood-Prone Dams*. As part of this process, the Council is undertaking a special consultative procedure (refer section 83 of the *Local Government Act 2002*).

The policy below covers:

- Principles the Council will apply when implementing the policy
- How the Council will keep information relevant to the policy
- How the Council will work with dam owners
- How the Council will take action or direct dam owners to address issues
- The Council's priorities in implementing the policy
- How the policy applies to heritage dams.

This consultation process gives an opportunity for interested parties to provide feedback on the draft policy prior to it being formally adopted. The Council looks forward to receiving your comments, feedback and submissions on this statement of proposal by 4pm on Monday 19 February 2024. Councilors and management are available to answer any questions or to discuss any of the proposals contained within this proposal.

Q. How do I make a submission to the Council?
A. Online
Visit https://www.trc.govt.nz/council/news-and-events/have-your-say/ to complete a form.

Post
Write a submission and send it to:
Policy on dangerous dams submission
The Chief Executive
Taranaki Regional Council
Private Bag 713
STRATFORD

Submissions can also be made online at www.trc.govt.nz. Your submission must arrive by 4pm on Monday 19 February 2024. Please include your telephone number.

The Council will be hearing submissions on Tuesday 2 April 2024, and if you wish to appear in person in support of your submission, please indicate this in your submission.

Q. Do I have to come and speak to my submission?
A. No. It is entirely up to you. You will be most welcome, but if you decide not to attend the

meeting, your written submission will be given full consideration.

Q. Will the hearing be very formal?
A. No. Council members will have read your submission beforehand and have it with them; the Chairperson will invite you to expand on it.

Q. Who can I contact at the Council to discuss the Dangerous Dams Policy?
A. You are welcome to call at the Council's offices at Cloten Road, Stratford, or phone (06-765-7127) and discuss the schedule of charges with any of the following Executive Staff:
Fred McLay (Director—Resource Management)
Daniel Harrison (Director—Operations).

The Taranaki Regional Council (“Council”)

S161 Building Act 2004

POLICY ON DANGEROUS DAMS, EARTHQUAKE-PRONE DAMS AND FLOOD-PRONE DAMS

[Council logo]	**Document Name:** Policy on Dangerous Dams, Earthquake-Prone Dams and Flood-Prone Dams
	Document Owner: Director Resource Management
	Authorised By: Taranaki Regional Council
	Implementation Date: 13 May 2024
	Review Period: 5 Years
	Last Reviewed: n/a
	Next Review: 13 May 2028

1. Introduction

This document sets out the policy on dangerous dams, earthquake-prone dams and flood-prone dams adopted by the Council in accordance with sections 161 and 162 of the Building Act 2004.

The policy states the approach and priorities the Council will take in performing its functions in relation to dangerous dams, earthquake-prone dams and flood-prone dams in Taranaki, and how the policy will apply to heritage dams.

This policy applies to dams defined in section 7 of the Building Act 2004 ("the Act").

The dam safety provisions in subpart 7 of Part 2 of the Act, apply to:

1. Classifiable dams (defined in regulation 5 of the Building (Dam Safety) Regulations 2022 ("the Regulations") to be either:
    a. 4m or more in height and holding 20,000m3 in volume; or
    b. 1m or more in height and retaining 40,000m3 in volume.
2. Referable dams as defined in the Regulations[1].
3. All dams but only for the purposes of section 133B[2] (height measurement of dams) and sections157-158 (measures by a regional authority to avoid immediate danger).

2. Application of this policy

This policy applies to dams everywhere in Taranaki, and irrespective of the age and intended life of the dam. Some parts of this policy may apply to all dams. Where required by the Act, this policy applies to classifiable dams, which also includes "large dams" as defined in section 7 of the Act.

The terms 'dangerous dam', 'earthquake-prone dam' and 'flood-prone dam' have the same meaning as provided in section 153, 153A and 153AA of the Act.[3]

This policy must be read alongside the Building (Dam Safety) Regulations 2022 ("the Regulations") which defines terms used in the Act in relation to "dangerous dams", "earthquake- prone dams" and "flood-prone dams".[4]

The Regulations and the Act can be accessed at www.legislation.govt.nz [5]:

This policy commences on 13 May 2024.

[1] The current Regulations do not define a referable dam.
[2] When measuring the height of the dam under this section, the crest of the dam includes any freeboard – refer Appendix A for the definition.
[3] This includes buildings in areas designated under subpart 6B as set out in section 153AA of the Building Act 2004.
[4] Section 19 of the Regulations defines moderate earthquake, moderate flood, earthquake threshold event and flood threshold event.
[5] https://www.legislation.govt.nz/regulation/public/2022/0133/latest/whole.html#LMS489207 and . https://www.legislation.govt.nz/act/public/2004/0072/latest/whole.html?search=ts_act%40bill%40regulation%40deemedreg_building+act+2004_resel_25_a&p=1#whole

This policy will be reviewed every five years or earlier as required. The policy remains in effect even though it is due for review or being reviewed.

3. Principles

The Council will apply the following principles to the exercise of its dangerous dams, earthquake-prone dams and flood-prone dams functions under the Building Act:

1. Dam owners have the primary responsibility for identifying, monitoring and reporting on dangerous, earthquake-prone and flood-prone dams and for reducing or removing the risk of harm to people, property and the environment in a timely and effective manner.
2. An engineer engaged (by the owner) to provide a certificate for the purposes of sections 135(1)(b), 142(1)(b), or 150(2)(f) will notify Council and the owner of the dam if he or she or they believe that the dam is dangerous.
3. The state of all dangerous, earthquake-prone and flood-prone dams (as defined in the Act and the Regulations) must be known (noting that other dam safety provisions in the Act apply to all dams) and this information, if known to the Council, will be made readily available by the Council, to all persons potentially affected by the safety risks of a dangerous, earthquake-prone or flood-prone dam.

4. Council's approach to performing these functions

4.1 Information on dam status

The Council will keep a register of all dams as required by section 151 of the Act, recording the dangerous, earthquake-prone and flood-prone status of each classifiable dam. The Council will develop a monitoring procedure to maintain the register.

Should the Council receive information about a dangerous, earthquake-prone and flood-prone dam in its region, the Council will notify the relevant territorial authority and Civil Defence and Emergency Management Group.

4.2 Working with dam owners

The Regulations require owners of all classifiable dams to know whether their dam is dangerous, earthquake-prone or flood-prone and that they will take the necessary steps, in a timely manner, to comply with the Act and the Regulations. The Act requires dam owners to immediately notify the Council if they have reasonable grounds for believing their dam is dangerous. This applies to dams that are either a high potential impact dam or a medium potential impact dam and are likely to fail in the ordinary course of events, or a "moderate earthquake" or "moderate flood" (as defined in the Regulations).

The Act also requires an engineer (engaged by the owner) to provide a certificate for the purposes of sections 135(1)(b), 142(1)(b), or 150(2)(f), to notify Council and the owner of the dam if he or she or they believes that the dam is dangerous.

The Council will work with the owners of identified dangerous dams, earthquake-prone dams and flood-prone dams to develop an action plan (with timeframes) with the goals of increasing the safety of the dam and eliminating or reducing the risks of the dam to people, property and the environment. It is not realistic to specify a timeframe in this policy for achieving this goal because timeframes will be dictated by the circumstances of each case. When setting a timeframe for action, the Council will consider the state of the dam, and the likelihood and consequences of dam failure.

4.3 Directing and taking action

The Council may intervene:

- For dangerous, earthquake-prone and flood-prone dams:
  - if the owner of any dam is not acting in accordance with an agreed action plan;
  - where there is no agreed action plan;
  - where it considers that the agreed action plan requires review or amendment; or
  - where ownership is not known or is disputed; and
- for all dams, where there is or likely to be a risk of immediate danger.

Before exercising any of its powers under Sections 154 to 159 of the Building Act the Council will, unless the circumstances dictate otherwise (such as where there is immediate danger to the safety of persons, property, or the environment), seek to discuss options for action with the owner of the dam, with a view to obtaining from the owner a mutually acceptable formal proposal for reducing or removing the danger. Acceptable actions by the owner may include, one or more of the following:

- operational changes such as reducing the volume of impounded fluid or completely emptying the reservoir;
- reconfiguring an existing spillway or creating a new or supplementary spillway so as to limit the maximum impounded volume and/or to safely route flood flows;
- increased surveillance and monitoring;
- development of emergency preparedness and response plans;
- review of the dam safety assurance programme;
- require the owner to engage a dam specialist to investigate and make recommendations with any report provided to the Council;
- implementing measures to enable controlled, rapid emptying of the impounded fluid;
- measures downstream of the dam to mitigate the impact of dam failure;
- physical works including reconstruction or partial demolition of the dam; and
- decommissioning and/or removal of the dam.

The whole or part of any agreement between the Council and the dam owner may be formalised in a Notice to Fix issued under section 164 of the Act. If agreement cannot be reached between the Council and the dam owner, the Council may exercise any of its statutory powers in sections 154-159 and 164 of the Act.

The Council will notify potentially affected communities downstream of a dangerous, earthquake-prone or flood-prone dams. The Council will do this by publishing information about any dangerous, earthquake-prone or flood-prone dams in its region. The Council will also work with the Taranaki Civil Defence Emergency Group.

The Council may at any time require the dam owner to review a dam safety assurance programme if the dam is an earthquake-prone or flood-prone dam.

In a situation where a dam is dangerous, the Council may:

- erect a hoarding or fence to prevent people from approaching the dam nearer than is safe;
- attach a notice on or near the dam (or affected downstream areas) that warns people not to approach; or
- give written notice to the owner requiring work to be carried out on the dam, and within the time stated in the notice to remove or reduce the danger.

In a situation where the Chief Executive of the Council considers that, because of the state of the dam, immediate danger to the safety of persons, property, or the environment is likely, then the Chief Executive of the Council may:

- cause any action to be taken to that is necessary to remove that danger; and
- recover the costs of taking any action from the dam owner.

5. Council's priorities in performing these functions

The dangerous dam provisions of the Building Act will be used by the Council as a mechanism to remedy an unsatisfactory situation that has developed in Taranaki, rather than a means of responding to "emergencies" that arise in the future. The Council's approach to dangerous dams is therefore tailored toward achieving a reduction in the pre-existing risk whilst still being able to deal with risks that emerge in the future.

The priorities will be as follows in which 1 is the highest priority and 5 is the lowest priority.

1. Dams that upon commencement of the Regulations are dangerous and/or earthquake-prone and/or flood-prone due to their pre-existing condition (and not an actual change in risk), and do not have a Dam Safety Assurance Programme (DSAP) that complies with the Regulations. This priority would first consider classifiable high potential impact dams followed by medium potential impact dams;

2. Dams that are dangerous and/or earthquake-prone and/or flood-prone

due to their pre-existing condition (and not an actual change in risk), and do have a Dam Safety Assurance Programme that complies with the Regulations. This priority would first consider classifiable high potential impact dams followed by medium potential impact dams;

3. Dams that due to deterioration or damage (e.g. reduction in structural integrity), or identification of previously unobserved defects, are regarded as dangerous and/or earthquake-prone and/or flood-prone (i.e. a change in likelihood of failure). This priority would first consider classifiable high potential impact dams followed by medium potential impact dams;

4. Dams that because of new or improved information (or their exposure or their setting e.g. change in assessment of whether the dam constitutes a “moderate flood” or “moderate earthquake” for that site) are regarded as dangerous and/or earthquake-prone and/or flood-prone. This priority would first consider classifiable high potential impact dams followed by medium potential impact dams;

5. Dams that due to the potential impact classification for the dam increasing from low to medium or high or from medium to high are regarded as dangerous and/or earthquake-prone and/or flood-prone (i.e. a change in consequence of failure). This priority would first consider classifiable high potential impact dams followed by medium potential impact dams.

6. Application to heritage dams

For the purposes of this policy, a heritage dam means a dam that is included on:

(a) the New Zealand Heritage List/Rārangi Kōrero maintained under section 65 of the Heritage New Zealand Pouhere Taonga Act 2014; or

(b) the National Historic Landmarks/Ngā Manawhenua o Aotearoa me ōna Kōrero Tūturu list maintained under section 81 of the Heritage New Zealand Pouhere Taonga Act 2014.

Section 4(2)(l) of the Building Act recognises the “need to facilitate the preservation of buildings of significant cultural, historical, or heritage value”.

The Council recognises the need to retain heritage values of the dam itself, but also the need to reduce or remove any risk posed by a heritage dam which has been classified as dangerous, flood-prone or earthquake-prone. When considering heritage dams under this policy, account will be taken of the need to facilitate the preservation of parts of the dams with significant heritage value.

When dealing with heritage dangerous dams, the Council will seek advice from the Heritage New Zealand/Pouhere Taonga and the relevant territorial authority (if appropriate) before any actions are undertaken by the regional authority under sections 153 – 160 of the Act.

The Council may also engage suitably qualified professionals with engineering expertise and heritage expertise to advise and recommend actions. When considering any recommendations, the Council will have regard to the priorities set out in clause 5 of this policy. Copies of all served notices for heritage dangerous dams, earthquake-prone dams and flood-prone dams will be provided to Heritage New Zealand/Pouhere Taonga.

The Council will record the heritage listing of all dangerous, earthquake-prone and flood-prone dams it is made aware of in its register of dams and supply this information to the relevant Territorial Authority for inclusion on any relevant Land Information Memorandum.

Requirements of section 83 of the Local Government Act 2002

Special consultative procedure

(1) Where this Act or any other enactment requires a local authority to use or adopt the special consultative procedure, that local authority must—

(a) prepare and adopt—

(i) a statement of proposal; and

(ii) if the local authority considers on reasonable grounds that it is necessary to enable public understanding of the proposal, a summary of the information contained in the statement of proposal (which summary must comply with section 83AA); and

(b) ensure that the following is publicly available:

(i) the statement of proposal; and

(ii) a description of how the local authority will provide persons interested in the proposal with an opportunity to present their views to the local authority in accordance with section 82(1)(d); and

(iii) a statement of the period within which views on the proposal may be provided to the local authority (the period being not less than 1 month from the date the statement is issued); and

(c) make the summary of the information contained in the statement of proposal prepared in accordance with paragraph (a)(ii) (or the statement of proposal, if a summary is not prepared) as widely available as is reasonably practicable as a basis for consultation; and

(d) provide an opportunity for persons to present their views to the local authority in a manner that enables spoken (or New Zealand sign language) interaction between the person and the local authority, or any representatives to whom an appropriate delegation has been made in accordance with Schedule 7; and

(e) ensure that any person who wishes to present his or her views to the local authority or its representatives as described in paragraph (d)—

(i) is given a reasonable opportunity to do so; and

(ii) is informed about how and when he or she may take up that opportunity.

(2) For the purpose of, but without limiting, subsection (1)(d), a local authority may allow any person to present his or her views to the local authority by way of audio link or audiovisual link.

(3) This section does not prevent a local authority from requesting or considering, before making a decision, comment or advice from an officer of the local authority or any other person in respect of the proposal or any views on the proposal, or both.

Summary of classifiable dams in Taranaki

Dam name	Date of construction/year operational	Purpose	Height (m)	Reservoir maximum capacity (m3)	District
Patea	1984	Hydro electric power	63	144,000,000	South Taranaki
Motukawa	1927	Hydro electric power	17	745,000+	New Plymouth
Mangorei	1931	Hydro electric power	25	1,000,000	New Plymouth
Mangaotuku	1988	Flood protection	13	336,000	New Plymouth
Waimea	1988	Flood protection	11	150,000	New Plymouth
Huatoki	1987	Flood protection	24	1,000,000	New Plymouth
McCallum	1981	Irrigation	10	45,500	South Taranaki
Waireka	2000	Amenity	6-7	56,000	New Plymouth
Jordan	2009	Irrigation	5.8	53,345	South Taranaki
Ward	2001	Irrigation	9.3	171,500	South Taranaki
Oberwil	2014	Water storage	9	24,750	South Taranaki
Pukekura Park	1878	Amenity	4	35,000	New Plymouth
Highlands Park	2005	Stormwater retention	4	29,900	New Plymouth

Taranaki Regional Council

MEMORANDUM
Policy & Planning

Date 21 November 2023

Subject: **Revised Biodiversity Credits Submission**

Approved by: A D McLay, Director - Resource Management

S J Ruru, Chief Executive

Document: 3220722

Purpose

1. To seek endorsement for a submission on the New Zealand Government's (the Government) discussion document on exploring a biodiversity credit system for New Zealand.

Executive summary

2. Based on the discussion on the draft biodiversity credits submission presented at the 20 October 2023 Policy and Planning Committee meeting, Council officers have revised the submission. The revised draft was circulated via email for further Committee consideration. No objections or requests for further changes were received. The submission has since been submitted. This memorandum seeks final endorsement of the submission.

Recommendations

That the Taranaki Regional Council:

a) <u>receives</u> the memorandum titled *Revised Biodiversity Credits Submission*

b) <u>endorses</u> the submission in Attachment One on the *Helping nature and people thrive: Exploring a biodiversity credit system for Aotearoa New Zealand – Discussion document*

c) <u>determines</u> that this decision be recognised as not significant in terms of section 76 of the *Local Government Act 2002*

d) <u>determines</u> that it has complied with the decision-making provisions of the *Local Government Act 2002* to the extent necessary in relation to this decision; and in accordance with section 79 of the Act, <u>determines</u> that it does not require further information, further assessment of options or further analysis of costs and benefits, or advantages and disadvantages prior to making a decision on this matter.

Background

3. In the meeting of 10 October 2023, the Policy and Planning Committee was presented a memorandum (#3207624) seeking approval of a draft submission on the *Helping nature and people thrive: Exploring a biodiversity credit system for Aotearoa New Zealand – Discussion document*. This memorandum also set out the background of the discussion document.
4. After discussion, the motion was passed to leave this paper on the table and delegate authority to the Chief Executive to approve the submission that is to be lodged by 3 November.
5. The key concern raised by the Committee on the draft was that it was too forthright in its support for biodiversity credits. This related to further concerns around:
    - the overall lack of detail in the discussion document making comment difficult;
    - the risk that a focus on biodiversity credits redistributes funding away from established modalities, such as community grants;
    - how a biodiversity credit system could provide long-term surety of funding to participants;
    - ambiguity on where the application of biodiversity credits makes the most sense; and
    - the risk that biodiversity credits are misused for green washing.
6. A revised submission was circulated via email to the Policy and Planning Committee for comment on 20 October 2023. Two responses in support of the revised submission were received. No objections or requests for further changes were received. The submission has since been signed out by the Chief Executive and submitted.

Issues

7. Biodiversity is in decline, including in Taranaki. An effective and efficient biodiversity credit system has the potential to incentivise protection and restoration activities. However, designing such a system is far from straight forward.

Discussion

8. Taking into account the feedback from the Committee in the 20 October meeting, the submission was redrafted. The changes were to express:
    - cautious support for biodiversity credits;
    - that existing funding methods are effective and credits must not detract from them;
    - the specific circumstances where biodiversity credits could be of the most use (i.e. mobilising nature-positive private sector finance and getting landowners more engaged in biodiversity restoration); and
    - the importance of long-term surety of funding.
9. The revised submission also emphasised more strongly that there is still a long way to go in designing an effective system, and there are many challenges to overcome.

Options

10. The options are:

(a) Endorse the submission as submitted.

(b) Not endorse the submission and direct officials to request the withdrawal of the submission.

11. With the revised submission having been considered by the Committee via email, and with no objections or requests for further changes received, option (a) is recommended.

Significance

12. This item is assessed as not significant with regards to the Significance and Engagement Policy.

Financial considerations—LTP/Annual Plan

13. 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

14. 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

15. 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.

Community considerations

16. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

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

Appendices/Attachments

Document 3219795: Taranaki Regional Council Biodiversity Credits Submission

30 October 2023
Document: 3207780

Water and Land Use Policy
Ministry for the Environment

Submission on Helping nature and people thrive: Exploring a biodiversity credit system for Aotearoa New Zealand – Discussion document

1. The Taranaki Regional Council (the Council) is cautiously supportive of developing a biodiversity credit system for New Zealand. It is undeniable that our biodiversity is in crisis, and considerable action is required if we are to preserve our unique ecosystems, flora and fauna for the benefit of current and future generations. A biodiversity credit system has the potential to be an important tool and complement existing funding mechanisms. But there are also considerable pitfalls to be navigated in system development.

2. Of principle concern to the Council is the risk that the already limited public funding for biodiversity is redirected through a potentially administratively onerous credit process. Established modalities for supporting community groups and local government have proven their effectiveness at delivering substantial biodiversity benefits, even on limited budgets. With our biodiversity in crisis now, the New Zealand Government must enhance these traditional funding approaches in tandem with exploring biodiversity credits. Every effort must also be made to design the system to minimize administrative costs.

3. The Council sees an area of promise for biodiversity credits in mobilizing private sector finance. A focus on the private sector has the potential to catalyze new finance for biodiversity restoration – as opposed to just redistributing existing public sector finance. However, the system must also be designed to ensure the objective of biodiversity restoration is paramount to commercial considerations and to avoid green washing.

4. A second area of promise is in better engaging landowners in biodiversity restoration. Biodiversity credits and the New Zealand Emissions Trading Scheme (ETS) can mutually reinforce each other to better incentivize native reforestation. At the moment, native reforestation is simply not cost-effective under the ETS. Biodiversity credits can change that. We also note the promise a biodiversity credit system has for promoting the restoration of New Zealand’s dwindling wetland ecosystems. To best support landowners, any system will need to provide long-term certainty of funding.

5. The discussion document starts to unpick the challenges faced in setting up a biodiversity credit system, but leaves much unanswered. The Council notes that system design will be a long process. Along this path, regional councils have considerable expertise to contribute. In particular for determining practical on-the-ground implementation options. Regional councils can also help to identify those ecosystems in a region that are most at risk and in need of support through a credit system.

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6. Appendix One contains the Council's detailed answers to the questions in the discussion document.

7. This content of this submission will be formally considered by the Council's Planning and Policy Committee on 21 November 2023. Any comments or amendments will be provided after that meeting.

Yours faithfully

S J Ruru
Chief Executive

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Appendix one: Detailed responses to consultation questions

	Question	Response
1	Do you support the need for a biodiversity credit system (BCS) for New Zealand? Please give your reasons.	Refer covering letter.
2	Below are two options for using biodiversity credits. Which do you agree with? a) Credits should only be used to recognise positive actions to support biodiversity. b) Credits should be used to recognise positive action to support biodiversity, and actions that avoid future decreases in biodiversity. Please answer (a) or (b) and give your reasons.	The Council supports option b if it can be designed so as to not duplicate existing legal requirements for avoiding future decreases under the National Policy Statement for Indigenous Biodiversity. Between supporting additionally on one side, and helping landowners meet existing legal requirements on the other, the balance of effort in a credit system should be on the former. Matters with regard to legal protection are also addressed in question 7 below.
3	Which scope do you prefer for a biodiversity credit system? a) Focus on terrestrial (land) environments. b) Extend from (a) to freshwater and estuaries (eg, wetland, estuarine restoration). c) (Extend from (a) and (b) to coastal marine environments (eg, seagrass restoration). Please answer (a) or (b) or (c) and give your reasons.	The Council supports option c in principle. Biodiversity is in crisis across all ecosystems and substantial action is needed. And the interconnected nature of these ecosystems necessitates a holistic approach. However, the wider design of the system will influence these options. Particularly who can apply for credits. For example, a credit system that was only available for private land would not provide much benefit for the coastal marine environment, but would still be invaluable for wetland restoration.
4	Which scope do you prefer for land-based biodiversity credits? a) Cover all land types, including both public and private land including whenua Māori. b) Be limited to certain categories of land, for example, private land (including whenua Māori).	The Council does not have a preferred option, noting further analysis is required. The primary focus of the system should be on incentivising on private land and whenua Māori. And Council does not support the use of a credit system to support central government agencies to support work that should be funded through the established budget process. However, there could be grounds to support credits on public land where a community

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	Please answer (a) or (b) and give your reasons.	group is undertaking the work and receives the credit. Having local government able to apply for credits could also be beneficial in overcoming the significant funding challenges they face.
5	Which approach do you prefer for a biodiversity credit system? a) Based primarily on outcome. b) Based primarily on activities. c) Based primarily on projects. Please answer approach (a) or (b) or (c) and give your reasons	The Council prefers option a if effective and efficient monitoring and verification systems can be produced to accurately measure a percentage change in indigenous biodiversity per hectare. Failing that, option b can provide a suitable alternative. Option c is likely to be too uncertain to provide wide-spread benefit and have too high administrative costs. Consideration should also be given to a hybrid approach of option a and b. Considering the time it takes to demonstrate substantial biodiversity outcomes, an approach that provides for an activity focus in the short-term could be useful to incentivise action.
6	Should there also be a requirement for the project or activity to apply for a specified period to generate credits? Please answer Yes/No and give your reasons.	As long as there is mechanism so that a project or activity has to pay back the credits if the biodiversity benefits either turn out not to have been achieved or are reversed, a specific period is not required. In the absence of such a mechanism, a specified period should be required.
7	Should biodiversity credits be awarded for increasing legal protection of areas of indigenous biodiversity (eg, QEII National Trust Act 1977 covenants, Conservation Act 1987 covenants or Ngā Whenua Rāhui kawenata? Please answer Yes/No and give your reasons.	If there is a mechanism to pay back credits if benefits are reversed, additional legal protections may not be required. Otherwise, awarding credits for legal protection would be useful.
8	Should biodiversity credits be able to be used to offset development impacts as part of resource management processes, provided they meet the requirements of both the BCS system and regulatory requirements?	No. The focus of the credit system should be on additionally, not offsetting or compensation.
9	Do you think a biodiversity credit system will attract investment to support indigenous biodiversity in New Zealand? Please give your reasons.	If designed appropriately, yes.

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10	What do you consider the most important outcomes a New Zealand biodiversity credit system should aim for?	The Council supports the outcome hierarchy as outlined in figure 4 on page 30. The principle outcome needs to be to increase the extent and condition of indigenous ecosystems, especially those that are rare or threatened.
11	What are the main activities or outcomes that a biodiversity credit system for New Zealand should support?	The outcomes are addressed in the previous question. Relevant activities that could be included are fencing, animal pest control, plant pest control and restoration planting. Consideration should be given to related communication and education activities being included as well.
12	Of the following principles, which do you consider should be the top four to underpin a New Zealand biodiversity credit system? Principle 1 – Permanent or long-term (eg, 25-year) impact Principle 2 – Transparent and verifiable claims Principle 3 – Robust, with measures to prevent abuse of the system Principle 4 – Reward nature-positive additional activities Principle 5 – Complement domestic and international action Principle 6 – No double-counting, and clear rules about the claims that investors can make Principle 7 – Maximise positive impact on biodiversity	Maximise positive impact on biodiversity Robust, with measures to prevent abuse of the system Transparent and verifiable claims Permanent or long-term impact
13	Have we missed any other important principles? Please list and provide your reasons.	Giving effect to Te Tiriti o Waitangi.

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14	What assurance would you need to participate in a market, either as a landholder looking after biodiversity or as a potential purchaser of a biodiversity credit?	That the credit is verifiable, traceable, robust, long-lasting, and cost effective. That there is a robust system for what happens if outcomes are not achieved or biodiversity gains that have received credits are reversed is also important.
15	What do you see as the benefits and risks for a biodiversity credit market not being regulated at all?	The principle risk of not having regulation is that the assurances set out in the answer to the above question are not met. This would undermine the ability of the system to deliver on improving indigenous biodiversity. The potential benefits of no regulation is a system with lower administrative costs that is easier for people to participate in.
16	A biodiversity credit system has six necessary components (see figure 5). These are: project provision, quantification of activities or outcomes, monitoring measurement and reporting, verification of claims, operation of the market and registry, investing in credits. To have the most impact in attracting people to the market, which component(s) should the Government be involved in? Please give your reasons.	The Council generally supports government taking an administrative role, so focusing on quantification, monitoring, verification and operation. But the scale of that involvement could vary significantly. For example there may be a role for some sort of certifier-auditor scheme to take much of the quantification, monitoring and verification burden. Government investing in credits could also be a useful tool for meeting key biodiversity targets.
17	In which areas of a biodiversity credit system would government involvement be most likely to stifle a market?	Involvement in project provision has the highest risk of stifling the market. Government involvement in any of the other components also needs to be developed appropriately to minimise administrative costs.
18	Should the Government play a role in focusing market investment towards particular activities and outcomes and if so why? For example, highlighting geographic areas, ecosystems, species most at threat and in need of protection, significant natural areas, certain categories of land.	Yes. Some biodiversity areas (e.g. wetlands) are acutely threatened and the system needs to provide additional incentives in these areas.
19	On a scale of 1, not relevant, to 5, being critical, should a New Zealand biodiversity credit system seek to align with international systems and frameworks? Please give your reasons	3. What matters is a system that works for New Zealand and New Zealand biodiversity. However, alignment with international systems and frameworks is useful to incentivise foreign investment in NZ biodiversity credits and to guide the development of the system.

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20	Should the Government work with private sector providers to pilot biodiversity credit system(s) in different regions, to test the concept? If you support this work, which regions and providers do you suggest?	Yes. The Taranaki Regional Council would welcome the opportunity to test the concept in the region through our long-running Key Native Ecosystems project or our regional biodiversity hub Wild for Taranaki.
21	What is your preference for how a biodiversity credit system should work alongside the New Zealand Emissions Trading Scheme or voluntary carbon markets? a) Little/no interaction: biodiversity credit system focuses purely on biodiversity, and carbon storage benefits are a bonus. b) Some interaction: biodiversity credits should be recognised alongside carbon benefits on the same land, via both systems, where appropriate. c) High interaction: rigid biodiversity 'standards' are set for nature-generated carbon credits and built into carbon markets, so that investors can have confidence in 'biodiversity positive' carbon credits. Please answer (a) or (b) or (c) and give your reasons.	Council prefers option b. Both systems should stand-alone to avoid overly complicating each. But it is important that they should be able to be recognised alongside each other. This is essential if the cost barriers to indigenous reforestation compared to exotic are to be overcome. While each system should stand-alone, there is still potential to align application and administrative processes between the two.
22	Should a biodiversity credit system complement the resource management system? (Yes/No)	The two should complement each other where possible. This is particularly so for using regional processes under the RMA, such as regional biodiversity strategies, to guide the application of credits in a region towards priority ecosystems.
23	Should a biodiversity credit system support land-use reform? (Yes/No)	By making indigenous reforestation more cost effective, a credit system will always support land-use reform to a certain extent.

Taranaki Regional Council

MEMORANDUM
Policy & Planning

Date	21 November 2023
Subject:	**Mayoral Forum Submission on Advancing New Zealand's Energy Transition**
Approved by:	A D McLay, Director - Resource Management
	S J Ruru, Chief Executive
Document:	3220754

Purpose

1. To inform the Taranaki Regional Council (the Council) of the Taranaki Mayoral Forum's submission on the *Advancing New Zealand's Energy Transition* package of consultation documents.

Executive summary

2. The Taranaki Mayoral Forum has submitted on the *Advancing New Zealand's Energy Transition* package of consultation documents. This covers offshore renewable energy, the gas transition, green hydrogen development and wider energy system options. The submission was developed collaboratively between the four councils and Venture Taranaki. Feedback obtained from the Policy and Planning Committee in the meeting on 10 October 2023 informed this process.
3. The submission sends a strong and unified message to the new government that Taranaki is ready to become New Zealand's centre of renewable energy excellence. The submission welcomes the considered approach regarding the gas transition, supports a bespoke system for offshore renewable energy, and emphasises the role Taranaki can play in supporting green hydrogen. The submission also notes there are differing views in Taranaki communities regarding the energy transition. It emphasises the importance of public consultation so all voices can be heard.

Recommendations

That the Taranaki Regional Council:

a) receives the memorandum titled Mayoral Forum Submission on Advancing New Zealand's Energy Transition

b) notes the submission contained in Appendix One.

Background

4. The Taranaki Mayoral Forum has submitted a detailed submission on the package of documents under the *Advancing New Zealand's Energy Transition* consultation. The specific consultation documents that were commented on were:
   - Gas Transition Plan Issues Paper: This seeks feedback on the strategic direction for the gas sector as it faces opportunities and obstacles as the country transitions away from fossil fuels.
   - Interim Hydrogen Roadmap: This paper seeks feedback on an emerging view on the potential role of hydrogen in New Zealand's energy transition and how the industry could develop.
   - Developing a Regulatory Framework for Offshore Renewable Energy: This is the second consultation document on offshore renewable energy. It focuses on proposals for the regulation of the construction, operation and decommissioning stages of development.
   - Measures for Transition to an Expanded and Highly Renewable Electricity System: This wide-ranging paper sets out different options to best support wider system development.
5. At the 10 October 2023 Policy and Planning Committee meeting a paper (#3208239) was presented seeking initial views on the consultation documents. The discussion from this meeting informed a collaborative drafting exercise by the four local councils and Venture Taranaki. The Taranaki Mayoral Forum then reviewed and approved the submission.

Discussion

6. Considering the importance of the energy sector to Taranaki, the submission from the Taranaki Mayoral Forum provides a unified and clear message for the incoming government. The core of this message is that transitioning to a new energy system, which both meets emissions targets and enhances community wellbeing, will be difficult. But with over fifty years of energy experience, Taranaki is ready to become New Zealand's centre of renewable energy excellence and meet this challenge.
7. Other key messages from the submission include:
   - Welcoming the package of consultation documents, but noting the continued absence of the wider New Zealand Energy Strategy.
   - Calling on specific Government actions, such as investment in transmission infrastructure, and creating a suitable enabling environment to support investment in both energy infrastructure and industries that can leverage generation assets.
   - Supporting a bespoke regulatory regime for offshore renewable electricity generation, and emphasising this regime needs to ensure environmental protections are in place while avoiding unnecessary complexity.
   - Stating that green hydrogen has a potentially critical role to play in New Zealand's energy future, and emphasising Taranaki is ideally placed to underpin and enable advancements in New Zealand's hydrogen industry.
   - Welcoming the considered approach to a gas transition and the importance of avoiding system shocks and helping households to electrify.

- Noting that across the consultation documents, there are a range of views in Taranaki communities on how New Zealand should achieve its renewable energy goals. Ample opportunities for community engagement are vital to ensure all voices are heard.

8. It remains to be seen how the incoming government will address energy policy. It is reasonable to assume it will form a core pillar of their climate change response programme. The messages contained in the Taranaki Mayoral Forum Submission will also be useful for future advocacy efforts.

Financial considerations—LTP/Annual Plan

9. 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

10. 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

11. 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.

Community considerations

12. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

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

Appendices/Attachments

Document 3219750: Taranaki Mayoral Forum Submission on Advancing New Zealand's Energy Transition

Te Kaunihera-ā-Rohe o Ngāmotu New Plymouth District Council

Taranaki Regional Council

Te Kaunihera ō Taranaki ki Te Tonga South Taranaki District Council

TE KAUNIHERA Ā ROHE O WHAKAAHURANGI STRATFORD DISTRICT COUNCIL

Taranaki Mayoral Forum

Our Reference
F22/55/007-D23/44575

Kia ora

Taranaki Mayoral Forum Submission on Advancing New Zealand's Energy Transition

1. The Taranaki Mayoral Forum is committed to ensuring our region remains at the heart of New Zealand's energy sector. The oil and gas industry in Taranaki has provided economic development and energy security for the country. But with climate change posing a systemic threat to communities and ecosystems, we know the country must reach our emissions targets. Transitioning to a new energy system, that enhances the well-being of communities, will require the cooperation of central government, local government, iwi, the private sector, communities and workers.

2. Through its people, natural resources and location, Taranaki has the potential to be a centre of renewable energy excellence and drive the country's transition. There is a wealth of energy expertise in the region that is ready to turn their abilities towards renewable energy production. Taranaki's world-class wind resource and ample sunlight is waiting to be harnessed. And our location in the North Island, close to major demand centres, offers transmission benefits.

3. Achieving the renewable potential of Taranaki and the country without harming communities in the process will require strategic nous and dedicated resource. The Mayoral Forum welcomes the package of consultation documents. They move us towards developing a New Zealand Energy Strategy and an Equitable Transitions Strategy, which we have been highly concerned about the lack of to date. Without these wider strategies in place, it is difficult to see the range of ideas presented in the current consultation documents coalescing into a cohesive and equitable programme of change.

4. We call on the Government to commit to placing Taranaki at the heart of New Zealand's renewable energy system. In particular, we call for:

   - support for advancing energy industry growth and tangible projects, leveraging our oil and gas expertise and infrastructure;
   - the creation of a suitable enabling environment to support the attraction of industry to leverage energy generation assets and the development of Port Taranaki for offshore wind and hydrogen export;
   - support for training and career development in our communities to meet the projected labour demands for renewable energy initiatives;
   - the development of a regulatory environment that facilitates investment in the renewable energy industry in Taranaki; and
   - investment in the transmission lines out of Taranaki so that Taranaki's renewable energy can reach the national grid.

   These actions both promote an equitable transition for Taranaki, and provide a strong approach for New Zealand's shift to clean, renewable energy.

5. We also recognise that there are divergent views on how New Zealand should achieve its renewable energy goals. For instance, we are aware that there is some opposition to hydrogen within our communities, and we expect that there will be some opposition to offshore wind as well. There is also a wide range of views on how important behaviour change and overall electricity demand reduction should be. The Government needs to provide a clear and consistent strategy on the approach, be flexible as technology changes, and provide ample opportunity for community engagement.

Taranaki Mayoral Forum
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Offshore electricity generation

6. We strongly support the development of a bespoke regulatory regime for offshore renewable electricity generation, and for this to be brought into force rapidly. This regulatory regime should be as simple as possible, while ensuring environmental protections are in place.

7. Drawing from the consultation document, our specific comments are as follows:

- We are supportive of there being a one-stop shop for consenting applications across the territorial sea and the exclusive economic zone. However, it is critical that local government has a strong and legally required role in this process. We have had considerable issues trying to monitor and enforce consent conditions that have been put in place by the Environmental Protection Authority where local government was not adequately involved in their drafting.
- The regime put in place needs to be fair to applicants. Applications should be assessed on their own merits, as opposed to being compared against each other.
- We favour an open-door policy rather than a 'block offer' approach for new permits. The latter creates difficulties for processing consents as applications end up grouped together.
- We strongly support the inclusion of iwi and hapū throughout the process. Guidance should be developed on expectations in this regard. The participation of iwi and hapū should also be compensated.
- We recommend that the regulatory criteria for commercial permits include consideration of local economic impacts and community benefits. Doing this properly requires the participation of relevant local authorities and regional economic development agencies.
- We recommend that the regulatory regime be as flexible as possible due to ongoing technological changes. This means avoiding statutorily imposed consent lifespans that will negatively impact on longer life technologies.
- As evidenced by past issues in Taranaki, consideration of decommissioning upfront is critical. Commercial permits must demonstrate full lifespan considerations, with commitments transferring to new asset owners. Regulations should encourage commercial permit holders to implement circular design principles in construction in order to minimise waste. Decommissioning regulations also need to address what happens if consent conditions are breached to such an extent that permits are revoked.
- We do not see a royalty regime as essential for offshore wind. New Zealand will be stretched to reach its renewable energy targets, and royalty charges could disincentivise investment. We also note the lack of royalties for onshore renewables, and the philosophical difference in charging royalties for non-renewable (e.g. oil and gas) and renewable (e.g. offshore wind) resources. However, if a royalty regime is instituted, those funds should be ring-fenced for the local region, rather than go into the consolidated fund. This reflects that the negative impacts of development will be felt locally.
- We wish to emphasise the crucial nature of port infrastructure. This is not only for offshore wind, but also green hydrogen. The Government needs to ensure an appropriate enabling environment for long-term and strategic port development that meets the needs of the industry.
- Regulations should promote collaboration between developers to ensure cost and resource efficiency in connecting to the transmission grid.
- We recommend that Government also incentivise early movers, and support research and development.

Hydrogen Roadmap

8. We consider green hydrogen potentially has a critical role to play in New Zealand's energy future. For the country, it offers promise in reducing emissions in hard to abate sectors. And we support those focused on in the consultation document (i.e. heavy transport, shipping, aviation and industrial processes). Hydrogen could also play a role in energy storage, albeit as part of a wider package of storage solutions. It's role in improving the economics of renewable generation, by providing a profitable off-ramp for supply when grid demand is low, should also not be understated.

9. As set out in the *H2 Taranaki Roadmap*, Taranaki is ideally placed to underpin and enable advancements in New Zealand's hydrogen industry. We are home to significant water, wind and solar resources; already have large producers and users of hydrogen; have considerable relevant industry expertise to draw on; and our deep-water port offers connection to developing hydrogen markets offshore. A hydrogen industry, through being a supply off-ramp, is particularly important for supporting the development of Taranaki's offshore renewable electricity industry.

10. Given the early stage of the industry, the Government has a key role to play. This is not only in defining a vision and roadmap. But also for actively enabling and accelerating its development in line with the latest understanding of its role decarbonisation. The Regional Hydrogen Transition Programme is a positive step in this direction. We call on the Government to be still more ambitious in its support for the industry. Along with dedicated funding, this also requires a strong focus on creating a world-class regulatory system – including bespoke advice for resource consenting processes – to manage risks without stifling a nascent but growing industry.

11. On the question of exports, the Mayoral Forum supports a regime that allows for New Zealand hydrogen to support climate mitigation around the world. For countries like Japan and Singapore, who simply do not have enough local renewable generation capacity to meet demand, hydrogen derived energy will be a critical component of their transition. Producers of hydrogen – or energy solutions that use hydrogen as a feedstock – should not be unduly restricted from export. A ton of carbon abated in New Zealand or Japan is still one less ton of carbon in the atmosphere. We recommend this begin with a feasibility study of the export potential of hydrogen that assesses the full carbon lifecycle of such exports.

12. Finally with regard to hydrogen, we note the development of the industry is opposed by some sections of our communities. It is clear that it carries unique risks that require careful management. While the current low-rate of conversion efficiency in its production is also a key limitation. It also must not be used as a crutch to avoid behaviour change or to allow unsustainable industry practice to continue. As the industry develops, ongoing public engagement will be vital to address issues around social licence.

Gas Transition

13. The Mayoral Forum welcomes the considered approach the Government is taking to a gas transition. It is clear that a transition needs to occur, but it must be managed to avoid economic or energy system shocks. An unmanaged transition poses considerable risks to community well-being, especially in Taranaki.

14. In a gas transition, we recommend a greater focus on helping households transition to alternative energy sources. This helps ensure that gas reserves are available for industrial uses, particularly those that have few viable alternatives at present. There is also a real risk that the fixed costs of the gas network will become spread over a decreasing base, causing households to face significant cost increases over time. A support package for the residential sector to electrify appliances will be crucial.

15. The Government must also be aware of the risk that a transition results in the inability of the private sector to match supply with demand and resulting market failure. For example, the unexpected exit of Methanex from the market would jeopardise continued investment in supply. The sector is not well placed to manage this risk. There needs to be a clear plan, with supporting regulation in place as required, to minimise such risk.

16. As part of the transition, we support continued investigation and investment into biogas, hydrogen, carbon capture and storage, renewable gas trading and gas storage. All options need to be kept on the table as we move towards our emissions targets. However, not all options are created equal[1]. It is important that none are used as an excuse to not reduce emissions. We view the potential for renewable gas trading to be a particularly important. It allows hard to abate sectors to efficiently achieve emissions reductions through incentivising lower emission gas alternatives.

Renewable Electricity

17. The Mayoral Forum is supportive of pursuing a range of measures to achieve an expanded and highly renewable electricity system. Achieving sufficient electricity supply, especially if hydrogen production becomes an important part of the energy solution, will be a challenge. We will need a wide range of tools to achieve our mitigation targets.

18. On renewable energy zones, we recommend the Government consider how these can work with the regional spatial strategies under the *Spatial Planning Act 2023* or its replacement. Spatial strategies will need to include indicative locations for infrastructure required to support renewable energy production. There is a strong opportunity for these to work together. To do so will require collaboration between councils, Transpower, local lines companies and potential energy generators.

[1] We note that some sections of our community have concerns about carbon capture and storage for this reason.

19. We also recommend that consideration be given to developing local energy transition plans at a community level. These plans can help communities to understand where spare capacity is available within the local network for electrification and where other alternatives may be required to decarbonise. We understand that internationally these have been done in conjunction with local government. Such a model could work well in New Zealand too.

20. We support the removal of barriers to distributed energy resources (DER) uptake, such as the Multiple Trading Relationships Pilot with Ara Ake and the Electricity Authority. Reducing barriers would provide Iwi and local communities with greater energy resilience and the ability to both consumer and produce electricity. This also helps with the behaviour change required to better manage energy efficiency.

21. Finally, across all the consultation documents, we wish to reiterate our commitment to working in partnership to achieve New Zealand's emissions reduction goals. Building the renewable energy infrastructure our country needs is a significant challenge. However, with over fifty years of energy experience, our region is ready to become New Zealand's centre of renewable energy excellence and meet this challenge.

Ngā mihi

Mayor Neil Volzke (Forum Chair)
Stratford District Council

Mayor Phil Nixon
South Taranaki District Council

Mayor Neil Holdom
New Plymouth District Council

Charlotte Littlewood
Charlotte Littlewood
Taranaki Regional Council Chairperson

AGENDA
Policy & Planning

Taranaki Regional Council

Date	21 November 2023
Subject:	**Proposed National Policy Statement for Natural Hazards Decision Making 2023 Submission**
Approved by:	A D McLay, Director - Resource Management S J Ruru, Chief Executive
Document:	3220553

Purpose

1. The purpose of this memorandum is to present the submission made on the Proposed National Policy Statement for Natural Hazards Decision Making 2023 (NPS-NHD) and to seek retrospective approval of the contents of the submission.

Executive summary

2. The Proposed NPS-NHD consultation period runs from 18 September 2023 to 20 November 2023 and aims to direct how decision makers consider natural hazard risk in planning decisions relating to new developments under the Resource Management Act 1991 (RMA).
3. The objective of the NPS-NHD is to minimise the risks that natural hazards pose to people, communities, the environment, property and infrastructure and on the ability of communities to quickly recover after natural hazard events.
4. We are seeking retrospective approval from the Committee on the submission prepared on behalf of Council, that address a number of high level points, previously endorsed by the Committee at the Policy and Planning meeting on 10 October 2023.

Recommendations

That the Taranaki Regional Council:

a) receives the memorandum titled *Proposed National Policy Statement for Natural Hazards Decision Making 2023* Submission

b) endorses the submission, on the draft National Policy Statement for Natural Hazards Decision Making

c) determines that this decision be recognised as not significant in terms of section 76 of the *Local Government Act 2002*

d) determines that it has complied with the decision-making provisions of the *Local Government Act 2002* to the extent necessary in relation to this decision; and in accordance with section 79 of the Act, determines that it does not require further information, further assessment of options or further analysis of costs and benefits, or advantages and disadvantages prior to making a decision on this matter.

Background

5. The proposed NPS-NHD applies to new development and is an interim measure as part of the governments more comprehensive one to two year programme to provide direction and guide decision-making where natural hazards are a concern.
6. *The Proposed-National-Policy-Statement-for-Natural-Hazard-Decision-making-Discussion-document* (the Discussion Document) provides the Government's current thinking. This document includes a number of high-level design questions, which have been used in conjunction with the points previously endorsed by the Committee to guide the submission.

Issues

7. Council needs to determine whether it is prepared to approve the submission made on the Proposed NPS-NHD.

Discussion

8. Overall, the TRC Submission supports the intent of the NPS-NHD and the development of a framework for the assessment of the risks of potential developments prone to natural hazards. The submission expresses reservations concerning non-climatic hazards, like volcanos and earthquakes that may require a more bespoke approach. The submission also emphasises potential resource constraints associated with hazard identification and assessment.
9. Attachment One contains a copy of the submission on the NPS-NHD.
10. In developing the Council's submission, Council officers have engaged closely with Te Uru Kahika, the regional sector's umbrella organisation. Discussion on the Te Uru Kahika submission has informed the Council submission. Key matters that have been integrated include:
    - That care is needed to ensure the framework recognises climate change and how risks can change over-time;
    - That no one is disproportionately affected by the framework;
    - That the use of some terms like tolerable/intolerable can be problematic when not accompanied with detailed explanations and/or assessment criteria; and
    - That the policy needs to ensure it provides clear support for natural solutions rather than engineered solutions, which may require long-term maintenance.
11. The Te Uru Kahika submission will be approved by regional chief executives ahead of submissions closing on 20 November.

Options

12. The options are:
    (a) Endorse the submission prepared and submitted to Ministry for the Environment (MfE) on 20 November 2023. The preparation of the submission is in line with the

contents overview endorsed in Memorandum # 3209539 - Proposed National Policy Statement for Natural Hazards Decision Making 2023 Submission at the committee meeting on the 10 October 2023.

(b) Amend the submission and request staff to submit an updated submission to the Ministry for the Environment.

13. Option (a) is recommended. The contents of the submission align with the recommendation endorsed by the Committee on 10 October 2023. If Option (b) is endorsed staff will provide an updated submission that includes any agreed amendments.

Significance

14. This item is assessed as not significant with regards to the Significance and Engagement Policy.

Financial considerations—LTP/Annual Plan

15. 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

16. 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

17. 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.

Community considerations

18. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

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

Appendices/Attachments

Document 3220834: Proposed National Policy Statement for Natural Hazards Decision Making 2023 - TRC Submission

Taranaki Regional Council

12 November 2023
Document: 3220834

National Policy Statement Natural Hazards Decision Making
Ministry for the Environment

Submission on the Proposed National Policy Statement Natural Hazards Decision Making

The proposed National Policy Statement for Natural Hazards Decision Making (NPS-NHD) relates to the work of the Taranaki Regional Council (TRC). To ensure the well-being of Taranaki communities, TRC recognizes the importance of appropriate hazard and climate change mitigation and ensuring that the region has a just transition to a hazard resilient future.

Council supports the intent of the NPS-NHD. It has however, significant reservations in regard to the timing of its proposed release in early 2024 and the use of such a simplistic approach to hazard risk identification across all hazard types. Council believe that further work needs to be progressed to develop a more comprehensive approach. TRC is supportive of the Government continuing with the phase 2 investigations to inform further refinement of the approach within the NPS-NHD.

Appendix A sets out TRC's response to select questions in the review of the NPS-NHD consultation document.

This content of this submission will be formally considered by the TRC Planning and Policy Committee at its meeting on the 21st November 2023. If the need arises, any comments or amendments from the Committee will be provided to the Government after that meeting.

Yours faithfully

S J Ruru
Chief Executive

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Please quote our document number in your reply

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Question		Submission
1	Is more action needed to reduce development from occurring in areas facing natural hazard risk?	Yes. Worsening coastal, flood and slope failure hazards are not yet fully reflected in peoples' decisions to subdivide, develop or extend property in coastal areas, on floodplains or in areas susceptible to slope failure. New Zealanders are still building new residential developments and investing in climate-risky locations. This means more lives and property will be at risk. Local and regional authorities and decision makers do not have a full set of integrated mechanisms to effectively manage the significant risks from natural hazards and climate change. Part of this is because the planning cycle takes such a long time to complete (i.e. 5-10 years) and is fraught with opposition from multiple groups. In addition, the regulatory regime is inconsistent. An example is the Medium Density Residential Standards and the National Policy Statement on Urban Development. Density requirements have created a minefield for managing the risks from natural hazards in specified areas. The ability to prevent inappropriate development and restrict density requirements hinges entirely on a robust understanding of the hazards of an area, coupled with a strong risk-based approach in district plans. In many places, there is currently neither. This is why a national policy statement, providing clear integrated direction, is so important. It is needed to direct the assessing and mapping of hazards, and the inclusion of a strong risk-based approach in regional and district plans. This should also be coupled with a requirement to undertake more community focussed and non-regulatory adaptation planning, the shape of which can be tailored to each district and community.
2	Are there any other parts of the problem definition that you think should be addressed through the NPS-NHD? Why?	Other key parts of the problem definition include: • Addressing the disproportionate impacts of natural hazards on marginalised and low income socioeconomic groups.

		• Inconsistent identification and assessment of natural hazards and risks is an ongoing issue. Common standards and clearer processes are required. This needs to be developed before this NPS is released. • The 'second' phase of hazard work by Central Government needs to be prioritised to enable effective implementation.
3	Are there other issues that have not been identified that need to be addressed through the NPS-NHD or the comprehensive National Direction for Natural Hazards?	A significant issue that must be addressed through this framework is how natural hazard risk, and our understanding of those risks, change over time including as a result of climate change. Areas with a low to moderate risk now, may become moderate to high risk in 20-50 years, and the NPS needs to allow for this assessment to be included in the policy framework. Clearer national guidance is also required on how to apply climate change scenarios in the decision making process. The safe access, egress, and ability for emergency evacuation routes also needs to be considered for hazard assessments. This needs to be included in the NPS. Finally, infrastructure resilience is a key concern. A lot of regionally significant and critical infrastructure is located in areas vulnerable to natural hazards. Consequently, the NPS needs to address 'use' as well as new development.
4	Do you support the proposed NPS-NHD's requirement that decision-makers take a risk based approach when making decisions on new development in natural hazard areas? Why or why not?	Yes. A risk-based approach ensures that both the likelihood of a hazard event and its potential consequences are assessed, followed by an appropriate response to land use and development based on that assessment. This should be used instead of tolerable/intolerable as tolerability is an extremely subjective and potentially politically loaded concept.
5	Should all natural hazards be in scope of the proposed NPS-NHD? Why or why not?	Yes. However, TRC would like to emphasise that geological hazards like volcanoes and earthquakes can be complex and need a different approach than climatic hazards. To account for this difference, the NPS-NHD needs to provide policy direction and guidance as to how these hazards are to be considered. This

		work needs to be prioritised to support the implementation of any risk based approach that is intended to apply to all hazards.
6	If not all natural hazards are in scope, which ones should be included? Why	n/a
7	Should all new physical development be in scope of the proposed NPS-NHD? Why or why not?	Yes. All development should be included in the NPS-NHD to ensure a fair and a consistent approach and the ability to manage risks in an integrated way.
8	What impact do you think the proposed NPS-NHD would have on housing and urban development? Why?	The application of risk assessments on non-climatic hazards could have a significant impact on Taranaki, if there is no further direction within the NPS-NHD and/or guidance provided to support implementation.
9	Do you agree with the proposed objective of the NPS-NHD? Why or why not?	Yes, but it requires some rewording. The objective(s) need to clearly link to a risk-based approach in the provisions. This would be best achieved by splitting the objective in two, with one objective focussing on high hazard areas, and a second objective focussing on low to moderate hazard areas where hazards can be better managed to help build community resilience through a risk based approach.
10	What are the pros and cons of requiring decision-makers to categorise natural hazard risk as high, moderate or low?	TRC supports the application of consistent low/medium/high terminology. But we note the broader difficulties of applying the same risk based approach to all hazards without the inclusion of a bespoke option to deal with non-climatic hazards.
11	What are the pros and cons of directing decision-makers to assess the likelihood, consequence and tolerance of a natural hazard event when making planning decisions?	Pros: • Ensures a holistic view of hazard risks. • Decisions are grounded in data. • Provides for adaptation under changing conditions. Cons: • Requires accurate scientific data. • There is ambiguity without clear guidance. • Has the potential to be overly complex.

		• There is the potential for significant resourcing requirements in the tolerance assessment.
12	What are the pros and cons of directing decision-makers to adopt a precautionary approach to decision-making on natural hazard risk?	Pros: • Prioritises safety over uncertainties. • Is pragmatic in unpredictable scenarios. • Promotes responsible development. Cons: • May hinder reasonable development. • Could result in significant restrictions in some regions.
13	What are the pros and cons of requiring natural hazard risk as a matter of control for any new development classified as a controlled activity in a plan, and as a matter of discretion for any new development classified as a restricted discretionary activity?	This is a positive requirement under the proposed NPS as it provides clear direction to local authorities and will prevent ongoing debate about the need to include provisions and an assessment of hazards for new development. It would be best if this could be implemented without the need for a plan change. Some of the challenges are, whilst controlled activities provide a simple framework in areas where risk is well defined and suitable mitigation measures can be implemented, the approach requires more investment for locations where there is more hazard complexity or a lack of information. Many councils will need to update their hazard mapping to ensure this approach can be properly implemented. Discretionary activities offer more flexibility and the ability to assess risk on a consent by consent basis, however it increases the complexity and cost of processing consents. Good guidance and a clear planning framework would assist with processing consent applications.
14	What are the pros and cons of requiring planning decisions to ensure the specific actions to address natural hazard risk outlined in policy 5?	If hazards have not already been mapped and assessed, which is a resource intensive process, some Councils will struggle to apply the framework. In these instances, additional guidance will need to be provided to aide in implementation. The question of how this work is to be funded also needs to be considered and agreed between central and local government.

		As discussed in other sections of this submission, using the term ‘tolerable’ is fraught and it would be better to use more easily understood terminology that is less open to subjective interpretation.
15	What is the potential impact of requiring decision-makers to apply this framework in their decision-making? Will it improve decision-making?	If applied appropriately, it should increase the resilience of our development, infrastructure and communities and provide stronger direction to prevent or control development in hazard prone areas. However, it needs to be made clear that any assessment of the likelihood and consequences of a natural hazard event is undertaken by suitably qualified experts. Additionally, if adequate information is not available, the effectiveness of implementing the NPS-NHD and any decision making is at risk.
16	What are the pros and cons of providing direction to decision-makers on the types of mitigation measures that should be adopted to reduce the level of natural hazard risk?	It is important that there is some policy direction around the application of hazard mitigation measures. They have the potential to have adverse effects on the environment, interfere with natural processes and ecosystems, or even exacerbate the risks through effects such as diverting floodwaters. The development of soft engineering, green infrastructure and nature based solutions, provide a range of other opportunities to mitigate the risks from natural hazards in ways that deliver environmental co-benefits. It is important that these options are fully explored when assessing the range of options that may be available in hazard mitigation decisions. Clause (b) appears to encourage the construction of large mitigation schemes and needs recrafting. Climate change is exacerbating the risks from natural hazards over time and in ways that are uncertain. This policy needs to be crafted in such a way that hazard mitigation structures are only constructed if necessary, and that it doesn’t encourage the develop of high hazard land through the use of hazard mitigation structures to moderate the hazard.

17	Does policy 7 appropriately recognise and provide for Māori rights, values and interests? Why or why not?	Council supports central government seeking direction on this from mana whenua.
18	Can traditional Māori knowledge systems be incorporated into natural hazard risk and tolerance assessments?	Yes. It is essential. Some iwi/hapū may also choose to lead natural hazard risk and tolerance assessments and should be supported to do so. Current processes often do not acknowledge or incorporate the long held knowledge and experiences of mana whenua in assessing natural hazard risks and adapting accordingly.
19	Does the requirement to implement te Tiriti settlement requirements or commitments provide enough certainty that these obligations will be met? Is there a better way to bring settlement commitments into the NPS?	TRC supports the intent to ensure that any rights established by specific Tiriti settlement legislation are upheld, and recommend a close look at implications of this NPS on various types of Māori land as described elsewhere in this submission. However, we note that Te Tiriti settlement requirements or conditions are not explicitly mentioned or required in the proposed NPS-NHD. Further certainty is required.
20	Is the implementation timeframe workable? Why or why not?	Not all Councils have the information required for implementation. Further work is needed to expand direction for the risk based approach of NPS-NHD. This work needs to be brought forward from 'Phase 2' to support effective implementation.
21	What do you consider are the resourcing implications for you to implement the proposed NPS-NHD?	If Policy 4 requires an RMA Schedule 1 plan change it will add considerably to the financial and resource burden of all councils. This is especially so in those regions with limited hazard information currently available. There will be resourcing issues to consider for Māori in implementing Policy 7, and for councils engaging with mana/tangata whenua where there may be challenges processing those consents in a timely manner.

22	What guidance and technical assistance do you think would help decision-makers to apply the proposed NPS-NHD?	Council considers that the following guidance would be useful: • Process based standards outlining the approach that should be adopted for each hazard type • Application of the risk-based approach • Determining risk (low, moderate, high) for different hazard types • The application of climate change scenarios • Adaptive pathways to support a new risk based framework Use of the word tolerance/tolerable is not recommended in this submission but if it used it requires good definition including: • Guidance on the hierarchy of priorities for determining tolerance. • Guidance on timeframes for determining risk tolerance thresholds.

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Taranaki Regional Council

MEMORANDUM
Policy & Planning

Date 21 November 2023

Subject: **Select Committee Inquiry into Climate Adaptation: Sector Submission**

Approved by: A D McLay, Director - Resource Management

S J Ruru, Chief Executive

Document: 3221041

Purpose

1. To inform the Taranaki Regional Council (the Council) of a submission from Te Uru Kahika, the regional sector's umbrella organisation, on the Environment Committee's Inquiry into Climate Adaptation.

Executive summary

2. The Environment Committee has commenced an inquiry into climate adaptation, with a particular focus on managed retreat. The goal of the inquiry is to explore how managed retreat could become part of the country's adaptation system and how the costs could be met.
3. Te Uru Kahika lodged a sector-wide submission on the inquiry. The submission sets out a clear message on the importance of developing a robust system with bipartisan support and strong funding mechanisms. Council officers were part of the working group that developed the submission.
4. As the Environment Committee process progresses, Council officers will closely monitor it and continue to work with Te Uru Kahika. As the New Zealand Government (the Government) develops specific proposals, these will be presented to the Policy and Planning Committee for consideration and discussion.

Recommendations

That the Taranaki Regional Council:

a) <u>receives</u> the memorandum titled *Select Committee Inquiry into Climate Adaptation: Sector Submission*

b) <u>notes</u> the Te Uru Kahika submission contained in Attachment One.

Background

5. The Environment Committee has commenced an inquiry into climate adaptation, with a particular focus on managed retreat – which the Government has termed community-led retreat. Managed, or community-led, retreat refers to a planned strategy to address the challenges and risks associated with rising sea levels, coastal erosion, and other climate-related impacts. This strategy involves the systematic relocation of settlements, infrastructure and assets away from high-risk areas.
6. The impetus for the inquiry came from the impacts of Cyclone Gabrielle. In this event, roads and homes were badly flooded and landslides cut off key state highways. Some communities were left without transport, power and a way to communicate. More than 10,000 people were displaced and 11 people died. These communities now face difficult choices about whether and how to rebuild.
7. Eventually, climate change will cause extreme weather risk in some places to become so great that it will no longer be safe to live there or affordable to rebuild. In other places, land will disappear due to sea level rise. Some of the places at risk are large and highly populated, and the challenges and costs of adapting will be significant. Rural and low-income communities will be particularly vulnerable. Māori will also be disproportionately impacted.
8. The goal of the inquiry is to explore how managed retreat could become part of the country's adaptation system and how the costs could be met. The Environment Committee is particularly interested in:
    - The current approach to community-led retreat and adaptation funding, its strengths, risks and costs.
    - Lessons learned from severe weather events and natural disasters in New Zealand for community-led retreat and funding climate adaptation.
    - Effective mechanisms for community-led decision making.
    - The role of the private sector in managing climate risk.
    - Potential institutional arrangements, including roles and responsibilities of central and local government agencies, iwi and hapū.
    - Māori participation, Crown obligations, and how to best give effect to the principles of te Tiriti o Waitangi, and integrate matauranga Māori and te ao Māori across the adaptation system.
    - Alignment and integration with existing legislation and regulatory frameworks, and any changes needed to regulatory powers and potential economic or other incentives needed to support adaptation actions.
    - Funding sources, access to them, and principles and criteria for cost sharing.
    - Targets or indicators for assessing progress to more resilient communities and infrastructure.

    The Environment Committee's findings will inform the development of the Climate Change Adaptation Bill.
9. To inform the inquiry and public submissions, the Ministry for the Environment released the paper *Community-led retreat and adaption funding: Issues and options*. The key points from this document are summarised in the below table.

Te Tiriti-based adaptation	Iwi, hapū and Māori are disproportionately affected by climate change. Te ao Māori and local mātauranga should be central to the development of risk assessments and adaptation planning at place. The Crown must proactively work with iwi, hapū and Māori to uphold Māori rights and interests, including through protecting Māori land and upholding Treaty settlements. Space should be created for iwi, hapū and Māori to have rangatiratanga over their whenua and taonga katoa in a Tiriti-based adaptation system.
Risk assessment	Risk assessment is the first step in adapting and is essential for understanding the risks we face. National direction under resource management legislation could be used to provide direction to councils on risk assessments, so they are more consistent and comprehensive.
Local adaptation planning	Once a region has identified its risks, it will need to focus on areas that are high priority for adaptation. Direction from central government could strengthen local adaptation planning. Local adaptation planning could include how actions will change if there is a disaster. A process for deciding between retreat and other adaptation options is needed.
Community-led retreat	New powers are needed to enable community-led retreat, including for the ownership, control, use, acquisition and retirement of land. The exact powers needed will depend on the system we design, including which parts are voluntary and which are not, and how we maximise choice.
Funding and financing	Consideration of how adaptation costs should be shared by individuals, households, businesses, councils and central government is needed. Where central government has a role, it may be helpful to clarify its funding priorities. Possible initial priorities include: property-level retreat funding; home resilience funding; flood protection; and a dedicated fund for iwi, hapū and Māori. Options for funding range from the current state (where the central government spends on a case-by-case basis) to a long-term fund covering a full range of adaptation costs.

Adapting through recovery	Pre-disaster adaptation is both similar and different to post-disaster adaptation. The enduring adaptation system could potentially be used to guide swift decision-making on adaptation in the immediate aftermath of a disaster. Some flexibility may still be needed to reflect the particular needs of disaster recovery.

10. Considering the importance of developing a robust approach to managed retreat, Te Uru Kahika prepared a sector wide submission. This was lodged ahead of submissions to the Environment Committee closing on 1 November 2023. Council officials formed part of the working group for the submission.

Discussion

11. The full submission is contained in Appendix One. Key points from the submission are:
    - Progress on climate adaptation, particularly managed retreat, is urgently needed.
    - The regional sector has considerable expertise to contribute in finding solutions.
    - Providing for the needs of Māori in the adaption system is critical. This requires genuine partnership.
    - The core need is for fair processes, clarity about individual and institutional accountability, strong legislation, robust funding mechanisms and defensible science.
    - Clear and agreed outcomes, principles and prioritised actions are also needed.
    - Flood management structures, implemented with due consideration of Te Mana o Te Wai and nature-based solutions, are a key immediate adaption tool. They will buy time to design and implement other solutions.
    - The term 'community-led decision making' is potentially misleading, as the system is unlikely to be completely community-led. 'Community-focused' or 'community-centric' is preferred.
    - The current institutional and legislative frameworks are not well connected or sequenced. They need to be better defined and aligned. Greater protection of local government from liability challenges is also important.
    - Local government’s funding system is under pressure. An annual Crown transfer of revenue, and other funding and financing mechanisms, are required.
    - The following actions are needed to establish a robust regime:
        - research and information gathering on vulnerability and risk tolerance;
        - clear definition of adaption concept and funding measures;
        - preparation of regional spatial plans to prevent future development being put at risk;
        - preparation of statutory plans to appropriately add resilience to existing and future developments through regulation; and
        - agreement about cost sharing arrangements to fund adaptation measures.

- More accessible tools are required to enable property owners to have a much higher level of awareness of the climate-change induced hazards they face.
- Long-term commitment and bipartisan support for climate change adaptation is critical.

12. The development of the submission was an excellent example of Te Uru Kahika's value add. It facilitated a process that enabled all regional councils to input and share expertise on a technically complex consultation. The process was that a small working group prepared the draft submission. The regional sector chief executives then discussed and approved submission. Te Uru Kahika will continue to engage with central government as the legislative process progresses.
13. Council officers will continue to work as part of Te Uru Kahika on the issue. As the Government develops specific proposals on climate adaptation, these will be presented to the Policy and Planning Committee for consideration and discussion.

Financial considerations—LTP/Annual Plan

14. 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

15. 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

16. 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.
17. Ngā Kairapu, the Māori Special Interest Group within Te Uru Kahika, made a substantial contribution to the submission.

Community considerations

18. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

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

Appendices/Attachments

Document 3221032: Te Uru Kahika Submission on Select Committee Inquiry into Managed Retreat

Te Uru Kahika Regional and Unitary Councils Aotearoa

To: ENVIRONMENT COMMITTEE / KOMITI WHIRIWHIRI TAKE TAIAO

From: TE URU KAHIKA REGIONAL AND UNITARY COUNCILS AOTEAROA

In the matter of the: INQUIRY INTO COMMUNITY-LED RETREAT AND ADAPTATION FUNDING

Contact details: Liz Lambert
Executive Director
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0274 285 618

Tena koutou katoa,

He whakatauaki tēnei nā Rev Māori Marsden

Ko te mātauranga kei te mātenga,
He kohinga korero,
Ko te mātauranga kei te ngākau,
Kei a ia anō ōna tikanga whakaaro

Knowledge is a thing of the head.
An accumulation of facts.
Wisdom is a thing of the heart.
It has its own thought processes.

Ko tēnei te kaupapa o te Ao Māori.

Te Uru Kahika Regional and Unitary Councils Aotearoa

Preface and contents of this submission

1. Te Uru Kahika Regional and Unitary Councils Aotearoa thanks and congratulates the Environment Committee for the decision to undertake a cross party inquiry into climate change adaptation and managed retreat. We welcome the opportunity to contribute to your thinking.

2. Te Uru Kahika acts on behalf of the collective of regional councils and unitary district councils of Aotearoa. It is governed by the mayors and chairs of regional authorities (the 'Regional Sector Group or RSG), directed by the Regional Chief Executive Officers' group (RCEOS) and supported by 26 special interest groups (SIGS) made up of subject-matter expert officers in the sector.

3. Te Uru Kahika works very closely with Local Government New Zealand and Taituarā and has a unique role to play in partnering with, and sitting between, central government, on the one side, and communities on the other. We have worked alongside these two agencies, and the New Zealand Planning Institute, in developing our respective submissions and there is a high level of consensus and support from Te Uru Kahika for their respective submissions.

4. Our submission is structured as follows:

Part one:	Executive Summary.
Part two:	Introduction.
Part three:	Challenges, outcomes, principles, and priorities.
Part four:	Effective mechanisms / actions.
Part five:	Te Tiriti based approaches.
Part six:	Roles, responsibilities, and institutional arrangements.
Part seven:	Lessons learned from recent adaptation experiences.
Part eight:	Role of the private sector.
Part nine:	Finance and funding.
Part ten:	Targets and indicators of progress.
Part eleven:	Conclusions and next steps.
Appendix one:	Lessons from Hawke's Bay.

Te Uru Kahika Regional and Unitary Councils Aotearoa

Part one: Executive summary

5. We welcome the decision to conduct an inquiry and we welcome the Expert Panel's report, because making progress on climate adaptation – particularly managed retreat, is urgently needed.

6. Te Uru Kahika has expertise and experience to bring to the table to find solutions. This expertise and experience have been developed at the coal face. Local government (regional and territorial authorities) are well positioned to continue to contribute leadership to community resilience decision-making, to help address and adapt to the effects of climate change.

7. Both the Crown and local government have obligations to give effect to the principles of the Tiriti o Waitangi across the adaptation framework. Providing for the needs of iwi / Māori in the adaptation system will be critical. Working in genuine partnership with iwi, hapū and marae is essential for all regional and unitary councils, and for achieving good community outcomes.

8. The essential adaptation and managed retreat need is for fair processes, clarity about individual and institutional accountability, strong legislation, robust funding mechanisms and defensible science / hazard information – with all of this being to drive achievement of the right outcomes. There is a long-standing policy vacuum that needs to be addressed.

9. Clear and agreed outcomes, principles and prioritised actions need to be developed. Our submission makes some suggestions about what these should be.

10. Managed retreat is more likely to be enabled after an event, rather than before an event. The adaptation and managed retreat lessons from recent Hawke's Bay's experiences provide a strong base for that which may now be applied pre-emptively i.e., 'pre-extreme event,' within other regions (Appendix one). Furthermore, a multi-hazard approach to climate change adaptation should be applied.

11. Flood management structures – implemented with due cognisance of Te Mana O Te Wai and nature-based solutions, are a key 'immediate' adaptation tool that will buy the nation more time to design and implement other managed retreat and adaptation solutions.

12. We are concerned about raising false expectations in communities by using the term 'community-led decision making.' Our preference is to use the terms 'community-focused' or 'community-centric'.

13. The current institutional and legislative frameworks affecting climate change, natural hazard and resource management roles and responsibilities do not appear to be well connected or sequenced. These need to be better defined and aligned and thereby

Te Uru Kahika Regional and Unitary Councils Aotearoa

- better understood. In addition, greater protection of local government from liability challenges is important.

14. Local government's funding system is under pressure. An annual Crown transfer of revenue, and other funding and financing mechanisms, are required to support local authority pre-emptive climate change adaptation activities.

15. We see merit in working together with central government to establish an ordered but urgent progression through the following actions:
    a. Research / information gathering - with a likely initial emphasis toward information that will help climate change hazard vulnerability and tolerance assessment.
    b. Clear definition of high level 'adaptation concept and funding' measures, for inclusion in the Climate Adaptation Act (CAA).
    c. Preparation of spatial plans at a regional scale (including the mapping of those areas subject to climate-change hazards) to prevent <u>future</u> developments being put at risk.
    d. Preparation of statutory plans to appropriately add resilience to <u>existing</u> and future developments and land uses through regulation.[1]
    e. Agreement about cost sharing arrangements to fund adaptation measures.

16. More accessible tools are required to enable property owners to have a much higher level of awareness of the climate-change induced natural hazards they face. Recent changes to LGOIMA (1987) are a good additional means of ensuring Land Information Memorandums (LIMS) provide better information to support people to make more informed decisions about the climate change risks affecting their properties.

17. To further develop options for managed retreat, we look forward to engaging with central government, iwi / Māori, and communities to add to the necessary research priorities, outcome frameworks and metrics for the evaluation of success.

18. Finally, long-term commitment and cross-party support for climate change adaptation is critical if we are to ensure the required system-shift will be enduring.

[1] We note the newly elected National-led government has indicated a policy intent to repeal new resource management legislation. This may include rescinding all or part of the recently passed Natural and Built Environment and Spatial Planning Acts that provide a base for the preparation of Regional Natural and Build Environment Plans and Regional Spatial Plans. Details about the exact nature of the proposed new Government's repeal intentions are not yet publicly available. We have prepared this submission in this context.

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Part two: Introduction

19. Te Uru Kahika acknowledges the steps the Ministry for the Environment (MfE) has taken to seek the views of concerned individuals, groups, and communities about climate change adaptation and managed retreat. Their August 2023 issues and options discussion paper is an excellent scene-setter and provides well-shaped questions to guide consideration of this challenge.
20. In addition, we would like to express our congratulations to the 'Expert Working Group on Managed Retreat'. Their report (25 August 2023) tackles managed retreat in an authoritative and comprehensive manner. Most of the hard questions and the possible solutions are now on the table, courtesy of their efforts.
21. The opportunity we jointly face as New Zealanders is to either 'adapt' to the inevitability of climate change or to continue to suffer the consequences, and ever-increasing cost, of our maladaptation.
22. We are very conscious of the political risks and enormous cost of all of this. Adaptation to climate change will take courage, communication, community discussion and long-term multi-party commitment. Now is the time to establish a clear vision for what is required, and to set in place the mechanisms to achieve it.
23. Te Uru Kahika is well positioned to assist to meet this challenge. Members of Te Uru Kahika from Hawke's Bay, Auckland, Tairawhiti and Northland have been at the forefront of recent actions to build community resilience against extreme weather events – including applying land classification systems to assist retreat decisions and working alongside iwi, hapū and all communities affected. (Hawkes Bay case study-learnings are included as appendix one of this submission).
24. The flood events affecting West Coast, Canterbury, Marlborough, Nelson, and Southland regions in 2021 / 22 demonstrate that all other regions face similar threats. Their local government leaders have similar learnings from these events to pre-emptively apply, to better manage the consequences of future climate change-influenced extreme events.

Part three: Challenges, outcomes, principles, and priorities

Our shared challenge.

25. The essential adaptation and managed retreat need is for fair processes and a te Tiriti-based approach, clarity about individual and institutional accountability, strong legislation, robust funding mechanisms, openness to innovation and defensible science / hazard information to back all of this up.
26. Current policy / legislative signals and institutional arrangements appear a little overlapping and lacking in certainty about sequencing and leadership. A clearer 'system map' would assist Te Uru Kahika to better understand how the pieces of the adaptation jigsaw fit together. Te Uru Kahika is ready to step up to the plate to play our part – but we need certainty about the roles we are best placed to play and how these roles dovetail into the roles to be played by others.

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27. Aotearoa needs a solution that matches the scale of the problem we face. As noted by the Expert Working Group, it is not since World War Two that we have faced such a formidable challenge. An agreed framework for long-term and strategic adaptation actions must be secured by the end of 2024.
28. Adaptation requires equal attention to decarbonisation efforts. We cannot afford to take our feet off the accelerator of decarbonisation – but the inevitability of needing to speed up our plans to adapt is now even more clearly apparent. The only point of conceptual difference between the importance of decarbonisation and adaptation is that decarbonisation is a global issue requiring local solutions, but adaptation is a matter that we must solve for ourselves.
29. In addition to the challenges of climate adaptation and decarbonisation, our nation is also facing unprecedented biodiversity decline, for which solutions are also needed. Biosecurity challenges will also arise. We draw attention to this to emphasise the merit of applying nature-based solutions to the climate change adaptation fabric.

Challenge extends beyond flooding.

30. We note the focus of the inquiry appears to be toward climate-change-induced flooding – and retreat from those areas where community resilience to floods is not able to be achieved by other means.
31. We know that coastal erosion and inundation and land slips have not been forgotten but they do not appear to feature in the background work as fully as perhaps they should.
32. Also important is wind, drought, and fire – but we note these are more open to non-retreat resilience-building tools than flood / coastal inundation effects.
33. In addition, we note climate change risks extend well beyond urban environments. Our farming and rural communities, including many hapū and marae, are just as vulnerable.
34. We urge adoption of a comprehensive approach to your inquiry, including exploration of measures to improve the resilience of our natural water and biodiversity systems against drought conditions. Greater Wellington Regional Council has developed a case example of how this may be achieved in the Wairarapa.

Outcomes and principles.

35. In general terms, we found the outcomes and principles enunciated in the first National Adaptation Plan (NAP, 2022) to be sound – and with minor amendment, suited to application to the current adaptation discussions.
36. Overall, our shared goal should be to strengthen community resilience against the effects of climate change by:
    a. Reducing vulnerability to the impacts of climate change.
    b. Enhancing adaptive capacity in community centric ways.
    c. Considering climate change in all our decisions, at all levels.
37. The principles we should apply to our climate change adaptation decision making should include enabling Māori led approaches where desired, being proactive; thinking long term; maximizing co-benefits; promoting equity; collaborating and adjusting as we go; making informed decisions by using the best available evidence; working with nature and applying nature-based solutions; always being open to

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innovative solutions; and clarifying the roles to be played nationally, regionally, and locally and between whanau / iwi, businesses, the insurance sector, communities and individuals.

38. In addition, we know that we will need to work together to ensure application of an approach that recognises the hardship, deprivation, and socio-economic sensitivity of some communities and individuals i.e., we will need to support those persons and families who have a clear need, rather than trying to assist everyone who may suffer economic loss and hardship.

39. Our final point on this subject is a call for help to clarify the priority to be accorded to competing outcomes arising from established national direction. The example we use to display this concern is the interface between managed retreat requirements and:
    a. National Policy Statement on Urban Development outcome of housing affordability / availability OR the…
    b. National Policy Statement on Highly Productive Land that may restrict future use of Māori land (held in general title) for papakāinga housing.

Part four: Effective mechanisms and actions for community-led decision making.

Community-led or community-focused?

40. We resile a little from the use of the term ‘community-led’ decision making but understand and appreciate the sentiment underpinning this. Our preference is to use the terms ‘community-focused’ or ‘community-centric’.

41. Our concern about the term ‘community led’ is centred in local government’s past experiences. These demonstrate that sometimes (as was the case for Kāpiti District Council and as will likely be the case for Buller District Council re Westport), the final and hard decisions about managed retreat may not be secured if the focus is only on ‘community-led’ decision making processes.

42. Regardless, we agree that communities need to be fully involved in decisions about their future. We also agree that it is critical to seek out different views across a community on the risks they face, what language and processes to use, how best to respond to those risks, how to fund those responses and what institution is best placed to lead resolution processes.

43. Māori communities should also be central in decision-making, planning, and executing climate change strategies. Our discussions with iwi suggest the language of 'retreat' is not liked by Māori. We propose the task of finding better language be left to mana whenua. Relocation might be more proactive because it includes the element of help/assistance with where to go.

Mechanisms – priorities?

44. We recommend application of a sequence of mechanisms to achieve higher levels of community resilience against the effects of climate change.

45. The priority action is to better understand the climate change risks we face in each of our regions. The concepts addressed in the ‘National Climate Change Risk

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Assessment for New Zealand' report (August 2020) provide good ground for developing this understanding.

46. This report makes use of information related to exposure, vulnerability, and risk tolerance - with the latter referring to the extent to which we accept risks to the things we value – health, environment, economy, buildings, and infrastructure.

47. To document how best to apply these concepts in the regions, we would be assisted by having national consistency about exactly what each of these concepts mean and by having good science and agreed standards to back them up. The target of having adequate information to support consistent and robust risk assessment and adaptive planning across the country is close to being met, but more work is required to make it consistent and accessible.

48. Toward this end, we have appreciated receiving information about:

a. Climatic change and extreme weather hazard locations for different emissions scenarios (noting NIWA have done a Stirling job to help define this already).

b. Susceptibility of areas to slips from heavy rain, drought, and rapid wet and dry changes.

c. Sea-level rise projections – (noting that Victoria University's NZ sea-rise programme and NIWA's Future Coasts programme have provided excellent location-specific information on this).

d. Specific property-based information about risk and exposure to natural hazards – as provided via the Toka Tū Ake / EQC portal.

49. We also support the recommendations of the Expert Working Group about opportunities to improve our approach to risk assessment. We are in accord with the Working Group in suggesting there is a need to:

    a. Give more certainty about who carries out risk assessments and how they are to be done.

    b. Establish preferred methodologies for undertaking risk assessment and risk tolerance assessments – with the latter perhaps best carried out by territorial local authorities and communities and iwi / hapu.

    c. Establish standardised terminology and definitions, including thresholds for levels of risk tolerance.

    d. Establish a risk threshold, or criteria to determine a threshold beyond which communities must consider retreat as an option.

    e. Provide for input on risk assessments for Māori land conducted by Māori, with appropriate support, and the use of Māori frames of reference, alongside the standard approach.

    f. Establish a range of expert groups at national, regional, and local levels to support the technical nature of risk assessment.

    g. Secure institutional arrangements that separate the following roles: standard setting, undertaking risk assessment and quality assurance (and the politics / value judgements affecting these things).

50. With the above points in mind, we can see merit in applying the following sequence of actions to the task of improving our resilience to the effects of climate change:

    a. Develop national science-based climate change impact scenarios, founded on agreed event frequency / magnitude, and identify and prioritise how these may affect regional, and local communities in low, moderate, and significant ways.

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b. Develop community understanding and agreement about their vulnerability to climate change events and their tolerance for the impacts of these events.

c. Apply a well-considered planning process, with the right authority held at the right level, and record this in the right legislative instrument, for example:

  i. Use of the Spatial Planning Act and Regional Spatial Plans to better manage both current and <u>future</u> land uses and developments at sites at risk from climate change.

  ii. Use of the Natural and Built Environment Act and Regional Natural and Built Environment Plans to manage <u>current</u> land uses and developments at risk from climate change.

  iii. Use of the Climate Adaptation Act to better define the complex legal, institutional, and funding issues associated with managed retreat and adaptation to climate change.

d. Commit to the well-founded adaptive management approaches.

e. Apply the best site-specific interventions to achieve the best-value community resilience possible, using a concert of protection, avoidance, retreat, and accommodation measures (PARA).

55. We can also see merit in consistently seeking out the co-benefits associated with climate change adaptation actions such as reversing biodiversity decline.

Other mechanisms to help community-focused decision-making.

56. We also see a need for more guidance and clarity about:

  a. How land may be used after retreat.

  b. The ‘rights’ of utility service providers to withdraw essential infrastructure services, in concert with retreat decisions.

57. Protection from liability is also important. Those local government decisions made in good faith and with good information – including decisions about the ‘level of service’ to be provided by flood management infrastructure, should not be subject to Court-focused liability challenges, unless they are found grossly negligent for not taking necessary action.

58. We would like to see the further cultivation of an environment that respects and utilises Māori innovations and insights in enhancing infrastructure and adaptation strategies.

National Adaptation Plan.

59. The Government prepared the first National Adaptation Plan (NAP) in 2022. Te Uru Kahika participated in the development of this NAP.

60. The current document brings together the Government’s efforts to assess and address risk.

61. We were saddened to see, despite our participation in the preparation of the first NAP, that it makes very little reference to local government actions. We recommend that future NAPs:

  a. Provide more clarity about the accountability and responsibilities and intended actions of local government, alongside the actions of central government and other agencies.

  b. Better define and support the special kaitiaki role of Māori for natural capital and ecosystems by committing to resourcing roles and responsibilities.

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c. Develop clearer measures and approaches to vet potential actions and determine which are likely to offer the greatest benefits for adaptation.
d. Make more fulsome reference to the important adaptation role played by flood protection and river management schemes.
e. Commit to working more closely with the science sector, iwi/Māori, policy makers and regional authority experts to develop a holistic future-focused research strategy for climate change adaptation.
f. Establish a joint oversight group to coordinate the delivery of the many necessary work programmes. (NB such an oversight group should be comprised of central/local government and iwi/Māori, working in partnership and in accord with te Tiriti principles).

Natural hazard risk assessment and climate change adaptation plans.

62. Under the Resource Management Act 1991, councils are required to control the use of land for the purposes of avoiding or mitigating natural hazard risks. Risk assessments undertaken for this purpose, generally provide the basis for local and regional climate change adaptation planning.
63. Currently there is no national direction, nor consistency in the preferred approach to natural hazard assessments.
64. We recommend that Te Uru Kahika and MfE work more closely together to establish a template and a 'hands-on' network of officers and officials to support the accelerated development of climate change adaptation plans.
65. We recommend the involvement of Māori communities and their traditional knowledge in risk assessment to enhance the effectiveness and cultural sensitivity of these endeavours.

National Policy Statement on Natural Hazard Decision Making.

66. A draft 'National Policy Statement on Natural Hazard Decision Making' is currently available for comment. We welcome the release of this draft even though it may shortly be overtaken by other more comprehensive instruments. We intend to prepare a submission on its content. We see it playing a critical role in helping local authorities immediately manage resource consent applications for housing 'in-fill,' subdivisions, and building consent applications - in those areas clearly subject to the effects of climate change.

Emergency Management Bill.

67. Te Uru Kahika will also prepare a submission (required by 11 November 2023) on the Emergency Management Bill. We mention this to draw your attention to two points:
    a. Flood management infrastructure should be included in the Bill's definition of critical infrastructure.
    b. The promulgation of the Bill is yet another indicator of the overly complex web of legislative and institutional arrangements with effect on climate change adaptation.

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Part five: Te Tiriti based approach to decisions about climate change adaptation[2]

51. Te Uru Kahika fully supports the need for a Te Tiriti based approach, and for increased focus and nation-wide learning on how to do this well. A Te Ao Māori view is by its very nature integrated, balancing what is good for people, the whenua, water, and climate, as well as protecting whakapapa, enhancing whanaungatanga and ensuring intergenerational sustainability and prosperity.
52. Both the Crown and local government have obligations to give effect to the principles of te Tiriti o Waitangi, including through empowering iwi/hapū to take Māori-led approaches where desired, integrating mātauranga Māori and te ao Māori across the adaptation system, and resourcing iwi/hapū to actively lead or participate in climate change decision making. Later in this submission, we provide additional information about how this may be achieved and more detail on the barriers to achieving good climate adaptation outcomes for Māori.
53. In this submission, wherever we discuss 'community' our assumption is that a partnership approach is taken with iwi/hapū, and wherever desired by Māori communities, Māori led processes are supported.
54. Our broader local government advisory network has suggested a te Tiriti o Waitangi framework for planned relocation should be developed to address, among other things, the:
    a. Special status of Māori land as taonga tuku iho.
    b. Unique rules that apply to Māori land under Te Ture Whenua Māori Act (1993).
    c. Relationship of Māori with the whenua and the customary rights and interests that arise.
    d. Importance of cultural infrastructure and taonga such as marae and urupā to iwi, hapu, and Māori.
    e. Challenges that planned relocation poses to the recognition of customary marine title under the Takutai Moana Act.

Barriers to achieving good climate change adaptation outcomes for Māori.

55. We agree with the barriers to Māori participation identified in the MFE issues and options paper (chapter 2) and agree that dedicated efforts need to be put in place to uphold Māori rights, including land protection and respect of Tiriti agreements.
56. Using the MFE's issues and options paper's four categories of barriers, we list below examples, based on our local government Māori staff experiences, of why current government led climate adaptation processes often fail to achieve good outcomes for Māori. We hope this might help to remove some of those barriers in the design of a comprehensive system within Aotearoa for climate adaptation.

[2] One of Te Uru Kahika's three strategic priorities is Te Ao Māori Partnerships. Working in genuine partnership with iwi, hapū and marae is essential for all regional and unitary councils, and for achieving good community outcomes. One way in which Te Uru Kahika supports these partnerships is through Ngā Kairapu - our Māori special interest group. Ngā Kairapu, made up of Māori staff from most of the regional/unitary councils in Aotearoa, has close connections with iwi and hapū around the motu. This section of the submission is based on lessons learned and experienced through working alongside Māori communities as Māori council staff, as well as insights gained from Ngā Kairapu members belonging to specific iwi and hapū.

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Barriers listed in Issues and Options Report	Examples
Barriers to Māori participation in climate change adaptation and upholding Māori rights and interests	• Processes and options are often focused on the majority, not the most vulnerable/impacted Māori communities • The options proposed sometimes assume that there are places for hapū and communities to go/retreat to • Central and Local Government do not yet understand how to enable and support Māori-led processes • Some climate adaptation responses or options can compromise Tiriti settlements • The fact that many mana whenua live within the wider community and not just within their own papakāinga and marae communities is often overlooked, meaning they can be excluded from the process or marginalised within majority community views • Māori communities often face the challenge of engaging with central and local government on multiple priorities simultaneously, leading to overburdening and limiting their capacity to effectively participate in climate adaptation planning.
Variable quality of risk assessments and local adaptation planning	• Processes don't acknowledge or incorporate the long-held knowledge and experiences of mana whenua in adapting to changing climate and weather • The language used (e.g. retreat) is not congruent with the way Māori communities already live, in constant adaptation and flexibility • There is a lack of quality information at a localised level, or at least a lack of careful translation, facilitation, communication and shared understanding about the risks and options
No enduring and comprehensive system for community-led retreat	• Lack of understanding of how to enable Māori led approaches that are different in each place • Some agency-led initiatives can lead to or appear to result in further dispossesion of lands and rights
Gaps in our funding approach	• Lack of funding overall, or complicated fund application processes, or funding tagged to uses that are not suitable for iwi/hapū led processes.

How to enable and support Māori-led processes.

57. Specific examples of things Central and Local Government and other agencies can do that 'enable and support Māori-led processes' and therefore ensure Māori rights and interests (and Te Tiriti) are upheld include:

   a. Take an empowering partnership approach from the start in overall adaptation approaches:

      i. Avoid rules or guidance that advise government to 'seek Te Ao Māori input.'

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  - ii. Enable and support wānanga approaches to community discussions within Māori-led processes where that's desired by iwi/hapū.
  - iii. Ensure decision making and participation opportunities for iwi/hapū in their own communities and regions. Put marae and hapū at the heart of solutions and policy design, and empower them to identify their needs, issues, and challenges.
  - iv. Provide non-rushed processes and timeframes that allow iwi/hapū to discuss (without outside agencies if desired) and process the changes, their implications, and desired outcomes.
  - v. Provide and support flexible options for iwi/hapū to develop clear decision pathways with all the information on hand (not just engineering advice).
  - vi. Consider how to involve mana whenua who live in wider community settings.
- b. Enable and foster Māori-led climate resilience strategies and implementation plans:
  - i. Cultivate an environment that respects and utilizes Māori innovations and insights in enhancing infrastructure and adaptation strategies.
  - ii. Ensure Traditional Ecological Knowledge (TEK) has influence and inclusion. Proactively address data sovereignty concerns and respect that rangatiratanga of mātauranga belongs with iwi/hapū/whānau.
  - iii. Work with Māori experts, contract dedicated Māori capacity and use unique Māori tools.
  - iv. Offer co-design opportunities for community communications and technical information.
- c. Ensure that access to and use of funding is flexible enough to be tailored to unique needs of Māori communities, and provide resources for:
  - i. The interpretation/translation of technical data, models and tools in ways that make sense to people at place.
  - ii. Locally based risk, resilience and tolerance assessments for marae and local communities.
  - iii. Wānanga and other processes (and support this through kai, communications, information, understanding, travelling to iwi/hapū, and practical help such as shifting chairs and serving tea).
- e. Implement guidance and resourcing to ensure that central and local government become better partners, including resources to help with:
  - i. Learning from and promoting Māori perspectives and adaptation experiences to foster respect and acknowledgment of a long history of pragmatic adaptation to change.
  - ii. Working with Māori experts right from the start to inform the way forward.
  - iii. Developing capacity at all levels of government to build relationships and integrate te ao Māori and mātauranga into policy.
  - iv. Well-designed communications developed with Māori communities.
  - v. Enabling regional government to work with central govt to appear almost as one agency for iwi/hapū.
  - vi. Understanding kaitiaki and hapū networks and the mahi they're doing on the ground (and therefore resources they need).

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vii. Supporting development of specialised facilitators to help with community conversations.

Part six: Potential institutional arrangements

Central government leadership.

68. Since 1989, Crown agencies have taken a somewhat piecemeal, disconnected, reactive and project-based approach to climate change resilience planning and investment, including for flood risk mitigation. The relationship between the Select Committee Inquiry and the DPMC supported / Roche-led 'Government Inquiry into the Response to the North Island Severe Weather Events' is an example of this.
69. In the past, the Crown's role has also been focused on responding, rescuing and cleaning-up the damage of extreme climate-change influenced events and helping communities to recover i.e., the ambulance at the bottom of the cliff.
70. A much higher level of central government collaboration with local government, iwi / hapu and communities and the designation of a strong single point or mechanism for leadership is required 'at the top of the cliff' i.e., on risk mitigation. This objective could be achieved by:
    a. Making necessary changes to legislative and regulatory frameworks including departmental 'statements of intent.' to clarify who will do what and when, for example:
        i. NEMA continuing to focus on responding to extreme climate-related events.
        ii. MPI working with Regional Authorities to assist the primary sector (in specified regions) to transition to a more drought prone climate regime.
        iii. MfE continuing to develop necessary climate change adaptation policy and legislation.
    b. DIA supporting local government to be a trusted partner of central government in all climate change matters.
    c. Requiring (perhaps via Government Policy Statements) alignment of the climate change related 'level of service' to be provided by utility network agencies such as Waka Kotahi with Regional Authority's resilience initiatives (NB this would help to ensure Waka Kotahi bridges and adjacent flood management infrastructure work in tandem to achieve community resilience rather than one undermining the other).
    d. Exercising Government departmental leadership over climate change resilience by establishing a 'lead' government agency, with much improved methods of support and collaboration between all relevant agencies (NB One option is for DPMC to continue to provide the scale of leadership they have exercised over Cyclone Gabrielle recovery and retreat initiatives for future similar events).

Local government leadership.

71. Local government (regional and territorial authorities and mana whenua) are well positioned to continue to contribute to community resilience decisions by:

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a. Prioritising expanded flood risk resilience decisions, including optimising Te Mana O Te Wai and nature-based solutions.
b. Working with the government to develop a co-investment formula for application to community risk resilience-improving investments.
c. Making land use / spatial planning decisions that accelerate managed retreat from hazards and prevent new development in 'at risk' areas.
d. Growing their capacity and capability to deliver capital projects that may provide a level of protection against flooding and coastal inundation.
e. Actively engaging with iwi and communities to support the urgency of taking necessary community / iwi-hapu-led risk resilience actions.

Other agencies.

72. Utility providers would help by:
    a. Making a commitment to work more collaboratively with providers of other 'at risk' resilience-improving interventions.

Escalation when local and regional decision-making fails.

73. If community-led adaptation mechanisms fail, there may be a need to activate a call-in power, enabling the responsible Minister to take action in certain circumstances, such as when the relevant decision-maker is unable or unwilling to discharge their functions (possibly because of local political pressure).
74. An alternative to 'call-in' is to consider the 'Commissioner' model established under the RMA for water management matters. The beauty of the Commissioner model is that it may provide the equivalent of an expert 'friend of the court' to help manage and facilitate collaboration amongst parties, and the resolution of residual resilience issues.
75. The need for escalation would diminish if litigation opportunities were restricted to points of law or unreasonableness, although we note the tension that exists between this and the principles of natural justice.

Part seven: Lessons learned from recent severe weather events.

Tairawhiti.

76. Small and isolated communities – including those located in eastern Tairawhiti have unique challenges requiring custom built and community / whanau focused solutions.

Hawke's Bay.

77. Inevitably there have been elements of 'flying the plane while designing it' in Hawke's Bay, but solutions were found. Some of these solutions are suited to application within other regions, including:
    a. The guidance and linkage to central government / DPMC-led decision making, as provided by region-specific Ministers and the Roache-led Cyclone Gabrielle Recovery Task Force.
    b. The regional focus on hazard definition and related-land categorisation (1, 2A, 2C, 2P or 3).
    c. The property-based focus of territorial local authorities.

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Auckland.

78. Auckland's flood experience was more pluvial and land slippage-related than river-flood related.
79. The land use planning implications arising from the need to upgrade storm water management systems and to 'make more room for water' include expensive buy-back and community relocation decisions.
80. These decisions will give rise to tensions with the objectives of the National Policy Statement on Urban Density. They will also affect the general desire to increase the affordability of housing. The National Planning Framework will need to provide clear guidance about how these tensions may be resolved.

Westport

81. Westport is the case example of social upheaval, damage and costs that could have been avoided if more central government 'adaptation' assistance had been available earlier. The investment of around $10m would have saved the $100m expenditure made on recovery after the July 2021 flood event.
82. The Budget 2023 package for Westport community resilience interventions is a belated but good case example of how to address flood challenges. This is because it has a focus on application of an adaptive management approach via the parallel use of:
    a. Protection measures (river embankment structures).
    b. Accommodation measures (including upgraded CDEM response).
    c. Avoidance measures (including raising house floor levels and entrenching necessary district plan provisions).
    d. Managed retreat measures (by making land, infrastructure, and community development plans available at the drier Alma Road site located to the Southwest of Westport township).
83. Nevertheless, challenges remain that may be resolved as part of the current Inquiry and policy development focus. These challenges include the:
    a. Unwillingness of the Crown to share in the cost of the managed retreat of approximately seven houses at Snodgrass peninsular.
    b. Absence of a commitment from Waka Kotahi to give priority to the raising of Westport's state highway bridges.
    c. Importance of a mechanism to ensure the new 'affordable water' entities give priority attention to investment in stormwater pumps (to prevent stormwater ponding within the proposed Westport embankment).
    d. Need for government assistance (perhaps via the NPS on Natural Hazard Decision Making) to avoid housing infill and further subdivision within areas protected by Westport's proposed embankments.

Iwi / hapu past involvement in adaptation.

84. There have been many lessons learned by councils and iwi / hapū in these affected regions about their partnerships and ways of working together/what processes have been good / not so good.

Importance of flood management structures.

85. The key 'immediate' tool, for application at most locations remains the construction of flood management infrastructure because this will buy time for other climate change

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adaptation tools to be developed and applied. But in making this comment, we note that before applying this solution, regional authorities have agreed to test and apply – to the greatest degree possible:

a. Nature-based / Te Mana O Te Wai solutions as part of the design of infrastructure-based solutions.
b. An adaptative management approach that fully recognises the limits to the community resilience achieved from structural solutions – and the associated need to transition or work in parallel with avoid, accommodate, and retreat solutions.
c. Innovation – noting the challenge we are facing means we can't just do what we have always done but bigger. We need to expand the toolbox by constantly searching for new solutions.

86. Government must return to the co-investment table, on a long-term basis, to support a ten-year pipeline of investment in flood management infrastructure. The authorising environment and social license to make this step change has never been stronger.
87. The necessary decade-long co-investment will enable higher levels of 'climate change' resilience to be achieved across New Zealand's existing 367 flood protection schemes. In the case of Wairoa and at several other locations, new / additional schemes will be a necessary part of this longer-term solution.
88. Co-investing in river management infrastructure protects matters of national interest - roads, railways, other infrastructure such as sub-stations, communication towers, landfills, airports, schools, hospitals - and the continued functioning of communities and economies. Flood management structures are 'critical infrastructure that protects other infrastructure'.
89. The estimated ten-year sum required from central government as a co-investment in flood management structures is estimated to be $2.5billion. Regional authorities are positioned to contribute a similar sum.
90. Once this funding commitment is made, decisions will then be required about the:
    a. Priority locations for this investment throughout Aotearoa.
    b. Level of 'community resilience' service to be provided by this investment, at each location.
    c. Relationship between the level of resilience to be provided by this 'protection' infrastructure and how (if necessary) a transition will be made to other longer-term avoid, accommodate, and retreat resilience-building measures.
    d. Methods to ensure optimal application of 'nature-based solutions.'
91. Initial Covid recovery Government (2021) co-investment of $211m in 57 flood protection schemes, was worth its weight in gold, as demonstrated by the flood management role played by these structures at Taradale during Cyclone Gabrielle and in Kāitaia during their 2022 floods.
92. A proposal for the co-investment of a further $257m in 92 similar projects is currently being considered by Treasury and DIA.

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Part eight: Role of the private sector in managing climate risk.

Property owners.

93. Recent changes to LGOIMA (1987) will help ensure Land Information Memorandums (LIMS) provide better information to support people in their making of informed decisions about natural hazard and climate change risks. Te Uru Kahika supports these changes. Our property system must take a 'let the buyer beware' approach. People who knowingly develop or buy properties in risky areas should bear the consequence of their decisions.
94. Many more tools than just LIMS are required to ensure property owners are aware of the climate change influenced natural hazard risks they face. We look forward to working with Government to consider how best to achieve the necessary level of natural hazard awareness.

Insurance.

95. Without clear climate change adaptation and community resilience building investments, Aotearoa will continue to experience partial or full insurance retreat. These insurance decisions will spark very negative effects on all parts of the economy.
96. The flip side of this is that insurance withdrawal may be a key mechanism to drive people to move, but this gives rise to 'just transition' issues. Provisions will also need to be developed to enable property owners, who purchased their property at a time when they could not have reasonably been expected to consider the impacts of climate change, to be given time or help to respond. Questions about the deadline beyond which offers of help may 'run-out,' also need to be addressed.
97. The Insurance Council of New Zealand has noted their support for maintaining the affordability and availability of insurance only if there is a proactive focus on controlling, avoiding, and accepting a degree of residual risk, in the face of climate change.
98. In addition, we see a need for the formulation of strategies addressing the distinct health challenges and evolving insurance scenarios impacting Māori communities due to climate change. As local government, we work closely with Te Whatu Ora in our regions, and we support inclusion of processes and mechanisms (Māori-led where desired) that integrate health and wellbeing.

Part nine: Finance and funding

National Resilience Fund.

99. Local government's funding system is under pressure. This pressure is not sustainable. Councils lack the financial capacity to adequately invest in adaptation on their own. An annual transfer of revenue to local government to support pre-emptive climate change adaptation activities is critical.
100. The $6b resilience fund announced as part of Budget 2023 was an excellent start to the challenge of securing funds to address climate change adaptation. Much of this will provide welcomed assistance to recover from the extreme weather events

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experienced earlier this year, including for road and flood management infrastructure repairs in Nelson / Marlborough, Northland, Auckland, Tairawhiti and Hawkes Bay. Some will also be used to meet the cost of managed retreat – with a focus on Auckland, Tairawhiti and Hawkes Bay, and possibly also on South Dunedin.

101. The number and intensity of extreme weather events will increase. Ad hoc or 'contestable funding' responses will not be sufficient - although the salience of a recent event provides a substantial 'not to be missed' opportunity to expedite necessary 'retreat' decisions.
102. By comparison, pre-emptive, 'before event' preparatory retreat presents a much higher level of challenge for all parties, but it is certainly not 'fanciful' to commit to progressing these challenges.
103. Certainty about preferred funding arrangements is a critical ingredient for the implementation of successful climate change adaptation measures. Local authorities are obliged to prepare detailed budgets in three-year cycles, as well as 30-year infrastructure strategies. If a funding source is contestable, we can't rely on it, which makes responding more difficult than it should be. Also, if we had clearer criteria around funding / cost-sharing, it might help to depoliticise some of our decision making.
104. Social assistance, community development and other post-relocation costs must be considered, as part of the 'managed retreat' funding and financing framework. There is also a need to further explore alternative funding models to facilitate climate change adaptation. This could include using government green bonds (with the revenue transferred to local government) or greater provision of concessional debt finance for climate adaptation.
105. In addition, we call for the deployment of equitable and transparent funding models to back Māori-led initiatives and address their distinctive needs in the adaptation framework. We agree with the need to discuss bespoke funding arrangements with iwi/hapū. One option we have heard of involves setting-up a central autonomous Tiriti based Te Ao Māori unit to support independent iwi-based participation in climate change matters.
106. The cost apportionment between ratepayers, Government, iwi/hapu/whanau, and property owners in Hawkes Bay may provide a model suited to application to other regions facing equal situations.
107. For many larger local authorities – most of whom have cities on the coast, the biggest challenge will be that of meeting the cost of structural solutions to sea level rise and inundation, in those circumstances where this is the most cost-effective intervention. This cost will be enormous and impossible to meet under existing local authority funding constraints / ceilings. However, the cost of managed retreat from affected city locations will be even larger, but still required. We will need to be clear-eyed about the limitations of structural solutions in the long-term for our big cities.
108. The cost of both managed retreat and structural solutions will bankrupt New Zealand's local authorities unless careful decisions are made about how much adaptation to address, where, when and with what type of cost-sharing formula.
109. We are aware Treasury have been exploring funding options based on the EQC precedent and the use of other financial instruments. We would urge this work be accelerated.

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110. In addition, we are mindful there are options to explore around using ETS revenues for local adaptation measures.

Part ten: Targets and indicators for assessing progress.

107. We are under no illusions about the magnitude of the climate change adaptation challenges Aotearoa faces. We congratulate government on the progress it has made so far. Cyclone Gabrielle was a necessary wake-up call. The risk we face is that the cost-of-living pressures we currently face, and the comparatively weak state of the New Zealand economy become an excuse for not taking necessary measures. Jointly, we cannot let that happen.
108. The task of defining targets and indicators for assessing progress is something Te Uru Kahika would like to partner with central government and iwi / hapū to develop.
109. One target is clear. We strongly support the need to proceed at pace to inform development of the Climate Change Adaptation Bill – and to get it adopted in 2024.
110. As part of the process of preparing this Bill, there is a need to implement feedback loops with Māori communities to incessantly refine climate and retreat policies to ensure cultural compatibility and dynamism.

Part eleven: Conclusion and next steps

111. The MFE discussion document and the Expert Working Group's report provide excellent frameworks to guide necessary future discussions.
112. What we are looking for on the institutional front, is strong and clear central government guidance; respectful and trusting partnerships between local government, central government, and iwi; and a system that ensures strong local representation and ownership of decisions.
113. Te Uru Kahika would welcome the opportunity to be part of any group established to further progress the matters raised in this submission and to develop answers to the tough questions it poses.

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Appendix one: Learnings from Hawke's Bay

Cyclone Gabrielle – the event

1. Cyclone Gabrielle occurred after 6 months of the wettest weather Hawke's Bay has ever experienced. The Esk Valley rainfall site recorded half a metre of rain in 24 hours. The equal of 6 months of usual rainfall occurred between 1am and 7pm on 14 February 2023. Thirty breaches occurred in 250km of stop banks and there was 28km of stop bank damage overall.

Early central government funding assistance

2. The provision of early financial assistance toward recovery from government was important and appreciated. This included \$35.4m for the well-being of rural communities, \$10.5m for woody debris management and just over \$200m for the disposal of silt and debris.

Centrally led or locally led.

3. With current drivers, not all necessary decisions would have been made if this was totally 'community led.' NB the difference between Christchurch and Hawke's Bay was the latter was locally led and centrally supported. This was viewed as far better than the centrally led, and locally supported approach applied in response to the greater Christchurch earthquake. Both approaches were viewed by some property owners as too directive.

4. DPMC and Treasury were good partners to local councils as was members of the Roche panel. MFE's strength will be in helping to craft the CAA. Regional Ministerial leadership x 3 regions could have worked well – but the appointed Ministers kept changing.

Land use and property categorisation

5. Early and decisive development of the property / affected-land classification system was valuable. This system lends itself to future use in similar post event circumstances – but with refinements.

6. Decisions about what properties fell into categories 1 and 3 were comparatively easy. 2 was more difficult – with 2P providing particularly problematic. Decisions to quickly move some properties from 2 to 1 – when information became available, was important. This provided assurance about insurance and enabled people to get on with their lives.

7. A total of 300 properties were confirmed as falling into category 3. Managed retreat from these properties is mostly managed by Hastings District Council.

Vulnerability to risks and tolerance to risk.

8. Land categorisation decisions were about 'vulnerability' and were technical in nature. Limited opportunity was provided for political / councillor override. 'Tolerance' is a less precise term with more variance. It was not extensively applied but officers were not immune to awareness of varying positions on this.

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9. The system provided an ability to 'make-good' on some past unwise property development decisions. Proposed legislative changes should add more rigor to future decisions.

10. There is a need to be careful to ensure the system does not incentivise property owners to decide to under insure or to not to take out insurance.

11. Local solutions e.g., multi house flood protection embankments, may be difficult to achieve in some circumstances because affected locals may find it difficult to fund their share. A speedier path is required to achieve these community level interventions e.g., local stop banks.

12. Initial categorisation decisions were made without the benefit of knowledge about the more-recently agreed cost share formula for property buy-out. This was probably a good thing. The formula is now on the table: after insurance, basically 50% is contributed by the Crown and 50% from the local authority. This has been supported by the local councils. But even 50% is difficult to achieve in places like Wairoa – because of the size of the impost on ratepayers.

13. Uncertainty remains about whether the cost share formula should be based on the property or the house value. Current decision making is weighted toward the later. This created some tension for life-style block owners with small scale orchards etc. but the lines needed to be drawn. The focus was and should be on risks posed to people / habitation rather than land uses per se. Equity of funding and insurance questions are yet to be fully resolved.

14. Operating managed retreat pre-emptively will be infinitely more challenging than applying it after a significant event.

Other matters

15. The system has been branded as voluntary. But loss of insurance and loss of infrastructure services may make it difficult for it to be voluntary. There are also legislative difficulties in terminating infrastructure services. These challenges need to be resolved via the inclusion of appropriate provisions in the CAA. The system could be helped by establishing a 'Commissioner' to whom concerned property owners could appeal land classification decisions – with powers of final decision making, and no liability.

16. There is a need for more consistency and clarity about the degree of protection provided by flood management structures – what is the right level of protection to provide where and why

MEMORANDUM
Policy & Planning

Date 21 November 2023

Subject: Development of a joint Future Development Strategy with New Plymouth District Council

Approved by: A D McLay, Director - Resource Management

S J Ruru, Chief Executive

Document: 3221487

Purpose

1. The purpose of this memorandum is to inform the Policy and Planning Committee on the requirements for the Taranaki Regional Council (TRC) to work with New Plymouth District Council (NPDC) on the development and implementation of a Future Development Strategy (FDS), under the National Policy Statement on Urban Development (NPS-UD) 2020.

Executive summary

2. The NPS-UD mandates a range of requirements on local authorities to provide for development capacity within their administrative boundaries, including the requirement for developing and implementing a FDS.
3. The FDS is a strategic framework intended to support local governments in creating and maintaining well-functioning urban environments, while providing for sufficient development capacity and integration of infrastructure decisions to meet the housing and business needs for their communities over the next 30 years.
4. Taranaki Regional Council and New Plymouth Councils are both Tier 2 local authorities under the NPS-UD, and as such they have a joint responsibility to develop and implement a FDS by utilising a special consultative procedure under section 83 of the Local Government Act 2002. This must be done in time to inform or at the same time as the local authorities' 2024 long-term plans (LTPs).
5. Staff of both Councils are presently cooperating to formulate a draft FDS and a proposed governance structure to fulfil the FDS requirements of the NPS-UD. The key components of this process are set out in this memorandum.

Recommendations

That the Taranaki Regional Council:

a) receives the memorandum *Development of a Future Development Strategy with New Plymouth District Council*

b) notes the background context for the National Policy Statement on Urban Development 2020

c) notes the combined obligations of the Taranaki and New Plymouth Councils, as directed under the National Policy Statement on Urban Development 2020, to develop a Future Development Strategy using a special consultative procedure under section 83 of the Local Government Act 2002

d) notes Taranaki and New Plymouth Council's collaborative arrangements for delivering the Future Development Strategy

e) notes the requirement for a joint committee to be developed to facilitate the special consultative procedure, including consideration of iwi representation, and for options on this process to be brought back to the committee in February 2024

f) delegates to the Chief Executive the authority to seek recommendations from iwi regarding the appointment of a iwi/hapū representative on the joint committee.

Background

6. In August 2020, the government released the NPS-UD (Appendix 1), superseding the earlier National Policy Statement on Urban Development Capacity (NPS-UDC) 2016. The NPS-UD provides local authorities with a consistent national framework by setting national objectives, policies, and implementation requirements in a way that will strengthen the urban planning system and land-use management practices in urban areas.

7. TRC and NPDC must develop and implement an FDS[1] as Tier 2 local authorities for the New Plymouth district.

8. The purpose of an FDS is to promote long-term strategic urban planning by local authorities, setting out how local authorities will achieve a well-functioning urban environment, while providing for enough development capacity to meet the expected rates of growth and demand of their communities for the next 30 years.

9. The objectives and policies of the NPS-UD that guide the development of the FDS seek to achieve four main outcomes:

    9.1. the development and implementation of an FDS to show how and where future development will occur in the district over the next 30 years;

    9.2. to accommodate foreseeable growth by providing sufficient development capacity to meet the market demand and being responsive to unanticipated or out-of-sequence developments;

    9.3. evidence-based decision making that requires local authorities to gather data on the local demand for housing and business to inform urban planning decisions; and

[1] Part 3, Subpart 4, of the NPS-UD – requirements of an FDS

9.4. engagement with key stakeholders to better align infrastructure and planning-decisions.

10. It is noted that Central Government has been providing policy direction in relation to growth and housing supply for a number of years. However, the requirements on local authorities have changed over this time.

11. TRC and NPDC have previously collaborated to prepare an FDS under the now repealed NPS-UDC. However, this work was not advanced to implementation due to the release of the NPS-UD, which initially removed the requirement for New Plymouth to have an FDS in place. This requirement was later re-introduced.

12. The earlier FDS, prepared under the NPS-UDC was prepared in accordance with a differing set of criteria and policy direction to what is now required. A review of the documentation has been undertaken and it is considered to be unsuitable for adaptation to satisfy the updated requirements of the FDS under the NPS-UD

Discussion

FDS requirements under the NPS-UD

13. The NPS-UD sets out purpose and content requirements of the FDS and requires a range of different information sources for its evidence-base to inform its development[2]. Key requirements to inform the FDS include:

    13.1. an up-to-date Housing and Business Capacity Assessment (HBA) . The HBA is a detailed analysis of housing and business growth across the New Plymouth District that is produced every three years;

    13.2. consideration of the advantages and disadvantages of different spatial scenario, Councils' LTPs and infrastructure strategies, tangata whenua values and any other national direction that is relevant;

    13.3. engagement with key stakeholders, including the development community and key infrastructure providers[3]; and

    13.4. a statement of values and aspirations of iwi and hāpu[4].

14. Importantly, the NPS-UD requires the first FDS to be published in time to inform, or at the same time, as the 2024 Long-Term Plan[5]. A draft LTP for both councils will be consulted on in the first quarter of 2024, therefore the first draft of the FDS will need to be completed to align with this timing. Whilst a review of the full FDS is only required every 6 years, a FDS implementation plan must be developed and updated annually, but it does not have the consultation requirements set out in clause 3.15.

15. In terms of these requirements, TRC and NPDC are not starting the FDS work from a blank canvas. NPDC has significant expertise in the delivery of long-term growth planning, including the provision of development capacity and infrastructure critical to supporting urban development. Relevant work that will underpin the draft FDS includes:

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[2] Clause 3.14 – what FDSs are informed by – NPS-UD
[3] Clause 3.15 of the NPS-UD
[4] Clause 3.13 – purpose and content of an FDS – NPS-UD
[5] Clause 4.1 – timeframes for implementation - NPS-UD

15.1. Land Supply Review 2007[6];

15.2. Framework for Growth 2008[7];

15.3. Plan Change 15 (operative 2015)[8];

15.4. Various rezoning Plan Changes[9] ;

15.5. Infrastructure Strategy 2018-2048[10] ;

15.6. Housing and Business Capacity Assessment (June 2019)[11];

15.7. District Plan Review and Draft District Plan (2015-2019);

15.8. Proposed District Plan and growth-related supporting documents (2019);

15.9. Housing Capacity Assessment (2021)[12]; and

15.10. Proposed District Plan – Decisions Version (2023).

16. These existing investigations and programmes of work provide a sound base for the development of the FDS.

Collaborative development and implementation of the FDS:

17. Both Councils have agreed to work collaboratively on development and implementation of the FDS.

18. As outlined in paragraph 15, NPDC has significant expertise in the delivery of long-term growth planning, and it has been agreed by both Councils that NPDC will initially undertake pre-engagement, coordination and drafting of the FDS with TRC providing review and technical support. Once drafted, both Councils will have joint responsibility for the FDS as it works though LTP consultation period (first quarter of 2024) and the subsequent submission and hearing processes.

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[6] New Plymouth District Council's Land Supply Review 2007. Initiated in 2006 in response to economic and household growth occurring at that time. The review aimed to address the supply of residential and employment land in New Plymouth/Bell Block and other area with the potential to grow
https://www.npdc.govt.nz/media/sgyngmzp/projects-land-supply-review-framework-for-growth-final-2008.pdf

[7] The Framework for Growth document represents the outcomes of the Land Supply Review and set out the recommended growth direction for urban expansion within the New Plymouth District.

[8] Bell Block Area Q (Wills Road to Airport Drive), Area R, New Plymouth Area N (Egmont Road to Henwood Road), New Plymouth Areas S, K and L (Smart Road), Waitara, Ōākura, Okato, Egmont Village, Onaero, and Inglewood recognised as "Future Urban Development Areas" in the Operative District Plan. , some of

[9] Bell Block Area Q, Waitara Area, Cowling Road/Frankley Road/Tukapa Street Area E, Inglewood, Area N to Industrial, Johnston Street Waitara.

[10] The Infrastructure Strategy (currently under review) identifies significant infrastructure issues the New Plymouth District is likely to face over the next 30 years.

[11]HBAs and reports- https://www.npdc.govt.nz/council/reports-and-publications/reports/national-policy-statement-urban-development/

[12] Updated housing component of the HBA 2019.

Timeline for delivery and key milestones

19. As work must be completed in a condensed period of time, the following high level work programme is being implemented:

- Pre-engagement
  November – December 2023
- First draft of FDS/proposed governance arrangements
  November 2023 – February 2024
- Formal consultation
  March 2024 – April 2024
- Hearings
  April 2024
- Panel deliberations
  May 2024
- Council adoption
  May/June

20. Both Councils' officers have regular weekly meeting scheduled to develop and review content that will be released publicly, to ensure that the requirements of the NPS-UD and FDS are adhered to, and to progress the preparation of the FDS for the next stages of formal consultation.

21. The council teams are currently focussed on the pre-engagement processes and early drafting stages of the FDS. Actions currently underway include:

    21.1. talking with key identified stakeholders to seek feedback on the high level direction of the FDS;

    21.2. early discussions with iwi to develop a plan for engagement over the next 6 months in order to articulate values and aspirations for urban development; and

    21.3. stocktake of all relevant information and requirements to inform the FDS development.

Special consultative procedure

22. The NPS-UD specifies that local authorities are required to engage in a special consultative procedure to inform the FDS. This means that the FDS is not a document that is managed under the RMA's regulatory framework and instead it must be

progressed through section 83 of the Local Government Act (LGA) 2002[13]. This means that TRC and NPDC must prepare and adopt a statement of proposal (the draft FDS), seek public submissions, and provide the opportunity for persons to be heard by a joint hearings panel. To facilitate the hearings process, the appointment of a joint committee with agreed membership from both TRC and NPDC will need to be established.

23. Additionally, consideration of iwi representation on this this joint committee will also need to be undertaken by TRC and NPDC. It is recommended that TRC's Chief Executive be delegated the authority to commence conversations with iwi on appropriate representation. This approach will ensure that discussions begin early between all relevant parties.
24. Staff are currently working together to refine the process required by s.83 of the LGA and a proposed approach to appoint a joint committee to the February 2024 Committee meeting. A decision to appoint a joint committee will need to be made at the Ordinary Council meeting scheduled for 27 February 2024. At the same time the draft FDS will also be presented for consideration.

Financial considerations—LTP/Annual Plan

25. 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. The FDS is an additional policy task to those in the LTP.

Policy considerations

26. 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

27. 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. Discussions with iwi are being progressed in relation to the development of a statement of values and aspirations for the future development strategy.

Community considerations

28. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

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[13] Section 83 of the Local Government Act 2002 - https://www.legislation.govt.nz/act/public/2002/0084/latest/DLM172328.html

Legal considerations

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

Appendices/Attachments

Document 3222579: National Policy Statement on Urban Development 2020

Te Kāwanatanga o Aotearoa
New Zealand Government

National Policy Statement on Urban Development 2020

May 2022

This National Policy Statement was approved by the Governor-General under section 52(2) of the Resource Management Act 1991 on 20 July 2020, and is published by the Minister for the Environment under section 54 of that Act.

This National Policy Statement replaces the National Policy Statement on Urban Development Capacity 2016.

This version of the National Policy Statement incorporates the following amendments:

1. amendments made by section 77S(1) of the Resource Management Act 1991 (as inserted by the Resource Management (Enabling Housing Supply and Other Matters) Amendment Act 2021)

2. amendments made by the Minister for the Environment under section 53(2) of the Resource Management Act 1991 and notified in the New Zealand Gazette on 11 May 2022 as the National Policy Statement on Urban Development 2020 Amendment No 1.

Contents

Part 1: Preliminary provisions

1.1 Title

(1) This is the National Policy Statement on Urban Development 2020.

1.2 Commencement

(1) This National Policy Statement comes into force on 20 August 2020.

(2) *See* Part 4, which sets out timeframes for complying with different parts of this National Policy Statement.

1.3 Application

(1) This National Policy Statement applies to:

(a) all local authorities that have all or part of an urban environment within their district or region (ie, tier 1, 2 and 3 local authorities); and

(b) planning decisions by any local authority that affect an urban environment.

(2) However, some objectives, policies, and provisions in Parts 3 and 4 apply only to tier 1, 2, or 3 local authorities.

1.4 Interpretation

(1) In this National Policy Statement:

accessible car park means a car park designed and marked (for instance, in accordance with the mobility car parking scheme) for use by persons with a disability or with limited mobility

Act means the Resource Management Act 1991

active transport means forms of transport that involve physical exercise, such as walking or cycling, and includes transport that may use a mobility aid such as a wheelchair

additional infrastructure means:

(a) public open space

(b) community infrastructure as defined in section 197 of the Local Government Act 2002

(c) land transport (as defined in the Land Transport Management Act 2003) that is not controlled by local authorities

(d) social infrastructure, such as schools and healthcare facilities

(e) a network operated for the purpose of telecommunications (as defined in section 5 of the Telecommunications Act 2001)

(f) a network operated for the purpose of transmitting or distributing electricity or gas

business land means land that is zoned, or identified in an FDS or similar strategy or plan, for business uses in urban environments, including but not limited to land in the following:

(a) any industrial zone

(b) the commercial zone

(c) the large format retail zone

(d) any centre zone, to the extent it allows business uses

(e) the mixed use zone, to the extent it allows business uses

(f) any special purpose zone, to the extent it allows business uses

centre zone means any of the following zones:

(a) city centre zone

(b) metropolitan centre zone

(c) town centre zone

(d) local centre zone

(e) neighbourhood centre zone

commencement date means the date on which this National Policy Statement comes into force (*see* clause 1.2)

community services means the following:

(a) community facilities

(b) educational facilities

(c) those commercial activities that serve the needs of the community

competitiveness margin means the margin referred to in clause 3.22

decision-maker means any person exercising functions or powers under the Act

development capacity means the capacity of land to be developed for housing or for business use, based on:

(a) the zoning, objectives, policies, rules, and overlays that apply in the relevant proposed and operative RMA planning documents; and

(b) the provision of adequate development infrastructure to support the development of land for housing or business use

development infrastructure means the following, to the extent they are controlled by a local authority or council controlled organisation (as defined in section 6 of the Local Government Act 2002):

(a) network infrastructure for water supply, wastewater, or stormwater

(b) land transport (as defined in section 5 of the Land Transport Management Act 2003)

FDS means the Future Development Strategy required by subpart 4 of Part 3

feasible means:

(a) for the short term or medium term, commercially viable to a developer based on the current relationship between costs and revenue

(b) for the long term, commercially viable to a developer based on the current relationship between costs and revenue, or on any reasonable adjustment to that relationship

HBA means the Housing and Business Development Capacity Assessment required by subpart 5 of Part 3

infrastructure-ready has the meaning in clause 3.4(3)

long term means between 10 and 30 years

long-term plan means a long-term plan (including the infrastructure strategy required to be included in it) adopted by a local authority under section 93 of the Local Government Act 2002

medium term means between 3 and 10 years

nationally significant infrastructure means all of the following:

(a) State highways

(b) the national grid electricity transmission network

(c) renewable electricity generation facilities that connect with the national grid

(d) the high-pressure gas transmission pipeline network operating in the North Island

(e) the refinery pipeline between Marsden Point and Wiri

(f) the New Zealand rail network (including light rail)

(g) rapid transit services (as defined in this clause)

(h) any airport (but not its ancillary commercial activities) used for regular air transport services by aeroplanes capable of carrying more than 30 passengers

(i) the port facilities (but not the facilities of any ancillary commercial activities) of each port company referred to in item 6 of Part A of Schedule 1 of the Civil Defence Emergency Management Act 2002

planned in relation to forms or features of transport, means planned in a regional land transport plan prepared and approved under the Land Transport Management Act 2003

plan-enabled has the meaning in clause 3.4(1)

planning decision means a decision on any of the following:

(a) a regional policy statement or proposed regional policy statement

(b) a regional plan or proposed regional plan

(c) a district plan or proposed district plan

(d) a resource consent

(e) a designation

(f) a heritage order

(g) a water conservation order

(h) a change to a plan requested under Part 2 of Schedule 1 of the Act

public transport means any existing or planned service for the carriage of passengers (other than an aeroplane) that is available to the public generally by means of:

(a) a vehicle designed or adapted to carry more than 12 persons (including the driver); or

(b) a rail vehicle; or

(c) a ferry

qualifying matter has the meaning in clause 3.32

rapid transit service means any existing or planned frequent, quick, reliable and high-capacity public transport service that operates on a permanent route (road or rail) that is largely separated from other traffic

rapid transit stop means a place where people can enter or exit a rapid transit service, whether existing or planned

RMA planning document means all or any of the following:

(a) a regional policy statement

(b) a regional plan

(c) a district plan

short-medium term means within the next 10 years

short term means within the next 3 years

tier 1 local authority means each local authority listed in column 2 of table 1 in the Appendix, and **tier 1 regional council** and **tier 1 territorial authority** have corresponding meanings

tier 2 local authority means each local authority listed in column 2 of table 2 in the Appendix, and **tier 2 regional council** and **tier 2 territorial authority** have corresponding meanings

tier 3 local authority means a local authority that has all or part of an urban environment within its region or district, but is not a tier 1 or 2 local authority, and **tier 3 regional council** and **tier 3 territorial authority** have corresponding meanings

tier 1 urban environment means an urban environment listed in column 1 of table 1 in the Appendix

tier 2 urban environment means an urban environment listed in column 1 of table 2 in the Appendix

tier 3 urban environment means an urban environment that is not listed in the Appendix

urban environment means any area of land (regardless of size, and irrespective of local authority or statistical boundaries) that:

(a) is, or is intended to be, predominantly urban in character; and

(b) is, or is intended to be, part of a housing and labour market of at least 10,000 people

well-functioning urban environment has the meaning in Policy 1.

(2) Terms defined in the Act and used in this National Policy Statement have the meanings in the Act, unless otherwise specified.

(3) Terms defined in the National Planning Standard issued under section 58E of the Act and used in this National Policy Statement have the meanings in that Standard, unless otherwise specified.

(4) A reference in this National Policy Statement to a **zone** is:

(a) a reference to that zone as described in Standard 8 (Zone Framework Standard) of the National Planning Standard; or

(b) a reference to the nearest equivalent zone, in relation to local authorities that have not yet implemented the Zone Framework in the National Planning Standard.

(5) If a local authority is required by this National Policy Statement to make a document publicly available, section 5(3) of the Local Government Act 2002 applies to the requirement as if it was made under that Act.

1.5 Implementation by tier 3 local authorities

(1) Tier 3 local authorities are strongly encouraged to do the things that tier 1 or 2 local authorities are obliged to do under Parts 2 and 3 of this National Policy Statement, adopting whatever modifications to the National Policy Statement are necessary or helpful to enable them to do so.

1.6 Incorporation by reference

(1) Clause 2(1) of Schedule 1AA of the Act does not apply to any material incorporated by reference in this National Policy Statement.

Part 2: Objectives and policies

2.1 Objectives

Objective 1: New Zealand has well-functioning urban environments that enable all people and communities to provide for their social, economic, and cultural wellbeing, and for their health and safety, now and into the future.

Objective 2: Planning decisions improve housing affordability by supporting competitive land and development markets.

Objective 3: Regional policy statements and district plans enable more people to live in, and more businesses and community services to be located in, areas of an urban environment in which one or more of the following apply:

(a) the area is in or near a centre zone or other area with many employment opportunities

(b) the area is well-serviced by existing or planned public transport

(c) there is high demand for housing or for business land in the area, relative to other areas within the urban environment.

Objective 4: New Zealand's urban environments, including their amenity values, develop and change over time in response to the diverse and changing needs of people, communities, and future generations.

Objective 5: Planning decisions relating to urban environments, and FDSs, take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).

Objective 6: Local authority decisions on urban development that affect urban environments are:

(a) integrated with infrastructure planning and funding decisions; and

(b) strategic over the medium term and long term; and

(c) responsive, particularly in relation to proposals that would supply significant development capacity.

Objective 7: Local authorities have robust and frequently updated information about their urban environments and use it to inform planning decisions.

Objective 8: New Zealand's urban environments:

(a) support reductions in greenhouse gas emissions; and

(b) are resilient to the current and future effects of climate change.

2.2 Policies

Policy 1: Planning decisions contribute to well-functioning urban environments, which are urban environments that, as a minimum:

(a) have or enable a variety of homes that:

(i) meet the needs, in terms of type, price, and location, of different households; and

(ii) enable Māori to express their cultural traditions and norms; and

(b) have or enable a variety of sites that are suitable for different business sectors in terms of location and site size; and

(c) have good accessibility for all people between housing, jobs, community services, natural spaces, and open spaces, including by way of public or active transport; and

(d) support, and limit as much as possible adverse impacts on, the competitive operation of land and development markets; and

(e) support reductions in greenhouse gas emissions; and

(f) are resilient to the likely current and future effects of climate change.

Policy 2: Tier 1, 2, and 3 local authorities, at all times, provide at least sufficient development capacity to meet expected demand for housing and for business land over the short term, medium term, and long term.

Policy 3: In relation to tier 1 urban environments, regional policy statements and district plans enable:

(a) in city centre zones, building heights and density of urban form to realise as much development capacity as possible, to maximise benefits of intensification; and

(b) in metropolitan centre zones, building heights and density of urban form to reflect demand for housing and business use in those locations, and in all cases building heights of at least 6 storeys; and

(c) building heights of at least 6 storeys within at least a walkable catchment of the following:

(i) existing and planned rapid transit stops

(ii) the edge of city centre zones

(iii) the edge of metropolitan centre zones; and

(d) within and adjacent to neighbourhood centre zones, local centre zones, and town centre zones (or equivalent), building heights and densities of urban form commensurate with the level of commercial activity and community services.

Policy 4: Regional policy statements and district plans applying to tier 1 urban environments modify the relevant building height or density requirements under Policy 3 only to the extent necessary (as specified in subpart 6) to accommodate a qualifying matter in that area.

Policy 5: Regional policy statements and district plans applying to tier 2 and 3 urban environments enable heights and density of urban form commensurate with the greater of:

(a) the level of accessibility by existing or planned active or public transport to a range of commercial activities and community services; or

(b) relative demand for housing and business use in that location.

Policy 6: When making planning decisions that affect urban environments, decision-makers have particular regard to the following matters:

(a) the planned urban built form anticipated by those RMA planning documents that have given effect to this National Policy Statement

(b) that the planned urban built form in those RMA planning documents may involve significant changes to an area, and those changes:

(i) may detract from amenity values appreciated by some people but improve amenity values appreciated by other people, communities, and future generations, including by providing increased and varied housing densities and types; and

(ii) are not, of themselves, an adverse effect

(c) the benefits of urban development that are consistent with well-functioning urban environments (as described in Policy 1)

(d) any relevant contribution that will be made to meeting the requirements of this National Policy Statement to provide or realise development capacity

(e) the likely current and future effects of climate change.

Policy 7: Tier 1 and 2 local authorities set housing bottom lines for the short-medium term and the long term in their regional policy statements and district plans.

Policy 8: Local authority decisions affecting urban environments are responsive to plan changes that would add significantly to development capacity and contribute to well-functioning urban environments, even if the development capacity is:

(a) unanticipated by RMA planning documents; or

(b) out-of-sequence with planned land release.

Policy 9: Local authorities, in taking account of the principles of the Treaty of Waitangi (Te Tiriti o Waitangi) in relation to urban environments, must:

(a) involve hapū and iwi in the preparation of RMA planning documents and any FDSs by undertaking effective consultation that is early, meaningful and, as far as practicable, in accordance with tikanga Māori; and

(b) when preparing RMA planning documents and FDSs, take into account the values and aspirations of hapū and iwi for urban development; and

(c) provide opportunities in appropriate circumstances for Māori involvement in decision-making on resource consents, designations, heritage orders, and water conservation orders, including in relation to sites of significance to Māori and issues of cultural significance; and

(d) operate in a way that is consistent with iwi participation legislation.

Policy 10: Tier 1, 2, and 3 local authorities:

(a) that share jurisdiction over urban environments work together when implementing this National Policy Statement; and

(b) engage with providers of development infrastructure and additional infrastructure to achieve integrated land use and infrastructure planning; and

(c) engage with the development sector to identify significant opportunities for urban development.

Policy 11: In relation to car parking:

(a) the district plans of tier 1, 2, and 3 territorial authorities do not set minimum car parking rate requirements, other than for accessible car parks; and

(b) tier 1, 2, and 3 local authorities are strongly encouraged to manage effects associated with the supply and demand of car parking through comprehensive parking management plans.

Part 3: Implementation

3.1 Outline of part

(1) This part sets out a non-exhaustive list of things that local authorities must do to give effect to the objectives and policies of this National Policy Statement, but nothing in this part limits the general obligation under the Act to give effect to those objectives and policies.

Subpart 1 – Providing development capacity

3.2 Sufficient development capacity for housing

(1) Every tier 1, 2, and 3 local authority must provide at least sufficient development capacity in its region or district to meet expected demand for housing:

(a) in existing and new urban areas; and

(b) for both standalone dwellings and attached dwellings; and

(c) in the short term, medium term, and long term.

(2) In order to be **sufficient** to meet expected demand for housing, the development capacity must be:

(a) plan-enabled (*see* clause 3.4(1)); and

(b) infrastructure-ready (*see* clause 3.4(3)); and

(c) feasible and reasonably expected to be realised (*see* clause 3.26); and

(d) for tier 1 and 2 local authorities only, meet the expected demand plus the appropriate competitiveness margin (*see* clause 3.22).

3.3 Sufficient development capacity for business land

(1) Every tier 1, 2, and 3 local authority must provide at least sufficient development capacity in its region or district to meet the expected demand for business land:

(a) from different business sectors; and

(b) in the short term, medium term, and long term.

(2) In order to be **sufficient** to meet expected demand for business land, the development capacity provided must be:

(a) plan-enabled (*see* clause 3.4(1)); and

(b) infrastructure-ready (*see* clause 3.4(3)); and

(c) suitable (as described in clause 3.29(2)) to meet the demands of different business sectors (as described in clause 3.28(3)); and

(d) for tier 1 and 2 local authorities only, meet the expected demand plus the appropriate competitiveness margin (*see* clause 3.22).

3.4 Meaning of plan-enabled and infrastructure-ready

(1) Development capacity is **plan-enabled** for housing or for business land if:

(a) in relation to the short term, it is on land that is zoned for housing or for business use (as applicable) in an operative district plan

(b) in relation to the medium term, either paragraph (a) applies, or it is on land that is zoned for housing or for business use (as applicable) in a proposed district plan

(c) in relation to the long term, either paragraph (b) applies, or it is on land identified by the local authority for future urban use or urban intensification in an FDS or, if the local authority is not required to have an FDS, any other relevant plan or strategy.

(2) For the purpose of subclause (1), land is **zoned** for housing or for business use (as applicable) only if the housing or business use is a permitted, controlled, or restricted discretionary activity on that land.

(3) Development capacity is **infrastructure-ready** if:

(d) in relation to the short term, there is adequate existing development infrastructure to support the development of the land

(e) in relation to the medium term, either paragraph (a) applies, or funding for adequate development infrastructure to support development of the land is identified in a long-term plan

(f) in relation to the long term, either paragraph (b) applies, or the development infrastructure to support the development capacity is identified in the local authority's infrastructure strategy (as required as part of its long-term plan).

3.5 Availability of additional infrastructure

(1) Local authorities must be satisfied that the additional infrastructure to service the development capacity is likely to be available.

3.6 Housing bottom lines for tier 1 and 2 urban environments

(1) The purpose of the housing bottom lines required by this clause is to clearly state the amount of development capacity that is sufficient to meet expected housing demand plus the appropriate competitiveness margin in the region and each constituent district of a tier 1 or tier 2 urban environment.

(2) For each tier 1 or tier 2 urban environment, as soon as practicable after an HBA is made publicly available (*see* clause 3.19(1)):

(a) the relevant regional council must insert into its regional policy statement:

(i) a housing bottom line for the short-medium term; and

(ii) a housing bottom line for the long term; and

(b) every relevant territorial authority must insert into its district plan:

(i) a housing bottom line for the short-medium term that is the proportion of the housing bottom line for the short-medium term (as set out in the relevant regional policy statement) that is attributable to the district of the territorial authority; and

(ii) a housing bottom line for the long term that is the proportion of the housing bottom line for the long term (as set out in the relevant regional policy statement) that is attributable to the district of the territorial authority.

(3) The housing bottom lines must be based on information in the most recent publicly available HBA for the urban environment and are:

(a) for the short-medium term, the sum of:

(i) the amount of feasible, reasonably expected to be realised development capacity that must be enabled to meet demand, along with the competitiveness margin, for the short term; and

(ii) the amount of feasible, reasonably expected to be realised development capacity that must enabled to meet demand, along with the competitiveness margin, for the medium term; and

(b) for the long term, the amount of feasible, reasonably expected to be realised development capacity that must enabled to meet demand, along with the competitiveness margin, for the long term.

(4) The insertion of bottom lines must be done without using a process in Schedule 1 of the Act, but any changes to RMA planning documents required to give effect to the bottom lines must be made using a Schedule 1 process.

3.7 When there is insufficient development capacity

(1) If a local authority determines that there is insufficient development capacity (as described in clauses 3.2 and 3.3) over the short term, medium term, or long term, it must:

(a) immediately notify the Minister for the Environment; and

(b) if the insufficiency is wholly or partly a result of RMA planning documents, change those documents to increase development capacity for housing or business land (as applicable) as soon as practicable, and update any other relevant plan or strategy (including any FDS, as required by subpart 4); and

(c) consider other options for:

(i) increasing development capacity; and

(ii) otherwise enabling development.

Subpart 2 – Responsive planning

3.8 Unanticipated or out-of-sequence developments

(1) This clause applies to a plan change that provides significant development capacity that is not otherwise enabled in a plan or is not in sequence with planned land release.

(2) Every local authority must have particular regard to the development capacity provided by the plan change if that development capacity:

(a) would contribute to a well-functioning urban environment; and

(b) is well-connected along transport corridors; and

(c) meets the criteria set under subclause (3).

(3) Every regional council must include criteria in its regional policy statement for determining what plan changes will be treated, for the purpose of implementing Policy 8, as adding significantly to development capacity.

Subpart 3 – Evidence-based decision-making

3.9 Monitoring requirements

(1) Every tier 1, 2, and 3 local authority must monitor, quarterly, the following in relation to each urban environment in their region or district:

- (a) the demand for dwellings
- (b) the supply of dwellings
- (c) prices of, and rents for, dwellings
- (d) housing affordability
- (e) the proportion of housing development capacity that has been realised:
  - (i) in previously urbanised areas (such as through infill housing or redevelopment); and
  - (ii) in previously undeveloped (ie, greenfield) areas
- (f) available data on business land.

(2) In relation to tier 1 urban environments, tier 1 local authorities must monitor the proportion of development capacity that has been realised in each zone identified in clause 3.37(1) (ie, each zone with development outcomes that are monitored).

(3) Every tier 1, 2, and 3 local authority must publish the results of its monitoring at least annually.

(4) The monitoring required by this clause must relate to the relevant urban environments, but may apply more widely (such as, for example, where the relevant data is available only on a region or district-wide basis).

(5) If more than one tier 1 or tier 2 local authority has jurisdiction over a tier 1 or tier 2 urban environment, those local authorities are jointly responsible for doing the monitoring required by this subpart.

3.10 Assessing demand and development capacity

(1) Every local authority must assess the demand for housing and for business land in urban environments, and the development capacity that is sufficient (as described in clauses 3.2 and 3.3) to meet that demand in its region or district in the short term, medium term, and long term.

(2) Tier 1 and tier 2 local authorities comply with subclause (1) in relation to tier 1 and tier 2 urban environments by preparing and publishing an HBA as required by subpart 5.

3.11 Using evidence and analysis

(1) When making plans, or when changing plans in ways that affect the development of urban environments, local authorities must:

(a) clearly identify the resource management issues being managed; and

(b) use evidence, particularly any relevant HBAs, about land and development markets, and the results of the monitoring required by this National Policy Statement, to assess the impact of different regulatory and non-regulatory options for urban development and their contribution to:

(iii) achieving well-functioning urban environments; and

(iv) meeting the requirements to provide at least sufficient development capacity.

(2) Local authorities must include the matters referred to in subclause (1)(a) and (b) in relevant evaluation reports and further evaluation reports prepared under sections 32 and 32AA of the Act.

Subpart 4 – Future Development Strategy (FDS)

3.12 Preparation of FDS

(1) Every tier 1 and tier 2 local authority must prepare, and make publicly available an FDS for the tier 1 or 2 urban environment:

(a) every 6 years; and

(b) in time to inform, or at the same time as, preparation of the next long-term plan of each relevant local authority.

(2) The FDS must apply, at a minimum, to the relevant tier 1 and 2 urban environments of the local authority, but may apply to any wider area.

(3) If more than one tier 1 or tier 2 local authority has jurisdiction over a tier 1 or tier 2 urban environment, those local authorities are jointly responsible for preparing an FDS as required by this subpart.

(4) If a local authority that is not a tier 1 or 2 local authority chooses to prepare an FDS, either alone or with any other local authority, this subpart applies as if it were a tier 1 or 2 local authority, except that any reference to an HBA may be read as a reference to any other document that contains broadly equivalent information.

(5) An FDS may be prepared and published as a stand-alone document, or be treated as part of any other document (such as a spatial plan).

3.13 Purpose and content of FDS

(1) The purpose of an FDS is:

(a) to promote long-term strategic planning by setting out how a local authority intends to:

(i) achieve well-functioning urban environments in its existing and future urban areas; and

(ii) provide at least sufficient development capacity, as required by clauses 3.2 and 3.3, over the next 30 years to meet expected demand; and

(b) assist the integration of planning decisions under the Act with infrastructure planning and funding decisions.

(2) Every FDS must spatially identify:

(a) the broad locations in which development capacity will be provided over the long term, in both existing and future urban areas, to meet the requirements of clauses 3.2 and 3.3; and

(b) the development infrastructure and additional infrastructure required to support or service that development capacity, along with the general location of the corridors and other sites required to provide it; and

(c) any constraints on development.

(3) Every FDS must include a clear statement of hapū and iwi values and aspirations for urban development.

3.14 What FDSs are informed by

(1) Every FDS must be informed by the following:

(a) the most recent applicable HBA

(b) a consideration of the advantages and disadvantages of different spatial scenarios for achieving the purpose of the FDS

(c) the relevant long-term plan and its infrastructure strategy, and any other relevant strategies and plans

(d) Māori, and in particular tangata whenua, values and aspirations for urban development

(e) feedback received through the consultation and engagement required by clause 3.15

(f) every other National Policy Statement under the Act, including the New Zealand Coastal Policy Statement

(g) any other relevant national policy required by, or issued under, legislation.

3.15 Consultation and engagement

(1) When preparing or updating an FDS local authorities must use the special consultative procedure in section 83 of the Local Government Act 2002.

(2) In order to prepare the draft required by that procedure, local authorities must engage with the following:

(a) other local authorities with whom there are significant connections relating to infrastructure or community

(b) relevant central government agencies

(c) relevant hapū and iwi

(d) providers of additional infrastructure

(e) relevant providers of nationally significant infrastructure

(f) the development sector (to identify significant future development opportunities and infrastructure requirements).

3.16 Review of FDS

(1) Every tier 1 and tier 2 local authority must regularly review its FDS to determine whether it needs updating, and the review must be done in time to inform the next long-term plan (ie, every 3 years).

(2) The review must:

(a) engage with the development sector and landowners to identify significant future development opportunities and associated infrastructure requirements; and

(b) consider the most recent HBA.

(3) If, following the review, the local authority decides that the FDS does not need updating, that decision and the reasons for it must be publicly notified.

(4) If, following the review, the local authority decides that the FDS is to be updated, the local authority must follow the same processes for consultation as apply to the preparation of an FDS, but only in relation to the aspects proposed to be updated.

3.17 Effect of FDS

(1) Every tier 1 and tier 2 local authority:

(a) must have regard to the relevant FDS when preparing or changing RMA planning documents; and

(b) is strongly encouraged to use the relevant FDS to inform:

(i) long-term plans, and particularly infrastructure strategies; and

(ii) regional land transport plans prepared by a local authority under Part 2 of the Land Transport Management Act 2003; and

(iii) any other relevant strategies and plans.

3.18 FDS implementation plan

(1) Every tier 1 and tier 2 local authority must prepare and implement an implementation plan for its FDS.

(2) If a tier 1 or tier 2 local authority consists of more than one local authority, the implementation plan must be prepared as a single document by all the local authorities that jointly prepared the FDS.

(3) Every implementation plan, or part of an implementation plan, must be updated annually.

(4) An implementation plan or part of an implementation plan:

(a) is not part of the FDS to which it relates; and

(b) does not need to be prepared using the consultation and engagement requirements set out in clause 3.15; and

(c) does not have the effect of an FDS as described in clause 3.17.

Subpart 5 – Housing and Business Development Capacity Assessment (HBA)

3.19 Obligation to prepare HBA

(1) Every tier 1 and tier 2 local authority must prepare, and make publicly available, an HBA for its tier 1 or tier 2 urban environments every 3 years, in time to inform the relevant local authority's next long-term plan.

(2) The HBA must apply, at a minimum, to the relevant tier 1 or tier 2 urban environments of the local authority (ie, must assess demand and capacity within the boundaries of those urban environments), but may apply to any wider area.

(3) If more than one tier 1 or tier 2 local authority has jurisdiction over a tier 1 or tier 2 urban environment, those local authorities are jointly responsible for preparing an HBA as required by this subpart.

3.20 Purpose of HBA

(1) The purpose of an HBA is to:

(a) provide information on the demand and supply of housing and of business land in the relevant tier 1 or tier 2 urban environment, and the impact of planning and infrastructure decisions of the relevant local authorities on that demand and supply; and

(b) inform RMA planning documents, FDSs, and long-term plans; and

(c) quantify the development capacity that is sufficient to meet expected demand for housing and for business land in the short term, medium term, and long term.

3.21 Involving development sector and others

(1) In preparing an HBA, every tier 1 and tier 2 local authority must seek information and comment from:

(a) expert or experienced people in the development sector; and

(b) providers of development infrastructure and additional infrastructure; and

(c) anyone else who has information that may materially affect the calculation of the development capacity.

3.22 Competitiveness margin

(1) A competitiveness margin is a margin of development capacity, over and above the expected demand that tier 1 and tier 2 local authorities are required to provide, that is required in order to support choice and competitiveness in housing and business land markets.

(2) The competitiveness margins for both housing and business land are:

(a) for the short term, 20%

(b) for the medium term, 20%

(c) for the long term, 15%.

Housing

3.23 Analysis of housing market and impact of planning

(1) Every HBA must include analysis of how the relevant local authority's planning decisions and provision of infrastructure affects the affordability and competitiveness of the local housing market.

(2) The analysis must include an assessment of how well the current and likely future demands for housing by Māori and different groups in the community (such as older people, renters, homeowners, low-income households, visitors, and seasonal workers) are met, including the demand for different types and forms of housing (such as for lower-cost housing, papakāinga, and seasonal worker or student accommodation).

(3) The analysis must be informed by:

(a) market indicators, including:

(i) indicators of housing affordability, housing demand, and housing supply; and

(ii) information about household incomes, housing prices, and rents; and

(b) price efficiency indicators.

3.24 Housing demand assessment

(1) Every HBA must estimate, for the short term, medium term, and long term, the demand for additional housing in the region and each constituent district of the tier 1 or tier 2 urban environment:

(a) in different locations; and

(b) in terms of dwelling types.

(2) Local authorities may identify locations in any way they choose.

(3) Local authorities may identify the types of dwellings in any way they chose but must, at a minimum, distinguish between standalone dwellings and attached dwellings.

(4) The demand for housing must be expressed in terms of numbers of dwellings.

(5) Every HBA must:

(a) set out a range of projections of demand for housing in the short term, medium term, and long term; and

(b) identify which of the projections are the most likely in each of the short term, medium term, and long term; and

(c) set out the assumptions underpinning the different projections and the reason for selecting the most likely; and

(d) if those assumptions involve a high level of uncertainty, the nature and potential effects of that uncertainty.

3.25 Housing development capacity assessment

(1) Every HBA must quantify, for the short term, medium term, and long term, the housing development capacity for housing in the region and each constituent district of the tier 1 or tier 2 urban environment that is:

(a) plan-enabled; and

(b) plan-enabled and infrastructure-ready; and

(c) plan-enabled, infrastructure-ready, and feasible and reasonably expected to be realised.

(2) The development capacity must be quantified as numbers of dwellings:

(a) in different locations, including in existing and new urban areas; and

(b) of different types, including standalone dwellings and attached dwellings.

3.26 Estimating what is feasible and reasonably expected to be realised

(1) For the purpose of estimating the amount of development capacity that is reasonably expected to be realised, or that is both feasible and reasonably expected to be realised, local authorities:

(a) may use any appropriate method; but

(b) must outline and justify the methods, inputs, and assumptions used to arrive at the estimates.

(2) The following are examples of the kind of methods that a tier 1 local authority could use to assess the amount of development capacity that is feasible and reasonably expected to be realised:

(a) separately estimate the number of feasible dwellings (using a feasibility model) and the number of dwellings that can reasonably be expected to be realised (using building consents data on the number of sites and extent of allowed capacity that has been previously developed), for the short, medium and long term; compare the numbers of dwellings estimated by each method; then pick the lower of the numbers in each time period, to represent the amount of development capacity that is feasible and reasonably expected to be realised

(b) estimate the number of feasible dwellings or sites, and then assess the proportion of these that can reasonably be expected to be developed in the short, medium and long term, using information about landowner and developer intentions

(c) integrate information about past development trends and future landowner and developer intentions into the feasibility model, which could mean modifying assumptions about densities, heights, and timing of development.

(3) The following is an example of the kind of methods that a tier 2 local authority could use to assess the amount of development capacity that is feasible and reasonably expected to be realised:

(a) assess the number of dwellings that can reasonably be expected to be developed (using building consents data on the number of sites and extent of allowed capacity that has been developed previously), for the short, medium and long term; and

(b) then seek advice from the development sector about what factors affect the feasibility of development.

(4) Different methods may be appropriate when assessing the development capacity that is reasonably expected to be realised in different circumstances, such as:

(a) in existing, as opposed to new, urban areas; and

(b) for stand-alone, as opposed to attached, dwellings.

3.27 Assessment of sufficient development capacity for housing

(1) Every HBA must clearly identify, for the short term, medium term, and long term, where there is sufficient development capacity to meet demand for housing in the region and each constituent district of the tier 1 or tier 2 urban environment.

(2) The requirements of subclause (1) must be based on a comparison of:

(a) the demand for housing referred to in clause 3.24 plus the appropriate competitiveness margin; and

(b) the development capacity identified under clause 3.25.

(3) If there is any insufficiency, the HBA must identify where and when this will occur and analyse the extent to which RMA planning documents, a lack of development infrastructure, or both, cause or contribute to the insufficiency.

Business land

3.28 Business land demand assessment

(1) Every HBA must estimate, for the short term, medium term, and long term, the demand from each business sector for additional business land in the region and each constituent district of the tier 1 or tier 2 urban environment.

(2) The demand must be expressed in hectares or floor areas.

(3) For the purpose of this clause, a local authority may identify business sectors in any way it chooses but must, as a minimum, distinguish between sectors that would use land zoned for commercial, retail, or industrial uses.

(4) The HBA for a tier 1 urban environment must:

(a) set out a range of projections of demand for business land by business sector, for the short term, medium term, and long term; and

(b) identify which of the projections is the most likely in each of the short term, medium term, and long term; and

(c) set out the assumptions underpinning the different projections and the reason for selecting which is the most likely; and

(d) if those assumptions involve a high level of uncertainty, the nature and potential effects of that uncertainty.

(5) The HBA for a tier 2 urban environment must:

(a) set out the most likely projection of demand for business land by business sector in the short term, medium term, and long term; and

(b) set out the assumptions underpinning that projection; and

(c) if those assumptions involve a high level of uncertainty, the nature and potential effects of that uncertainty.

3.29 Business land development capacity assessment

(1) Every HBA must estimate the following, for the short term, medium term, and long term, for the region and each constituent district of the tier 1 or tier 2 urban environment:

(a) the development capacity (in terms of hectares or floor areas) to meet expected demand for business land for each business sector, plus the appropriate competitiveness margin; and

(b) of that development capacity, the development capacity that is:

(i) plan-enabled; and

(ii) plan-enabled and infrastructure-ready; and

(iii) plan-enabled, infrastructure-ready, and suitable for each business sector.

(2) A local authority may define what it means for development capacity to be "suitable" in any way it chooses, but suitability must, at a minimum, include suitability in terms of location and site size.

3.30 Assessment of sufficient development capacity for business land

(1) Every HBA must clearly identify, for the short term, medium term, and long term, whether there is sufficient development capacity to meet demand for business land in the region and each constituent district of the tier 1 or tier 2 urban environment.

(2) The requirements of subclause (1) must be based on a comparison of:

(a) the demand for business land referred to in clause 3.28 plus the appropriate competitiveness margin; and

(b) the development capacity identified under clause 3.29.

(3) If there is any insufficiency, the HBA must identify where and when this will occur and analyse the extent to which RMA planning documents, a lack of development infrastructure, or both, cause or contribute to the insufficiency.

Subpart 6 – Intensification in tier 1 urban environments

3.31 Tier 1 territorial authorities implementing intensification policies

(1) Every tier 1 territorial authority must identify, by location, the building heights and densities required by Policy 3.

(2) If the territorial authority considers that it is necessary to modify the building height or densities in order to provide for a qualifying matter (as permitted under Policy 4), it must:

(a) identify, by location, where the qualifying matter applies; and

(b) specify the alternate building heights and densities proposed for those areas.

(3) The territorial authority must make the information required by subclauses (1) and (2) publicly available at the same time as it notifies any plan change or proposed plan change to give effect to Policy 3.

3.32 Qualifying matters

(1) In this National Policy Statement, **qualifying matter** means any of the following:

(a) a matter of national importance that decision-makers are required to recognise and provide for under section 6 of the Act

(b) a matter required in order to give effect to any other National Policy Statement, including the New Zealand Coastal Policy Statement

(c) any matter required for the purpose of ensuring the safe or efficient operation of nationally significant infrastructure

(d) open space provided for public use, but only in relation to the land that is open space

(e) an area subject to a designation or heritage order, but only in relation to the land that is subject to the designation or heritage order

(f) a matter necessary to implement, or ensure consistency with, iwi participation legislation

(g) the requirement to provide sufficient business land suitable for low density uses to meet expected demand under this National Policy Statement

(h) any other matter that makes higher density development as directed by Policy 3 inappropriate in an area, but only if the requirements of clause 3.33(3) are met.

3.33 Requirements if qualifying matter applies

(1) This clause applies if a territorial authority is amending its district plan and intends to rely on Policy 4 to justify a modification to the direction in Policy 3 in relation to a specific area.

(2) The evaluation report prepared under section 32 of the Act in relation to the proposed amendment must:

- (a) demonstrate why the territorial authority considers that:
  - (i) the area is subject to a qualifying matter; and
  - (ii) the qualifying matter is incompatible with the level of development directed by Policy 3 for that area; and
- (b) assess the impact that limiting development capacity, building height or density (as relevant) will have on the provision of development capacity; and
- (c) assess the costs and broader impacts of imposing those limits.

(3) A matter is not a qualifying matter under clause 3.32(1)(h) in relation to an area unless the evaluation report also:

- (a) identifies the specific characteristic that makes the level of development directed by Policy 3 inappropriate in the area, and justifies why that is inappropriate in light of the national significance of urban development and the objectives of this National Policy Statement; and
- (b) includes a site-specific analysis that:
  - (i) identifies the site to which the matter relates; and
  - (ii) evaluates the specific characteristics on a site-specific basis to determine the spatial extent where intensification needs to be compatible with the specific matter; and
  - (iii) evaluates an appropriate range of options to achieve the greatest heights and densities directed by Policy 3, while managing the specific characteristics.

3.34 Effects on consideration of resource consents

(1) Nothing in Policies 3 or 4 or this subpart precludes the consideration (under section 104 of the Act) of any actual or potential effects on the environment associated with building heights.

Subpart 7 – Development outcomes for zones

3.35 Development outcomes for zones

(1) Every tier 1, 2 or 3 territorial authority must ensure that:

- (a) the objectives for every zone in an urban environment in its district describe the development outcomes intended for the zone over the life of the plan and beyond; and

(b) the policies and rules in its district plan are individually and cumulatively consistent with the development outcomes described in the objectives for each zone.

3.36 Development outcomes consistent with intensification policies

(1) Every tier 1 territorial authority must ensure that the development outcomes for zones in its tier 1 urban environments are consistent with the outcomes required by Policy 3.

3.37 Monitoring development outcomes

(1) Every tier 1 territorial authority must monitor the extent to which development is occurring in each of the following zones as anticipated by the development outcomes included in the objectives for the zone:

(a) city centre zones

(b) metropolitan centre zones

(c) town centre zones

(d) mixed use zones

(e) high density residential zones

(f) medium density residential zones

(g) general residential zones.

(2) If monitoring under this clause indicates that development outcomes are not being realised, the territorial authority must, as soon as practicable:

(a) undertake an assessment to identify whether provisions of the district plan (individually and cumulatively), or any other factors (and if so, what factors), or both, are contributing to the failure to realise development outcomes; and

(b) give public notice (as defined in the Act) of the results of the assessment.

(3) If the assessment indicates that provisions of a district plan are contributing to the failure to realise development outcomes, the territorial authority must change its district plan to address the deficiency.

(4) If the assessment indicates that other factors are contributing to the failure to realise development outcomes, the territorial authority must consider alternative methods to improve the rate of realisation (such as the use of incentives for site amalgamation).

(5) Any plan change required under subclause (3) must be notified as soon as practicable, and no later than 12 months after the assessment is publicly notified.

Subpart 8 – Car parking

3.38 Car parking

(1) If the district plan of a tier 1, 2, or 3 territorial authority contains objectives, policies, rules, or assessment criteria that have the effect of requiring a minimum number of car parks to be provided for a particular development, land use, or activity, the territorial authority must change its district plan to remove that effect, other than in respect of accessible car parks.

(2) Territorial authorities must make any changes required by subclause (1) without using a process in Schedule 1 of the Act.

(3) Nothing in this National Policy Statement prevents a district plan including objectives, policies, rules, or assessment criteria:

- (a) requiring a minimum number of accessible car parks to be provided for any activity; or
- (b) relating to parking dimensions or manoeuvring standards to apply if:
  - (i) a developer chooses to supply car parks; or
  - (ii) when accessible car parks are required.

Part 4: Timing

4.1 Timeframes for implementation

(1) Every tier 1, 2, and 3 local authority must amend its regional policy statement or district plan to give effect to the provisions of this National Policy Statement as soon as practicable.

(2) In addition, local authorities must comply with specific policies of this National Policy Statement in accordance with the following table:

Local authority	Subject	National Policy Statement provisions	By when
Tier 1 only	Intensification	Policies 3 and 4 (*see* Part 3 subpart 6)	Proposed plan or plan change notified no later than 2 years after the commencement date
Tier 2 only (other than a tier 2 territorial authority required by section 80F of the Act to prepare an IPI)	Intensification	Policy 5	Proposed plan or plan change notified no later than 2 years after the commencement date
Tiers 1 and 2	First FDS made publicly available after the commencement date	Policy 2 (*see* Part 3 subpart 4)	In time to inform the 2024 long-term plan
Tiers 1 and 2	HBA so far as it relates to housing	Policy 2 (*see* Part 3 subpart 5)	By 31 July 2021
Tiers 1 and 2	HBA relating to both housing and business land	Policy 2 (*see* Part 3 subpart 5)	In time to inform the 2024 long-term plan
Tiers 1, 2, and 3	Car parking	Policy 11(a) (*see* clause 3.38)	No later than 18 months after the commencement date

Appendix: Tier 1 and tier 2 urban environments and local authorities

Table 1

Tier 1 urban environment	Tier 1 local authorities
Auckland	Auckland Council
Hamilton	Waikato Regional Council, Hamilton City Council, Waikato District Council, Waipā District Council
Tauranga	Bay of Plenty Regional Council, Tauranga City Council, Western Bay of Plenty District Council
Wellington	Wellington Regional Council, Wellington City Council, Porirua City Council, Hutt City Council, Upper Hutt City Council, Kāpiti Coast District Council
Christchurch	Canterbury Regional Council, Christchurch City Council, Selwyn District Council Waimakariri District Council

Table 2

Tier 2 urban environment	Tier 2 local authorities
Whangārei	Northland Regional Council, Whangarei District Council
Rotorua	Bay of Plenty Regional Council, Rotorua District Council
New Plymouth	Taranaki Regional Council, New Plymouth District Council
Napier Hastings	Hawke’s Bay Regional Council, Napier City Council, Hastings District Council
Palmerston North	Manawatū-Whanganui Regional Council, Palmerston North City Council
Nelson Tasman	Nelson City Council, Tasman District Council
Queenstown	Otago Regional Council, Queenstown Lakes District Council
Dunedin	Otago Regional Council, Dunedin City Council

AGENDA AUTHORISATION

Agenda for the Policy and Planning Committee meeting held on Tuesday 21 November 2023

Confirmed:

13 Nov, 2023 10:46:39 AM GMT+13

A D McLay

Director Resource Management

Approved:

14 Nov, 2023 12:06:39 PM GMT+13

S J Ruru

Chief Executive