Policy and Planning Committee

Tuesday 24 April 2018
10.30am
Taranaki Regional Council, Stratford

Agenda for the meeting of the Policy and Planning Committee to be held in the Taranaki Regional Council chambers, 47 Cloten Road, Stratford, on Tuesday 24 April 2018 commencing at 10.30am.

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

Notification of Late Items

Closing Karakia and Karakia for kai

Agenda Memorandum

Date 24 April 2018

Memorandum to
Chairperson and Members
Policy and Planning Committee

Subject: Confirmation of Minutes – 13 March 2018

Approved by: A D McLay, Director-Resource Management

B G Chamberlain, Chief Executive

Document: 2039507

Resolve

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

1. takes as read and confirms the minutes of the Policy and Planning Committee meeting of the Taranaki Regional Council held in the Taranaki Regional Council chambers, 47 Cloten Road, Stratford, on Tuesday 13 March 2018 at 10.30am
2. notes the recommendations therein were adopted by the Taranaki Regional Council on 10 April 2018.

Matters arising

Appendices

Document #2021385 – Minutes Policy and Planning Committee

Minutes of the Policy and Planning Committee Meeting of the Taranaki Regional Council, held in the Taranaki Regional Council Chambers, 47 Cloten Road, Stratford, on Tuesday 13 March 2018 at 10.30am.

Members	Councillors	N W Walker	(Committee Chairperson)
		M P Joyce	
		C L Littlewood	
		D H McIntyre	
		B K Raine	
		C S Williamson	
		D N MacLeod	(ex officio)
Representative Members	Ms	E Bailey	(Iwi Representative)
	Councillor	G Boyde	(Stratford District Council)
	Mr	J Hooker	(Iwi Representative)
	Councillor	R Jordan	(New Plymouth District Council)
	Councillor	P Nixon	(South Taranaki District Council)
	Mr	M Ritai	(Iwi Representative)
Attending	Messrs	B G Chamberlain	(Chief Executive)
		A D McLay	(Director-Resource Management)
		G K Bedford	(Director-Environment Quality)
		S R Hall	(Director-Operations)
		C L Spurdle	(Planning Manager)
		G C Severinsen	(Policy and Strategy Manager)
		R Ritchie	(Communications Manager)
		P Ledingham	(Communications Officer)
		S Tamarapa	(Iwi Communications Officer)
		S Ellis	(Environmental Services Manager)
		R Phipps	(Science Manager)
	Mrs	K van Gameren	(Committee Administrator)
	Mrs	J Ritchie	(Policy Analyst)
	Mrs	V McKay	(Science Manager)
	Mrs	N West	(Policy Analyst)
	Mrs	F Mulligan	(Iwi Representative)
	Mr	K Holwsich	(Iwi Representative)
	Mr	J Clough	(Wrightson Consulting)
	Mr	D McClutchie	(Tiaki Te Mauri o Parininihi Trust)
	Mr	C O'Çarroll	(Tiaki Te Mauri o Parininihi Trust)
	Ms	M Benson	(Tiaki Te Mauri o Parininihi Trust)
	Ms	A McKay	(Tiaki Te Mauri o Parininihi Trust)

One Member of the Media.

Apologies The apologies from Councillor D L Lean and Mr P Muir (Taranaki Federated Farmers) were received and sustained.

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

1. Confirmation of Minutes – 30 January 2018

Resolved

THAT the Policy and Planning Committee of the Taranaki Regional Council

1. takes as read and confirms the minutes and confidential minutes of the Policy and Planning Committee meeting of the Taranaki Regional Council held in the Taranaki Regional Council chambers, 47 Cloten Road, Stratford, on Tuesday 30 January 2018 at 10.40am
2. notes that the recommendations therein were adopted by the Taranaki Regional Council on 20 February 2018.

Williamson/McIntyre

Matters Arising

Proposed Coastal Plan for Taranaki

It was noted that three submissions have been received on the *Proposed Coastal Plan for Taranaki*. Submissions close 27 April 2018.

2. Key Native Ecosystems programme update 2018

2.1 Mr S R Hall, Director-Operations, spoke to the memorandum presenting for Members' information an update on the identification of twelve new Kay Native Ecysystem sites. Mr S Ellis, Environment Services Manager, provided a presentation *Biodiversity Programme* in support of the agenda item.

Recommended

That the Taranaki Regional Council:

1. receives this memorandum and the attached inventory sheets for Campbell's Bush; Mangamingi Bush Reserve; The Two Sisters; Whakamara; Fisher Family Bush; Rukumoana Reserve; QEII Covenants 5/06/011 & 5/06/031; Huiroa Reserve; Vujcich Kamahi Swamp Maire Forest; Willing's Woodlot; Jupp Covenant (Bean Dog's Bush) and Harlow Fern
2. notes that the aforementioned sites have indigenous biodiversity values of regional significance and should be identified as Key Native Ecosystems.

Littlewood/MacLeod

3. Tiaki Te Mauri O Parininihi Trust – Annual Update

Mr John Hooker, Iwi Representative, gave a Mihi whakatau to welcome the guests from Tiaki Te Mauri O Parininihi Trust to the meeting.

3.1 Mr S R Hall, Director-Operations, spoke to the memorandum introducing the annual report prepared by the Tiaki Te Mauri O Parininihi Trust on its operational activities through to August 2017.

3.2 Mr Davis McClutchie, Trustee Tiaki Te Mauri O Parininihi Trust Chairperson, provided a verbal presentation to the Committee summarising the Trust's pest control work, operational activities, kiwi and rare plant monitoring/protection, and promotional and educational events, including the Kokako release in May and July 2017.

Recommended

That the Taranaki Regional Council:

1. receives the memorandum and the report entitled *Tiaki te Mauri o Parininihi Trust – Progress report for the Taranaki Regional Council – August 2017*.

Hooker/Bailey

4. Annual report on the implementation of the National Policy Statement for Freshwater Management: 2016/2017

4.1 Mr C L Spurdle, Planning Manager, spoke to the memorandum reporting on the implementation programme for the *National Policy Statement for Freshwater Management 2014* (NPS-FM) for the 2016/2017 financial year.

Recommended

That the Taranaki Regional Council:

1. receives the memorandum on the *Report on the implementation of the National Policy Statement for Freshwater Management: 2016/2017*
2. notes the progress on the implementation of the NPS-FM for the 2016/2017 financial year.
3. notes this agenda item fulfils the public reporting provisions of the progressive implementation plan.

Littlewood/Jordan

5. Report on draft swimmability targets

5.1 Mr G K Bedford, Director Environment Quality, spoke to the memorandum introducing a report setting out draft regional targets for swimmable rivers and lakes in Taranaki.

5.2 It was noted that one of the National Policy Statement (NPS) Freshwater Management criteria for swimmability would require large reductions in E coli concentrations during high flows. Ministry for the Environment regional sector modelling of projected reductions had not adequately taken this into account, and had also in the opinion of officers, over-estimated the benefits for water quality of dairy effluent diversion to land. The Council had previously raised these and other concerns with the Ministry. While a re-drafted modelling report had only noted but not responded to these concerns, a more recent Ministry email advised that all modelled improvements for Taranaki had been wrongly presented in the report. A Ministry letter just received confirmed that these and other errors were being corrected. The Ministry would be engaging with the Council over the question of high flows and high counts, that the final report would include a paragraph recording the Council's concerns, and that the Ministry were committed to reviewing seasonality within the NPS criteria. The letter had not challenged the Council's concerns.

Recommended

That the Taranaki Regional Council:

1. receives the memorandum *Report on draft swimmability targets*
2. notes that draft regional targets will be made available to the public by 31 March 2018 as required by the National Policy Statement for Freshwater Management
3. notes the community will not be able to meet the Government's targets
4. notes feedback from the public will be sought on the targets
5. sends a copy of the report to the Ministry for the Environment
6. notes that the targets could change before the Council is required to adopt final targets by 31 December 2018.

Joyce/Raine

6. Draft report on incorporating mātauranga Māori into monitoring of freshwater in Taranaki

6.1 Mr S Tamarapa, Iwi Communications Officer, spoke to the memorandum introducing a draft report into how the Council might incorporate mātauranga Māori into the monitoring of freshwater in Taranaki. The report is considered draft because it contains important cultural matters the Council wishes to consult Taranaki iwi authorities on. A presentation, *Incorporating Mātauranga Māori into the Monitoring of Freshwater in Taranaki* was provided in support of the agenda item.

6.2 Concern was noted to the Committee by Ms E Bailey concerning the process in developing the draft report. Engagement with Iwi and Hapu on how they would see the development of this matter, especially at the initial stage, was considered fundamentally important. The report was designed to inform the Council and Committee on the requirements of the National Policy Statement and what mātauranga Māori is and did not presume an outcome.

6.3 Council staff agreed to reconsider the way forward, noting the comments and concerns expressed. It was agreed to keep the draft report as an internal report and commence consultation with iwi/hapu. Accordingly the recommendations were ammended.

Recommended

That the Taranaki Regional Council:

1. receives the memorandum *Draft internal report on incorporating mātauranga Māori into monitoring of freshwater in Taranaki*
2. agrees to initiate consultation with iwi on developing a freshwater monitoring plan incorporating mātauranga Māori.

Hooker/Littlewood

7. Department of Conservation review of the effect of the NZ Coastal Policy Statement

7.1 Mr C L Spurdle, Planning Manager, spoke to the memorandum briefing the Committee on the key outcomes of the Department of Conservation's review of the effect of the New Zealand Coastal Policy Statement 2010 on regional policy statements, plans, and resource consents, and other decision making.

Recommended

That the Taranaki Regional Council:

1. receives the memorandum and notes the key outcomes of the review of the effect of the New Zealand Coastal Policy Statement

Nixon/Boyde

8. Quarterly monitoring report on urban development indicators for New Plymouth District

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

Recommended

That the Taranaki Regional Council:

1. receives the memorandum *Quarterly monitoring report on urban development indicators for New Plymouth district*
2. notes that the Quarterly Monitoring Report has been prepared by the New Plymouth District Council and gives effect to district and regional council requirements under the NPS-UDC

3. notes that Council will be working and liaising closely with New Plymouth District Council regarding our mutual responsibilities under the NPS-UDC to monitor and plan for housing and business capacity in the New Plymouth urban area.

Raine/Williamson

There being no further business, the Committee Chairperson Councillor N W Walker, declared the Policy and Planning Committee meeting closed at 12.40pm.

Confirmed

Chairperson _____

N W Walker

Date **24 April 2018**

Agenda Memorandum

Date 24 April 2018

Memorandum to
Chairperson and Members
Policy and Planning Committee

Subject: **New Zealanders' views of the primary sector**

Approved by: AD McLay, Director – Resource Management

BG Chamberlain, Chief Executive

Document: 2017142

Purpose

The purpose of this memorandum is to introduce a research report commissioned by the Ministry for Primary Industries on urban and rural New Zealanders' views of rural New Zealand and the primary sector. These sorts of surveys, while not targeted specifically to the Taranaki region, are useful to resource management agencies such as this Council.

A copy of the Executive Summary from the report is attached for Members' information. A copy of the full report together with a media release from the Minister of Agriculture, can be viewed on https://www.beehive.govt.nz/release/what-rural-urban-divide

Executive summary

The report "New Zealanders' views of the primary sector" was published in October 2017 and explores urban and rural New Zealanders' views of rural New Zealand. It repeated a similar benchmark study undertaken in 2008.

The primary purpose of the study was to gain an in-depth understanding of the beliefs and values held across both urban and rural New Zealanders, regarding the primary sector.

The key finding of the report was that with very few exceptions, the views of rural and urban New Zealanders are very similar across key topics in the primary sector including water quality and expansion through value-add. The findings are contrary to the study's media literature scan, which suggested there is a growing divide between the two groups.

Respondents said the most significant environmental issue facing New Zealand was water quality (rural 53% and urban 47%) with recognition that farmers were looking to do something about this issue.

Other issues dealt with in the survey include views on biodiversity, climate change, animal welfare and access to services, among others.

These sorts of surveys, while not targeted specifically to Taranaki, are nonetheless very useful in gaining an understanding of the values and perceptions of New Zealanders on various topics, in this case, New Zealanders' views on the primary sector. They assist resource management agencies such as this Council in carrying out their work. We have reported similar surveys to this Committee in the past.

Recommendation

That the Taranaki Regional Council:

1. receives the memorandum *New Zealander's views of the primary sector.*

Background

The report "New Zealanders' views of the primary sector" was published in October 2017. The study explored urban and rural New Zealanders' views of rural New Zealand and the primary sector. It repeated a similar benchmark study undertaken in 2008.

The main objectives of the study were to:

- gain an in-depth understanding of the beliefs and values held across both urban and rural New Zealanders, regarding the primary sector (agriculture, horticulture, food, fishing, aquaculture, and forestry industries)
- explore and identify pathways in the development of beliefs and values and
- quantify views of urban and rural New Zealanders across a range of focus areas.

The study used both qualitative (focus group) and quantitative (telephone survey) approaches. A media and literature scan was also carried out.

To ensure that an accurate picture of changes in attitudes between 2008 and 2017 was obtained, the sampling regime and the majority of questions were kept as similar as possible.

The report's findings

The key finding of the report was that with very few exceptions, the views of rural and urban New Zealanders are very similar across key topics in the primary sector including water quality and expansion through value-add.

These findings were contrary to the study's media literature scan, which suggested that there is a growing divide and polarisation of views between the two groups.

Views of both urban and rural respondents towards pastoral farming industries were "mildly positive", which have slipped from very positive in 2008. 50% of rural respondents and 47% of urban respondents held positive views towards dairy farming. However, positive views towards the dairy sector were still twice as high as negative ones (21% rural and 25% urban).

Respondents said the most significant environmental issue facing New Zealand was water quality (rural 53% and urban 47%) with recognition that farmers were looking to do something about this issue. In the focus groups, there was increasing concern expressed about the 'corporatisation' of primary production in New Zealand and in many cases, this

was used to indicate foreign ownership, which was linked to intensification, and negative impacts on the environment.

Respondents agreed that expansion through value-add products was good for New Zealand (rural 70% and urban 69%) and were equally concerned about threats to biosecurity from pests and disease (rural 88% and urban 87%).

Both urban and rural respondents felt strongly that responding to key issues such as biosecurity and climate change were the responsibility of all New Zealanders.

The survey also highlighted very positive views about New Zealand's animal welfare, and in particular, the focus groups felt New Zealand led the world in animal welfare standards and performance. Participants in the focus groups felt most negative media reports about animal welfare were highlighting an exception rather than normal behaviour of New Zealand farmers.

There was a notable increase in urban respondents who agreed that everyone should have access to services and would pay a bit more if it meant that rural people could access them at reasonable cost – 63% up from 52% in 2008.

Both urban and rural New Zealanders indicated that better lifestyle, open spaces, population size and a clean environment were the positives about living in rural New Zealand. Lack of infrastructure, lack of amenities and facilities, distance form school, work and friends and isolation were seen as key negatives.

Participants in the focus groups talked about the need for transparency and more accurate information to help guide useful conversations that currently were more influenced by partial and often negative information from the media.

These sorts of surveys, while not targeted specifically to Taranaki, are nonetheless very useful in gaining an understanding of the values and perceptions of New Zealanders on various topics, in this case, New Zealanders' views on the primary sector. They assist resource management agencies such as this Council in carrying out their work. We have reported similar surveys to this Committee in the past.

Decision-making considerations

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

Financial considerations—LTP/Annual Plan

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

Policy considerations

This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks

including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

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

Legal considerations

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

Attachment

Document 2029329: New Zealanders' views of the primary sector

New Zealanders' views of the primary sector

Ministry for Primary Industries

October 2017

Contents

1. Purpose of Research

Purpose of research

- The primary purpose of this 2017 study was to repeat the 2008 benchmark study that explored urban and rural New Zealanders' views of rural New Zealand and the primary sector. The main objectives for this study include:
  - gaining an in-depth understanding of the beliefs and values held, across both urban and rural New Zealanders, regarding the primary sector (agricultural, horticulture, food, fishing, aquaculture and forestry industries)
  - exploring and identifying pathways in the development of beliefs and values
  - quantifying views of urban and rural New Zealanders across a range of focus areas
- To answer these objectives, and in keeping with the 2008 study, a combined qualitative (focus groups) and quantitative (telephone survey) approach was used
- To ensure an accurate measure of change, the sampling regime and the majority of questions have been kept as similar as possible
- Some questions have been amended to reflect changes in New Zealand and the Ministry for Primary Industries (MPI) (MAF in 2008)* over the last 10 years. This means for a few data points we are unable to make longitudinal comparisons
- A media and literature scan was also conducted for the 2017 study. Relevant parts of the scan are included in this report – the full media and literature scan is documented in a separate report

**Formed in April 2012, MPI is a merger of the Ministry of Agriculture and Forestry (MAF), the Ministry of Fisheries, and the New Zealand Food Safety Authority.*

Reporting notes

- The term ‘respondents’ in this report refers to those New Zealanders who responded to quantitative telephone survey questions
- The term ‘participants’ in this report refers to those New Zealanders who participated in the qualitative focus group discussions
- As much as possible, 2017 figures are compared to the 2008 results. In some cases, questions have been amended to reflect real-world changes. Whenever this has happened it is noted in the charts
- Throughout this report, direct verbatim quotes are used from the focus groups. Verbatim text is always in italics and there is an identifier at the end of the quote, which gives the participant’s location, type of group and gender
- This report focuses on the main findings from the study and data are presented in charts. More detail is provided in a full set of tables in an appendix report which is easily referenced as it follows the same order as this report
- Throughout this report, scale questions have been used to gather the data
    - For example – a 1 to 5 agreement scale where 1 means strongly agree and 5 means strongly disagree. For clarity purposes, we usually report on the positive part of the scale such as ‘total agreement’ which is the sum of 1 + 2 on the scale
- Throughout the report some findings from the media and literature scan are included – full references for these findings are documented at the end of this report
    - When information from the scan is cited we make it clear if it is from a media article or a research report

Statistical significance testing

Sub-sample differences

- Statistically significant differences in the percentages across demographics are reported on and are placed in text boxes next to the charts

Differences between 2017 and 2008

- Statistically significant differences between the 2017 and 2008 percentages are reported on and are placed in text boxes next to the charts

Open-ended multiple response questions

- Statistically significant differences in any open-ended multiple type response questions should be interpreted with care, this has been noted on the slides
- Comparing 2017 and 2008 results across open-ended multiple response questions over time can be inherently problematic. As these are coded questions, there is an element of subjectivity in the coding that can be managed but not completed eliminated
- To manage this going forward, in our methodological recommendations section we suggest reducing the number of open-ended questions in the quantitative (telephone) survey

Note: Multiple comparisons problem

- We have used t-tests to determine whether two percentages are different from each other. With each t-test that is done, we incur a probability of a Type I error (rejection of a true null hypothesis or in other words 'false positive'). The probability of committing a Type I error is the significance level of the test, which is set to 5%. When doing multiple tests, the Type I error rate is inflated. We have used the false discovery rate (FDR) method to control the expected proportion of 'discoveries' that are false
- In other words, based on this statistical testing method we have used whenever this report shows a statistically significant difference between 2017 and 2008 (between the urban and rural sub-samples) there is a 5% chance it will be a false positive

2. Executive Summary

Executive summary

Views of the primary sector

- Both urban and rural respondents were most positive about the horticulture industry and least positive about fisheries
  - In 2017, 69% of rural respondents up 11% (from 2008) and 66% of urban respondents up 6% (from 2008) held positive views about the horticulture industry
  - Positive views towards fisheries were 40% for rural respondents and 39% for urban respondents (this question was not asked in 2008)
- Views of both urban and rural respondents towards the pastoral farming industries were mildly positive, which have slipped from very positive in 2008*
  - In 2017, 63% of rural respondents and 59% of urban respondents held positive views towards sheep and beef farming, also 50% of rural respondents and 47% of urban respondents held positive views towards dairy farming
    - However, positive views towards the dairy sector are still twice as high as negative ones with corresponding negative ratings for dairy being 21% (rural) and 25% (urban)
  - These 2017 figures have slipped from 83% of rural respondents and 78% of urban respondents who held a positive view of farming in general in 2008

***Note:** In 2008 the question was asked about 'farming' in general – this was split into two specific questions in 2017 that asked directly about 'sheep and beef' and also 'dairy' farming.*

Executive summary (cont.)

Views of the primary sector (cont.)

- A majority of urban and rural respondents (albeit a slightly smaller one than 2008) continued to agree that expansion of the primary sector in the future is good for New Zealand
  - However, the focus groups showed that this expansion did not necessarily mean growing in size, but also meant improving efficiencies and adding value to produce
- The quantitative results showed that many New Zealanders (both urban and rural) still hold overall positive views about the primary sector, however, over the last 10 years or so this positivity has decreased
  - The qualitative research suggests this was largely because of the critical role people felt the primary sector played in the economy

Main issues facing the primary sector

- The most significant change since 2008 was a doubling in the percentage of both urban (from 23% to 47%) and rural (from 26% to 53%) respondents who now see water pollution and quality as the most significant environmental issue facing New Zealand
- The most significant environmental issue facing the primary sector was also considered to be water pollution and quality by both urban (52%) and rural (58%) respondents
  - It was felt that the dairy industry was the main source of concern and the biggest issues were thought to be in the Canterbury region

Executive summary (cont.)

Main issues facing the primary sector (cont.)

- In the focus groups, there was also increasing concern about the 'corporatisation' of primary production in New Zealand
- 'Corporatisation' was in many cases used to indicate foreign ownership and this was linked to intensification and negative impacts on the environment
- Participants' concerns about sustainability in the primary sector were conflicted because they viewed the sector as their current option for maintaining and growing the economy

Biosecurity

- The vast majority of all respondents were concerned about the threat of pests and diseases to New Zealand
- Almost all (87%) urban and (88%) rural respondents agreed that, '*Pests and diseases are a threat to New Zealand*'
- Both urban and rural respondents also placed a high level of responsibility on all parts of society for helping to protect New Zealand from the entry or spread of pests and diseases
- There was strong support in the focus groups for taking measures to control pests and diseases
- Participants suggested talking more about biosecurity in schools, and making the issue more real for people by focusing on the impacts an incursion would have on local businesses, families and jobs

Executive summary (cont.)

Biosecurity (cont.)

- The media and literature scan reinforced these findings. It suggested that New Zealanders believed prevention was better than dealing with an incursion, and that most were willing to participate in passive surveillance, albeit with direction (research report; Yockney & Field, 2016)
- This research showed that 'biosecurity' appeared to be a term with which many New Zealanders were becoming familiar. However, references to the term were dominated more by border security and less by domestic measures for controlling the spread of pests and diseases

Climate change

- In 2017, both urban (19% down from 27%) and rural respondents (18% down from 21%) felt the importance of climate change as an environmental issue facing New Zealand has decreased slightly since 2008
    - However, a strong majority agreed that, *'Responding to climate change is the responsibility of all New Zealanders'*
- The 2017 results also showed that both urban and rural respondents were now more likely to accept that climate change is the result of human activity and that there was something that a small country like New Zealand could do about climate change
- There was a significant decrease in the percentage of urban and rural respondents who considered natural weather cycles are more important than people, with only 28% of urban (down from 45%) and 38% of rural respondents (down from 51%) agreeing with this

Executive summary (cont.)

Animal welfare

- Almost all respondents (both urban and rural) agreed it was important that the welfare of all farmed animals in New Zealand is protected
- In 2017, the level of agreement that farm animals were treated well by farmers is less than in 2008. However, it still remains in strongly positive territory
  - Among rural respondents 73% (down from 82% in 2008) agreed farm animals were treated well by farmers; the comparable results among urban respondents was 68% agreement (down from 71%)
- In a new question this year, just over half of both urban (56%) and rural respondents (51%) agreed that, '*Generally, New Zealanders living in cities and towns treat their animals well*'
- In the qualitative research (focus groups):
  - Many participants admitted they did not really know how animals were treated on farms, but they felt that New Zealand led the world in animal welfare standards and performance
  - Participants felt most negative media reports about animal welfare were highlighting an exception rather than normal behaviour of New Zealand farmers
  - Concerns tended to focus on caged farming and corporate farming
  - Concerns in urban areas tended to focus around the mistreatment of dogs

Executive summary (cont.)

Working in the primary sector (skills)

- A majority of respondents agreed that, '*A wide range of skills are needed to work in the primary sector*', (77% rural and 76% urban respondents), however; rural respondents were much more likely (64%) than urban respondents (48%) to indicate that they would recommend working in the primary sector to someone else
- There was strong acknowledgement that the, '*Primary industries involve cutting-edge thinking and technologies*', (67% of rural and 66% of urban respondents agreed with this)
- Under half of both rural and urban respondents populations agreed that, '*Businesses in the primary sector are good employers*' (41% of rural and 37% of urban respondents)
- The percentage of both urban and rural respondents who were either currently or had previously worked in the primary sector has decreased since 2008

Views of urban and rural New Zealand

- Similar to the 2008 results, both urban and rural respondents are twice as likely to say that over the last five years their view of rural New Zealand had become more positive compared to those whose view had become more negative
- Most other results have remained relatively stable since 2008 except for a large* increase in the percentage of both urban and rural respondents who now cite, *'Pollution caused by dairying'* as the reason they hold a negative view of rural New Zealand

**Due to small sub-sample this figure needs to be interpreted with care, however its consistency with the qualitative research adds weight to the result*

Executive summary (cont.)

Views of urban and rural New Zealand (cont.)

- In 2017, there has been a significant increase in the percentage of urban respondents who agreed that everyone in New Zealand should have reasonable access to services regardless of the cost (81% up from 74% in 2008). Also 63% of urban respondents now agreed that they don't mind paying a bit more if it means rural people can access services at a reasonable cost, up from 52% in 2008
- The media and literature scan suggested an increasing polarisation of views between urban and rural New Zealanders and that dairying was causing some of this (media articles; Edmeades, 2017; Hart, 2017; Mackay & Maharey, 2017; Mackay, Rookes & Uden, 2017)
- However, this research suggests that the 'divide' between urban and rural populations may not be as big as some media reports indicate, instead showing few differences between urban and rural attitudes and views
- Instead, concerns about the impact of dairying were shared across urban and rural populations

Social License to operate

- The focus group discussions suggested that framing the way New Zealand seeks to manage its primary sector around a 'social licence to operate' was potentially useful
- Participants talked about the need for transparency and more accurate information to help guide useful conversations that currently were more influenced by partial and often negative information from media platforms

Executive summary (cont.)

Social License to operate (cont.)

- It was considered that the primary sector currently earns its ‘social licence to operate’ by providing employment opportunities, economic stability and food for New Zealanders
- In the qualitative research there was no questioning of the economic contribution of the primary sector to New Zealand. However, many questioned the lack of affordable and quality food that it provided locally

Agenda Memorandum

Date 24 April 2018

Memorandum to
Chairperson and Members
Policy and Planning Committee

Subject: **NIWA Study of riparian management and freshwater health, quality and swimmability in Taranaki**

Approved by: GK Bedford, Director-Environment Quality

BG Chamberlain, Chief Executive

Document: 2036507

Purpose

The purpose of this memorandum is to present the background and findings of a report the Council commissioned the National Institute of Water and Atmosphere (NIWA) to undertake, '*Analysis of stream responses to riparian management on the Taranaki ring plain*' (NIWA, April 2018). The findings of the report are set out within this memorandum. The full draft report is provided as a separate attachment, and will be circulated and made available on the Council's website when received as a finalised version.

A power point presentation on the report will be provided at the meeting.

Executive summary

The NIWA study described herein shows there is a strong correlation between the implementation of riparian management and improved stream health (as measured across a range of metrics for in-stream community abundance, diversity, composition, and change from a baseline state as riparian management progresses), and reduced *E coli* levels in the waterways of Taranaki.

On the other hand, the study finds minimal correlation between the concentrations of nutrients, or changes in those concentrations, and in-stream health. This runs counter to commonly expressed assumptions, and highlights the potential dangers of a 'one size fits all' problem analysis and solution imposition at a national level.

The study found a lack of correlation between increasing riparian interventions and any evidence of a change in attainment of the National Policy Statement on Fresh Water Management (NPS-FM) swimmability criteria; this goes to the heart of the matter in terms of the NPS-FM requirement to implement riparian fencing as the designated means for NZ's waterways to become swimmable.

The study finds a very high rate of attainment of swimmability in Taranaki if our waterways are assessed against European Union (EU) criteria instead of NPS-FM criteria.

In respect of the benefits for stream health that arise from riparian interventions, the report concludes as follows:-

*Our analysis suggests that the regional restoration approach fostered by the Taranaki Riparian Management Programme has succeeded in assuaging several of the commonly-blamed causes for lack of restoration effects on stream macroinvertebrates. The first of these is the mismatch between scales of restoration (*ie a site by site basis*) and degradation (*catchment basis*). The second is dispersal constraints and low recolonization. However, the Taranaki region is already exceptional in that it has a prime source of diverse recolonists in Egmont (Taranaki) National Park.*

On top of that, the Riparian Management Programme has resulted in establishment of many small sections of restored riparian vegetation scattered across the Ring Plain. These riparian corridors are preferred habitat for many species of flying adult invertebrates, while individual patches may serve as "stepping stones" connecting restored reaches to each other and to the National Park. Therefore, the combination of its unique landscape and dedicated management program has made Taranaki an ideal experiment for investigating the relationships between riparian restoration and stream ecological and recreational values, and the results after the first 20 years are noteworthy.

Recommendations

That the Taranaki Regional Council:

1. receives the memorandum *NIWA Study of riparian management and freshwater health, quality and swimmability in Taranaki*
2. receives the independent draft report *Analysis of stream responses to riparian management on the Taranaki ring plain,* (NIWA, March 2018), and notes it is innovative and leading edge in terms of its timeframes, spatial scope and findings
3. notes the findings of the report with particular reference to the strong correlation between the implementation of riparian management and improved stream health and reduced *E coli* levels; the lack of correlation between increasing riparian interventions and any evidence of a change in attainment of the NPS-FM swimmability criteria; the very high rate of attainment of swimmability in Taranaki if assessed against EU criteria instead of NPS-FM criteria; and the absence of any correlation between nutrient trends and macroinvertebrate community health trends
4. notes the report's findings highlight the potential dangers of a 'one size fits all' problem analysis and solution imposition to water quality interventions at a national level
5. notes that the findings of the report are available to inform the Council's position in matters of freshwater quality management policies and interventions, at regional and national level.

Background

The Taranaki ring plain is one of the most intensive dairy farming areas in New Zealand. The ring plain also contains over 6000 kilometres of rivers and streams; almost every dairy farm is crossed by at least one stream, with more than 6 km of stream bank per property on average. Although the water quality of Taranaki streams is generally very good because they generally have their source in springs within the bush-covered Egmont National Park, in the early 1990s the Taranaki Regional Council became concerned about the reduction in riparian vegetation along the edges of rivers and streams on the ring plain which had occurred over the past 170 years of dairy farming. Many waterways were also not fenced to keep cattle from entering the streams. Consequently, at that time the Council introduced a voluntary

initiative to support the region's farmers to fence and plant native vegetation on either side of the waterways on their properties, known as the riparian management programme. The programme has been widely adopted, and currently 85%, or over 11,000 km, of all ring plain waterways are now fenced, and 70%, over 8,500 km, are planted.

Co-incidentally, in the 1990s the Council also initiated monitoring of the ecological state of rivers and streams within the region (State of the Environment Monitoring, or SEM). The data collected are used to calculate the macroinvertebrate community index (MCI), a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution and stream habitat conditions, to indicate stream health. Analyses of long-term trends in the annual monitoring data show that MCI scores have improved significantly across most of the ring plain over time since 1995 (when monitoring began). The Council also monitors physico-chemical variables, including nutrients and *E. coli* levels, at 11 SEM sites.

It has been recently proposed in national discussions on the 'swimmability' of New Zealand waterways that riparian development, particularly fencing, may be one means of reducing *E. coli* levels in streams and rivers. There is also growing interest at national level around the need for and means of controlling nutrient levels in waterways. The Taranaki riparian restoration programme and the SEM ecological and physico-chemical dataset offers a rare opportunity to test these hypotheses. While there are any number of studies into the efficacy of riparian management elsewhere, rarely do they encompass even a complete catchment, let alone an entire region, and rarely do they utilise data extending over such a long period as the records of the Council provide.

Separately, the Committee has previously been briefed on the requirements and provisions of the government's NPS-FM, and in particular the imposition that each regional council must set a regional target for 'swimmability', as defined by four criteria within the NPS-FM, applied across the larger waterways of the region and to year-round data ie this included waterways being made swimmable all year round. The NPS-FM also prescribes a requirement for riparian fencing on these waterways, the clear implication being that the fencing of riparian margins for cattle exclusion will result in more or most waterways becoming swimmable. Each council is obliged to report to its community on:-

- the improvements that will be made to water quality in rivers and lakes under programmes that are planned or underway;
- the regional target for swimmability, and when the anticipated water quality improvements will be achieved; and
- the likely costs of all interventions, and where these costs will fall.

A joint taskforce of central and local government representatives sought to use what they considered the best information available to model these obligations on a regional and national scale. The joint taskforce subsequently advised the Council that based on the modelling approach adopted, currently, overall 39% of rivers in the Taranaki region are estimated to be swimmable, and that the anticipated delivery of swimmability for the Taranaki region based on the taskforce modelling of programmes already underway is for 65.5% of rivers that are fourth order or larger to become swimmable by 2030. These figures have been generated by the computer modelling undertaken on behalf of the taskforce.

However, Taranaki Regional Council staff assessments of swimmability as defined by the NPS-FW, put the likely level of compliance on completion of the current programme and further proposed interventions at 50-55% of rivers rather than 65%. The Council's view is

that the MfE inputs to the modelling are overly optimistic, especially around the anticipated water quality benefits of riparian management.

The Council has received and publicly presented a report from officers on a target for Taranaki. The Council believes that the 50-55% figure is a more realistic outcome to be expected, and is an appropriate target to be pursued. Following its consideration at the last Policy and Planning Committee meeting, this information has been placed on the Council's website for any community feedback. A final report adopting a regional target must be provided to the Ministry for the Environment (MfE) by 31 December 2018. However, it should be noted that even should MfE's overly optimistic analysis be accepted, the region would fall well short of what is required as a national average under the NPS-FM. This is despite the fact that through the region's riparian programme Taranaki is investing and doing far more than the NPS-FM requires and doing more than many other regions in New Zealand.

The current Minister has noted the swimmability criteria could be reviewed, particularly the all year round requirement.

The Council has commented on the modelling assumptions and parameters used by MfE which raise issues of concern with the value and applicability of the modelling across a number of inputs and assumptions. The Council believed a fundamental review of the modelling work was required. The study herein discussed represented an important and timely investment in research to inform critical questions being asked about water quality management and the way forward.

Therefore, the Council wished to determine:
1) Whether there are strong correlations between: a) the progressive increase in fencing/planting (as quantified by restoration indices that might be developed); b) the observed increases in MCI values (including independent verification as to whether such increases were actually occurring); and c) stream nutrient concentrations with either (a) or (b), at both the individual catchment/site and the overall ring plain scale.
2) Whether there has been a reduction in *E. coli* levels in Taranaki streams over the course of the riparian restoration programme, at either a ring plain scale or in any individual catchments, and whether any observed reductions are correlated with the chosen restoration index.
3) Whether each site meets 'swimmability' standards based on alternatively the New Zealand NPS-FM, EU, and US Environmental Protection Authority (EPA) criteria for *E. coli*.

Discussion

Objectives and methodology

The project has five main objectives:
1) To determine whether improvements in MCI scores can be linked to the implementation of the riparian management programme;
2) To investigate whether specific environmental drivers (e.g., nutrients, water temperature) are correlated with improved MCI scores and other measures of macroinvertebrate community change and stream health.
3) To investigate any correlation between the implementation of riparian management and changes in nutrient levels in waterways.
4) To investigate whether there is a correlation between trends in the degree of riparian

management above each SEM site (e.g. restoration index), and trends in the *E. coli* levels at each site.
5) To apply the full suite of criteria for assessing swimmability by, respectively, the NPS-FM, the EU, and the USEPA (including data selection and numerical criteria) to determine whether each site meets the 'swimmability' criteria for *E. coli*.

Key tasks to be undertaken by NIWA to meet these objectives included:-

- working with the Council to create a 'restoration index' to represent the degree of riparian restoration which has occurred at each site, and trialling these indices to compare complexity of index with predictive power around ecological health; and then testing relationships between restoration indices and macroinvertebrate communities across all SEM sites. The three 'restoration indices' took into account respectively: (i) the percentage of upstream bank that was being either fenced or planted; (ii) an additional factor that took account of the time since the fencing or planting had occurred; and (iii) an additional consideration of the degree of shading of the river or stream in relation to the width of the waterway.
- NIWA further tested for correlations between specific environmental drivers (e.g., temperature, nutrients) and MCI scores across a subset of SEM sites that have associated physicochemical data.
- In terms of swimmability, NIWA analysed the *E. coli* data at each site for any evidence of trends in the 95th %ile *E. coli* count (ie the highest concentrations of *E coli*) and in the percentage of *E coli* counts exceeding 540/100 ml (the guideline for acceptable health risk when swimming), using: (a) the full records; and (b) only the records for flows at or below median flow (i.e. 'swimmable' conditions) both with and without excluding three days following significant rainfall or river freshes.
- NIWA also determined the best method for testing for an association between *E. coli* levels at each site (e.g. means or medians of *E. coli*, distance or % of catchment above each site under riparian management, appropriate time period for analysis) and the state of riparian management above each site, and subsequently tested whether there is a correlation between trends in the degree of riparian management above each SEM site with trends in *E coli* at each site when measured as described above.
- NIWA also assessed the 'swimmability' of each site based on full application of the New Zealand, EU and US EPA approaches (ie. applying the numerical criteria used by the EU/US as well as effectively following their requirements with regard to selection of sampling occasion and raw data.)

Measures of macroinvertebrate community health and change in the study included MCI, as well as richness and abundance of EPT (Ephemeroptera, Plecoptera, and Trichoptera; known sensitive species), the richness and abundance of forest specialist taxa, and community turnover (both change from a baseline state, and variability between samples).

The details of the study are set out in full in the report *Analysis of stream responses to riparian management on the Taranaki ring plain.*

While the identification of necessary data and its subsequent scientific analysis was carried out by NIWA independently of the Council, the assistance given to NIWA in providing data by the Council's freshwater ecologist, hydrologist, and GIS team was acknowledged.

Key findings

The details of the study's findings and conclusions are set out in full in the report *Analysis of stream responses to riparian management on the Taranaki ring plain*. The summary below highlights the main findings of the report, together with some observations and additional commentary from Council officers.

Invertebrates, riparian management, and water quality

Measures of macroinvertebrate community sensitivity, diversity, and abundance, shifts away from initial community composition, and measures of the abundance and percentage community composition of more sensitive species (that is, tests such as MCI, SQMCI, EPT richness and percent EPT), all showed overall positive relationships between restoration and the measures' values, across all three restoration indices tested. That is, increasing riparian management is strongly associated with better community health and diversity, and invertebrate communities have demonstrably improved in all aspects with increasing riparian restoration implementation across Taranaki's landscape over time. The Council's riparian programme has improved stream health on a regional basis. Measures of variability in composition and health between sampling occasions all had overall negative relationships with restoration, showing that sites where riparian fencing and planting are present are more resilient and are less susceptible to changes in physicochemical water quality. Of the three restoration indices formulated for this study, Index 1 (a simple measure of the proportion of upstream length where there is riparian management) gave the best fit to MCI (a metric for overall community sensitivity), EPT (presence of sensitive species) richness, and community shift metrics; 'forest species' metrics were most closely associated with Index 2 (that takes age of planting/time since riparian intervention) into account; and EPT percentage of community and low turnover were most closely associated with index 2 and 3 (shading factors) equally.

No sites showed a negative relationship between riparian interventions and indicators of desirable stream health.

Examination by NIWA of the correlations between stream health metrics and nutrient trends brought out more robustly the observations that Council officers have brought to the Council on previous occasions: that the relationship between nutrient and stream health is not as simplistic and straightforward as is often suggested in national conversations. In particular nitrogen species were found to have positive correlations with invertebrate health metrics- that is, if the concentrations of nitrogen species were higher, then it was often found that stream health was simultaneously better (rather than being worse, as is commonly presented). Nitrate is found to be positively correlated with measures of composition and negatively with turnover, while ammonia is found to be positively associated with metrics of abundance. That is, higher nitrate and/or ammonia occurs at the sites in Taranaki's waterways that are showing better stream health, and higher nitrate co-incides with less community instability.

This suggests that at the very least, factors other than nutrient levels and trends are the dominant driver of stream community health in the Taranaki landscape. This highlights the dangers of adopting a generic 'one size/one solution fits all' approach that ignores the reality of drivers and effects on a site-by-site or region-by-region basis. As noted above, the correlation between riparian interventions and stream health emerges very clearly in this study.

Total phosphorus was found to negatively correlate with macroinvertebrate sensitivity and abundance metrics: that is, lower phosphate and better stream health co-incided. The Council is reminded that in the Council's own studies, officers have noted trends of improvements in stream health at the regional scale were evident well before reductions in phosphate became clear, and there is no similarity between what is happening to trends in phosphate at the regional scale and what is happening to trends in macroinvertebrate health. Thus, officers suggest a distinction should be drawn between the findings of the NIWA study (levels of phosphate are inversely correlated with better stream health) and the Council's studies (trends in phosphate are not associated with trends in stream health). The same observation applies to the NIWA and Council analyses of nitrate and total nitrogen trends in Taranaki.

The NIWA study included an assessment of whether there were any clear correlations between degrees of riparian management and concentrations of nutrients or other water quality parameters. No correlations emerged strongly, other than for turbidity, where restoration interventions were found to result in improved water clarity. (Reductions in soil runoff where there is riparian management would account for this finding). Studies elsewhere on a site by site basis indicate that riparian management results in minor to substantial reductions across a range of contaminants and metrics, but that finding did not appear in the present study. As noted above, the Council's own studies have already noted that trends in nutrients can be quite variable over time, while there has been steady increases in riparian interventions; the finding of this study that there is a lack of significant correlation between them on a regional scale is therefore not surprising.

The study found that all three restoration indices had very similar predictive power for both *E. coli* and invertebrate metrics. From an ecological perspective, this could indicate that the benefits of restoration are primarily realized soon after implementation rather than subsequently increasing substantially over time as factored into indices two and three. Additionally, it may be that the quantity (in this case, length) of restoration is a more important factor than the type or age of vegetation. (It should be noted that this finding does not suggest that the type of vegetation is not important, nor that benefits do not continue to accrue with time). NIWA note that the Taranaki dataset provides an ideal opportunity to continue exploring important questions on relative merits of different restoration methods.

Almost all of the invertebrate metrics including in the modelling analysis were found to have a detectable relationship with restoration at the region-wide scale. The report describes this as in itself an impressive result; the majority of post-restoration monitoring studies have reported a disappointing lack of detectable improvement in biodiversity. However, most riparian restoration projects focus on individual reaches, even though degradation typically occurs at the catchment-scale. While it has been shown that upstream land use and riparian cover within a catchment can have stronger negative influences on downstream water quality and biota than immediately adjacent conditions, there have been few opportunities to test the converse, i.e., whether upstream restoration can benefit downstream communities (but one study by Kail and Hering, reported in 2009, showed that near-natural reaches upstream have a positive effect on downstream reaches). The NIWA report notes that the Council's riparian management and SEM data has provided a unique look at the cumulative influence of upstream restoration on downstream macroinvertebrate communities, in one of the first analyses of riparian restoration at the landscape scale.

The report notes that it was somewhat surprising that indices two and three, which both incorporated an age component, did not consistently outperform the simpler index 1. This

may be because trying to include age added too much additional 'noise' into the analysis. Alternatively, it could indicate that age of restoration is not as important as previously thought. It is generally expected that there will be a time lag between completion of restoration measures and ecological recovery, due to natural successional processes and/or hysteresis. For example, Parkyn, Davies-Colley et al (2003) predicted the full effects of restoration would not be realized until vegetation had grown sufficiently to create a closed canopy. The current study was unable to tease apart temporal effects in this study because the restoration indices, being cumulative, co-varied with time. Nevertheless, the results raise interesting questions about timescales of recovery, and the report's authors suggest that additional analyses focused specifically on timing and rates of recovery in relation to upstream restoration would be worthwhile.

In respect of the benefits for stream health that arise from riparian interventions, the report concludes as follows:-

Our analysis suggests that the regional restoration approach fostered by the Taranaki Riparian Management Programme has succeeded in assuaging several of the commonly-blamed causes for lack of restoration effects on stream macroinvertebrates. The first of these, as mentioned above, is the mismatch between scales of restoration and degradation. The second is dispersal constraints and low recolonization. However, the Taranaki region is already exceptional in that it has a prime source of diverse recolonists in Egmont (Taranaki) National Park.

On top of that, the Riparian Management Programme has resulted in establishment of many small sections of restored riparian vegetation scattered across the Ring Plain. These riparian corridors are preferred habitat for many species of flying adult invertebrates, while individual patches may serve as "stepping stones" connecting restored reaches to each other and to the National Park. Therefore, the combination of its unique landscape and dedicated management program has made Taranaki an ideal experiment for investigating the relationships between riparian restoration and stream ecological and recreational values, and the results after the first 20 years are noteworthy.

Swimmability: *E coli*, flows, the NPS-FM, and riparian restoration relationships

NIWA's correlation studies of *E. coli* in relation to upstream restoration support a finding that the landscape-scale riparian restoration undertaken in the Taranaki region has had a beneficial effect on water quality.

All three restoration indices showed a negative relationship between *E coli* concentrations and the degree of restoration. That is, where riparian restoration increased, *E coli* concentrations were lower.

E. coli concentrations had a negative relationship with restoration across 10 of the 11 monitoring sites, indicating that *E. coli* concentrations decreased (ie water quality improved) with increasing restoration. That is, the Council's promotion of riparian management is resulting in regional water quality that is improving from the perspective of its bacteriological state. The eleventh site, in the Mangaoraka Stream, showed an increasing trend in *E coli* counts even though riparian interventions have been made in this catchment; officers have previously noted to the Council concern that deteriorating water quality in this particular catchment seems related to changes in land use activity and/or intensity, so it appears that these pressures are affecting the stream in spite of the benefits provided by riparian interventions. The study did not take these outside factors into account.

However, the study has found that the percentage of 'swimmable' sites defined according to current NPS-FM criteria has remained consistently low (27%) throughout the duration of the study period, despite the extent of riparian fencing increasing from 50% to 85% and the extent of riparian planting increasing from 42% to 70% of the region's ringplain waterways during this time. Officers note that this finding demonstrates that while riparian management has been shown to reduce concentrations of *E coli* in the region's waterways, the reduction has not been of sufficient magnitude under all circumstances (season, flow, concentrations) to simultaneously satisfy the four NPS-FM criteria to a greater degree than was the case for the first period at the start of the study record (1995-2000). Delivery of comprehensive riparian management across one-third of the ring plain over the last two decades has made no demonstrable difference to regional attainment of swimmability as defined in the NPS. This finding clearly calls into question the government's explicit promotion of riparian fencing as the panacea for national swimmability issues and the means of delivering the swimmability targets it has imposed.

The analysis of the statistical distribution of *E coli* data compared with the various NPS-FM criteria confirmed what has previously been observed by Council officers, that the greatest rate of NPS-FM non-compliance is with the criterion that requires that even if the levels of *E coli* are well above the acceptable level of 540 *E coli*/100 mls, and therefore people should not be swimming in any case, the Council must nevertheless seek to cap those high counts to below a certain threshold (despite the lack of any public health benefit in so doing). As previously noted to the Council, this swimmability criterion requires the Council to control *E coli* levels even under non-swimming conditions; it emerges from the study that compliance with this particular criterion poses the Council the greatest NPS challenge overall.

E coli concentrations were also shown to increase as flows increase. This reflects the findings of many studies elsewhere. The study went on to examine what happened to rates of compliance with swimmability criteria if samples taken during flows above the annual median or within three days following a rainfall event were excluded from the dataset. This analysis reflects the Council's view that people are less likely to swim during periods when river flow conditions are turbulent and water clarity is reduced and hence less appealing; there is widespread recognition that bacteriological levels nationally will be higher under these conditions.

This analysis showed that compliance with 3 of the 4 NPS-FM criteria significantly improves when samples collected under high flow conditions are excluded from the record. This approach resulted in reductions in the percentage of sites that exceeded the 95th percentile, the %> 540 *E. coli*/100 mL, and the % > 260 *E. coli*/100 mL attributes. The percentage of sites meeting these criteria improved from around 27% to 73-82%: that is, if bad weather samples can be excluded, Taranaki immediately comes close to meeting or even surpassing the national swimmability target of 80% of rivers.

However, the percentage of sites that exceed the NPS-FM median criteria (that is, the required proportion of samples that have very low levels of *E coli*, far below the public health threshold for recreational use) did not change if high flow conditions were excluded. (This makes sense intuitively- very low *E coli* counts would generally occur only under very low flow/fine weather conditions, when improved riparian margin management offers little benefit by way of reduced diffuse pollution runoff).

Therefore, even if high flow samples are excluded from a monitoring regime, the overall grades of each site remained the same (because all four NPS-FM criteria have to be satisfied

simultaneously, and so a river's grading is always based solely on the poorest grading). The percentage of sites exceeding the MfE/MoH 2003 criteria and the US EPA criteria also did not change when high flow days were excluded from the dataset.

However, the percentage of sites that met the EU 'Excellent' and 'Good' standards, did substantially increase if bad weather samples were excluded, from 18 to 36% and from 27 to 82%, respectively. That is, under river conditions that are suitable for recreational use, only 27% of Taranaki's rivers are deemed swimmable by the criteria of the NPS-FM, but if European standards are applied, more than 82% of the region's rivers would be deemed suitable. (The European standards also include a further category of river quality suitable for swimming, of 'acceptable'. NIWA have been asked to extend their study to add this category in the analysis, alongside 'excellent' and 'good'). The question arises as to why New Zealand has imposed recreational water quality standards that are so much more stringent in sampling and grading protocols than are accepted across Europe.

In conclusion, the study notes that the statistical distribution of *E. coli* concentrations in Taranaki is very similar to the distribution observed from the national dataset, but the percentage of swimmable Taranaki sites is lower than the national average. The report suggests that the lower than average 'pass rate' observed for Taranaki sites may be because the national dataset includes rivers and streams from a variety of land uses and catchment sizes, whereas the Taranaki data primarily comes from sites with pastoral land upstream.

Although the modelling indicated that there has been a negative relationship between increasing restoration and *E. coli* concentrations at ten of the eleven monitoring sites, any changes in concentrations have not yet been large enough to result in an improvement in swimmability; the percentage of sites meeting current NPS swimmability criteria has remained low (27%) since 2000, despite very substantial increases in riparian fencing and planting since then.

Conclusion

The study has provided a rare opportunity for leading edge research. Many restoration studies are unable to detect any effect of restoration on invertebrate communities, potentially due to the mismatch between scale of restoration, which is typically conducted at the reach scale, and scale of degradation, which usually occurs at the catchment scale, in conjunction with land use changes. The study concludes that the analysis of this study suggests that when restoration is conducted at the landscape scale, detectable benefits on downstream communities and water quality do occur at the catchment and regional scale.

Decision-making considerations

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

Financial considerations—LTP/Annual Plan

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

Policy considerations

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

Iwi considerations

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

Legal considerations

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

Attachments

Document 2023040: *Analysis of stream responses to riparian management on the Taranaki ring plain* (in draft) prepared for Taranaki Regional Council by NIWA, March 2018

NIWA
Taihoro Nukurangi

DRAFT

Analysis of stream responses to riparian management on the Taranaki ring plain

Prepared for Taranaki Regional Council

March 2018

Prepared by:
Elizabeth Graham
Charlotte M. Jones-Todd
Sanjay Wadhwa
Richard Storey

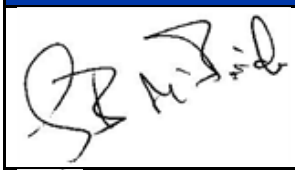
For any information regarding this report please contact:

Elizabeth Graham
Freshwater Ecologist
Freshwater Ecology
+64-7-856 1752
Elizabeth.Graham@niwa.co.nz

National Institute of Water & Atmospheric Research Ltd
PO Box 11115
Hamilton 3251

Phone +64 7 856 7026

NIWA CLIENT REPORT No: 2018051HN
Report date: March 2018
NIWA Project: TRC18201

Quality Assurance Statement		
	Reviewed by:	Graham McBride
	Formatting checked by:	Aarti Wadhwa
	Approved for release by:	David Roper

Contents

Tables

Figures

Highlights

- Modelling of *E. coli* and invertebrate metrics in relation to upstream restoration suggests that the landscape-scale riparian restoration undertaken in the Taranaki region as part of the Riparian Management Programme has had a beneficial effect on water quality and downstream communities.
- *E. coli* concentrations had a negative relationship with restoration across 11 monitoring sites, indicating that *E. coli* concentrations decreased with increasing restoration. However, percentage of 'swimmable' sites according to current NPS-FM criteria has remained consistently low (27%).
- Invertebrate metrics including MCI, SQMCI, EPT richness and percent EPT had positive relationships with restoration across 59 sites, indicating that invertebrate communities improved with increasing restoration over time.

Executive summary

The Taranaki ring plain has 1800 dairy farms and nearly 13,000 km of streambank. To protect the ring plain waterways, the Taranaki Regional Council introduced a voluntary Riparian Management Programme (RMP) in the early 1990s, in which the council works with farmers to develop individual riparian management plans for their properties, and supplies native plants at cost for riparian plantings. Currently 99.5% of Taranaki dairy farms have riparian plans, and plan holders have fenced over 84% of all ring plain waterways and planted approximately 70%.

The objective of this study was to assess the relationships between the riparian fencing and planting undertaken in the Riparian Management Programme and stream health and recreational values in Taranaki streams. Stream health and recreational values were measured by macroinvertebrate metrics and *Escherichia coli* concentrations, respectively. To quantify the effects of the Riparian Management Programme, three different "restoration indices" of varying complexity were developed to represent the ecological effects of riparian restoration. The first index was calculated as the simple proportion of upstream bank length fenced or planted, the second index weighted that proportion by age and type of restoration (fencing vs. planting), and the third index weighted the proportion by predicted shading effects based on age and height of vegetation. Bayesian models were used to examine the relationships between three restoration indices and *E. coli* concentrations and invertebrate metrics. The 'swimmability' of Taranaki's *E. coli* monitoring sites was also assessed following the current National Policy Statement for Freshwater Management criteria for "Human Health for Recreation" (as amended in 2017) under various flow scenarios.

The modelling indicated an overall negative relationship between restoration and *E. coli* concentrations across 11 monitoring sites, suggesting that *E. coli* levels have decreased with increasing restoration, but the percentage of swimmable sites (above or including the "C" attribute state in the NPS-FM) has remained low (27%) and largely unchanged since implementation of the RMP. Several invertebrate metrics had overall positive relationships with restoration, including National and Taranaki versions of the MCI (macroinvertebrate community index) and SQMCI (semi-quantitative MCI) scores, and EPT richness (number of sensitive Ephemeroptera, Plecoptera, and Trichoptera species). An additional measure of community change based on dissimilarity to original composition also had a positive relationship with restoration, suggesting there has been a shift in stream invertebrate community composition since the Programme began. However, the site-to-site variability for all metrics was high, and for many sites it was not possible to determine the direction of the relationships between certain metrics and restoration.

The restoration index designed to represent stream shading was the best-fitting model for *E. coli* across all sites, but the simplest restoration index, calculated as the proportion of upstream bank length fenced and/or planted, was the best fit when individual site relationships were considered. The simple proportional index was also the best fit for the MCI and SQMCI models, while the more complex metrics were better fits for other metrics, including species richness and percent EPT.

Overall, the findings of this study suggest that the Taranaki Riparian Management Program has had beneficial effects on stream health and water quality for human health and recreation in the region. Many restoration studies are unable to detect any effect of restoration on invertebrate communities, potentially due to the mismatch between scale of restoration, which is typically conducted at the reach scale, and scale of degradation, which usually occurs at the catchment scale, in conjunction with land use changes. The analysis in this study suggests that when restoration is also conducted at the landscape scale, detectable benefits on downstream communities and water quality do occur.

1 Introduction

1.1 Background

The Taranaki ring plain is one the most intensive dairy farming areas in New Zealand. The ring plain also contains approximately 13,000 kilometres of streambank (Bedford 2015) and most dairy farms are crossed by at least one stream (TRC 2011). Although the water quality of Taranaki streams is generally very good because they have their source in the bush-covered Egmont National Park (TRC 2011), in the early 1990s the Taranaki Regional Council (hereafter "the Council" or "TRC") became concerned about the reduction in riparian vegetation along the edges of rivers and streams on the ring plain which had occurred over the past 170 years of dairy farming. Many waterways were also not fenced to keep cattle from entering the streams. Consequently, the Council introduced a voluntary initiative to support the region's farmers to fence and plant native vegetation on either side of the waterways on their properties, known as the Riparian Management Programme (RMP). The Taranaki Riparian Management Programme was applied to all waterways, including intermittent flows as well as permanent streams of any size, not just to the larger streams previously identified in various national programmes. The Programme has been widely adopted; currently over 11,000 km, or 84%, of all ring plain waterways are now fenced and over 8,500 km, or 70%, are planted (Bedford 2015). The RMP has been one of the largest and longest-running riparian planting and enhancement schemes on private land in New Zealand (TRC 2011). The Council now wishes to determine whether ecological and recreational values of Taranaki streams, such as stream ecosystem health and suitability for primary contact ('swimmability'), respectively, have improved over the course of the Programme. Both ecosystem health and human health for recreation are compulsory national values under the New Zealand National Policy Statement for Freshwater Management (NPS-FM) (MfE 2017).

Riparian fencing and planting are used widely in New Zealand and internationally for mitigating land use intensification effects on adjacent waterways and enhancing stream health (Greenwood, Harding et al. 2012). Fencing reduces stock access to the stream, thereby reducing bank erosion and sediment and faecal bacteria inputs, while plantings increase shading, reduce stream temperatures, intercept sediments, nutrients, and bacteria in run-off, increase inputs of leaves and wood, and enhance in-stream habitat (Parkyn, Davies-Colley et al. 2003; Wilcock, Betteridge et al. 2009; Greenwood, Harding et al. 2012). It is generally assumed that these improvements in water quality and habitat will in turn enhance biodiversity and ecological functions (Parkyn, Davies-Colley et al. 2003; Wilcock, Betteridge et al. 2009; Greenwood, Harding et al. 2012). However, this assumption is rarely tested, primarily due to lack of adequate post-restoration monitoring (Bernhardt, Palmer et al. 2005; Wortley, Hero et al. 2013) and empirical support to date has been equivocal (Parkyn, Davies-Colley et al. 2003; Greenwood, Harding et al. 2012; Collins, Doscher et al. 2013).

Macroinvertebrates are commonly used as biological indicators of stream health (Moore and Neale 2008; Wagenhoff, Shearer et al. 2016) and have recently been included as such in the most recent NPS-FM (MfE 2017). The relative abundances of macroinvertebrate taxa collected from a monitoring site are used to calculate various metrics indicative stream health, including the New Zealand-specific macroinvertebrate community index (MCI) and its semi-quantitative version, the SQMCI, as well as total taxon richness, EPT (Ephemeroptera, Plecoptera, and Trichoptera) richness, and percent EPT richness. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution and stream habitat conditions (Stark and Maxted 2007). Other factors

known to affect macroinvertebrate community composition and abundance include temperature, flow, dissolved oxygen, and high amounts of fine sediment (Moore and Neale 2008). Taranaki Regional Council samples macroinvertebrates at fifty-nine sites twice per year as part of their 'State of the Environment Monitoring' (SEM) Programme. A 2014 analysis of long-term trends in the annual monitoring data found that MCI scores had improved at most sites across the region since 1995, when monitoring began (Bedford 2015).

Under the NPS-FM, Human Health for Recreation (popularly known as 'swimmability'[11]) in non-lake fed rivers is assessed using *Escherichia coli (E. coli*) bacteria. *E. coli* is as an indicator of faecal contamination and the risk of exposure to other harmful water-borne pathogens, particularly *Campylobacter*, but also *Cryptosporidium* oocysts, *Giardia* cysts, Norovirus, other human enteric viruses, and/or *Salmonellae* (McBride and Soller 2017; MfE 2017). Faecal contamination of water by livestock or other animals can occur via direct deposition, runoff from pastoral land, and piped discharges from farms. Human contamination of water can occur due to leaking sewage pipes or septic tanks, poorly treated sewage, and overflow of storm water systems during heavy rain (McBride and Soller 2017). Heavy rains and/or high flows are also known to increase *E. coli* concentrations via sediment mobilisation, in which in-channel stores may also be resuspended and/or transported (McKergow and Davies-Colley 2010). Taranaki Regional Council monitors *E. coli* levels monthly at 11 of the State of Environment Monitoring (SEM) sites across the region.

The combination of the Riparian Management Programme and the regular monitoring of macroinvertebrates and *E. coli* across Taranaki streams offer a unique opportunity to test the effect of riparian restoration on stream health and recreational values. The aim of this study was to assess the relationships between the riparian restoration (fencing and planting) undertaken in the Riparian Management Programme and MCI values and *E. coli* levels in Taranaki streams. To quantify the effects of the Riparian Management Programme, three different "restoration indices" were developed to represent the degree of riparian restoration which has occurred at each SEM monitoring site.

1.2 Scope of the project

The project had four main objectives:

1) To assess the relationships between MCI scores and other invertebrate metrics and restoration conducted during the Riparian Management Programme.

2) To investigate whether riparian management is correlated with specific environmental variables (e.g., nutrients, water temperature) and whether those variables were in turn correlated with improved MCI scores and other measures of macroinvertebrate community change and stream health.

3) To assess the relationships between *E. coli* concentrations over time and restoration conducted during the Riparian Management Programme.

4) To determine whether each site meets the 'swimmability' standards defined by NZ, EU, and US criteria for *E. coli*.

[1] It should be noted that while 'swimmability' in this report refers solely to protection from faecal contamination, in other contexts it can refer to a wider range of values, such as water clarity, algal growth, odour, etc.

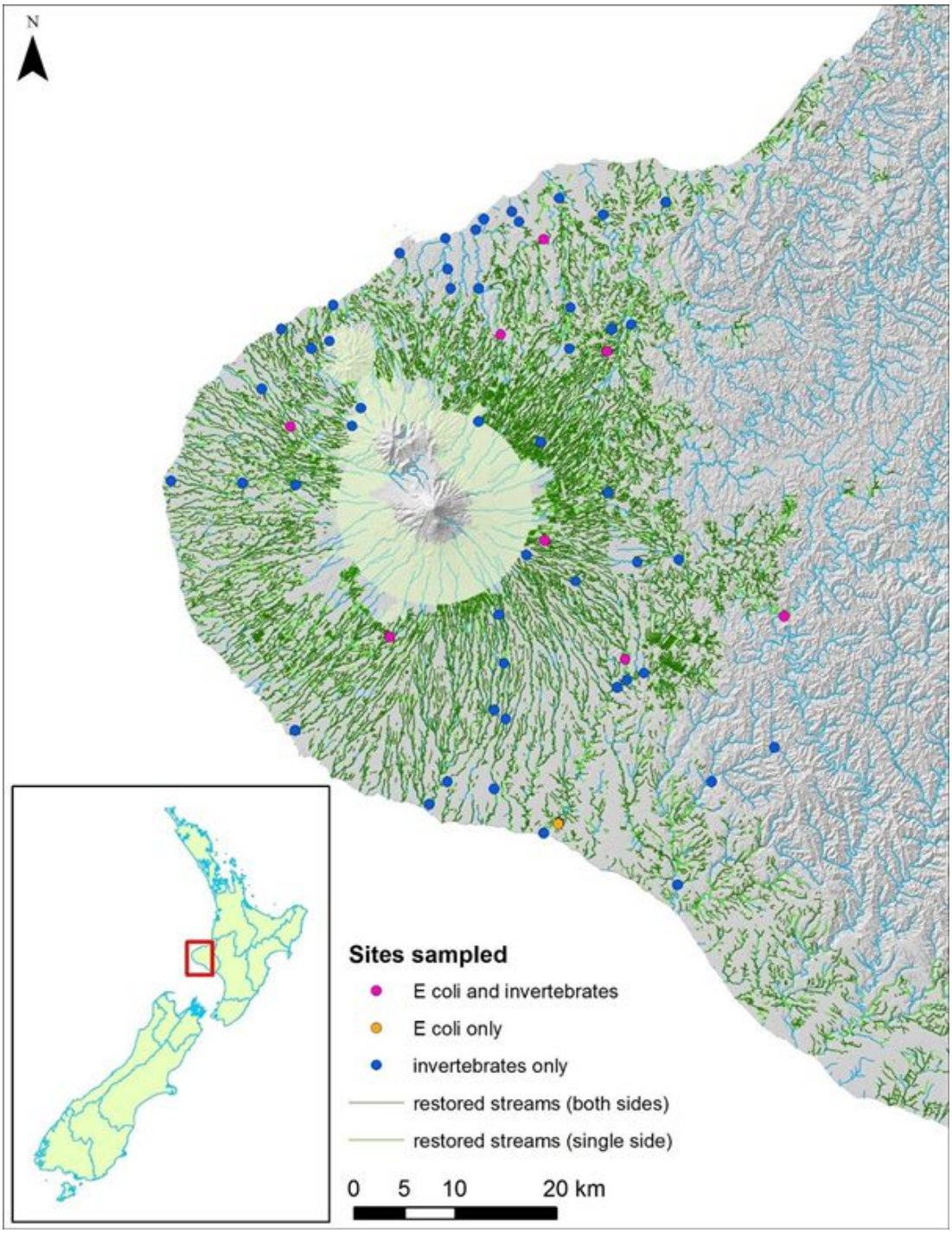


Figure 1-1: Location of invertebrate and *E. coli* sampling sites on the Taranaki Ring Plain. Sites at which both *E. coli* and invertebrates were sampled are represented by pink dots, sites were invertebrates only were sampled are represented by blue dots, and the site were only *E. coli* was measured is represented by an orange dot. Stream restoration that has occurred during the Riparian Management Programme is shown in green; streams with both banks fenced and/or planted are dark green and those with one bank fenced and/or planted are light green. Note that the map shows all restored streams in the region, whereas the analysis in this report only included streams within the upstream catchment of an invertebrate or *E. coli* monitoring site.

2 Methods

The Taranaki Regional Council provided 14-23 years of data (depending on site) from 60 SEM monitoring sites across the region (Figure 1-1). Fifty-nine of the sites were sampled twice annually for macroinvertebrates, a subset of 10 of those sites were also sampled monthly for *E. coli* and other physicochemical parameters, including nutrients, dissolved oxygen, turbidity, and temperature. One additional site was sampled for physicochemical parameters and *E. coli* but not macroinvertebrates, and therefore included in the *E. coli* analysis only.

Daily mean flow records were also provided for the eleven physicochemical monitoring sites. Five sites did not have a flow gauge at the same location the monitoring was conducted, in which case data from the nearest flow gauge was used instead. This approximation adds some extra uncertainty into the *E. coli* models, as the model framework assumes that the approximated flow corresponds to a specific date-site combination. In order to ensure any observed *E. coli*-flow relationships held without this added noise the models were also run for the subset of sites where flow measurements were taken at the same location (Appendix A; Table A-1). The *E. coli*-flow relationship remained positive in the paired-flow subset, therefore estimated flows were used to increase the number of sites, and therefore statistical power, in the modelling analysis.

2.1 GIS

Spatial data provided by the Council, including stream lines, fence lines and vegetation planted during the Riparian Management Programme, were matched to stream lines from the River Environment Classification (REC) national stream network database and a digital elevation map in ArcGIS. The combined data were then used to determine the length of fence and vegetation along each stream during each year the Riparian Management Program was implemented. This information was used to create 'restoration indices' for each stream upstream of a monitoring site, as described below.

However, in some cases the restoration data provided by Taranaki Regional Council was along farm drains or other streams too small to be included in the REC database. We tested two different methods to resolve this issue: 1) only including restoration that matched up to an REC stream segment and 2) creating our own stream network using the finest-scale digital elevation map (DEM) available, which had 2 km resolution. Because the 2 km DEM still excluded some of the drains and small streams included in the council dataset, we chose to use the restoration indices calculated using restoration along REC steam segments only for the modelling presented in the main body of this report. However, indices calculated using the two methods were highly correlated (Figure B-1), and analysis of a subset of models using the 2km DEM-derived restoration indices confirmed that the overall results and general were similar between analyses using either set of indices (Appendix B, Appendix C). Therefore, we can be confident that the results presented using only restoration on REC streams are robust, even though restoration was slightly under-estimated by excluding drains and smalls streams that did not match up to an REC stream segment.

2.2 Restoration indices

Three restoration indices were trialled to represent the cumulative effect of the fencing and planting undertaken as part of the Riparian Management Programme. The calculated restoration indices for each site are shown in Figure 2-1.

Index 1 was calculated as the simple proportion of upstream bank length restored, with fencing and planting given equal weight.

Index 2 was designed to be sensitive to the type of restoration implemented and reflect that restoration benefits increase over time as vegetation grows, then level off once maximum growth is reached. Therefore, this index was calculated as the proportion of upstream bank length restored, but with the length of each restored patch weighted by the type of restoration (fence, tall vegetation, or short vegetation) and how long it had been in place, so that the weighting increased over time since restoration. Tall vegetation weight was set to increase from 0 to 50% over the first 4 years and then from 50 to 100% over years 5 to 20; it was assumed that most streams would not be more than 3-4 meters wide and therefore shade would be close to maximum after 20 years (Parkyn, Collier et al. 2010). Short vegetation was assumed to have half the maximum benefit of tall vegetation, and to reach full height after 4 years. Consequently, short vegetation was weighted from 0 to 50% over the first 4 years, with no change thereafter. Fencing 'benefit,' was calculated following the same procedure as short vegetation, as fencing has been shown to result in rapid reductions in sediment exports (McKergow, Weaver et al. 2003), although little is currently known about fencing impacts on bank erosion rates (Hughes 2016), which will depend on stream size, bank height, and bank material.

Index 3 was designed to be sensitive to the effects of stream shading by vegetation on invertebrate communities. Vegetation type and age were used to create a 'shading' function based on simulation modelling of re-forestation of riparian zones by Davies-Colley, Meleason et al. (2009). Tall vegetation shading was calculated as:

$$y = 1 - y_0 + a(1 - b^x)$$

where y is shading, y_0 is DIFN (diffuse non-interceptance, a measure of lighting; $0<y_0<1$), x is stream width, and a and b are the constants derived from the simulation modelling. Low vegetation shading was calculated as:

$$y = 1 - y_0 + \frac{a}{1 + (x/x_0)^b}$$

where again y is shading, x is the vegetation height/stream width ratio, y_0 is DIFN, and x_0, a, and b are constants from the simulation modelling (Davies-Colley, Meleason et al. 2009). Fencing was weighted from 0 to 1 over the first four years and remaining at 1 thereafter. If the fencing 'benefit' was greater than the shading 'benefit,' then fencing alone was used to calculate the restoration index (multiplied by proportion of upstream reach restored) and vice versa.

Vegetation or fences that were already present prior to implementation of GIS management of Riparian Management Programme restoration data in 2001 were assigned the maximum benefit at time zero and given no further age weighting. The upstream length within the National Park was treated as pre-existing tall vegetation and assigned maximum benefit with no further age weighting. In effect, this represents the initial, or baseline, state at each site beginning in 2001.

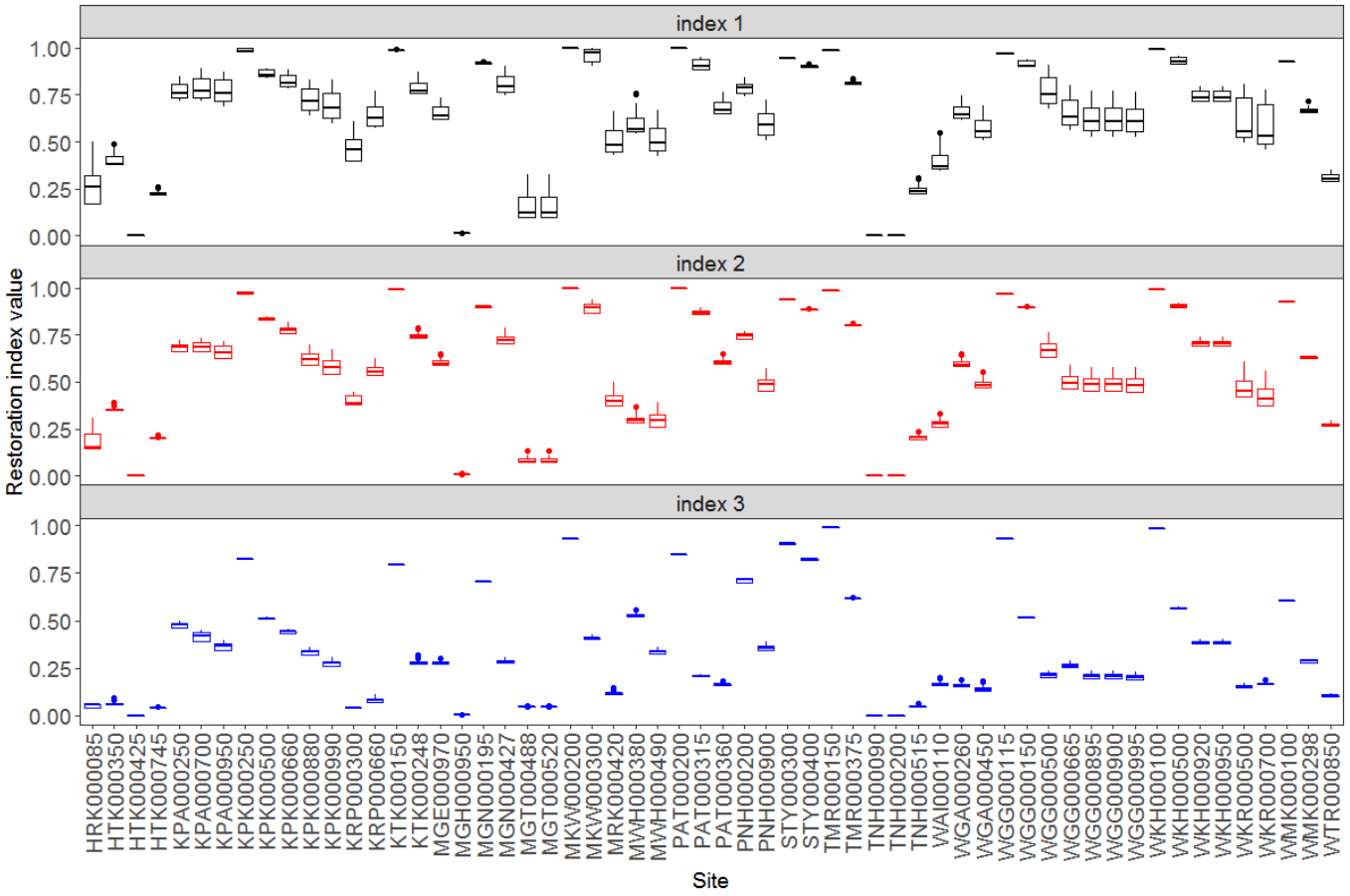


Figure 2-1: Restoration indices for each site over the Riparian Management Programme. Index 1 is the proportion of upstream streambank fenced and/or planted, index 2 is the upstream proportion weighted by type (fencing or planting) and age, index 3 incorporates age of vegetation to predict shading effects. The lower and upper edges of each box indicate the 25th and 75th quartile, respectively. The thick line in the middle is the median. The whiskers indicate data within 1.5 times the inter-quartile range (IQR; distance between 1st and 3rd quartiles). Points indicate outliers outside the IQR range.

2.3 *E. coli*

Swimmability was assessed in relation to both New Zealand and international criteria for *E. coli*. The current New Zealand criteria, from the 2017 amendment to the National Policy Statement for Freshwater, includes four different attributes to assess swimmability (long term) grading: 1) the percent of *E. coli* counts that exceed 540 *E. coli*/100 mL, 2) the percent of *E. coli* counts that exceed 260 *E. coli*/100 mL, 3) the median *E. coli* concentration per 100 mL) and 4) the 95th percentile of *E. coli* per 100 mL (MfE 2017). There are five different attribute states, A-E, associated with different numeric values of each attribute and the corresponding risk of *Campylobacter* infection (Table 2-1). The swimmability threshold is the bottom of the "C" attribute state, which restricts median risks to be less than 1 infection per 1000 exposures (McBride and Soller 2017; MfE 2017). The European Union (EU) *E. coli* criteria are based on the 95th and 90th percentiles of *E. coli*/100 mL (Table 2-4) (EU Council 2006), while the United States Environmental Protection Agency (US EPA) recommendation levels include both the geometric mean of *E. coli*/100 mL and a 90th percentile for an estimated infection rate of 32 in 1000 (Table 2-5) (US EPA 2012). In general, the 2017 NPS grades for swimmability are less restrictive than the US EPA water quality criteria but comparable to the EU "Excellent" grade (McBride and Soller 2017).

The criteria were applied over the entire dataset, for each site and year individually, and in accordance with the sampling methodology prescribed in the NPS-FM, namely using the previous five years' data to calculate the current grade (MfE 2017). Swimmability was also compared using only samples collected on days where the mean daily flow was below the annual median flow, and excluding 3 days following a 'significant' river fresh, defined as either 3 times or 7 times the annual median flow, to reflect recommended practice of avoiding immersion for up to 3 days after a large rainfall/flow event (McBride and Soller 2017).

Table 2-1: New Zealand National Policy Statement for Freshwater Management criteria for human health and recreation (MfE 2017).

Attribute State	Numeric Attribute State				Narrative Attribute State
	% exceedances over 540 *E. coli*/100 mL	% exceedances over 260 *E. coli*/100 mL	Median concentration (*E. coli*/100 mL)	95th percentile of *E. coli*/100 mL	Description of risk of Campylobacter infection (based on *E. coli* indicator)
A (Blue)	<5%	<20%	≤130	≤540	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk) The predicted average infection risk is 1%*
B (Green)	5–10%	20–30%	≤130	≤1000	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk) The predicted average infection risk is 2%*
C (Yellow)	10–20%	20–34%	≤130	≤1200	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk) The predicted average infection risk is 3%*
D (Orange)	20–30%	>34%	>130	>1200	20-30% of the time, the estimated risk is ≥50 in 1000 (>5% risk) The predicted average infection risk is > 3%*
E (Red)	>30%	>50%	>260	>1200	For more than 30% of the time, the estimated risk is ≥50 in 1000 (>5% risk) The predicted average infection risk is >7%*

* The predicted average infection risk is the overall average infection to swimmers based on a random exposure on a random day, ignoring any possibility of not swimming during high flows or when a surveillance advisory is in place (assuming that the *E. coli* concentration follows a lognormal distribution). Actual risk will generally be less if a person does not swim during high flows.

Table 2-2: Ministry of Health grading guidelines for freshwater recreation (MfE/MoH 2003).

Microbiological Assessment Category	95th percentile (*E. coli*/100 mL)[a]
A	≤130
B	131–260
C	251–550
D	>550

[a] Calculated using the Hazen method

Table 2-3: Ministry of Health surveillance criteria for freshwater (MfE/MoH 2003).

Mode	*E. coli* concentration per 100 mL	Action
Acceptable Green	no samples >260 *E. coli*/100 mL	– Continue routine (e.g., weekly) monitoring
Alert Amber	single sample >260 and <550 *E. coli*/100 mL	– Increase sampling to daily (initial samples will be used to confirm if a problem exists – Consult the CAC to assist in identifying possible location of sources of faecal contamination – Undertake a sanitary survey and report on sources of contamination
Action Red	single sample >550 *E. coli*/100 mL	– Increase sampling to daily (initial samples will be used to confirm if a problem exists – Consult the CAC to assist in identifying possible location of sources of faecal contamination – Undertake a sanitary survey and report on sources of contamination – Erect warning signs – Inform public through the media that a public health problem exists

Table 2-4: European Union bathing water criteria for inland waters (EU Council 2006).

Criteria	Excellent Quality	Good Quality	Sufficient
E. coli (cfu/100 mL)	500*	1000*	900**

* Based on a 95-percentile evaluation

** Based on a 90-percentile evaluation

Table 2-5: United States Environmental Protection Agency criteria (US EPA 2012).

Criteria	Grade 1 Estimated Illness Rate 32/1000		Grade 2 Estimated Illness Rate 36/1000	
	GM (cfu/100 mL)	STV (cfu/100 mL)	GM (cfu/100 mL)	STV (cfu/100 mL)
E. coli	100	320	126	410

GM = geometric mean

STV = statistical threshold value – should not be exceed by more than 10% of samples (approximates the 90th percentile)

2.4 Invertebrates

Eight different metrics were calculated for each SEM sample: taxon richness (total number of taxa), EPT richness (number of sensitive Ephemeroptera, Plecoptera, and Trichoptera species), percent EPT richness, MCI (Macroinvertebrate Community Index) and semi-quantitative MCI (SQMCI). Two versions of the MCI and SQMCI were calculated, one using national MCI species tolerance values and the other using Taranaki region species tolerance values, which are slightly different to the National MCI for some species. The richness and abundance of forest specialist taxa in each sample were also calculated, along with community dissimilarity, a multivariate measure of change in species composition compared to the previous sampling, and total turnover, which can be broken down into two components, appearance and disappearance of species.

2.5 Statistical modelling of *E. coli* and macroinvertebrate indices

Modelling of *E. coli* and macroinvertebrate indices against the restoration indices was carried out in R (R Development Core Team 2008) using the R-INLA package (Rue, Martino et al. 2009) which uses integrated nested Laplace approximation (INLA) methodology to estimate regression parameters in a Bayesian setting. INLA methodology developed by Rue, Martino et al. (2009) is specifically designed to fit latent Gaussian models well-suited to account for spatial, temporal or spatio-temporal structure inherent in the data. We assumed a Poisson distribution for *E. coli* and invertebrate abundance and species richness because they were count data. We assumed a gamma distribution for the MCI and QMCI metrics because they are positively continuous variables. We assumed a binomial distribution for percent EPT (because it is a proportion) and a gaussian distribution for turnover and dissimilarity measures, as well as physicochemical variables.

Because the goal of this study was to examine the relationships between *E. coli* concentrations and macroinvertebrate indices and restoration at both the regional and site scale, we constructed two models, one to test for overall relationships between *E. coli* and invertebrate responses and restoration, and the other to examine differences between sites. The first model included restoration index as a fixed effect (i.e., covariate) and site as a random intercept to account for the correlation between levels of *E. coli* or invertebrates at each site. The second model included restoration and site as random slopes; this enabled comparison of relationships between *E. coli* and invertebrates and restoration between sites. The second invertebrate model also included a random intercept for site, similar to the first model, to account for different initial values of invertebrate metrics. There were too few sites in the *E. coli* dataset for the random slope *E. coli* model to also be able to incorporate a random site intercept as well (the model algorithm would not converge). All models except for the invertebrate dissimilarity metric models also included a random seasonality term, monthly for the *E. coli* data and bi-annually for the invertebrate data, to incorporate seasonal differences in response variables. The dissimilarity metrics were calculated as pairwise comparisons between sampling points, therefore the two seasonal samplings were averaged together to avoid confounding effects of within-year being more similar than between-year pairs. Flow was also included as an additional covariate in the *E. coli* model to account for the known effect of flow on *E. coli* concentrations (Larned, Snelder et al. 2015). The influence of other physicochemical variables on macroinvertebrate metric responses was also tested by including them as covariates and performing backwards stepwise model selection (Redding, Lucas et al. 2017).

The relationship between parameters and response variables was assessed by looking at the mean values and 95% credible intervals (the probability that the true value lies between those intervals) for each parameter; if the credible intervals for a parameter do not include zero, then it can be confidently inferred that the parameter has a positive or negative (indicated by the sign of the coefficient) effect on the response variable.

3 Results

3.1 *E. coli*

The raw data indicates that *E. coli* concentrations fluctuated from year to year with no consistent temporal pattern across all sites combined (Figure 3-1). *E. coli* concentrations in 1995 were substantially lower than other years, however we noted that effect was an artefact of only one sample taken in 1995. Therefore, the subsequent modelling of *E. coli* only included data from 1998 onwards, when regular monthly sampling was implemented across all sites (except MKW000300, where sampling began in 2003).

3.1.1 Swimmability

Three of the eleven Taranaki Region *E. coli* monitoring sites met NPS swimmability criteria when applied across the entire dataset (Table 3-1). Site STY000300, which is located on conservation land, was in the top A-Blue grade, while site PAT000200, which is located in a large catchment with mixed land use, was in the B-Green grade and site PNH000200, which is located in a primarily agricultural catchment, was in the C-Yellow grade. The remaining sites were below the minimum swimmability criteria (bottom of the C grade) for one or more attributes. Six sites were in the D-Orange grade and three were in the E-Red grade. The sites which fell in the D grade band were located in a variety of land uses, primarily large catchments with multiple impacts, but also land under intensive usage and in the eastern hill country. Of the three sites in the E grade band, two were located on agricultural land, but one was on conservation land (site MKW000300). Sites that were in the D or E grade tended to be in that grade across all attributes, whereas the B and C grade sites often met the median and % >260 *E. coli*/100 mL attributes but not the 95th percentile or % >540 *E. coli*/100 mL attribute. Yearly grades for each site calculated following the sampling procedure outlined in the NPS-FM (rolling calculation over previous five years) are included in Table 3-3. The percentage of swimmable sites has remained fairly constant since 2003, with 27% swimmable under the NPS-FM criteria, 9% swimmable under the MfE/MoH 2003 criteria, 9% and 18% swimmable under the US EPA mean and 90th percentile criteria, respectively, and 18 and 27% swimmable under the EU Excellent and Good criteria, respectively. Although the NPS-FM is considered less restrictive than the EU criteria (McBride and Soller 2017), both criteria resulted in the same number of swimmable sites for this dataset. Pre-2003 differences were most likely due to fewer number of sites sampled during those years rather than any changes in swimmability status.

Excluding samples taken during flows above the annual median or within three days following a rainfall event reduced the percentage of sites that exceeded the 95th percentile, %> 540 *E. coli*/100 mL, and % > 260 *E. coli*/100 mL attributes, but not the percentage of sites that exceed the median criteria (Table 3-2; Appendix D). Consequently, the overall grades of each site remained the same. The percentage of sites exceeding the MfE/MoH 2003 criteria and the US EPA criteria also did not change when high flow days were excluded from the dataset. The percentage of sites that met the EU “Excellent” and “Good” standards, however, did increase, from 18 to 36% and 27 to 82%, respectively.

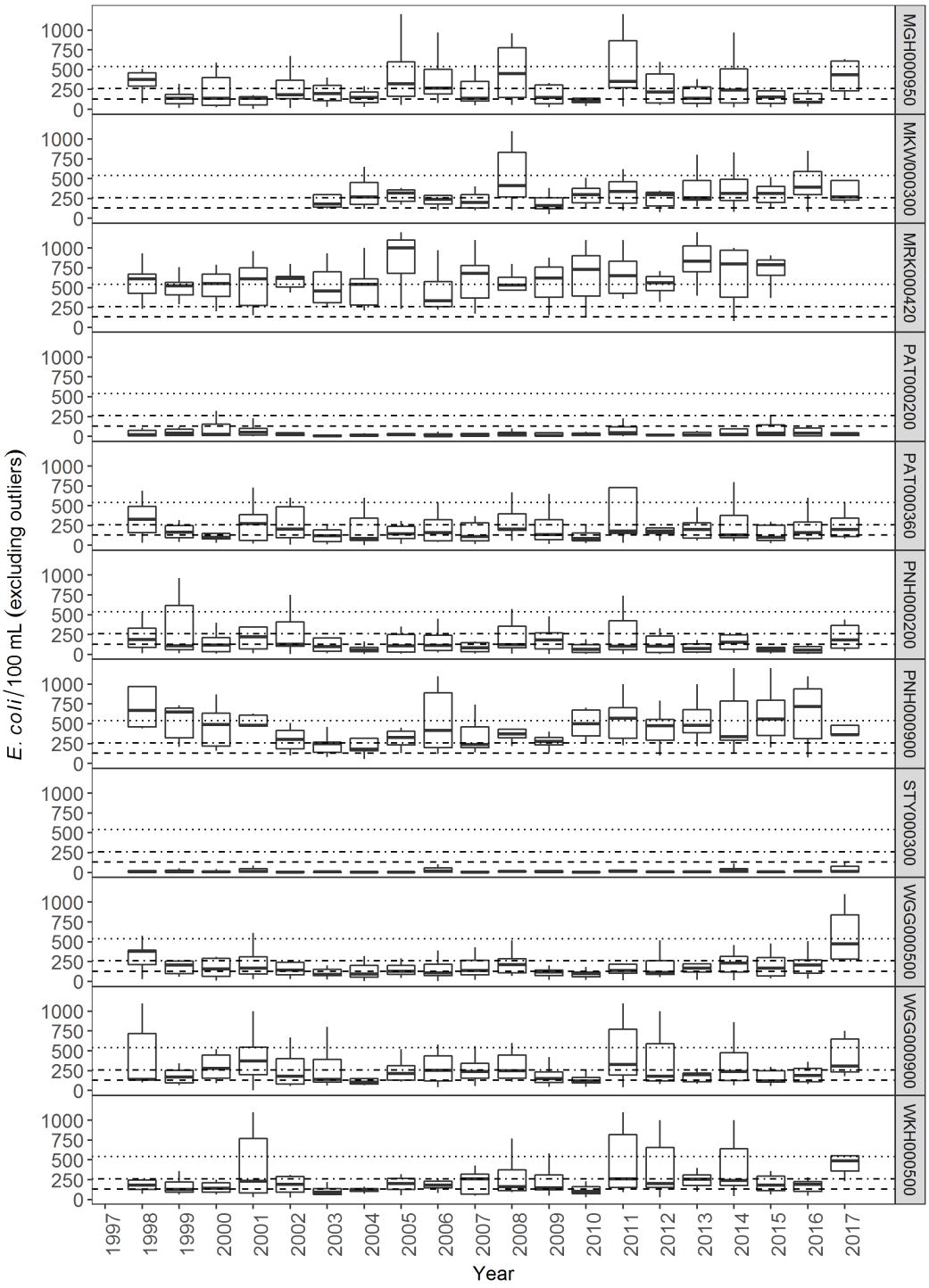


Figure 3-1: Distributions of *E. coli* concentrations grouped by site and year. The lower and upper edges of each box indicate the 25th and 75th quartile, respectively. The thick line in the middle is the median. The whiskers indicate data within 1.5 times the inter-quartile range (IQR; distance between 1st and 3rd quartiles). The dashed line indicates the NPS median criteria for swimmability, 130 *E. coli*/100 mL, the dotted lines indicate the percent exceedance thresholds, 260 *E. coli*/100 mL and 540 *E. coli*/100 mL (also the 95th percentile threshold). Note that this plot excludes outliers (points >1.5 * IQR).

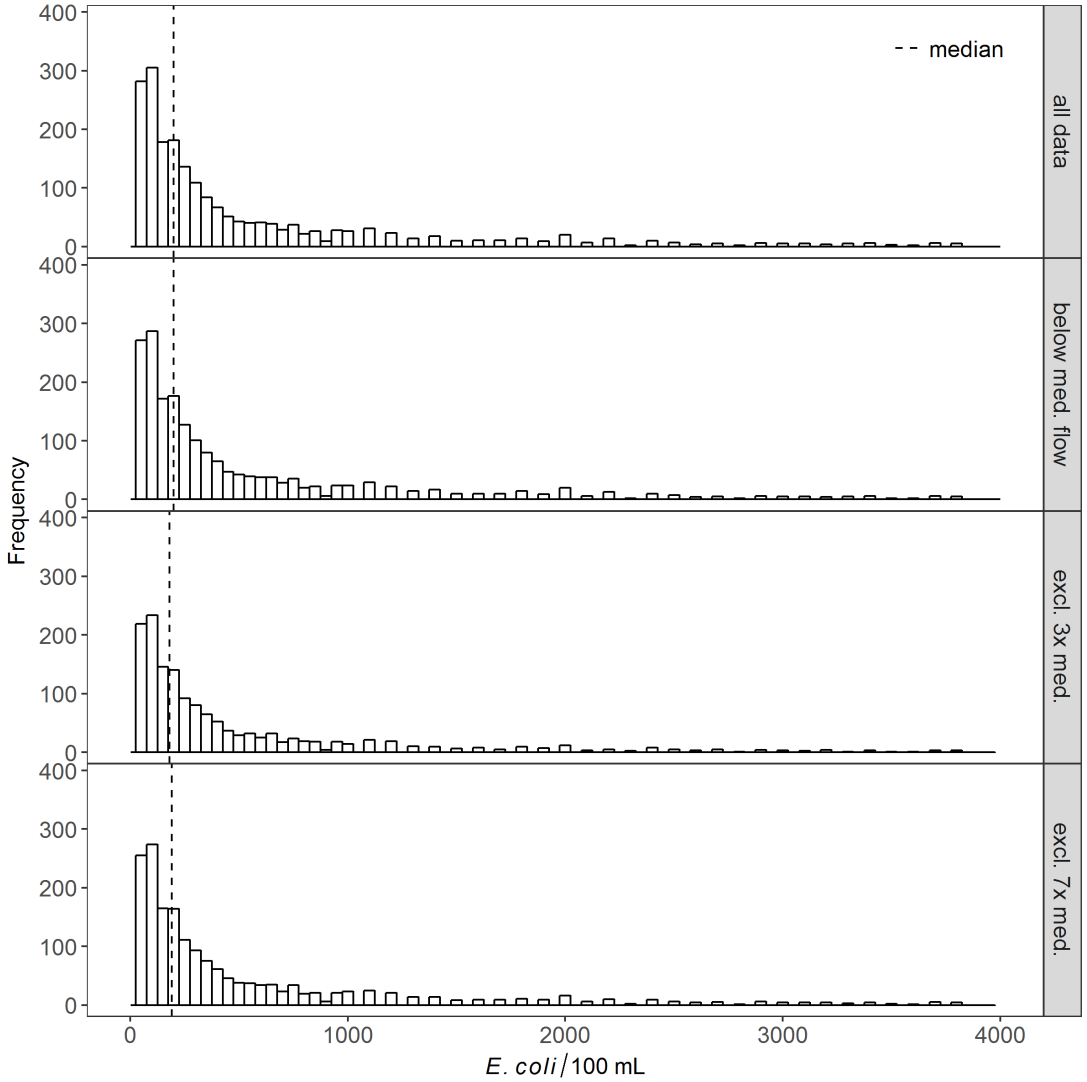


Figure 3-2: Distributions of *E. coli* concentrations per 100 mL for all Taranaki Region monitoring sites under various flow conditions between 1995 and 2017. The dashed lines indicate the median concentration for each dataset. Note that this plot excludes the 4% of data (outliers) which exceeded 4000 *E. coli*/100 mL.

Table 3-1: Swimmability for each monitoring site using the full data record (1995-2017) relative to the NPS-FM criteria.

Site	n	Median value	95th percentile	% > 540/100 mL	% > 260/100 mL	Median grade	95th Percentile grade	% > 540/100 mL grade	% > 260/100 mL grade	Overall lowest grade
All	2547	200	3400	26.2	41.7	D-Orange	D, E	D-Orange	D-Orange	D-Orange
MGH000950	242	220	3300	28.5	45.0	D-Orange	D, E	D-Orange	D-Orange	D-Orange
MKW000300	168	325	4620	30.4	62.5	E-Red	D, E	E-Red	E-Red	E-Red
MRK000420	216	785	12000	71.8	91.7	E-Red	D, E	E-Red	E-Red	E-Red
PAT000200	242	21	573	5.4	7.9	A, B, C	B-Green	B-Green	A-Blue	B-Green
PAT000360	242	200	6095	25.2	42.2	D-Orange	D, E	D-Orange	D-Orange	D-Orange
PNH000200	242	100	1095	15.3	25.6	A, B, C	C-Yellow	C-Yellow	B-Green	C-Yellow
PNH000900	240	500	3200	47.1	76.7	E-Red	D, E	E-Red	E-Red	E-Red
STY000300	242	8	100	2.1	2.9	A, B, C	A-Blue	A-Blue	A-Blue	A-Blue
WGG000500	242	180	3290	19.4	36.0	D-Orange	D, E	C-Yellow	D-Orange	D-Orange
WGG000900	229	220	2060	23.1	41.1	D-Orange	D, E	D-Orange	D-Orange	D-Orange
WKH000500	242	210	3685	25.6	29.3	D-Orange	D, E	D-Orange	D-Orange	D-Orange

Table 3-2: Percentage of Taranaki *E. coli* monitoring sites which meet New Zealand NPS-FM and US and European criteria under various flow scenarios. Flow scenarios included all data, data only from days with mean daily flow at or below annual median flow, and data from at or below annual median and excluding samples taken within 3 days of a 3 times median or 7 times median flow.

Approach	% swimmable All data	% swimmable Flow ≤ Median	% swimmable Flow ≤ Median Excluding 3 days post 3x median flow	% swimmable Flow ≤ Median Excluding 3 days post 7x median flow
NPS 2017 (A-C)	27%	27%	27%	27%
Median	27%	27%	27%	27%
95th percentile	27%	73%	73%	73%
% >540/100 mL	36%	82%	82%	82%
% >260/100 mL	27%	73%	73%	73%
MfE/MoH 2003				
Grade (A-B)	9%	9%	9%	9%
US EPA				
Mean (Grade 1)	18%	18%	18%	18%
Mean (Grade 2)	27%	18%	27%	18%
90th percentile (G1)	9%	9%	9%	9%
90th percentile (G2)	9%	9%	9%	9%
EU				
Excellent	18%	36%	36%	36%
Good	27%	82%	82%	82%

Table 3-3: Percentage of Taranaki *E. coli* monitoring sites which meet New Zealand NPS-FM and overseas swimmability criteria based on the previous 5 years of monitoring data, as per the sampling procedure described in the NPS-FM.

Year	no. sites	NPS lowest grade	NPS median	NPS 95th percentile	NPS %>540/100 mL	NPS %>260/100 mL	MfE/MoH 2003 grade	US EPA Mean G1	US EPA Mean G2	US EPA 90th Percentile G1	US EPA 90th Percentile G2	EU excellent	EU good
2000	10	30	30	30	40	40	10	20	20	10	10	20	40
2001	10	20	20	20	30	20	10	20	20	10	10	20	30
2002	10	20	20	20	30	20	10	20	20	10	10	20	30
2003	11	18	27	18	27	27	9	18	18	9	9	18	27
2004	11	18	27	18	45	36	9	18	18	9	9	18	45
2005	11	27	27	27	45	55	9	18	27	9	9	18	55
2006	11	27	27	18	45	45	9	18	18	9	9	18	36
2007	11	27	27	9	36	64	9	18	27	9	9	18	27
2008	11	27	27	27	36	64	9	18	27	9	9	18	27
2009	11	27	27	27	36	55	9	18	27	9	9	18	27
2010	11	27	27	27	36	45	9	18	27	9	9	18	27
2011	11	27	27	27	36	36	9	18	27	9	9	18	27
2012	11	27	27	27	36	36	9	27	27	9	18	18	27
2013	11	27	27	27	45	36	18	27	27	18	18	18	27
2014	11	27	27	27	36	36	9	27	27	18	18	18	27
2015	11	27	27	27	36	36	9	27	27	18	18	18	36
2016	11	27	27	27	27	36	9	27	27	9	18	18	27
2017	11	27	27	27	27	27	9	27	27	9	18	18	27

3.1.2 Relationship with restoration

As described in section 2.5, two sets of models were run, one with the three different restoration indices as fixed effects and one with the restoration indices as random slope terms. Flow was also added as a covariate (fixed effect) to account for the effect of flow on *E. coli* concentrations, which has been found to be a positive relationship (i.e., increased flow associated with increased *E. coli*) (Larned, Snelder et al. 2015). Model fit was assessed by comparing the model predictions to observed data, and the three models compared by DIC (Deviance Information Criterion, a relative measure of fit, or deviance, penalised by the number of parameters; the smaller the DIC the better the relative fit. Spiegelhalter, Best et al. 2002).

All three models estimated an overall positive relationship between *E. coli* concentrations and flow and an overall negative relationship *between E. coli* and restoration, indicated by the positive parameter coefficient for flow and the negative parameter coefficient for restoration, and 95% credible intervals that did not include zero (Table 3-4). The model with restoration index one, the unweighted proportion of upstream length fenced and/or planted, had the lowest DIC score out of the three fixed effect models. Figure 3-3 shows the random seasonal effect, which indicates that on average *E. coli* concentrations were lower in winter and higher in summer compared to the baseline (i.e., expected value if there was no seasonal effect). This is contrary to the positive flow-*E. coli* relationship observed from our modelling and other studies (Larned, Snelder et al. 2015), which would predict increased *E. coli* in conjunction with higher rainfall and elevated flows over winter. However, a similar seasonal pattern of high summer concentrations was reported for Campylobacter in the Tairei River in Otago (Eyles, Niyogi et al. 2003), and in a UK study of streams within agricultural lands (Hunter, Perkins et al. 2000). The atypical seasonal pattern in both cases was attributed to higher stocking densities over the summer months causing a build-up of faecal material on land, which was then washed into streams by periodic small flow events (Eyles, Niyogi et al. 2003). A similar scenario is likely to occur on the heavily farmed Taranaki Ring Plain.

The site-specific random effects (intercepts) are shown in Figure 3-4. Three sites (MRK000420, PAT000360, and WKH000500) had positive coefficients, indicating that *E. coli* concentrations at these sites were higher than the baseline (i.e., expected value if there were no differences between sites). Another three sites (MGH000950, PAT000200, and PNH000200) had negative coefficients, indicating that *E. coli* concentrations at these sites were lower than the baseline. The credible intervals for the remaining five sites crossed zero, indicating that *E. coli* concentrations were similar. The model predictions from the restoration as a fixed effect models plotted against the observed data are shown in Figure 3-5; all three models gave similar predictions of *E. coli* concentration.

The model with restoration index one, the simple proportion of upstream length fenced/planted, also had the lowest DIC with restoration as a random slope term. All three models also estimated a positive relationship between *E. coli* concentrations and flow (Table 3-4). Similar seasonal random effects were observed as in the restoration as fixed effect models; *E. coli* concentrations were lower in winter and higher in summer (Figure 3-3). Ten of the eleven sites had negative posterior means for the site-specific intercept, or slope, of restoration (Figure 3-7, Table 3-5), indicating that there was a negative relationship between restoration and *E. coli* at those sites (i.e., as restoration index increased, *E. coli* concentrations declined). The eleventh site, MRK000420 had a positive relationship between restoration and *E. coli*. The model predictions from the random slope models plotted against the observed data are shown in Figure 3-8; again, all three models gave similar predictions.

Table 3-4: Model parameter coefficients, standard errors, 95% credible intervals, and DIC scores for *E. coli* models with each restoration index. Note that coefficients (means) are on the scale of the linear predictor (log scale).

Model	Restoration index	Parameter	Mean	Standard error of the mean	2.5% quantile	97.5% quantile	DIC[a]
Restoration	Index 1	Intercept	7.2935	0.3443	6.6520	7.9357	**4718818**
fixed effect		Flow	0.0335	0.0000	0.0334	0.0336	
		Restoration	-1.3732	0.0128	-1.3983	-1.3480	
	Index 2	Intercept	8.1143	0.3681	7.4190	8.8097	4719888
		Flow	0.0335	0.0000	0.0335	0.0336	
		Restoration	-2.7619	0.0271	-2.8150	-2.7088	
	Index 3	Intercept	9.0279	0.5593	7.9323	10.1254	4723190
		Flow	0.0335	0.0000	0.0335	0.0336	
		Restoration	-6.6144	0.0795	-6.7705	-6.4585	
Restoration	Index 1	Intercept	7.7703	0.2444	7.3160	8.2251	**4718629**
random slope		Flow	0.0333	0.0000	0.0332	0.0333	
	Index 2	Intercept	8.2396	0.2476	7.7814	8.6976	4720486
		Flow	0.0334	0.0000	0.0333	0.0335	
	Index 3	Intercept	7.7265	0.2465	7.2683	8.1853	4728147
		Flow	0.0333	0.0000	0.0333	0.0334	

[a] DIC = Deviance Information Criterion, a relative measure of fit, or deviance, penalized by the number of parameters; the smaller the DIC the better the relative fit (Spiegelhalter, Best et al. 2002)

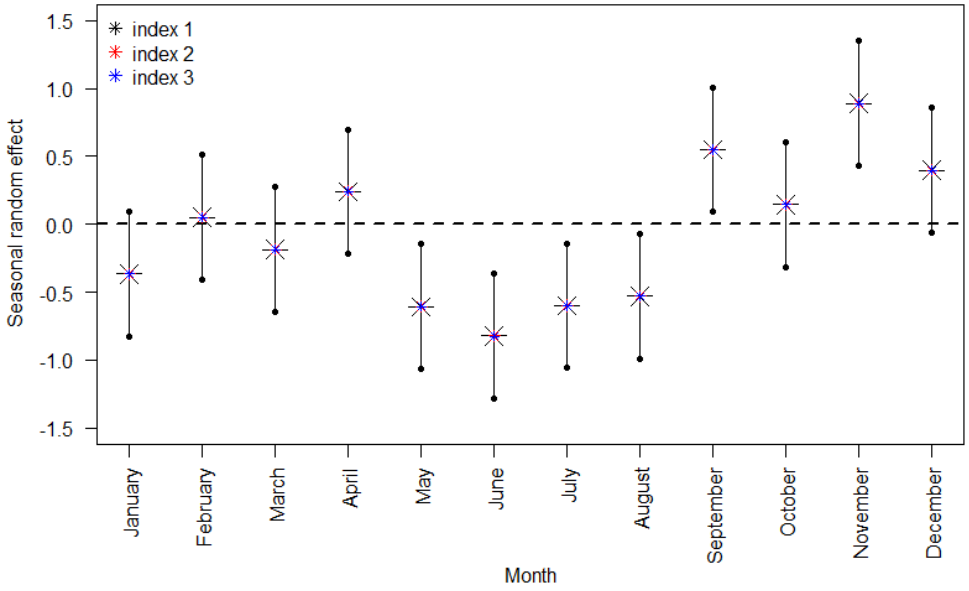


Figure 3-3: Posterior estimates and credible intervals for the seasonal (i.e., monthly) random effect in the restoration as a fixed effect models. The coefficients and credible intervals for restoration index 3, the best fitting model, are shown largest and in black, and the coefficients from the restoration index 1 and restoration index 3 models are shown in red and blue, respectively. The symbols for the three indices are superimposed when the coefficient values are very similar for each model.

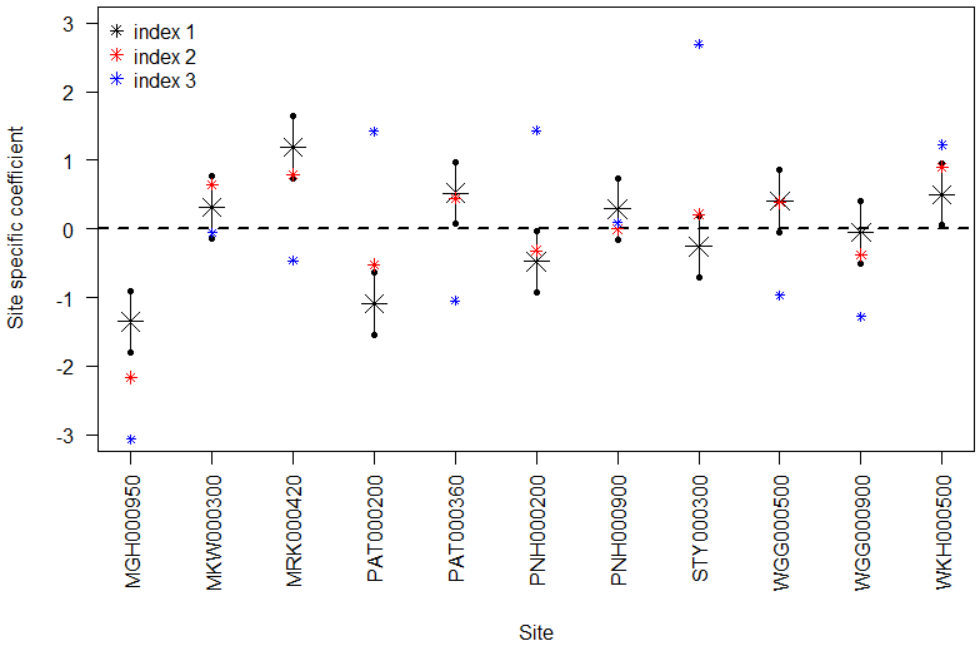


Figure 3-4: Site specific intercepts and credible intervals for *E. coli* models with restoration as a fixed effect. The coefficients and credible intervals for restoration index 3, the best fitting model, are shown largest and in black, and the coefficients from the restoration index 1 and restoration index 3 models are shown in red and blue, respectively.

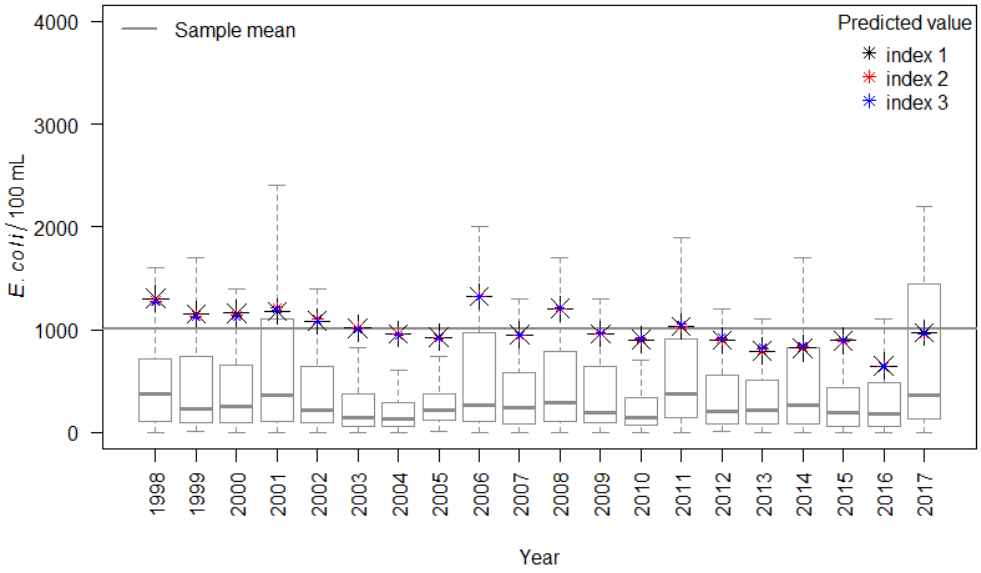


Figure 3-5: Predicted *E. coli* concentrations from the fitted fixed effect restoration models compared to observed values. Note that this plot does not show outliers, but the mean value (grey line) indicates their influence. The observed data is shown by the grey boxplots. The predicted values for the restoration index 3 model (the best-fitting model) are shown largest and in black, the predicted values from models with restoration indices 1 and 3 are shown in red and blue, respectively.

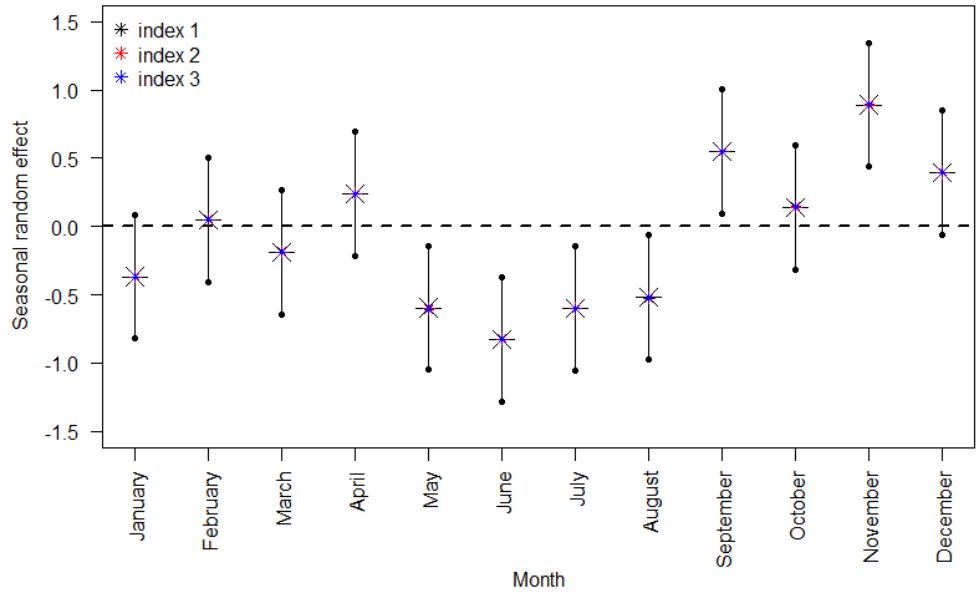


Figure 3-6: Posterior estimates and credible intervals for the seasonal (i.e. monthly) random effect in the restoration as a random slope models. The coefficients and credible intervals for restoration index 1, the best fitting model, are shown largest and in black, and the coefficients from the restoration index 2 and restoration index 3 models are shown in red and blue, respectively.

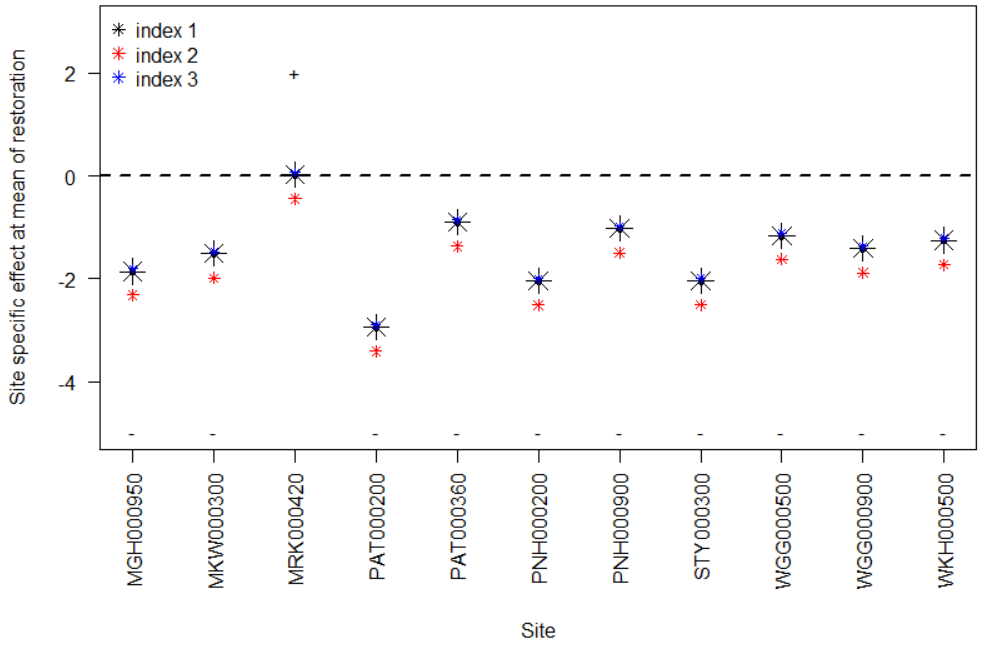


Figure 3-7: Site specific restoration coefficients (slopes) for the three restoration index models, evaluated at the mean of the restoration index at that site. A negative posterior mean with credible intervals that do not include zero indicates a negative relationship between restoration and *E. coli* concentration at that site, a positive posterior mean with credible intervals that do not include zero indicate a positive relationship between restoration and *E. coli* concentration at that site. The coefficients and credible intervals for restoration index 1, the best fitting model, are shown largest and in black, and the coefficients from the restoration index 2 and restoration index 3 models are shown in red and blue, respectively.

Table 3-5: Posterior estimates for restoration index coefficients for the restoration index 1 random slope model. A negative posterior mean with credible intervals that do not include zero indicates a negative relationship between restoration and *E. coli* concentration at that site. A positive posterior mean with credible intervals that do not include zero indicates a positive relationship between restoration and *E. coli* concentration. It is important to note that the coefficients and quantiles are at the scale of the linear predictor (i.e., log scale), therefore a large negative value represents a smaller effect than a small negative value.

Site	Mean restoration coefficient (slope)	2.5% quantile	95.5% quantile
MGH000950	-1.8568	-1.8720	-1.8415
MKW000300	-1.5090	-1.5240	-1.4940
MRK000420	0.0250	0.0107	0.0392
PAT000200	-2.9382	-2.9557	-2.9208
PAT000360	-0.8965	-0.9112	-0.8819
PNH000200	-2.0406	-2.0564	-2.0249
PNH000900	-1.0243	-1.0390	-1.0096
STY000300	-2.0312	-2.0510	-2.0114
WGG000500	-1.1636	-1.1786	-1.1487
WGG000900	-1.4038	-1.4189	-1.3888
WKH000500	-1.2513	-1.2660	-1.2366

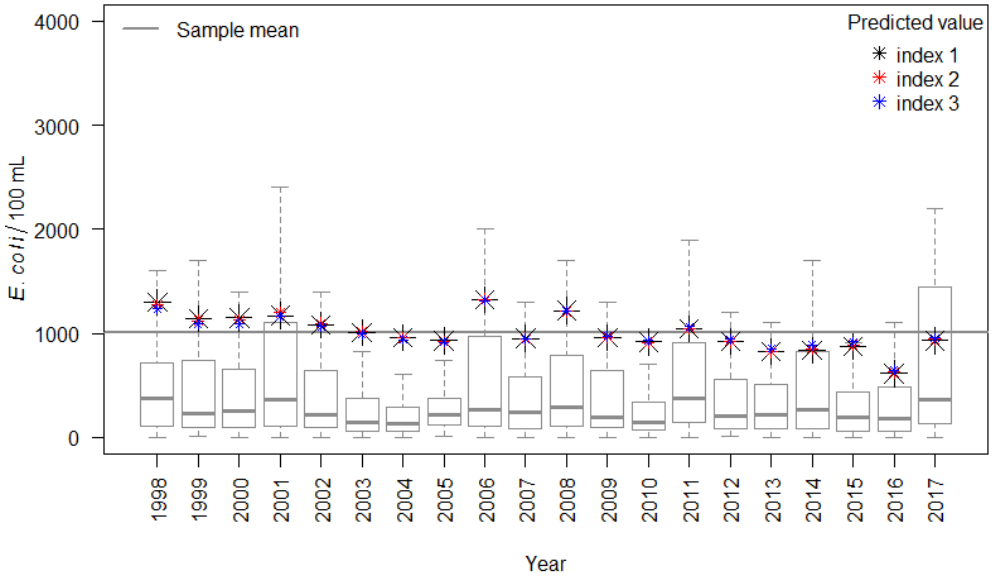


Figure 3-8: Predicted *E. coli* concentrations from the fitted random slope restoration models compared to observed values. Note that this plot does not show outliers, but the mean value (grey line) indicates their influence. The observed data is shown by the grey boxplots. The predicted values for the restoration index 1 model (the best-fitting model) are shown largest and in black, the predicted values from models with restoration indices 2 and 3 are shown in red and blue, respectively.

3.2 Invertebrates

Boxplots of the raw data indicate that there were no strong patterns in invertebrate metric scores over time for all sites combined (Figure 3-9, Figure 3-10). Most metrics had similar distributions across years, with few outliers, except for forest taxa richness and abundance, which had large outliers in most years.

3.2.1 Relationship with restoration

As described in section 2.5, two sets of models were fit to each invertebrate metric, one with the three different restoration indices as fixed effects and one with the restoration indices as random slope terms. Site was included as a random intercept in both models to account for the likely correlation between values at the same site. Detailed plots and model parameter tables are presented here for the National SQMCI metric model to illustrate the information returned by each component of the models. National SQMCI was chosen because it is a commonly used metric and the results were representative of several other metrics. The results for the other metrics are summarized in Table 3-8.

All three restoration index models estimated a positive relationship between National SQMCI and restoration (i.e., SQMCI increased as restoration increased), indicated by the positive parameter coefficient and 95% credible intervals that did not include zero (Table 3-6). The average intercept coefficient for the three models was 0.6 on the log scale, or 1.8 on the response scale. In other words, for every unit increase in the restoration index, the National SQMCI score is predicted to

increase by about 2. However, it should be noted that one is the maximum value of the restoration index, and the change in restoration index in the dataset was 0.34, at site HRK000085 (Figure 2-1). The National SQMCI model with restoration index one, the simple proportion of upstream length fenced/planted, had the lowest DIC score with restoration as a fixed effect. Figure 3-11 shows the seasonal random effect; the spring samples were higher than the baseline (i.e., expected value if there was no seasonal effect).

The site-specific coefficients were quite variable, with many sites having either higher or lower National SQMCI scores than the baseline (Figure 3-12). Other sites had credible intervals that crossed zero, indicating similar scores to other sites. The predicted annual means are plotted with the observed data in Figure 3-13; all three models gave similar predicted National SQMCI metric scores.

The model with restoration index one also had the lowest DIC score with restoration as a random slope (Table 3-6). Figure 3-14 shows that National SQMCI scores were higher than the baseline in spring than summer in this model as well. The site-specific intercepts in the random slope models were either positive, indicating sites had higher scores than the baseline, or had credible intervals which crossed zero, indicating scores were similar to those in other sites (Figure 3-15).

The site-specific restoration coefficients (slopes) are shown in Figure 3-16. Almost half (49%) of sites had a positive coefficient with a credible interval that did not include zero, indicating positive relationships between restoration and National SQMCI scores (i.e., SQMCI scores increased as the amount restoration increased; The remaining sites all had credible intervals which included zero, which means the direction of the relationship between restoration and National SQMCI cannot be confidently inferred for that site. No sites had negative relationships between restoration and National SQMCI. Finally, the model predictions plotted with the observed data are shown in Figure 3-17; again, all three restoration index models gave similar predictions.

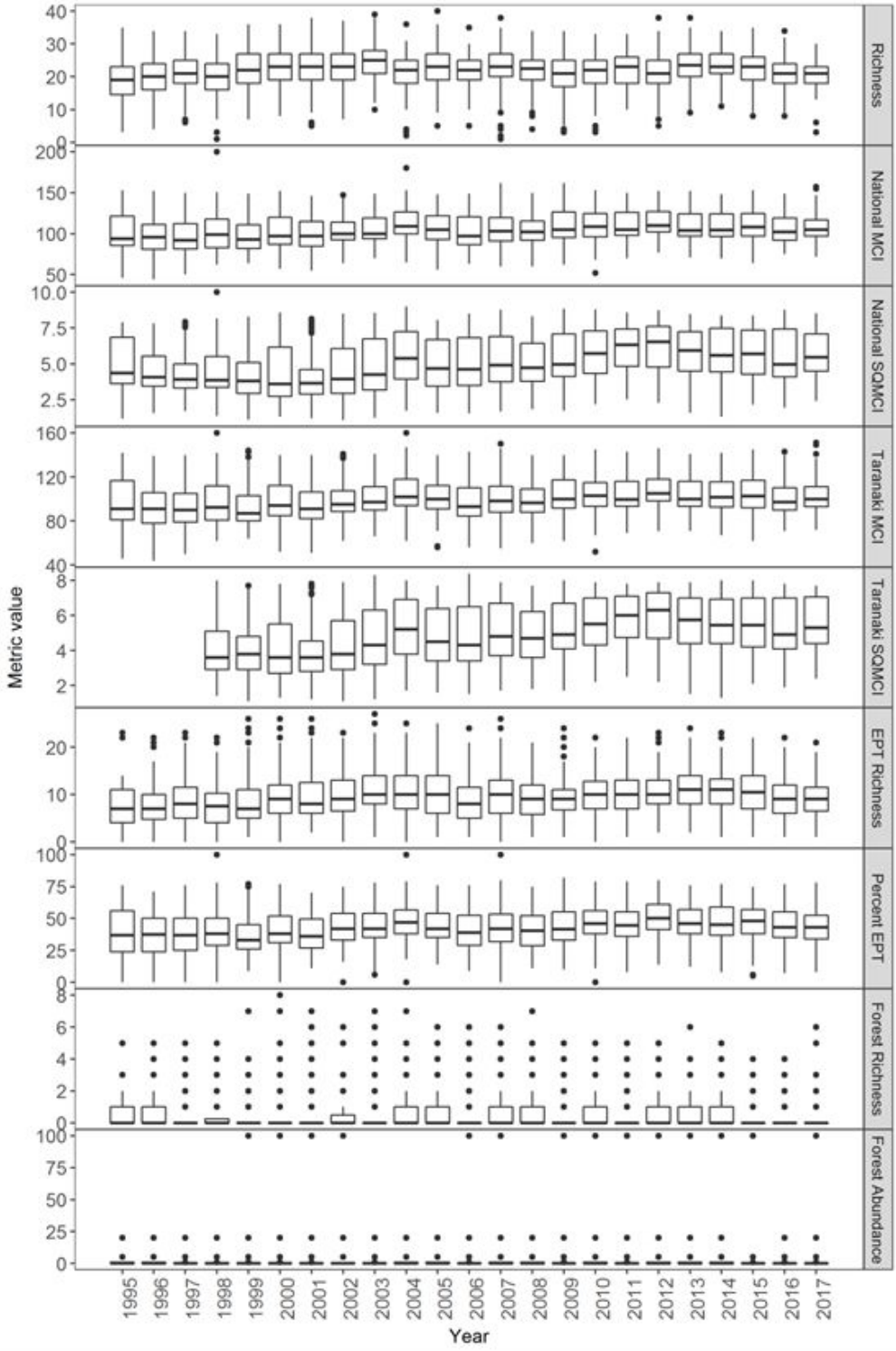


Figure 3-9: Invertebrate metric score distributions across all sites per year. The lower and upper edges of each box indicate the 25th and 75th quartile, respectively. The thick line in the middle is the median. The whiskers indicate data within 1.5 times the inter-quartile range (IQR; distance between 1st and 3rd quartiles). Points indicate outliers outside the IQR range.

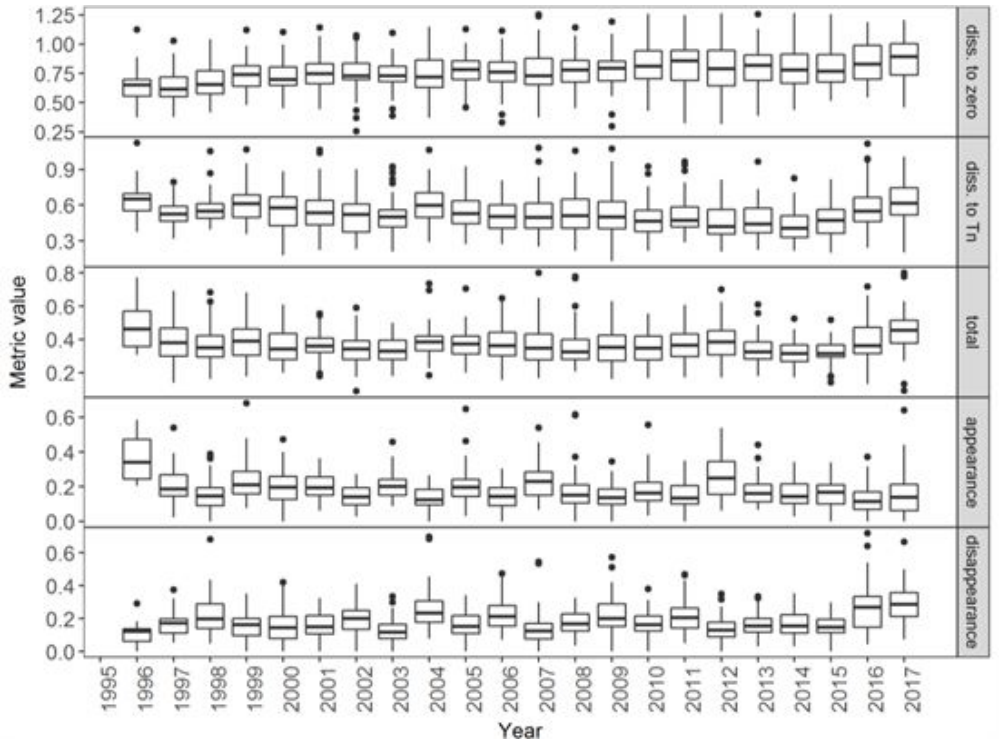


Figure 3-10: Invertebrate dissimilarity measure distributions across all sites per year. The lower and upper edges of each box indicate the 25th and 75th quartile, respectively. The thick line in the middle is the median. The whiskers indicate data within 1.5 times the inter-quartile range (IQR; distance between 1st and 3rd quartiles). Points indicate outliers outside the IQR range.

Table 3-6: Model parameter coefficients, standard errors, 95% credible intervals, and DIC scores for the National SQMCI models with each restoration index. Note that parameter means and quantiles are on the linear scale of the predictor (i.e., log scale).

Metric	Model	Restoration index	Parameter	Mean	Standard error of the mean	2.5% quantile	97.5% quantile	DIC[a]
National SQMCI	Restoration	Index 1	Intercept	0.6140	0.0875	0.4370	0.7804	**6904.71**
	Fixed effect		Restoration	1.5610	0.1053	1.3571	1.7685	
		Index 2	Intercept	-0.1590	0.1986	-0.5562	0.2170	6933.58
			Restoration	3.0914	0.2868	2.5244	3.6323	
		Index 3	Intercept	1.2799	0.0530	1.1699	1.3788	7189.86
			Restoration	0.9244	0.1176	0.7093	1.1726	
	Restoration	Index 1	Intercept	0.4282	0.1797	0.0613	0.7685	**6746.40**
	Random slope	Index 2	Intercept	-0.2320	0.2793	-0.7815	0.3150	6785.30
		Index 3	Intercept	1.5004	0.0465	1.4119	1.5943	7227.36

[a] DIC = Deviance Information Criterion, a relative measure of fit, or deviance, penalized by the number of parameters; the smaller the DIC the better the relative fit (Spiegelhalter, Best et al. 2002).

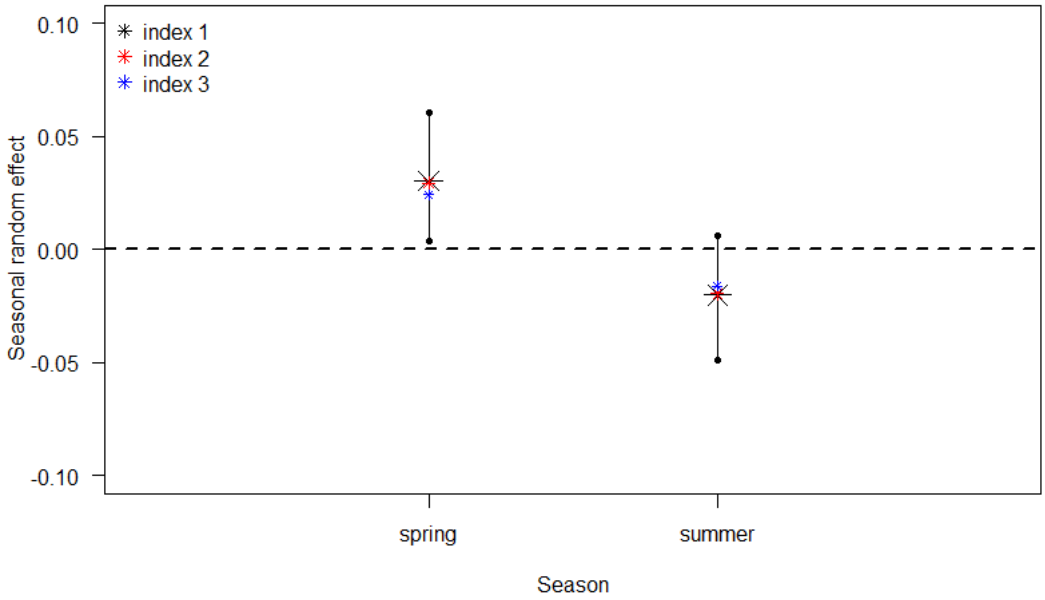


Figure 3-11: Posterior estimates and credible intervals for the seasonal effect in the National SQMCI with restoration as fixed effect models. The coefficients and credible intervals for restoration index 1, the best fitting model, are shown largest and in black, and the coefficients from the restoration index 2 and restoration index 3 models are shown in red and blue, respectively.

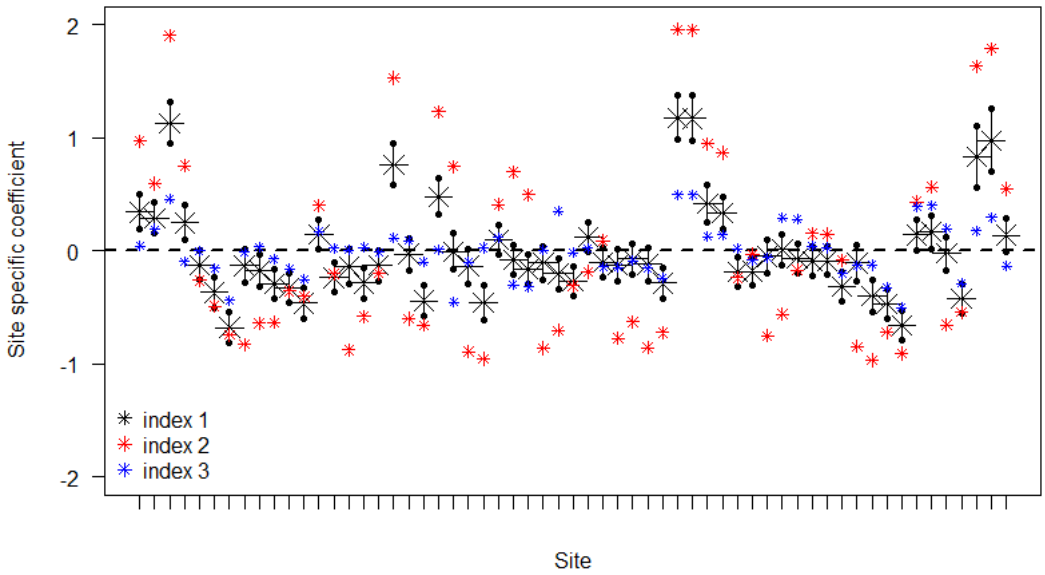


Figure 3-12: Site-specific intercepts for National SQMCI models with each restoration index as a fixed effect. The coefficients and credible intervals for restoration index 1, the best fitting model, are shown largest and in black, and the coefficients from the restoration index 2 and restoration index 3 models are shown in red and blue, respectively. Site names are ommitted for visual clarity.

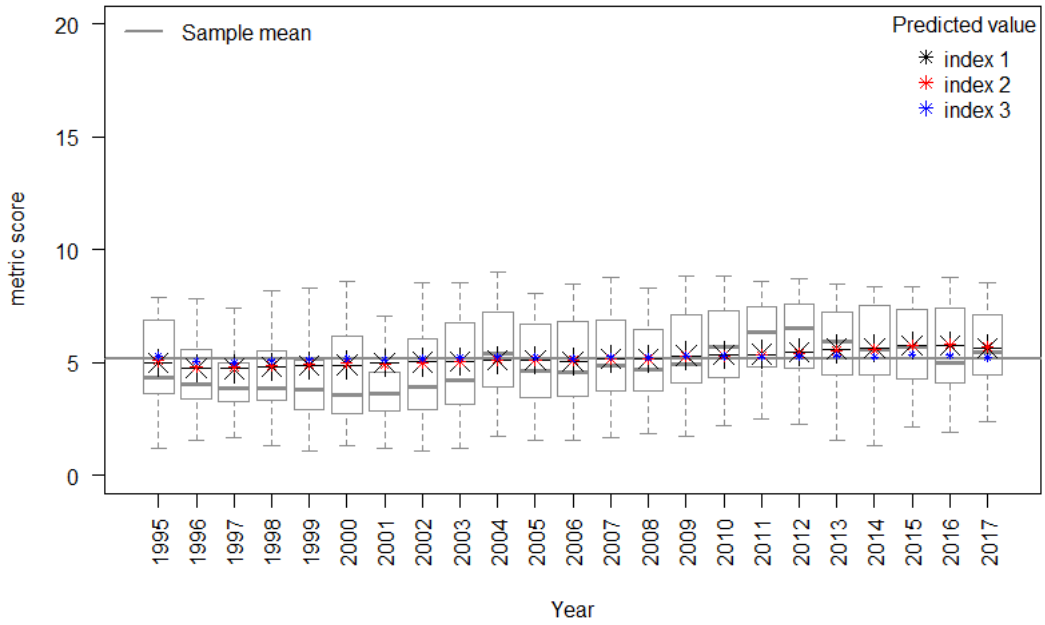


Figure 3-13: Predicted values from the National SQMCI with restoration as a fixed effect models plotted overtop the observed data distribution. The observed data is shown by the grey boxplots, the overall sample mean is shown by the grey line, predicted values and credible intervals for restoration index 1, the best fitting model, are shown largest and in black, and the predicted values from the restoration index 2 and restoration index 3 models are shown in red and blue, respectively.

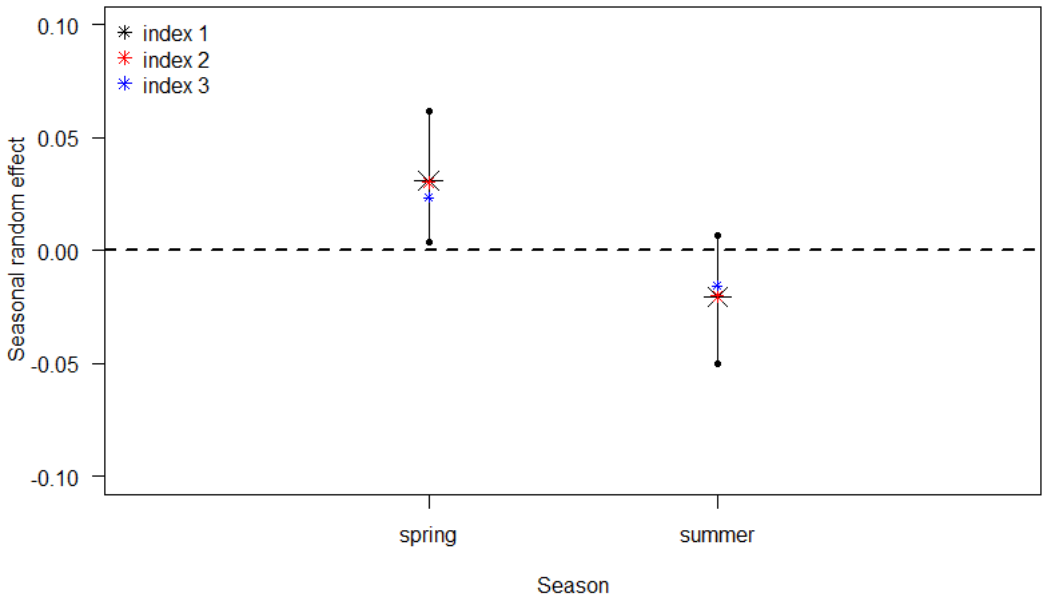


Figure 3-14: Posterior estimates and credible intervals for the seasonal effect in the National SQMCI with restoration as random slope models. The coefficients and credible intervals for restoration index 1, the best fitting model, are shown largest and in black, and the coefficients from the restoration index 2 and restoration index 3 models are shown in red and blue, respectively.

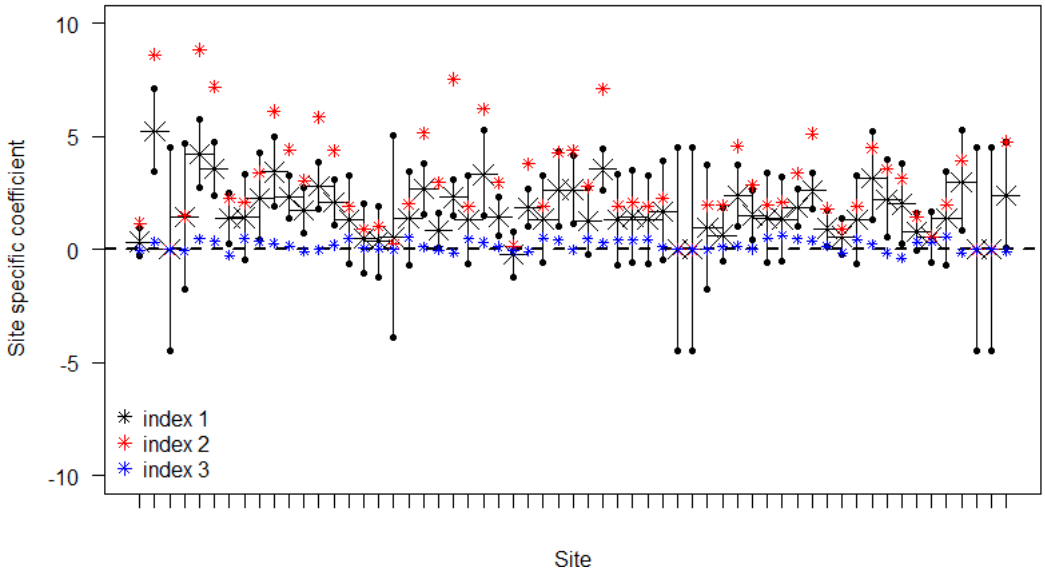


Figure 3-15: Site-specific intercepts for National SQMCI models with each restoration index as a random slope. The coefficients and credible intervals for restoration index 1, the best fitting model, are shown largest and in black, and the coefficients from the restoration index 2 and restoration index 3 models are shown in red and blue, respectively. Site names are omitted for visual clarity.

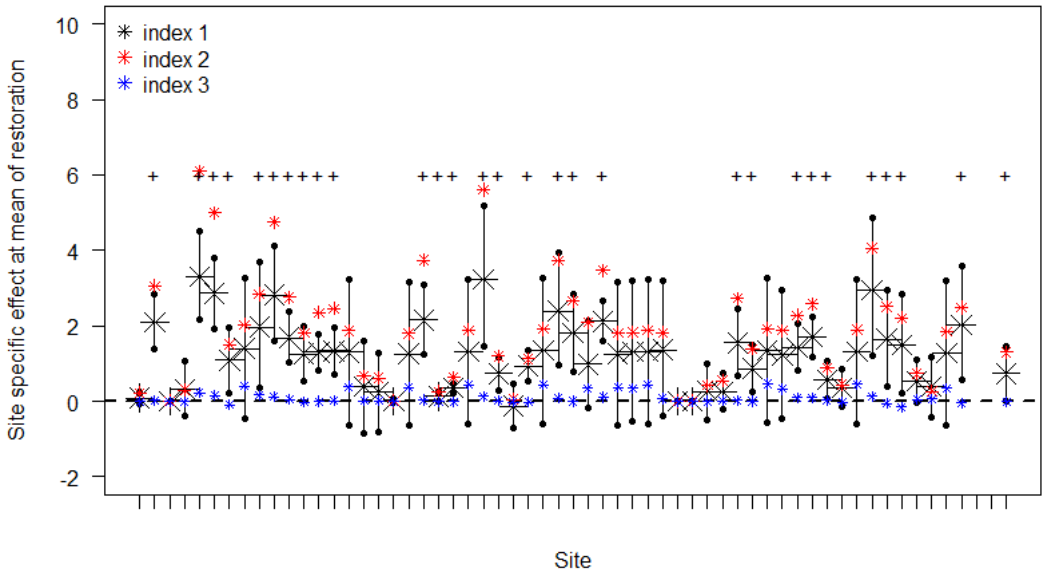


Figure 3-16: Site-specific restoration coefficients (slopes) for the National SQMCI models with each restoration index, evaluated at the mean of the restoration index at that site. '+' indicates sites with positive posterior means, indicating a positive relationship between restoration and National SQMCI scores, and '-' indicates a negative relationship. No sign indicates the credible intervals include zero and therefore direction of the relationship cannot be confidently inferred. The coefficients and credible intervals for restoration index 1, the best fitting model, are shown largest and in black, and the coefficients from the restoration index 2 and restoration index 3 models are shown in red and blue, respectively. Site names are ommitted for visual clarity.

Table 3-7: Posterior estimates for restoration index coefficients for the National SQMCI with restoration index 1 random slope model. A positive posterior mean with credible intervals that do not include zero indicates positive relationships between restoration and macroinvertebrate metric scores at that site. It is important to note that the coefficients and quantiles are at the scale of the linear predictor (i.e., log scale). A slope of 0 indicates the restoration index remained constant at that site, "--" indicates either that no restoration has been done upstream of this site or if so, data was not available.

Site	Intercept mean	Intercept 2.5% CI	Intercept 97.5% CI	Slope mean	Slope 2.5% CI	Slope 97.5% CI	Nat. SQMCI-Rest. Relationship
HRK000085	0.3328	-0.2742	0.9455	0.0908	-0.0748	0.2578	
HTK000350	5.2296	3.4204	7.0987	2.1015	1.3745	2.8525	+
HTK000425	0.0000	-4.4952	4.4883	0.0000	0.0000	0.0000	
HTK000745	1.4208	-1.7341	4.6600	0.3223	-0.3934	1.0572	
KPA000250	4.2070	2.7413	5.7305	3.3009	2.1509	4.4962	+
KPA000700	3.5478	2.3927	4.7256	2.8581	1.9276	3.8069	+
KPA000950	1.3717	0.2770	2.4741	1.0851	0.2191	1.9573	+
KPK000250	1.4140	-0.4596	3.3055	1.3995	-0.4549	3.2715	
KPK000500	2.2773	0.4091	4.2634	1.9663	0.3533	3.6813	+
KPK000660	3.4172	1.9318	4.9714	2.8221	1.5954	4.1056	+
KPK000880	2.3225	1.3966	3.2533	1.6858	1.0137	2.3614	+
KPK000990	1.7444	0.7495	2.7462	1.2553	0.5394	1.9763	+
KRP000300	2.8111	1.7961	3.8377	1.3013	0.8315	1.7766	+
KRP000660	2.0842	1.0998	3.0802	1.3331	0.7034	1.9701	+
KTK000150	1.3107	-0.6324	3.2547	1.2971	-0.6258	3.2208	
KTK000248	0.4798	-1.0546	2.0050	0.3827	-0.8411	1.5992	
MGE000970	0.3587	-1.2298	1.9368	0.2397	-0.8218	1.2943	
MGH000950	0.5260	-3.9079	5.0462	0.0063	-0.0469	0.0605	
MGN000195	1.3687	-0.6874	3.4236	1.2568	-0.6312	3.1438	
MGN000427	2.6605	1.5366	3.8051	2.1494	1.2414	3.0741	+
MGT000488	0.8424	0.1037	1.5960	0.1292	0.0159	0.2447	+
MGT000520	2.2954	1.5231	3.0846	0.3489	0.2315	0.4689	+
MKW000200	1.3156	-0.6122	3.2439	1.3156	-0.6122	3.2439	
MKW000300	3.3019	1.5033	5.3032	3.2259	1.4687	5.1812	+
MRK000420	1.4506	0.5903	2.3204	0.7339	0.2986	1.1740	+
MWH000380	-0.2145	-1.2071	0.7930	-0.1283	-0.7219	0.4742	
MWH000490	1.8304	1.0059	2.6583	0.9416	0.5175	1.3675	+
PAT000200	1.3424	-0.5856	3.2705	1.3424	-0.5856	3.2705	
PAT000315	2.6382	1.0402	4.3320	2.3964	0.9449	3.9351	+
PAT000360	2.6476	1.1638	4.1745	1.8063	0.7940	2.8479	+
PNH000200	1.2481	-0.2176	2.7095	0.9800	-0.1708	2.1276	
PNH000900	3.5392	2.6455	4.4386	2.1152	1.5811	2.6528	+
STY000300	1.3328	-0.6775	3.3502	1.2614	-0.6412	3.1707	
STY000400	1.4570	-0.5909	3.5295	1.3138	-0.5328	3.1826	
TMR000150	1.3228	-0.6256	3.2716	1.3054	-0.6174	3.2285	
TMR000375	1.6776	-0.4640	3.9234	1.3678	-0.3783	3.1988	
TNH000090	0.0000	-4.4952	4.4883	0.0000	0.0000	0.0000	
TNH000200	0.0000	-4.4952	4.4883	0.0000	0.0000	0.0000	

Site	Intercept mean	Intercept 2.5% CI	Intercept 97.5% CI	Slope mean	Slope 2.5% CI	Slope 97.5% CI	Nat. SQMCI-Rest. Relationship
TNH000515	0.9753	-1.7839	3.7585	0.2616	-0.4786	1.0083	
WAI000110	0.6362	-0.5362	1.8295	0.2580	-0.2175	0.7419	
WGA000260	2.3637	1.0392	3.7162	1.5488	0.6809	2.4350	+
WGA000450	1.5234	0.4342	2.6259	0.8693	0.2478	1.4984	+
WGG000115	1.3889	-0.5801	3.3597	1.3467	-0.5624	3.2577	
WGG000150	1.3455	-0.5159	3.2011	1.2320	-0.4724	2.9311	
WGG000500	1.8479	1.0406	2.6590	1.4280	0.8041	2.0548	+
WGG000665	2.5919	1.7841	3.4036	1.6994	1.1698	2.2317	+
WGG000895	0.9314	0.1263	1.7393	0.5798	0.0786	1.0827	+
WGG000995	0.5716	-0.2249	1.3715	0.3549	-0.1397	0.8515	
WKH000100	1.3339	-0.6098	3.2778	1.3208	-0.6038	3.2456	
WKH000500	3.1677	1.3145	5.2298	2.9488	1.2236	4.8683	+
WKH000920	2.2136	0.5327	3.9597	1.6465	0.3962	2.9454	+
WKH000950	2.0049	0.2828	3.7986	1.4961	0.2111	2.8346	+
WKR000500	0.7802	-0.0500	1.6053	0.5414	-0.0347	1.1140	
WKR000700	0.5612	-0.5927	1.6971	0.3912	-0.4132	1.1831	
WMK000100	1.3794	-0.6699	3.4277	1.2787	-0.6210	3.1775	
WMK000298	2.9838	0.8484	5.2884	2.0183	0.5739	3.5772	+
WNR000450	0.0000	-4.4952	4.4883	--	--	--	
WTR000540	0.0000	-4.4952	4.4883	--	--	--	
WTR000850	2.3699	0.0522	4.7401	0.7326	0.0161	1.4652	+

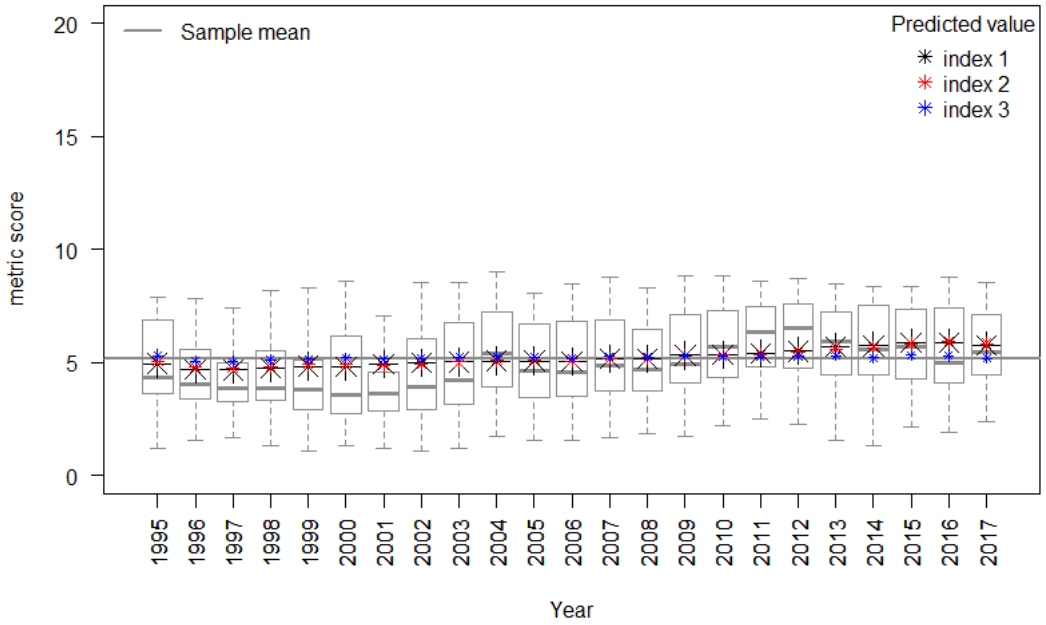


Figure 3-17: Predicted values for each National SQMCI restoration as random slope model plotted overtop the observed data distribution. The observed data is shown by the grey boxplots, the overall sample mean is shown by the grey line, predicted values and credible intervals for restoration index 1, the best fitting model, are shown largest and in black, and the predicted values from the restoration index 2 and restoration index 3 models are shown in red and blue, respectively.

Out of the other metrics, National MCI, Taranaki SQMCI and MCI, EPT richness, percent EPT, forest species richness, forest species abundance, and dissimilarity to zero all also had overall positive relationships between restoration and metric values (Table 3-8). Dissimilarity to previous sampling ($T_{n-1,}$ where T is time and n is time step number), total turnover, and the appearance component of species turnover all had overall negative relationships with restoration. The index with the best fitting restoration as fixed effect model varied between metrics. Index 1, the simple proportion of upstream length fenced and planted, was the best fitting model (chosen by lowest DIC score) for all the restoration as fixed effect models for National MCI, Taranaki SQMCI and MCI, EPT richness, and all turnover metrics except disappearance. Forest species richness and forest species abundance were best fit by the second index, in which restoration was weighted by type and age. Percent EPT and the disappearance turnover metric were equally well fit by the second index and the third index, which is weighted by predicted shading effects.

Table 3-8: Summary of model results for all invertebrate metric models with restoration indices as fixed effects and as random slopes. The best-fitting index was determined by lowest DIC score, and the direction by the sign of the restoration fixed effect coefficient if the 95% credible intervals did not include zero. 2-3 indicates models with indices 2 and 3 fit equally well, 1-3 indicates that all three models fit equally well. If no direction is given, the credible intervals for that parameter crossed zero and therefore the direction of the relationship cannot be confidently inferred. The percentage of sites with positive relationships between restoration and the given metric was determined by the number of sites with positive random slope coefficients with 95% credible intervals that did not include zero. There were no sites with negative relationships. If no percentage is given then credible intervals for all sites crossed zero.

Metric	Best-fitting Index Restoration fixed effect	Direction Restoration fixed effect	Best-fitting Index Restoration random slope	% positive relationships	% negative relationships
National SQMCI	1	+	1	49%	
National MCI	1	+	1	56%	
Taranaki SQMCI	1	+	1	47%	
Taranaki MCI	1	+	1	61%	
Richness	1		1		
EPT Richness	1	+	1-3		
Percent EPT	2-3	+	1-3		
Forest Richness	2	+	2	2%	
Forest Abundance	2	+	1	7%	
Dissimilarity to T_0	1	+	1		
Dissimilarity to T_{n-1}	1	-	1-3		
Total Turnover	1	-	1-3		
Appearance	1	-	1-3		
Disappearance	2-3		3		

3.2.2 Physicochemical covariates

The influence of physicochemical covariates on invertebrate metrics was examined via stepwise backwards selection of the best-fit models for each metric with a suite of physicochemical parameters included. However, these results must be interpreted with some caution, as only 10 sites had both invertebrate and physicochemical data.

Physicochemical parameters were chosen by the model selection procedure if their inclusion improved the overall fit of the model (indicated by DIC score). However, in many cases a parameter was included even though there was no clear relationship between that parameter and the metric (i.e., credible intervals included zero; Table 3-9). The direction of relationships which could be inferred, on the other hand, were for the most part consistent across metrics. For example, total phosphorus had a negative relationship with National SQMCI, National MCI and Taranaki SQMCI. Dissolved reactive phosphorus, DRP, had a negative relationship with abundance of forest taxa. Nitrate nitrogen (NO_3) had a positive relationship with National MCI and Taranaki MCI and a negative relationship with the appearance turnover metric. Ammoniacal nitrogen (NH_4) had a positive relationship with Taranaki SQMCI and abundance of forest taxa. The positive relationships between

NO_3 and NH_4 and SQMCI and MCI metrics is rather unusual, as it is generally expected that nutrient enrichment will have a negative effect on sensitive taxa (Stark and Maxted 2007). It may be an artefact of the small sample size, or be due to associations with some other unmeasured effect or parameter. Turbidity had a negative relationship with species richness, but a positive relationship with National SQMCI and Taranaki SQMCI. Turbidity is generally expected to have a negative effect on invertebrates, because it can reduce primary production, or algal growth, a key food source for many invertebrates (Ryan 1991).

Restoration continued to have a positive relationship with National SQMCI and MCI, Taranaki SQMCI and MCI, EPT richness, and percent EPT, and dissimilarity to zero even with the addition of covariates. This suggests that the positive relationships between metrics and restoration were not related to other covariates relationship with invertebrates. However, the positive relationships between restoration and forest taxa abundance and richness were no longer observed in the covariate models. Likewise, the negative relationships between restoration and dissimilarity to T_{n-1}, total turnover, and appearance of new species, all became undetermined in the covariate models. These shifts suggest that the observed relationships between restoration and forest invertebrates may be attributed to covariates rather than restoration alone. Again, however, the models were fit using only data from 10 sites, and therefore results may not be generalisable.

Only one of the six physicochemical variables examined had a direct relationship with restoration, tested by running the restoration as a fixed effect models with the physicochemical parameter as the response variable compared to an intercept-only model without restoration (

Table 3-10). For most of the physicochemical variables, the intercept-only model was a better fit, indicating no relationship with restoration. Turbidity, however, had a negative relationship with restoration, indicating that water clarity improved with restoration.

Table 3-9: Parameter coefficients and DIC scores for invertebrate metric models with restoration as a fixed effect and selected physicochemical covariates. The fixed effect model indicates the overall relationship between parameters and metrics. '% sites' is the proportion of the ten sites which had a positive or negative relationship (direction indicated in brackets) with restoration in the corresponding random slope model. Parameters tested include DRP, dissolved reactive phosphorus (g/m^3); NH_4, ammoniacal nitrogen (g/m^3); NO_3, nitrate nitrogen (g/m^3); TN, total nitrogen (g/m^3); TP, total phosphorus (g/m^3); TURBIDITY, turbidity (NTU).

Metric	Restoration index	Parameter	Mean	Standard error of the mean	2.5% quantile	97.5% quantile	direction	DIC
National SQMCI	1	Intercept	0.1335	0.2587	-0.4073	0.6067		1389.00
		NH_4	0.2455	0.1642	-0.0668	0.5788		
		NO_3	-0.0282	0.0683	-0.1623	0.1059		
		TN	0.0161	0.0568	-0.0953	0.1277		
		TP	-1.1765	0.3299	-1.8211	-0.5259	-	
		TURBIDITY	0.0080	0.0029	0.0023	0.0138	+	
		Restoration	2.1526	0.2847	1.5982	2.7077	+	
National MCI	1	Intercept	4.2856	0.0699	4.1418	4.4174		3123.09
		DRP	0.1572	0.3095	-0.4501	0.7654		
		NH_4	0.0604	0.0526	-0.0416	0.1651		
		NO_3	0.0429	0.0152	0.0131	0.0727	+	
		TP	-0.1698	0.0791	-0.3244	-0.0137	-	
		Restoration	0.5784	0.0791	0.4276	0.7385	+	
Taranaki SQMCI	1	Intercept	0.2498	0.3136	-0.3894	0.8234		1223.68
		DRP	2.0111	1.0882	-0.1219	4.1513		
		NH_4	0.3921	0.1627	0.0815	0.7213	+	
		TP	-2.6613	0.5083	-3.6426	-1.6457	-	
		TURBIDITY	0.0215	0.0073	0.0075	0.0360	+	
		Restoration	1.9561	0.3803	1.2170	2.6783	+	
Taranaki MCI	1	Intercept	4.2514	0.0672	4.1129	4.3777		2997.20
		DRP	0.0750	0.2826	-0.4795	0.6302		
		NH_4	0.0673	0.0483	-0.0264	0.1631		
		NO_3	0.0367	0.0138	0.0096	0.0638	+	
		TP	-0.1405	0.0722	-0.2817	0.0020		
		Restoration	0.5502	0.0748	0.4076	0.7012	+	
Richness	1	Intercept	3.1346	0.1672	2.8059	3.4660		2425.91
		DRP	0.7085	0.7244	-0.7230	2.1215		
		NH_4	0.1403	0.1392	-0.1390	0.4082		
		NO_3	-0.0073	0.0627	-0.1303	0.1158		
		TN	-0.0625	0.0540	-0.1688	0.0432		
		TURBIDITY	-0.0047	0.0023	-0.0094	-0.0003	-	
		Restoration	-0.0976	0.1868	-0.4671	0.2681		
EPT Richness	1	Intercept	1.5136	0.2543	0.9841	1.9857		2057.56
		DRP	-0.2288	1.1750	-2.5463	2.0675		

Metric	Restoration index	Parameter	Mean	Standard error of the mean	2.5% quantile	97.5% quantile	direction	DIC
		NH_4	0.2704	0.2021	-0.1387	0.6557		
		NO_3	0.1087	0.0900	-0.0680	0.2851		
		TN	-0.0939	0.0753	-0.2421	0.0534		
		TURBIDITY	-0.0065	0.0037	-0.0141	0.0005		
		Restoration	1.0852	0.2970	0.5268	1.6937	+	
Percent EPT	2-3	Intercept	-0.8315	0.2641	-1.3579	-0.3207		586.51
		DRP	-2.0509	6.4821	-14.8641	10.5917		
		NH_4	0.8274	1.2677	-1.7018	3.2796		
		NO_3	-0.2855	0.2168	-0.7156	0.1361		
		TP	-3.0073	3.0524	-9.2150	2.7811		
		TURBIDITY	0.0145	0.0253	-0.0354	0.0641		
		Restoration	1.1194	0.3628	0.4161	1.8399	+	
Forest Richness	2	Intercept	-4.9152	1.4262	-7.8103	-2.1399		407.40
		DRP	2.5432	7.7960	-12.6424	17.9540		
		NO_3	-0.4276	0.6415	-1.7470	0.7768		
		TN	-0.4277	0.2758	-0.9806	0.1032		
		TP	-4.2543	4.4119	-13.8473	3.4611		
		Restoration	3.3820	1.9003	-0.4409	7.1317		
Forest Abundance	2	Intercept	-3.9900	2.1955	-7.8531	0.9281		931.32
		DRP	-25.4258	4.3648	-34.0166	-16.8811	-	
		NH_4	4.1168	0.9609	2.2934	6.0948	+	
		NO_3	-0.5555	0.3761	-1.3176	0.1606		
		Restoration	1.9880	3.0585	-5.0912	7.1093		
Dissimilarity to T_0	1	Intercept	0.2504	0.1732	-0.1091	0.5726		-342.29
		DRP	1.5863	0.8192	-0.0216	3.1971		
		NH_4	-0.4172	0.3763	-1.1572	0.3213		
		NO_3	-0.1123	0.0577	-0.2256	0.0010		
		TN	0.0609	0.0348	-0.0076	0.1293		
		TURBIDITY	-0.0009	0.0009	-0.0028	0.0009		
		Restoration	0.7934	0.1716	0.4483	1.1236	+	
Dissimilarity to T_{n-1}	1	Intercept	0.6157	0.0559	0.5221	0.7459		-135.11
		DRP	-0.2579	1.0412	-2.4245	1.6811		
		NH_4	-0.8310	0.5974	-2.0068	0.3406		
		NO_3	0.0449	0.0469	-0.0399	0.1473		
		TURBIDITY	0.0025	0.0015	-0.0004	0.0055		
		Restoration	-0.1184	0.0725	-0.2878	0.0031		
Total Turnover	1	Intercept	0.3294	0.0543	0.2266	0.4423		-397.98
		DRP	0.6159	0.6650	-0.6914	1.9220		

Metric	Restoration index	Parameter	Mean	Standard error of the mean	2.5% quantile	97.5% quantile	direction	DIC
		NH_4	-0.4554	0.3298	-1.1033	0.1923		
		NO_3	-0.0445	0.0413	-0.1253	0.0370		
		TN	0.0191	0.0296	-0.0390	0.0772		
		Restoration	0.0219	0.0684	-0.1205	0.1511		
Appearance	1	Intercept	0.1731	0.0242	0.1289	0.2252		-407.84
		DRP	0.4054	0.5045	-0.5887	1.3987		
		NH_4	0.1487	0.3220	-0.4839	0.7811		
		NO_3	-0.0688	0.0306	-0.1297	-0.0091	-	
		TN	0.0420	0.0275	-0.0121	0.0958		
		Restoration	-0.0046	0.0314	-0.0724	0.0525		
Disappearance	3	Intercept	0.1219	0.0350	0.0491	0.1890		-382.82
		DRP	0.2093	0.6070	-0.9922	1.3987		
		NH_4	-0.5104	0.3416	-1.1815	0.1607		
		NO_3	0.0254	0.0380	-0.0470	0.1026		
		TN	-0.0144	0.0298	-0.0729	0.0440		
		TURBIDITY	0.0013	0.0008	-0.0003	0.0030		
		Restoration	0.0746	0.0448	-0.0111	0.1680		

Table 3-10: Physicochemical variable relationships with restoration (index 1). The DIC intercept only indicates the fit of a model without restoration included, DIC restoration indicates whether the fit was improved by including restoration. The lower DIC value, indicating better fit, is in bold. Direction indicates whether the relationship was positive, negative, or undetermined.

Physicochemical variable	DIC intercept only	DIC restoration	Model parameter	Mean	Standard error of the mean	2.5% quantile	97.5% quantile	direction
DRP	**-13813.52**	-13811.81	Intercept	-0.0027	0.0073	-0.0170	0.0118	
			Restoration	0.0017	0.0067	-0.0115	0.0148	
NH_4	**-7201.53**	-7200.33	Intercept	-0.0019	0.0126	-0.0275	0.0221	
			Restoration	-0.0003	0.0150	-0.0290	0.0301	
NO_3	1356.58	**1354.54**	Intercept	-0.1098	0.2067	-0.5228	0.2972	
			Restoration	0.2163	0.1186	-0.0163	0.4490	
TN	**2638.44**	2638.85	Intercept	0.1720	0.2435	-0.3133	0.6518	
			Restoration	-0.2132	0.1529	-0.5133	0.0871	
TP	**-3561.30**	-3560.95	Intercept	0.0137	0.0202	-0.0260	0.0541	
			Restoration	-0.0175	0.0255	-0.0685	0.0325	
TURBIDITY	11194.48	**11170.21**	Intercept	10.1017	2.2992	5.5911	14.6283	
			Restoration	-15.2748	2.9911	-21.1479	-9.4060	-

4 Discussion

This analysis conducted in this report suggests that the Taranaki's Riparian Management Program has had beneficial effects on stream ecosystem health and water quality for human health and recreation in the region. The modelling analysis indicated negative relationships between *E. coli* concentrations and restoration, and positive relationships between macroinvertebrate metric scores and restoration. However, note that that all statistical models are simplifications of actual processes, and do not attribute causation. In analyses like these we cannot rule out the possibility that the observed relationships have been influenced by other parameters not measured or included in the models. Moreover, there was considerable variability between sites, and for many sites it was not possible to infer any directional relationship between restoration and a given response variable.

The model comparison showed that modes with restoration index 1, the simple proportion of upstream bank length that has been fenced and planted, often had the lowest DIC scores, indicating better relative fit. Nonetheless, all three models gave very similar predicted values for both *E. coli* and invertebrate metrics. From a practical perspective, this indicates that future analysis and/or prediction of ecological responses to restoration can use the simpler and easier index 1 approach without loss of accuracy. From an ecological perspective, this could indicate that the benefits of restoration are realized soon after implementation rather than increasing substantially over time as factored into indices two and three. Additionally, it may be that the quantity (in this case, length) of restoration is a more important factor than the type or age of vegetation. The Taranaki dataset provides an ideal opportunity to continue exploring important questions on relative benefits of different restoration methods.

4.1 *E. coli*

Although the modelling indicated that there has been a negative relationship between increasing restoration and *E. coli* concentrations at ten of the eleven monitoring sites, any changes in concentrations have not yet been large enough to result in an improvement in swimmability; the percentage of sites meeting current NPS swimmability criteria has remained low (27%) since 2000.

The percentage of swimmable Taranaki sites is lower than the national average; a recent analysis of 792 NRWQN and Regional Council monitoring sites found that 49% of sites nationwide met the median criteria ($\leq$130 *E. coli*/100 mL) and 31% of sites met the 95th percentile criteria (<540 *E. coli*/100 mL) (McBride and Soller 2017). However, the distribution of *E. coli* concentrations in Taranaki is very similar to the distribution observed from the national dataset (Figure 4-1). It is possible that the lower than average "pass rate" observed for Taranaki sites may be because the national dataset includes rivers and streams from a variety of land uses and catchment sizes, whereas the Taranaki data primarily comes from sites with pastoral land upstream.

The three different restoration index models generally gave very similar predicted values, which suggests that weighting by age or restoration type may not be necessary to predict *E. coli* responses to restoration. In fact, the first restoration index, the unweighted proportion of upstream bank length fenced and/or planted, had the lowest DIC score for both restoration as a fixed effect and restoration as a random slope models. Ten of the eleven sites had negative site-specific relationships, further supporting the overall inference that upstream restoration is a possible strategy for managing downstream *E. coli* levels. The one site which showed a positive relationship between restoration and *E. coli* concentration, MRK000420, is located in a primarily agricultural catchment, and thus is likely to receive higher *E. coli* inputs than many of the other sites.

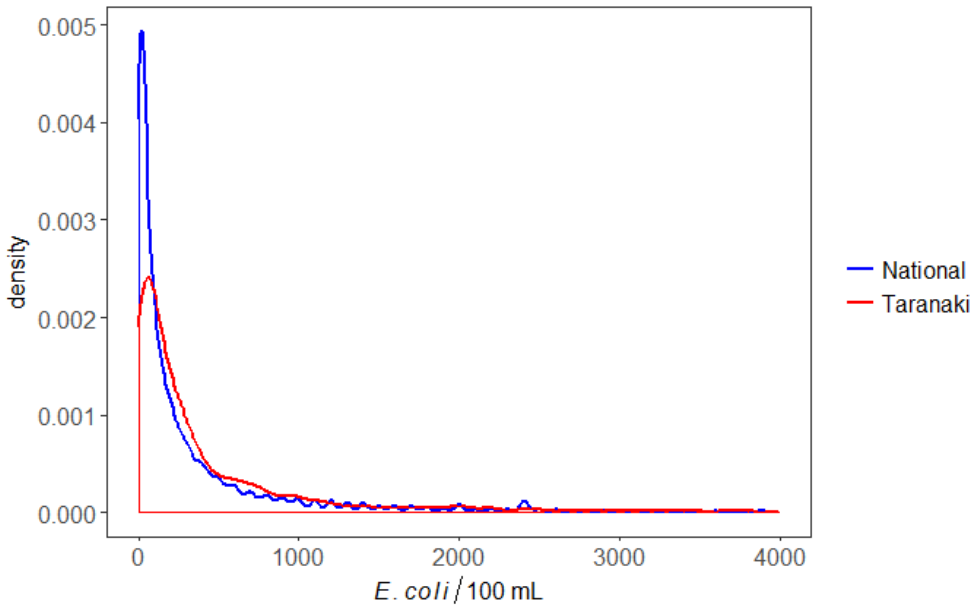


Figure 4-1: Distributions of Taranaki (red) and nation-wide (blue) *E. coli* concentrations. The national data comes from 792 NRWQN and Regional Council monitoring sites analysed in McBride and Soller (2017).

4.2 Invertebrates

Twelve out of the fourteen invertebrate metrics including in the modelling analysis were found to have a detectable relationship with restoration at the region-wide scale (restoration as a fixed effect across all sites). This is in itself an impressive result; the majority of post-restoration monitoring studies have reported a disappointing lack of detectable improvement in biodiversity (Parkyn, Davies-Colley et al. 2003; Palmer, Menninger et al. 2010; Louhi, Mykrä et al. 2011; Leps, Sundermann et al. 2016; Lorenz, Haase et al. 2018). However, most riparian restoration projects focus on individual reaches, even though degradation typically occurs at the catchment-scale (Bernhardt and Palmer 2011; Lorenz and Feld 2013; Giling, Mac Nally et al. 2016). While it has been shown that upstream land use and riparian cover within a catchment can have stronger negative influences on downstream water quality and biota than immediately adjacent conditions (Dodds and Oakes 2008; Lorenz and Feld 2013; Giling, Mac Nally et al. 2016), there have been few opportunities to test the converse, i.e., whether upstream restoration can benefit downstream communities (but see Kail and Hering 2009, who showed that near-natural reaches upstream have a positive effect on downstream reaches). The Taranaki Regional Council Riparian Management data has provided a unique look at the cumulative influence of upstream restoration on downstream macroinvertebrate communities, in one of the first analyses of riparian restoration at the landscape scale.

MCI and SQMCI scores, EPT richness, percent EPT, and forest species richness and abundance all had positive relationships with restoration, indicating that presence and relative abundances of sensitive taxa and forest specialist taxa increased with restoration. Correspondingly, the relationship between restoration and dissimilarity to zero, a measure of compositional change, was also positive, indicating that community composition has shifted away from the initial condition.

Which restoration index model had the best fit/lowest DIC score varied between metrics, suggesting that while upstream length fenced/planted may be sufficient to predict some invertebrate responses (namely MCI and SQMCI scores and EPT richness and percent EPT), other characteristics of invertebrate communities, particularly the richness and abundance of forest species, may be more dependent on type and age of restoration, or the amount of shading provided.

It was somewhat surprising that indices two and three, which both incorporated an age component, did not consistently outperform the simpler index 1. This may be because trying to include age added too much additional 'noise' into the analysis. Alternatively, it could indicate that age of restoration is not as important as previously thought. It is generally expected that there will be a time lag between completion of restoration measures and ecological recovery, due to natural successional processes and/or hysteresis (Leps, Sundermann et al. 2016). For example, Parkyn, Davies-Colley et al. (2003) predicted the full effects of restoration would not be realized until vegetation had grown sufficiently to create a closed canopy. Conversely, a study of 44 river restoration projects in Germany found that restoration age was a poor predictor of community compositional change (Leps, Sundermann et al. 2016). Similarly, we found that incorporating age or predicted shading effects into the restoration index did not appear to improve the fit of the models to the observed invertebrate data. We are unable to tease apart temporal effects in this study because the restoration indices, being cumulative, co-varied with time. Nevertheless, our results raise interesting questions about timescales of recovery, and suggest that additional analyses focused specifically on timing and rates of recovery in relation to upstream restoration would be worthwhile.

Again, note that observed relationships are correlational, not causal. We cannot rule out the possibility that restoration and invertebrates are both increasing due to unmeasured parameters. Furthermore, it is also important to note that the between site variability was also quite high, and it was not possible to infer a directional relationship for more than half the sites for any given metric. As mentioned above, this is not unusual in restoration studies, particularly those conducted at the reach scale. Nevertheless, our analysis suggests that the regional restoration approach fostered by the Taranaki Riparian Management Programme has succeeded in assuaging several of the commonly-blamed causes for lack of restoration effects on stream macroinvertebrates. The first of these, as mentioned above, is the mismatch between scales of restoration and degradation. The second is dispersal constraints and low recolonization. However, the Taranaki region is already exceptional in that it has a prime source of diverse recolonists in Egmont (Taranaki) National Park. On top of that, the Riparian Management Programme has resulted in establishment of many small sections of restored riparian vegetation scattered across the Ring Plain. These riparian corridors are preferred habitat for many species of flying adult invertebrates (Collier and Smith 1998; Petersen, Winterbottom et al. 1999; Petersen, Masters et al. 2004), while individual patches may serve as "stepping stones" connecting restored reaches to each other and to the National Park. Therefore, the combination of its unique landscape and dedicated management program has made Taranaki an ideal experiment for investigating the relationships between riparian restoration and stream ecological and recreational values, and the results after the first 20 years are noteworthy.

5 Acknowledgements

Thank you to Katie Blakemore, Fiona Jansma, and Chris Lambert at Taranaki Regional Council for provision of relevant data. Thank you to Kathy Walter from NIWA for processing the flow data files.

6 Glossary of abbreviations and terms

DIC	Deviance Information Criterion, a calculation of fit, or deviance, penalized by the number of parameters. The smaller the DIC, the better the fit.
E. coli	*Escherichia coli*, a bacteria commonly associated with faecal material and used as a human health indicator.
EPT	Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies); sensitive indicator taxa.
INLA	Integrated Nested Laplace Approximation; a computationally efficient method for fitting Bayesian models.
MCI	Macroinvertebrate Community Index, a measure of an invertebrate community's sensitivity to organic pollution.
NPS-FM	National Policy Statement for Freshwater Management.
RMP	Riparian Management Programme.
SEM	State of the Environment monitoring; conducted by Regional Councils.
SQMCI	Semi-quantitative version of the MCI.
TRC	Taranaki Regional Council.

7 References

Bedford, G. (2015) Investing in our stream banks: the riparian programme transforming Taranaki, New Zealand. *Land Use and Water Quality Conference*, Vienna, Austria.

Bernhardt, E.S., Palmer, M.A. (2011) River restoration: the fuzzy logic of repairing reaches to reverse catchment scale degradation. *Ecological Applications*, 21(6): 1926-1931.

Bernhardt, E.S., Palmer, M.A., Allan, J.D., Alexander, G., Barnas, K., Brooks, S., Carr, J., Clayton, S., Dahm, C., Follstad–Shah, J., Galat, D., Gloss, S., Goodwin, P., Hart, D., Hassett, B., Jenkinson, R., Katz, S., Kondolf, G.M., Lake, P.S., Lave, R., Meyer, J.L., O'Donnell, T.K., Pagano, L., Powell, B., Sudduth, E. (2005) Synthesizing U.S. River Restoration Efforts. *Science*, 308(5722): 636–637.

Collier, K.J., Smith, B.J. (1998) Dispersal of adult caddisflies (Trichoptera) into forests alongside three New Zealand streams. *Hydrobiologia*, 361(1): 53–65.

Collins, K.E., Doscher, C., Rennie, H.G., Ross, J.G. (2013) The Effectiveness of Riparian 'Restoration' on Water Quality—A Case Study of Lowland Streams in Canterbury, New Zealand. *Restoration Ecology*, 21(1): 40–48.

Davies-Colley, R.J., Meleason, M.A., Hall, R.M.J., Rutherford, J.C. (2009) Modelling the time course of shade, temperature, and wood recovery in streams with riparian forest restoration. *New Zealand Journal of Marine and Freshwater Research*, 43(3): 673–688.

Dodds, W.K., Oakes, R.M. (2008) Headwater influences on downstream water quality. *Environmental Management*, 41(3): 367–377.

EU Council (2006) Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC. *Official Journal of the European Union*.

Eyles, R., Niyogi, D., Townsend, C., Benwell, G., Weinstein, P. (2003) Spatial and temporal patterns of Campylobacter contamination underlying public health risk in the Taieri River, New Zealand. *Journal of Environmental Quality*, 32: 1820–1828.

Giling, D.P., Mac Nally, R., Thompson, R.M. (2016) How sensitive are invertebrates to riparian-zone replanting in stream ecosystems? *Marine and Freshwater Research*, 67(10): 1500–1511.

Greenwood, M.J., Harding, J.S., Niyogi, D.K., McIntosh, A.R. (2012) Improving the effectiveness of riparian management for aquatic invertebrates in a degraded agricultural landscape: stream size and land-use legacies. *Journal of Applied Ecology*, 49(1): 213–222.

Hughes, A.O. (2016) Riparian management and stream bank erosion in New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 50(2): 277–290.

Hunter, C., Perkins, J., Tranter, J., Hardwick, P. (2000) Fecal Bacteria in the Waters of an Upland Area in Derbyshire, England: The Influence of Agricultural Land Use. *Journal of Environmental Quality*, 29(4): 1253–1261.

Kail, J., Hering, D. (2009) The influence of adjacent stream reaches on the local ecological status of Central European mountain streams. *River Research and Applications*, 25(5): 537–550.

Larned, S., Snelder, T., Unwin, M., McBride, G., Verburg, P., McMillan, H. (2015) Analysis of water quality in New Zealand lakes and rivers. *NIWA Client Report, Prepared for Ministry for the Environment*.

Leps, M., Sundermann, A., Tonkin, J.D., Lorenz, A.W., Haase, P. (2016) Time is no healer: increasing restoration age does not lead to improved benthic invertebrate communities in restored river reaches. *Science of The Total Environment*, 557–558: 722–732.

Lorenz, A., Feld, C. (2013) Upstream river morphology and riparian land use overrule local restoration effects on ecological status assessment. *Hydrobiologia*, 704: 489–501.

Lorenz, A.W., Haase, P., Januschke, K., Sundermann, A., Hering, D. (2018) Revisiting restored river reaches – Assessing change of aquatic and riparian communities after five years. *Science of The Total Environment*, 613–614: 1185–1195.

Louhi, P., Mykrä, H., Paavola, R., Huusko, A., Vehanen, T., Mäki-Petäys, A., Muotka, T. (2011) Twenty years of stream restoration in Finland: little response by benthic macroinvertebrate communities. *Ecological Applications*, 21(6): 1950–1961.

McBride, G., Soller, J. (2017) Technical Background for 2017 MfE 'Clean Water' Swimmability Proposals for Rivers. *NIWA Report*.

McKergow, L.A., Davies-Colley, R.J. (2010) Stormflow dynamics and loads of Escherichia coli in a large mixed land use catchment. *Hydrological Processes*, 24(3): 276–289.

McKergow, L.A., Weaver, D.M., Prosser, I.P., Grayson, R.B., Reed, A.E.G., (2003) Before and after riparian management: sediment and nutrient exports from a small agricultural catchment, Western Australia. *Journal of Hydrology*, 270(3): 253–272.

MfE (2017) National Policy Statement for Freshwater Management 2014 (updated 2017).

Moore, S., Neale, M. (2008) Freshwater Invertebrate Monitoring: 2003–2007 analysis and evaluation. *Auckland Regional Council Technical Report*.

Palmer, M.A., Menninger, H.L., Bernhardt, E. (2010) River restoration, habitat heterogeneity and biodiversity: a failure of theory or practice? *Freshwater Biology*, 55: 205–222.

Parkyn, S., Collier, K., Clapcott, J., David, B., Davies-Colley, R., Matheson, F., Quinn, J., Shaw, W., Storey, R. (2010) *The Restoration Indicator Toolkit: Indicators for monitoring the ecological success of stream restoration*. National Institute of Water & Atmospheric Research Ltd, Hamilton, New Zealand: 134.

Parkyn, S.M., Davies-Colley, R.J., Halliday, N.J., Costley, K.J., Croker, G.F. (2003) Planted Riparian Buffer Zones in New Zealand: Do They Live Up to Expectations? *Restoration Ecology*, 11(4): 436–447.

Petersen, I., Masters, Z., Hildrew, A.G., Ormerod, S.J. (2004) Dispersal of adult aquatic insects in catchments of differing land use. *Journal of Applied Ecology*, 41(5): 934–950.

Petersen, I., Winterbottom, J.H., Orton, S., Friberg, N., Hildrew, A.G., Spiers, D.C., Gurney†, W.S.C. (1999) Emergence and lateral dispersal of adult Plecoptera and Trichoptera from Broadstone Stream, U.K. *Freshwater Biology*, 42(3): 401–416.

R Development Core Team (2008) R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org

Redding, D.W., Lucas, T.C.D., Blackburn, T.M., Jones, K.E. (2017) Evaluating Bayesian spatial methods for modelling species distributions with clumped and restricted occurrence data. *PLOS ONE*, 12(11): e0187602.

Rue, H., Martino, S., Chopin, N. (2009) Approximate Bayesian inference for latent Gaussian models by using integrated nested Laplace approximations. *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, 71(2): 319–392.

Ryan, P.A. (1991) Environmental effects of sediment on New Zealand streams: A review. *New Zealand Journal of Marine and Freshwater Research*, 25(2): 207–221.

Spiegelhalter, D.J., Best, N.G., Carlin, B.P., Van Der Linde, A. (2002) Bayesian measures of model complexity and fit. *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, 64(4): 583–639.

Stark, J., Maxted, J. (2007) A user guide for the Macroinvertebrate Community Index. *Cawthron Report*, 1166:58.

TRC (2011) Transforming Taranaki: The Taranaki Riparian Management Programme. *Tarnaki Regional Council Report*.

US EPA (2012) 2012 Recreational water criteria.

Wagenhoff, A., Shearer, K., Clapcott, J. (2016) A review of benthic macroinvertebrate metrics for assessing stream ecosystem health. *Cawthron Report*.

Wilcock, R.J., Betteridge, K., Shearman, D., Fowles, C.R., Scarsbrook, M.R., Thorrold, B.S., Costall, D. (2009) Riparian protection and on-farm best management practices for restoration of a lowland stream in an intensive dairy farming catchment: A case study. *New Zealand Journal of Marine and Freshwater Research*, 43(3): 803–818.

Wortley, L., Hero, J.-M., Howes, M. (2013) Evaluating Ecological Restoration Success: A Review of the Literature. *Restoration Ecology*, 21(5): 537–543.

Appendix A Flow estimate comparison for *E. coli* model

As noted in the Methods section, we had to use estimated flow measures for some sites, resulting in uncertainty not being propagated through the model correctly. In order to ensure that the positive *E. coli*-flow relationship held without this added noise, the models were run for the subset of sites where flow measurements were taken at the same location. A positive *E. coli*-flow relationship was still found, although the model with index 2 now has the lowest DIC. However, this change could be due either to the improvement in uncertainty or due a loss of information from excluding restoration data from 5 out of 11 sites.

Table A-1: Model parameter coefficients, standard errors, 95% credible intervals, and DIC scores for *E. coli* models using only data from sites with paired flow data. Note that coefficients (means) are on the scale of the linear predictor (log scale).

Model	Restoration index	Parameter	Mean	Standard error of the mean	2.5% quantile	97.5% quantile	DIC[a]
Restoration	Index 1	Intercept	7.4392	0.4513	6.5641	8.3153	3634990
fixed effect		Flow	0.0329	0.0000	0.0328	0.0330	
		Restoration	-1.2901	0.0146	-1.3188	-1.2615	
	Index 2	Intercept	8.2042	0.5801	7.0605	9.3479	**3634105**
		Flow	0.0330	0.0000	0.0329	0.0331	
		Restoration	-2.9608	0.0318	-3.0233	-2.8984	
	Index 3	Intercept	8.3403	0.7237	6.8999	9.7800	3636892
		Flow	0.0330	0.0000	0.0329	0.0331	
		Restoration	-7.8029	0.1032	-8.0056	-7.6004	

[a] DIC = Deviance Information Criterion, a relative measure of fit, or deviance, penalized by the number of parameters; the smaller the DIC the better the relative fit (Spiegelhalter, Best et al. 2002)

Appendix B *E. coli* modelling using 2 km DEM streams

As described in the Methods section, some of the restoration data provided by Taranaki Regional Council was along farm drains or other streams too small to be included in the REC national stream network data layer. We tested two different methods to resolve this issue: 1) only including restoration that matched up to an REC stream segment (the results presented in the main text of this report) and 2) creating our own stream network using the finest-scale digital elevation map (DEM) available, which had 2 km resolution. Because the 2 km DEM still did not include some of the drains and small streams included in the council dataset, we choose to use the restoration indices calculated using restoration along REC stream segments only for the modelling presented in the main body of the report. However, to confirm those results, we also conducted the modelling analysis using the restoration indices calculated using our 2 km DEM stream network. The resulting restoration indices were highly correlated (Figure B-1) and overall results and general conclusions of the *E. coli* modelling analysis were the same for both methods; there was a negative relationship between restoration and *E. coli* concentrations across all sites. Model parameters and plots are presented below.

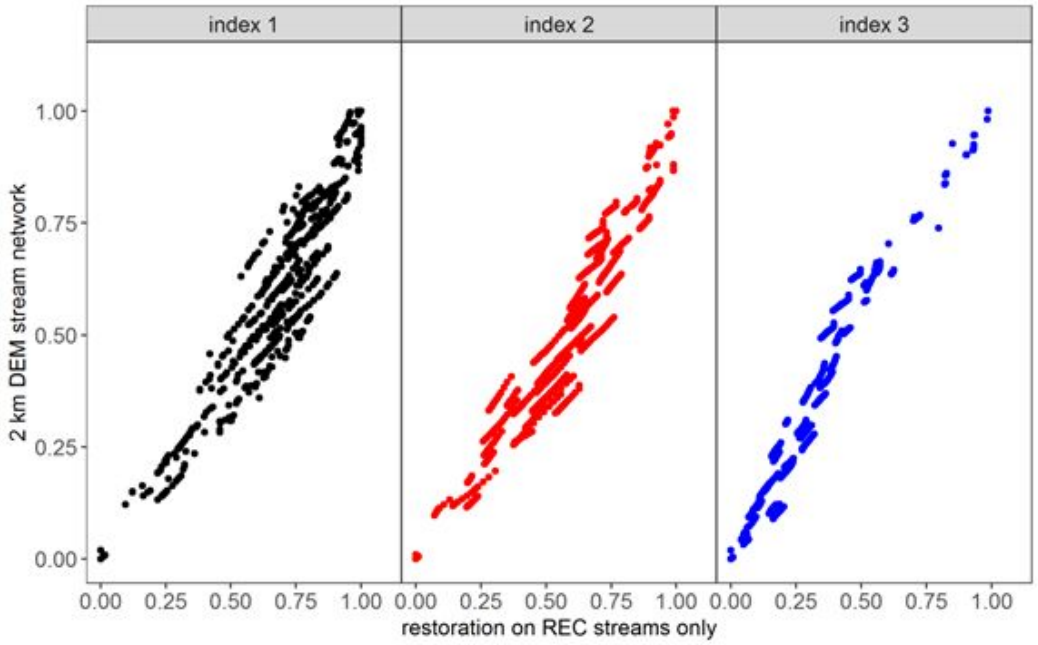


Figure B-1: Restoration index values calculated using only restoration along REC streams plotted against restoration index values calculated using a stream network derived from a 2 km resolution digital elevation map (DEM). The two sets of indices were highly correlated.

Table B-1: Model parameter coefficients, standard errors, 95% credible intervals, and DIC scores for *E. coli* models with each restoration index calculated using the 2 km DEM stream network. Note that coefficients (means) are on the scale of the linear predictor (log scale).

Model	Restoration index	Parameter	Mean	Standard error of the mean	2.5% quantile	97.5% quantile	DIC[a]
Restoration fixed effect	Index 1	Intercept	7.5571	0.3456	6.9129	8.2022	**4720851**
		Flow	0.0336	0.0000	0.0335	0.0337	
		Restoration	-1.8999	0.0195	-1.9381	-1.8617	
	Index 2	Intercept	8.8067	0.4357	7.9707	9.6436	4721008
		Flow	0.0336	0.0000	0.0336	0.0337	
		Restoration	-4.1568	0.0429	-4.2411	-4.0725	
	Index 3	Intercept	10.0362	0.7448	8.5659	11.5078	4723989
		Flow	0.0339	0.0000	0.0338	0.0340	
		Restoration	-8.3730	0.1050	-8.5791	-8.1672	
Restoration random slope	Index 1	Intercept	7.8647	0.2444	7.4104	8.3194	**4720765**
		Flow	0.0333	0.0000	0.0332	0.0334	
	Index 2	Intercept	8.5590	0.2454	8.1029	9.0158	4721579
		Flow	0.0335	0.0000	0.0334	0.0335	
	Index 3	Intercept	7.4566	0.2476	6.9966	7.9172	4730396
		Flow	0.0334	0.0000	0.0333	0.0335	

[a] DIC = Deviance Information Criterion, a relative measure of fit, or deviance, penalized by the number of parameters; the smaller the DIC the better the relative fit (Spiegelhalter, Best et al. 2002)

Table B-2: Model parameter coefficients, standard errors, 95% credible intervals, and DIC scores for *E. coli* 2 km DEM models using only data from sites with paired flow data. Note that coefficients (means) are on the scale of the linear predictor (log scale).

Model	Restoration index	Parameter	Mean	Standard error of the mean	2.5% quantile	97.5% quantile	DIC[a]
Restoration fixed effect	Index 1	Intercept	7.7252	0.5110	6.7269	8.7248	3634291
		Flow	0.0331	0.0000	0.0330	0.0332	
		Restoration	-2.0815	0.0225	-2.1257	-2.0373	
	Index 2	Intercept	8.8725	0.7731	7.3305	10.4138	**3633195**
		Flow	0.0332	0.0000	0.0331	0.0333	
		Restoration	-5.0229	0.0512	-5.1235	-4.9225	
	Index 3	Intercept	9.5016	1.1473	7.2006	11.8038	3634969
		Flow	0.0337	0.0000	0.0336	0.0338	
		Restoration	-11.9618	0.1357	-12.2283	-11.6956	

[a] DIC = Deviance Information Criterion, a relative measure of fit, or deviance, penalized by the number of parameters; the smaller the DIC the better the relative fit (Spiegelhalter, Best et al. 2002)

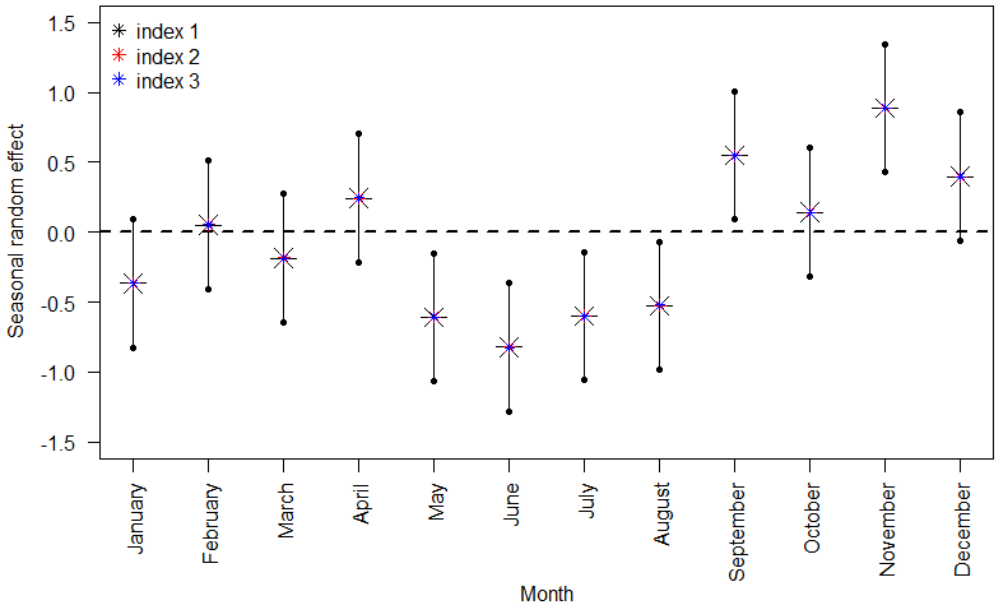


Figure B-2: Posterior estimates and credible intervals for the seasonal (i.e., monthly) random effect in the restoration as a fixed effect models. The coefficients and credible intervals for restoration index 3, the best fitting model, are shown largest and in black, and the coefficients from the restoration index 1 and restoration index 3 models are shown in red and blue, respectively. The symbols for the three indices are superimposed when the coefficient values are very similar for each model.

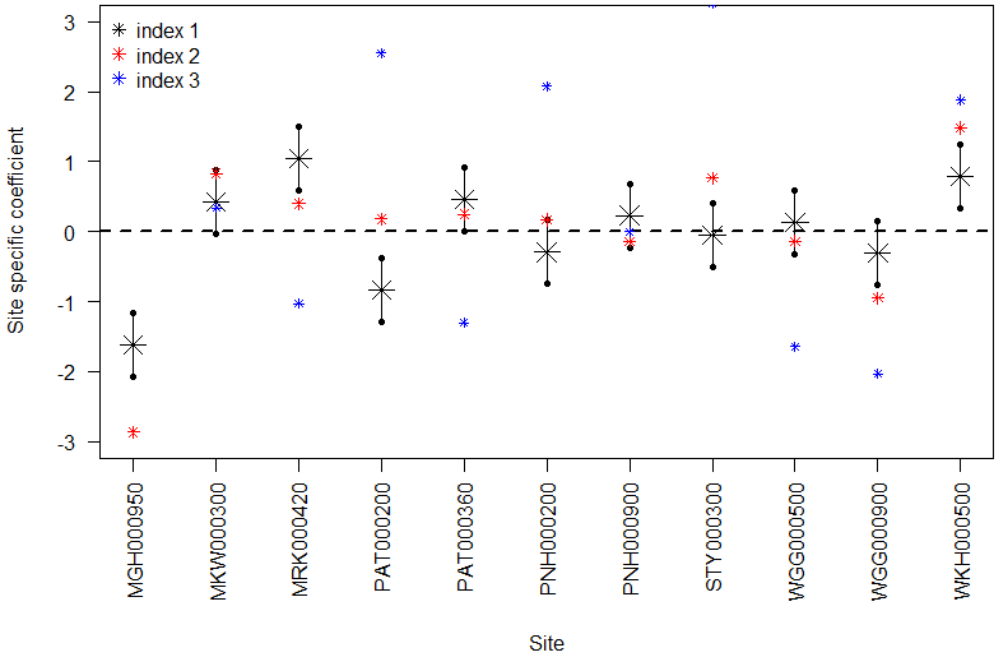


Figure B-3: Site specific intercepts and credible intervals for *E. coli* models with restoration as a fixed effect. The coefficients and credible intervals for restoration index 3, the best fitting model, are shown largest and in black, and the coefficients from the restoration index 1 and restoration index 3 models are shown in red and blue, respectively.

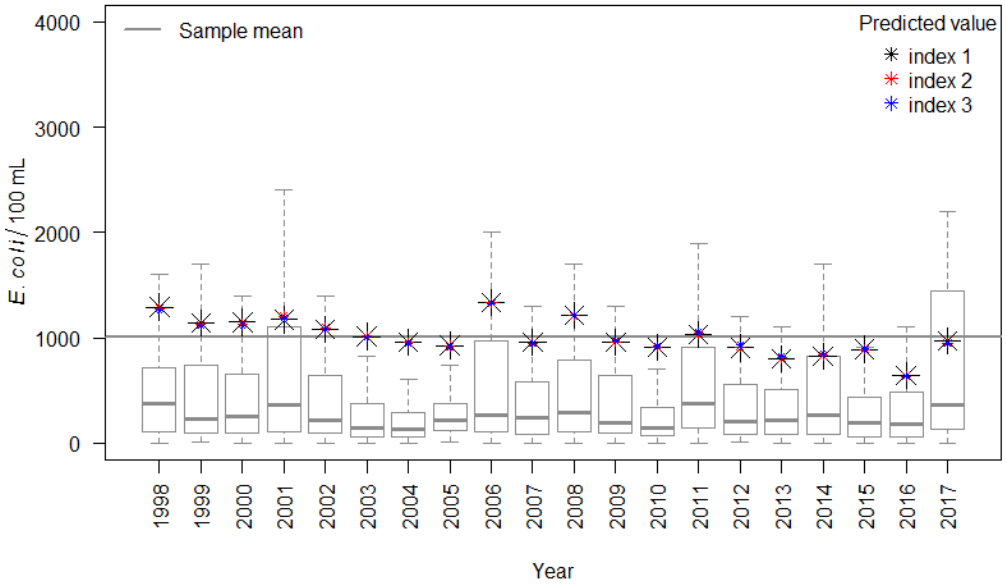


Figure B-4: Predicted *E. coli* concentrations from the fitted fixed effect restoration models compared to observed values. Note that this plot does not show outliers, but the mean value (grey line) indicates their influence. The observed data is shown by the grey boxplots. The predicted values for the restoration index 3 model (the best-fitting model) are shown largest and in black, the predicted values from models with restoration indices 1 and 3 are shown in red and blue, respectively.

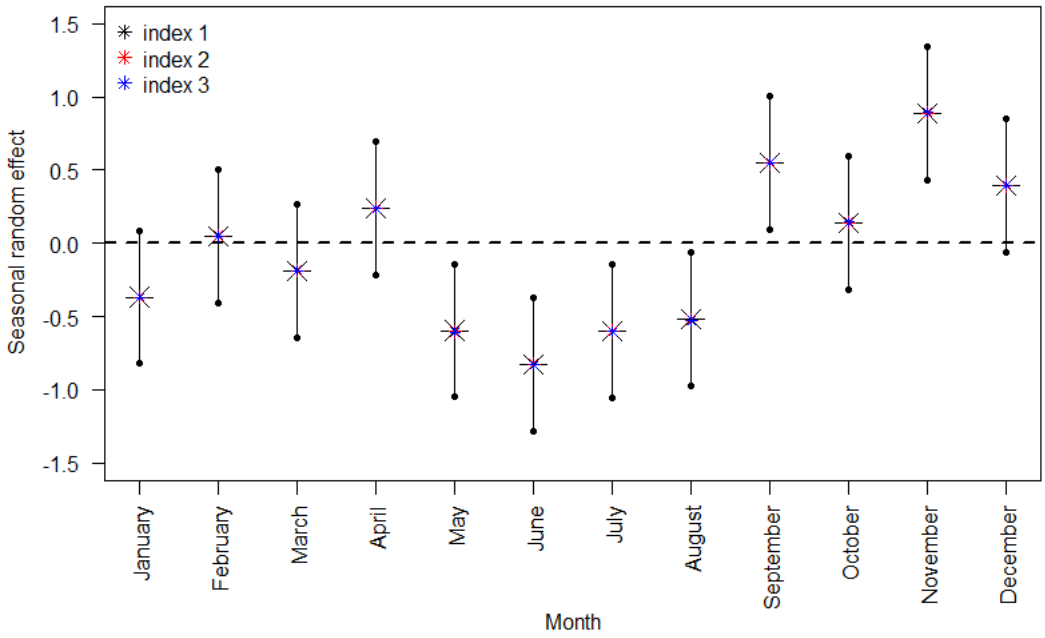


Figure B-5: Posterior estimates and credible intervals for the seasonal (i.e., monthly) random effect in the restoration as a random slope models. The coefficients and credible intervals for restoration index 1, the best fitting model, are shown largest and in black, and the coefficients from the restoration index 2 and restoration index 3 models are shown in red and blue, respectively.

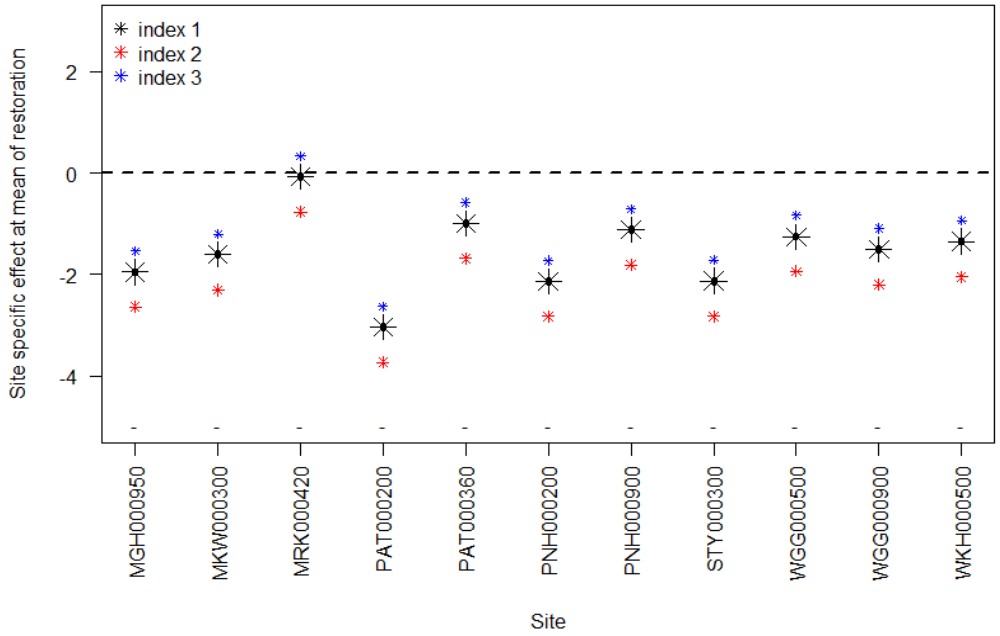


Figure B-6: Site specific restoration coefficients (slopes) for the three restoration as random slope models, evaluated at the mean of the restoration index at that site. A negative posterior mean with credible intervals that do not include zero indicates a negative relationship between restoration and *E. coli* concentration at that site, a positive posterior mean with credible intervals that do not include zero indicate a positive relationship between restoration and *E. coli* concentration at that site. The coefficients and credible intervals for restoration index 1, the best fitting model, are shown largest and in black, and the coefficients from the restoration index 2 and restoration index 3 models are shown in red and blue, respectively.

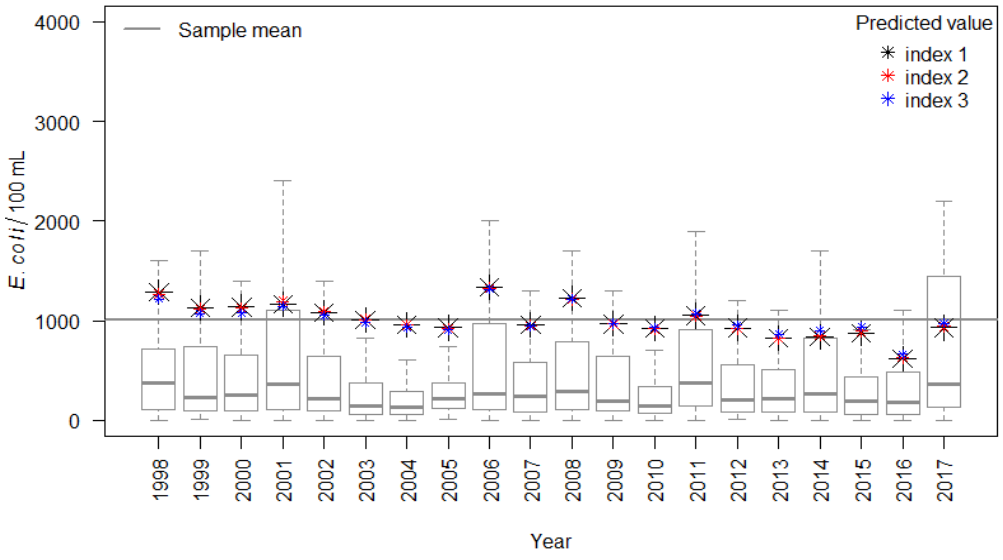


Figure B-7: Predicted *E. coli* concentrations from the fitted random slope restoration models compared to observed values. Note that this plot does not show outliers, but the mean value (grey line) indicates their influence. The observed data is shown by the grey boxplots. The predicted values for the restoration index 1 model (the best-fitting model) are shown largest and in black, the predicted values from models with restoration indices 2 and 3 are shown in red and blue, respectively.

Appendix C Invertebrate modelling using 2 km DEM streams

The invertebrate modelling analysis using National SQMCI as a response variable was also conducted using the restoration indices calculated using our 2 km DEM stream network to confirm the REC-only results presented in the main text of this report. The overall results and general conclusions were the same for both methods; there was a positive relationship between restoration and National SQMCI metric scores across all sites. Model parameters and plots are presented below. Because the National SQMCI results were similar for both sets of models, we infer the other invertebrate metric models will also be similar across the two restoration index calculation methods.

Table C-1: Model parameter coefficients, standard errors, 95% credible intervals, and DIC scores for National SQMCI models with each restoration index. Note that coefficients (means) are on the scale of the linear predictor (log scale).

Model	Restoration index	Parameter	Mean	Standard error of the mean	2.5% quantile	97.5% quantile	DIC[a]
Restoration	Index 1	Intercept	0.2933	0.1328	0.0234	0.5427	**6918.61**
fixed effect		Restoration	2.2819	0.1848	1.9252	2.6435	
	Index 2	Intercept	-0.8745	0.3027	-1.4866	-0.3067	6944.13
		Restoration	4.7646	0.4711	3.8403	5.6627	
	Index 3	Intercept	1.3125	0.0518	1.2071	1.4114	7208.86
		Restoration	0.7755	0.1053	0.5773	0.9924	
Restoration	Index 1	Intercept	0.1150	0.2336	-0.3625	0.5567	**6762.68**
random slope	Index 2	Intercept	1.5011	0.0549	1.3979	1.6121	7225.57
	Index 3	Intercept	1.5344	0.0480	1.4459	1.6338	7235.63

[a] DIC = Deviance Information Criterion, a relative measure of fit, or deviance, penalized by the number of parameters; the smaller the DIC the better the relative fit (Spiegelhalter, Best et al. 2002).

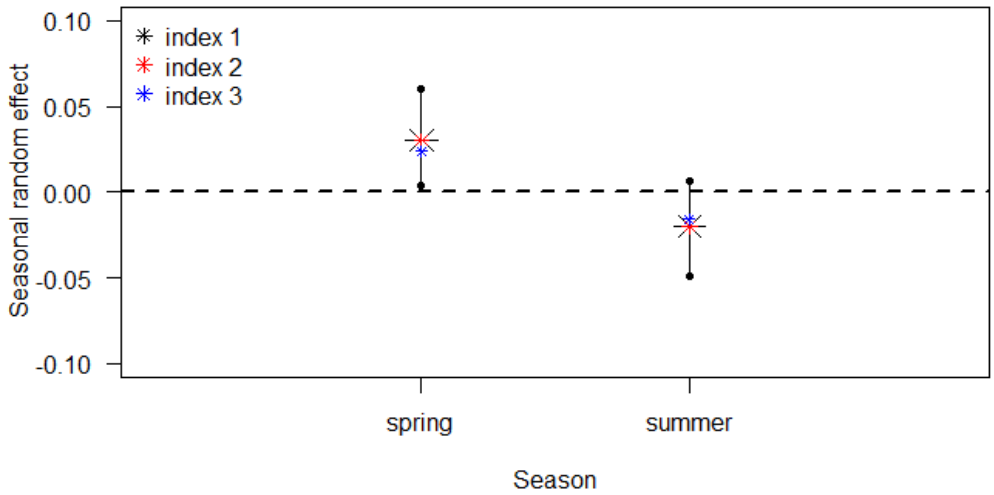


Figure C-1: Posterior estimates and credible intervals for the seasonal random effect in the restoration as a fixed effect models. The predicted values for the restoration index 1 model (the best-fitting model) are shown largest and in black, the predicted values from models with restoration indices 2 and 3 are shown in red and blue, respectively.

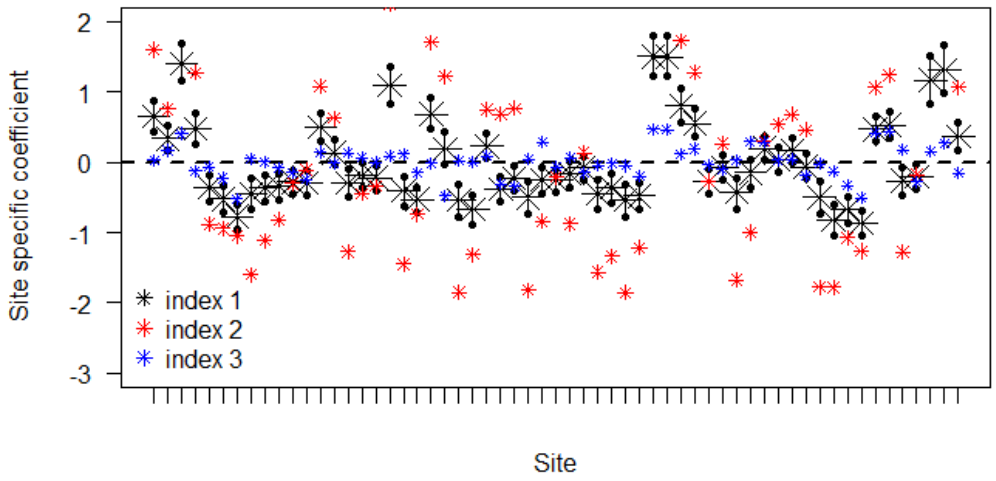


Figure C-2: Site specific intercepts and credible intervals for National SQMCI models with restoration as a fixed effect. The predicted values for the restoration index 1 model (the best-fitting model) are shown largest and in black, the predicted values from models with restoration indices 2 and 3 are shown in red and blue, respectively.

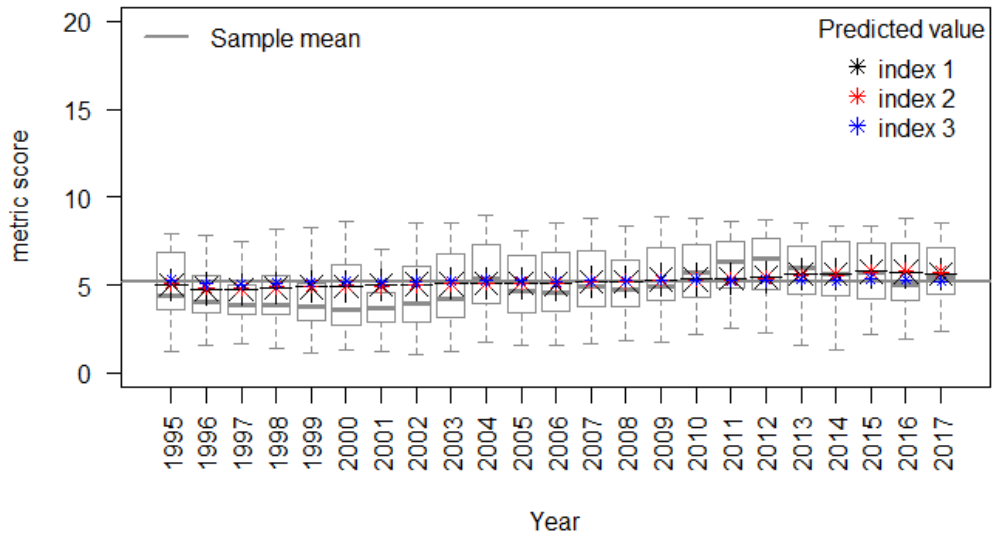


Figure C-3: Predicted National SQMCI metric values from the fitted fixed effect restoration models compared to observed values. The observed data is shown by the grey boxplots. The predicted values for the restoration index 3 model (the best-fitting model) are shown largest and in black, the predicted values from models with restoration indices 1 and 3 are shown in red and blue, respectively.

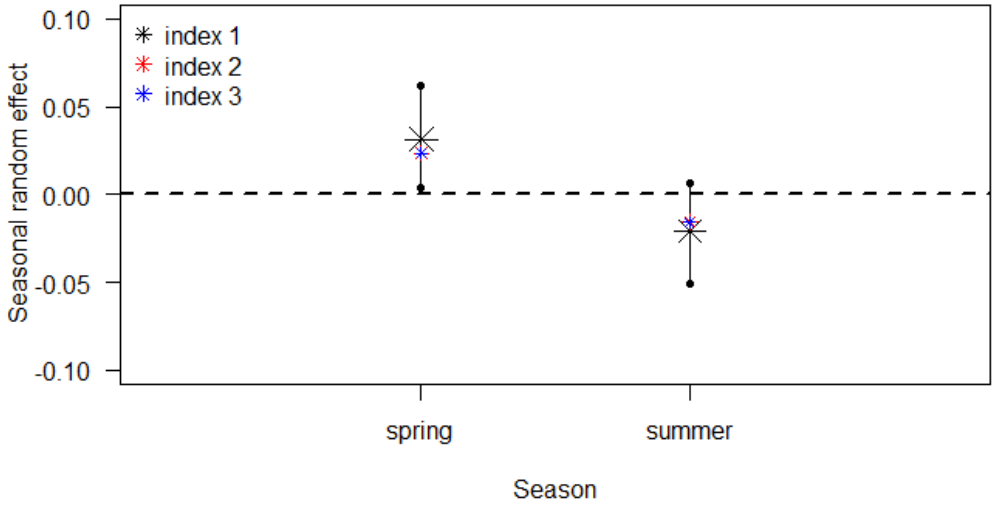


Figure C-4: Posterior estimates and credible intervals for the seasonal random effect in the restoration as a random slope models. The predicted values for the restoration index 3 model (the best-fitting model) are shown largest and in black, the predicted values from models with restoration indices 1 and 3 are shown in red and blue, respectively.

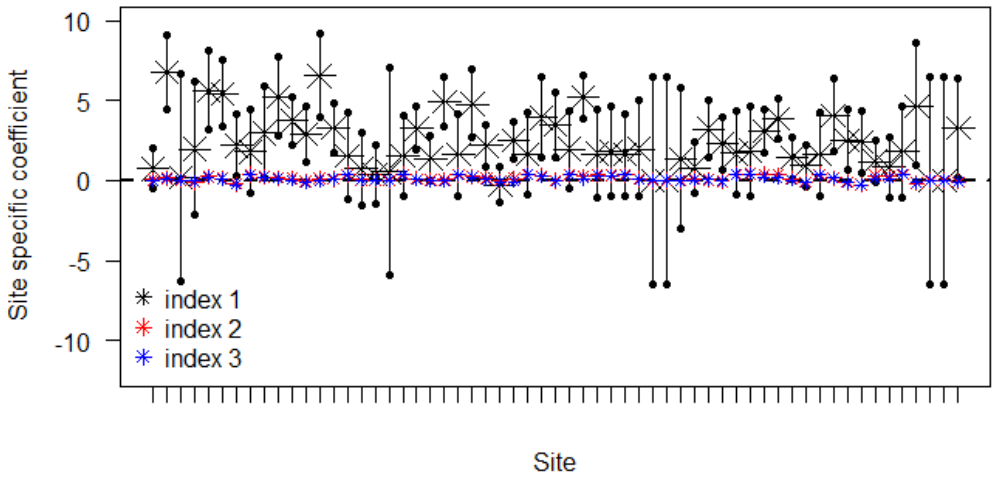


Figure C-5: Site specific intercepts and credible intervals for National SQMCI models with restoration as a random slope. The predicted values for the restoration index 3 model (the best-fitting model) are shown largest and in black, the predicted values from models with restoration indices 1 and 3 are shown in red and blue, respectively.

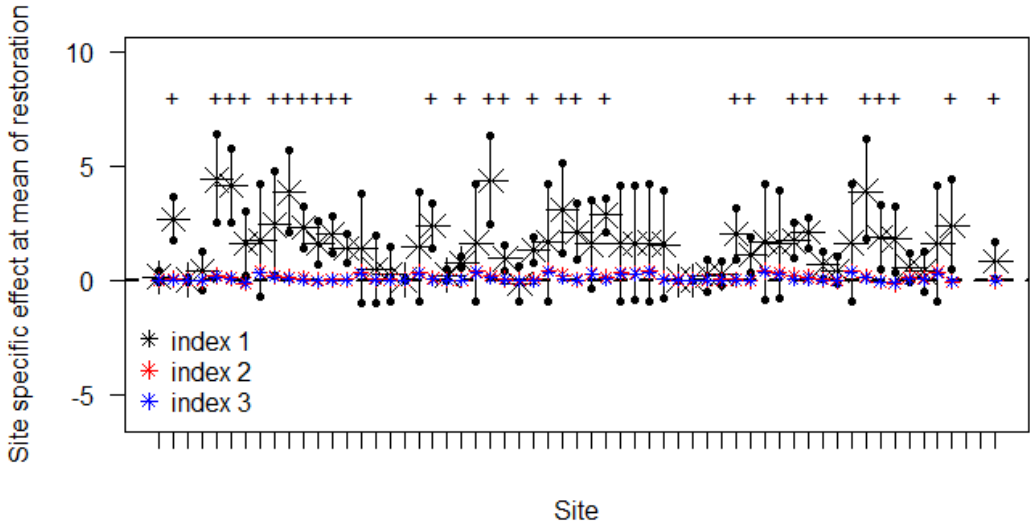


Figure C-6: Site specific restoration coefficients (slopes) for the three restoration index models, evaluated at the mean of the restoration index at that site. A negative posterior mean with credible intervals that do not include zero indicates a negative relationship between restoration National SQMCI metric values at that site, a positive posterior mean with credible intervals that do not include zero indicate a positive relationship between restoration and National SQMCI scores at that site. The coefficients and credible intervals for restoration index 1, the best fitting model, are shown largest and in black, and the coefficients from the restoration index 2 and restoration index 3 models are shown in red and blue, respectively.

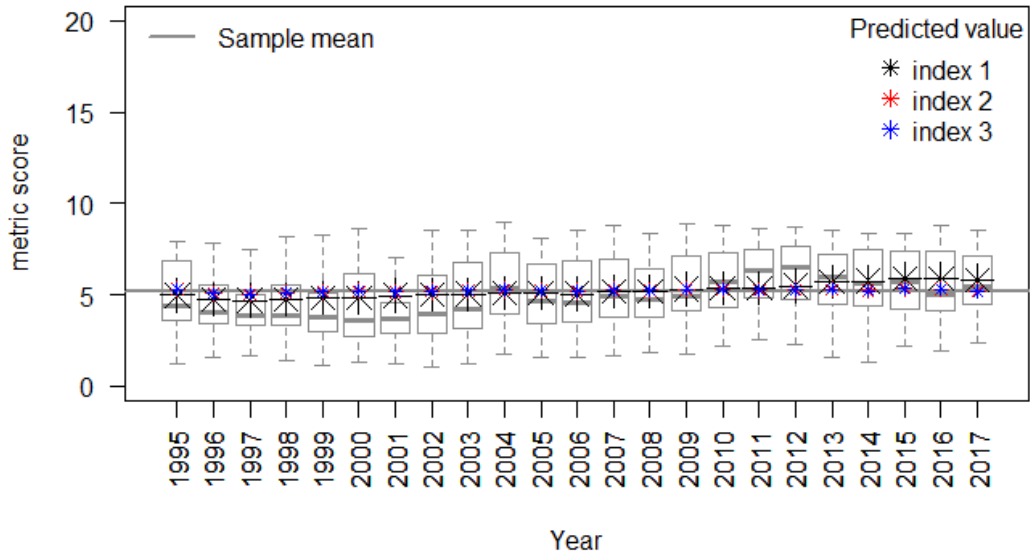


Figure C-7: Predicted National SQMCI metric values from the fitted random slope restoration models compared to observed values. The observed data is shown by the grey boxplots. The predicted values for the restoration index 1 model (the best-fitting model) are shown largest and in black, the predicted values from models with restoration indices 2 and 3 are shown in red and blue, respectively.

Table C-2: Posterior estimates for restoration index coefficients for the National SQMCI with restoration index 1 random slope model. A positive posterior mean with credible intervals that do not include zero indicates positive relationships between restoration and macroinvertebrate metric scores at that site. It is important to note that the coefficients and quantiles are at the scale of the linear predictor (i.e., log scale). A slope of 0 indicates the restoration index remained constant at that site, "--" indicates either that no restoration has been done upstream of this site or if so, data was not available.

Site	Intercept mean	Intercept 2.5% CI	Intercept 97.5% CI	Slope mean	Slope 2.5% CI	Slope 97.5% CI	Nat. SQMCI-Restoration Relationship
HRK000085	0.7428	-0.5021	2.0038	0.1414	-0.0956	0.3815	
HTK000350	6.7798	4.4824	9.1448	2.6757	1.7690	3.6090	+
HTK000425	0.1843	-6.3276	6.7079	0.0035	-0.1212	0.1285	
HTK000745	1.9719	-2.1168	6.1494	0.3923	-0.4211	1.2233	
KPA000250	5.5860	3.1953	8.1441	4.3836	2.5075	6.3911	+
KPA000700	5.4169	3.3404	7.5860	4.1243	2.5434	5.7759	+
KPA000950	2.1918	0.2834	4.1294	1.5828	0.2047	2.9820	+
KPK000250	1.8056	-0.7880	4.4301	1.7252	-0.7530	4.2329	
KPK000500	2.9690	0.2377	5.8837	2.4191	0.1937	4.7939	+
KPK000660	5.2452	2.8392	7.7917	3.8264	2.0711	5.6840	+
KPK000880	3.7272	2.2190	5.2461	2.3027	1.3709	3.2410	+
KPK000990	2.8962	1.2041	4.6022	1.6147	0.6713	2.5658	+
KRP000300	6.5470	3.9216	9.2322	1.9953	1.1952	2.8136	+
KRP000660	3.3089	1.7765	4.8601	1.3735	0.7374	2.0174	+
KTK000150	1.5677	-1.1423	4.2536	1.3864	-1.0102	3.7616	
KTK000248	0.7246	-1.5765	3.0183	0.4661	-1.0140	1.9414	
MGE000970	0.3801	-1.4719	2.2278	0.2431	-0.9415	1.4251	
MGH000950	0.5354	-5.9377	7.0902	0.0034	-0.0374	0.0447	
MGN000195	1.5646	-0.9745	4.0901	1.4660	-0.9131	3.8324	
MGN000427	3.2540	1.9133	4.6096	2.3770	1.3976	3.3672	+
MGT000488	1.3983	-0.0094	2.8280	0.2179	-0.0015	0.4407	
MGT000520	4.9303	3.4328	6.4544	0.7644	0.5322	1.0007	+
MKW000200	1.6268	-0.9388	4.1987	1.6268	-0.9388	4.1987	
MKW000300	4.7890	2.6930	7.0153	4.3263	2.4328	6.3374	+
MRK000420	2.1820	0.8610	3.5187	0.9414	0.3714	1.5181	+
MWH000380	-0.2501	-1.3656	0.8837	-0.1707	-0.9320	0.6030	
MWH000490	2.5171	1.3869	3.6577	1.3120	0.7229	1.9065	+
PAT000200	1.6546	-0.9113	4.2261	1.6546	-0.9113	4.2261	
PAT000315	3.9262	1.4874	6.5197	3.0775	1.1658	5.1103	+
PAT000360	3.4692	1.4321	5.5562	2.0909	0.8631	3.3487	+
PNH000200	1.9637	-0.4481	4.3892	1.5752	-0.3594	3.5210	
PNH000900	5.2206	3.8379	6.6174	2.8321	2.0820	3.5898	+
STY000300	1.6838	-1.0342	4.4157	1.5673	-0.9626	4.1103	
STY000400	1.8272	-0.9668	4.6537	1.6171	-0.8556	4.1186	

Site	Intercept mean	Intercept 2.5% CI	Intercept 97.5% CI	Slope mean	Slope 2.5% CI	Slope 97.5% CI	Nat. SQMCI-Restoration Relationship
TMR000150	1.6228	-0.9425	4.1945	1.6228	-0.9425	4.1945	
TMR000375	1.9804	-0.9908	5.0482	1.5523	-0.7766	3.9567	
TNH000090	0.0000	-6.5295	6.5196	0.0000	0.0000	0.0000	
TNH000200	0.0000	-6.5295	6.5196	0.0000	0.0000	0.0000	
TNH000515	1.3484	-3.0464	5.7926	0.2153	-0.4865	0.9250	
WAI000110	0.8079	-0.8034	2.4454	0.2612	-0.2598	0.7907	
WGA000260	3.2277	1.4384	5.0500	2.0153	0.8981	3.1530	+
WGA000450	2.3062	0.6885	3.9421	1.1147	0.3328	1.9054	+
WGG000115	1.7052	-0.9194	4.3369	1.6575	-0.8937	4.2158	
WGG000150	1.8721	-0.9291	4.6798	1.5691	-0.7788	3.9226	
WGG000500	3.0967	1.7170	4.4836	1.7143	0.9505	2.4820	+
WGG000665	3.8782	2.6367	5.1286	2.0752	1.4108	2.7442	+
WGG000895	1.4387	0.1285	2.7559	0.6594	0.0589	1.2630	+
WGG000995	0.9272	-0.3699	2.2321	0.4219	-0.1683	1.0157	
WKH000100	1.6472	-0.9379	4.2381	1.6327	-0.9297	4.2008	
WKH000500	4.0397	1.8559	6.4156	3.8847	1.7847	6.1695	+
WKH000920	2.5390	0.6510	4.4648	1.8748	0.4807	3.2967	+
WKH000950	2.3994	0.4553	4.3865	1.7773	0.3372	3.2493	+
WKR000500	1.2046	-0.1425	2.5429	0.5670	-0.0671	1.1970	
WKR000700	0.8282	-1.0980	2.7263	0.3797	-0.5034	1.2500	
WMK000100	1.8139	-1.0221	4.6609	1.6001	-0.9017	4.1116	
WMK000298	4.6368	0.9424	8.6380	2.3577	0.4792	4.3921	+
WNR000450	0.0000	-6.5295	6.5196	--	--	--	
WTR000540	0.0000	-6.5295	6.5196	--	--	--	
WTR000850	3.2640	0.1635	6.4184	0.8314	0.0417	1.6350	+

Appendix D Swimmability tables

Please see supplementary Excel files.

Agenda Memorandum

Date 24 April 2018

Memorandum to
Chairperson and Members
Policy and Planning Committee

Subject: **LAWA: Release of analysis of water quality trends at national and regional level**

Approved by: GK Bedford, Director-Environment Quality

BG Chamberlain, Chief Executive

Document: 2039047

Purpose

The purpose of this memorandum is to advise the Committee of the release of results for trend analysis of freshwater quality at national level for the most recent 10 year period, on the LAWA (Land Air Water Aotearoa) website. The analysis provided trends at both national and regional data levels, and so this memorandum also presents the 10 year trends in a suite of water quality parameters for the Taranaki region. The LAWA information is available at https://www.lawa.org.nz/explore-data/river-quality/#/tb-national .

Executive summary

The memorandum presents trends in water quality at both national and Taranaki regional level. It also presents analysis of and commentary on the national picture, by several parties. Between one-third and two-thirds of all sites nationwide were found to show a trend. For every parameter, there were more improving trends than deteriorating trends. That is, water quality is improving in New Zealand at national level across all measures.

Water clarity, ammoniacal nitrogen and total phosphorus concentrations showed many times more sites with improving trends than degrading trends. By comparison with an earlier national level trend analysis (using the same analytical methodology), total oxidised nitrogen (nitrate) and total nitrogen are now showing more improving sites than deteriorating sites, reversing the finding emerging from the older dataset. That is, there has been a swing in these trends in the last few years, which commentators note has been brought about by the scale and direction of resources being applied to water quality management nationally.

The trend analysis for Taranaki likewise shows positive trends across all parameters on a regional basis, reflecting the ongoing investment by Council and the regional community.

Recommendations

That the Taranaki Regional Council:

1. receives the memorandum *LAWA: Release of analysis of water quality trends at national and regional level*
2. notes the trend data and commentary presented in the LAWA analysis

Background

The LAWA website and data library is a collaboration originally between the Taranaki Regional Council and New Zealand's other 15 Regional and Unitary Councils, and more recently with Cawthron Institute and Ministry for the Environment. It is supported by Massey University and the Tindall Foundation. Data from each council's individual sites used for environmental monitoring is routinely uploaded upon generation, and is freely and fully accessible to the public. Currently, physicochemical and biological measures of freshwater quality are displayed, together with air quality data and land use/land cover measures. There are a number of initiatives underway to add other environmental data domains such as marine and groundwater quality.

Discussion

On Monday 16 April the report LAWA National River Water Quality Trends (2007 - 2016) was released on the LAWA website.

This is the first set of trends released by LAWA and includes council data from the sites monitored in each region. From September 2018 (following the next refresh of data, for the 2017-2018 year) the trends will be updated and released annually, to show how New Zealand is tracking as a country year on year.

This release by LAWA shows that for all river water quality parameters monitored over the last 10 years, considerably more sites were improving than deteriorating on a national basis, across all water quality parameters reported. This finding stands in contrast to some of the commentary offered into national level conversations about the state of water quality in New Zealand.

The *National River Water Quality Trends (2007 – 2016)* report released by LAWA follows a similar 10-year analysis released in 2015 by National Institute of Water & Atmospheric Research (NIWA). Compared with the 2015 report, a change in the trend of nitrogen is particularly noteworthy, with significant progress in the number of improving sites compared with the number that are deteriorating.

A media statement from LAWA notes that this encouraging trend has been welcomed by scientists and local government who have pointed to freshwater ecosystem management practices as contributing to the progress.

Cawthron Freshwater Group Manager and Ecologist, Dr Roger Young led the analytical work. He described the overall trend as 'exciting' and said, 'Looking back from 2016 at a decade of data, for every monitored parameter, more sites showed strong evidence of improving water quality, than degrading. My hope is this could represent a turning point in

New Zealand's river health story. While this trend gives us cause for optimism, water quality is just one indicator of river health and there is still more work to be done. In order to continue this trend and improve further, we need to invest in freshwater ecosystem management, routine monitoring, and further research and innovation.'

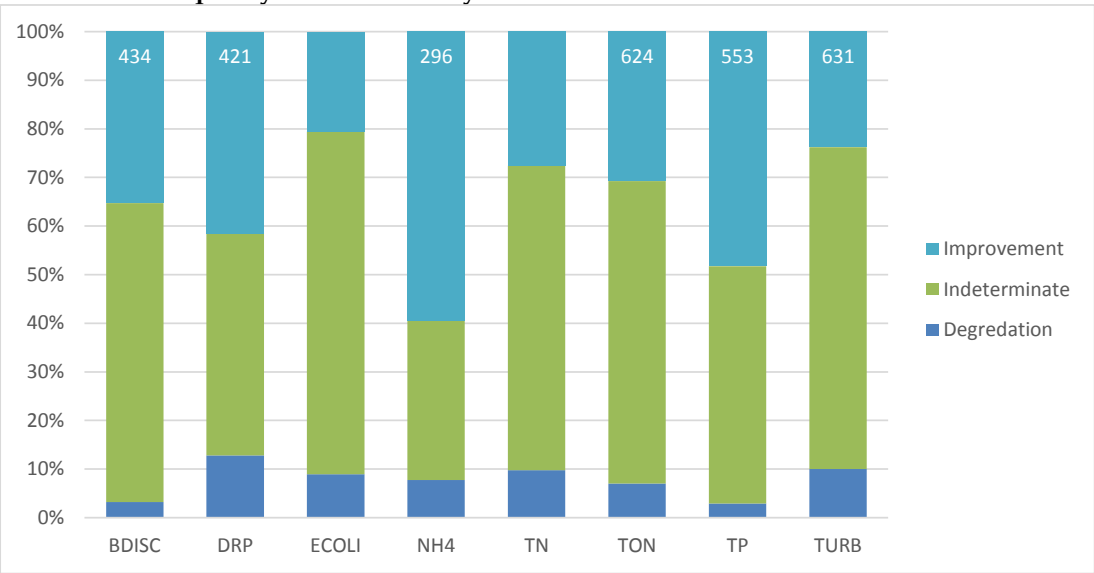
LAWA and Otago Regional Council Chair, Stephen Woodhead said the purpose of the LAWA release was about looking at what is happening in New Zealand's waterways overall. 'The LAWA website makes environmental monitoring data from all of New Zealand's Regional and Unitary Councils freely available, and this 10-year trend analysis looks at all of this information at a national level. It's important to have a national river water quality trend so we know how we're tracking. I invite all of New Zealand to get behind the effort to improve this trend further,' said Mr Woodhead.

The chair of Local Government New Zealand Regional Sector and the Bay of Plenty Council, Doug Leeder also has welcomed the National River Water Quality Trends. 'A great deal of resource has been dedicated to freshwater management. This is a sign that positive actions by central and local Government, landowners, businesses, iwi, and communities are making a difference. Councils will continue to monitor and research their regions, to better understand their unique problems, and work towards solutions that will contribute further to improving the national trend.'

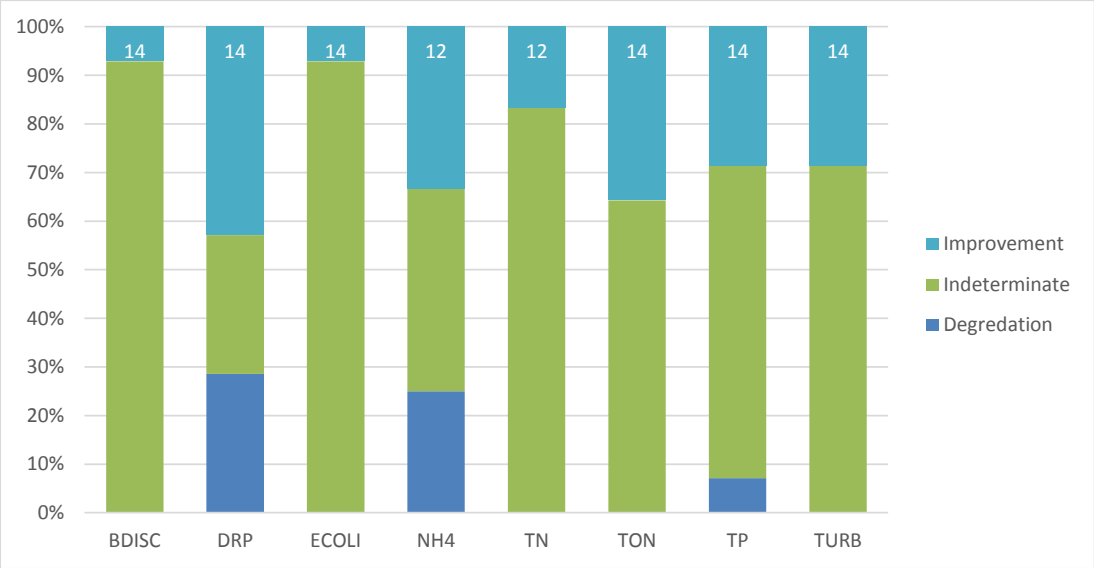
The discussion presented on the LAWA website of the national trends is reproduced in full, including detailed assessment of nutrients, *E coli*, and other physicochemical metrics, in the attachment to this report.

As noted in the Executive Summary above, while the trend analysis now presented on the LAWA website sets out the overall results only at national level, each region was concurrently provided with a regional level analysis of 10-year trends for their own data. The results for Taranaki are displayed below for the information of the Committee. The national and Taranaki regional figures are reproduced directly from the internal working documents. In both figures, the numbers at the top of each column give the number of sites from which data has been extracted for that particular parameter.

National water quality data trends: 10 year record



Taranaki water quality data trends: 10 year record



The Taranaki data shows that as at national level, for every parameter there are more sites showing improvement than deterioration. This is a very significant finding, and in the view of officers reflects the effort being put into fresh water management by the Council and the region's community. In summary:-

-the concentrations of total nitrogen and *E coli*, along with black disc measures of clarity, have shown no significant overall pattern of a trend, but particularly given a national level focus on catchments where nitrogen is increasing, the fact that this is not increasing in Taranaki is noteworthy;

-there is a shift toward overall improvements in oxidized nitrogen (nitrate) and turbidity on a regional scale; and

-while dissolved reactive phosphate, ammonia, and total phosphate are deteriorating at a few sites, the number of sites concerned is fewer than the number of sites where these parameters are improving.

The Council's own trend analysis and reporting is in preparation. The Council uses a 7-year period for current trend analysis (as has been agreed with NIWA), as a balance between currency and a record of sufficiently long duration to move past climatic and weather-induced short-term variations in data. A much fuller discussion of this region's water quality will be presented within that report.

Decision-making considerations

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

Financial considerations—LTP/Annual Plan

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

Policy considerations

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

Iwi considerations

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

Legal considerations

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

Attachment

From the LAWA website: (https://www.lawa.org.nz/explore-data/river-quality/#/tb-national) information on 10 year trend analysis of New Zealand's fresh water quality

From the LAWA website:

Trends in river water quality have been assessed for sampling sites all around the country over the last 10 years (2007-2016)[1]. Suitable data[2] was available for between 296 and 696 sites depending on which water quality parameter is being looked at. The analysis included sites where samples are collected monthly, bimonthly or quarterly.

There were trends (improving and degrading) in river water quality over the last 10 years at between 29% - 67% of sampling sites depending on which water quality parameter you look at (e.g. *E. coli* vs ammoniacal nitrogen) (Figure 1). At the other sites there is insufficient evidence to determine an improving or degrading trend over the last 10 years – i.e. indeterminate trends.

Improving trends for water quality were more common than degrading trends for all water quality parameters. Water clarity, ammoniacal nitrogen and total phosphorus concentrations showed 11, 8 and 16 times more sites with improving trends than degrading trends, respectively (Table 1, Figure 1).

While all parameters show there are more sites with improving trends than degrading trends, there are degrading trends for all parameters (Table 1, Figure 1).

Compared to a previous national water quality trend summary based on data from 2004-2013[3], the latest results were generally consistent but provide more positive signs relating to water quality improvements. Both found more improving trends than degrading trends for total phosphorus, dissolved reactive phosphorus, *E. coli*, ammoniacal nitrogen and water clarity. The latest results also show more improving trends than degrading trends for total oxidised nitrogen and total nitrogen, this was the opposite in the older dataset.

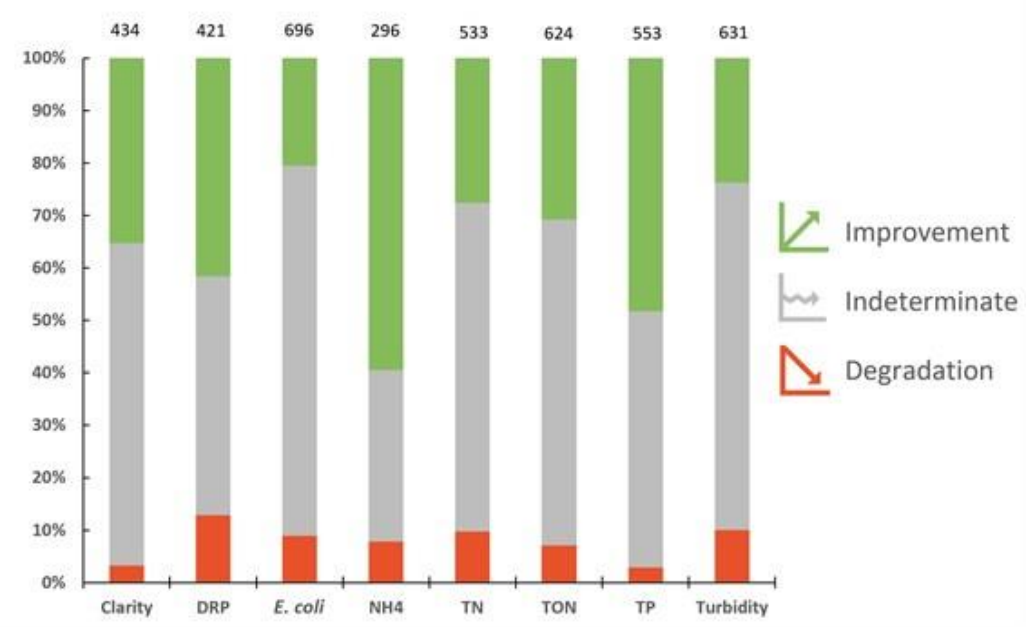


Figure 1. Percentage of sampling sites with improving or degrading trends over the last 10 years for a range of water quality parameters. There was insufficient data to determine an

improving or degrading trend at indeterminate sites. **DRP** = dissolved reactive phosphorus, ***E. coli*** = faecal indicator bacteria, **NH4** = ammoniacal nitrogen, **TN** = total nitrogen, **TON** = total oxidised nitrogen, **TP** = total phosphorus. The number of sites with suitable data for each parameter is shown at the top of the bar.

Table 1. The number of sites with improving or degrading trends over the last 10 years for a range of water quality parameters. There was insufficient data to determine an improving or degrading trend at indeterminate sites. **DRP** = dissolved reactive phosphorus, ***E. coli*** = faecal indicator bacteria, **NH4** = ammoniacal nitrogen, **TN** = total nitrogen, **TON** = total oxidised nitrogen, **TP** = total phosphorus.

Parameter	Improvement	Indeterminate	Degradation
Clarity	153	267	14
DRP	175	192	54
E. coli	143	491	62
NH_4	176	97	23
TN	147	334	52
TON	192	388	44
TP	267	270	16
Turbidity	150	418	63

[1] The direction of any trends was identified by determining whether zero was included in the 95 % confidence interval range around the Seasonal Sen Slope Estimate for each site and parameter combination. If zero was within the confidence interval range we concluded that there is insufficient data to determine trend direction i.e. an indeterminate trend.

[2] Sites were excluded from the analysis if they had less than 90% of the data expected in any one year of the data record, or if more than 30% of the data was less than or greater than laboratory detection limits. Sites with suitable data were available from all Regional and Unitary Council regions and from the National River Water Quality Network run by NIWA.

[3] From Larned S, Snelder T, Unwin M, McBride G, Verberg P, McMillan H 2015. Analysis of water quality in New Zealand lakes and rivers. Prepared for Ministry for the Environment. NIWA Client Report No. CHC2015-033. The data analysis approach is similar between the LAWA trends and previous national trend summary report, but not identical. The differences relate to flow adjustment and the threshold for laboratory detection limits.

Agenda Memorandum

Date 24 April 2018

Memorandum to
Chairperson and Members
Policy and Planning Committee

Subject: Regional plan alignment with National Environmental Standard for Plantation Forestry

Approved by: A D McLay, Director – Resource Management

B G Chamberlain, Chief Executive

Document: 1997412

Purpose

The purpose of this memorandum is to advise Members of the findings of a review into regional plan rules to ensure alignment with the *National Environmental Standard for Plantation Forestry* (NES-PF) and to present recommendations relating to plan alignment.

Also attached for Members' information is a useful Local Government New Zealand article providing an overview of the NES-PF entitled *Plantation forestry rules – gear up for change on May 1*.

Executive summary

- Under the *Resource Management Act 1991* (RMA), regional policy statements and plans must give effect to any national environmental statement.
- The NES-PF was published on 3 August 2017 and will commence on 1 May 2018.
- The NES-PF aims to maintain or improve the way New Zealand manages the environmental effects of plantation forestry while also increasing the efficiency and certainty of managing plantation forestry activities.
- The NES-PF regulations apply to any forest of more than 1 hectare that has been planted specifically for commercial purposes and harvesting. It does not apply to trees grown for fruit, nut crops, shelter belts, or nurseries.
- The NES-PF requires the Council, amongst other things, to identify any plan rules that duplicate or conflict with the NES, or which deal with the same effects.
- As soon as practicable after 1 May 2018, any rules that duplicate or conflict with the NES-PF must be amended to remove that duplication or conflict.
- Officers have reviewed the Council's four regional plans and have subsequently identified 35 rules in the *Regional Air Plan for Taranaki* and *Regional Freshwater Plan for Taranaki* and *Regional Soil Plan for Taranaki* that need to be amended to comply with NES-PF requirements.

- Officers recommend that relevant rules be amended. The nature of the changes are inconsequential and largely relate to the inclusion of advisory notes in relevant rules to highlight that the rule cannot apply to plantation forestry activities covered by the NES-PF.
- These plan changes do not require Council to use the public process associated with Schedule 1 of the RMA.

Recommendations

That the Taranaki Regional Council:

1. receives the memorandum on the *Regional plan alignment with the National Environmental Standard for Plantation Forestry*
2. notes NES-PF requirements for the Council to review and amend any regional rules that duplicate or conflict with the NES as soon as practicable after 1 May 2018
3. notes that officers have completed a review of regional rules in relation to the NES-PF and agrees to amend relevant regional plans to ensure alignment with the NES.

Background

National environmental standards are regulations made under the *Resource Management Act 1991* (RMA) that councils must give effect to.

The NES-PF was promulgated on 3 August 2017 and will commence on 1 May 2018. Members will recall that development of the NES-PF is part of a Government response to ensure alignment across councils on rules affecting the forestry sector. The Government anticipates that through a NES-PF they can deliver better protection of the environment and deliver significant savings in compliance costs for 1.7 million hectares of plantation forestry across New Zealand.

The NES-PF applies to foresters throughout New Zealand and directs local authorities (both regional and district) on how they will regulate the environmental effects of plantation forestry. The stated purpose of the NES-PF is to:

- maintain or improve the way New Zealand manages the environmental effects of plantation forestry; and
- increase the efficiency and certainty of managing plantation forestry activities.

The NES-PF defines "plantation forest" or "plantation forestry" as a forest deliberately established for commercial purposes, being at least one hectare of continuous forest cover that has been planted, and has or will be harvested or replanted. It does not apply to trees grown for fruit, nut crops, shelter belts, or nurseries.

THE NES-PF covers eight "plantation forestry activities" over the life cycle of forestry, which are defined and given an activity status. The eight forestry activities are:

1. afforestation (planting new forest);
2. pruning and thinning-to-waste (selective felling of trees that remain on site);
3. earthworks;
4. river crossings;

5. forestry quarrying (extraction of rock, sand, or gravel within a plantation forest or for operation of a forest on adjacent land);
6. harvesting;
7. mechanical land preparation; and
8. replanting.

The NES-PF is by far the most comprehensive NES released to date. Councils will no longer need to develop forestry-specific rules in their plans for those activities covered by the NES-PF or address forestry activities via general plan rules.

The Council is now required by section 44A of the RMA to review current and proposed regional plans to identify any plan rules that duplicate or conflict with the NES-PF, or which deal with the same effects. Any rules that duplicate or conflict with the NES-PF must be removed from the plans, without needing to use the public Schedule 1 process of the RMA, as soon as practicable after 1 May 2018.

Review of Plan alignment with the NES-PF

This Council has four operative RMA plans covering freshwater, land, coastal and air resources in the Taranaki region. In February 2018, the Council also publicly notified its *Proposed Coastal Plan for Taranaki*. At around that time, officers commenced a review of the four operative plans plus the proposed plan for rules that potentially duplicate or conflict with the NES.

Council plans are effects-based rather than activity-focused. Accordingly there are no rules explicitly targeting forestry activities (i.e. forestry specific rules). However, the Council's plans do contain general rules, which apply to a broad range of activities, including forestry. With the promulgation of the NES-PF, regional rules may now duplicate or conflict with NES-PF regulations. This is not allowed unless provided for in the NES-PF as 'stringency rules' (refer to discussion below).

Rules may be more stringent or lenient than the NES-PF where a forestry activity has a different activity status, is subject to different conditions, or both. As identified in Table 1 below, three regional plans – these being the *Regional Air Quality Plan for Taranaki*, the *Regional Freshwater Plan for Taranaki* and the *Regional Soil Plan for Taranaki* – have been identified as containing rules that duplicate or conflict with the NES-PF.

Table 1: Assessment of Plan alignments with the NES-PF

NES-PF activities	Do Plan rules duplicate or conflict with NES-PF?				
	Air Quality Plan	Soil Plan	Freshwater Plan	Coastal Plan	Proposed Coastal Plan
Afforestation (planting new forest)	N/A	N/A	**Yes**	N/A	N/A
Pruning and thinning-to-waste	N/A	**Yes**	**Yes**	N/A	N/A
Earthworks	N/A	**Yes**	**Yes**	N/A	N/A
River crossings	N/A	N/A	**Yes**	N/A	N/A
Forestry quarrying	N/A	**Yes**	**Yes**	N/A	N/A
Harvesting	N/A	**Yes**	**Yes**	N/A	N/A

Mechanical land preparation	N/A	**Yes**	**Yes**	N/A	N/A
Replanting	N/A	N/A	**Yes**	N/A	N/A
Other – slash traps, non indigenous vegetation clearance, discharges, disturbance & diversions	**Yes**	**Yes**	**Yes**	N/A	N/A

For the purposes of this Plan alignment, individual rules (the gateway and associated conditions) were assessed in terms of whether they applied to plantation forestry activities covered by the NES-PF and, if so, whether the rules duplicate or conflict with NES-FP regulations. A rule duplicates or conflicts with NES-FP regulations as follows:

- a rule conflicts with the NES-PF if it is more stringent than the standard and the standard does not expressly provide for a rule to be more stringent;[1]
- a rule conflicts with the NES-PF if it is more lenient; and
- a rule duplicates NES-PF provisions if it addresses any plantation forestry activity regulated by the standard (and is not more stringent or lenient).

Thirty-five rules over three plans – the freshwater, soil and air quality plans – have been identified as duplicating or conflicting with NES-PF regulations. They include four rules in the Regional Air Quality Plan (out of 63), two rules in the Regional Soil Plan (out of two), and 29 rules in the Regional Freshwater Plan (out of 87).

Table 2 below identifies those rules that need to be amended to address duplication or conflict with the NES-PF.

Table 2: Assessment of Plan rules that conflict or duplicate NES-PF regulations

Regional plans	Plan rules that duplicate or conflict with the NES-PF	Comment
Regional Air Quality Plan	Rules 56, 58, 59 and 60	Rules relating to the burning or spraying of agrichemicals on "production land" are covered by Regulation 95 of the NES-PF where they cover non indigenous vegetation clearance activities Of note rules relating to the burning or spraying of agrichemicals of indigenous vegetation on "production land" still apply
Regional Soil Plan	Rule 1 and 2	Vegetation disturbance rules are also covered by NES-PF regulations relating to earthworks, forestry quarrying, harvesting and mechanical land preparation
Regional Freshwater Plan	Rules 18, 19, 20, 21, 23, 24, 25, 26, 27, 52, 53, 54, 55, 56, 57, 59, 61, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, and 76*	A third of the rules in the Freshwater Plan duplicate or conflict with the NES-PF. The NES-PF prevails over these rules Other rules in the Freshwater Plan were determined not to apply to plantation forestry activities or were identified as 'stringency test' rules whereby the NES-PF provides for these rules to prevail over its regulations

* In circumstances where these rules cover activities impacting on wetlands, the rule may still prevail. Refer 'stringency test' discussion below

[1] *A rule does not conflict with the NES-PF where it meets one of the requirements in Regulation 6 (refer to stringency test discussion below).*

In most cases, plantation forestry activities will be governed by the NES-FP (not regional rules). However, there will be occasion, when a regional rule will prevail for forestry activities. This is provided for under section 43B of the RMA and Regulation 6 of the NES-PF and only applies in relation to the Freshwater Plan and in relation to:

- **The Hangatahua (Stony) catchment:** This catchment is identified as an outstanding natural feature and landscape in the *Regional Policy Statement for Taranaki* (RPS) and the *Proposed Coastal Plan for Taranaki*. Accordingly, Freshwater Plan rules in the Hangatahua catchment would prevail over NES-PF regulations where they are more stringent.
- **Wetlands:** Wetlands meet the definition of Significant Natural Areas through Bio Policy 4 of the RPS. According, Freshwater Plan rules relating to wetlands would prevail over NESPF regulations where these rules are more stringent.

Amending regional plans

As a result of the above findings, the Council must now amend relevant plan rules to address the duplication/conflict.

Regional rules duplicating or conflicting with the NES-PF are still retained as they manage non forestry activities. However, amendments to the air quality, soil and freshwater plans are recommended to address the duplication or conflict and give effect to Section 44A(4) of the RMA.

Proposed amendments are as follows:

- amend background information in the freshwater, soil and air quality plans (and any other inconsequential changes) to recognise the NES-PF and note that the regulations generally prevail over any duplicating or conflicting rule;
- amend the 'gateway' to relevant rules in the freshwater, soil and air quality plans to include an advisory note (or similar) that reads as follows; "…*Note: Excludes plantation forestry activities covered by the Resource Management (National Environmental Standard for Plantation Forestry) Regulations 2017*"; and
- amend the 'gateway' to more stringent rules in the Freshwater Plan relating to the Hangatahua catchment (Rules 2 to 14) and wetlands (rules 80 to 87) and which prevail over the NES-PF under Regulation 6. The amendments relate to the inclusion of an advisory note (or similar) to read as follows: "…*Note: Pursuant to section 43B of the RMA and Regulation 6 of the NES-PF, this rule prevails over any requirements under the Resource Management (National Environmental Standard for Plantation Forestry) Regulations 2017.*"[2]

The inclusion of advisory notes in amended plans is not mandatory but is consistent with Ministry for Primary Industries' (MPI) guidance and will help provide clarity to plan users/forestry activities as to whether NES-PF regulations or regional rules prevails.

Pursuant to section 44A of the RMA, the Council must amend its plans or proposed plans to remove any duplication or conflict "…*without using the process in Schedule 1*" and "…*as soon as practicable after the date on which the standard comes into force*." Officers therefore recommend amending the relevant Plan provisions to ensure no plan rules duplicate or conflict with the NES-PF.

[2] *There is no requirements to identify rules that may be more stringent than a national environmental standard under section 43B(1). However, MPI draft guidance recommends that this forms part of the process to identify whether a more stringent rule conflicts with a provision in a NES under 44A(2)(ii) and represents good practice to provide certainty to plan users.*

In due course Council may wish to consider plan changes, to insert new rules of the type that are allowed to be more stringent than the NES-PF. Of note the NES-PF does not regulate some types of effects and some forestry-related activities, such as effects on cultural and historic heritage and the effects of logging truck movements. These continue to fall within the scope of regional and district plan rules.

Other work

The promulgation of the NES-PF means increased consenting and compliance monitoring for forestry activities in the region. As a result Council can expect to be playing a more significant role.

In addition to the Plan alignment exercise, the Council is reviewing existing advisory, monitoring and compliance programmes to ensure they are fit for purpose in relation to forestry under the NES-PF regime.

On 20 March 2018, Council and MPI officials participated in a joint workshop with interested foresters to discuss how the NES-PF will work in practice. To assist councils and the forestry sector with implementing the regulations, MPI are developing guidance resources. Council will work with industry and MPI to develop and disseminate appropriate guidance and educational material on meeting NES-PF requirements in the Taranaki region.

Under the NES-PF, forestry activities are subject to a raft of conditions that must be complied with. Given the subjectivity inherent in some of the permitted activity conditions (e.g. slash and debris management) Council has also redesigned its compliance monitoring and charging regime for forestry activities to ensure environmental effects are being appropriately addressed. The setting and recovery of monitoring costs from the permitted forestry activities was recently confirmed as part of the long term planning process for 2018/2019.

As previously noted, some effects such as the management of adverse effects on cultural and historic heritage are not covered by the NES-PF. Where plantation forestry activities covered by the NES-PF 'trigger' cultural or historic heritage considerations covered by a regional plan, the Council will ensure that these considerations are addressed through the consenting process and in accordance with any arrangements with the relevant iwi authority.

Decision-making considerations

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

Financial considerations—LTP/Annual Plan

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

Policy considerations

This memorandum and the associated recommendations are consistent with the policy

documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Biosecurity Act 1993*.

Iwi considerations

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

Legal considerations

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

Attachment

Document number 2037905: *Plantation forestry rules – gear up for change on May 1.*

Plantation forestry rules

Gear up for change on May 1

Oliver Hendrickson outlines the new national environmental standards for plantation forestry.

In August last year, the Ministry for Primary Industries (MPI) and the Ministry for the Environment launched a new nationwide set of regulations to manage plantation forestry activities.

The National Environmental Standards for Plantation Forestry (NES-PF) will come into force on May 1, this year, replacing the current system where regional and district council plan provisions control forestry activities and associated environmental outcomes.

The lack of nationally-consistent rules has sometimes caused difficulty for the forestry industry. Around 300 forest owners (whose forests account for 80 percent of the nation's plantation estate) have plantations that straddle local government boundaries or manage forests in more than one region of the country.

The nationwide regulations cover core activities in the life cycle of a commercial forest – afforestation, pruning and thinning-to-waste, earthworks, river crossings, forest quarrying, harvesting, mechanical land preparation, and replanting.

Most forestry activities are permitted by the NES-PF provided foresters meet the permitted activity conditions. If not, they will need to apply to council for a resource consent.

The NES-PF recognises there will be instances where it will not be possible to manage locally-significant issues through a set of rules that apply nationally. The regulations allow councils to impose more stringent rules to give effect to the National Policy Statement for Freshwater Management and the New Zealand Coastal Policy Statement and to manage unique and sensitive environments.

Councils will no longer need to develop forestry-specific rules in their plans for activities covered by the NES-PF or include forestry activities under general plan rules. This should reduce the costs of plan development and litigation.

The NES-PF is supported by three tools that assist councils in making decisions as to whether resource consents will be needed.

The **Erosion Susceptibility Classification** divides the New

Zealand landscape into four categories. Land designated as green (low) or yellow (moderate) is considered unlikely to pose a significant risk of erosion and so forestry activities are permitted, subject to the permitted activity conditions in the regulations.

Some forestry activities on land designated orange (high) and red (very high) will require resource consents.

While the tool is not available until May 2018, the database is available to download on the MPI website (see link in the information box).

The **Fish Spawning Indicator** indicates the likelihood of 33 vulnerable freshwater fish species being present in New Zealand waterways and their spawning times.

Again, the tool will not be available until May 2018. The database is available to download on the MPI website (see link in the information box).

Finally, the **Wilding Tree Calculator** allows foresters to work out the risk of the spread of wilding trees from any forest they are planning. Foresters have to supply the results of their calculations to the relevant council and, where the risk score exceeds a certain threshold, afforestation will require a resource consent.

Council can request copies of management plans that the NES-PF requires foresters to draw up for harvesting, erosion and sediment management during forest quarrying, and for earthworks.

For more information

Phone: 0800 00 83 33 (option 3)

Email: info@mpi.govt.nz (with NES-PF in the subject line)

Visit: The MPI website. bit.ly/MPI_NES_PF

Forest owners and operators will need to assess the potential environmental risk of these activities as it relates to their particular site and describe how they will carry out operations to comply with the conditions and avoid, remedy or mitigate these environmental risks.

In some cases, it may not be possible to meet the conditions as laid out in the regulations, or the land may be classified as having a higher environmental risk. In these cases, a resource consent will be required.

It's recognised that council staff in planning, consenting, and monitoring and compliance roles will need time to understand the regulations, how they relate to other rules in their plans and to wider legislation, and to develop systems to use them.

To assist this process, MPI has developed a range of guidance material available on its website (see box). LG

• Oliver Hendrickson is director spatial, forestry and land management at the Ministry for Primary Industries.

Agenda Memorandum

Date 24 April 2018

Memorandum to
Chairperson and Members
Policy and Planning Committee

Subject: **Interim review of the efficiency and effectiveness of the Regional Air Quality Plan for Taranaki**

Approved by: A D McLay, Director – Resource Management

BG Chamberlain, Chief Executive

Document: 2028722

Purpose

The purpose of this memorandum is to introduce the report entitled *Interim review of the Regional Air Quality Plan for Taranaki – Evaluation of appropriateness, efficiency and effectiveness* (the Report).

A copy of the Report is attached to the agenda and gives effect to a *Resource Management Act 1991* (RMA) requirement to compile and make available to the public a review of the results of the Council's monitoring on the efficiency and effectiveness of regional plans.

Executive summary

- The current *Regional Air Quality Plan for Taranaki* (the RAQP) became operative on 25 July 2011. The RAQP addresses 12 issues and contains four objectives, 33 policies, 15 methods, and 63 rules. Its purpose is to assist the Council to carry out its functions under the RMA to promote the sustainable management of the air resource of the Taranaki region.
- Pursuant to sections 35(2)(b) and (2A) of the RMA, the Council must undertake an interim review of the efficiency and effectiveness of its plans every five years.
- The attached Report and interim review process gives effect to that requirement.
- The interim review process has involved a desktop review and analysis of legislative and government policy changes, state of the environment and compliance monitoring data, and other relevant information.
- Key findings of the Report on the effectiveness and efficiency of the RAQP are:
  - state of the environment monitoring confirms that Taranaki has high overall air quality and that the RAQP is achieving its objectives of maintaining that high air quality;
  - Taranaki's air quality is rated overall as 'good' to 'excellent' according to MfE environmental performance indicators;

  - compliance monitoring programmes confirm that 97% of air permit holders routinely achieved a 'high' or 'good' compliance performance;
  - there have been increased levels of poultry farming over the life of the RAQP. Notwithstanding that, Plan provisions have been generally efficient and effective in managing the cumulative effects of that increase with negligible impacts on local air quality;
  - the assessment shows that the RAQP methods are being implemented; and
  - the RAQP is efficient and effective and is delivering benefits that are considered to be substantially greater than its costs.

- Notwithstanding the above, the Report has identified a number of 'change' factors (mainly legislative) where the RAQP potentially could be updated or amended. Council experiences in the implementation of the RAQP have also highlighted areas for further consideration and/or where Plan provisions could be refined or improved.
- None of these change factors are significant enough to warrant an immediate full review of the Plan. Instead it is recommended that these matters be considered and addressed as part of the full review scheduled to occur in 2021 as part of a combined plan process.
- Overall, Taranaki's clean air provides significant health and amenity benefits to the region.

Recommendations

That the Taranaki Regional Council:

1. receives this memorandum and attached report *Interim review of Regional Air Quality Plan for Taranaki – Evaluation of appropriateness, efficiency and effectiveness;*
2. notes that the RAQP continues to be relevant, efficient and effective; and
3. agrees that no immediate changes to the RAQP are required.

Background

Under section 30(1)(f) of the *Resource Management Act 1991* (the RMA), a function of the Taranaki Regional Council (the Council) is to control the discharge of contaminants to air in the region.

The purpose of the *Regional Air Quality Plan* (RAQP) is to assist the Council to carry out its functions under the RMA to promote the sustainable management of the air resource of the Taranaki region. It is the statutory 'rulebook' for the management of air and has effect over the whole region, excluding the coastal marine area.

Section 15 of the RMA restricts the discharge of contaminants into the environment, including into the air. No discharge may contravene a rule in a regional plan or proposed plan, unless the discharge is expressly allowed by a resource consent, or is an existing lawful activity. Discharges from industrial or trade premises are allowed only if they have resource consent or by a rule in a plan. Discharges to air from any other source are regulated only if they are covered by a rule in the RAQP.

In 1997, the Council adopted its first *Regional Air Quality Plan for Taranaki*– the first fully operative air plan in New Zealand. This Plan was subsequently reviewed and a revised Plan adopted in 2011. The second RAQP largely built on the objectives of the previous Plan,

which is to maintain the existing high standard of ambient air quality in the Taranaki region and to improve air quality where it was being adversely affected, while allowing for economic and social well-being.

The RAQP addresses twelve air quality issues:

- degradation of air quality from the discharge of contaminants to air;
- recognition of the air resource as a taonga and protection of wāhi tapu from the intrusion of odour or visual contaminants;
- adverse effects on the environment from the discharge of contaminants to air from –
  - industrial and trade premises (excluding waste management processes, as dealt with separately);
  - waste management processes;
  - site development, earthworks and the application of soil conditioners;
  - aquaculture and intensive farming processes;
  - the discharge of agrichemicals into the air;
  - burning of vegetation on production or on forested land;
  - burning of tyres or untreated used oil;
  - fire training activities or fire safety research or education purposes; and
  - domestic sources of discharges of contaminants to air; and
- recognition of the benefits from activities discharging to air.

To address these issues, the RAQP sets out four objectives, 33 policies, 15 methods, and 63 rules. The two main changes from the previous plan were a prohibition on 'backyard burning' on residential properties in urban areas (outdoor fires excluding hāngī and barbeques); and increased recognition and provision for managing 'reverse sensitivity' impacts (e.g. protecting existing rural activities such as poultry broiler sheds from encroachment by lifestyle development).

A full statutory review of the Council's RMA plans is required within 10 years of them becoming operative. The current version of the RAQP was made operative in 2011 and consequently requires a full review in 2021. However, pursuant to section 35(2)(b) and (2A) of the RMA Council must carry out an interim review (i.e, every five years) to monitor and report on the efficiency and effectiveness of its plan policies, rules and other methods. The attached report gives effect to that requirement.

Effectiveness and efficiency review – purpose, methodology and criteria

This is not a full review of the RAQP, but is an examination of its effectiveness and efficiency. It is a monitoring mechanism for ensuring that RAQP policy is 'on track', that implementation is occurring, and that outcomes sought are being achieved. In the event that policy is not on track, a council can then determine whether immediate changes need to be made to the planning document.

For the purposes of this review, Council officers undertook a desktop review of legislative and government policy changes, state of the environment monitoring information, and other relevant information and datasets to determine the efficiency and effectiveness of the RAQP. The information was compiled in the attached report, which sought to answer three key questions:

1. Are the significant air quality issues identified in the RAQP (there are 12) still relevant (are there any drivers for change and does the RAQP continue to focus on the appropriate regionally significant issues)?
2. Is the RAQP effective and efficient in achieving its purpose of providing for the sustainable management of air resources in the Taranaki region (is it achieving its objectives, are the policies and methods being implemented)?
3. On the basis of the above, are changes to the RAQP required as a matter of urgency (are there any priority areas where additional information and analysis may be required)?

Through the interim review process, the Council is seeking to ensure that the RAQP remains relevant, lawful and appropriate and that it is achieving its purpose in an efficient and effective way. In the event of any deficiencies in the RAQP the Council must consider whether the deficiencies are significant or minor. Depending on the conclusions drawn from the review, the Council can consider and determine whether changes are required now or can wait until the 10-year review of the Plan in 2021.

In deliberating as to the necessity to make immediate changes to the RAQP, Council has had regard to the following criteria (as set out in Appendix III of the attached report):

- The *ongoing relevance* of the RAQP in terms of section 35(2) matters. Part of this assessment will need to include consideration of the:
  - timeliness of any change, particularly in view of any proposed changes in legislation and new or emerging issues; and
  - costs to the Council or resource users.
- The *effectiveness* of RAQP policies in achieving the objectives.
- The *effectiveness* of the RAQP in terms of the clarity and appropriateness of the rules.
- The *efficiency* of the RAQP in terms of its benefits and costs.
- The *effectiveness* of the RAQP in terms of its delivery of the methods of implementation.

The Report

The purpose of the attached Report is to outline the Council's findings on the effectiveness and efficiency of the RAQP. The scope and methodology adopted in the Report is similar to exercises previously undertaken by the Council when assessing the efficiency and effectiveness of the *Regional Policy Statement for Taranaki*, and other Council plans. The Report has also been structured and aligned with sector best practice guidelines set out in the report *Evaluating Regional Policy Statements and Plans – A Guide for Regional Councils and Unitary Authorities (2008)*.[1]

In brief, the Report concludes that the RAQP is performing its functions well and is assisting the Council in carrying out its resource management responsibilities. No issues have so far been identified that would warrant an urgent review.

Key findings are presented in section 7 of the draft Report. They include:

- State of the environment monitoring confirms that Taranaki has high overall air quality and that the RAQP is meeting all its policies and objectives.

[1] *Enfocus Limited*, July 2008.

- State of the environment and compliance monitoring programmes show that Taranaki's air quality is tracking well and is rated 'good' to 'excellent' according to MfE environmental performance indicators.
- Compliance monitoring programmes confirm high levels of compliance with RAQP and consenting provisions – 97% of air permit holders routinely achieved a 'high' or 'good' compliance performance.
- The levels of poultry farming have increased in Taranaki over the life of the RAQP. Notwithstanding that, Plan provisions have been generally efficient and effective in managing the cumulative effects of that increase with a negligible impact on air quality.
- The assessment shows that all RAQP methods are being implemented.
- The RAQP is efficient and effective. An internal analysis of the RAQP shows that it has delivered benefits that are considered to be substantially greater than its costs.
- Overall, Taranaki's clean air provides significant health and amenity benefits to the region.

Section 6 of the Report discusses issues experienced with the implementation of the RAQP, including proposed amendments to existing rules and an evaluation of the urgency for change. Of note, most issues so far identified are relatively minor and/or involve recognising changes in law or government policy.

Section 7 of Report presents the interim review's conclusion, including recommendations.

The interim review has not so far identified cause for making immediate changes to the RAQP. Notwithstanding that assessment, the report does identify a number of 'change' factors (e.g. changes to legislation and government policy, and development of best practice) which have emerged since the adoption of the RAQP, and which should be taken into account as part of the full review scheduled to occur in 2021. The report also identifies a number of areas to improve and build on the current RAQP as part of the next review, including potential for amendments to:

1. Rule 31 (Waste incineration on site);
2. Rule 33: (Combustion of solid waste material generated on production land);
3. Rule 34: (Combustion of waste material in defined urban areas);
4. Rule 40: On-farm liquid waste management processes and the issue of Reverse Sensitivity;
5. Rules 51-54: Discharges from Intensive Poultry Farming Processes; and
6. Rules 56-58: Discharges of agrichemicals into the air;

A number of operational issues were also identified through the interim review that will be considered as part of the next plan review. These related to working with district councils to promote better aligned and effective enforcement of the backyard burning rule and the management of beach bonfires in the CMA (where that has been transferred to the district council), and work with central government to address anomalies in the NES-AQ relating to the licensing of wood burning appliances.

Decision-making considerations

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

Financial considerations—LTP/Annual Plan

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

Policy considerations

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

Iwi considerations

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

Legal considerations

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

Appendices/Attachments

Document #1970757: *Interim Review of the Regional Air Quality Plan for Taranaki*

Interim review of the Regional Air Quality Plan for Taranaki

Evaluation of appropriateness, efficiency and effectiveness

Taranaki Regional Council

Private Bag 713

Stratford

24 April 2018

Document number: 1970757

(THIS PAGE IS INTENTIONALLY BLANK)

Executive summary

Under section 35 of the Resource Management Act 1991 (RMA) the Taranaki Regional Council (the Council) is required to undertake and make available to the public a review of the results of its monitoring into the efficiency and effectiveness of the *Regional Air Quality Plan for Taranaki 2011* (the **RAQP**). This report gives effect to that requirement.

The RAQP was adopted in 2011. It is now timely to carry out an interim review of the RAQP. The purpose of the interim review is to set out the findings of an interim review of the effectiveness and efficiency of the RAQP. Have the outcomes sought been achieved? Did the Council implement what it said it would implement in the RAQP? Finally, do the benefits of having the RAQP outweigh the costs?

The result of the evaluation, which involved an internal review and desktop analysis of the efficiency, effectiveness and appropriateness of the RAQP, shows that the RAQP is standing the test of time well and is assisting the Council in carrying out its resource management responsibilities. Key preliminary findings are:

- State of the environment monitoring confirms that Taranaki has high overall air quality and that the RAQP is on track to meet its objectives (environmental outcomes).
- State of the environment and compliance monitoring programmes show that Taranaki's air quality is tracking well and is rated 'good' to 'excellent' according to MfE environmental performance indicators.
- The assessment shows that the methods for implementing RAQP objectives and policies are been implemented.
- The RAQP is efficient and effective and it has delivered benefits that are considered to be substantially greater than its costs.
- The review has not identified cause for making immediate changes to the RAQP.
- Overall, Taranaki's clean air provides significant health and amenity benefits to the region.

Notwithstanding that, the report also identifies a number of 'change' factors (e.g. changes to legislation and government policy, and development of best practice), which have emerged since the adoption of the second RAQP that could be taken into account as part of the full review scheduled to occur in 2021. The report also identifies a number of areas to improve and build on the current RAQP as part of the next review.

It is recommended that Council, when it undertakes a full review in 2011, investigate amendments to:

1. Rule 31 (Waste incineration on site);
2. Rule 33: (Combustion of solid waste material generated on production land);
3. Rule 34: (Combustion of waste material in defined urban areas);
4. Rule 40: On-farm liquid waste management processes and the issue of Reverse Sensitivity;
5. Rules 51-54: Discharges from intensive poultry farming processes;
6. Rules 56-58: Discharges of agrichemicals into the air; and
7. Implementation issues –
    a. enforcing the ban on backyard burning;
    b. managing beach bonfires;
    c. licensing of wood burning appliances.

(THIS PAGE IS INTENTIONALLY BLANK)

Table of contents

List of figures

List of tables

(THIS PAGE IS INTENTIONALLY BLANK)

1. Introduction

1.1 Purpose

The purpose of this report is to undertake an evaluation of the efficiency and effectiveness of the *Regional Air Quality Plan for Taranaki 2011* (the RAQP), as part of the Taranaki Regional Council's (the Council) non-statutory interim review of that document.

Accordingly, this report:

- examines state of the environment results relating to air quality;
- examines trends in relation to resource consenting, pollution incidents and enforcement action since the RAQP for Taranaki was adopted in 2011;
- assesses the effectiveness, efficiency and suitability of RAQP provisions, including methods and regional rules, in addressing air quality issues, and any disputes over their interpretation;
- assesses the effectiveness of other plan methods (e.g. advice and information) in addressing the issues;
- assesses any implications arising from changes or proposed changes in law and the establishment of any national standards and policies such as amendments to the *Resource Management Act 1991* and national environmental standards;
- assesses whether the RAQP is achieving its purpose of providing for the sustainable management of air resources in the region; and
- on the basis of the above, identifies whether changes to the RAQP are required as a matter of urgency, including any recommendations for change.

1.2 Background

1.2.1 Development of Taranaki's air quality policy

The licensing of discharges to air was once the responsibility of the Ministry of Health but following the enactment of the *Resource Management Act* (the RMA) in 1991 this responsibility was devolved to regional councils. The development of Council's air quality policy commenced shortly thereafter.

Between 1992 and 1994, the Council undertook a detailed and robust process to develop a regional plan that would address widespread and point source discharges of contaminants to air and subsequently released a proposed *Regional Air Quality Plan for Taranaki* in 1995. The RAQP was made operative in 1997 – it was the first fully operative air plan in New Zealand. The Plan was prepared pursuant to section 64 and the First Schedule of the RMA.

The first RAQP was reviewed and a revised Plan adopted in 2010. In the Plan the Council set an objective to –

> *"...maintain the existing high standard of ambient air quality in the Taranaki region and to improve air quality in those instances or areas where air quality is adversely affected, whilst allowing for communities to provide for their economic and social well-being."*

The reviewed RAQP included two main changes from the previous version: a prohibition on 'backyard burning' on residential properties in urban areas (outdoor fires excluding hāngī and barbeques), and provision for 'reverse sensitivity' (protecting existing rural activities such as poultry broiler sheds from encroachment by lifestyle development).

In developing the RAQP, the 14 air quality standards introduced in the Government's national environmental standards were taken into account and given effect to. These non-optional measures included:

- seven activity standards that ban various activities that discharge unacceptable contaminants into the air (landfill fires, burning of tyres in the open, bitumen burning for road maintenance, burning of coated wire in the open, burning of oil in the open, high temperature hazardous waste incinerators, and school/healthcare incinerators unless consented)
- five ambient air quality standards for carbon monoxide (CO), fine particulate (PM_{10}), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and ozone (O_3)
- a design standard for new small-scale domestic wood-burning appliances, and the prohibition of discharge from certain woodburners
- a requirement for landfills over one million tonnes of refuse to collect greenhouses gas emissions.

Like the first RAQP, no Environment Court hearing process was required with issues being resolved through the engagement process. The second RAQP drew on the comprehensive state of the environment monitoring programmes put in place by the Council prior to, but more substantially subsequent to, the adoption of the first Plan.

1.2.2 The Regional Air Quality Plan for Taranaki

The second RAQP was made operative on 25 July 2011. It sets out how our air resources should be managed into the future, and impacts on how people, businesses, and industry use, develop and protect Taranaki's resources. District plans must not be inconsistent with a regional plan for any matter specified in section 30(1) of the RMA (section 75(4)(b) RMA).

The over-riding purpose of the RAQP for Taranaki is to assist the Council to carry out its functions under the RMA to promote the sustainable management of the air resource of the Taranaki region.

Issues

Twelve air quality issues are identified in the RAQP. These being:

1. Degradation of air quality from the discharge of contaminants to air;
2. Recognition of the air resource as a taonga and protection of wāhi tapu from the intrusion of odour or visual contaminants;
3. Adverse effects on the environment from the discharge of contaminants to air from industrial and trade premises (excluding waste management processes, as dealt with separately);
4. Adverse effects on the environment from the discharge of contaminants to air from waste management processes;
5. Adverse effects on the environment from the discharge of contaminants to air from site development, earthworks and the application of soil conditioners;
6. Adverse effects on the environment from the discharge of contaminants to air from aquaculture and intensive farming processes;
7. Adverse effects on the environment from the discharge of contaminants to air from the discharge of agrichemicals into the air;
8. Adverse effects on the environment from the discharge of contaminants to air from burning of vegetation on production or on forested land;
9. Adverse effects on the environment from the discharge of contaminants to air from burning of tyres or untreated used oil;
10. Adverse effects on the environment from the discharge of contaminants to air from fire training activities or fire safety research or education purposes;
11. Adverse effects on the environment from domestic sources of discharges of contaminants to air; and
12. Recognition of the benefits from activities discharging to air.

Objectives

Four objectives are identified in the RAQP for air quality in the Taranaki region:

1. To maintain the existing high standard of ambient air quality in the Taranaki region and to improve air quality in those instances or areas where air quality is adversely affected, whilst allowing for communities to provide for their economic and social wellbeing.
2. To safeguard the life-supporting capacity of air throughout the Taranaki region.
3. To provide for activities discharging to air.
4. To avoid, remedy or mitigate the adverse effects of activities discharging contaminants to air in the Taranaki region, including adverse effects on the amenity and aesthetic qualities of air.

To address the issues and implement the objectives, the RAQP includes policies and methods of implementation, together with regional rules.

The RAQP uses a combination of regulatory and non-regulatory methods (such as the preparation and development of guidelines and other advice and information) to protect and maintain the region's generally excellent air quality.

Rules

The regional rules of the RAQP have the force and effect of a regulation under the Act. The rules permit, control or prohibit air discharge activities depending upon the scale and significance of the adverse effects associated with particular activities, and the need to ensure measures are adopted to avoid or minimise those effects of concern. The rules classify activities according to the following categories:

(a) **Permitted activities**: activities that may be carried out through a rule in the Plan, without resource consent, subject to their compliance with any conditions prescribed in the rule, e.g. discharge of agrichemicals or burning of vegetation on production or forested land.

(b) **Controlled activities:** activities that may be carried out, through a rule in the Plan, with resource consent that must be granted by the Council, subject

to the activity complying with standards and terms set out in the rule[1].

(c) **Restricted discretionary activities**: activities that may only be carried out if resource consent is obtained. The Council may decline or grant resource consent for this type of discretionary activity. The Council will exercise its discretion in accordance with Section 104 of the Act including consideration of the objectives and policies in the Plan.

(d) **Discretionary activities**: activities that may only be carried out if resource consent is obtained. The Council has the discretion to grant or decline a resource consent application for this type of discretionary activity and, depending upon the rule, impose conditions on the consent.

(e) **Prohibited activities**: activities that the Plan expressly prohibits, e.g. discharges to air from the burning of metal cables, motor vehicles, tyres and untreated waste oil.

The RMA also provides for 'non-complying activities'. Non-complying activities are activities that are not prohibited but which otherwise contravene or fall outside the scope of a rule in the Plan (and for which the Council has the discretion to grant or decline the consent application). However, there are no regional rules in the RAQP for Taranaki that allow for non-complying activities.

Under the RAQP all major industrial, trade and agricultural activities that discharge contaminants to air are addressed through regional rules. **Appendix I** summarises the arrangement of rules in the Plan according to discharge source or activity. Depending upon the scale and significance of the effects associated with the discharge source or activity, differing standards, terms and conditions are applied.

Methods of implementation

The RAQP contains 15 methods of implementation. For the purposes of this review, the methods have been grouped according to the following broad themes:

1. Applying regional rules to allow, regulate or prohibit activities.
2. Applying policies and section 104 of the RMA (see section 3.1 below) when granting discharge to air permits or the conditions of such a permit.
3. Requiring applicants for discharge to air permits to adopt the best practicable option to prevent or minimise adverse effects.
4. Consulting with iwi and hapū regarding identification of places of special cultural and traditional value associated with the air resource.
5. Providing advice and information, including guidelines, to landowners, resource users, and the public.
6. Supporting and promoting the preparation and adoption by sector groups of guidelines and certification programmes.
7. Working with the poultry growing industry to reduce the effects of broiler operations on air quality.
8. Monitoring and gathering information.
9. Receiving and responding to public complaints.
10. Implementing and promoting effective integrated management of air quality issues with territorial authorities.
11. Applying and contributing to the monitoring of national environmental standards for air quality.
12. Advocating to relevant agencies.
13. Providing information on the location of electricity transmission networks.
14. Encouraging the installation of cleaner heating methods and appliances and increases in home energy efficiency
15. Defining a Port Air Zone to provide boundaries for controlling the effects of air emissions in the coastal marine area at Port Taranaki.

1.3 This review

Under the RMA, a full review of the RAQP must be commenced within 10 years of it becoming operative. The current RAQP is therefore due for full review in 2021.

In the interim, under section 35(2)(b) of the RMA, Council must monitor the efficiency and effectiveness of policies, rules, or other methods in their regional plans. Monitoring results are also set out in the regular state of the environment monitoring reports[2]. Section 35(2A) of the RMA (refer **Appendix II**) further requires that the Council compiles and makes available to the public an interim review of the results of its monitoring of the efficiency and effectiveness of its regional plan policies, rules or other methods.[3]

[1] In effect, controlled activities are permitted, the Council cannot refuse consent), and subject only to Council discretion regarding those controls specified in the Plan. This allows the Council flexibility to deal with those activities that it considers should be permitted but which the Council feels there should be some discretion to imposed appropriate conditions on a case-by-case basis.
[2] Taranaki Regional Council, 2015, *Taranaki as One; Taranaki Tangata Tu Tahi State of the Environment Report 2015*.
[3] Reviewing the effectiveness of policy is an important component of resource management, completing the circle of policy development, delivery of that policy through methods, monitoring the outcomes of delivering that policy and taking appropriate actions to deliver on the policy.

This report, amongst other things, gives effect to that requirement and summarises the findings of a review on the efficiency and effectiveness of the RAQP.

Through the interim review process, the Council is seeking to ensure that the RAQP remains relevant, lawful and appropriate and that it is achieving its purpose in an efficient and effective way. In the event of any deficiencies in the RAQP the Council must consider whether the deficiencies are significant or minor.

If the deficiencies in the Plan are significant, changes to the RAQP may need to be made immediately as a matter of urgency, i.e. half way through the 'life' of the Plan. If the deficiencies in the RAQP are relatively minor then any changes can wait until the Council undertakes a full review in 2021. **Appendix III** of this report sets out the criteria by which the Council will consider making changes to the Plan. The criteria include consideration of the issues, lawfulness, clarity, practicality and affordability, efficiency, equity and section 32 duties including the risk of acting or not acting.

1.3.1 Assessment criteria

In deliberating as to the necessity to make immediate changes to the RAQP, Council has had regard to the following criteria:

- The ongoing relevance of the RAQP in terms of section 35(2) matters. Part of this assessment will need to include consideration of the:
  - timeliness of any change, particularly in view of any proposed changes in legislation and new or emerging issues (refer sections 3 and 6 below); and
  - costs to the Council or resource users.
- The *effectiveness* of RAQP policies in achieving the objectives (refer section 4 below).
- The *effectiveness* of the RAQP in terms of the clarity and appropriateness of the rules (refer section 5.1 below).
- The *efficiency* of the RAQP in terms of its benefits and costs (refer section 5.2-5.4 below).
- The *effectiveness* of the RAQP in terms of its delivery of the methods of implementation (refer section 5 and Appendix V below).

This report summarises and is underpinned by comprehensive state of the environment monitoring undertaken by the Council.

1.3.2 Assessment methodology

The methodology for assessing the effectiveness and efficiency of the RAQP is similar to those previously undertaken by the Council. The methodology is also based on best practice guidelines set out in the report *Evaluating Regional Policy Statements and Plans – A Guide for Regional Councils and Unitary Authorities*.[4]

This report seeks to answer three key questions:

1. Are the significant air quality issues still relevant in 2018 (are there any drivers for change and does the RAQP continue to focus on the appropriate *regionally significant issues*)?
2. Is the RAQP effective and efficient in achieving its purpose of providing for the sustainable management of air resources in the Taranaki region (is it achieving its objectives, are the policies and methods being implemented)?
3. On the basis of the above, are changes to the RAQP required as a matter of urgency (are there any priority areas where additional information and analysis may be required)?

To answer these questions the Council undertook:

1. A desktop review of legislative and government policy changes, state of the environment information, and other relevant information.
2. The preparation of this report, which compiles the results of that monitoring, including the Council's findings and will be made available to the public.

As noted above, a desktop review of the state of the environment information and Council databases was undertaken. Assessment of the effectiveness of the policies towards achieving the RAQP objectives was based largely upon the Council's *Taranaki as One; Taranaki Tangata Tu Tahi State of the Environment Report 2015*[5].

1.4 Structure

The report is divided into seven sections, as follows:

Section 1 (this section) introduces the purpose, background, methodology and structure of the report.

Section 2 summarises the context of the review, including the current state of air quality in the Taranaki region and the current legislative and policy context.

Section 3 identifies legislative change factors.

Section 4 examines the effectiveness of the RAQP's objectives and policies.

[4] Enfocus Limited, July 2008.
[5] *Read the report by clicking on the following link: https://www.trc.govt.nz/council/plans-and-reports/environmental/state-of-the-environment-report-2015/*

Section 5 examines the efficiency of RAQP implementation, including the costs and benefits.

Section 6 identifies implementation issues arising from the review including potential for future inclusion of additional matters, and evaluation of the urgency for change.

Section 7 presents the conclusions on the efficiency and effectiveness of the RAQP.

Appendices are presented at the back of the report. The appendices set out the arrangement of rules according to discharge source or activity, and the legislative requirement to undertake an interim review under section 35 of the RMA, the criteria for review of the RAQP, *Regional Policy Statement for Taranaki 2010* provisions relating to reverse sensitivity, and a summary of progress in respect of implementing RAQP methods.

2. Context of review

2.1 The current state of air quality in Taranaki

The combination of a windy and exposed environment, a dispersed and small population, relatively light industry and a low number of vehicles means that the overall quality of air in the Taranaki region is excellent. As there are no significant pressures upon the quality of air in the region the focus of the RAQP and its rules are generally on maintaining and, at specific locations, enhancing air quality.

Taranaki is one of only two regions in New Zealand that have never exceeded national air quality standards. For that reason we have never been required to create a 'gazetted airshed' (a defined body of air within a specific locality) to address air quality issues. Continued demonstration of excellent air quality means that, unlike other regions in the country, National Environmental Standard monitoring is not compulsory in Taranaki.

Most emissions to air in Taranaki are diffuse emissions from natural sources: from vegetation, land cover, farm animals and sea-spray drift. They also come from industry, homes, and motor vehicles.

Point source discharges (from a single large source) are more obvious than diffuse emissions and come from industry, land development, and farms with housed livestock (such as piggeries and poultry sheds).

The potential effects of air emissions range from amenity effects (such as haze, smoke, or offensive odours) to potential or actual negative impacts on human and ecosystem health. For example over time, increased levels of poultry farming have resulted in increased resource consents for air discharges in the region. However, effective regulations promoting best practice, together with monitoring to enforce conditions, mean there has been a negligible impact on local air quality.

2.2 Current legislative and policy context

2.2.1 Resource Management Act

Section 15 of the RMA restricts the discharge of contaminants into the environment, including discharges of contaminants from any industrial or trade premises into air, unless the discharge is expressly allowed by a rule in a regional plan, any relevant proposed regional plan, a resource consent, or regulations.

Discharges to air from places that are not industrial or trade premises (including farmland, residential properties and all moveable sources) are allowed, unless a rule in the RAQP or other regional plan provides otherwise.

Of note air discharges in the coastal marine area (CMA) are addressed separately by the Regional Coastal Plan.

2.2.2 National policy statements and environmental standards

National policy statements (NPSs) and environmental standards (NESs) are issued by the government to provide direction to local government on matters of national significance.

National environmental standards (NES) are regulations that prescribe standards for environmental matters, to ensure consistency. Issued under section 43 of the RMA, they can apply regionally or nationally (although all current national environmental standards apply nationally). Each regional, city or district council must enforce the same standard. In some circumstances, and where specified in the NES, councils can impose alternative standards.

NPSs and NESs that may be of relevance to the RAQP are outlined below.

2.2.3 NES for Air Quality Regulations

The *National Environmental Standards for Air Quality* (NES-AQ)[6] are regulations made under the RMA, which aim to set a guaranteed minimum level of health protection for all New Zealanders in respect of air quality.

The NES-AQ covers the field of air pollutants, dioxins and other toxins. The standard restricts the lighting of fires or burning of waste at landfills and the burning of other pollutants, and establishes minimum air quality standards applied to airshed boundaries. These standards are to be implemented by regional councils (or unitary authorities) under regional plans. When the maximum pollution levels are reached, remedial action may be considered and no further consents for harmful emissions may be granted.

If a standard allows, regional plans may impose stricter air pollution standards, and may include rules that prohibit the installation of open fireplaces in urban properties.

Emissions from motor vehicles are not covered by the standards directly, but may be regulated under traffic rules and vehicle performance standards.

The NES-AQ came into effect on 8 October 2004. The standards are made up of 14 separate and interlinked standards (see section 1.2.1 above).

Regional councils and unitary authorities are responsible for managing air quality under the RMA national environmental standards. They are required to identify areas where air quality is likely, or known, to exceed the standards. These areas are known as airsheds.

In June 2009 the regulations relating to Particulate Matter of a certain size – PM_{10} – were reviewed to address concerns about the perceived stringency of the ambient standard, the lack of equity for industrial air pollution sources, and difficulty in achieving the original target timeline of 2013. The standards were revised and the amended Regulations came into force on 1 June 2011. These have been consolidated into the NES-AQ.

2.2.4 NES for Electricity Transmission Activities Regulations

The *(National Environmental Standards for Electricity Transmission Activities) Regulations 2009* (NES-ET) applied nationally from 14 January 2010.

The NES-ET sets out a national framework of permissions and consent requirements for activities on existing high voltage electricity transmission lines. Activities include the operation, maintenance and upgrading of existing lines.

The NES-ET does not apply to the construction of new transmission lines or substations.

Regulations 25–27 of the NES-ET are relevant to air quality because they relate to permitted, controlled, and restricted discretionary activities in relation to discharges from blasting and applying protective coatings to transmission line support structures.

The requirements of the NES-ET are in addition to those given in this Plan. The NES-ET contains rules that apply to Electricity Transmission Activities and if any of those rules duplicate those in the RAQP, the relevant rules in the RAQP do not apply.

2.2.5 NES for Plantation Forestry

The National Environmental Standards for Plantation Forestry (NES-PF) was published on 3 August 2017 and will commence on 1 May 2018.

The NES-PF aims to maintain or improve the way New Zealand manages the environmental effects of plantation forestry while also increasing the efficiency and certainty of managing plantation forestry activities.

The NES-PF regulations apply to any forest of more than 1 hectare that has been planted specifically for commercial purposes and harvesting. It does not apply to trees grown for fruit, nut crops, shelter belts, or nurseries.

Eight core plantation forestry activities are covered, these being:

- afforestation (planting new forest);
- pruning and thinning;
- earthworks;
- river crossings;
- forestry quarrying;
- harvesting;
- mechanical land preparation; and
- re-planting.

Most forestry activities are permitted by the NES-PF as long as foresters meet specific conditions to prevent significant adverse environmental effects, including dust.

For forestry related activities covered by the NES-PF, regional rules will not apply unless provided for by Regulation 6 of the standards.

[6] The title of these Regulations, previously "Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins, and Other Toxics) Regulations 2004" was amended, as from 1 June 2011, by regulation 4(1)(a) Resource Management (National Environmental Standards for Air Quality) Amendment Regulations 2011 (SR 2011/103) by substituting "for Air Quality" for "Relating to Certain Air Pollutants, Dioxins, and Other Toxics".

2.2.6 Medical Officers of Health and Health Protection Officers

The Taranaki District Health Board also contributes to air quality objectives in the RAQP through the provisions of the *Health Act 1956*.

Under section 123 of the *Health Act* the District Health Board is the default agency to conduct any sanitary work pursuant to this Act, if the local authority fails to start or complete this work.

In Schedule 2 of the *Health Act*, there is a responsibility to notify the Medical Officer of Health (MOH) of any infectious or communicable disease. This includes a chemical poisoning incident that could become a public health issue as a result of, for example, an agrichemical spraying operation.

2.2.7 National Ambient Air Quality Guidelines

The purpose of the *National Ambient Air Quality Guidelines 2000* is to promote sustainable management of the ambient air resource in New Zealand and to provide guidance on the management of air quality under the RMA. The Guidelines apply only to ambient air outside buildings or structures, and not to indoor air or air in the workplace.

Guideline values are the minimum requirements that outdoor air quality should meet in order to protect human health and the environment. While the Guidelines are not legislative requirements, the Council accords them weight as a technical reference document which represents the best applied scientific knowledge. The Guidelines were last reviewed in 2002.

2.2.8 Other statutes and regulations

The provisions of the RAQP do not replace other legislation, regulations or bylaws relating to air quality. These may include legislative requirements, regulations or bylaws made by the New Plymouth, Stratford or South Taranaki District Councils under the *Local Government Act 1974*, *Local Government Act 2002*, or otherwise under the *Health Act 1956*, the *Forest and Rural Fires Act 1977*, or the *Hazardous Substances and New Organisms Act 1996* (HSNO).

2.2.9 Hazardous Substances and New Organisms Act 1996 (HSNO)

All entities involved in the transporting, storing, handling, or management of dangerous goods and hazardous substances are required to comply with the provisions of HSNO. All users (from home users to major industry), including storage and transport companies, and waste treatment and disposal companies, need to comply with the controls set by the Authority on each hazardous substance that it deals with.

Compliance may include having to get a test certificate if the substance or substances are highly hazardous or if there are large quantities. Handlers of highly hazardous substances need to get certification from a test certifier who has been approved by the Environment Protection Authority.

3. Legislative change factors

There have been some changes to the legislative context since the current RAQP was made operative in 2011. This section examines potential change factors in relation to the ongoing relevance of the RAQP.

3.1 RMA amendments

Since the RAQP was adopted in 2011, the RMA has been amended a number of times.

The *Resource Management Amendment Act 2013*- :

- Made changes to the resource consent regime.
- Create a streamlined process for Auckland's first unitary plan.
- Set a six-month time limit for processing consents for medium-sized projects.
- Create easier direct referral to the Environment Court for major regional projects.
- Set up stronger requirements for councils to base their planning decisions on a robust and thorough evaluation of the benefits and costs.

In 2017 the Government enacted the *Resource Legislation Amendment Act*. This Act contains reforms that comprise substantive, system-wide changes to the resource management system. Key changes of relevance to the RAQP include:

- Councils have the ability to charge for monitoring of activities permitted by a NES. However Councils will not be able to charge financial contributions under the RMA (from 5 years after Royal Assent).
- A national planning template that aims to improve the consistency of RMA plans and policy statements, reduce complexity, and improve the clarity and user-friendliness of plans. The national planning template provisions will be mandatory after 5 years from Royal Assent (i.e. by 2022).
- A statutory obligation on councils to invite iwi to form an iwi participation arrangement that will establish the engagement expectations when consulting during the early stages of the Schedule 1 plan-making process. This obligation aims to improve consistency of iwi engagement during plan development.
- Other minor process improvements concerning the waiving of resource consents for marginal or temporary rule breaches, fixing of fees for resource consents, and changes to requirements around public notices and service of documents.

The above amendments have not so far required Council to amend the current RAQP but will have implications when a full review is required. Further significant changes to the RMA are anticipated over the next couple of years that may also have implications when it is due for its full review – scheduled to occur in 2021.

3.2 Proposed amendments to the NES for Air Quality

In March 2015 the Parliamentary Commissioner for the Environment requested that the National Environment Services-Air Quality (NES-AQ) be amended to include a standard for particular matter $PM_{2.5}$.

The Government is currently developing amendments to the NES-AQ, which are intended to address $PM_{2.5}$ and reflect improved scientific understanding on health impacts. This amendment process is tentatively due to be completed in 2018/2019, but this is subject to prioritization by the new Government. The Government will seek submissions from the general public, iwi, regional councils, and air quality practitioners once a discussion document is released for consultation.

Of note, the Council already conducts monitoring for $PM_{2.5}$ and results are well within the World Health Organisation (WHO) guideline of 25µg/m^3 over an average of 24 hours.

3.3 Effect of key change factors

As outlined above, there are a number of legislative 'change' factors that have emerged since the adoption of the RAQP in 2011. However, a review of these change factors has not identified any new or emerging issues that warrant immediate changes to the RAQP.

Other issues that have arisen since 2011 and may require changes to the Plan are discussed in Section 6 of this report.

Notwithstanding the above, when preparing the next RAQP Council will take the aforementioned Government reviews, strategies, and initiatives (plus other change factors) into account where they are relevant to the purpose of the RAQP.

4. Are the objectives and policies effective?

As indicated earlier in this report, the RAQP contains four objectives for air quality in the region. They are:

1. To maintain the existing high standard of ambient air quality in the Taranaki region and to improve air quality in those instances or areas where air quality is adversely affected, whilst allowing for communities to provide for their economic and social wellbeing.
2. To safeguard the life-supporting capacity of air throughout the Taranaki region.
3. To provide for activities discharging to air.
4. To avoid, remedy or mitigate the adverse effects of activities discharging contaminants to air in the Taranaki region, including adverse effects on the amenity and aesthetic qualities of air.

This section examines, compiles and presents state of the environment monitoring results relevant to each objective, together with qualitative assessments where necessary.

In relation to each objective, the effectiveness or otherwise of the RAQP five years on in terms of achieving or working towards its objectives is evaluated and assessed as:

- **Achieved** – objective is being achieved across the broad range of environmental indicators.
- **Generally being achieved** – objective is largely being achieved. Monitoring results and this assessment indicates generally positive trends and outcomes across most (but not all) environmental indicators.
- **Partially being achieved** – monitoring results and this assessment has identified mixed positive and negative results across the range of environmental indicators. Negative results indicate significant risk that elements of the RAQP objective may not be achieved.
- **Not achieved** - objective is not being achieved across the broad range of environmental indicators.

4.1 Objective 1: Maintaining and improving ambient air quality

Air quality data has been gathered and maintained for more than 20 years at up to 20 representative sites, including urban, industrial, rural, coastal and pristine areas. Screening methods are also used to monitor air quality at locations that have the most potential for adverse impacts as a result of surrounding land use. Consistently good results from the air quality monitoring programme confirm that the screening approach is justified and cost-effective.

The Council looks at key indicators of ambient air quality, including inhalable particulates; chemicals such as nitrogen oxides, benzene, carbon monoxide, sulphur oxides and formaldehyde; and suspended particulates and deposition. Visibility is also monitored.

The Council also monitors air quality as part of resource consent compliance programmes to ensure resource consent conditions are met in industry and agriculture and also in residential areas (for activities such as backyard fires).

The Council undertakes further regular testing of air quality in areas determined to be 'worst-case scenario' checkpoints, such as urban areas of high traffic flow. In this way, we can monitor trends to ensure that activities are continuing to have no or acceptable adverse effects, and that the high quality of air in the region is being maintained.

Using Ministry for the Environment (MfE) environmental performance indicators for air, Taranaki's air quality is rated overall as 'good' to 'excellent' across various measures of quality at the region's representative monitoring sites, including built-up areas and areas of high vehicular use[7]. Some minor localised issues have occurred from time to time, but otherwise no major issues have been identified. An explanation of MfE's environmental performance indicators for air is provided in Table 1 overleaf.

Result: Objective 1 is being achieved

[7] *Taranaki as One; Taranaki Tangata Tu Tahi State of the Environment Report 2015*.

Table 1: MfE environmental performance indicator categories for air quality

Category	Measured value	Explanation and Action
Action	More than 100% of the National Environmental Standard (NES) or alternative guideline value	Exceedences of the guideline are a cause for concern and warrant action if they occur on a regular basis. Action requires achievement of the guideline value within shortest possible timeframe and comprehensive investigation and monitoring.
Alert	Between 66% and 100% of the NES or other guideline value	This is a warning level, which can lead to exceedences if trends are no curbed. Action requires further reduction where practicable and monitoring.
Acceptable	Between 33% and 66% of the NES or other guideline value	This is a broad category where maximum values might be of concern in some sensitive locations, but are generally at a level that does not warrant dramatic action. Action requires maintenance, reduction where practicable, and periodic monitoring.
Good	Between 10% and 33% of the NES or other guideline value	Peak measurements in this range are unlikely to affect air quality. Action requires maintenance
Excellent	Less than 10% of the National Environmental Standards guideline value	Of little concern. Action requires maintenance and occasional monitoring.

4.2 Objective 2: Safeguarding the life-supporting capacity of air

Objective 1 and 2 are inter-related. However, for the purposes of this report, Council examines in greater detail the constituent parts of air quality that contribute to safeguarding the life supporting capacity of air in Taranaki.

4.2.1 Particulate matter (PM_{10})

One aspect of air quality the Council measures is PM_{10} (airborne particulate matter of less than 10 micrometres in diameter per cubic metre of air) emissions. PM_{10} emissions come from sources such as burning coal, oil, wood, petrol and diesel in domestic fires, transportation and industrial processes and from natural sources, including sea salt, dust, pollens and volcanic activity. PM_{10} is associated with health issues ranging from respiratory irritations to cancer.

The NES for PM_{10} is 50 micrograms per cubic metre ($\mu g/m^3$) over a 24-hour average period. The NES allows one sample per site to exceed this limit per year.

Surveys in the CBD (2010) and at Port Taranaki (2012) found that the majority of the results were within the Ministry's 'Excellent' or 'Good' categories and the remainder met the 'Acceptable' category (refer Figure 1). To ensure a 'worst-case' air quality scenario, sites with high traffic movements and marine influences were chosen. The CBD survey was undertaken between two main roads close to the foreshore. Similarly, the Port Taranaki survey site was subject to heavy vehicles and marine influences. No survey results entered the 'Action' category, meaning no result exceeded the NES of 50 $\mu g/m^3$.

Traffic flows were found to have no discernible effect on particulate matter emissions. However, onshore winds

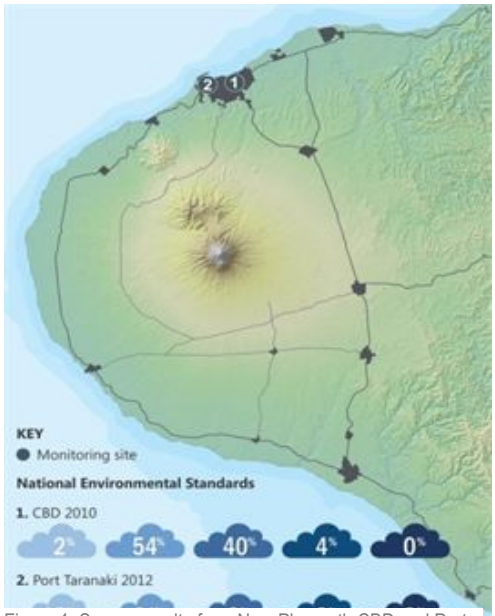


Figure 1: Survey results from New Plymouth CBD and Port Taranaki

were found to be a major influence upon air quality, with airborne salt causing PM_{10} concentrations to double.

Elsewhere in New Zealand, the highest PM_{10} results occur in winter, as a result of wood and coal use for heating and traffic-related emissions. This is not the case in Taranaki because there is a comparatively low use of solid fuels and the exposed environment means less periods of calm weather in winter.

4.2.2 Particulate matter ($PM_{2.5}$)

The Council also measures $PM_{2.5}$ concentrations around the region. These finer particles, commonly derived from

incomplete combustion, pose a greater public health risk than PM_{10}.

The Government is currently developing amendments to the NES-AQ, which will require regional councils to monitor $PM_{2.5}$ and reflect improved scientific understanding on health impacts (refer section 2.2.3 above).

State of the environment monitoring results over the life of the RAQP for $PM_{2.5}$ confirms concentrations are well within World Health Organisation guidelines of 25µg/m^3 over an average of 24 hours.

4.2.3 Nitrogen oxides (NO_x)

Nitrogen oxides (NO_x) are a group of gases that typically comprise mainly nitric oxide (NO) and nitrogen dioxide (NO_2), and a small proportion of nitrous oxide (N_2O).

Nitrogen oxides are produced from soil, vegetation and other natural sources, as well as motor vehicles and other fuel combustion processes. Indoor domestic appliances such as gas stoves or unflued gas heaters can be significant sources of nitric oxide and nitrogen dioxide. These gases can accumulate, particularly in poorly ventilated areas. It is widely accepted that nitrogen dioxide can aggravate asthma and reduce lung defences against bacteria.

As part of its state of the environment monitoring, since 1997 the Council has surveyed nitrogen oxides at seven sites throughout the region (refer Figure 2). In this programme, passive absorption discs that capture target gases are placed at each site. Samples gathered are then analysed by an external party and the results converted to the equivalent exposures for a one-hour period. Unsurprisingly, the highest concentrations are found in the urban environment (sites 4 and 5 in New Plymouth city). Another eight sites in the region are monitored as part of consent compliance programmes.

Concentrations at all state of the environment monitoring (SEM) sites since that time have been well within the relevant NES values, with no observable upward trend. Five (80%) of the SEM sites monitored were consistently within the 'Excellent' category of the MfE Environmental Performance indicator, with nitrogen oxide concentrations less than 10 µg/m^3.

In a 2011–2012 survey, the Council monitored Fonterra's Whareroa dairy factory generation plant and Downer EDI's asphalt and bitumen plant as part of its industrial consent compliance monitoring. Results found that NO_x concentrations at Fonterra were comparable with monitoring sites located near major roads and the Downer site was also well within NES guidelines. The highest result of this survey (24.7 µg/m^3) was from a busy traffic intersection in New Plymouth and was still well below limits.

Overall, 97% of results from all Council monitoring in 2015/16 have been within the Ministry's 'Good' or 'Excellent' categories in the environmental performance indictor table. This is consistent with previous years.

These results indicate that NO_x levels are consistently well below the limits posed by the National Environmental Standard and there is no evidence that concentrations in the region are increasing.

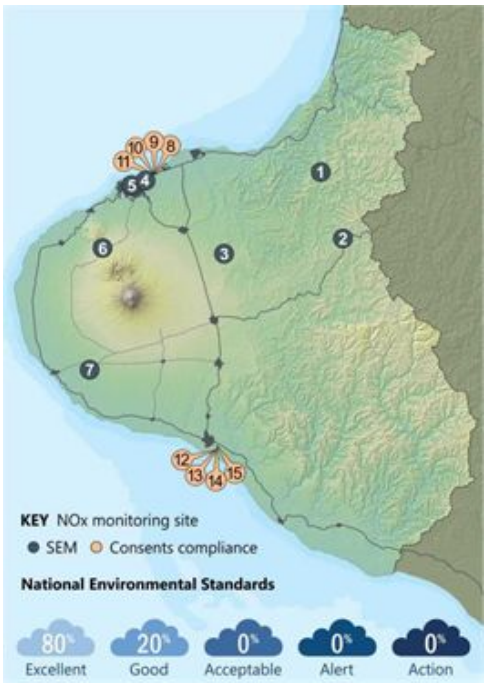


Figure 2: Monitoring results for SEM and consents compliance

4.2.4 Volatile organic compounds (VOCs)

The Council also monitors air quality for gases that are classified as volatile organic compounds or VOCs. The four most common VOCs are benzene, toluene, ethylbenzene and xylenes—often found together and referred to as BTEX. These volatile gases occur naturally as a component of crude petroleum and vegetable oils (in small amounts). They are also produced during the combustion of organic matter such as petroleum products. Other common sources of exposure are solvents (including paints and glues), petrol and diesel fuels.

Short-term or acute exposure to high levels of BTEX components has been associated with skin and sensory irritation, central nervous system depression and adverse effects on the respiratory system. Prolonged or chronic exposure to high levels of these compounds can affect the kidney, liver and blood systems. Studies by the United States Environmental Protection Agency show long-term exposure to benzene can be carcinogenic for humans.

In April 2012, the Council conducted an air quality survey to monitor BTEX at four sites in Taranaki: two in New Plymouth city urban area, with one near a busy traffic intersection (site 2). One site was at a gas production station (site 3). These sites represented localities with potentially 'worst case' public exposure. As demonstrated in Figure 3 all results from the 2012 survey were within the recommended National Ambient Air Quality guidelines (2000).

Levels of toluene and xylene were found to be far below National Ambient Air Quality guideline values. All toluene and xylene results fell into the MfE 'Excellent' air quality category. Three of the four benzene results were within the MfE 'Acceptable' category and one result fell within the 'Good' category.

The Council also monitors for VOCs around significant potential sources, such as gas production stations, as part of consent compliance programmes. Results always fall well within guideline values.

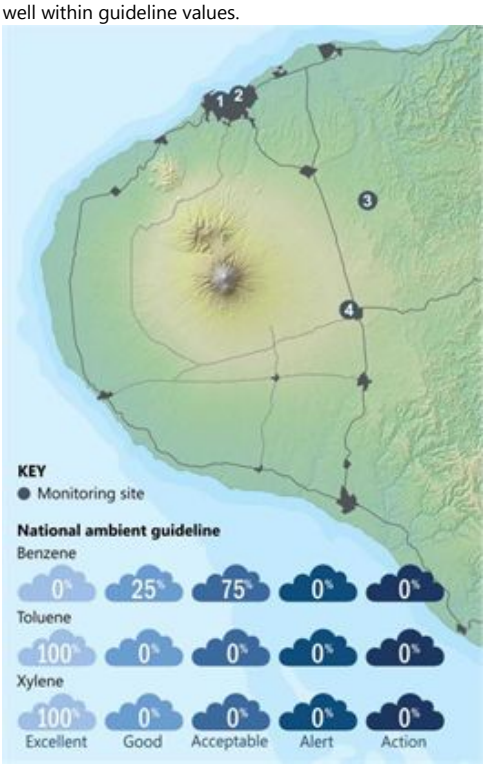


Figure 3: VOC monitoring results

4.2.5 Carbon monoxide

Carbon monoxide (CO) is the result of incomplete fossil fuel combustion. For example, it comes from motor vehicle emissions and from burning wood or coal for home heating or industrial purposes.

In high concentrations carbon monoxide can cause dizziness or aggravate heart conditions. It can be fatal. In New Zealand, the NES for carbon monoxide is 10 mg/m^3 (calculated as an eight-hour average).

A one-month survey of carbon monoxide concentrations in New Plymouth in 2012 met the NES, with monitoring showing low levels of CO in the area most of the time.

The Council also undertakes routine consent compliance monitoring for carbon monoxide in Taranaki around significant potential sources such as gas production stations. Results never reach more than a trivial level of either the National Ambient Air Quality guidelines or NES guideline values and are reported publicly in individual annual monitoring reports.

4.2.6 Hydraulic fluid flaring

Hydrocarbon exploration operations can include hydraulic fracturing, or 'fracking'[8]. Fracking fluids are generally recycled or disposed of off-site. However sometimes, for the safety of workers or equipment, disposal via a flare is required. The process of 'flaring' involves combusting and vaporising the recovered fluids into the air.

Previous examination of the effects of flaring on air quality at well sites found that beyond 100 metres downwind of a flare, there was no elevation of risk to public health over normal everyday exposure. However with increased fracturing activity in Taranaki, and in response to public concerns, the Council decided to undertake further investigations to evaluate fracking air emissions in 2012-2013.

These investigations tested emission and ambient air samples collected both at and downwind of a flare in the process of combusting/vaporising recovered fluids. The samples were tested for particulate matter; dioxins and furans; polyaromatic hydrocarbons; aldehydes; volatile organic compounds and methanol. Other measures of the combustion process (oxygen, carbon dioxide, carbon monoxide, nitrogen oxides, and sulphur dioxide) were also investigated. Results showed:

- no elevation of dioxins or furans concentrations
- PM levels at or below those generally found throughout the region
- polyaromatic hydrocarbon levels lower than those found in central city areas

[8] Fracking is a well stimulation technique used to increase the flow of hydrocarbon fluids to the surface by pumping fluids down at pressures sufficient to fracture the reservoir rock, propping open the fracture with permeable material, and capturing the fluids (which sometimes contain produced hydrocarbons) that flow back to the surface.

- volatile organic compounds (including benzene), aldehyde and methanol levels well within Ministry for the Environment guidelines
- no trace of carbon monoxide, and minimal levels of the other conventional products of combustion.

The design and implementation of the investigation projects were independent of any influence or direction from the exploration and production companies and were subject to external peer review.

The results of the study are consistent with others overseas and have demonstrated that, even if hydrocarbon production in the region was to expand significantly, public health would not be compromised. The full report can be found online at www.trc.govt.nz/hydraulic-fracturing/.

Result: Objective 2 is being achieved

4.3 Objective 3: Providing for activities to discharge to air

In the three years either side of the adoption of the first RAQP in 1997,[9] nearly three-quarters of the major air discharge consent holders upgraded their emissions control or production technology to improve the quality of their discharges to air. Further, through the resource consents process, and with through general advice and advocacy, the Council has continued to promote on-going improvements to emissions control or production technology in the region.

A total of 294 air discharge consents were issued between 2011 and 2017, making up 10.3% of the total number of consents processed by Council (2,853) in that time.

Just over half of the air discharge consents (155) are related to the Hydrocarbon (Oil and Gas) industry. A further quarter (75) relate to the Poultry industry. Abrasive Blasting (15) and Power Generation (eight) are the next highest number of consents issued, followed closely by Meat and By-products Processing and the Piggery Industry air discharge consents, at seven consents each. Crematoria and Dairy Processing sites are the next largest, with four consents.

The remainder of air discharge consents relate to Asphalt/Bitumen processing; Chemical Processing and Manufacture; Distribution/Storage of Fertiliser; Earthworks; Landfill; Metal Processing; Petrochemical Processing; Sewage Treatment; and the Timber and Wrecking industries.

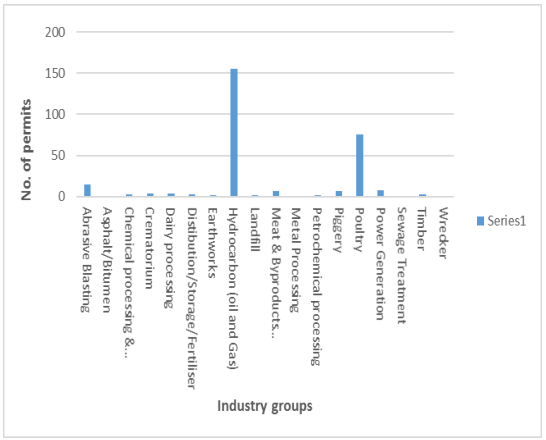


Figure 4: Number of air discharge permits held by industry

The volatility of export markets for oil and gas has contributed significantly to decreasing air discharge consent numbers since 2011. Rising from 25 air discharge consents in 2010/11 to 98 in 2013/14, Hydrocarbon air discharge consents have decreased again to 20 in the 2016/17 year.

For further information on consenting please refer to section 5.1 below.

Result: Objective 3 is being achieved

4.4 Objective 4: Avoiding, remedying, or mitigating adverse effects on air

4.4.1 Compliance monitoring results

In the early years of the RAQP, the Council undertook regular monitoring of representative monitoring sites and monitored discharges to air from large or complex consented point sources that have the potential for significant adverse effects on air. Once it was identified that Taranaki has consistently excellent air quality by national and international criteria, the number of general air quality investigations were reduced. However there are a range of tests related to air quality that the Council continues to conduct at consented sites.

More recently the Council has integrated the timing of the State of the Environment (SEM) and compliance monitoring programmes in respect of NO^x measurements, and has implemented continuous $PM^{2.5}$ measurements at a new SEM site. Officers survey air quality at specific sites including:

[9] 1992-1996 and 1997-2001.

- Bell Block Bypass (PM_{10}, $PM_{2.5}$, NO_x, CO, BTEX)
- Vickers to City Upgrade Project (PM_{10}, $PM_{2.5}$, NO_x, CO, BTEX)
- Port Taranaki (PM_{10}, $PM_{2.5}$)
- Permanent continuous $PM_{2.5}$ monitoring site at New Plymouth Central School
- Fourteen sites covering all industrial area across the region (NO_x, PM_{10}, CO).

Compliance monitoring confirmed that in 2015/16, 97 % of air permit holders routinely achieved a 'high' or 'good' performance based upon a rating system adopted by the Taranaki Regional Council to grade a resource consent holder's overall environmental performance and compliance (refer Table 2).

Result: Objective 4 is being achieved

Table 2: Council rating system for compliance monitoring

Grading category	Explanation
High	Where there are essentially no adverse environmental effects to be concerned about, and no, or trivial, lack of compliance with conditions (eg, a deadline for delivery of results or a contingency plan missed by a few days).
Good	Where the adverse environmental effects of activities during the year were negligible or minor at most. Any issues of concern were resolved positively, cooperatively, & quickly. No unauthorised incidents were recorded or abatement notices issued. Perhaps some items were included on inspection notices for attention but these items were not deemed urgent or critical, and subsequent follow-up showed they had been addressed.
Improvement desirable	Indicates that unauthorised incidents were recorded or an abatement notice issued. There may have been several instances involving moderate to significant adverse environmental effects or other matters arising from activities that required intervention by Council. There may have been matters that took some time to resolve or remain unresolved at the end of the period under review.
Poor	Indicates a significant or serious non-compliance issue to the extent that further enforcement action might be considered.

5. Efficiency of the RAQP

Reviewing the efficiency of the RAQP, at its simplest, is a measure of whether outcomes sought have been achieved at a reasonable cost. That is, does the delivery of the RAQP, its methods of implementation, represent value for money?

Assessment of whether RAQP methods have been implemented is based upon Council's Long Term Plan reporting and state of the environment monitoring.

This section assesses–

- the RAQP's methods of implementation:
- The benefits of the RAQP; and.
- The cost of the RAQP in terms of administrative, compliance and broader economic costs.

A summary of progress in implementing the RAQP methods is contained in **Appendix V**.

5.1 Implementation of the RAQP

The implementation of the RAQP has streamlined the resource consents process resulting in reduced costs and increased certainty for resource users. Set out below is an explanation of how improvements in the resource consents process have improved efficiency.

5.1.1 Regional rules

Like other regional plans, the RAQP includes rules that are used to regulate or allow activities that have potential to result in significant adverse environmental effects on air resources. The rules also increase efficiency because they provide certainty to resource users, limiting the time and cost of resource consent applications.

For activities that have little or no environmental effect, the RAQP has rules 'permitting' the activity without the requirement, and cost, of obtaining resource consent. Permitted activities are still required to meet certain conditions dealing with the prevention or mitigation of adverse effects (refer section 5.1.2 of this report).

In circumstances where the conditions of the permitted rule cannot be met, resource consent is required. Resource consent is also required for activities having more than minor adverse effects.

Since the second generation RAQP became operative in 2011, 297 air discharge consents have been processed, issued, monitored, and reported upon (refer section 5.1.3 of this report).

In addition to the conditions related to specific permitted and consented activities detailed in the RAQP, the Council assesses the effects of air discharges on a case-by-case basis when considering resource consent applications. To regulate the potential effects on the environment, all air discharge resource consents are granted with consent conditions.

This activity implements **Methods 1, 2, 3 and 4** of the RAQP.

5.1.2 Permitted activities

Through the implementation of the RAQP, air discharge activities having no or very little environmental effect have been identified through the regional rules and those activities are now 'permitted', without the requirement (and cost) to obtain resource consent.

There are currently 63 regional rules in the RAQP pertaining to the discharge of contaminants to air from a wide range of industrial, trade and agricultural activities. 31 (or 50%) of these rules permit air discharge activities[10]. Notwithstanding their permitted status, permitted air discharge activities must comply with the conditions prescribed in the rule. If they cannot, a resource consent is required for that activity.

In 2013/14, the failure of a number of activities to comply with the conditions of a permitted activity rule resulted in this Council undertaking prosecutions in the Environment Court.

A review of the permitted activity rules in the RAQP demonstrates that in the main these rules adequately target activities that have little or no adverse effects – so long as they comply with the conditions prescribed in the rule.

5.1.3 Air discharge permits

Air discharge permits make up 7% of current resource consents processed by the Council in 2016/17. As at 30 June 2017, the total number of air discharge consents held in Taranaki was 348. This is an increase of 10% since 2011, when there were 315 resource consents.[11].

In recent years, due to a slow-down in oil and gas activity in the region, there has been a decrease in the number of air discharge consents for emissions from hydrocarbon

[10] 26 (or 41%) of the regional rules in the RAQP require air discharge activities to obtain a resource consent with the remaining 6 (or 9%) being prohibited because of unacceptable adverse environmental effects.
[11] As per statistics maintained by Council officers.

exploration and servicing facilities – from 206 in 2013/2014 to 155 in 2016/17.

Overall, the number of resource consents held for emissions from industry such as landfills (dust, odour, landfill gas) and from chemical and metal processing (odour) has remained the same since 2010/2011.

The number of air discharge permits granted by the Council for each year since 2011 is shown in Figure 5. In any one year the figure includes new permits, variations to current permits, renewals of permits, and reviews. Over the life of the RAQP the number of air discharge permits granted ranged between 20 and 98. However, typically it is in the order of 30 to 40 air discharge permits granted per annum.

Piggeries and poultry farms accounted for almost 28% of all air discharge permits granted in the 2016/17 year.

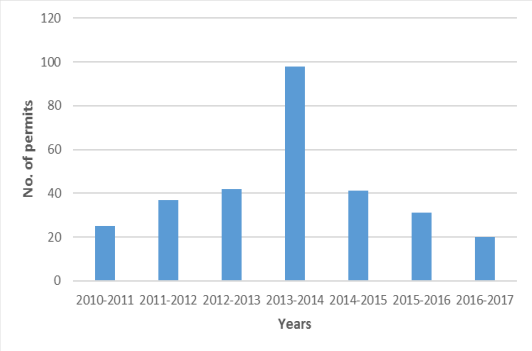


Figure 5: Number of air discharge permits granted

5.1.4 Notification of air discharge permits

In the years following initial implementation of the RAQP, one of the most significant benefits to arise was a reversal in the proportion of air discharge permits notified under the RMA. This has achieved significant savings to the Council and resource consent applicants with respect to the time taken and costs associated with processing resource consent applications.

The regional rules in the RAQP effectively minimise the need for the Council to publicly notify most air discharge permit applications it receives. As indicated in Figure 4 below, the proportion of air discharge permits that do not have to be notified has generally stayed high over time. The proportion of permits limited notified or non-notified has ranged from 92% in the 2010/2011 year to 100% in the 2016/2017 year.

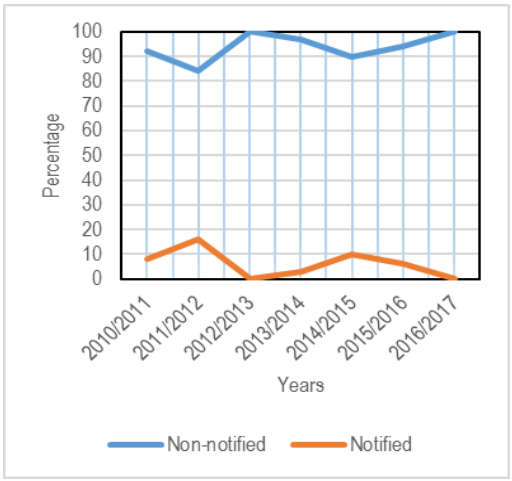


Figure 6: Proportion of non-notified and notified air discharge permits granted per annum

The implications of whether an air discharge permit is notified or non-notified are significant to applicants, particularly in relation to the time and cost of processing the application. Between the 2014/15 and 2015/16 the average cost charged to an applicant for processing a non-notified air discharge permit was approximately $1,955 (although there is some variation in costs depending on the complexity of the consent). However, the cost charged to an applicant for a notified air discharge permit is significantly more, with the average at $12,061.[12]

Consultation is required for both notified and non-notified applications. The added costs incurred for notified applications are primarily due to the greater complexity of the issues related to the air discharge permit, which leads to more time (and associated costs) required by Council to publicly notify the application, liaise with the applicant, prepare and process relevant reports, attend pre-hearing meetings, address submitters' concerns, conduct hearings and such like.

5.1.5 Iwi/Hapū involvement in consents issued

Method 4 of the RAQP states that the Council will –

Consult with iwi and hapū with regard to the identification of places of special cultural and traditional value associated with the air resource, with the aim of ensuring these values are recognised and provided for in the resource consent process and, where appropriate, these places and values are adequately protected from the adverse effects of activities.

In practice, this method is implemented by way of Iwi/Hapū involvement in the consenting process. Since 2011, an average of 14 air discharge consent consultations per year have included Iwi and hapū. The average

[12] Figures based upon a record of the costs for applications granted or under appeal 1 July 2014 to 30 June 2016 as maintained on the Council database IRIS.

percentage over that time is 33% of air discharge consents. These figures compare to an average of 94 consultations and 31% of consents for other types of consents (excluding dairy discharges 2011/12 to 2015/16).

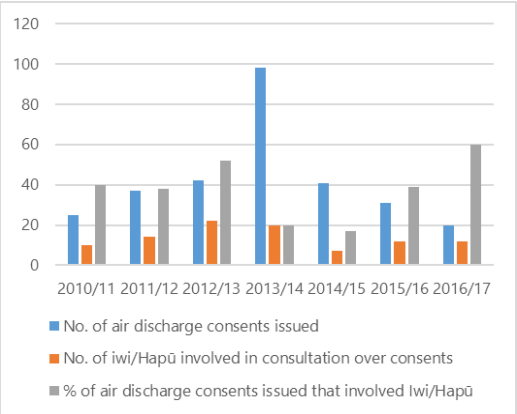


Figure 7: Iwi/Hapu involvement in consents

5.1.6 Enhanced certainty as to outcomes

Since the adoption of the RAQP, resource users have benefited economically through enhanced certainty as to the outcome of their air discharge permit applications. Business consent holders, in particular, have security and certainty of operation in the region due to the consistent return on their capital and operating expenditures by way of permitted air discharge activities.

Prior to the first RAQP becoming operative, all air discharge activities were a discretionary activity whereby consent applications were considered on a case by case basis with no certainty as to whether the Council would grant or decline the application or the conditions and standards that might be imposed. With the adoption of the current Plan, and the continued inclusion of regional rules specifying some air discharge sources or activities to be controlled activities, consent applicants can be certain that their application will be granted subject to conditions.

Figure 7 shows the number and type of air discharge permits granted since 2010. Sixteen percent of the air discharge permits granted under the RAQP since 2010 have been classified as controlled activities.

Under a controlled activity classification the Council cannot refuse consent and the consent can be subject to only those conditions and on those matters Council has specified in the Plan. Industries most likely to have air discharges authorised as controlled activities were for activities such as abrasive blasting, hydrocarbon industry (oil and gas), earthworks, and landfills.

Fifty-three percent of air discharge permits granted were classed as discretionary activities and 30% as restricted discretionary.[13] Restricted discretionary and discretionary permits need to be considered on a case-by-case basis because of the size and significance of the activity or potential effects. Industries most likely to be classed as either discretionary permit type were abrasive blasting, earthworks, meat and by-product processing industries, piggeries and poultry industries.

This activity implements **Method 1**of the RAQP.

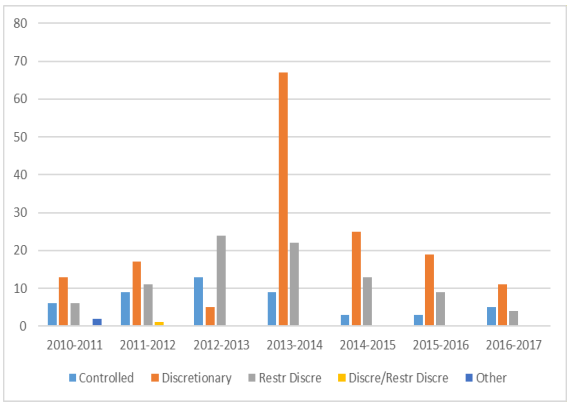


Figure 8: Controlled vs Discretionary Consents

5.1.7 Resource consent monitoring

When the Council grants resource consent for a significant activity, it implements an annual compliance monitoring programme to ensure the consent holders meet the conditions set out in the consent. These conditions usually relate to the manner of operation, the quantity and quality of the discharge, and the permitted extent of effects in the receiving environment. In the 2016/2017 year, the Council undertook 22 individual resource consent monitoring programmes that had an air quality monitoring component (See Table 3 below). Sites included sewage plants, petrochemical and petroleum production facilities, landfills, composting sites, dairy processing and manufacturing factories, metal smelting and galvanizing plants, meatworks, fertiliser storage, pig and poultry farms, quarries and abrasive blasters.

This activity implements **Methods 1, 2, 3, 5, 6, 9 and 13** of the RAQP.

[13] One consented activity (representing 0.3% of air discharge permits) was approved as a combined restricted discretionary/discretionary consent.

Table 3: Number of resource consent monitoring programmes with air quality component since 2011

2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18
23	22	24	24	21	20	20	22

5.1.8 Other consenting performance measures

Statutory timeframes

Along with the more streamlined resource consents process, the Council's performance in the processing of resource consents within statutory timeframes also improved with the RAQP.

The RMA sets out timelines under which regional councils should process air discharge permits. The statutory timeline for processing a non-notified air discharge permit is 20 working days. Since March 2015, for notified applications without a hearing, it is 60 working days. For Limited Notified applications with a hearing it is 100 working days, and it is 130 working days for a Public Notified application[14].

In 2016/2017 the Council processed 100% of all consent applications within statutory timelines. This high performance is attributable, amongst other things, to increased certainty and clarity with respect to what policies, conditions and other matters are considered by Council for particular consent applications.

Of interest is the Council's performance in relation to other local authorities. As it does annually, in 2016/2017 MfE surveyed all territorial and regional authorities in relation to their compliance with statutory timelines for processing consents under the RMA (refer Table 5 below). That survey indicated that the Council compared extremely favourably with the national average. In 2016/2017, the national average for compliance with RMA timelines was 96%, compared to 100% for the Council.

Section 92 applications

Another indicator of Council efficiency, through less delays in the processing of resource consents, is that the Council made less use of section 92 of the RMA to request further information. In 2015/2016, the Council utilised the section 92 provisions for only 0.8% of all air discharge consent applications, compared with 11% for other types of resource consent applications. Again this compares favourably with MfE's national average, which showed 36% of councils utilised the section 92 provisions (and took more time) to request further information for resource consent applications.

Pre-hearing meetings

Both before and after the adoption of the RAQP the Council, as a matter of policy, utilised the pre-hearing provisions of the RMA to avoid and/or reduce the length of costly hearings. In 2016/2017, the Council held pre-hearing meetings for only five notified air discharge consent applications for which submissions were received in opposition (note that not all notified consent applications necessarily result in submissions). The pre-hearing process resolved 100% of submitters' concerns to the extent that no formal hearing was necessary.

Appeals

There have been no successful references (appeals) to the Environment Court against Council's decisions on air discharge permits over the life of the RAQP. Equally important, the Council received no complaints from applicants regarding the time taken to process their applications. Indeed, many applicants for consent renewals seek extensions of time to allow valued pre-hearing meeting processes to run their course.

This activity implements **Methods 1, 2, 3, 5, 6, 11 and 13** of the RAQP.

5.1.9 Incidents investigated

The Council records the number of complaints received from the general public on air quality including complaints of odour. In the 2016/2017 year, the Council recorded 131 air incidents, accounting for 24% of the total incidents reported in that year.

The majority of air quality complaints relate to offensive odour. Complaints about air quality and odour arose mostly from dairy farms, fertiliser storage or distribution; meat and by-product processing; and sewage treatment. Fourteen of the air incidents were unsourced. Burning of materials and vegetation accounted for 29 incidents alone.

The number of air incidents reported in any given year has fluctuated over the past five years, from 217 incidents in 2011/2012, to 325 incidents in 2013/14, and back down to 131 incidents in 2016/2017. This is largely attributed to problems and complaints attributed to odour from backyard burning that year.

[14] These times can be extended for further information [section 92], waiting for affected parties' approval [section 94], and/or other reasons [sections 37(1) and 37(5A)], with or without the approval of the applicant.

All complaints are investigated and enforcement action is taken where appropriate. However, a complaint does not necessarily constitute further action and in some cases, investigation can find a complaint to be unsubstantiated. In the 2016/2017 year, the Council issued four abatement notices and three infringement notices relating to air quality incidents. No prosecutions were undertaken in the 2016/17 year.

Air quality incidents, make up, on average, 36% of all pollution incidents reported to the Council between 2011 and 2017.[15] Odour incidents make up approximately 23% of all air quality incidents reported to the Council over that time period. Other air quality incidents include complaints about dust, smoke and spray drift etc.

The number of complaints received by the Council each year is highly variable (272 or 50% in 2016/17 compared to 372 or 65% in 2015/16).

This activity implements **Methods 1, 2, 3, 5, 6, 8, 9, 12 and 13** of the RAQP.

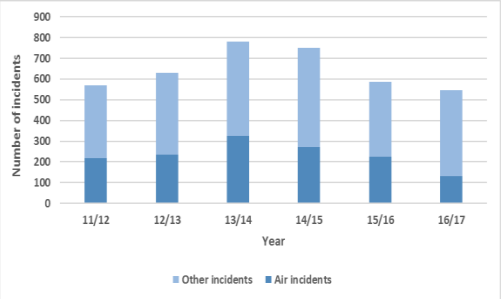


Figure 9: Air quality complaints 2011 to 2017

5.1.10 Enforcement and Prosecution

There have been few problems associated with the enforcement of the regional rules. In relation to enforcement, the Council has increasingly looked to utilise enforcement provisions such as abatement notices, infringement notices and prosecution action to address significant air quality incidents.

In addition to punitive actions involving abatement and infringement notices and prosecutions to enforce compliance, the Council has also required a number of activities that would otherwise be permitted to obtain resource consent, because they were breaching the conditions allowing them to operate as a permitted activity.

Resource consents conditions specifically address odour or other air quality concerns and regular monitoring undertaken by the Council ensures those conditions are being complied with. Unfortunately, there are times when monitoring or resource investigations require further action, and on the rare occasion prosecution is warranted. In the 2013/2014 year, the Council brought two cases relating to air quality (odour) before the courts. One prosecution related to odour from a waste water treatment plant and one from a grain store. Both sites were situated in urban areas. Both prosecution actions were successful.

No infringement notice issued by the Council in respect of air quality has been overturned.

This activity implements **Methods 1, 2, 3, 5, 6, 9 and 13** of the RAQP.

Table 4: Enforcement actions for air quality incidents over time[16]

	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
No. of unauthorised incidents	217	234	325	271	226	131
No. of abatement notices	6	8	19	11	10	4
No. of infringement notices	13	22	33	21	15	3
No. of prosecutions	0	0	2	0	0	0

[15] All public complaints received by the Council, and breaches of discharge permit conditions notified by the permit holder or discovered by Council officers are recorded on the Unauthorised Incidents Register.
[16] As per data maintained by the Council.

5.1.11 Information, education and advice

The Council provides information and advice to the public relating to air quality in the region.

Highlights since 2011 include:

- producing a guide to the requirements of the RAQP for all farmers in the region. The guide covers effluent disposal, burning, spraying, fertiliser applications and pig and poultry farming
- inclusion of information on air quality in the Council's *Environmental Management Guide* for businesses and industries
- 2012 distribution of a flier to all households in Taranaki providing information on the ban of backyard burning in the urban areas of Taranaki, together with advice and guidance on how to dispose of household waste.

This activity implements **Methods 5, 6, and 13** of the RAQP.

Figure 10: Information produced by the Council on backyard burning ban and disposal of household waste.

In summary all methods set out in the RAQP have been actioned.

5.2 Costs of the RAQP

Costs associated with the administration and implementation of the RAQP are those incurred by the Council, (i.e. administration costs) and the wider community, (i.e. compliance costs and broader economic costs).

5.2.1 Administration costs

Administration costs are the costs incurred by Council to implement the methods of the RAQP.

Council has evaluated and rated the administration costs associated with RAQP as low. There are regulatory costs, associated with the consideration and issuing of consents, compliance monitoring and enforcement. Pursuant to the Council's charging policy, the consenting and administrative cost incurred by the Council are charged back to the applicant on a full cost recovery basis.

The non-regulatory methods of the RAQP include consulting with iwi and hapū, providing advice and information, supporting and promoting guidelines and certification programmes, working with various sector groups, and implementing and promoting effective integrated management with territorial authorities. These methods are an important but relatively minor investment (in scale) by the Council.

Other administration costs incurred by the Council include policy and planning costs associated with the preparation, monitoring and review of the RAQP (including state of the environment reporting), responding to public enquiries on its provisions, research into air quality issues and management, and general advocacy.

Overall administration costs (both regulatory and non-regulatory) are low in comparison with the net environmental benefits of maintaining Taranaki's high overall air quality. All administrative costs are publicly considered and tested on an annual basis through the Long Term Plan process and on other occasions through a full review of the RAQP.

5.2.2 Compliance costs

Compliance costs are the costs incurred by resource users to comply with RAQP provisions (e.g. costs associated with applying for consents and undertaking physical works to comply with consent conditions, through requirements to modify their practices and equipment, and/or other RAQP provisions).

Table 7 sets out the air consent costs for Taranaki for the last four financial years. While total costs are often increased by large industry consents and notified applications, median costs are more reflective of applicant costs in general. As approximately 98% of this Council's consent applications are non-notified, the median price of a consent is relatively low. Overall, therefore, compliance costs have been assessed as moderate.

Table 5: Taranaki consenting costs

Year	2013/14	2014/15	2015/16	2016/17
Total Costs	$92,362	$121,640	$47,341	$39,228
Median	$654	$1626	$1317	$1749

Section 104(1) [Consideration of applications] of the RMA requires consent authorities to have regard to any relevant provisions of the Regional Policy Statement when considering resource consent applications and any associated submissions. However, as the RAQP gives effect to the RPS there are no added compliance costs associated with meeting RPS provisions.

5.2.3 Broader economic costs

Broader economic costs refer to the potential for costs associated with the RAQP, as a regional plan, constraining production and innovation or resulting in the sub-optimal allocation of resources.

The standards, terms and conditions set out in the RAQP's rules and in the Council's resource consent process are generally consistent with industry standards and best practice. The evaluation to date has not identified any issues where the RAQP has unnecessarily constrained production and innovation, constrained resource use, or resulted in the sub-optimal use of resources.

5.2.4 Summary of the economic costs of implementing the RAQP

A summary of the economic costs of implementing the RAQP is set out in Table 5 below.

Table 6: Assessment of the costs of implementing the RAQP

Type of costs	Measures	Evaluation			Comments
		Low	**Moderate**	**High**	
Administrative cost **(costs incurred by Council to administer the RAQP & implement non-regulatory methods)**	Added costs incurred by Council to deliver regulatory methods	√			Overall administrative costs have been assessed as low. The cost of implementing the RAQP's methods principally relate to the administration, monitoring and enforcement of rules. Most of these costs are recovered from the resource user. Other costs are associated with delivery of non-regulatory methods such as advice and education, advocacy and liaison, and state of the environment monitoring.
	Costs incurred by Council to deliver non regulatory methods	√			
	Planning costs incurred by Council to develop, monitor and review RAQP	√			
Compliance costs **(costs incurred by resource users to comply with RAQP provisions)**	Added consenting and other costs charged to resource users		√		Overall compliance costs incurred by resource users remains relatively low. On average, 42 air discharge permits are granted per annum with approximately 94% of applications being non-notified.
Other economic costs **(broader costs associated with RAQP constraining production & innovation, or resulting in the sub–optimal allocation of resources)**	Constraints limiting resource users' flexibility to achieve environmental results anticipated	√			No issues so far identified. RAQP provisions generally consistent with industry best practice & should not unnecessarily constrain production, new entrants or resource use flexibility. Only six rules out of 63 rules prohibit any form of discharges to air.
	Production constraints placed upon targeted sectors	√			
	Constraints limiting new entrants to a sector / industry, or limiting resource use flexibility	√			
	Constraints through a lack of certainty to resource users about what they can do & how they manage resources	√			
Overall economic cost of RAQP provisions					**LOW**

5.3 Benefits of the RAQP

The benefits of the RAQP are the environmental outcomes outlined in Section 4 [Effectiveness of the RAQP] above. These benefits are considered to be considerable and ongoing.

Unsustainable air resource use can have (and historically has had) significant adverse environmental and economic costs through increased health risks and degradation of amenity and cultural values. However, over the last decade, state of the environment monitoring confirms generally positive trends. Taranaki has good health-supporting air quality as assessed against national and international air quality guidelines. Its clear air – air which has no vehicle smog or chronic evening smoke haze – has high amenity value.

In addition to its positive environmental outcomes, the RAQP has enabled appropriate use of air resources and has not unnecessarily restricted activities.

As stated in section 5.1.6, the benefits of the RAQP also include increased certainty and clarity to resource users, who have benefited economically through enhanced certainty as to the outcome of their air discharge permit applications. As noted elsewhere, the RAQP rules effectively minimise the need for the Council to publicly notify most air discharge permit applications it receives. The implications of whether an air discharge permit is notified or non-notified are significant to applicants, particularly in relation to the time and cost of processing the application.

In addition, just under half (31 out of 63) of the RAQP rules are for permitted activities. A further 11 of the rules are for controlled activities, which means that consent applicants can be certain their application will be granted subject to conditions.

The high number of non-notified, permitted, and controlled activities gives business consent holders consistent returns on their capital and operating expenditures.

5.4 Comparing the benefits and costs of the RAQP

Monetising all benefits and costs is impracticable. While it is possible to quantify costs to Council of implementing programmes (although not necessarily in monetary terms), it is less easy to quantify community and land occupier costs. It is even harder to quantify the monetary value of the environmental outcomes achieved. Assessing the RAQP has necessarily relied on a combination of qualitative and quantitative evaluation.

Table 10 summarises the results of the Council's assessment of the benefits and costs of the RAQP. In brief, the RAQP has been assessed as being very efficient with the benefits being substantially greater than the cost.

Table 7: Summary of the benefits and costs of the RAQP

Benefits **(Summary from cost effectiveness assessment)**	Costs **(Summary from cost estimation)**
Environment (outcome) benefit **No air quality issues** **High ambient air quality**	**Administrative costs** Administrative costs include the cost of implementing the RAQP's rules, including regulatory costs associated with the consideration and issuing of consents, compliance monitoring and enforcement. Non-recoverable administrative costs incurred by the Council in administrating the RAQP principally relate to policy and planning costs associated with the preparation, monitoring and review of the RAQP (including state of the environment reporting) and the implementation of non-regulatory methods. Overall, administrative costs have been assessed as low.
	Compliance costs Implementation costs incurred by resource users have now largely fallen away. As approximately 98% of this Council's consent applications are non-notified, the average price of a consent is relatively low. Overall compliance costs have been assessed as moderate
Other benefits Protection of air resources and associated values, while also avoiding, remedying and mitigating adverse effects associated with resource use	**Economic costs** Few constraints on resource users in terms of RAQP constraining production and innovation, or resulting in the sub–optimal allocation of resource
Summary Benefits of RAQP assessed as high. Environmental monitoring shows overall quality of air in the Taranaki region is excellent.	**Summary** Costs and constraints associated with RAQP administration and implementation have been assessed as low overall.
Conclusion	
The RAQP has a positive ratio of benefit to cost	
This conclusion is based on Council's assessment that: • The RAQP is meeting its objectives. This assessment has not identified any objectives that were not being achieved. In relation to the maintenance of the quality of our air, state of the environment monitoring indicates that Taranaki is on track in terms of data trends. • The administrative costs associated with the consenting and enforcement regime are moderate, with minimal costs on resource users. The costs of implementing non-regulatory methods are moderate and the costs are minor in comparison to the environmental outcomes being achieved.	
The efficiency of the RAQP is regarded as: **High (the benefit is substantially greater than the cost)**	

6. Discussion of implementation issues arising

Council staff have undertaken an evaluation of the RAQP to identify any issues relating to the scope or interpretation of regional methods and rules. This review has noted that the Plan is, in the main, very effective and efficient in maintaining and in some cases improving Taranaki's good air quality and has not identified major deficiencies in the methods or rules or in the standards, terms and conditions as they are currently drafted.

Notwithstanding that, the review has identified some minor areas where, with the benefit of experience and evolving best practice, the methods and rules could be improved, sharpened or made more comprehensive, or alternatively, where discussions with other parties could assist or enhance implementation. Having regard to the criteria for review outlined in Appendix III, the benefits of undertaking those changes at this point would not outweigh the cost. Instead it is suggested that these areas be identified and addressed when the lifespan of the RAQP is reached, i.e. in 2021. Sections 6.1 – 6.3 below discuss potential improvements to implementation highlighted by this interim review, including recommended amendments to the RAOP. Section 6.4 summarises the significance of the issues identified.

6.1 Amendment to existing rules

Inevitably over the life of a regional plan, experiences with its implementation will identify areas where Plan provisions could be improved to address new or emerging issues. Through this interim review, this report identifies the following eleven rules where it is recommended that changes would be useful.

6.1.1 Rule 31: Waste incineration on site

Rule 31 applies to discharges of contaminants to air from the disposal by combustion of industrial and trade waste, where the waste material is generated on the premises, and the activity occurs in an incinerator.

Rule 31 allows institutions to incinerate their waste on-site as a restricted discretionary activity. A consent will be granted subject to the applicant complying with various conditions. The setting of the conditions is limited to those matters specified in the Rule.

The RAQP does not include a definition of 'incinerator'. On occasion this has been problematic in that there is some uncertainty and clarity as to what is an incinerator.

Compliance monitoring has indicated that some institutions are using old drums or similar containers as incinerators, which do not have lids, grills, or flues and are therefore inadequate. Officers recommend that as part of any plan review that the RAQP be amended to:

- Include a definition of 'incinerator' in the Plan
- include additional Control/Discretion matters to addresses the kind of incinerator that should be used plus other appropriate matters
- include policy (and supporting guidance) setting out decision-making considerations for allowing incinerators, including when they should be used and whether there are any other options for disposal).

6.1.2 Rule 33: Combustion of solid waste material generated on production land

Rule 33 applies to discharges to air from the combustion of certain solid waste material generated on production land. This kind of discharge is a permitted activity subject to certain stated conditions being met. The conditions include specifications of materials that may be combusted, including non-chlorinated plastics.

Over the life of the RAQP, compliance monitoring surveys have highlighted challenges with farmers properly identifying non-chlorinated plastics and improperly disposing of this and other forms of waste.

For the purposes of certainty and clarity, it is recommended that Council, as part of any plan review, amend Rule 33 conditions to specify particular on-farm plastics that can be combusted as a permitted activity.

It is also recommended that Rule 33 conditions be further amended to clearly preclude the burning of domestic waste such as fridges and stoves.

It is also considered necessary to clarify the category of area to which Rule 33 refers to. For example, if the rule is restricted to production land only, does that category cover the curtilage of farm houses that are used to house owners and/or staff? Alternatively, what happens when a piece of production land is retired from productive use?

6.1.3 Rule 34: Combustion of waste material in defined urban areas

Rule 34 prohibits backyard burning in defined urban areas[17] on sections of under 0.5 hectares, which are used primarily for residential purposes[18] and are serviced by a weekly municipal refuse collection service. The Rule only bans burning for the purpose of waste disposal, not for cooking (bbqs or hangi), or heating purposes.

The application of Rule 34 excludes residential property in rural areas, subdivisions and undeveloped land, and possibly some lifestyle blocks. This situation has created reverse sensitivity issues (see 6.1.4 below) that could be addressed. Options to mitigate the problem include–

- Extend the boundaries of defined 'urban areas' to include more properties;
- Map larger areas in conjunction with District Councils so that the Council can police them;
- Increase the lot size to include rural properties;
- Define a "rural property", and specify a buffer zone that prohibits backyard burning within that buffer on a rural property, to limit any adverse effects.

As a consequence of the above mitigation options Council officers suggest that backyard incinerators may need to be banned.

6.1.4 Rule 40: On-farm liquid waste management processes and the issue of Reverse Sensitivity

Rule 40 applies to the discharge of contaminants to air from on-farm waste management processes for liquid contaminants, which arise from the use of production land or through intensive farming, subject to certain conditions. Essentially this rule allows the Council to proactively manage any odour that arises from the disposal of on-farm liquid waste.

Sometimes discharge of liquid waste results in 'reverse sensitivity' issues in certain locations. Reverse sensitivity refers to situations where lawfully-established industries, which have addressed offsite effects as far as is practicable and reasonable, may become constrained by the emergence of new and often incompatible land uses in the neighbourhood – such as residential subdivisions.

Farms with effluent ponds, spray irrigation processes, holding sumps or feed pads may create odour at various sites and times on the property. This has the potential to create a cumulative odour effect for neighbours. However these activities are legitimate on-farm discharges and lawful existing activity of this kind should ideally not be restricted or compromised over time by changing land use patterns occurring in and around the area.

Better alignment is necessary between the policies and methods of the *Regional Policy Statement for Taranaki 2010* (the RPS) in respect of reverse sensitivity issues (Refer **Appendix IV**) and the policies and methods of the RAQP.

Policy 2.5 of the RAQP notes that reverse sensitivity should be managed through district plans and territorial authority consent conditions:

Land use and subdivision should be managed to avoid, remedy or mitigate adverse effects on people and the environment from reverse sensitivity effects arising from the inappropriate location of sensitive activities in proximity to legitimate activities discharging contaminants to air.

Problems arising from reverse sensitivity effects shall be avoided, remedied or mitigated primarily through district plans and territorial authority consent decisions which:

a) prevent the future establishment of potentially incompatible land-use activities near each other; or
b) allow the establishment of potentially incompatible land-use activities near each other provided no existing lawful activity, operating in a lawful manner is restricted or compromised.

Method 10 of the RAQP states that, *in conjunction with the territorial authorities, the Council will implement memoranda of understanding to promote effective integrated management of air quality issues.* Implementation of Method 10 may need to be reviewed.

Rule 40 issues

Under Rule 40 any activity that involves discharge of liquid effluent on farms must not result in offensive or objectionable odour beyond the boundary of the property, and any farm effluent ponds or zones of spray irrigation must be located at least 150 metres away from any dwelling-house or place of public assembly, unless prior approval has been obtained.

However, although Method 10 of the RAQP refers to memoranda of understanding, there does not seem to be plan alignment between this Council and the district councils in respect of reverse sensitivity and air quality.

In particular, there is currently no mechanism with which Council officers can control activities or require compliance in respect of the location of new dwelling houses and/or places of public assembly.

Officers recommend that, as part of a Plan review, the Council explore options for better addressing the issue of reverse sensitivity (and Rule 40) with Federated Farmers and the local territorial authorities, to assess the issue and

[17] As shown in Appendix II of the Plan.
[18] As defined in Section 2 of the Plan.

consider how it might be improved. It may be that the size of the buffer area could be reduced, and a restricted discretion be created for the local authorities to investigate the potential for odour issues, in relation to the initial location of any new dwelling-house sites or potential places of public assembly.

6.1.5 Rules 51-54: Discharges from Intensive Poultry Farming Processes

When the previous RAQP was prepared, poultry farms were beginning to increase in size and had reached sizes of ≥120,000 birds. At the date of this review, however, newer farms can contain over a million birds. This is more than 10 times the size envisaged when buffer distances and best practice guidelines were put in place (see Appendix IV and V of the RAQP).

A structural change of this magnitude requires consideration of the need to include an additional category and more Council discretion in the RAQP for these larger farms.

6.1.6 Rules 56-58: Discharges of agrichemicals into the air

Rules 56 and 57 are 'permitted activities' and apply to the discharge of contaminants to air from the spraying of agrichemicals on production land (i.e. farmland - Rule 56) and from public amenity areas or roadside and railway verges (Rule 57). Rule 58 applies to the discharge of contaminants to air from the land types described in Rule 56 and 57 where the discharge does not satisfy the rule conditions. Rule 58 is a restricted discretionary "catch-all" rule. Two issues have arisen with respect to this group of rules.

First, Rules 56 and 57 make reference in conditions (f)(i)-(ii) to the requirement to hold current GROWSAFE® certificates of various kinds to be a ground or commercial spray operator. Other quality assurance schemes are now operating and it would be helpful to provide for them in the conditions. This report therefore recommends that the conditions and rule be amended to "providers registered under s95A of the Hazardous Substances and New Organisms Act 1996 for the application of agricultural chemicals."

Second, Rules 56 and 57 refer only to the discharge of contaminants to air to **production land**. The definition of production land–

> *(a) means any land and auxiliary buildings used for the production (but not processing) of primary products (including agricultural, pastoral, horticultural, and forestry products;*
>
> *(b) does not include land or auxiliary buildings used or associated with prospecting, exploration, or mining for minerals –*

*and **production** has a corresponding meaning.*

Accordingly any land or an area on a farm property that has been retired from productive use (e.g. wetland, area of bush, riparian margin), or in a domestic garden, would fall outside the 'production land' component of the property and Rule 56 would not apply.

Currently there are no RAQP rules that provide for discharges to air either in domestic gardens or on retired land. Consequently the RAQP does not align with the Council's Freshwater Plan, which does contain such provisions. This report recommends that this misalignment and omissions be remedied when the RAQP is fully reviewed in 2021.

In addition, the landowner or occupier must give notice to "all occupied dwellinghouses, owners or occupiers of properties, sensitive crops and farming systems and places of public assembly located within 30 metres of the area to be sprayed (if spraying is by ground application) or within 100 metres of the area to be sprayed (if spraying is by aerial application." It is noted that the above buffer areas are smaller than the buffer distance set out in Rule 40 (i.e. 150 metres) and alignment may be beneficial.

Refer to section 4.5 and Table 12 for an assessment of the urgency in which the RAQP should be reviewed and possibly amended to better address the above activities.

6.1.7 Implementation issues

The review of the RAQP has also identified several issues with the implementation of the RAQP that require further consideration when a full review takes place in 2021.

- **Enforcing the ban on backyard burning**: Rule 34 of the RAQP prohibits burning of waste material in defined urban areas (see section 6.1.3 above). Implementation of this rule has been transferred to the respective district councils in New Plymouth and Stratford districts and enforcement is inconsistent across council areas. Better alignment and clarity is required.
- **Managing beach bonfires**: A similar issue has arisen in respect of bonfires on beaches, where the Council has transferred its air quality monitoring and compliance powers to the respective district councils in New Plymouth and Stratford districts. Enforcement is inconsistent across council areas and better alignment and clarity is required.
- **Licensing of woodburning appliances**: Method 14 of the RAQP states that the Council will "encourage the installation of cleaner forms of heating, and clean heating appliances, and

> increases in energy efficiency of dwellings." However, although local district councils consent to woodburner installation, they do not have jurisdiction to ascertain whether the particular model of woodburner is licensed under the NES. Moreover coal and/or pellet burners do not have to be licensed. Both of these issues are anomalies arising under the NES-AQ. This is a matter that has to be addressed at central government level.

Refer to section 4.5 and Table 12 for an assessment of the urgency in which the RAQP should be reviewed and possibly amended to address implementation issues.

6.1.8 Other matters

In the future, digital and spatial technology will be investigated to further improve efficiency by improving the accessibility and user-friendliness of all the Council's planning documents (i.e. E-Planning).

Typographical or reference errors or improvements to wording for the purposes of certainty & clarity may also be required. Minor typos can be corrected immediately. Other changes, such as changes to agency and standards names and other assessment factors, are more significant but the benefits of immediately reviewing the Plan would not outweigh the costs incurred by the Council.

6.2 Evaluation of urgency for change

The criteria for considering making immediate changes to the RAQP are outlined in **Appendix III** of this report.

Following the adoption of any regional plan, experience in the implementation of that plan will inevitably highlight minor typographical errors or areas for improvement in Plan provisions. Similarly, this review has identified rules in the RAQP for which the conditions and wording could be improved or fine-tuned.

Of note, this review has identified eleven rules (out of 63) where changes are recommended. The recommended changes relate to the inclusion of additional matters in Rules 31, 33, and 34, the consideration of reverse sensitivity effects in Rule 40, an additional category and more Council discretion in Rules 51-54, plus the discharges of agrichemicals to air in Rules 56-58. Other recommended changes relate to implementation issues including consistency of enforcement of the ban on backyard burning and in managing beach bonfires; and licensing of wood burning appliances.

The aforementioned issues are relatively minor and, in their current form, have not adversely impacted on the achievement of RAQP objectives. Furthermore, Council has experienced little difficultly in the interpretation and application of Plan provisions (as demonstrated by the small number of occasions issues have been raised during the resource consents process or legal challenges to the Environment Court).

After having regard to these criteria, none of the issues discussed in sections 6.1 above, individually or collectively, warrant the Council initiating an immediate and full review of the RAQP under section 79 of the RMA.

Table 8: Evaluation of recommended amendments to the Plan

Recommended amendments	Are changes required to the Plan based upon?						Comments
	Issues	Lawfulness	Clarity	Practicality & affordability	Efficiency	Equity	
Inclusion of additional matters							
Rule 31: Include an additional condition describing the incinerator required to be used and providing criteria for its use.	Minor	No	Minor	No	No	No	Additional matters that have arisen since the RAQP was last fully reviewed in 2011. In the case of Rule 40 there are regional reverse sensitivity issues that will need discussion in order to address, and those discussions can begin following this interim review, allowing more time to resolve the issue prior to the full review. However, the benefits of immediately reviewing the Plan would not outweigh the costs incurred by Council.
Rule 33: Specify which on-farm non-chlorinated plastics can be burned; and Restrict the burning of domestic waste such as fridges and stoves; and Consider varying the areas that the rule relates to.	Minor	No	Minor	No	No	No	
Rule 34: Provide for areas currently omitted including residential property in rural areas, subdivisions, undeveloped land and lifestyle blocks.	Minor	No	Minor	No	Minor	No	
Rule 40: Address reverse sensitivity issues across the region with Federated Farmers and local territorial authorities to provide more control of on-farm liquid waste management and enable greater compliance	Moderate	No	No	No	No	No	
Rules 51-54: Consideration of need for additional category and more Council discretion for farms of above 250,000 birds.	Moderate	No	No	No	No	No	
Rules 56-68: Consideration of need for alignment with Council's Freshwater Plan.	Minor	No	No	No	No	No	

Recommended amendments	Are changes required to the Plan based upon?						Comments
	Issues	Lawfulness	Clarity	Practicality & affordability	Efficiency	Equity	
Implementation issues							
Enforcing the ban on backyard burning: Address consistency of regional implementation in light of Council transfer of its air quality monitoring and compliance powers to the respective district councils.	Minor	No	No	Minor	No	Minor	The review of the RAQP has also identified some implementation issues that require some consideration when a full review takes place in 2021.
Managing beach bonfires: Address consistency of regional implementation in light of Council transfer of its air quality monitoring and compliance powers to the respective district councils.	Minor	No	No	Minor	No	Minor	
Backyard burning incinerators: Submit to Government that, as a consequence of previous and recommended changes to Rule 34, (see above), backyard incinerators may need to be banned.	Minor	No	No	Minor	No	Minor	
Licensing of heating appliances: Submit to Government on anomalies arising under the NES-AQ in respect to ability to enforce compliance as to required woodburner models, and other burner licensing.	Minor	No	No	Minor	No	Minor	
Align rules with new government standards	No	No	No	No	No	No	Government is still developing a new NES for Air Quality so it is not appropriate or timely to make changes at this time
Correct typographical errors or references or improve wording for the purposes of certainty & clarity	No	No	Minor	No	No	No	Minor typographical errors, or areas where change or fine-tuning would be useful to clarify Council's interpretation. Typos do not require a full review & should be immediately corrected. Other changes such as changes to agency

Recommended amendments	Are changes required to the Plan based upon?						Comments
	Issues	Lawfulness	Clarity	Practicality & affordability	Efficiency	Equity	
							names and standard versions and other assessment factors are more significant but the benefits of immediately reviewing the Plan would not outweigh the costs incurred by the Council.

No = in relation to that criterion, no issue of concern
Minor = in relation to that criterion, an issue of minor concern but not significant enough to warrant an immediate review of the Plan.
Moderate = in relation to that criterion, an issue of moderate concern but not significant enough to warrant an immediate review of the Plan.
Major = in relation to that criterion, an issue of major concern that necessitates an immediate review of the Plan.

35

7. Conclusion

In conclusion, the RAQP is working well. The Council has progressively implemented the policies and methods, with successful outcomes so far.

State of the environment monitoring programmes confirms that the RAQP objectives and policies for managing air quality are being achieved. Of note:

- The overall quality of air in Taranaki is excellent due to lots of wind, light traffic, and scattered industry. National air quality standards have never been exceeded in Taranaki.
- Taranaki's air quality is rated overall as 'good' to 'excellent' according to MfE environmental performance indicators for air based upon data from the region's representative monitoring sites, including built-up areas and areas of high vehicular use.
- Compliance monitoring programmes confirms that 97% of air permit holders routinely achieved a 'high' or 'good' performance.
- Over the life of the RAQP, increased levels of poultry farming and hydrocarbon exploration and production have resulted in increased numbers of resource consents for air discharges. However, effective regulation and monitoring means there has been a negligible impact on air quality in the region.
- Overall, Taranaki's clean air provides significant health and amenity benefits to the region.

This review further confirms that the regional rules in the RAQP are efficient. Of particular note:

- Most air discharge permits are non-notified (94% in 2016/17);
- Resource users have certainty as to the outcome of their air discharge permit application with 42% of the air discharge permits granted being classified as controlled activities;
- Since the adoption of the 2011 RAQP, the Council has continued to maintain its performance, with 100% of consent applications being processed within statutory timelines.

Notwithstanding that this review identifies the RAQP as efficient and effective, inevitably change is required over time. This interim review has highlighted a small number of provisions that could be improved, sharpened or made more comprehensive.

Based upon the Council's experience in the administration of the Plan some minor changes to the Plan are proposed but they are not so significant that a full review of the Plan is necessary or appropriate. These changes (other than typographical errors, which can be addressed immediately) can be addressed when the Plan is fully reviewed in 2021.

References

Air Quality Management Ltd (Backshall D), 2013. Atmospheric Dispersion Modelling of Discharges to Air from the Flaring of Fracturing Fluid. Report Number 13-008, Prepared for Taranaki Regional Council.

Business and Economic Research Ltd (BERL), 2002: *Community Investment in Environmental Improvements in Taranaki*. Report to the Taranaki Regional Council.

Enfocus Limited, July 2008: *Evaluating Regional Policy Statements and Plans – A Guide for Regional Councils and Unitary Authorities*.

Environment Canterbury (Hepburn I and Keeling C), 2013. *Non-natural Rural Wastes – Site Survey Data Analysis: Summary Report* No. R13/97.

Hawkes Bay Regional Council, Taranaki Regional Council, Manawatu-Wanganui Regional Council, Otago Regional Council and Southland Regional Council, March 1998: *Regional Policy Statements and Regional Plans – A Guide to their Purpose, Scope and Content*.

Ministry for the Environment and the Ministry of Health, 2002. *Ambient Air Quality Guidelines*, Air Quality Report No 32, 2002 update.

Ministry for the Environment, 2011. *Clean Healthy Air for All New Zealanders: National Air Quality Compliance Strategy to Meet the PM_{10} Standard*. Wellington: Ministry for the Environment.

Ministry for the Environment, 2011. *2011 Users' Guide to the revised National Environmental Standards for Air Quality: Updated 2014*. Wellington: Ministry for the Environment.

Taranaki Regional Council, 2010, *Is There Something in the Air?*

Taranaki Regional Council, 2010. *Inhalable Particulates (PM_{10}) Regional Monitoring Report.*

Taranaki Regional Council, 2011: *Regional Air Quality Plan for Taranaki*.

Taranaki Regional Council, 2012. *Inhalable Particulates Monitoring at Port Taranaki*.

Taranaki Regional Council, 2012-*Investigation of air quality arising from flaring of fracturing fluids -emissions and ambient air quality*. Technical Report 2012– 03.

Taranaki Regional Council, 2013. *Air Monitoring Survey of Hydrocarbon Compounds (BTEX) in Taranaki Region*.

Taranaki Regional Council, 2013. *Monitoring of Nitrogen Oxides (NO_x) Levels in Taranaki.*

Taranaki Regional Council, 2014. *Ambient Air Quality Survey at Bell Block Bypass*.

Taranaki Regional Council, 2015: *Taranaki As One –Taranaki Tāngata Tū Tahi,* State of Environment Report.

Taranaki Regional Council, 2016: *2015/2016 Long Term Plan.*

(THIS PAGE IS INTENTIONALLY BLANK)

Appendix I

Arrangement of rules according to discharge source or activity

Category	Source or Activity	Rule No.	Rule Category
Industrial or trade premises	**Products of combustion**		
	Burning of natural gas or LPG as a fuel	1 to 4	Permitted or controlled
	Burning of wood, diesel, kerosene, petroleum, coke, coal, charcoal, oil & non-chlorinated alcohols as a fuel	5 to 7	Permitted or controlled
	Burning of coated or covered metal cables, motor vehicles or other metals	8	Prohibited
	Flaring of petroleum	9 to 10	Controlled or restricted discretionary
	Gas treatment or production plants	11	Controlled
	Hydrocarbon-produced well head or well sites	12	Restricted discretionary
	Trade processes		
	Sale of motor fuels	13	Permitted
	Manufacture, preparation or cooking of food or beverages for human consumption	13	Permitted
	Dry cleaning	13	Permitted
	Sale, service, repair of motor vehicles, trailers & boats	13	Permitted
	Painting, varnishing, dyeing, polishing & other coating processes	13	Permitted
	Dying, printing or finishing of yarns, threads, fabrics or garments	13	Permitted
	Storage, loading & unloading of waste materials	13	Permitted
	Manufacture of concrete products	13	Permitted
	Welding, soldering or other metal fusing	13	Permitted
	Hydrocarbon distribution and transmission networks	14	Permitted
	Power stations, electrical substations or switchyards not covered by Rules 1-54 and / or 56-63	15	Permitted
	Recreational areas or trade premises	16	Permitted
	Abrasive blasting processes		

Category	Source or Activity	Rule No.	Rule Category
	Wet and dry abrasive blasting	17 to 21	Permitted, controlled, restricted discretionary or prohibited
	Other moveable and fixed industrial sources		
	Road burners	22	Prohibited
	Moveable or permanent asphalt / bitumen plants	23	Discretionary
	Heat or water vapour-based plumes from fixed sources		
	Air-cooled heat exchangers	24	Permitted
	Water-based cooling systems	25 & 26	Permitted or discretionary
	Steam	27	Permitted
	Cooling towers that do not comply with Rules 25 or 26	28	Restricted discretionary
	Fumigation		
	Fumigation activities	29	Permitted
Waste management processes	**Combustion**		
	Specific waste materials other than in an incinerator	30	Prohibited
	Industrial or Trade waste in an incinerator	31	Restricted discretionary
	Industrial or Trade waste in a high temperature hazardous waste incinerator	32	Restricted discretionary
	On-farm solid waste disposal by combustion	33	Permitted
	Residential waste disposal by combustion	34	Prohibited
	Disposal of solid wastes to land		
	On-farm solid waste disposal to land	35	Permitted
	Composting or disposal to land of waste material – residential areas	36	Permitted
	Active landfills	37	Controlled
	Closed landfills	38	Permitted
	Cleanfills	39	Permitted
	On-farm liquid waste management processes	40	Permitted
	Sewage treatment	41	Permitted
Site development, earthworks or application of soil conditioners	Site development and landscaping	42	Permitted
	Earthworks		
	Small-scale earthworks	43	Permitted

Category	Source or Activity	Rule No.	Rule Category
	Large-scale earthworks	44	Controlled
	Fertiliser and other Soil Conditioners		
	Fertiliser and other Soil Conditioners	45	Permitted
Aquaculture or intensive farming processes	Aquaculture	46	Permitted
Intensive Pig Farming Processes	Small intensive pig farming processes	47	Permitted
	Existing intensive pig farming processes	48	Restricted discretionary
	New large intensive pig farming processes	49	Restricted discretionary
	Intensive pig farming processes that do not comply with Rules 47-49	50	Discretionary
Intensive Poultry Farming Processes	Small intensive poultry farming processes	51	Permitted
	Existing intensive poultry farming processes	52	Restricted discretionary
	New large intensive poultry farming processes	53	Restricted discretionary
	Intensive poultry farming processes that do not comply with Rules 51-53	54	Discretionary
Other discharges	Discharges to air that cannot comply with Rules 1 - 54	55	Discretionary
Agrichemicals	Agrichemicals sprayed onto production land	56	Permitted
	Agrichemicals sprayed onto public amenity areas or roadside railway verges	57	Permitted
	Agrichemicals sprayed that do not comply with Rules 56 - 57	58	Restricted discretionary
Burning	Burning of vegetation on production or forested land	59	Permitted
	Burning of vegetation that does not comply with Rule 59	60	Controlled
	Burning of tyres or untreated waste oil	61	Prohibited
	Fire training activities	62	Permitted
	Fire training activities that do not comply with Rule 62	63	Controlled

(THIS PAGE IS INTENTIONALLY BLANK)

Appendix II
Section 35 of the RMA

35. Duty to gather information, monitor, and keep records

(1) Every local authority shall gather such information, and undertake or commission such research, as is necessary to carry out effectively its functions under this Act or regulations under this Act.

(2) Every local authority shall monitor—

(a) the state of the whole or any part of the environment of its region or district—

(i) to the extent that is appropriate to enable the local authority to effectively carry out its functions under this Act; and

(ii) in addition, by reference to any indicators or other matters prescribed by regulations made under this Act, and in accordance with the regulations; and

(b) the efficiency and effectiveness of policies, rules, or other methods in its policy statement or its plan; and

(c) the exercise of any functions, powers, or duties delegated or transferred by it; and

(d) the exercise of the resource consents that have effect in its region or district, as the case may be; and

(e) in the case of a regional council, the exercise of a protected customary right in its region, including any controls imposed on the exercise of that right under Part 3 of the Marine and Coastal Area (Takutai Moana) Act 2011—and take appropriate action (having regard to the methods available to it under this Act) where this is shown to be necessary.

(2A) Every local authority must, at intervals of not more than 5 years, compile and make available to the public a review of the results of its monitoring under subsection (2) (b).

(THIS PAGE IS INTENTIONALLY BLANK)

Appendix III
Criteria for review

The following criteria were applied when considering making changes to the *Regional Air Quality Plan for Taranaki*.

(a) Issues:
- There is a new issue of regional significance that has emerged since adoption of the Plan that is not addressed in the Plan or in other policies, strategies or plans and, after considering criteria (b) to (g) below, it is necessary and appropriate for that issue to be included in the Plan; or
- An issue already identified in the Plan is no longer appropriate or necessary and after considering criteria (b) to (g) below, that issue should be removed from the Plan.

(b) Lawfulness:
- The Plan is clearly leading directly to outcomes that are contrary to the **purpose and principles** of the Act; or
- The Plan is clearly failing in its purpose of achieving **integrated management** and this failure is a consequence of the Plan itself; or
- The provisions of the Plan are **ultra vires** and require immediate change in the interests of clarity and certainty and the efficient, effective and legally correct administration of the Act.

(c) Clarity:
- The provisions of the Plan are so **unclear or uncertain** that those provisions are causing confusion and problems in administration and implementation of the Plan to the extent that the Plan requires immediate change.

(d) Practicability and affordability:
- The provisions of the Plan have emerged as being not practical or affordable and cannot realistically be undertaken **and** these provisions are causing problems in administration of the Plan that require its immediate change.

(e) Efficiency:
- The provisions of the Plan do not promote the efficient management of resources, result in excessive compliance costs or are not cost-effective for the community (ie, costs are too high relative to the benefits expected) to the extent that the Plan requires immediate change.

(f) Equity:
- The provisions of the Plan impose unacceptable costs or benefits on one sector and not others to the extent that the Plan requires immediate change.

(g) Section 32 duties:

Any change to the Plan is subject to the duties imposed under section 32 of the Act and these must be considered in the review process. In proposing any changes to objectives, policies, or methods the Council must have regard to:
- The extent to which the objective, policy or method is **necessary** in achieving the purpose of the Act;
- **Other means** to achieve the purpose of the Act;
- The **reasons** for adapting the objective, policy or method, the principal alternative means available or of taking no action where the Act does not require otherwise;
- **Benefits and costs** of the principal alternative means;
- The **appropriateness** of the objective, policy or method having regard to its efficiency and effectiveness relative to other means;
- The **risk of acting or not acting** if there is uncertain or insufficient information about the subject matter of the policies, rules, or other methods.

Part of this assessment will need to include consideration of the:
- **Timeliness** of any change (particularly in view of any proposed changes in legislation, and roles or responsibilities); and
- **Costs** to the Council in processing a change to the Plan and compliance costs imposed on resource users.

(THIS PAGE IS INTENTIONALLY BLANK)

Appendix IV
The Regional Policy Statement for Taranaki 2010 – Reverse sensitivity

The *Regional Policy Statement for Taranaki 2010* (the RPS) contains policies and methods that address reverse sensitivity issues with respect to discharging contaminants to air, as follows:

AQU Policy 3 provides:

Land use and subdivision should be managed to avoid, remedy or mitigate adverse effects on people and the environment from reserve sensitivity effects arising from the inappropriate location of sensitive activities in proximity to legitimate activities discharging contaminants to air.

AQU Method 6 provides:

In conjunction with the territorial authorities, implement memoranda of understanding to promote effective integrated management of air quality issues.

The RPS also suggests that the territorial authorities may wish to consider AQU Method 8, which states –

> *Include in **district plans** or **resource consents**, provisions or conditions to control either or both:*
>
> *(a) The siting and establishment of land uses that discharge contaminants to air that have an adverse effect on the amenity and character values of the adjacent land uses; or*
>
> *(b) The siting and establishment of sensitive or incompatible land uses in the vicinity or neighbourhood of the discharging land use.*

(THIS PAGE IS INTENTIONALLY BLANK)

Appendix V
Summary of Progress: implementing RAQP methods

What did we promise to deliver?	Where are we at?	Conclusion
Applying regional rules to allow, regulate or prohibit activities.	All 63 rules are applied as appropriate and necessary.	Commitment is being delivered.
Applying policies and section 104 of the RMA when granting discharge to air permits or the conditions of such a permit.	Statutory provisions and guidelines are adhered to when granting discharge to air permits.	Commitment is being delivered.
Requiring applicants for discharge to air permits to adopt the best practicable option to prevent or minimise adverse effects.	All applicants are required to demonstrate that they are implementing best practice in their air discharge processes.	Commitment is being delivered.
Consulting with iwi and hapū regarding identification of places of special cultural and traditional value associated with the air resource.	Iwi and hapu have been involved in an average of 33% of all air discharge consent applications since 2010.	Commitment is being delivered.
Providing advice and information, including guidelines, to landowners, resource users, and the public.	Advice and public information is provided through visits by officers and social and print media.	Commitment is being delivered.
Supporting and promoting the preparation and adoption by sector groups of guidelines and certification programmes.	Provided ongoing support and promotion of guidelines and other certification to sector groups as appropriate.	Commitment is being delivered.
Working with the poultry growing industry to reduce the effects of broiler operations on air quality.	Worked with the poultry industry to effect best practice mitigation of air quality effects.	Commitment is being delivered.
Monitoring and gathering information.	Ongoing monitoring and gathering of air quality information by science and technical officers.	Commitment is being delivered.
Receiving and responding to public complaints.	Inspectorate and compliance officers received and responded to all public complaints,	Commitment is being delivered.
Implementing and promoting effective integrated management of air quality issues with territorial authorities.	Integrated management implemented by officers liaising with territorial councils in respect of shared and delegated activities.	Commitment is being delivered.
Applying and contributing to the monitoring of national environmental standards for air quality.	Advocacy and response through National Working Group on Air Quality and other fora in respect of national environmental standards for air quality.	Commitment is being delivered.
Advocating to relevant agencies.	Advocacy and response to relevant agencies in respect of air quality guidelines and standards.	Commitment is being delivered.

What did we promise to deliver?	Where are we at?	Conclusion
Providing information on the location of electricity transmission networks.	Provided information on location of electricity transmission networks when requested.	Commitment is being delivered.
Encouraging the installation of cleaner heating methods and appliances and increases in home energy efficiency	Continued to encourage installation of cleaner and more efficient home heating methods together with territorial authorities.	Commitment is being delivered.
Defining a Port Air Zone to provide boundaries for controlling the effects of air emissions in the coastal marine area at Port Taranaki.	Port Air Zone defined as per Figure 2 of the RAQP.	Commitment is being delivered.

Policy and Planning Committee
Public Excluded

In accordance with section 48(1) of the *Local Government Official Information and Meetings Act 1987*, resolves that the public is excluded from the following part of the proceedings of the Policy and Planning Committee Meeting on Tuesday 24 April 2018 for the following reason/s:

Item 8- Hill country sustainable management programme

THAT the public conduct of the whole or the relevant part of the proceedings would be likely to result in the disclosure of information where the withholding of the information is necessary to enable any local authority holding the information to carry out, without prejudice or disadvantage, commercial activities .

Whakataka te hau

Karakia to open and close meetings

Whakataka te hau ki te uru	Cease the winds from the west
Whakataka te hau ki tonga	Cease the winds from the south
Kia mākinakina ki uta	Let the breeze blow over the land
Kia mātaratara ki tai	Let the breeze blow over the ocean
Kia hī ake ana te atakura	Let the red-tipped dawn come with a sharpened air
He tio, he huka, he hauhu	A touch of frost, a promise of glorious day
Tūturu o whiti whakamaua kia tina.	Let there be certainty
Tina!	Secure it!
Hui ē! Tāiki ē!	Draw together! Affirm!

Nau mai e ngā hua

Karakia for kai

Nau mai e ngā hua	Welcome the gifts of food
o te wao	from the sacred forests
o te ngakina	from the cultivated gardens
o te wai tai	from the sea
o te wai Māori	from the fresh waters
Nā Tāne	The food of Tāne
Nā Rongo	of Rongo
Nā Tangaroa	of Tangaroa
Nā Maru	of Maru
Ko Ranginui e tū iho nei	I acknowledge Ranginui above and
Ko Papatūānuku e takoto ake nei	Papatūānuku below
Tūturu o whti whakamaua kia tina	Let there be certainty Secure it!
Tina! Hui e! Taiki e!	Draw together! Affirm!