



**Traverse
Environmental**

Tairāwhiti Water Quality and Ecosystem Health Expert Panel Report



Prepared for: Gisborne District Council

August 2025

Tairāwhiti Water Quality and Ecosystem Health Expert Panel Report

Prepared for: Gisborne District Council

Prepared by: Oliver Ausseil, Technical Chair
Mark Heath Technical Support

Traverse
Environmental

Joanne Clapcott Panel Member

 CAWTHRON

Anna Madarasz-Smith Panel Member


PATTLE DELAMORE PARTNERS

Richard Muirhead Panel Member

BIOECONOMY
SCIENCE
INSTITUTE

 **agresearch**
āia mātai, mātai whetū

Paul Murphy Panel Member

 Te Kaunihera o Te Tairāwhiti
GISBORNE
DISTRICT COUNCIL

Andrew Neverman Panel Member

BIOECONOMY
SCIENCE
INSTITUTE

 Manaaki Whenua
Landcare Research

Ned Norton Panel Member

 landwaterpeople | **LWP**

Date of issue: 12th August 2025

Disclaimer: This report has been prepared for the sole use of our client, for the particular brief and on the terms and conditions agreed with our client. It may not be used or relied on (in whole or part) by anyone else, or for any other purpose or in any other contexts, without our prior written agreement.

Cover photo: Tairāwhiti water quality and ecosystem health expert panel.

Recommended citation: Ausseil O., Heath M., Clapcott J., Madarasz-Smith A., Muirhead R., Murphy P., Neverman A. and Norton N. (2025). Tairāwhiti Water Quality and Ecosystem Health Expert Panel Report. Report prepared for Gisborne District Council.

Executive summary

Background

To support the review of the Tairāwhiti Resource Management Plan and the implementation of the National Policy Statement for Freshwater Management 2020 (NPS-FM), GDC established the Tairāwhiti Freshwater Quality and Ecosystem Health Expert Panel ('the Panel') in mid- 2024.

This report was commissioned by Gisborne District Council (GDC) to summarise the Panel's expert assessment of water quality and ecosystem health across the region, including the potential outcomes of five future land and water management scenarios (see Section 1).

The Expert Panel Approach

The Panel was formed to provide independent, multidisciplinary advice on freshwater and estuarine water quality and ecological health. The Panel assessed the current and baseline state of freshwater and estuarine systems, a "full afforestation" scenario (best achievable state), and three timebound mitigation scenarios representing progressively stronger regional action in 2040, 2060, and 2090. The mitigations considered in these scenarios primarily focused on reducing losses of sediment and *E.coli* from land into waterbodies.

The Panel's assessment of scenarios was based on monitoring data from 116 monitoring sites, region-wide scenario modelling of key contaminants (sediment, *E. coli*, nutrients), national and regional models of water quality and ecological indicators, a technical library, an interactive web platform, and a multiple-lines-of-evidence approach combining data, expert judgement, and qualitative interpretation where data were lacking (see Sections 2 and 3). The assessment Results were captured in an Assessment Spreadsheet and narrative summaries.

The Panel was also asked to identify issues and drivers of water quality and ecology, and knowledge gaps, in the Poverty Bay Flats area.

Current State Key Issues

The Panel identified multiple areas of concern across the region (see Section 4):

- Suspended and deposited sediment: 69% of monitored freshwater sites fall below the National Bottom Line for visual clarity (Band D), reflecting high erosion rates, exacerbated by past deforestation. Widespread accumulation of fine sediment on streambeds results in most streams being in poor condition for deposited sediment (Band D), with exceptions in some forested areas.
- Water temperature and DO: Moderate to severe thermal and oxygen stress was recorded across many rivers and estuaries, especially in lowland and urban areas.
- Ecological health: Macroinvertebrate communities and stream habitat quality are degraded in many catchments, especially in lowland, urban and estuarine areas. Fish habitat is particularly limited by sedimentation, poor riparian cover, and high temperatures.
- Eutrophication: The detrimental effects of nutrients is not a notable problem in most of the freshwaters of Tairāwhiti, except in some of the Poverty Bay Flats area.
- Human health: *E. coli* levels in freshwater frequently exceed safe thresholds for contact recreation. Estuarine water quality is similarly degraded, although data are limited.
- Estuaries: Tūranganui Estuary (Taruhuru arm) shows evidence of significant sediment stress and degraded ecological condition. Data for other estuaries is sparse, but modelling suggests similarly poor conditions for tidal lagoon estuaries, and estuaries with high risk features.

Scenario Assessments

The Panel assessed five management scenarios, each with sub-options incorporating climate change (see Section 5). Key findings included:

- Full Afforestation: Demonstrated the best-case outcome for sediment and *E. coli* reduction but is not a realistic policy scenario. It highlights the potential limits of what is achievable with the removal of animal agriculture in Tairāwhiti's erodible terrain.
- 2040 Scenario: Represents a challenging but achievable intervention strategy. Modelling suggests moderate improvements in sediment loads and visual clarity at priority sites but minimal reductions in *E. coli*, with monitored sites unlikely to improve NPS-FM Band.
- 2060 and 2090 Scenarios: Show incremental improvements over time. However, due to the legacy of land degradation, many attributes will take decades to recover, and even the 2090 scenario may not meet all NPS-FM bottom lines. Reductions in *E. coli* concentrations will be minor and still unlikely to result in improving the Bands at monitored sites.
- Climate Change: Across all scenarios, climate change undermines water quality improvements, especially through increased erosion, temperature, and flood-related contaminant loads.

Poverty Bay Flats

The Panel considered water quality and aquatic ecology issues and their drivers in three areas of the Poverty Bay Flats (see Section 6).

The Taruheru River is subject to multiple water quality and aquatic ecology issues, affecting both its freshwater and estuarine reaches:

- Poor ecological health is likely driven by the combined effects of multiple factors, particularly sediment, low dissolved oxygen, elevated temperatures, poor habitat quality, hydrological modification and low summer flows.
- Low dissolved oxygen is likely to be primarily driven by plant and algae growth caused by elevated nutrient concentrations. The highest nitrogen concentrations are recorded in the Taruheru River at Tuckers Rd, and these exceed the NPS-FM National Bottom Line for nitrate and ammonia toxicity.
- The lower catchment has consistently poor water quality, with elevated *E. coli* levels posing a significant health risk to recreational users.

There is clear evidence that intensive land use is the likely main source of elevated nutrient and *E. coli* in the Taruheru River. The Panel's view was that the Taruheru catchment is a complex system, and a measurable improvement in ecological health was likely to require the coordinated mitigation of multiple drivers and stressors.

The Lower Waipaoa catchment presents multiple water quality and aquatic ecology issues, including:

- Poor ecological health, likely driven by high levels of deposited sediment, altered flow regimes and high water temperatures
- Poor recreational water quality
- Restricted fish passage

There is no direct evidence of nutrient-related issues in the lower Waipaoa River or its estuary. Te Wherowhero Lagoon is likely to be highly sensitive to sediment and nutrient impacts, but its actual condition cannot be assessed due to a lack of data. Ongoing monitoring of Te Wherowhero Lagoon should be prioritised.

The presence or emergence of issue(s) associated with intensive land use in the lower Uawa River could not be confirmed due to a lack of data. Monitoring in the lower river is recommended to establish a baseline of water quality and ecology, especially if further land use intensification and/or expansion is likely.

Key Messages

The Panel's assessments provide critical insights for freshwater policy development (see Section 7). Key messages include:

1. Sediment is the primary issue

Erosion from highly erodible hill country, especially mass movement processes, is the dominant source of sediment. Major reductions in sediment loads require extensive mitigations, including space planting, afforestation, gully stabilisation, and riparian buffering.

2. Timeframes for improvement are long

Improvements in water quality and ecological condition will take decades to realise, especially for sediment and ecological indicators. Even under the most ambitious (2090) scenario, some attributes may remain below NPS-FM bottom lines.

3. Incremental action works—but is not enough alone

Scenario 3 (2040) delivers measurable improvements and is considered “challenging but achievable”. Scenarios 4 and 5 deliver incrementally greater improvements with more widespread implementation, but are not expected to meet NPS-FM national bottom lines everywhere.

4. Climate change undermines gains

Climate change increases erosion, temperature stress, and pathogen loads, diminishing the benefits of mitigation. Policies should account for climate change and factor in future pressures.

5. Focus on representative sites but plan for the network

Current models and data are most reliable at existing monitoring sites. However, relying solely on these sites risks missing issues elsewhere. The Panel supports a site-based approach to analysing water quality and ecological health, but emphasises the need to extrapolate findings regionally with caution. Policy writers will need to consider how to use site-based plan provisions along with broader spatial planning provisions.

6. Knowledge gaps remain

Key data gaps exist for estuarine systems, nutrient loads in intensively farmed areas (e.g., Poverty Bay Flats), and ecological outcomes of mitigation. Urban water quality issues, including stormwater and wastewater impacts, need separate, dedicated assessment. Further monitoring and targeted investigation are needed to reduce uncertainty.

7. Action planning must be targeted and sustained

Achieving water quality improvements requires enduring investment in mitigation—especially in sediment-prone areas. Interventions must be scaled, targeted, and enduring, acknowledging natural limits to recoverability and the compounding effects of climate change. Riparian planting, stock exclusion, and erosion control are critical mitigations, but their effectiveness is reduced by spatial and climatic variability.

Contents

Executive summary	3
1 Introduction	12
1.1 Background and context	12
1.2 Purpose and structure of this report	13
2 Expert Panel Process	15
2.1 Why an expert Panel?	15
2.2 Expert panel composition	15
2.3 Purpose and Objectives	16
2.4 Scope	16
2.5 Region-wide scenarios	17
2.6 Poverty Bay Flats	20
2.7 Panel questions	20
2.8 Guiding principles	21
3 Assessment methods and data	22
3.1 Spatial units	22
3.2 Assessment sites	22
3.3 Assessment variables	24
3.4 Information and data available to the Panel	25
3.4.1 Technical Library	25
3.4.2 State and trend data	25
3.4.3 Assessment Spreadsheet	26
3.4.4 Web application	26
3.4.5 Scenario modelling	26
3.5 Assessment Methods	28
3.5.1 Assessment process for region-wide scenarios	28
3.5.2 Poverty Bay Flats	29
4 Panel Assessment of state and trends	30
4.1 Sediment-related attributes	30
4.1.1 Visual clarity (freshwater)	30
4.1.2 Visual clarity (estuaries)	32
4.1.3 Deposited fine sediment (freshwater)	32
4.1.4 Deposited fine sediment (estuaries)	33

4.2	Physico-chemical and habitat attributes	34
4.2.1	Water temperature (freshwater and estuaries)	34
4.2.2	Dissolved Oxygen (DO) (freshwater and estuaries)	35
4.2.3	Stream habitat	36
4.3	Eutrophication related attributes	38
4.3.1	Nutrients and periphyton (freshwater)	38
4.3.2	Nutrients, phytoplankton and macroalgae (estuaries)	40
4.4	Ecological attributes	42
4.4.1	Macroinvertebrates (freshwater)	42
4.4.2	Macroinvertebrates (estuaries)	44
4.4.3	Fish	45
4.5	Human health attributes	47
4.6	<i>E. coli</i> (Freshwater)	47
4.6.2	Baseline state	49
4.7	Human health (estuaries)	50
4.8	Summary of key issues	51
5	Panel assessment of scenario outcomes	53
5.1	Sediment loads and visual clarity	53
5.1.1	Scenarios, methods and limitations	53
5.1.2	Full afforestation (Scenario 2)	54
5.1.3	2040 (Scenario 3)	55
5.1.4	2060 (Scenario 4)	55
5.1.5	2090 (Scenario 5)	55
5.1.6	Response timeframes	56
5.1.7	Key messages	57
5.2	Deposited fine sediment	58
5.2.1	Scenarios, methods and limitations	58
5.2.2	Full afforestation (Scenario 2)	58
5.2.3	2040 (Scenario 3)	58
5.2.4	2060 (Scenario 4)	59
5.2.5	2090 (Scenario 5)	59
5.2.6	Response timeframes and key messages	59
5.3	Nutrient related attributes	59
5.3.1	Scenarios, models and limitations	59
5.3.2	Full afforestation Scenario (Scenario 2)	60
5.3.3	2040, 2060 and 2090 (Scenarios 3-5)	60

5.3.4	Influence of Climate change	61
5.3.5	Response timeframes	61
5.3.6	Key messages	62
5.4	Water temperature	62
5.4.1	Scenarios, models and limitations	62
5.4.2	Full afforestation (Scenario 2)	63
5.4.3	2040 (Scenario 3)	63
5.4.4	2060 (Scenario 4)	63
5.4.5	2090 (Scenario 5)	63
5.4.6	Response timeframes	63
5.4.7	Key messages	64
5.5	Dissolved oxygen	64
5.5.1	Scenarios, models and limitations	64
5.5.2	Full afforestation (Scenario 2)	65
5.5.3	2040 (Scenario 3)	65
5.5.4	2060 (Scenario 4)	65
5.5.5	2090 (Scenario 5)	65
5.5.6	Response timeframes	65
5.5.7	Key messages	65
5.6	Habitat	66
5.6.1	Scenarios, models and limitations	66
5.6.2	Full afforestation (Scenario 2)	66
5.6.3	2040 (Scenario 3)	66
5.6.4	2060 (Scenario 4)	67
5.6.5	2090 (Scenario 5)	67
5.6.6	Effects of Climate change	67
5.6.7	Response timeframes	67
5.6.8	Key messages	67
5.7	Macroinvertebrate communities	68
5.7.1	Scenarios, methods and limitations	68
5.7.2	Full afforestation (Scenario 2)	69
5.7.3	2040 (Scenario 3)	69
5.7.4	2060 (Scenario 4)	69
5.7.5	2090 (Scenario 5)	69
5.7.6	Influence of climate change and response timeframes	69
5.7.7	Estuaries	70

5.7.8	Key messages	70
5.8	Fish communities	70
5.8.1	Scenarios, methods and limitations	70
5.8.2	Full afforestation (Scenario 2)	71
5.8.3	2040 (Scenario 3)	71
5.8.4	2060 (Scenario 4)	71
5.8.5	2090 (Scenario 5)	71
5.8.6	Effects on tuna (eel) populations	72
5.8.7	Response timeframes	72
5.8.8	Key messages	72
5.9	Human Health Attributes	72
5.9.1	Scenarios, models and limitations	72
5.9.2	Full afforestation (Scenario 2)	74
5.9.3	2040 (Scenario 3)	74
5.9.4	Scenario 4 (2060)	75
5.9.5	Scenario 5 (2090)	75
5.9.6	Influence of climate change	75
5.9.7	Response timeframes and confidence	75
5.9.8	Key messages	76
6	Poverty Bay Flats: Issues and drivers	77
6.1	Taruheru catchment	77
6.1.1	Key issues	80
6.1.2	Sources and drivers	81
6.1.3	Potential actions	83
6.2	Waipaoa catchment	84
6.2.1	Key issues	86
6.2.2	Sources and drivers	87
6.2.3	Potential actions	87
6.3	Uawa Catchment	88
7	Knowledge gaps and recommendations	90
7.1	Freshwater	90
7.1.1	Sediment related attributes	90
7.1.2	Physico-chemical and habitat attributes	91
7.1.3	<i>Ecological variables</i>	92
7.1.4	Human health attributes (<i>E. coli</i>)	92

7.1.5	Eutrophication	93
7.1.6	Other knowledge gaps	93
7.2	Estuaries	93
References		94
Appendix A	Terms of reference	96
Appendix B	Technical Library	103
Appendix C	Summary tables and figures	104

List of figures

Figure 1: Tairāwhiti freshwater catchment areas.....	14
Figure 2: Waipaoa Catchment Freshwater Management Units (planning areas).	23
Figure 3: Waipaoa flood control scheme.....	78
Figure 4: Intensive land use and water quality and ecology monitoring sites in the lower Taruheru catchment.	79
Figure 5: Intensive land use and water quality and ecology monitoring sites in the lower Waipaoa catchment.....	85
Figure 6: Intensive land use and water quality and ecology monitoring sites in the Uawa catchment.....	89

List of tables

Table 1: Summary of region-wide scenarios	17
Table 2: Mitigations and actions for 2040, 2060 and 2090 scenarios. L03B means Land Overlay 3b, representing highly erodible land with connectivity to waterways.....	18
Table 3: Freshwater attributes and indicators assessed by the expert Panel and spatial scale of the assessment. Underlined attributes and indicators are those covered in scenario modelling.	24
Table 4: Estuarine attributes and indicators assessed by the expert Panel and spatial scale of assessment. Underlined attributes and indicators are those covered in scenario modelling at catchment "terminal" nodes.	24
Table 5: Overview of region-wide scenario modelling	27
Table 6: Summary of Suspended Fine Sediment (visual clarity) current attribute state at Te Tairāwhiti monitoring sites.	31
Table 7: Summary of human health (<i>E. coli</i>) current attribute state at Te Tairāwhiti monitoring sites.....	48
Table 8: Summary of <i>E. coli</i> concentration data available at riverine recreational sites. Percentage of time contact recreation sites in each class of 'suitable' (≤ 260 cfu/100 mL), 'caution advised' (>260 - ≤ 540 cfu/100 mL), and 'unsuitable' (>540 cfu/100mL) for contact recreation between supplied data and LAWA. n.: number of samples.	48

Table 9: Summary of *E. coli* concentration data available at riverine recreational sites. Percentage of time contact recreation sites in each class of 'suitable' (≤ 260 cfu/100 mL) and 'unsuitable' (> 260 cfu/100mL) for contact recreation between supplied data and LAWA. 49

Table 10: Summary of *E. coli* concentration data available at estuarine recreational sites or river recreational site near the river mouth. Percentage of time contact recreation sites in each class of 'suitable' (≤ 260 cfu/100 mL), 'caution advised' ($> 260 - \leq 540$ cfu/100 mL) , and 'unsuitable' (> 540 cfu/100mL) for contact recreation between supplied data and LAWA. n.: number of samples. 51

1 Introduction

1.1 Background and context

Following the release of the Essential Freshwater package in 2020, the Gisborne District Council (GDC) initiated the Tairāwhiti Resource Management Plan (TRMP) review. This process requires the setting of freshwater objectives and the evaluation of policies to achieve the objectives. GDC's review of its current Regional Freshwater planning provisions, comprises nine inter-connected areas of work:

- Seven catchment plans
- Regional freshwater provisions
- Supporting technical work.

The seven catchment areas are shown in Figure 1. The seven catchment plans under development are:

- Wharekahika- Waikura (Northern) Catchment Plan
- Waiapu Catchment Plan
- Ūawa Catchment Plan
- Waimatā – Pakarae Catchment Plan
- Waipaoa Catchment Plan
- Mōtū Catchment Plan
- Hangaroa-Ruakituri (Southern) Catchment Plan

A critical component of each catchment plan is to implement the National Objectives Framework (NOF) process outlined in the National Policy Statement – Freshwater Management 2020 (NPS-FM). The NOF requires the setting of environmental outcomes, freshwater values and attribute states for 22 freshwater attributes for every river and lake in Te Tairāwhiti. In implementing the NOF, Council must define:

- Current Attribute States (CAS) and Baseline Attribute States (BAS) representing the environmental state of each attribute as of a particular point in time;
- Target Attribute States (TAS) for each of the 22 attributes set at or above the National Bottom Line (NBL), and equivalent to, or better than the BAS;
- Limits¹ and Action Plans² that set out specific actions to achieve the TAS for each attribute.

In developing its freshwater policies, GDC is taking an integrated ki uta ki tai approach, which means that the values, sensitivity and state of downstream environments, such as estuaries must be considered. TAS that require different levels of water quality improvements will require different levels of interventions to mitigate the effects of human activities on water quality, and their relative costs and benefits must be considered to support decision making. TAS must be realistic and achievable, and linked to stated environmental outcomes, values and the overall vision for the environment.

To support the TRMP review in general, and the implementation of the NOF in each catchment plan in particular, GDC established the Tairāwhiti Freshwater Quality and Ecosystem Health Expert Panel ('the Panel') in mid- 2024. The purpose of the Panel was to provide expert opinion and advice on the likely impacts on water quality and ecological indicators (i.e., sediment, nutrients, pathogens, macroinvertebrate community index, fish) under different scenarios.

In 2024, the government announced its intention to review the NPS-FM and subsequently introduced changes to the Resource Management Act 1991 restricting notification of freshwater planning instruments (regional policy statements and plans that give effect to the NPS-FM 2020) until a new NPS-FM takes effect, or 31

¹ Attributes set in NPS-FM Appendix 2A require the setting of 'limits on resource use'

² Attributes set in the NPS-FM Appendix 2B require Action Plans, which may include both regulatory and non-regulatory measures

December 2025., whichever comes first. Whilst this change introduced a degree of uncertainty in the freshwater resource management framework, Council made the decision to continue with the Panel process as this information would be needed and useful to any future planning process, irrespective of the specific planning instrument. However, the Panel process was adapted to focus on key issues relevant to Te Tairāwhiti and selected water quality and ecological indicators to ensure applicability to any future planning process.

1.2 Purpose and structure of this report

The primary purpose of this report is to provide a summary of the Panel process, methods and outcomes. In addition to this first, introduction, section this report comprises the following five sections

- Section 2 describes the Panel process.
- Section 3 describes the data and information available to the Panel, and the methods used by the Panel in their assessment.
- Section 4 provides a summary of the outcomes of the Panel assessment of the current, baseline and reference states and temporal trends of water quality and ecological indicators, as well as a broad summary of issues and information gaps.
- Section 5 provides a summary of the outcomes of the Panel assessment of five region-wide management scenarios, including the potential influence of climate change, on water quality and ecological indicators in freshwater and estuaries.
- Section 6 provides a summary of the Panel's assessment of issues and drivers of water quality and ecology in the Poverty Bay Flats area.

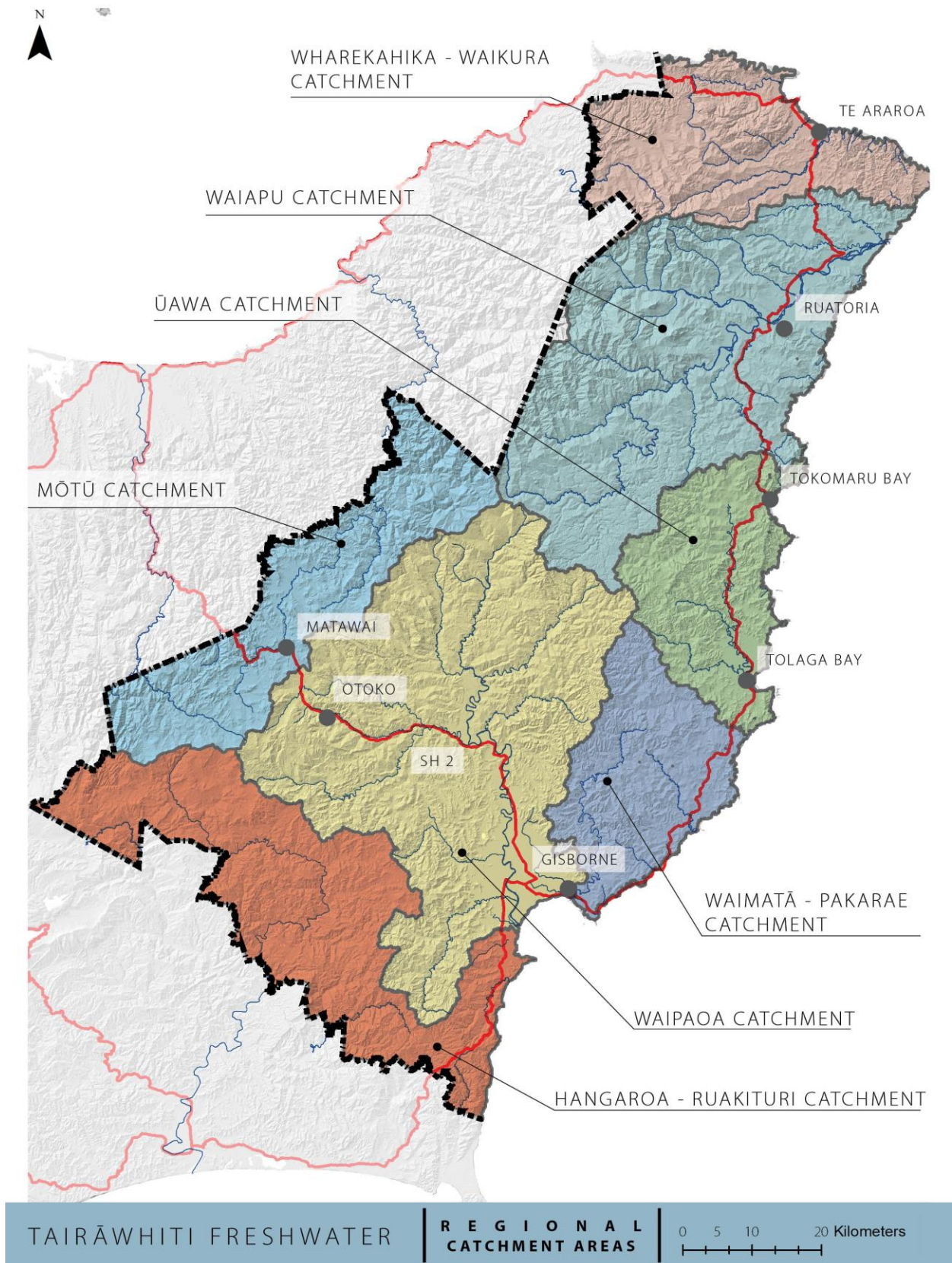


Figure 1: Tairāwhiti freshwater catchment areas.

2 Expert Panel Process

2.1 Why an expert Panel?

Fundamental components of freshwater policy development include (1) a clear understanding of the state of the resource and related issues, (2) the development of potential policy directions, and (3) an evaluation of the potential outcomes of the policies, including an understanding of feasibility costs and benefits. To support this process, it is common practice for regional councils, partners and stakeholders to evaluate a range of “management scenarios” defined on the basis of:

- Various degrees of water quality improvements (e.g., “maintain water quality”, improve to NBL, improve over time to a better attribute state). In this case the type and level of interventions (and their costs) that must be implemented to achieve the TAS must be estimated.
- Various “types” (e.g., stock exclusion, stormwater treatment) or implementation levels (e.g., voluntary, mandated) of interventions. In this situation, their costs and the water quality outcomes resulting from their implementation must be assessed.

The overarching objective of assessing management scenarios is to provide insights into the potential water quality benefits associated with distinct each scenario. This, in turn, facilitates well-informed decision-making pertaining to the establishment of freshwater objectives (target attribute states), limits, methodologies, and timeframes, as mandated by the NOF.

Assessing scenarios is a technically challenging exercise, as it must be based on a sound understanding of current state, and requires quantifying the cumulative effectiveness of a range of interventions or mitigation actions at the catchment or sub-catchment scale and their potential flow-on effects on water quality and ecological attributes over time. Catchment models can be useful to support the assessment of scenarios, as they present the advantage of being able to integrate complex catchment-scale mitigation assumptions and produce an indication of the direction and magnitude of scenario outcomes at a location-specific scale. However, catchment models can be very costly and time-consuming to develop and run, and often have significant limitations, particularly with regards to assessing response times (many models are “steady state³” models), quantifying ecological responses and the level of trust communities may have in models due to their complexity and perceived opacity (PCE, 2024).

Expert panels tend to be more agile and are able to draw on, and synthesise, diverse data and information sources, including existing models. Expert assessment can be applied to a wider range of metrics/attributes, especially ecological indicators that are not currently well represented in models. Being composed of independent subject matter experts, expert panels can be perceived as more transparent and impartial than individual experts; they are also able to evaluate complex questions and interact directly with consultation partners and stakeholders in a way that models cannot. Nationally, expert panels have been used in different regions to assess freshwater quality and ecology (e.g., Canterbury, Wellington, West Coast and Bay of Plenty), water quantity and allocation (e.g., Horizons, Wellington), as well as coastal water quality and ecology (e.g., Wellington). In some of these examples, the evaluation of management scenarios extended to societal, cultural, and economic outcomes.

2.2 Expert panel composition

Panel members were appointed following a public request for proposal (RFP) process released on the government electronic tender service in July 2024. The RFP sought experts in one or more of the following fields at a local and/or national level:

- River water quality and ecology

³ A ‘steady state’ model assumes that conditions do not change over time and that the system is in equilibrium. E.g., that the amount of sediment entering and leaving a system is constant over time.

- Lake water quality and ecology
- Catchment modelling
- Erosion and sediment transport processes and loss mitigation
- *E. coli* transport processes and loss mitigation
- Nutrients and periphyton
- Estuarine water quality and ecology
- Mātauranga Māori and Te Ao Māori, particularly in a Te Tairāwhiti context.

Following evaluation of the proposals, the following six experts were selected:

- Dr Joanne Clapcott, Freshwater Ecologist at Cawthron Institute
- Anna Madarasz-Smith, Technical Director Coastal at Pattle Delamore Partners Ltd (PDP)
- Dr Richard Muirhead, Senior Scientist at the AgResearch Group of the Bioeconomy Science Institute
- Paul Murphy, Environmental Science Technical Lead at GDC
- Dr Andrew Neverman, Senior Researcher - Geomorphology / Erosion & Sediment Processes at the Manaaki Whenua – Landcare Research group of the Bioeconomy Science Institute
- Ned Norton, consultant Director at LWP.

To support the Panel assessment process, Dr Olivier Ausseil and Dr Mark Heath from Traverse Environmental were appointed as technical chair and technical support, respectively. The Panel's Terms of Reference (ToR) provide further detail on the Panel composition and process (Appendix A).

2.3 Purpose and Objectives

The purpose and objectives of the Panel are defined in the ToR (Appendix A). The purpose of the Panel was to provide expert advice and judgement on the likely impacts on water quality and ecological indicators (i.e., sediment, nutrients, pathogens, MCI, fish etc.) under different scenarios.

The objectives of the Panel were defined as follows:

- Refine the assessment methodology developed by Gisborne District Council (GDC).
- Contribute as appropriate to a technical library which will include journal articles, reports, monitoring data, modelling information and any other publications relevant to the Waipaoa catchment and the wider Gisborne Regions catchments and/or which will inform the work of the Panel.
- Develop a shared understanding of the bio-physical state of surface water quality and ecology within the catchment, based on information in the technical library.
- Drawing on the technical library, evaluate different scenarios that may influence indicators of water quality and ecosystem health (primarily related to NPS-FM attributes, but not limited to these).
- Produce a summary for each assessment unit for each of the various indicators which includes using a set of criteria to determine the potential magnitude of change (in attribute state as per the NPS-FM National Objectives Framework), the effect and level of confidence in the assessment, as well as some high-level explanatory comments.

2.4 Scope

The Panel's assessment was limited to assessing the potential outcomes of each scenario on freshwater and/or estuarine water quality and ecology. The Panel's scope specifically excluded freshwater lakes and wetlands, as well as open coastal waters. The Panel's scope excluded assessment of the costs or feasibility of implementing any mitigations. The Panel's assessment also excluded any in-depth assessment of issues associated with urban areas, such as stormwater and wastewater discharges.

Following evaluation of the applications and appointment of the Panel, GDC decided to seek advice and input relating to cultural matters outside the Panel. Mātauranga Māori was thus excluded from the Panel's scope.

2.5 Region-wide scenarios

A set of region-wide management scenarios were developed by the GDC freshwater project team and provided to the Panel for their review and input. The Panel input was limited to clarifying key assumptions to ensure clarity and consistency of scenario modelling. The overall direction, focus and intent of each scenario were defined by the GDC freshwater project team and were not modified by the Panel. An overview of the region-wide scenarios is provided in Table 1. Table 2 provides a breakdown of land mitigation actions assumed under each region-wide scenario. These scenarios focus on management of sediment and faecal contamination (*E. coli*), those having previously been identified as the two main region-wide water quality issues in the Tairāwhiti Region. Each Scenario was assessed on the basis of two sub-scenarios, under current climatic conditions and assuming a range of climate change (CC) projections (thereafter noted as Scenario X plus CC). Although outside the scope of the Panel's assessment, these scenarios may also form the basis for economic, social and cultural assessments.

Table 1: Summary of region-wide scenarios

Scenario	Description
Scenario 1: Current State	Represents current and baseline state. Two region-wide sub-scenarios are: (1a) without climate change and (1b) with climate change projections (mid-century and late-century projections). <i>Note: it was assumed this scenario provided a reasonable representation of the current level of implementation of land retirement, erosion control and riparian management measures. Climate change scenarios therefore represent the impact of climate change if no further mitigations were implemented.</i>
Scenario 2: Full afforestation	Represents "best achievable" state. This scenario is not intended to represent a credible policy option but rather it is a way to assess best potential state that could be achieved given naturally occurring / un-mitigatable processes if the catchments were returned to full permanent tree cover, under a contemporary climatic and hydrological regime. This scenario assumes permanent, mature tree cover, and thus represents a long-term outcome. The starting point is the contemporary conditions, incorporating original deforestation and history of land use since. For sediment modelling, contemporary gullies (i.e. including those triggered or exacerbated by historical deforestation) considered "un-mitigatable" remain un-mitigated in this scenario.
Scenario 3: 2040	Represents a policy package that could be implemented region-wide through TRMP in the next 10 to 15 years. This scenario is based on a "challenging but achievable" level of implementation of key mitigations / actions that primarily target erosion (e.g., tree planting on highly erodible land) across the region and <i>E. coli</i> (e.g., stock exclusion) in two catchments with high recreational use as a priority. Two region-wide sub-scenarios are: (3a) without climate change and (3b) with climate change (mid-century projections).
Scenario 4: 2060	This scenario represents a progression between Scenarios 3 and 5. This scenario assumes a progressive increase in key mitigation measures targeting erosion and <i>E. coli</i> across the region. For <i>E. coli</i> , stock exclusion is prioritised in all catchments upstream of recreational sites.
Scenario 5: 2090 (Long term vision)	This scenario represents a long-term "aspirational" state that could be achieved by the turn of the century. Based on extensive implementation of key mitigation measures targeting erosion and <i>E. coli</i> across the region. Two region-wide sub-scenarios are: (5a) without climate change and (5b) with climate change (late-century projections)

Table 2: Mitigations and actions for 2040, 2060 and 2090 scenarios. LO3B means Land Overlay 3b, representing highly erodible land with connectivity to waterways.

Mitigation / action	Mitigation description 2040	Changes for 2060	Changes for 2090
Land overlay 3B	<p>Assumes 30% of LO3B land currently in forestry and 20% of LO3B land currently in pastoral land use will be transitioning to permanent woody vegetation.</p> <p>Of the forestry land to be mitigated:</p> <ul style="list-style-type: none"> 50% non-harvested exotic forest (assume trees by 2040) 50% planted in natives or naturally reverting (assume scrub by 2040). <p>Of the pastoral land use to be mitigated:</p> <ul style="list-style-type: none"> 50% planted in natives or naturally reverting (assume scrub by 2040) 50% pole planting Assume no stock exclusion except for land planted in native plants <p>25% of those gullies that are mitigatable will be mitigated by 2040</p> <p>All mitigations will be spatially randomised across the region (i.e. we don't know what is going to happen where.)</p>	<p>Assumes 80% of LO3B land currently in forestry and 50% of LO3B land currently in pastoral land use will be transitioning to permanent woody vegetation (these are % of total LO3B land area, i.e. include land already mitigated under the 2040 scenario).</p> <p>Of the additional (vs. 2040) forestry land to be mitigated:</p> <ul style="list-style-type: none"> 50% non-harvested exotic forest (assume trees by 2060) 50% planted in natives or naturally reverting (assume scrub by 2060) <p>Of the additional pastoral land use to be mitigated:</p> <ul style="list-style-type: none"> 50% planted in natives or naturally reverting (assume scrub by 2040) 50% pole planting Assume no stock exclusion except for land planted in native plants <p>80% of those gullies that are mitigatable will be mitigated by 2060.</p> <p>The land mitigated in the 2040 scenario is assumed to be in mature vegetation / trees in 2060 (from scrub in 2040).</p> <p>"New / additional" mitigated land (being land areas mitigated in the 2060 scenario but not in the 2040 scenario) assumed to be in shrub / scrub</p>	<p>Assumes 100% of LO3B land currently in forestry and 80% of LO3B land currently in pastoral land use will be transitioning to permanent woody vegetation (these are % of total LO3B land area, i.e. include land mitigated under the 2060 and 2040 scenarios).</p> <p>Of the additional (vs 2060) forestry land to be mitigated:</p> <ul style="list-style-type: none"> 50% non-harvested exotic forest (assume trees by 2040) 50% planted in natives or naturally reverting (assume scrub by 2040) <p>Of the pastoral land use to be mitigated:</p> <ul style="list-style-type: none"> 50% planted in natives or naturally reverting (assume scrub by 2040) 50% pole planting Assume no stock exclusion except for land planted in native plants <p>100% of those gullies that are mitigatable will be mitigated by 2090.</p> <p>All mitigated land assumed to be in trees (long-term scenario).</p>
Erosion control outside of LO3B:	<p>Pastoral: Assume 15% space planted in poles (no stock exclusion)</p> <p>Forestry: Assume 10-m wide permanent riparian buffer with woody vegetation (noting riparian / streams within forestry areas are expected to be captured in LO3B land)</p>	<p>Pastoral: Assume 40% planted in poles (no stock exclusion)</p> <p>Forestry: Assume 10-m wide permanent riparian buffer with woody vegetation (noting riparian / streams within forestry areas are expected to be captured in LO3B land)</p>	<p>Pastoral: Assume 70% planted in poles (no stock exclusion)</p> <p>Forestry: Assume 10-m wide permanent riparian buffer with woody vegetation (noting riparian / streams within forestry areas are expected to be captured in LO3B land)</p>

Mitigation / action	Mitigation description 2040	Changes for 2060	Changes for 2090
Pastoral Steep – high susceptibility class land (Classes 5 (HL) & 6 (HM) from shallow landslide susceptibility-connectivity model ⁴)			
Stock exclusion & riparian planting (pastoral land only)	<p>Assume 100% implementation of NES</p> <p>Assume 15% stock exclusion (streams of order ≥ 3, 5-m wide mixed planted buffer) in catchments upstream of:</p> <ul style="list-style-type: none"> • Wharekopae at Rere falls • Hangaroa at Doneraile Park • Stock exclusion spatially randomised <p>Assume 3% stock exclusion (streams of order ≥ 3, 3-m wide grass filter strips) elsewhere</p> <p>Stock exclusion spatially randomised across the region</p>	<p>Assume 50% stock exclusion (streams of order ≥ 3, 5-m wide mixed planted buffer) in catchments upstream of all recreational sites</p> <p>Assume 10% stock exclusion (streams of order ≥ 3, 3-m wide grass filter strips) elsewhere</p>	<p>Assume 80% stock exclusion (streams of order ≥ 3, 5-m wide mixed planted buffer) in catchments upstream of all recreational sites</p> <p>Assume 15% stock exclusion (streams of order ≥ 3, 3-m wide grass filter strips) elsewhere</p>
Mitigations not included in Panel assessment			
Animal management	Targeted animal management to control ungulate and possum numbers in catchments with regionally significant recreational sites	Targeted animal management to control ungulate and possum numbers in catchments with regionally significant recreational sites	Targeted animal management to control ungulate and possum numbers in catchments with regionally significant recreational sites
Farm / Environmental plans	<p>Farm / Environmental plans will be main policy “vehicle” for mitigation packages / action plans</p> <p>Critical source areas identified in Farm / Environmental plans</p> <p>Assume 10% of critical source areas for <i>E. coli</i> and nutrients are mitigated</p>	Assume 30% of critical source areas for <i>E. coli</i> and nutrients are mitigated	Assume 50% of critical source areas for <i>E. coli</i> and nutrients are mitigated

⁴ Technical Library TL#034

2.6 Poverty Bay Flats

Whilst it was originally anticipated that land use scenarios would be developed and modelled specifically for the Poverty Bay Flats area, where most of the intensive land-use in the region is located, a lack of detailed information on current land use practices meant that only a single “idealised” scenario (where fertiliser applications were reduced to a theoretical point where further reductions would mean loss of crop quality or quantity) was able to be modelled and no mitigation measures were modelled by Plant and Food Research (PFR) (Green et al., 2024; Technical Library TL#031). A simplified approach was developed for the Panel’s assessment of the Poverty Bay Flats area, based on the identification of issues and drivers and knowledge gaps (see Question Group 6 in the following section).

2.7 Panel questions

To provide a basic structure for the Panel assessment, a set of questions was developed by the GDC freshwater project team. Similarly to the scenarios, the overall direction, focus and intent of these questions were defined by the GDC freshwater project team, and the Panel input was limited to clarification and consistency aspects. The questions were grouped in six groups, summarised below. The full list of questions is included in the section describing the Panel’s assessment of scenarios (Section 5).

- **Question Group 1: Current / baseline state and trends.** The intent of this first group of questions is to provide an assessment of what is known about the current, baseline and reference states and temporal trends of each freshwater attribute at (1) each of the specified sites and (2) at the scale of the region and assessment (catchment or planning area) areas. The data and information used to support this assessment included monitoring data and modelled current state.
- **Question Group 2: Scenarios.** The intent of this group of questions was to support the development and description of catchment scenarios.
- **Question Group 3: Modelling approach.** The intent of this group of questions is to capture the Panel’s comments on the data and methods used to model the outcomes of the 5 scenarios and how the modelling outputs may / may not be used.
- **Question Group 4: Modelling outputs.** The intent of this group of questions was to record (1) a high-level narrative assessment of the outcomes of each scenario at catchment / planning area scale (site-scale assessment is captured in the Assessment Spreadsheet) and (2) an expert-opinion based interpretation of the modelling results. For example, the Panel were asked to comment on potential response time, given all models used to run the region-wide scenarios are “steady state” models, i.e. do not provide outputs related to response timeframes.
- **Question Group 5: Non-modelled Attributes.** The outcomes of the various scenarios were only modelled for a limited range of freshwater quality attributes. Water quality scenario outcomes were not modelled but were informed by the freshwater modelling at terminal nodes (i.e. immediately upstream of estuaries). A key function of the Panel is to provide an assessment of the potential / likely outcomes of each scenario on non-modelled attributes or indicators, especially those relating to physical habitat and ecological health at site- scale and catchment / planning area-scale.
- **Question Group 6: Taruheru / Poverty Bay Flats.** The intent of this group of questions was to capture the Panel’s assessment of water quality and ecological issues associated with intensive land use in the Poverty Bay Flats area, their drivers and potential solutions. The geographic area covers the Taruheru River, lower Waipaoa River and Uawa catchments.

2.8 Guiding principles

The GDC freshwater project team identified the following general principles to be considered by the Panel:

- **Focus on the big issues:** where possible, the Panel should focus their attention and effort on the main regional issues and selected key water quality and ecological indicators.
- **Acknowledge uncertainty:** relative to upcoming changes in the national freshwater legislation and policy framework, the Panel should focus on key indicators that are likely to remain relevant regardless of future legislative changes.
- **Provide overall narrative assessments:** where possible and useful, particularly for indicators not directly relevant to a main issue, or in situations where only a qualitative or semi-quantitative assessment can be undertaken.
- **Identify knowledge gaps:** to guide future monitoring and investigations, limitations, uncertainties and unknowns should be stated.

The GDC freshwater project team also indicated a general intention to focus the setting and monitoring of target attribute state (TAS) at key, representative sites within each catchment or planning area, and thus a strong preference for the Panel to focus their assessment on existing monitoring sites. Key reasons for this preference included:

- A lack of reliable regional models to predict the current state of key indicators (sediment-related attributes, *E. coli*, macroinvertebrates).
- Perceived poor performance / reliability of national models, in part due to the lack of Tairāwhiti data in the datasets used for national model development and the distinctive erosion dynamics in the Tairāwhiti region.
- Difficulties with assessing progress towards TAS in the future, based on models only.

However, the GDC freshwater project team also raised the issue that setting TAS only at specified sites did not provide certainty for freshwater targets elsewhere in the stream network, and some advice from the Panel of how results may be able to be extrapolated to areas without information would be useful.

Based on the above guiding principles and direction from the GDC team, the Panel resolved to prioritise the quantified assessment of scenario outcomes at specified sites (i.e., assessment sites) but to also provide, insofar as possible, a broader scale assessment (i.e., planning area/catchment) of scenario outcomes based on:

- Outcomes of the modelled scenario outputs at specified sites,
- An evaluation of the representativeness of sites within spatial units, and
- A consideration of readily available current and reference state spatial models and their applicability to the Tairāwhiti region.

3 Assessment methods and data

3.1 Spatial units

The TRMP review includes the preparation of seven catchment plans, collectively covering the whole of the Tairāwhiti region Figure 1. Further, four Freshwater Management Units (planning area) were defined in the Waipaoa catchment (Figure 2). The Panel was therefore required to structure their assessment around the following ten discrete (catchment or planning area) areas, thereafter called “planning areas”:

1. Hangaroa – Ruakituri
2. Mōtū
3. Waiaapu
4. Ūawa
5. Waimatā
6. Wharekahika - Waikura
7. Waipaoa - Hill Country
8. Waipaoa - Gisborne Urban
9. Waipaoa - Poverty Bay Flats
10. Waipaoa - Te Arai

3.2 Assessment sites

As part of its various freshwater monitoring programmes, GDC collects, or has recently collected, data at 116 sites (hereafter called ‘assessment sites’), which were used to form the basis of the Panel’s site-based assessment. A summary of monitoring sites in each planning area, what is monitored at each site (e.g., water quality, ecology), and some of the site’s biophysical characteristics (e.g., stream order, REC class, catchment area, sediment class, etc) is provided in Appendix 2.

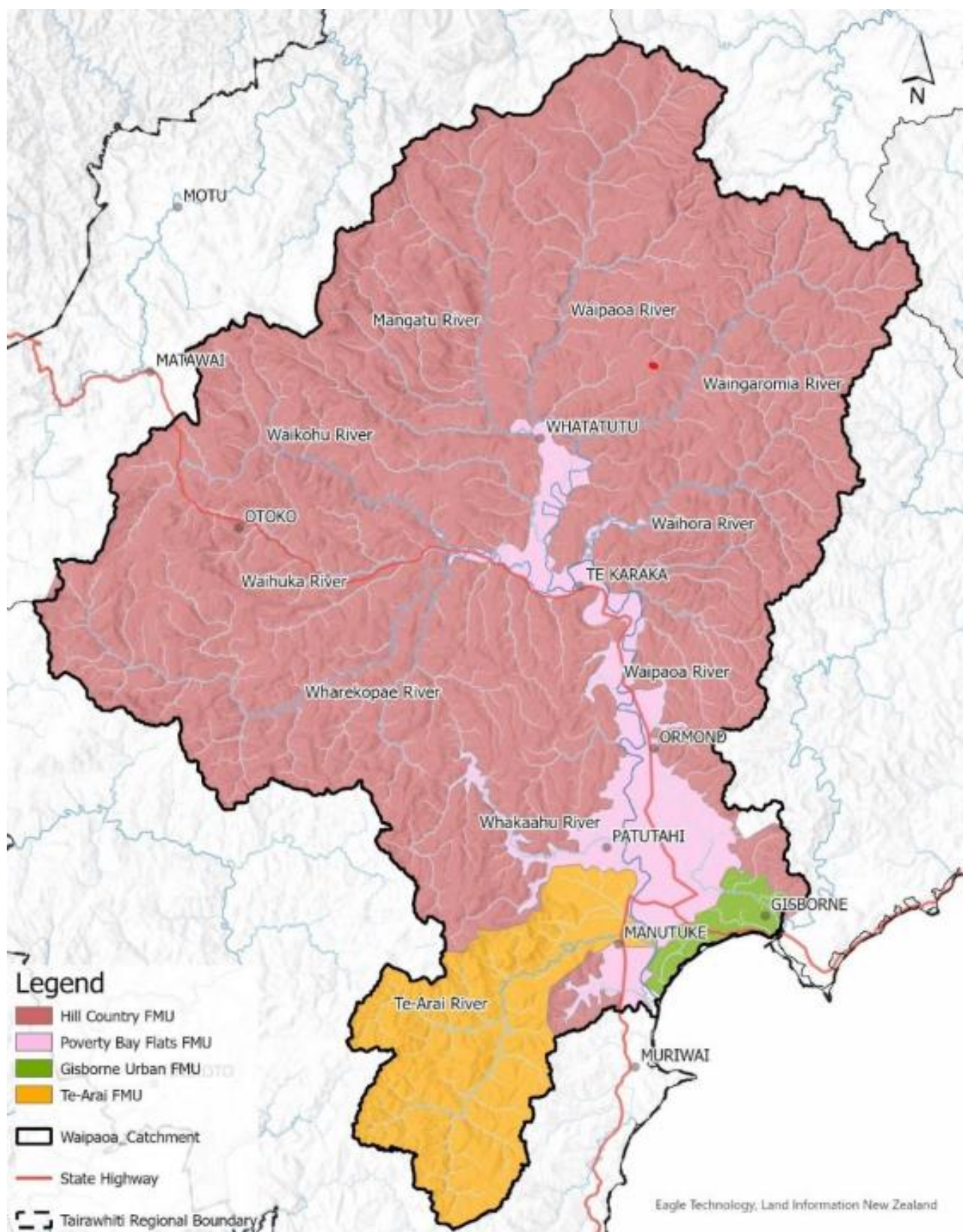


Figure 2: Waipaoa Catchment Freshwater Management Units (planning areas).

3.3 Assessment variables

Table 3 and Table 4 below list the freshwater and estuarine attributes and indicators covered by the Panel assessment of scenario outcomes.

Table 3: Freshwater attributes and indicators assessed by the expert Panel and spatial scale of the assessment. Underlined attributes and indicators are those covered in scenario modelling.

Attribute class	Attribute / Indicator	Spatial scale	Catchments
Sediment	<u>Mean annual suspended sediment loads</u> <u>Suspended fine sediment (visual clarity)</u> Deposited fine sediment (DFS)	Assessed at site scale	All Tairāwhiti catchments
Human Health / pathogens	<u>E. coli</u>	Site	All Tairāwhiti catchments
Nutrient	<u>DIN</u> <u>DRP</u>	Site Site	Poverty Bay Flats & Uawa flats Region wide
Physico-chemical variables	Temperature DO	Site	All Tairāwhiti catchments
Habitat	Rapid Habitat Assessment (RHA)	Site	All Tairāwhiti catchments
Ecological	Periphyton / phytoplankton Macroinvertebrate communities Fish	Site	All Tairāwhiti catchments

Table 4: Estuarine attributes and indicators assessed by the expert Panel and spatial scale of assessment. Underlined attributes and indicators are those covered in scenario modelling at catchment “terminal” nodes.

Attribute class	Attribute / Indicator	Spatial scale	Catchments
Sediment	<u>Mean annual suspended sediment loads (qualitative assessment only) and</u> <u>Suspended sediment concentration (TSS)</u> Sediment mud content (<63um)	Assessed at site scale	All specified estuaries
Human Health / pathogens	<u>E. coli</u> / <u>Enterococci</u>	Site	All recreational water sites within estuaries
Nutrient	<u>DIN/TN</u> <u>DRP/TP</u>	Site Site	Poverty Bay Flats & Uawa flats Region wide
Physico-chemical variables	Temperature DO	Site	All specified estuaries
Ecological	Macroalgal blooms Macroinvertebrates Fish	Site	All specified estuaries

3.4 Information and data available to the Panel

To enable the Panel to understand the region's water quality and ecological issues—along with their spatial and temporal variability—and to assess both current state and future states under different management scenarios, a range of tools, information and data sources was assembled. The purpose of these resources was to ensure that all Panel members had access to consistent and reliable information, supporting a robust and efficient assessment process. The primary tools were:

- A technical library, assembling technical reports, memos, scientific publications and datasets relevant to the Panel's assessment
- Assessment spreadsheet to capture the Panel's assessment of current and reference state and scenario outcomes at each assessment site
- An interactive Web application displaying monitoring sites and nodes, current state and trends, and spatial spread of monitoring sites,
- State and trends data from monitoring and national-scale models describing reference, baseline and current states, and
- Scenario modelling.

Further details on information sources, key assumptions, data for each attribute, the pre-population of the assessment spreadsheet, and guidance on the various tools were provided to the Panel in a technical memo⁵

3.4.1 Technical Library

One of the principal tools used by the Panel was the science technical library. This served as a shared repository of key technical information, enabling all Panel members to access to the same data and develop a consistent understanding. The library included:

- Technical reports on current state and trends,
- National modelling data describing state,
- Maps and GIS layers of current and future land use,
- Scenario modelling of future states under the catchment management scenarios, and
- Scientific journal articles and technical reports on the effectiveness of mitigation measures and land use change on water quality and ecological outcomes.

A full list of resources contained in the technical library is provided in Appendix B. Each resource was allocated a unique identifier (e.g., TL#001), used throughout this report for references to technical library resources.

3.4.2 State and trend data

Analysis of state and trend data for a range of freshwater NOF and non-NOF attributes were prepared to support the Panel's assessments. This included:

- Measured baseline and current state data — in most cases, current state was assessed over the five-year period from July 2018 to June 2023,
- Modelled reference state — where available from existing national models, were used to provide a benchmark for assessing future state under different catchment management scenarios,
- Modelled current state — where available from existing national models, were used to estimate current state at all monitoring sites and nodes, and to determine the proportion of stream segments falling into each attribute band, and
- Technical reports — where monitoring data were limited (e.g., for periphyton), targeted technical assessments were undertaken to inform state estimates.

⁵ Technical Library TL#086. Heath, 2025, technical memo.

3.4.3 Assessment Spreadsheet

To support the Panel's assessment, an "Assessment Spreadsheet" was created. This spreadsheet served two main purposes: (1) as a repository of metadata and information relevant to the Panel's assessment in each planning area and (2) as a vehicle to record the Panel's assessment of state (current, baseline, reference) and scenario outcomes for each attribute or indicator and at each site. The spreadsheet was limited to freshwater assessment sites and attributes.

The spreadsheet was populated with the following metadata and information for each of the 10 planning areas:

- A table showing the monitoring sites in each planning area, what is monitored at each site (e.g., water quality, ecology), and some of the site's biophysical characteristics (e.g., stream order, REC class, catchment area, sediment class, etc).
- A table showing modelled current state estimates (from national-scale models), of the proportion of stream segments within each planning area falling into each attribute band.

The third main component of the assessment spreadsheet was a large table enabling the recording, showing, for each assessment site and each attribute or indicator, of the Panel's assessment of:

- State (current, baseline and reference) and associated confidence level (low /medium/high);
- Scenario outcomes under each scenario and associated confidence level.

At the Panel's request, and where possible, this table was pre-populated with state information (current and modelled attribute states) and numerical scenario outcomes for modelled variables (sediment loads, visual clarity, *E. coli* and nutrients). Importantly, all information was reviewed and assessed in detail and modified by the Panel as required. The final assessment spreadsheet thus represents the Panel's own assessment. For convenience, key components of the Assessment Spreadsheet are provided in Appendix C of this report.

3.4.4 Web application

To help the Panel locate monitoring sites within each planning area, assess spatial variation in state across planning areas and the wider Tairāwhiti region, and evaluate how representative different types of monitoring sites were, an interactive web application was developed. The application displayed monitoring sites and nodes, current state and trends, site distribution, and land cover.

3.4.5 Scenario modelling

To support the Panel in assessing future state under each catchment management scenario, modelling was undertaken to estimate potential outcomes for key water quality attributes: visual clarity, nutrients (DIN and DRP), and *E. coli*. Table 5 provides an overview of the modelling approach, key model outputs and limitations and references to technical documentation.

Table 5: Overview of region-wide scenario modelling

Attribute / indicator	Modelling Approach	Outputs	Limitations	References
Sediment Attributes (mean annual suspended sediment loads and visual clarity)	Manaaki Whenua tasked with modelling 7 region-wide scenarios using a modified version of the national-scale model developed by Neverman et al., 2023, incorporating regional gully mapping data into the model framework.	~80 modelling nodes covering existing monitoring sites and terminal reach of main river catchments. Changes in mean annual suspended sediment loads at each node (52 nodes) Changes in visual clarity at nodes with existing data (33 sites)	Cannot model small catchments (order 3 and below). Steady state model (no consideration of response time between mitigation and water quality improvement). Freshwater only.	Scenario modelling: Neverman & Smith, 2025. Model description: Neverman et al., 2023 and Neverman & Smith, 2025.
<i>E. coli</i>	Modelling of the 5 scenarios undertaken by Traverse Environmental, using OLW Scenario Builder ⁶ for rivers, modified to use median ETC from empirical model (McDowell et al., 2013) for native vegetation land cover Two sub-scenarios to be modelled for each scenario: <ul style="list-style-type: none"> Land-use change Land-use change plus fencing mitigation 	116 modelling nodes covering existing monitoring sites and terminal reach of main river catchments. Predicted relative change in average annual load and median <i>E. coli</i> concentration at all nodes. Predicted future concentration at all modelling nodes with existing <i>E. coli</i> data (SoE and recreation monitoring programmes).	Runoff events / 95 th percentile will not be modelled. Freshwater only, degree of change at freshwater terminal nodes was modelled to support estuarine assessment. The only mitigations that can be modelled through this approach are stock exclusion and land use change. Other mitigation measures (e.g., critical source areas mitigation, stock water reticulation) have unknown effectiveness and cannot be modelled. Climate change scenarios cannot be modelled. The influence of pest control on <i>E. coli</i> is unknown and cannot be modelled.	Scenario modelling: Technical memo (TL#082) Model description in Snelder et al., 2024.
Nutrients (excluding intensive land use in Taruheru / Gisborne flat areas)	Modelling of the 5 scenarios undertaken by Traverse Environmental, using OLW Scenario Builder for rivers.	116 modelling nodes covering existing monitoring sites and terminal reach of main river catchments. Predicted relative change in average annual load and median TN, TP, DIN and DRP concentration at all nodes. Predicted future concentration at all modelling nodes with existing data	Freshwater only, degree of change at freshwater terminal nodes was modelled to support estuarine assessment. First order estimate of direction and quantum of change associated with the land use change associated with Scenarios 2-5 only. Climate change cannot be assessed through model.	Scenario modelling: Technical memo (TL#082) Model description in Ausseil et al., 2024.

⁶ Described in Ausseil et al., 2024 and associated references, e.g., Snelder et al., 2020, 2024, Srinivasan et al., 2021, Monaghan et al., 2021.

3.5 Assessment Methods

3.5.1 Assessment process for region-wide scenarios

The assessment process used by the Panel was based on a suite of three logical steps.

- The first step was to establish an understanding of the current state and drivers of the freshwater and estuarine systems, based on available information. The Panel's assessment was supported by a significant body of evidence provided in technical reports and memos. The Panel's assessment relied on best available information. Where data was insufficient to support a full, data-based assessment (e.g., 5 years of monthly data required to formally assess NPS-FM current or baseline attribute state), the Panel used a "multiple lines of evidence" approach, which consists in using different types of data from various sources to strengthen the validity and reliability of findings by ensuring consistency across diverse data points. For each attribute or indicator, the Panel was asked to assess current, baseline and reference states and temporal trends. The assessment was undertaken at the scale of each assessment site (as captured in the Assessment Spreadsheet). The Panel was also asked to provide a narrative describing the patterns of state and trends in each planning area, the data and methods used in the assessment and the Panel's level of confidence in the assessment. In some situations, the Panel were unable to provide an assessment; in which case they were asked to record the reason(s).
- The second step was to model the water quality outcomes of different management scenarios. Whilst the development of the scenarios and their modelling was undertaken outside of the Panel, members were asked to review and provide a narrative describing the modelling methods (data, assumptions, methods), outputs and level of confidence.
- The last step was to use the best available data and information to assess both the modelled outcomes described above, and the potential outcomes of each scenario on the attributes or indicators that were not modelled (typically habitat, ecological and estuarine attributes and indicators). The Panel's assessment generally relied on multiple lines of evidence and expert knowledge, incorporating the outcomes of the first two steps and any additional information relevant to the assessment. The sequence of assessment of each attribute or indicator was determined to account for known causal links between indicators. For example, deposited sediment and periphyton are known drivers of macroinvertebrate health; the Panel therefore assessed the likely outcomes of each scenario on deposited sediment (based on the outcomes of sediment load modelling) and periphyton (based on the outcomes of nutrient modelling) first, then used the outcomes of this assessment to inform into their assessment of macroinvertebrate outcomes of each scenario.

At each step, the assessments of each scenario were undertaken at each of the 116 assessment sites, complemented by a narrative summarising patterns at the planning area scale, the data and methods used in the assessment and the Panel's level of confidence in the assessment.

To make best use of each Panel member's areas of expertise and minimise the time required to undertake the assessment, the Panel decided to divide initial assessment tasks amongst Panel members. The approach consisted in allocating sub-groups of 2-3 Panel members to lead different parts of the Panel assessment. The assessments developed by the sub-groups were then presented to the rest of the Panel for discussion during the Panel's final workshop, when an agreed assessment from the Panel was finalised.

The Panel's site scale assessment of each attribute or indicator at each of the 116 assessment sites is captured in the Assessment Spreadsheet, which forms an electronic appendix to this report. For convenience, the main elements the spreadsheet are reproduced in Appendix 2.

At each of the 116 assessment sites and for each attribute or indicator where data was available, the spreadsheet contains the Panel's assessment of:

- current, baseline and reference state and confidence rating (low/medium/high)
- outcome of Scenarios 2 to 5, for modelled variables (visual clarity, nutrients and *E. coli*) and, where possible, non-modelled variables (e.g., deposited sediment, periphyton, MCI), and associated confidence rating.

3.5.2 Poverty Bay Flats

As explained in Section 2.6, the Panel were asked to specifically focus on potential issues associated with intensive land uses in the Poverty Bay Flats area. In the absence of detailed management scenario modelling, the Panel were asked to answer a series of questions relative to the identification of issues and drivers and knowledge gaps (see Question Group 6). The data and information sources available to the Panel for this assessment was summarised in a technical memo provided to the Panel⁷.

⁷ Technical Library TL#087. Ausseil, 2025, technical memo.

4 Panel Assessment of state and trends

This section provides a summary of the Panel's assessment in response to Question Group 1. The intent of Question Group 1 was to support an assessment of what is known about the current, baseline and reference states and temporal trends of each freshwater attribute at (1) each of the 116 assessment sites and (2) at the scale of each planning area. To round up Question Group 1, a final set of questions required the Panel to comment on the scale and significance of each main water quality or ecological issue. The main purpose of this assessment was to establish a clear and robust basis (starting point) for the assessment of scenarios.

The Panel's site scale assessment of each attribute or indicator at each of the 116 assessment sites is captured in the Assessment Spreadsheet, which forms an electronic appendix to this report. For convenience, the main elements of the spreadsheet are reproduced in Appendix 2.

The Panel noted that "baseline state" is a term specifically defined in the NPS-FM and is only required for freshwater attributes. Accordingly, the Panel did not assess baseline state for estuarine attributes or indicators.

The Panel notes that their assessment of temporal trends was generally limited due to the available data or data consistency issues. Data was considered insufficient to support temporal trends assessments for estuarine water quality or ecology, and for many freshwater variables (e.g., temperature, DO, habitat, fish, visual clarity, deposited sediment). Whilst long-term datasets exist for key freshwater water quality variables (e.g., various forms of nutrients), a change in laboratory and analytical methods in c. 2015 introduced significant step changes in some variables, significantly affecting confidence in any trends based on datasets incorporating the time of laboratory change. On that basis, the Panel only considered short-term (5-year) trends from the most recent trends report (Kodur, 2024)⁸, noting however the significant limitations associated with the interpretation of short-term trends.

4.1 Sediment-related attributes

The NPS-FM defines two sediment related attributes for freshwater:

- Suspended fine sediment (SFS) measured as visual clarity in metres.
- Deposited fine sediment (DFS) measured as % fine sediment cover of the visible stream bed.

Visual clarity and deposited fine sediment are also key indicators of estuarine water quality and ecological health.

4.1.1 Visual clarity (freshwater)

4.1.1.1 Data, assumptions and methods

The evaluation of current state of visual clarity relies on two main data and information sources:

- Measured data from GDC monitoring programme (data available at 42 sites), and
- A national model of current state (Whitehead et al. 2021)

Measured data is always assumed to be most accurate for the location measured and was used by the Panel to estimate current state where available (i.e. at monitoring sites). The Panel's confidence in measured data was noted as 'medium' owing to a degree of uncertainty introduced by the monitoring method⁹.

Modelled current state of visual clarity did not align well with measured state (modelled state frequently two to three times higher (i.e., clearer) than measured) and was only used by the Panel where no other data was

⁸ Technical Library, TL#033.

⁹ Measured clarity states are derived from visual clarity tube measurements converted to black disc equivalents. This introduces uncertainty, particularly for clarity tube readings above 0.6 m visual clarity, where uncertainty ranges may span several bands (refer to State and Trends report, TL#036 for details).

available. Where possible, the Panel preferred estimating visual clarity at unmeasured sites as having the same band or clarity (where sediment class differs) as measured sites on same river, based on Panel members' knowledge of the catchments. Estimates based on the national models were noted as 'low' confidence.

4.1.1.2 Current state

The Panel's overall assessment was that visual clarity is degraded across most of Te Tairāwhiti, with the exception of the Wharekahika – Waikura planning area. Monitoring data indicates that close to two thirds (69%) of the 42 monitoring sites in Te Tairāwhiti with visual clarity monitoring data currently fall in Band D, i.e. do not meet the National Bottom Line (NBL). Only 14% of sites, mostly located in the Wharekahika – Waikura planning area are in Band A, with the remainder of sites (17%) in Bands B and C.

Streams in the Wharekahika – Waikura planning area are likely to have a current state of Band A based on measured data. Modelled data indicates streams in the 'Hangaroa – Ruakituri' and 'Waipaoa – Te Arai' planning areas are also likely to be in Band A, but limited measured data exists in these catchments to validate modelled estimates. The mainstems of the Mangatū and Waipaoa Rivers, as well as the lower reaches of the remaining non-urban catchments and planning areas are likely to be below the NBL. In the mid to upper reaches, sites with extensive gullied terrain are likely to also be below the NBL. Sites with less gullying and more extensive forest cover may be above the NBL. Measured clarity states indicate these mid to upper reaches are likely to be in Band B or Band C, while modelled data suggests they are likely to be in Band A. Streams in the 'Waipaoa – Urban' planning area are likely to be below the NBL.

Table 6: Summary of Suspended Fine Sediment (visual clarity) current attribute state at Te Tairāwhiti monitoring sites.

Catchment / planning area	Number of sites	Band A	Band B	Band C	Band D
Hangaroa – Ruakituri	1	0	0	0	1
Mōtū	4	0	0	1	3
Waipū	5	0	0	0	5
Ūawa	2	0	0	1	1
Waimatā	7	0	2	2	3
Wharekahika - Waikura	5	5	0	0	0
Waipaoa - Hill Country	5	1	0	0	4
Waipaoa - Gisborne Urban	7	0	0	0	7
Waipaoa - Poverty Bay Flats	5	0	0	0	5
Waipaoa - Te Arai	1	0	1	0	0
Region	42	6 (14%)	3 (7%)	4 (10%)	29 (69%)

4.1.1.3 Baseline state

For this assessment, the baseline state at each site was assumed to be equivalent to the estimated current state, with 'low' confidence. The current state is the best estimate of the state in 2017 (i.e. the baseline state).

4.1.1.4 Temporal trends

The Panel considered there was insufficient data to support an assessment of temporal trends in visual clarity in any of the planning areas. High interannual variability in visual clarity is associated with highly variable climatic patterns, and trends are unlikely to be able to be detected in short-term datasets.

4.1.1.5 Reference state

The reference state for visual clarity was estimated from a national model (McDowell et al., 2013), resulting in estimated reference state as Band A for most sites outside the Waipaoa Urban planning area, which was

typically modelled in Band B and Band D. Confidence in these estimates is low, because erosion processes are not captured in the national model. Monitoring at reference or near-reference sites is limited (2 sites only) and does not allow extensive cross-validation of modelled estimates.

4.1.2 Visual clarity (estuaries)

The current state of visual clarity in estuaries is unknown. There are, however, indications that visual clarity in most estuaries is likely to be poor, based on the current state of freshwater monitoring sites located upstream of estuaries, acknowledging that the methods and guidelines for freshwater systems are unlikely to be appropriate for estuarine systems. Visual observations confirm the general degraded state of visual clarity in most estuarine systems. The confidence in the current state assessment is low, due to the lack of actual data.

There is no data to support an assessment of baseline state or temporal trends of visual clarity in estuaries.

The reference state for estuarine systems in the region is very difficult to ascertain given extensive modification of estuaries for flood protection and river drainage. Additionally, flat land adjacent to several estuaries has been urbanised or drained for pasture expansion.

4.1.3 Deposited fine sediment (freshwater)

4.1.3.1 Data, assumptions and methods

Deposited fine sediment (DFS) is not measured monthly using the instream visual method, SAM2, as suggested in the NPS-FM. Instead, one-off annual measurements have been undertaken at 97 sites during macroinvertebrate monitoring. The assessment of current state of the DFS attribute in freshwater was based on multiple lines of evidence, including:

- measured data where available acknowledging limitations
- Rapid Habitat Assessment data
- knowledge of sites

NPS-FM bands have been assigned assuming an accurate classification of sites into sediment classes (NPS-FM Table 24), noting that there is minor discrepancy between locally-assigned and REC-assigned classification of sites as 'soft bottom'. Only the REC assignment was used for current state assessment. Confidence rating assumes sites are representative, sediment class definitions are applicable, and considers distance from band thresholds.

4.1.3.2 Current state

In general, the state of DFS is Band D for most planning areas in the region. Exceptions include forested upper reaches in the Mōtū catchment (although these are close to the NBL), and forested upper reaches and coastal streams in the Waipū catchment.

Confidence in the assessment was considered 'medium' at all sites with monitoring data. Whilst the data is limited, the majority of observations were a long way below the NBL, which gives 'medium' confidence in the Band D classification.

4.1.3.3 Baseline state

There is no data to support a direct assessment of baseline state for DFS; however, there is no evidence to support an argument that the state in 2017 would have been detectably different than in 2023, given the high interannual variability in deposited sediment associated with highly variable climatic patterns.

The baseline state for DFS is assessed as the same as current state, with a confidence rating of 'low' due to the lack of data.

4.1.3.4 Temporal trends

The Panel considered there was insufficient data to support an assessment of temporal trends in DFS in any of the planning areas. High interannual variability in DFS is associated with highly variable climatic patterns, and trends are unlikely to be able to be detected in short-term datasets.

4.1.3.5 Reference state

To determine the reference state for DFS, the Panel considered multiple lines of evidence resulting in an estimated Band A for hard bottom streams in the region. There was no information available on naturally occurring processes and no modelled reference state was used. Modelled current and reference state was available (Clapcott & Goodwin, 2017; Haddadchi et al., 2018) but these spatial regression models are not suitable for site-scale assessment in the absence of monitoring data. Nine monitoring sites are classified as Indigenous Forest land cover and could be considered as 'reference', but site-based data (e.g., RHA) suggests these sites are locally impacted and not representative of reference state. As such, the Panel accepted the NPS-FM sediment class definitions and suggested Band A as likely reference state for hard bottom streams (from Franklin et al., 2019).

4.1.4 Deposited fine sediment (estuaries)

4.1.4.1 Data, assumptions and methods

The only available monitoring data for estuaries was from the Tūranganui estuary, where macroinvertebrate data were used a biological indicator to inform sediment assessments. Panel members also drew on their local knowledge and field experience to help interpret sediment conditions in the absence of broader monitoring data.

4.1.4.2 Current state

There is very limited monitoring information on the current state of deposited fine sediment in estuaries. Sediment load estimates from a national model (NIWA, 2019) indicate very high sediment loads from many freshwater systems in Te Tairāwhiti. However, only the Tūranganui and Waimatā estuaries and Te Wherowhero Lagoon are considered susceptible to sediment deposition. Other estuaries are predominantly freshwater-dominated, with low residence times and lower susceptibility to sediment accumulation, unless mouth restriction occurs.

Monitoring data indicated that the Taruheru arm of the Tūranganui Estuary experiences sediment stress, with mud content reaching up to 70% at some sites. This is further supported by the absence of sediment-sensitive macroinvertebrate species. In contrast, the Waimatā arm is in comparatively better condition, showing low to moderate sediment stress. Confidence in this assessment was noted as "medium to high", as it relies on measured data but is limited to a single sampling event. Monitoring of the Kaitawa estuary and Te Wherowhero Lagoon was undertaken in summer 2024-25; however, monitoring results were not available at the time of writing.

4.1.4.3 Temporal trends

There is no data to support an assessment of temporal trends of deposited sediment in estuaries.

4.1.4.4 Reference state

As indicated previously, the reference state for estuarine systems in the region is very difficult to ascertain given extensive modification of estuaries; however, the national model (NIWA, 2019) indicates relatively high sediment loads under "historic" conditions. This is also reflected in the full afforestation scenario modelled by Neverman & Smith (2025).

4.2 Physico-chemical and habitat attributes

4.2.1 Water temperature (freshwater and estuaries)

4.2.1.1 Data, assumptions and methods

Temperature is not an attribute in the NPS-FM. However, guidelines values for the Cox-Rutherford Index (CRI) are proposed in Davies-Colley et al., 2013 for Eastern Dry regions, which applies to Tairāwhiti. The CRI is indicative of thermal stress on aquatic organisms and is calculated as the average of mean and maximum daily temperatures from the 5 hottest days over summer. When CRI is < 19 °C there is no thermal stress, whereas there is significant thermal stress on a range of aquatic organisms (and risk of local elimination of keystone species with loss of ecological integrity) when CRI > 25°C. Water temperature varies following diurnal and seasonal cycles. GDC regularly monitors water temperature as part of its routine water quality monitoring programmes; however, such “discrete” measurements only provide temperature at a given point in time and do not provide a direct measure of mean or maximum temperature. High frequency (often termed “continuous”) monitoring is preferable for variables subject to diurnal cycles such as temperature, DO and pH.

Data available to the Panel for the state assessment of water temperature included:

- High frequency temperature data for 21 sites collected between November 2024 and March 2025
- High frequency (between 16 and >3000 days) from 83 sites collected between ~2015 and 2023
- Discrete measures of maximum temperature at 83 sites from July 2018 to June 2023

Confidence in discrete measures can be estimated from regressions with Cox-Rutherford Index measures calculated from high frequency data, where available.

4.2.1.2 Current state

Available water temperature data suggests that in general, streams and rivers in Tairāwhiti are under moderate to significant thermal stress. In the pre 2024/25 high frequency dataset, only 6 (out of 83) sites showed no thermal stress when measured over summer months. In 2024/25 summer, all 21 sites showed moderate to significant thermal stress (except minor stress at Mangatutu Stream at Sh35-Waipahuru Bridge). The Waipaoa PB Flats streams had an average CRI of 24.9°C and most sites (6/8) showed significant thermal stress.

The average maximum temperature (24.9°C) calculated from 59 sites (with >30 discrete measurements) confirmed thermal stress across the region. There was a weak relationship ($R^2 = 0.49$) between maximum temperature observed from discrete measurements between 2018-23 and CRI calculated from high frequency data at 20 sites with both datasets. The only streams with data showing no or minor thermal stress appear to be in forested areas of the Upper Mōtū planning area.

The Panel assessed the level of confidence in the assessment of the current state of temperature as medium, based on the combined datasets.

In estuaries, benthic species tend to be more resilient to changes in water temperature than transitory species (e.g., fish) due to daily periods of immersion and emersion. However, elevated temperatures in freshwater terminal reaches and estuaries suggest that thermal conditions may create barriers for migratory species. Lagoon areas such as Te Wherowhero have recorded temperatures reaching 27°C, likely indicating thermal stress for some species. Where available, CRI statistics, support this assessment for the terminal reach and estuarine sites.

4.2.1.3 Baseline state

The Panel assessed the baseline state for water temperature as the same as current state, with the same level of confidence, as there is insufficient pre-2017 high frequency data to distinguish between baseline and current state.

4.2.1.4 Temporal trends

The Panel considered data was insufficient to assess temporal trends in water temperature, due to a lack of high frequency long-term data.

4.2.1.5 Reference state

For low order streams in forested catchments, it is estimated that riparian shade and catchment vegetation would mediate water temperature so that reference conditions would be indicative of a Band A for the Cox-Rutherford Index, i.e. $\leq 19^{\circ}\text{C}$. For higher order rivers, open canopies may allow greater solar radiation to warm stream water and reference conditions may be in Band A or B, i.e. $\leq 21^{\circ}\text{C}$.

The Panel's assessment of reference state relied on water temperature data collected at four monitoring sites with upstream catchments predominantly in Indigenous Forest cover and the Cox-Rutherford Index guideline values. Three out of four sites with Indigenous Forest land cover had CRI values less than 19°C , the other site was 23°C possibly due to a lack of shade as indicated by RHA data suggesting that this site is not indicative of reference state. No national or regional models were available to assess the reference state of water temperature. No data was available to assess temporal trends in estuarine water temperature.

Confidence in the temperature reference state assessment was rated as 'low' due to the limited data available.

4.2.2 Dissolved Oxygen (DO) (freshwater and estuaries)

4.2.2.1 Data, assumptions and methods

Data available to the Panel for the state assessment of DO included:

- High frequency data at 25 sites from between 2018 to 2023
- High frequency data from 8 Waipaoa Poverty Bay Flats sites in 2024/2025
- Discrete data from SoE monitoring data from 92 sites.

The Panel's assessment of DO state in freshwater was primarily based on the high frequency data available. Discrete data was only used to acknowledge risk as per Depree et al., 2016.

There was very little data on DO for estuarine waters, although some of the sites with high frequency data (in the Poverty Bay Flats and Urban planning areas) were located close to, or within terminal freshwater / tidal reaches. Data was also available for the Anaura Bay North Lagoon.

4.2.2.2 Current state

The Panel's assessment of current state of DO in freshwater ranges from Band A to Band D across the region.

Most sites with high frequency data are in Band A or B suggesting no or occasional minor stress on sensitive organisms. Exceptions include Band C or D at lowland sites in the Uawa (associated with high temperature and periphyton), Hangaroa – Ruakituri (noting nonsensical results at Maraetaha Str at No2 Br should be investigated), and the Mata at Pouturu B (Waiapu; periphyton and temperature issues).

The Panel estimates that in general, upland sites will be in Band A (although low flow sites in pasture or harvested exotic forests could be in a lower band) and lowland sites are more susceptible to biological oxygen demand and in-stream productivity driving lower dissolved oxygen minima. Low flows and elevated water temperatures are also risk factors for exceeding the NBL for dissolved oxygen.

The 2024/2025 high frequency data show anoxic conditions in lowland Poverty Bay Flats streams including Taruheru R, Te Kowai St, Whakaahu St and Ratahi Lagoon. Occasional to moderate stress due to low DO was also apparent in the Waipaoa R and Waihirere St., often co-occurring with high temperatures.

The Panel's confidence in the site scale assessment at sites with high frequency data was rated as 'medium' because the data from limited to a relatively short term range. The Panel had low confidence in estimates of DO state at the planning area scale.

Only limited data was available to assess the state of DO in estuarine waters. What data was available showed extremely low DO minima:

- Taruheru @Peel Street – 0.6 mg/L
- Waikanae @Grey Street – 0.7 mg/L
- Anaura Bay North Lagoon – 1.9 mg/L

Data available for the Waipapu planning area showed no apparent DO issues. Very little to no data was available to assess current state of DO in the Waimata and Wharekahika – Waikura planning areas.

4.2.2.3 Baseline state

The Panel assessed the baseline state for DO as the same as current state, with the same level of confidence, as there is insufficient pre-2017 high frequency data to distinguish between baseline and current state.

4.2.2.4 Temporal trends

The Panel considered data was insufficient to assess temporal trends in DO in either freshwater or estuarine waters, due to a lack of long-term high frequency data.

4.2.2.5 Reference state

Reference state for DO is expected to be in Band A, which is based on a 7-day mean minimum DO ≥ 8.0 mg/L and 1-day minimum during summer is ≥ 7.5 mg/L as described in the NPS-FM (Table 17).

The Panel's determination of reference state was based on consideration of DO data at reference sites and naturally occurring processes. High frequency DO data was only available at two sites in REC classified Indigenous Forest land cover; one site was in Band A and one site was in Band B. Discrete data was also available at 3 additional sites in Indigenous Forest. The Panel notes that one site had a discrete measure of only 2.3 mg/L DO, indicating either a potential risk of DO stress or incorrect data. There was no evidence to suggest naturally occurring processes are present which would impact DO reference state, although localised low DO can be expected in freshwaters with groundwater upwelling or hot springs. Overall, the Panel considered there was insufficient data to inform a robust assessment of reference state across the region and so adopted guidance on expected reference state from the NPS-FM DO Attribute Table 17.

Confidence in the DO reference state assessment was rated as 'low' due to the limited data available.

4.2.3 Stream habitat

The habitat assessment conducted by the Panel only covered freshwater streams and rivers, as there was no habitat data for estuaries aside from the visual records from a single sampling event.

4.2.3.1 Data, assumptions and methods

The Panel's assessment of habitat state was primarily based on Habitat Quality Score (HQS). HQS data was collected using the Rapid Habitat Assessment (RHA) method at 83 sites from 2015 to 2024. Between 2 and 9 replicate RHA measures at each site were conducted annually between 2015-16 and 2023/24. State was assigned as per Clapcott et al., 2019 for hard bottom streams, with a Habitat Quality Score of 0–25 indicating Poor (D), 26–50 indicating Fair (C), 50–75 indicating Good (B), and 76–100 indicating Excellent (A) stream

habitat quality. There is no National Bottom Line. Hard bottom streams were determined by the deposited sediment classification (NPS-FM Table 24). For soft-bottom streams, parameter 1 was not used in the score calculation, so the total score was calculated as the sum of the remaining 9 parameters/90*100 as recommended by Clapcott (2015).

4.2.3.2 Current state

The Habitat Quality Score shows that in general streams in the region are in a Fair (C) to Good (B) condition. Six planning areas are in Good (B) condition overall; two firmly in B (Waipaoa Hill Country and Mōtū) and four in B but close to Fair (C) condition (Te Arai, Uawa, Waiapu, Wharekahika – Waikura). A further three planning areas (Poverty Bay Flats, Hangaroa – Ruakituri and Waimata) are in a Fair (C) condition, and there was no data for the Gisborne Urban planning area.

Individual parameter scores within the RHA show that all planning areas in Tairāwhiti have significant issues with a lack of riparian shading and associated bank or riparian vegetation cover. High deposited fine sediment cover is an issue throughout the region's, and along with low benthic habitat and hydraulic habitat diversity is likely to be affecting invertebrate and fish habitat suitability, especially evident in the Waipaoa planning areas.

Confidence level was rated as 'high' at sites with three or more replicates (most sites), and 'medium' at sites with less than three replicates.

4.2.3.3 Baseline state

The Panel assessed the baseline state for stream habitat as the same as current state, with the same level of confidence, as there is insufficient pre-2017 data to distinguish between baseline and current state.

4.2.3.4 Temporal trends

The Panel considered data was insufficient to assess temporal trends in stream habitat quality in, due to a lack of long-term data.

4.2.3.5 Reference state:

The Panel's assessment of stream habitat reference state is a HQS score > 75 at sites on small streams ($\leq$ 3rd order streams), and a HQS score > 66 at sites on larger streams and rivers ($\geq$ 4th order streams).

The Panel's determination of habitat reference state was based on consideration of habitat data at reference sites and national analyses. The HQS at nine sites in catchments with dominant Indigenous Forest landcover ranged from 43 to 84. At four of these sites, with scores between 43 and 55, individual parameters identify a lack of riparian/bank vegetation, shade, or fish cover suggesting that local conditions at these sites may not represent reference state. The remaining 5 sites had high scores in total (>75) and across all parameters. A national analysis shows the average HQS in 'Native' landcover was greater than 75 (Clapcott et al., 2019). The analysis suggests that sites with an excellent stream health should have a Habitat Quality Score greater than 75. This should be achievable at all sites in $\leq$ 3rd order streams where riparian closure provides sufficient shade. Allowing for a lower riparian shade score at higher stream order sites, results in a HQS greater than 66 (with a 1 score for riparian cover) as a reference state.

Across the region, monitoring sites at $\leq$ 3rd order streams have an average HQS of 54 (21 below the reference value of 75) and at sites on stream order 4-7, the average HQS is 55 (11 below the very conservative reference value of 66).

The Panel's confidence in the habitat reference state assessment was rated 'medium', due to limited reference site data from 9 sites (not representative of reference state throughout the region) and guidance from national analyses.

4.3 Eutrophication related attributes

Eutrophication is a general term describing a process in which nutrients accumulate in a body of water, resulting in increased growth of algae that may deplete the oxygen in the water and adversely affect invertebrates, fish and other aquatic life. The key attribute for describing eutrophication status in freshwaters of Te Tairāwhiti is the periphyton attribute, while macroalgae and phytoplankton are the key indicators of eutrophication for estuarine waters.

Nutrients (various chemical forms of nitrogen and phosphorus) are among the key drivers of eutrophication state (e.g., periphyton, phytoplankton) but do not solely determine this state. Other factors combine with nutrients to determine periphyton state (e.g., flow regime, substrate stability, water clarity and temperature, riparian cover light attenuation, nutrient ratio limitation and invertebrate grazer community structure). Hence the nutrient concentration attributes are of subsidiary importance as a contributing cause of eutrophication, not an end in or of themselves. Periphyton and/or phytoplankton biomass (along with any resulting impacts on dissolved oxygen or habitat for invertebrates and fish) are the key indicators of eutrophication outcome interest.

4.3.1 Nutrients and periphyton (freshwater)

4.3.1.1 Data, assumptions and methods

Long-term datasets relating to key forms of nutrients: nitrate-nitrogen ($\text{NO}_3\text{-N}$), ammoniacal nitrogen ($\text{NH}_4\text{-N}$), dissolved inorganic nitrogen (DIN) total nitrogen (TN), dissolved reactive phosphorus (DRP) and total phosphorus (TP) are available from GDC's water quality monitoring sites (c. 45 sites).

Of the two major nutrients (N and P), there is particularly large uncertainty with estimating current and reference state for P in unmeasured locations. There is also more uncertainty in estimating periphyton state in response to changes in P than for N. The Panel has been cautious with interpreting the influence of P and has regarded estimates of elevated DRP as an indicative "risk" factor for periphyton eutrophication problems rather than being deterministic of a problem.

Periphyton data is available from 39 sites. Data was insufficient to undertake a full assessment of the current state of periphyton against the NPS-FM attribute (requiring three years of monthly monitoring data). The Panel reviewed and agreed with the approach laid out in Memo #7¹⁰ and Heath (2024)¹¹ that uses multiple lines of evidence including both measurements and models, to estimate the current state of nutrient eutrophication attributes across Tairāwhiti. The approach taken to estimate periphyton state is likely to be conservative, tending to estimate a worse state than may actually exist. This is an appropriate precautionary approach but is relevant context to bear in mind.

The Panel has used a 3-point scale to describe their level of confidence in estimating state (high, medium and low) and generally assigns high confidence to estimates at measured locations and medium confidence to estimates based on data-trained models for unmeasured locations.

The Panel considers this to be a sensible, pragmatic and responsible approach to using the available information for estimating current state.

4.3.1.2 Current state

Estimates of current state for nutrients and periphyton at site scale are laid out in the Panel's Assessment Spreadsheet (Appendix C).

The assessment categorised 14 sites in Band A, 9 sites in Band B and 6 sites in Band C. No sites were categorised in Band D (i.e. below NBL) for periphyton. As an initial high-level statement these estimates suggest eutrophication of freshwaters is less of an issue in Tairāwhiti than for many regions in New Zealand

¹⁰ Technical Library TL# 086

¹¹ Technical library TL#035

and is certainly a smaller water quality issue than Gisborne's well-recognised sedimentation problem. Nonetheless, there are spatial nuances to this statement that require further explanation.

- In five of the planning areas (Mōtū, Uawa, Waiapu, Wharekahika-Waikura and upper Waipaoa Hill Country), there is negligible evidence of any periphyton problem or risk of eutrophication at all. In these areas, nitrate, ammonia and DIN are estimated predominantly to be in Band A with a small proportion of river sections in Band B. While DRP is estimated predominantly to be in Band B or C with a small proportion (<15%) in Band D, there is no evidence this is leading to eutrophication problems. The periphyton estimates in these five planning areas are almost all in Band A or B with only one site in Band C and none in Band D. It is noted that the lowland reaches of the Uawa catchment may be subject to eutrophication risks similar in nature to the Poverty Bay Flats described later (Question Group 6), but no data was available to support an assessment.
- In the Hangaroa and Waimatā planning areas, there is negligible evidence of a periphyton problem or risk of eutrophication across most of the areas, although some potential for eutrophication issues exists in the lower catchment flat areas. The Hangaroa catchment has elevated DRP and some risk of TN excess in the lower flats in the vicinity of Te Wherowhero Lagoon; there have also been anecdotal reports of algal blooms in Te Wherowhero Lagoon (Paul Murphy, GDC; personal communication). The Waimatā planning area has elevated DRP (40% stream sections estimated to be in Band D) mostly in lower flats areas; there have also been phytoplankton blooms recorded in the lower tidal reaches of the Waimatā River which are considered part of the Tūrangānui Estuary and described later in the estuary nutrients section.
- The three sub-areas in the lower Waipaoa planning area (i.e., the Te Arai, Poverty Bay Flats, and Urban planning areas; see Figure 2) are the main notable exceptions to the otherwise low indication of eutrophication problems across Tairāwhiti. The lower reaches of streams and rivers in these flat areas are the main areas for eutrophication risk. These areas include slow flowing low-gradient freshwater reaches and also the tidally influenced "estuarine" lower river sections of the Taruheru River, Waimatā River and Waikanae Creek that together constitute the Tūrangānui Estuary. For both the freshwater and estuarine sections of these rivers, the observed eutrophication response has been largely phytoplankton and macroalgae rather than periphyton (i.e., there have been no measured or estimated incidences of Band D periphyton state in hard bottom streams of the Waipaoa planning area). This whole topic will be addressed in detail separately under Question Group 6 (Section 6 of this report).

The Panel generally assigns high confidence to estimates at measured locations and medium confidence to estimates based on data-trained models for unmeasured locations.

4.3.1.3 Baseline state

The Panel considers that the estimates of current state described above are also a pragmatic and credible estimate of the "baseline state" (BAS) for serving the intent of this term in the NPS-FM. Indeed, given the known natural environmental variability inherent in eutrophication attributes within and between years, and the short record of available periphyton measurement data (i.e. insufficient to formally meet the requisite NPS-FM 3 years of monthly data requirement) the Panel would be unable to distinguish between current state in 2024 and BAS in 2017.

The Panel considered there were no incidences where current freshwater eutrophication problems were identified as being a result of naturally occurring processes (i.e., being estimated as the reference condition).

4.3.1.4 Temporal trends

Generally, with the water quality data available and known natural interannual environmental variability, it is difficult to characterise trends over short periods (e.g., only 5 years). The Panel has higher confidence that trends may be meaningful over the longer periods (e.g., 15 years) compared to shorter (e.g., 5 years); however, as noted in the introduction to Section 4, the assessment of temporal trends in the region was limited due to

data availability (length of data records) and / or consistency (caused by changes in analytical methods) issues in long-term datasets.

The Panel limited their review to the short-term trend analysis presented in Kodur (2024) and have assigned a low confidence rating to these short-term trends for the reasons stated above.

4.3.1.5 Reference state

The site-scale assessment of reference state of nitrogen and phosphorus indicators (TN, NO₃-N, DRP, TP) in the Assessment Spreadsheet used a national model (McDowell et al., 2013). The Panel notes that the “reference state” estimated by this approach has been extrapolated as the state that would occur if all current land use were changed to natural vegetation cover, all other things being equal (e.g., current hydrological regimes, atmospheric deposition etc); this is distinct from the notion of “natural” or pre-European or pre-human reference condition.

The reference state information on DRP was considered during the Panel’s assessment of current state, because there is some potential for naturally elevated DRP from naturally eroding geology in Tairāwhiti. However, McDowell et al., 2013 predicted only a small proportion of river sections in a few localised areas would have been in Band D for DRP reference state. Generally, for all catchments where DRP was estimated (by modelling) to be currently in Band D this was a substantially greater proportion than estimated for reference condition in the same area. The Panel’s interpretation of this result is that elevated DRP in large parts of Tairāwhiti has been substantially exacerbated by human land-use changes and associated soil erosion over more than 150 years.

Despite the human-induced exacerbation of DRP concentrations in rivers the elevated DRP is not considered on its own to be driving a major eutrophication problem in freshwaters of Tairāwhiti. There were no incidences where current freshwater eutrophication problems were identified as being a result of naturally occurring processes (i.e., being estimated as the reference condition). Known eutrophication problems occur where N is also elevated. Nitrogen levels were likely low under reference conditions with extensive natural vegetation, meaning periphyton would have been in Band A across all sites.

The Panel considers the available information has been used and is the best available approach. The Panel rated their confidence in estimates in the reference state as ‘High’ for nitrogen and periphyton and ‘Medium’ for DRP. Estimates of reference DRP state are considered with caution.

4.3.2 Nutrients, phytoplankton and macroalgae (estuaries)

4.3.2.1 Data, assumptions and methods

Nutrient enrichment can present as phytoplankton blooms in estuaries with high residence time, macroalgal blooms in estuaries with low residence time, or as sediment and water anoxia (low dissolved oxygen) driven by productivity. Estuaries are transitional zones where nutrient limitation can transition from P limitation in the upper reaches to N limitation towards the seaward side. However, estuaries may also be ‘unlimited’ with excesses in each nutrient. Data and information sources used by the Panel to inform their assessment included:

- Water quality monitoring, dissolved oxygen studies (as an expression of eutrophication), sediment quality data where this is available-
- Bloom observations recorded in Hancock GDC pers. Comm., 2019; Biessy et al., 2024
- Nutrient load estimates from Plew et al., 2018; however, it is important to note that the modelled ETI is based on estuary type based on national models (Coastal Explorer) and not refined for local ‘at risk’ features. Nutrient loads were considered by the Panel in relation to estuary type and likely susceptibility to expressions of eutrophication
- Modelled reference state is used from Plew et al., 2018 as the pre-human state.
- Estuarine Trophic Index (ETI) tool 1 (Robertson et al., 2016).

4.3.2.2 Current state

The estuaries of the Tairāwhiti region generally fall into one of two types:

- Shallow, short resident time tidal river estuaries (SSRTRE – e.g., Waipaoa, Tūranganui, Pouawa, Waimoko, Pakarae and Kaitawa); and
- Shallow intertidal dominated estuaries (SIDE – e.g., Te Wherowhero Lagoon).

The probability that nutrient additions may create adverse effects (e.g., excessive phytoplankton or macroalgal growth, water column or sediment hypoxia/anoxia etc) within the estuary, depends on how long the estuary is exposed to these increased levels, and how quickly high nutrient water exits the system. As such, estuary type is an important feature of an estuary's susceptibility to expressions of eutrophication (adverse effects).

SSRTRE estuaries generally have a short residence time (water exits the system quickly) and therefore have a lower susceptibility to adverse effects from higher nutrients than estuaries with longer residence time (e.g., SIDE type estuaries). However, physical features within estuaries can create localised conditions that behave more like other estuary types and increase vulnerability to nutrient enrichment.

For example, the Kaitawa Estuary is primarily a SSRTRE estuary but has a southern embayment with characteristics of a SIDE estuary. Similarly, the Tūranganui Estuary is largely SSRTRE however, during high flows in the Waimata River (which forms the Waimata arm of the estuary), water can become trapped in the Taruheru arm, increasing residence time and causing the Tareheru arm of the estuary to temporarily function more like a SIDE system.

In addition, SSRTRE estuaries that discharge to the coast in gravel or sand barrier beaches, they may during times of high easterly swells become 'closed' where gravel or sand builds up and prevents tidal flow until the river flow exceeds the barrier and reopens.

These nuances or 'high risk' features, are critical to understanding estuarine responses to nutrient loading and are not captured in national-scale models. They were carefully considered by the Panel during their assessment.

Current state indicates that SSRTRE estuaries are mostly below interim thresholds where eutrophic systems could be considered 'unlikely' (2000mgN/m²/d).

For estuaries that have a higher residence time or contain 'at risk' features (e.g., Taruheru arm of the Tūranganui and Kaitawa), or that may have a restriction of mouth, susceptibility to expressions of eutrophication can be estimated based on annual nitrogen load rates. Load rates from Plew et al., 2018 were used to inform the assessment. These indicate that the risk from nutrient inputs are:

- 'Low' for the Waipaoa and Pakarae systems. Despite relatively high nitrogen loads, these systems are well flushed and have low residence times (0.1 and 0.8 days respectively). It is likely that the coastal area is the ultimate receiving environment where potential effects may be experienced. If the mouth to either of these was restricted for a relatively long period of time, it is possible that symptoms may appear based on nitrogen load.
- 'High' for Te Wherowhero Lagoon which has a longer residence time of 10.6 days; and
- 'Very High' for Tūranganui and Kaitawa. Residence times in the Tūranganui and Kaitawa are noted as short (1.0 and 1.3 days respectively) however as described above, these two estuaries have 'high risk' features which mean that under certain conditions they have similarities to SIDE type estuaries. Therefore, the assessment has focused on these periods, which are in line with observations of Council staff (P. Murphy, pers. Comm.).

It is noted that the assessment for the Tūranganui and Kaitawa estuaries differs to that described by Plew et al., 2018, who described these systems as SSRTRE, while the Panel have opted to use local knowledge to apply the more conservative SIDE estuary guidelines.

Applying these loads to the estuaries using the Estuarine Trophic Index (Robertson et al., 2016) indicates that:

- Te Wherowhero – Band C –this suggests 'moderate stress on a number of aquatic biota caused by the indicator exceeding preference levels for some species and a risk of sensitive biota species being lost or reduced'. This assessment is supported by reports of algal blooms in Te Wherowhero Lagoon (Paul Murphy, pers. Comms.).
- Tūranganui and Kaitawa (at certain areas/locations) – Band D –this suggests 'significant, persistent stress on a range of aquatic biota caused by the indicator exceeding tolerance levels. A likelihood of local extinctions of keystone species and loss of ecological integrity. Algal dominated, turbid systems, seagrass absent or reduced'. This assessment is supported by observed phytoplankton blooms recorded in the lower tidal reaches of the Waimatā River (Hancock GDC pers. Comm., 2019; Biessy et al., 2024).

It is important to note that the above is based on risk, and how estuaries deal with nutrients (the amounts that are transformed, taken up etc) is site specific. Therefore, how this risk equates to actual effects is unable to be determined without estuary assessments to verify the modelled nutrient concentrations.

Confidence in this assessment is considered 'low'. This is predominantly due to the lack of estuary water quality monitoring to verify how nutrients are being transformed through the estuary. Additionally, most of the systems can be considered tidal river systems which have limited data associated with them to inform robust, predictive relationships. There is, however, supporting information for the Tūranganui (Taruhēru) system, which indicates that enhanced productivity is causing significant ecosystem responses (e.g., levels of hypoxia that approach anoxia at times).

4.3.2.3 Baseline state

Current state is expected to inform baseline state.

4.3.2.4 Temporal trends

There is insufficient data to determine temporal trends in estuarine nutrient concentrations.

4.3.2.5 Reference state

Reference state for estuarine systems in the Gisborne/Tairāwhiti area very difficult to ascertain given extensive modification of estuaries for flood protection and river drainage. Additionally, flat land adjacent to estuaries has been urbanised or drained for pasture expansion.

For nutrient loads, Plew et al., 2018 has estimated that pre-human loads were approximately half of the current loads. This ranges from the historic load being 38.1% of the current load for the Waikomoko Estuary to the historic load being 58.7% of the current load for the Kaitawa/Uawa Estuary.

4.4 Ecological attributes

4.4.1 Macroinvertebrates (freshwater)

4.4.1.1 Data, assumptions and methods

The primary source of data supporting the Panel's assessment of the current state of macroinvertebrate communities is monitoring data available at 59 sites collected between July 2018 and June 2023. The Panel used score summaries per planning area as shown in Kodur 2024¹² and additional sites as summarised in the Assessment Spreadsheet. Modelled contemporary MCI was also used as an indication of broad spatial patterns.

¹² Technical Library TL#033

4.4.1.2 Current state

In general, macroinvertebrate data (MCI, QMCI, ASPM) show macroinvertebrate communities indicative of moderate to severe nutrient or organic pollution. Although not explicitly mentioned in the NPS-FM attribute band narrative, the Panel considers these communities also reflect moderate to severe deposited sediment pollution, along with sensitivity to temperature and flow. The observed and modelled MCI data show a strong spatial pattern in MCI with higher values observed in headwaters and upper reaches and lower values observed at lowland reaches, except in the Waipaoa – Hill Country where below NBL values occur higher in the catchment. A high proportion of sites in the Waimatā and Waipaoa catchments are below the NBL. Only sites in the upper Waiapu planning area had consistent A grades for macroinvertebrate metrics.

The Panel's confidence in their assessment of current state of macroinvertebrate communities was rated as 'High' despite some sites only having four years of data for the definition of CAS because of presence of BAS data and modelled data.

4.4.1.3 Baseline state

BAS was estimated at 72 sites based on data from 2017-2022 (except 1 site sampled in Jan 2023) between 2 to 5 annual replicates per site.

In general, macroinvertebrate data (MCI, QMCI, ASPM) show that the baseline state for macroinvertebrate communities was effectively the same as the current state at a broad spatial scale. This is because these assessments are based on a difference of only one calendar year of data. Where there were differences at a planning area scale, this was due to data availability, i.e. more sites were available to provide an assessment of baseline than current state. Specifically, additional baseline sites in the Waipaoa- Hill Country, Waipaoa – Poverty Bay Flats, Waimata and Uawa confirm Band D in these planning areas, one extra site in Hangaroa – Ruakituri and Mōtū were in Band D also. For the Waiapu, 3 extra baseline sites confirm broad spatial patterns of Band A or B in forested headwaters and Band C or D in lowland reaches.

Confidence in baseline state estimates was rated as 'High' for sites with 5 years of data and 'Medium' for sites with less than 5 years of data

4.4.1.4 Reference state

The reference state of macroinvertebrates is estimated to range from Band A to Band C based on measured data at reference sites and national model predictions of MCI.

There are 9 sites classified as Indigenous Forest landcover that could be considered representative of reference conditions. The MCI scores at these sites range from Band A to D. Sites with Band C/D grades also have low HQS scores, which suggests local factors are contributing to the state of macroinvertebrates and these sites do not represent reference conditions. The modelled reference values at these 9 Indigenous Forest sites range from Band A to B (with one site also just in Band C). Similarly, modelled reference MCI scores predict a range from Band A to C across all monitored sites in the region, which suggests that factors other than land use could account for low observed MCI scores. However, no sites are predicted to be in Band D in a reference state.

All sites that are in Band D currently are predicted to be in either Band B or C under reference conditions. For sites currently in Band D, the minimum numerical difference between observed and predicted MCI scores is 20 MCI and sites are on average 30 MCI scores below what they are predicted to be under reference condition. For sites currently in Band C, they are predicted to be in Band B under reference conditions; sites are on average 15 MCI scores below what they are predicted to be under reference conditions. For sites currently in Band B, they are predicted to be in either Band A or B under reference conditions; sites are on average 5 MCI scores below what they are predicted to be under reference conditions. All sites currently observed in Band A are predicted to be in Band A under reference conditions.

Spatially, the greatest disparity between observed and predicted reference state occurs in areas with poor macroinvertebrate communities, e.g., lowland rivers and streams and Waipaoa – Hill Country.

4.4.1.5 Temporal trends

In general, most sites in the region showed no determinable trend in macroinvertebrate community metrics (MCI, QMCI, ASPM). Likewise, there were no consistent trends observed at sites classified as Indigenous Forest landcover (accepting that these sites may not be representative of reference state). This suggests that there are no over-riding factors driving a change in metrics and instead local conditions are most likely to be driving observed patterns.

Some sites showed consistent trends in both ASPM and MCI/QMCI metrics. Where these were observed they are summarised below for each planning area. Notably, half the monitored sites in Wharekahika – Waikura are likely or very likely degrading whereas improving trends are observed at some Waiapu and Waimatā sites.

- Waipaoa Te Arai: 2 out of 6 sites showed temporal trends, both likely or very likely improving;
- Waipaoa Hill Country: 5 out of 12 sites showed temporal trends; three likely or very likely improving and two likely or very likely degrading;
- Waipaoa Poverty Bay Flats: 1 out of 3 sites showed a likely degrading temporal trend;
- Hangaroa – Ruakituri: 2 out of 11 sites showed temporal trends; one likely improving and one likely degrading;
- Waiapu: 5 out of 10 sites showed temporal trends; 4 likely improving and 1 very likely degrading;
- Waimatā: 3 out of 5 sites showed temporal trends; all very likely improving;
- Wharekahika – Waikura: 5 out of 8 sites showed temporal trends; 1 likely improving and 4 likely or very likely degrading.
- Mōtū, Urban and Uawa: no temporal trends.

The Panel's confidence was rated as 'Medium', based on medium term (between 7 and 8 years) trend analysis of measured data.

4.4.2 Macroinvertebrates (estuaries)

4.4.2.1 Data, assumptions and methods

Monitoring data is currently only available for the Taruheru and Waimatā sites within the Tūrangānui estuary from studies undertaken in 2019¹³ and 2024¹⁴.

No assessment of current state could be made for other sites.

4.4.2.2 Current state

The estuaries of the Tairāwhiti region generally fall into one of two types:

- Shallow, short resident time tidal river estuaries (SSRTRE – e.g., Waipaoa, Tūrangānui, Pouawa, Waimoko, Pakarae and Kaitawa); and
- Shallow intertidal dominated estuaries (SIDE – e.g., Te Wherowhero Lagoon).

Available data indicate that both the Taruheru and Waimatā sites within the Tūrangānui Estuary exhibit low abundance of epifaunal macroinvertebrates and low richness of infaunal species, particularly when compared to other New Zealand estuaries. These results remain consistent even when compared specifically to other shallow, short residence time tidal river estuaries (SSRTRE) across the country. The observed patterns are broadly consistent with other SSRTRE estuaries along the east coast of the North Island, such as those in Hawke's Bay, which are also characterised by depauperate macroinvertebrate communities.

¹³ Kelly S., Sim-Smith, C. 2020. Ecological effects of wastewater overflows. Coast and Catchment Environmental Consultants Ltd. Report 2019-06. Prepared for Gisborne District Council.

¹⁴ Ho M., Alder A., Clere I., Hills T., 2024. Monitoring of Tūrangānui Estuary: 2024. Cawthron Institute Report 4067. Prepared for Gisborne District Council.

At the Waimatā site, macroinvertebrate diversity was notably low. The presence of the invasive Asian date mussel suggests a shift in community composition, potentially reflecting disturbance or habitat modification. Bivalve species such as cockle (tuangi) and pipi were present, likely as a result of the sandier sediments with lower mud content.

The benthic health model (BHM) results for the Taruheru arm of the Tūranganui indicate high sediment stress and moderate trace metal stress. The results of the BHM model for the Taruheru are indicative of high to very high impact from sedimentation compared to other estuaries around New Zealand.

The Waimatā site of the Tūranganui was not well described by the benthic health model, indicating that it falls outside the model parameters and therefore it cannot be used to compare the health of this estuary with other New Zealand estuaries.

Confidence in the assessment of current state was rated as medium/low for sites with available data. Data at these sites is comprehensive but lacks a temporal record.

4.4.2.3 Temporal trends

Temporal trends could not be assessed due to a lack of long-term monitoring data.

4.4.2.4 Reference state

No data or information sources were available to the Panel to assess the reference state of macroinvertebrate communities in estuaries, however, the Panel assumes that macroinvertebrate communities would be 'natural' and healthy and reflective of sediment, estuary type and freshwater inflow in the absence of structures, edge hardening, discharges and sedimentation.

4.4.3 Fish

4.4.3.1 Data, assumptions and methods

Fish are not routinely measured by GDC using protocols required to calculate the Fish Index of Biotic Integrity (F-IBI) metric in the NPS-FM Table 13. Historic data in the New Zealand Freshwater Fish Database (NZFFD) is temporally and spatially limited. There is no recent compilation of NZFFD available. Environmental DNA (eDNA) surveys at 198 sites over 3 years (2021-2024) provides an estimate of species present in the catchments above sampled sites but is not suitable for calculating F-IBI for several reasons, as outlined in the memorandum by Heath (Sept 2024)¹⁵. The timing of eDNA sample collection in relation to cyclone/high flow disturbance also lowers confidence in eDNA results. Limited information on fish abundance is available from reports summarising NZFFD data (Clapcott 2012, Froude 2003). There is no information available on fish community structure.

To assess the current state of fish communities the Panel adopted the following assessment framework:

- A grade – Fish community abundance, structure, and composition reflect an excellent state of aquatic ecosystem health.
- B grade – Fish community abundance, structure, and composition reflect a good state of aquatic ecosystem health.
- C grade – Fish community abundance, structure, and composition reflect a fair state of aquatic ecosystem health.
- D grade – Fish community abundance, structure, and composition reflect a poor state of aquatic ecosystem health.

However, based on data limitations the Panel were only able to assess the 'composition' (fish diversity) component of this assessment with any confidence.

¹⁵ Technical Library TL#064

4.4.3.2 Current state

In general, fish diversity (not abundance or structure) at a planning area scale is good to excellent. Fish diversity is the least sensitive component of the above assessment, so it is likely that fish communities overall are in a poorer state than indicated by this assessment.

The Panel's assessment of fish diversity in each planning area is as follows:

- Waipaoa Te Arai has a high diversity of species and is likely achieve an A grade. All 9 of the previously recorded fish species were detected using eDNA. A single backpack electric fishing event in 2020 noted high abundance of inanga, eel and bullies (NZFFD). Threatened or At-Risk species are present including longfin eel, kōaro, giant bully and torrent fish. The Panel notes recent fish passage improvements in this planning area.
- Waipaoa Hill Country has moderate species diversity and is likely to achieve a B grade, with eDNA confirming the presence of torrent fish and bluegill bully in pockets. Longfin eel and shortfin eel are widespread. Exotic fish (trout, goldfish and gambusia) were also detected. There is poor fish diversity in upper Waipaoa and Waihuka reaches.
- Waipaoa Poverty Bay Flats has a moderate species diversity in the mainstem with surprisingly high diversity in main tributaries (Waikaahu, Waikohu). This planning area is likely to achieve a B grade overall, but with low confidence due to the potential influence of all the headwaters on eDNA results. The presence of vulnerable species (LFE, torrent fish, bluegill bully, kōaro) was confirmed by eDNA results. Trout, goldfish and gambusia were also detected. Lamprey was detected at Whatatuna.
- Hangaroa – Rukuturi has relatively low diversity with moderate abundances and is dominated by eels (with possibly giant bully) and introduced species (trout, goldfish). It is likely to achieve a C grade at the planning area scale despite pockets of moderate to high diversity in lowland coastal area, e.g., Maraetaha and Kopuawhara where kōaro, bluegill bully, torrent fish, and giant bully detected along with inanga. This part of the planning area has potential to achieve an A grade.
- Mōtū has low species diversity, which might be expected at this far distance to coast with longfin eel, shortfin eel and trout dominant. There was no evidence of kōaro, shortjaw kokopu or bluegill bully in recent eDNA results, which suggested a decrease in diversity. Likely to be a C grade.
- Uawa has a high diversity of fish species with recent eDNA confirming presence of vulnerable species (torrent fish, bluegill bully) and giant bully in the upper reaches and kōaro in the Mangakino Stream and coastal streams. Longfin eel and shortfin eel are present. This planning area is likely to achieve a B grade overall, with patches of A grade where vulnerable species are present.
- Waiapu has moderate species diversity with recent eDNA data confirming the scattered presence of vulnerable species (torrent fish, bluegill bully, torrent fish, kōaro) Longfin eel and shortfin are widespread. There was no evidence of shortjaw kokopu or giant kokopu in eDNA results. This planning area is likely to achieve a B grade for fish diversity.
- Waimata high species diversity with the only eDNA record of shortjaw kokopu found in this area. Also detected at Whakaauranga were koōro, banded kokopu, and bluegill bully. Other sites in this planning area had relatively high diversity with longfin eel, shortfin eel, bullies and inanga often present. Lamprey was detected at Waimata R at Monowai Bridge. This planning area is likely to achieve an A grade.
- Wharekahika – Waikura has high species diversity with the only eDNA record of giant kokopu in the region found in this planning area. eDNA results confirm the presence of vulnerable species (longfin eel, bluegill bully, torrent fish, kōaro) and inanga widespread. This planning area is likely to achieve an A grade.

Confidence in this assessment was rated as 'Low' to 'Medium', with 'Medium' confidence assigned where three eDNA replicate samples confirmed previous distributions of species and 'Low' confidence otherwise assigned.

4.4.3.3 Baseline State

The Panel assessed the baseline state for fish as the same as current state, with the same level of confidence, as there is insufficient pre-2017 data to distinguish between baseline and current state.

4.4.3.4 Temporal trends

There was insufficient data to support a temporal trend analysis of fish diversity in the region.

National studies have shown declines for 47 years up to 2017 in the relative occurrence of lamprey, longfin eel, common bully, bluegill bully, redfin bully, shortjaw kokopu, giant kokopu, torrentfish, kōaro, shortfin eel, banded kokopu and inanga (Joy et al., 2018). Similarly, decreasing trends in relative abundance were observed for common bully, kōaro from 1995 to 2015 (Crow et al., 2016).

The Panel's confidence in the assessment of temporal trends on fish diversity was rated as 'Medium'. While limited local data these national trends show degrading trend in most species present in the region.

4.5 Human health attributes

4.6 *E. coli* (Freshwater)

4.6.1.1 Data, assumptions and methods

The NPS-FM defines two *E. coli* attributes.

- Appendix 2A Table 9 attribute relies on four metrics: median, 95th percentile, %samples >260 cfu/100mL and % samples >540 cfu/100mL;
- Appendix 2B, 22 attribute is applicable to primary contact sites only and relies on the 95th percentiles of samples taken during the bathing season.

Measured *E. coli* data was available at 38 water quality sites plus 18 recreational sites. To define the current state at each site, the Panel used measured data where available, and estimates from the Whitehead et al., 2021 spatial model elsewhere. The Panel noted that there appeared to be a correlation between the measured and modelled grades for the individual metrics in the rural regions, but not in the urban areas.

The measured data available was generally sufficient for a robust definition of current state for both *E. coli* attributes as defined in the NPS-FM with a high level of confidence. Estimates based on the national model were assigned a medium level of confidence.

The estimated current and reference *E. coli* concentrations and grading for each site class are provided in Appendix C3 (Table 12).

4.6.1.2 Current state

Overall, the current state of human health freshwater quality attributes in Te Tairāwhiti is poor, with a high proportion of sites in Band D or E Table 7. There appear to be many sites where the median concentration is an A grade (or close to it) but the overall grade is poor due to the upper percentiles. This indicates the water quality data is actually good more than half the time, but this is not reflected in the overall grades.

All sites specified as contact recreation are graded 'Poor' and below the NBL for NPS-FM Table 22. However, data on the percentage of time that the riverine recreational sites were in each band is summarised in Table 8. This data shows that the sites were suitable for swimming from 18 to 81% of the time across the sites with a median of 49%. This indicates that on average the recreational sites across the region were swimmable half of the time and unsuitable approximately 25% of the time (with 25% caution).

Table 7: Summary of human health (*E. coli*) current attribute state at Te Tairāwhiti monitoring sites.

Catchment / planning area	Number of sites	Band A	Band B	Band C	Band D	Band E
Hangaroa – Ruakituri	1	0	0	0	1	0
Mōtū	4	0	1	0	3	0
Waipapu	8	1	1	1	5	0
Ūawa	2	0	0	1	1	0
Waimatā	7	0	0	0	3	4
Wharekahika - Waikura	5	0	1	1	3	0
Waipaoa - Hill Country	8	0	0	0	5	3
Waipaoa - Gisborne Urban	6	0	0	0	1	5
Waipaoa - Poverty Bay Flats	5	0	0	0	2	3
Waipaoa - Te Arai	1	0	0	0	1	0
Tairāwhiti	47	1 (2%)	3 (6%)	3 (6%)	25 (53%)	15 (32%)

Table 8: Summary of *E. coli* concentration data available at riverine recreational sites. Percentage of time contact recreation sites in each class of 'suitable' (≤ 260 cfu/100 mL), 'caution advised' ($>260 - \leq 540$ cfu/100 mL), and 'unsuitable' (>540 cfu/100mL) for contact recreation between supplied data and LAWA. n.: number of samples.

	Suitable	Caution	Unsuitable	n	Suitable	Caution	Unsuitable	n
Site	GDC data				LAWA data			
Hangaroa River at Donneraile Park	67	12	21	74	N/A			
Karakatuwhero River at SH35 Br	81	9	10	187	86	7	7	192
Makarika Str at Makarika Br	51	20	29	49	67	14	19	69
Mangahauini River at Tokomaru Bay	49	26	25	53	58	22	20	74
Rere falls	38	29	33	184	48	34	18	211
Rere rockslide (top)	40	26	34	184	51	30	19	211
Tūranganui River at Gladstone Rd Bridge	49	17	34	578	56	13	31	248
Urukamuka Stream	18	57	25	55	29	54	17	76
Waipapu River at Rotokautuku Br (SH35)	70	10	20	202	70	12	18	134
Waimata River at Anzac Park	65	12	23	126	60	13	27	189
Waiotu Str at Waiotu Rd Bridge	40	19	42	43	54	15	31	71
Waipaoa River at Kanakanaia	34	26	40	252	49	13	38	137
Wharekahika River U/S of Wharf Bridge	51	28	21	176	77	11	12	129

Table 9: Summary of *E. coli* concentration data available at riverine recreational sites. Percentage of time contact recreation sites in each class of 'suitable' (≤ 260 cfu/100 mL) and 'unsuitable' (> 260 cfu/100mL) for contact recreation between supplied data and LAWA.

Site	Suitable	Unsuitable	Suitable	Unsuitable
	GDC data		LAWA data	
Anaura Bay Nth Lagoon	59	41	75	25
Hangaroa River at Donneraile Park	79	21		
Karakatuwhero River at SH35 Br	90	10	93	7
Makarika Str at Makarika Br	71	29	81	19
Mangahauini River at Tokomaru Bay	75	25	80	20
Rere falls	67	33	82	18
Rere rockslide (top)	66	34	81	19
Tūranganui River at Gladstone Rd Bridge	66	34	69	31
Urukamuka Stream	75	25	83	17
Waipatu River at Rotokautuku Br (SH35)	80	20	82	18
Waikanae Beach at Grey St CHNES003	92	8	81	18
Waimata River at Anzac Park	77	23	73	27
Waiotu Str at Waiotu Rd Bridge	58	42	69	31
Waipaoa River at Kanakanaia	60	40	62	38
Wharekahika River U/S of Wharf Bridge	79	21	88	12

Confidence in the current state assessment at sites with measured data was rated as high. There appears to be a strong correlation between the measured and modelled data in the rural parts regions. This gives a 'medium' level of confidence in the sites where the data is modelled. This correlation between measured and modelled is not strong in the Urban planning area but there is measured data for all urban sites (i.e. the assessment did not rely on modelled data for sites in the Urban planning area).

4.6.2 Baseline state

The baseline state for human health water quality was determined from *E. coli* measured data at each of the 56 sites with sufficient data. The Panel noted that the baseline state tended to be better than the current state at many sites across the region, i.e. there is a deterioration in *E. coli* concentrations between the baseline and current states. This is consistent with the most recent trend analysis report (Kodur 2024), but the Panel is not aware of any investigation into the causes of these trends.

Within each planning assessment:

- Hangaroa – Ruakituri: No baseline sites
- Mōtū: 1 baseline site in Band B, 3 baseline sites in Band D or E.
- Waipatu: Total of 8 baseline sites with data; 4 sites are Band A but only one remains in Band A at current state, and all 7 of the sites degrade at current state.
- Ūawa: 2 baseline sites would be in Band A based on the median metric but are classified as Band D overall due to high 95th percentiles.
- Waimatā: 7 baseline sites, all Band D or E. One site (Waimata River at Goodwins Rd Bridge) was Band A based on the median metric but Band D based on the 95th percentile.
- Wharekahika – Waikura: 5 baseline sites, all Band A based on medians, 2 sites overall Band A, 2 sites were Band B and 1 site was Band D. But deterioration overall between baseline and current state.

- Waipaoa - Hill Country: 6 baseline sites with 4 sites classified as Band A based on the median metric but all sites as Band D based on the 95th percentile.
- Waipaoa - Gisborne Urban: 7 baseline sites all graded as Band D or E overall.
- Waipaoa - Poverty Bay Flats: 6 baseline sites all graded Band D or E overall, but 3 sites would be in Band A based on the median metric. Tūranganui River at Gladstone Rd Bridge appears to be deteriorating.
- Waipaoa - Te Arai: 1 baseline site graded as Band D and remains in Band D in the current state.

4.6.2.1 Temporal trends

The assessment of temporal trends for *E. coli* was limited to short-term (5-year) trend analysis, for the reasons noted in the introduction to Section 4. The freshwater faecal indicator bacteria monitored by GDC was faecal coliforms until c. 2015, when it shifted to *E. coli*. There is no direct relationship between FC and *E. coli*, and the change in indicator bacteria further reduces the validity of long-term *E. coli* trend analysis in the region.

Short-term trends Kodur (2024) indicate an overall deteriorating condition. Most deteriorating trends are site specific with only the Waipapua planning area showing 7 out of 8 sites deteriorating.

4.6.2.2 Reference state

The best estimate of reference state for *E. coli* was based on the values from McDowell (2013), noting however these estimates are based on current state of catchments currently predominantly in native vegetation, i.e. they include the effects of existing levels of birds and mammal populations.

To an extent, the faecal contamination inputs from wild animals (especially birds) can be considered a naturally occurring process; although higher levels of contamination due to high abundance of pest animals are arguably beyond naturally occurring processes. To the Panel's knowledge, data to allow a robust quantification of what would constitute fully "natural" *E. coli* concentrations and/or the impact of pest animals vs. those of abundant native animal populations does not exist. There is also no data to support an assessment of the effectiveness of pest control on *E. coli* concentrations in streams.

The estimated reference *E. coli* concentration at each site class is provided in Appendix C3 (Table 12), noting there are very wide confidence intervals in the McDowell *E. coli* model for some REC classes (WW) in Tairāwhiti (i.e. low confidence in these predictions), except for CWH (i.e. higher confidence in reference predictions for these streams).

4.7 Human health (estuaries)

4.7.1.1 Data, assumptions and methods

Robust recreational water quality monitoring data is available for estuarine recreational sites within the Tairāwhiti region. Additionally, data from freshwater sites located at or near terminal reaches offer valuable insight into the recreational water quality of the region's tidal and estuarine areas.

4.7.1.2 Current state

Monitoring data show that estuarine (lagoon) areas are often classified as 'unsuitable' for contact recreation for most of the time (Table 10¹⁶). Based on LAWA data, the following sites were classified as unsuitable:

- Tūranganui: 31% of the time
- Anaura Bay Nth Lagoon: 25% of the time
- Waimata River at Anzac Park: 27% of the time
- Mangahauini River at Tokomaru Bay: 20% of the time

¹⁶ Data source LAWA Can I Swim Here? Accessed May 2025. <https://www.lawa.org.nz/explore-data/swimming>

- Te Wherowhero Lagoon: 9% of the time

Faecal indicator bacteria (enterococci) in lower reaches of the Taruheru exceeded “action” levels during a 2017 faecal source tracking study conducted under base flow conditions. At these levels the water would be considered unsuitable for swimming. Ruminant and avian sources were identified, and the was indicative of aged faecal material (Devane, 2017).

Table 10: Summary of *E. coli* concentration data available at estuarine recreational sites or river recreational site near the river mouth. Percentage of time contact recreation sites in each class of ‘suitable’ (≤ 260 cfu/100 mL), ‘caution advised’ (>260 - ≤ 540 cfu/100 mL) , and ‘unsuitable’ (>540 cfu/100mL) for contact recreation between supplied data and LAWA. n.: number of samples.

	Suitable	Caution	Unsuitable	n	Suitable	Caution	Unsuitable	n
Site	GDC data				LAWA data			
Anaura Bay Nth Lagoon	36	23	41	61	54	21	25	85
Karakatuwhero River at SH35 Br	81	9	10	187	86	7	7	192
Mangahauini River at Tokomaru Bay	49	26	25	53	58	22	20	74
Tūranganui River at Gladstone Rd Bridge	49	17	34	578	56	13	31	248
Waikanae Beach at Grey St CHNES003	89	3	8	124	78	3	18	223
Waimata River at Anzac Park	65	12	23	126	60	13	27	189
Waiotu Str at Waiotu Rd Bridge	40	19	42	43	54	15	31	71
Wharekahika River U/S of Wharf Bridge	51	28	21	176	77	11	12	129

4.7.1.3 Temporal trends

No temporal trends are available for recreational water quality monitoring sites (e.g., summer only) so it is suggested that the data from SOE river quality sites provide the best indication of likely direction of trends in downstream estuarine waters (Kodur, 2024). This relationship between freshwater sources and trends within the estuary may not be consistent if inputs of faecal contaminants are from localised sources such as stormwater, wastewater or bird life.

4.7.1.4 Reference state

No information was available to define the reference state of *E. coli*; however data and analysis for freshwaters would suggest that the reference state for estuaries would also be in Band A or ‘Suitable’ for contact recreation.

4.8 Summary of key issues

Sediment is a widespread and significant issue throughout Te Tairāwhiti. Visual clarity and deposited fine sediment are generally in poor to very poor state in most freshwater catchments and directly affect a range of ecological, recreational and cultural values. Sediment is likely to be the main driver negatively affecting freshwater ecological health (e.g., macroinvertebrates and fish) across the region. Deposited sediment is also a known key stressor associated with decreased estuarine ecosystem health. Given the dominance of soft

sedimentary geology, there is a high risk of sediment stress in estuaries in the Tairāwhiti Region, especially in estuaries with long residence times and / or depositional areas (e.g., Tūranganui, Kaitawa, Te Wherowhero).. For other estuaries with shorter residence times (e.g., Waipaoa, Pouawa) the Panel notes the open coastal environment is likely to be the final receiving environment for sediment (and other contaminants), but assessing the coastal environment was outside the Panel's scope.

Water temperature and dissolved oxygen are also identified as significant issues and there is evidence that both are currently important drivers of poor ecological health in Tairāwhiti. Data indicate that thermal stress is prevalent across most of the region's waterways, except in heavily vegetated areas. By contrast, DO issues appear to be limited to lowland waterways, such as in the Poverty Bay Flats area. High water temperatures and low DO concentrations are likely to have a direct influence on macroinvertebrate and fish communities and can lead to local elimination of keystone species with loss of ecological integrity. They can also limit the movement of migratory fish. High temperature and low DO can be exacerbated by modified flow regimes (e.g., water abstractions) and instream and riparian habitat modifications (e.g., channelisation, reduced shading and aeration by turbulent flow), which are also identified as key issues by the Panel.

Faecal contamination of waterbodies poses a significant, region-wide risk to human health risk and affects the recreational suitability of both freshwater and estuaries, including key mahinga kai sites. To improve recreational value, the Panel recommends prioritising management actions in catchments with high recreational use, such as the Wharekopae catchment above Rere Falls. Notably, *E. coli* data indicate that while many sites achieve an A grade for median levels, they fail on the 95th percentile metric (D grade), suggesting that water quality is generally good much of the time, but occasionally experiences high contamination events.

The Panel considers that nutrient driven eutrophication is not the most pressing, widespread environmental issue in Tairāwhiti, although there is evidence of eutrophication issues in the lowland parts of the Waipaoa planning area (i.e., in Te Arai, Poverty Bay Flats, and Urban sub-areas; see Figure 2). In these areas, it is generally the growth of phytoplankton and/or macroalgae (and consequently DO and pH fluctuations and potentially toxic growths) that are causing eutrophication, not periphyton. These issues are considered in more detail in response to Question Group 6 (Section 6 of this report).

Extensive landscape modification, river diversion and drainage of lowland and estuarine wetland areas are likely to have significantly altered estuarine habitat in Tairāwhiti. Many of the region's estuaries are predominantly river dominated (naturally and / or as a result of modifications) and, as such, represent relatively low risk environments for sediment deposition or eutrophication issues. This is due to the relatively short residence time of water within these systems, which means that contaminants such as sediment, nutrients and faecal contaminants are transported through the system quickly. For these systems the coastal environment becomes the ultimate receiving environment.

The Panel however identified three estuarine systems that are likely to be more sensitive to land use effects in the Tairāwhiti region. The Tūranganui, Kaitawa and Te Wherowhero Lagoon, have longer residence time (water stays in the system for a longer time and therefore sediment drop out and deposit, and nutrients are utilised for growth), and available data indicates that these systems are showing signs of stress and poor ecosystem health. The Panel recommends that these estuaries should be the focus of future monitoring and management response.

5 Panel assessment of scenario outcomes

The Panel's assessment of scenario outcomes on each attribute at each of the 116 assessment sites was recorded in the Assessment Spreadsheet. The relevant modelled outputs (e.g., change in mean annual sediment loads, change in visual clarity, and *E. coli* and nutrient concentrations under each scenario) were first populated in the spreadsheet. The Panel then recorded their assessment of scenario outcomes on non-modelled attributes and indicators. Not all attributes were able to be assessed at site scale:

- The Panel were able to assess the scenario outcomes at site scale for the following attributes and indicators: visual clarity, DFS, DRP, DIN, TN, TP, periphyton, temperature, MCI and *E. coli*.
- For other attributes and indicators, the Panel felt that the available state data and/or modelling information were insufficient to support a credible site-by-site assessment and instead relied on a broad scale narrative assessment of the likely outcomes of each scenario. These were: DO, habitat and fish.
- For estuarine systems, reductions in the freshwater attribute were quantitatively assessed (where possible e.g., nutrient loads and total suspended sediments) in terms of how the reductions would contribute to outcomes for the estuary. Where either baseline or scenario data was insufficient to assess these quantitatively, a qualitative or narrative assessment was made.

The Panel notes that assessing the effects of flow regimes was outside its scope and, specifically, the Panel has not assessed the effects of the current or future levels of water abstraction, or the potential effects of the increases in overall catchment tree cover on hydrology under any of the management scenarios. Similarly, the Panel did not consider the effects of potential changes in farming systems or practices (such as changes in stocking rates or irrigation) that may occur in the future as a consequence of climate change, future policies or market mechanisms.

5.1 Sediment loads and visual clarity

5.1.1 Scenarios, methods and limitations

The Panel considered the scenarios provided were sufficiently clear and understandable to support the assessment of scenario outcomes on sediment-related attributes. The strong focus of management measures on sediment and erosion control in Scenarios 2-5 is consistent with the significance and widespread distribution of the sediment issue in the region. Sediment is the key contaminant in the region and needs to be directly addressed in the scenarios, with implications for the other contaminants flowing from this sediment focus.

The data, assumptions and methods supporting the scenario modelling is described in detail in Neverman and Smith, 2025¹⁷. This was reviewed by the Panel, who was satisfied the model was fit for the purpose of assessing the outcomes of the 5 management scenarios. The Panel noted that the model used Gisborne-specific data for visual clarity, gully location and size, gully erosion rates, and mitigation effectiveness values, which provides greater confidence in the model outputs. A range of climate scenarios were able to be represented. Whilst climate change predictions are inherently uncertain, the ensemble of model outputs was selected to represent the range of uncertainties (Neverman & Smith, 2025), thus providing greater certainty in common trends and spatial patterns resulting from the combined effects of management actions and climate change.

Scenarios 3 (2040) and 5 (2090) were each modelled under two sets of climate assumptions: current climatic conditions (Scenarios 3a and 5a) and a range of climate change projections (Scenarios 3b and 5b), explained in detail in Neverman and Smith, 2025.

The Panel noted a number of limitations and factors affecting uncertainty, including:

¹⁷ Technical library TL#081

- The Sediment model framework is not able to represent all erosion processes in all spatial domains, for example streambank erosion is not represented in hill country, which is extensive in Tairāwhiti. This constrains the ability to reflect the net impact of climate change and mitigations
- The model outputs relate to sediment loads. The relationship used to estimate change in median visual clarity from the modelled change in mean annual suspended sediment loads is based on fitting to a national dataset, which may not represent local relationships between sediment load and visual clarity at a given site
- Some estimates of the current state of visual clarity are uncertain (due to the monitoring method, as explained in Section 4.1.1). This introduces uncertainty in the current state and estimates of change needed to achieve target states.

Overall, the Panel considered the model provided medium to high confidence in broader spatial patterns and results integrating larger catchment areas (i.e. relative differences within and between catchments/Planning areas), with confidence reducing to medium to low at smaller spatial scales. Model outputs should be used to identify spatial patterns and trends, avoiding over interpretation of absolute values, particularly at sites with smaller catchment areas.

5.1.2 Full afforestation (Scenario 2)

This scenario represents a theoretical state where each of the 10 catchment areas is fully re-vegetated with permanent, mature woody vegetation (trees) within the contemporary catchment setting (i.e. the contemporary channel network and catchment hydrology). This scenario therefore represents a best achievable state, considering that erosion is a naturally occurring process and some degree of erosion exists under mature forest vegetation, and considering the land clearance and land use history of the region. Specifically, contemporary gullies (i.e. including those triggered or exacerbated by historical deforestation) considered “un-mitigatable” remain un-mitigated in this scenario. This scenario thus represents a state that is somewhat different (potentially higher erosion than) a theoretical historical “natural” state.

Scenario 2 (full afforestation) is estimated to result in significant reductions in suspended sediment load across all the planning areas, particularly those with the most extensive areas of pastoral hill country. Reductions in sediment load over 50% are expected at most $\geq 4^{\text{th}}$ order sites. Most sites across the region are predicted to achieve Band A and B across the region, except for sites downstream of large gullies which are unlikely to stabilise under afforestation, resulting in sites along the Waipaoa, Waiapu, and Tapuaeroa Rivers remaining in Band D.

For estuaries where data was available (Tūranganui and Waipaoa), and assuming a one-to-one relationship between the sediment reductions and TSS (at a mid-range 7.5% reduction), scenario 2 resulted in a distribution of total suspended sediment from:

For the Tūranganui Estuary:

- 12% less samples in the Very High TSS range
- 13% less samples in the High TSS range
- 5% less samples in the Moderate TSS range
- 21% more samples in the Low TSS range; and
- 9% more samples in the Very Low TSS range.

For the Waipaoa Estuary:

- 17% less samples in the Very High TSS range
- 3% less samples in the High TSS range
- 5% less samples in the Moderate TSS range
- 19% more samples in the Low TSS range; and
- 6% more samples in the Very Low TSS range.

5.1.3 2040 (Scenario 3)

Under this scenario, the mitigations implemented before 2040 are assumed to be partially mature, and therefore partially effective for erosion reduction.

Under current climatic conditions, [Scenario 3a](#) is expected to result in reductions in sediment load of typically 5-10% expected across ≥ 4 th order sites by 2040 for all planning areas, with proportional visual clarity improvements expected to be less than proportional sediment load reduction at these values¹⁸. Greater variability is expected at lower order stream sites, depending on the location of mitigation actions. This scenario is unlikely to result in widespread changes in the attribute state band for visual clarity, except for those with current state visual clarity that is very close to a band threshold.

This scenario is also unlikely to meaningfully alter the distribution of very high to very low total suspended sediments in the estuarine waters (e.g., less than 2% change).

Incorporating the potential impacts of climate change, [Scenario 3b](#) indicates that the mitigations assumed under this scenario are unable to offset the effects of climate change by 2040 across the region, with net increases in sediment load centred around 25% for all planning areas, equivalent to a 15% reduction in clarity. Under this scenario, visual clarity is expected to degrade across the region, with approximately two thirds (57-71%) of sites with a baseline state above NBL expected to degrade in attribute band by 2040. Most of the region where the current state is Band B or C is therefore likely to degrade in attribute band state under this scenario. Those sites currently in Band A but close to the Band B threshold are also likely to decline in a band state. Those sites significantly above the Band A threshold are unlikely to decline in a band state. The highest level of compliance with the NBL is likely to be achieved in the Wharekahika-Waikura, where most streams in the planning area may remain in Band A. Scenario 3b is not represented in the Assessment Spreadsheet, but details may be found in Figure 17 and Tables A4.1 and A4.2 in Neverman and Smith, 2023¹⁹.

5.1.4 2060 (Scenario 4)

Under this scenario, the mitigations implemented up to 2040 are now considered to be fully effective for erosion reduction. Mitigations implemented between 2040 and 2060 are assumed to be partially mature, with corresponding partial effectiveness.

Under Scenario 4, reductions in sediment loads of 15% - 25% are expected in most planning areas, with the greatest sediment load reductions expected in the Waiapu and Ūawa planning areas (25% - 35%)²⁰. Improvements in visual clarity are expected at all sites, with sites already above NBL likely shifting one band higher. Significant load reductions are required to move Band D sites above NBL, therefore these sites unlikely to change across all planning areas²¹.

Whilst the climate change impacts were not modelled for Scenario 4, the Panel considered this scenario is likely to represent the transition from net increased loads and declines in visual clarity which occur under Scenario 3B, to the net reductions in sediment load and improved visual clarity which occur under Scenario 5B, and therefore mitigation and climate effects may be expected to cancel out, resulting in similar states to current.

5.1.5 2090 (Scenario 5)

Under this scenario, the mitigations implemented up to 2060 are now considered to be fully effective for erosion reduction. Mitigations implemented between 2060 and 2090 are assumed to be partially mature, with

¹⁸ Technical Library TL#047: Figure 11 and Tables A3.1 and A3.2 in Neverman and Smith, 2023

¹⁹ Technical Library TL#047 Figure 17 and Tables A4.1 and A4.2 in Neverman and Smith, 2023

²⁰ Technical Library TL#047 Figure 17 and Tables A3.1 and A3.2 in Neverman and Smith, 2023

²¹ Technical Library TL#081 Table A1.1 in Neverman and Smith, 2025

corresponding partial effectiveness. A small degree of further improvement in sediment loads is thus expected to occur in addition to those predicted under this scenario.

Under current climatic conditions, Scenario 5a is generally expected to result in reductions in sediment load of 30% – 45% across most planning areas²². Such reductions can potentially shift state by up to 2 bands for sites already above NBL. Reductions in the Ūawa catchment are centred around 65%, which may be sufficient to shift about half of the sites in Band D to Band C (above NBL)²³. Figure 14 of Neverman and Smith, 2025 indicates sites in the Ūawa and Waimatā are the most likely to change band. Based on data in the Assessment Spreadsheet, we would therefore expect many low order sites across these planning areas to achieve Band A, along with other sites currently above NBL. The Wharekahika-Waikura planning area is likely to be mostly in A band. Sites along the Waipaoa, Waiapu, and Tapuaeroa Rivers are likely to remain in Band D, as are sites in the Waipaoa – Urban planning area. Other lowland sites currently in Band D may shift to Band C across the planning areas.

Incorporating the potential impacts of climate change, modelling of Scenario 5b indicates that sediment loads in the Mōtū planning area are likely to increase by 2090 under higher greenhouse emission scenarios (e.g., RCPs 6.0 and 8.5), leading to degraded visual clarity, unless more significant decreases in greenhouse gas emissions are achieved (e.g., RCPs 2.6 and 4.5)²⁴. Reductions in sediment load are expected across all other planning areas for most climate scenarios, centred around a net 10% - 15% reduction, except under RCP 8.5, where increases in load are expected across the Waimatā, Waipaoa, and Wharekahika-Waikura. Load reductions are expected to be greatest in the Ūawa planning area, centred around 55%. Sites across the Wharekahika-Waikura are likely to remain in Band A. Sites along the Waipaoa, Waiapu, Tapuaeroa Rivers, and in the Waipaoa – Urban planning area are likely to remain in Band D. Other sites with a current state in Band D are also likely to remain in Band D by 2090. Sites above NBL in the Ūawā are likely to improve by 1-2 bands. Sites in other planning areas, except the Mōtū, where current state is above NBL may see an improvement in attribute band.

For estuaries where data was available (Tūranganui and Waipaoa), and assuming a one to one relationship between the sediment reductions and TSS (at a mid-range 37.5% reduction), scenario 2 resulted in a distribution of total suspended sediment from:

For the Tūranganui Estuary:

- 10% less samples in the Very High TSS range
- 8% less samples in the High TSS range
- 0.5% less samples in the Moderate TSS range
- 14% more samples in the Low TSS range; and
- 5% more samples in the Very Low TSS range.

For the Waipaoa Estuary:

- 14% less samples in the Very High TSS range
- 2% less samples in the High TSS range
- 7% less samples in the Moderate TSS range
- 15% more samples in the Low TSS range; and
- 4% more samples in the Very Low TSS range.

5.1.6 Response timeframes

To aid in the interpretation of the modelling outcomes, the Panel were asked a series of questions relative to the likelihood of the modelled outcomes actually occurring and when the in-river response may occur.

²² Technical Library TL#081: Figure 11 in Neverman and Smith, 2025

²³ Technical Library TL#081: Table A1.1 and Figures 9 and 10 in Neverman and Smith, 2025

²⁴ Technical Library TL#081: Figure 17 in Neverman and Smith, 2025

The Panel's opinion was that the detectability of reductions in suspended sediment load at a site will depend on when, and how extensively, mitigations are implemented upstream. In small catchments extensively mitigated, with mitigations implemented early, reductions in sediment loads and improvement in visual clarity may be detectable within a decade. As catchment area increases and the proportion of land mitigated decreases, response times are likely to extend out to multiple decades as climate change offsets the mitigation signal. For large catchments, improvements may not be detectable until mid to late century. The Panel considered a range of factors likely to influence when the response to mitigations will occur in-river, including:

- Different mitigations measures will take different times to become fully effective: based on empirical data from the Gisborne region, trees will take 10 – 20 years to reach their full capacity for erosion reduction, whilst stock exclusion and grass riparian buffers become effective sooner as they immediately prohibit stock trampling of stream banks, and grass growth occurs quickly, trapping sediment transported by overland flow/sheetwash (surface erosion)
- The 'policy package' assumed in the scenarios is fairly ambitious, with majority of erodible land to have mitigations applied by 2060, but the mitigations may not be fully effective until late century;
- Episodic nature of erosion and sediment loads, and lag effects in the catchment system can increase the time it takes to see an improvement trend from mitigation efforts, further complicated by climate change.
- Sediment loads can remain elevated for several years to a decade following high magnitude events. Catchments in Gisborne are known to have large volumes of sediment in storage, which may elevate loads through subsequent entrainment for long periods of time, until storage is depleted or no longer entrained.
- Modelling of Scenarios 3, 4 and 5 suggests climate change is likely to offset mitigation efforts before 2060, with mitigations beginning to offset climate change later in the century.

The Panel expresses 'medium' confidence in the response timeframes for sediment loads, with most uncertainty arising from the challenge of anticipating climatic variability, but lower confidence in the response timeframes for visual clarity, as the relationship between clarity and suspended load may change under future climate and land cover.

5.1.7 Key messages

The Panel considers that the three future management scenarios represent an ambitious policy package that is consistent with the significance and the ubiquitous nature of sediment-related issues in the region. The policy package assumed under the scenarios is likely to result in material reductions in sediment loads and improvements in visual clarity over time across the region. Climate change is likely to have a significant detrimental impact on sediment loads in Tairāwhiti and might offset or delay the benefits of early mitigation actions, but the scenario mitigations are likely to offset the detrimental effects of climate change in all but the most extreme climate scenarios from mid-century (2060 scenario). The long-term scenario (2090) is expected to result in material improvements in sediment-related attributes despite the detrimental impacts of climate change for all but the most extreme climate projections.

In developing regional freshwater policy, it is important to bear in mind that sediment load and visual clarity response times are likely to range from within a decade in small catchments with extensive mitigation actions to multiple decades in large catchments where improvements may not be detectable until mid to late century depending on the impacts of climate change.

The Panel considers the modelling of the full afforestation scenario (Scenario 2) represents a robust estimate of the best possible achievable state given the historical land clearance and land use in the region. Modelling outputs for this scenario indicate that the NBL for visual clarity may not be achievable in some streams and rivers, such as the Waipaoa, Waiapu, and Tapuaeroa Rivers.

Landslides and gullies are predominant sources of fine sediment in Tairāwhiti, thus the most effective mitigations will be:

- Tree planting of pastoral hillslopes most susceptible to shallow landslides and most likely to connect to waterways; and
- Afforestation of mitigatable gullies and large landslides such as rotational landslides (slumps) and earthflows.

5.2 Deposited fine sediment

5.2.1 Scenarios, methods and limitations

Direct scenario modelling of deposited fine sediment (DFS) was not undertaken, as the Panel believes it is not currently possible given existing knowledge and modelling tools. In the absence of an equation to predict changes in DFS from changes in sediment load, the Panel made a coarse assumption of a 1:1 relationship (% change in load: % change in DFS) in freshwater. However, there is significant error unaccounted for in this assumption, in terms of spatial variability in environmental drivers (slope, flood frequency/flashiness, channel size and bedform, geology, sediment characteristics), attenuation and lag time, variation in land use practices, and the non-linear relationship between load and deposition. As noted in the suspended sediment scenario modelling, limitations in how erosion processes are spatially represented introduce additional uncertainty into the estimated net effects of climate and mitigation scenarios on DFS. The modelled reductions at 4th order and higher sites are assumed to broadly represent reductions at lower order sites. However, this assumption may not hold everywhere, as lower order streams can be heavily influenced by locally significant point sources (e.g., gullies) and may have different sediment retention efficiencies — with lower stream power potentially leading to higher sediment retention and reduced transport downstream. The Panel notes that more accurate predictions could be gained from better DFS data and investigation of suitability of the NPS-FM Deposited Sediment Classification.

For estuaries, the Panel concluded that, although the direction of change of deposited sediment is likely to be the same as that of sediment loads, the outcomes on DFS in estuaries cannot be quantified with any reliability given the current state of information and knowledge. In particular, the Panel did not consider a 1:1 relationship between change in sediment loads and change in DFS can be assumed for estuaries, given that sediment deposition through estuaries is variable and dependant on hydrological processes and dynamics. The Panel recommends ongoing monitoring of deposited sediment and mud content in at-risk estuaries to establish a baseline and measure change over time.

5.2.2 Full afforestation (Scenario 2)

Scenario 2A (Afforestation) is expected to result in significant reductions in suspended sediment load, in excess of 50%, at most $\geq 4^{\text{th}}$ order sites. Although significant, these load reductions are unlikely to bring all sites above the NBL. For example, all sites with greater than 60% deposited fine sediment cover are expected to remain in Band D with 50% sediment load reduction. These include sites downstream of large gullies which are unlikely to stabilise under afforestation, resulting in sites along the Waipaoa, Waiapu, and Tapuareaoa remaining in Band D. Greater than 70% reductions in sediment load, as seen in the Waiapu, Waimata, Wharekahika, are expected to bring sites above the NBL and close to Band A for DFS. Finally, sites in Band D are likely to remain in Band D where low reductions in sediment load occur due to already predominantly forested catchments, e.g., Upper Mōtū Tributary at Mangatu site.

5.2.3 2040 (Scenario 3)

Under Scenario 3a (2040), mitigations are recently implemented, and this scenario is unlikely to change attribute band at any site.

Under Scenario 3b (2040 plus CC), the Panel expects mitigations are unable to offset climate change by 2040 across the region, with net increases in sediment loads, and thus DFS, in all planning areas. With most of the region already in Band D, this pattern is expected to remain. There is also a high risk that areas above, yet close to the NBL, may degrade including in the Mōtū, Uawa and Wharekahika planning areas. Streams in parts of the Waiapu planning area are most likely to remain beyond the NBL.

5.2.4 2060 (Scenario 4)

Under scenario 4A (2060), mitigations implemented before 2040 become fully effective for erosion reduction. Mitigations implemented between 2040 and 2060 are assumed to be partially mature. The resulting state is predicted to be midway between 2040 (3a) and 2090 (5a) scenario. The majority of streams are still predicted to be below the NBL under this scenario, although improvements may possibly be detected at sites, especially in the Uawa and Mōtū planning areas.

Under Scenario 4b (2040 plus CC), mitigations are expected to offset the effects of climate change across the region, and the majority of the region will remain below the NBL as is in current state.

5.2.5 2090 (Scenario 5)

Under Scenario 5a (2090), reductions in sediment load of 30% – 45% are generally expected across most planning areas. Detectable improvements (change in 1 attribute band) are most likely in parts of Waipaoa Hill Country, Mōtū, Uawa, Waiapu and Wharekahiku planning areas. However, many sites currently have very high DFS, significantly beyond the NBL, and are expected to remain below the NBL under this scenario. Greater improvements unlikely to be detectable by this timeframe given the current high loads of fine sediment in the river systems.

Under Scenario 5b (2090 plus CC), mitigations will most likely offset or outweigh the effects of climate change when the deposited fine sediment level is in Band A, B or C only. Otherwise, the moderated 10-15% reduction in loads is unlikely to lead to a change in attribute state for the majority of the region.

5.2.6 Response timeframes and key messages

Because predictive models for DFS are not available, the Panel considers that changes in DFS under each scenario – as well as the expected timeframes – will generally follow similar patterns to those of sediment loads. Therefore, the response timeframes and key messages for DFS align with those outlined in Sections 5.1.6 and 5.1.7.

5.3 Nutrient related attributes

5.3.1 Scenarios, models and limitations

The Panel considered the scenarios provided were sufficiently clear and understandable to support the assessment of scenario outcomes on nutrient-related attributes. Nutrient mitigation is not the focus of the management actions assumed in Scenarios 2-5, which is consistent with the conclusion reached by the Panel that nutrients are not a widespread issue for most of the region. The exception is the Poverty Bay Flats area, which is addressed separately in Question Group 6. The scenarios are consistent with the approaches taken in other regions, for regions, or parts of regions, that have no, or small, nutrient issues.

The data, assumptions and methods supporting the scenario modelling, as well as the model outputs for each scenario are described in detail in technical documentation provided to the Panel ²⁵. The model was based on the OLW Scenario Builder²⁶, which uses available high-level information across many NZ environment types to

²⁵ Ausseil & Heath, 2025. (TL#082)

²⁶ Described in Ausseil et al., 2024 and associated references, e.g., Snelder et al., 2020, 2024, Srinivasan et al., 2021, Monaghan et al., 2021.

make coarse level predictions of direction and approximate magnitude of change in places with similar land use characteristics, but for which measured data is not available. The model and associated information was reviewed by the Panel, who was satisfied the model was fit for the purpose of providing reasonable estimates of likely direction and approximate magnitude of change under land use change assumed in scenarios at the catchment and large sub-catchment scale. This does not imply accuracy at river segment, property level or even small sub-catchment scale, and model outputs should not be used to set or implement property level nutrient discharge allowances or set absolute numeric TAS at specific sites.

Each scenario was modelled at 116 sites across the region. The modelled outcomes of each scenario for each site were provided to the Panel in the Assessment Spreadsheet. The Panel estimated the periphyton outcome of each scenario at each site where current periphyton state was available and populated the Assessment spreadsheet accordingly.

The model was useful to describe the co-benefits that are gained for nutrients and eutrophication through application of policies that induce land use change driven by other issues (i.e., sediment and *E. coli*). The impacts of climate change on nutrient concentrations were not modelled but were assessed by the Panel based on professional experience and opinion.

The Panel noted the following confidence in modelled:

For broad-scale application (large sub-catchments and larger):

- Nitrogen – Medium to High confidence
- Phosphorus – Low to Medium confidence

For small-scale application (small sub-catchment and smaller):

- Nitrogen – Low confidence
- Phosphorus – Very low confidence.

5.3.2 Full afforestation Scenario (Scenario 2)

The full afforestation scenario resulted in significant estimated reductions in the concentrations of both nitrogen and phosphorus. Across the 116 modelled sites, the median reduction in phosphorus was 65% and the interquartile range was 51% – 74%. For nitrogen, the median reduction was 78% and the interquartile range was 69 – 81%.

The Panel estimated that all sites currently in Band A for periphyton would remain in Band A but show a reduction in absolute biomass values (i.e. moving higher within Band A) due to large nutrient reductions and anticipated improvements in riparian cover, light regime, and temperature under Scenario 2. Sites currently in Bands B and C could potentially improve enough to move to Band A for the same reasons.

In estuaries, Scenario 2 would be expected to return nutrient concentrations to, or close to, reference conditions. However, the trophic state of estuaries is not expected to return to reference conditions as other factors, such as hydrological and habitat modifications of estuaries, are not assumed to change under Scenario 2.

5.3.3 2040, 2060 and 2090 (Scenarios 3-5)

Scenarios 3 to 5 were all predicted to result in relatively small reductions in both nitrogen and phosphorus (median reduction of 1-2% for phosphorus and 1-3% for nitrogen) at all sites. The Panel noted that the modelled predictions for phosphorus were probably underestimates (i.e. in reality, greater reductions may occur), because the model did not consider the potential reductions in sediment-bound phosphorus inputs likely to occur under all scenarios.

The Panel assessed that although any nutrient reduction helps lower the risk of eutrophication, the current state grade would likely remain unchanged under Scenarios 3 to 5. This is because the predicted nutrient reductions in these scenarios were very small and fall within uncertainty margins regarding periphyton response.

In estuaries, similarly, any nutrient reduction is favourable for reducing risk of eutrophication, but no material change in estuarine trophic state is expected in Scenarios 3-5.

5.3.4 Influence of Climate change

Climate change could influence how the scenarios affect nutrient loss from land to streams and also the eutrophication response to nutrient changes (e.g., periphyton growth).

The main aspects of climate change influencing how nutrients are lost from land into waterways include rainfall and the frequency and intensity of rain events. More frequent and intense high rainfall events would tend to exacerbate nutrient loss while lower base rainfall (e.g., median rainfall) would tend to reduce nutrient losses.

The main aspects of climate change that exacerbate the eutrophication response to nutrients include lower river baseflows (e.g., lower median rainfall and increased abstraction demand) and warmer water temperatures, both of which would exacerbate the growth of algae and consequently DO and pH fluctuations that stress invertebrates and fish. The algae would most likely be periphyton in the mid and upper reaches of rivers, but phytoplankton and macroalgae in lower tidal reaches of rivers and estuaries. Conversely, more frequent high rainfall events under climate change would tend to flush out growths more regularly. The net effect of these two processes would be worse eutrophication responses accumulating during periods of stable weather conditions but potentially more frequent re-setting events.

Similarly for estuaries, the impacts of climate change related to nutrients and/or eutrophication are likely to be primarily through any change to the hydrological regime of the estuaries. This may include similar factors to those outlined for rivers, such as lower river baseflows, increased temperatures promoting algal growth, and the frequency, duration and magnitude of rainfall.

Overall, the Panel considers that climate change is likely to exacerbate the eutrophication effects of nutrients in both freshwater and tidal / estuarine systems. In the few localised places where eutrophication is currently an issue in Tairāwhiti, eutrophication effects will likely get worse under climate change unless mitigated. This applies to lower parts of the Waipaoa planning area (i.e., the lower Taruheru River in the Poverty Bay Flats and Gisborne Urban sub-areas, and some lower reaches in the Te Arai sub-area). Climate change may also increase the risk of future eutrophication problems in some other planning areas with similar lowland flats if these are intensively used in future for horticulture, agriculture or urban development (e.g., in limited parts of the Waimata, Hangaroa, Uawa planning areas).

5.3.5 Response timeframes

Nitrogen response times are likely to be relatively rapid following implementation of land use changes, particularly where pastoral land use is replaced by trees (forestry or native vegetation). This is because most agricultural nitrogen is known to get washed from the soil profile every winter and groundwater residence times are expected to be short in most of Te Tairāwhiti hill country, where the land use change is concentrated. Phosphorus response times are likely to be longer as they are more directly associated with how sediment-bound phosphorus may be retained, which depends on longer timeframes for forest regeneration (e.g., decades to 2090).

In terms of the modelled response of nutrient concentrations to land use change it seems reasonable that nutrient reductions would occur from re-vegetation (reduces N sources and N loss by increasing uptake) and stabilisation (reduces P loss from run-off and soil loss). There is 'medium' confidence this will occur in response to the mitigation actions assumed under each scenario.

There is greater uncertainty around the eutrophication response to increased nutrients (such as algal growth and resulting fluctuations in DO and pH) because there are several other key factors that could drive the periphyton, phytoplankton or macroalgae. These factors include flow regime, light availability (affected by riparian vegetation and water clarity), sedimentation, and water temperature) – many of which may also be directly impacted by climate change.

The Panel notes that the reduction in sediment under Scenarios 2-5 could, in theory, lead to an increase in periphyton, and phytoplankton/macroalgal growth in estuaries due to more light penetration through the water column and less stream bed smothering. This would however only occur over long timeframes (same as the sediment response), and some ongoing monitoring of periphyton should be maintained.

5.3.6 Key messages

The full afforestation scenario represents the best possible state for nutrients and periphyton, with most sites expected to stay in, or improve to, Band A throughout the region.

All other scenarios are expected to achieve only small reductions in nutrient levels in rivers and streams across the region, which is consistent with their primary focus on sediment and *E. coli* mitigation.

The Panel concluded that eutrophication is not a notable problem in most of the freshwaters of Tairāwhiti, except in some of the areas covered in Question Group 6. The current state is expected to be maintained overall under Scenarios 3-5, although there is some uncertainty associated with the future effects of climate change and long-term sediment reduction. These uncertainties justify some on-going monitoring of periphyton, at least at key at-risk sites across the region.

5.4 Water temperature

5.4.1 Scenarios, models and limitations

Modelling of scenario outcomes on water temperature was not undertaken, although the Panel notes predictive modelling of temperature is possible, e.g., using STREAMLINE (Rutherford et al., 1999) or alternate models that predict stream temperature as a function of stream size, flow, substrate, aspect, catchment vegetation cover, and riparian shade and air temperature. However, high frequency data at high spatial resolution is not currently available to inform such models. Model development would require the placement of temperature loggers at high-risk sites subject to scenarios. Analysis should quantify the relative contribution of drivers of water temperature and facilitate prediction to broader spatial areas where mitigations will occur.

Meanwhile, coarse predictions of change in water temperature can be made based on land cover, riparian shade and air temperature. Heat flux is greatest in open grasslands and lowest in evergreen forest. Closed riparian canopies (>70%) can moderate diurnal temperature change whereas open canopies can result in water temperature being within 2 degrees of air temperature throughout the day, especially in shallow waterways with little groundwater connectivity and absorptive substrates/water column. A general rule of thumb is a 2 degree increase in air temp results in a 1-1.5 degree increase in water temperature in an open canopy stream and a 0.5-1 degree increase in a closed canopy stream.

Subsequently, the Panel assessed the potential co-benefits of sediment and *E. coli* focused mitigations on stream temperature primarily through changes in land cover and riparian shading. There is uncertainty about the degree of riparian shading that will result from the re-vegetation of LO3B land, although it is assumed it will generally follow small (stream orders 1 and 2) streams, especially in convergent hill country. The land classified as LO3B as shown in the maps provided to the Panel is quite fragmented (many small, detached polygons), but it is assumed that the actual implementation will result in more continuous tracts of re-vegetation.

The Panel Assessment of scenario outcomes was semi-quantitative, based on the above rules of thumb and the following sources of evidence:

- Temperature data (site median, maximum and CRI where available)
- Land use and riparian extent under scenarios
- Summary table of climate related variables (temperature and flow)

The effects of climate change on stream water temperature are uncertain. The location of future mitigation actions is unknown, which adds further uncertainty to the spatial predictions of scenario outcomes.

Additionally, the effects of climate change on estuarine water temperature need to consider changing temperatures from ocean warming and marine heatwaves which add another layer of uncertainty to the assessment.

The Panel's confidence on the assessment of scenario outcomes on water temperature is low, due to the lack of quantitative assessment and the above limitations.

5.4.2 Full afforestation (Scenario 2)

Under Scenario 2 (Afforestation), catchment vegetation and riparian shade are expected to moderate water temperature. This scenario is expected to result in a state of Band A for temperature throughout most of the region, with the exception of wide, shallow rivers experiencing low summer flows, such as the lower Waipaoa and Waiapu, where Band B is expected.

5.4.3 2040 (Scenario 3)

Scenario 3A (2040) is not expected to result in a detectable change in state because implementation of mitigations is only beginning and mitigations are unlikely to be effective at reducing water temperatures by 2040.

Similarly, Scenario 3B (2040 + CC) is not expected to result in a detectable change in state. Climate change predictions are less than 1°C increase in mean autumn air temperature by 2040, except for up to 1.5°C for Wharekahika, but current land use in this area is likely to moderate change in water temperature. Incremental reductions in temperature from mitigation are likely to offset incremental increases from climate change.

5.4.4 2060 (Scenario 4)

No detectable change in state is expected under Scenario 4A (2060), except potentially in low stream order sites with a high degree of mitigation, e.g., streams in the catchments of recreational sites. However, stock exclusion and grass riparian strips alone are unlikely to affect stream temperatures; tall riparian vegetation is required to shade streams and moderate water temperatures.

Under Scenario 4B (2060 plus CC), the Panel expects that the incremental reductions in temperature from mitigation are likely to offset incremental increases from climate change. As such, no change in the state of water temperature is predicted.

5.4.5 2090 (Scenario 5)

Under Scenario 5 a (2090), the Panel expects improvement in state for most planning areas, with improvements from Band D to Band C for Te Arai, Waipaoa Hill Country, Uawa, Waiapu, Waimata (Turihaua only). Detectable decreases in water temperature (CRI) are expected when between 10% and 27% of area (i.e. 100% of LO3B) are planted in woody vegetation providing a cooling effect to the stream from shade and surface flow.

Under Scenario 5b (2090 + CC), the climate change predictions for Tairāwhiti correspond to 2.5°C increase in mean annual temperature and up to 3°C increase in autumn mean temperature. Overall, the Panel expects that the beneficial effects of mitigations will offset the detrimental effects of climate on water temperature, with an overall result of no change from current state. However, there is potential for improvement in water temperature due to cumulative factors of changes in flow (greater catchment retention) and less heat absorption due to the improved visual clarity of water.

5.4.6 Response timeframes

The timeframe for water temperature to respond is expected to align with how long it takes for mitigation actions to become effective. In particular, the time needed for riparian vegetation to provide effective shading depends on stream characteristics—especially width, but also aspect, depth, and how deeply the stream is incised—as well as the type of vegetation planted. For very small streams, effective shading may develop

within 3 to 10 years. In contrast, for wider streams and rivers, it may take more than 30 years, especially where tall woody vegetation is needed to provide sufficient shade.

5.4.7 Key messages

In general, streams and rivers in Tairāwhiti are currently under moderate to significant thermal stress and water temperature is likely to be a key driver of ecological health in the region. Key drivers of elevated water temperatures include the lack of shading from riparian vegetation, low summer flows and modifications to in-stream habitat such as channelisation. Climate change is likely to increase water temperature overall and exacerbate the level of thermal stress in the absence of mitigations, which could lead to critical levels of thermal stress where it is already high.

The management scenarios do not specifically focus on temperature management; instead, the Panel has assessed the potential co-benefits of sediment and *E. coli* focused mitigations on stream temperature. Scenarios 3-5 are expected to lead to some moderation of water temperatures, especially in streams with high levels of re-vegetation of riparian margins; although there is a risk that the mitigation actions assumed in these scenarios will not fully mitigate the effects of climate change.

Given the significance of the temperature issue, the Panel recommends a stronger policy focus on water temperature management. Some monitoring and investigation efforts should be directed to identifying temperature “refuge” areas; and temperature mitigation efforts should be prioritised to managing temperature in these areas, particularly smaller streams and rivers where riparian shading can have a beneficial effect on water temperature (typically < 10m width).

In estuaries, there is limited scope to actively manage water temperatures, and estuarine intertidal species are generally resilient to changes in temperature, commonly associated with periods of immersion and emersion. High water temperature in estuarine and tidal areas can however act as a barrier to diadromous fish migration and alter the distribution of intertidal and subtidal habitats. Management actions should focus on the lower, tidal reaches of smaller streams and rivers where riparian shading can have a beneficial effect on water temperature.

5.5 Dissolved oxygen

5.5.1 Scenarios, models and limitations

Modelling of scenario outcomes for dissolved oxygen (DO) was not undertaken, and the Panel notes that this could not easily be done with the limited data and predictive models available, including limited understanding of current state.

Instead, the Panel assessment was based on the consideration of drivers of DO in freshwater and estuaries, and how each scenario might influence these drivers. Dissolved oxygen minima are determined by respiration of autotrophs (instream plants) and heterotrophs (organic matter decomposers); hence the assessment requires consideration of nutrient and organic enrichment, coupled with flow and temperature, which have been modelled in response to scenarios. The Panel assessment was thus limited to a qualitative assessment. Primary sources of evidence used in the Panel assessment of DO in freshwaters included:

- Available monitoring data (DO and temperature)
- Periphyton state and scenario predictions
- Slope
- Land use and riparian extent under scenarios
- Summary table of climate related variables (temp and flow)

Overall, the Panel rated the level of confidence associated with DO scenario outcomes predictions in freshwater as ‘low’.

Little is known about the state and drivers of DO in many of the estuaries and tidal areas of Tairāwhiti, which considerably affected the Panel's ability to assess the outcomes of the management scenarios. However, the limited data available indicated the primary productivity was driving low DO in high intensity areas (such as Poverty Bay Flats). The Panel's assessment was limited to a qualitative assessment with low confidence.

5.5.2 Full afforestation (Scenario 2)

Scenario 2a (Afforestation) is expected to result in a DO state of Band A throughout the region for freshwater and estuaries. Catchment vegetation and shade are expected to moderate instream productivity and the delivery of autochthonous material, which drives ecosystem metabolism and resulting DO minima.

5.5.3 2040 (Scenario 3)

Scenarios 3a (2040) and 3b (2040 + CC) are expected to result in no change in DO state in either freshwater or tidal / estuarine systems. This is because the implementation of mitigations is only beginning, and mitigations are unlikely to be effective at moderating instream productivity. Any effect of mitigations is likely to offset the effect of climate change.

5.5.4 2060 (Scenario 4)

Scenario 4a (2060) is also predicted to result in no detectable change in state in either freshwater or tidal / estuarine systems. However, the Panel considers Scenario 4b (2060 + CC) has the potential to result in detectable poorer state associated with increased temperature in stream reaches with no riparian shade. Increased eutrophication could lead to areas currently above, but close to, the NBL for DO falling below the NBL, including the Lower Waipaoa River, The Uawa River, Matawai Stream (Mōtū) and Mata River (Waiapu).

5.5.5 2090 (Scenario 5)

Scenario 5a (2090) is expected to result in no change in state when the current state is Band A. For lowland sites where riparian vegetation is restored or enhanced, increases in DO minima (reflected as a band change) may occur alongside reductions in water temperature and increased shading of periphyton, particularly in smaller order stream. Little change in DO minima is expected in estuaries and tidal areas, especially those where DO patterns are primarily driven by primary production (e.g., Taruheru tidal reaches and estuary).

Under Scenario 5b (2090 + CC), the Panel expects mitigations (catchment and riparian vegetation) will likely offset the climate change effect of higher temperatures on DO saturation.

5.5.6 Response timeframes

Since changes in DO are predicted to occur alongside changes in temperature, any response – if it occurs – is likely to follow a similar timeline to that of temperature (see Section 5.4.6).

5.5.7 Key messages

The Panel's analysis of current state concluded that DO issues appear to be limited to lowland areas, such as the Poverty Bay Flats area. Where DO is an issue, it is likely to have a direct influence on macroinvertebrate and fish communities in conjunction with high water temperature. Scenario outcomes on DO were not modelled and the Panel considered it would have not been easy to do so. DO was also not the focus of mitigation actions in Scenarios 3-5, and the Panel noted more could potentially be done to specifically target DO and temperature management in lowland areas.

Some actions assumed under Scenarios 3-5 – mainly riparian management – have the potential to improve dissolved oxygen minima and reduce water temperature. Improvements are most likely in lowland areas where riparian vegetation is restored or enhanced. However, these changes are expected to take decades to fully take effect. Meanwhile, climate change is anticipated to cause an overall decline in DO minima due to increased eutrophication.

Limited information is available on the state and drivers of DO in the estuaries and tidal areas of Tairāwhiti, which considerably constrains the Panel's ability to assess the potential outcomes of the management scenarios. However, under Scenarios 3-5, little change in DO minima is expected in these areas, particularly where DO patterns are mainly influenced by primary production (e.g., Taruheru tidal reaches and estuary). This is because modelled nutrient reductions were minimal, and other potential mechanisms that could improve DO (such as temperature or flow regime) were not targeted under Scenarios 3-5.

5.6 Habitat

5.6.1 Scenarios, models and limitations

The management scenarios do not explicitly target in-stream or riparian habitat improvements. However, the Panel has assessed the potential co-benefits of sediment and *E. coli* focused mitigation actions on stream habitat. The Panel notes some uncertainty regarding the extent of direct stream bank mitigation (e.g., shading) achieved through the re-vegetation of LO3B land. It is assumed that re-vegetation will generally occur along small streams (order 1 and 2), particularly in convergent hill country. While the mapped LO3B areas presented to the Panel appear fragmented, consisting of small, disconnected polygons, it is expected that on-the-ground implementation will lead to more contiguous tracts of re-vegetation.

Direct modelling using HQS as a response variable cannot currently be undertaken, but some modelling of the parameters that constitute the HQS and other stream habitat variables could. For example, geomorphological modelling can be used to identify channel evolution in response to mitigations and storm flows. Channel evolution can inform instream and off-channel habitat diversity, hydraulic heterogeneity (i.e., pool depth and run-riffle-pool sequencing), substrate diversity, and bank stability.

No direct modelling of scenarios on freshwater habitat was undertaken for this scenario assessment, and the Panel assessment was restricted to a broad-scale qualitative (narrative) assessment, based on the following primary sources of evidence:

- RHA data (parameter scores and total HQS)
- Sediment scenario model predictions
- Land use and riparian extent under scenarios
- Summary table of climate related variables (flow)

In estuaries, the scenarios are not expected to directly influence habitat, although some improvement is associated with the reduction in suspended and deposited fine sediment. These improvements are described in previous sections and no further assessment of scenario outcomes on estuarine habitat was undertaken.

5.6.2 Full afforestation (Scenario 2)

Under Scenario 2 (Afforestation), 'Band A' outcomes are expected across the region based on site-scale RHA data. The Panel notes, however, some legacy effects from historic land use, wetland drainage, fish barriers and flood management will not be mitigated by afforestation under this scenario. These factors are not fully accounted for in the RHA, which excludes some key aspects of physical habitat condition – such as channelisation, reduced sinuosity, and the presence of fish barriers. Consequently, heavily modified lowland streams, particularly those with flood protection infrastructure, are likely to remain in poorer condition than suggested by RHA results alone.

5.6.3 2040 (Scenario 3)

Scenario 3a (2040) is expected to result in no change in habitat attribute state. Even where mitigations are extensive (i.e. >15% of area), vegetation is yet to establish and affect physical habitat sufficiently to lead to state changes.

Similarly, no overall change in state is expected under scenario 3B (2040 plus CC). Lower rainfall and more storms are already affecting the current state of instream parameters (high sediment loads), this scenario is unlikely to lead to a detectable change in 15 years, as mitigations are still phasing in.

5.6.4 2060 (Scenario 4)

Scenario 4A (2060): No change is expected for similar reasons to Scenario 3a.

Scenario 4B (2060 plus CC): No change is expected for similar reasons to Scenario 3b.

5.6.5 2090 (Scenario 5)

Scenario 5A (2090): Where mitigation is extensive, this scenario is expected to result in sufficient riparian vegetation to improve several site-scale habitat parameters including shading, riparian width, bank vegetation, and potentially fish cover. However, improvements are likely to require more than 60 years to fully materialise. Reductions in sediment load will also contribute to improvements in the deposited sediment attribute. Bank stability is expected to improve over time due to moderated flows and reduced sediment loads from catchment scale mitigation, though full adjustment of channel form may similarly take over 60 years. Overall, a detectable positive shift in habitat condition is anticipated, particularly in areas with extensive mitigation, including Te Arai, Uawa, Waiapu, Waimata, Hangaroa- Ruakituri, and parts of Wharekahika-Waikura, Waipaoa Hill Country and PBF (mainly lower order streams).

Scenario 5B (2090 plus CC): The effects of climate change on habitat parameters are mitigated in lower order streams mainly due to shade and reductions in sediment load, exceptions include higher order stream sites where site-scale remediation is insufficient to improve these parameters.

5.6.6 Effects of Climate change

Climate change predictions for 2090 include a 15% decrease in annual rainfall and a subsequent decrease in mean annual low flow, as well as an increase in extreme rainfall days leading to more high flows. Lower baseflows result in habitat shrinkage, reducing the availability for invertebrates and fish, increasing water temperature (which can stress aquatic life and reduce DO levels), concentrating pollutants, and disrupting life cycles – particularly for diadromous fish. Increased peak flows lead to habitat scouring through bank and riverbed erosion, greater sedimentation in downstream depositional zones, displacement of species (potentially causing localised extinctions where refugia habitats are absent), and altered channel morphology, including increased channel instability. Overall, without mitigation, climate change is expected to lead to a significant deterioration in stream habitat state with band change in state.

5.6.7 Response timeframes

Improvements in stream habitat quality are expected to occur over long timeframes, typically spanning several decades. This is due to the time required for riparian vegetation to establish an mature (approximately 20-30 years for tall riparian vegetation) to reach maturity), the slow response of sediment loads and sediment deposition processes, and the gradual adjustment of stream channel morphology following catchment-scale changes.

5.6.8 Key messages

Stream habitat is an important driver of ecological health. The Panel expects (with 'medium' confidence) that there will be a positive effect of mitigations on site-scale stream habitat parameters in the long term (Scenario 5). Whilst climate change is expected to have an overall detrimental effect on stream habitat, the Panel expects (also with 'medium' confidence) that mitigations assumed in Scenarios 3-5 will be sufficient to offset the effects of climate change. However, the Panel has low confidence that the positive effects of mitigation will be observed by 2090, as long response times are anticipated. A focus on habitat aspects not addressed by

current scenarios is required to achieve catchment-scale stream habitat improvement, including wetland drainage, fish barriers, and flood management.

In estuaries, the scenarios are not expected to directly influence habitat, although some improvement is associated with the reduction in suspended and deposited fine sediment.

5.7 Macroinvertebrate communities

5.7.1 Scenarios, methods and limitations

Freshwater and estuarine macroinvertebrate communities are influenced by multiple factors, with sediment and temperature (freshwater) likely to be the dominant drivers in Tairāwhiti. The Panel considered the influence of these drivers, the expected scenario outcomes, and associated confidence levels to provide an overall assessment of macroinvertebrate responses at both site and planning area scales.

Key pressures and drivers likely to influence the state of freshwater macroinvertebrate communities and considered by the Panel included:

- Sediment load. Both deposited fine sediment and suspended sediment limit habitat (physical and water quality) and food availability.
- Water temperature directly inhibits growth and alters key processes (e.g., organic matter breakdown, dissolved oxygen saturation) which limits habitat (physical and water quality) and food availability.
- Poor riparian and bank vegetation fails to moderate temperature but also limits terrestrial food inputs.

In the lowland PBF/Urban area, high organic loads and low dissolved oxygen limit suitable habitat (water quality) availability. Key pressures and drivers likely to influence the state of estuarine macroinvertebrate communities and considered by the Panel included:

- Sediment load. Both deposited fine sediment, mud content and suspended sediments can alter suitable habitat for estuarine flora and fauna.
- Changes to the physical morphology of estuaries can reduce habitat and harden edge structures.

Consequently, the primary sources of evidence in the Panel assessment of freshwater macroinvertebrates included:

- MCI data (measured and modelled)
- Sediment (deposited and suspended) scenario model predictions
- Nutrient scenario model predictions and to a lesser degree periphyton scenario predictions
- Current state and scenario outcomes for temperature, habitat, and DO
- Land use and riparian extent under scenarios
- Summary table of climate related variables (flow)

Panel assessments focussed on the Macroinvertebrate Community Index (MCI), with the Panel assuming that other attributes of macroinvertebrate health (such as QMCI and ASPM) will generally exhibit similar directions, magnitudes of change, and spatial patterns.

For estuarine macroinvertebrate, the evidence available to the Panel was limited to single studies in the Tūranganui Estuary in both the Taruheru and Waimatā arms which inhibited an assessment of the scenario outcomes for estuarine health outside of changes to sediment loads.

Overall, the Panel rated the level of confidence of the assessment of scenario outcomes on macroinvertebrates as 'Low', due to the reliance on multiple uncertain assumptions and the compounding effects of these uncertainties, and a lack of data for the regions estuaries.

5.7.2 Full afforestation (Scenario 2)

Scenario 2a (Afforestation) is expected to result in macroinvertebrate communities in Band A or B across the region. Catchment and riparian vegetation moderate sediment and nutrient loads, flow regime and heat flux providing suitable habitat for sensitive macroinvertebrates.

5.7.3 2040 (Scenario 3)

Scenario 3a (2040) is expected to result in a positive improvement in macroinvertebrate metrics, but no detectable change in state, due to the small but measurable improvements in drivers.

Under Scenario 3b (2040 plus climate change) a possible degradation in macroinvertebrate metrics is expected but no detectable change in state. Mitigations assumed under this scenario are unlikely to offset climate change effects, which, although relatively minor by this time, already increase thermal risk, in lowland streams especially.

5.7.4 2060 (Scenario 4)

Under Scenario 4a (2060), an overall improvement in MCI is predicted for most streams, but it will not result in a change in attribute band, due to the small but measurable improvements in drivers.

Scenario 4B (2060 plus climate change) is not expected to result in overall change in current state. Temporal trends are too variable to detect positive effect of mitigation or negative effect of climate change disturbance.

5.7.5 2090 (Scenario 5)

Scenario 5A (2090): The Panel's assessment is based on significant changes in drivers and current position in band. Overall, an improvement in MCI is predicted for most streams. Considering each planning area:

- in the Te Arai planning area, 5 out of 7 sites will increase by one attribute band and only one site remains below the NBL.
- In the Uawa planning area, all sites are predicted to increase by one attribute band.
- In the Waipua and Wharekahika–Waikura planning areas, over half of the sites are predicted to improve and no site was below the NBL resulting in an overall state of Band B.
- In the Waimatā, all but 2 sites improved by an attribute band with one site not subject to mitigation staying below the NBL; on average the planning area is in Band B or C.
- In Waipaoa Hill Country only 3/19 sites are predicted to increase by an attribute band by 2090, mainly because of the persistent effects of deposited sediment and low starting values. At a planning area scale, attribute state will probably remain in Band C on average with 3 sites below the NBL.
- Similarly, in Waipaoa Poverty Bay Flats area there is no change and the planning area remains in Band D on average.
- In Hangaroa-Ruakuturi, no change in MCI state by 2090 is predicted because MCI values are currently well below band thresholds at monitoring sites.
- In Mōtū, no change in MCI state is predicted and the planning area remains in Band B or C.

Under Scenario 5b (2090 plus climate change), the effects of climate change on macroinvertebrate communities are expected to be mitigated and there are no decreases in MCI, which would occur without mitigation. The Panel noted that significant declines in MCI are expected in areas without mitigation.

5.7.6 Influence of climate change and response timeframes

The 2090 scenario represents the earliest timeframe in which measurable changes in macroinvertebrate attribute state are expected in response to mitigation efforts. Prior to this, additional climate change impacts and declining trends in MCI may still occur. Improvements in stream conditions are expected to continue beyond 2090 as catchments and stream habitats progressively adjust. However, macroinvertebrates are likely

to experience long-lasting legacy effects, primarily due to reduced habitat suitability associated with the persistence of fine sediment load with stream systems.

5.7.7 Estuaries

Decreased sediment loads (and hence deposition rates) will positively impact estuarine macroinvertebrates. A positive direction of change is expected, but the scale of the response and the response timeframes are unknown. Data is insufficient to make any form of temporal assessment of scenario outcomes on ecological health. I

5.7.8 Key messages

Overall, the Panel expects the range of mitigation actions considered under the scenarios will have beneficial effect on macroinvertebrate communities, both in freshwater and estuaries. Measurable changes in attribute state in freshwater will, however, take in the order of decades before they can be detected. In estuaries, the response timeframes are unknown.

Climate change is expected to have an overall detrimental effect on macroinvertebrate communities and there is a risk that the mitigations assumed under the scenarios will not be able to mitigate the effects of climate change until late century (2090). Further improvements are likely to occur beyond 2090 as streams adjust.

5.8 Fish communities

5.8.1 Scenarios, methods and limitations

Fish communities are influenced by multiple drivers. The Panel considered the influence of these drivers, the expected scenario outcomes, and associated confidence levels to provide an overall assessment of fish community response at the planning area scale. The qualitative assessment used the narrative bands defined in section 4.4.3, not the F-IBI metric.

No data was available to determine the impacts of the scenarios on estuarine fish.

Key pressures and drivers likely to influence the state of fish communities and considered by the Panel were:

- Water quality (suspended sediment, water temperature)
- Habitat availability (deposited fine sediment, hydraulic heterogeneity, habitat diversity)
- Habitat connectivity (not just road culverts but also physical, flow and physico-chemical barriers)
- Food (riparian vegetation, macroinvertebrates)
- Introduced species (in some areas)

Consequently, the primary sources of evidence considered by the Panel in the assessment of fish communities were:

- Historical records from the NZFFD
- Recent eDNA results, which provide a probability of species presence
- Suspended sediment scenario model predictions
- Macroinvertebrates
- Temperature
- Habitat
- Land use and riparian extent under scenarios
- Summary table of climate related variables (flow)

The Panel notes that the management scenarios do not consider river flow or physical barriers to fish migration and understand these are outside of the Panel's scope.

In addition to commenting on the health of fish communities as a whole, the Panel were asked to provide specific comments on the likely scenario outcomes on the populations of tuna (eel), owing to the significance of tuna as a keystone species both ecologically and for mahinga kai (see section 5.8.6).

5.8.2 Full afforestation (Scenario 2)

All sites and planning areas are expected to achieve an A grade in fish diversity under Scenario 2 (Afforestation), as long as there are no fish barriers.

5.8.3 2040 (Scenario 3)

Under scenario 3a (2040), the Panel expects the state to remain largely unchanged from current conditions, with no improvement in fish community diversity anticipated within 15 years of implementing mitigation measures.

Under Scenario 3b (2040 plus CC), key climate drivers show relatively little change with small increases in water temperature and lower MALF²⁷. Mitigations assumed under this scenario are unlikely to moderate these changes. Which means that although changes are small, further degradation in fish diversity is possible especially for temperature sensitive species (e.g., kōaro, giant kokopu, shortjaw kokopu, and banded kokopu all prefer ≤16°C annual mean) in areas with high thermal risk. At the planning area scale, diversity is unlikely to change except for potential to lose shortjaw kokopu from the Waimatā planning area and giant kokopu from Wharekahika planning area.

5.8.4 2060 (Scenario 4)

The outcomes of Scenario 4a (2060) on fish diversity are expected to be the same as under Scenario 3a (2040), i.e. improvements in planning area scale diversity are unlikely. Quantitative monitoring would be required to detect any positive changes in abundance and structure, which may be expected at sites with significant mitigation of sediment load and temperature/DO and improved food and fish cover (i.e. sites with riparian vegetation and improved MCI).

Scenario 4B (2060 plus CC): Same as under Scenario 3b, with possible loss of vulnerable species.

5.8.5 2090 (Scenario 5)

Under Scenario 5a (2090), no broad scale changes in fish diversity are expected; however, the Panel expects a higher probability of detecting improvement in overall fish community health, if using quantitative monitoring at key sites.

Scenario 5B (2090 plus CC): Significant effects of climate change on factors likely to negatively affect fish are predicted, with 15% decrease in rainfall affecting MALF and habitat availability, life history cues, food availability, water temperature increases (2.5°C increase in mean annual temp and up to 3°C increase in autumn mean temperature). It is possible that mitigations assumed under Scenario 5 will moderate the effects of climate change on fish communities at a catchment scale, but there is a high likelihood of localised loss of vulnerable species (i.e. truncated distribution). This will affect diadromous species with water quality barriers in lowland reaches. The competition and predation effects of invasive species is not considered, although wider distributions of these species are expected under climate change.

²⁷ Minimum Annual Low Flow, a commonly used measure of low stream/river flows

5.8.6 Effects on tuna (eel) populations

The mitigations assumed under the scenarios are expected, qualitatively, to have a positive effect on tuna population health.

Under Scenario 2, afforestation is expected to stabilise flow, moderate temperature and improve stream habitat, with significant benefits to tuna population health.

Response timeframes are likely to be long, and no detectable changes are expected in the short-term under Scenarios 3a and 4a. The greatest gains are expected under Scenario 5a in response to improved habitat suitability – flow, reduced sediment load, increased habitat suitability and hydraulic heterogeneity, cooler water temperatures, and improved food availability.

Climate change will have a negative effect on tuna population health due to thermal stress and altered flow regimes. While adult longfins tolerate temperatures above 30°C, chronic stress starts well below that and can skew sex ratios and cut reproductive success. Migrating glass eels prefer 16.5 °C; temperatures above 22 °C sharply reduce their upstream movement, so warmer summers can block recruitment into headwater habitats. Sustained reductions in low flows (MALF) results in less in-stream habitat and increases the risk of more anoxic events and fish stranding. Increased high storm events results in a greater risk of mistiming of migration cues, (e.g., warmer flashier flows outside of the autumn migration period) and could lead to decreased recruitment and abundance when eels miss the ocean currents.

5.8.7 Response timeframes

The 2090 scenario is the minimum timeframe before changes in fish communities or tuna population health are expected in response to mitigations. There may be some further climate change impacts and decreasing trends observed before then. Ongoing improvements are expected from mitigations post 2090 as streams adjust. There will be a long legacy effect of sediment entrained in the streams on fish communities.

5.8.8 Key messages

Overall, the Panel expects the range of mitigation actions considered under the scenarios will have beneficial effect on fish communities generally and eel populations in particular. However, it may be decades before positive changes are detected. Measures of fish diversity and the F-IBI, are based on the presence or absence of species and are very insensitive to change. Changes are better monitored using quantitative monitoring techniques, as these provide information on abundance and population structure, but these are resource intensive.

Climate change is expected to have an overall detrimental effect on fish communities and there is a risk that the mitigations assumed under the scenarios will not be able to mitigate the effects of climate change until late century (2090 and beyond). Targeted management actions beyond the current scenarios will be needed to mitigate the effects of climate change on fish communities, such as the identifying and establishing temperature and flow “refuge” areas.

5.9 Human Health Attributes

5.9.1 Scenarios, models and limitations

The Panel considered the scenarios provided were sufficiently clear and understandable to support the assessment of scenario outcomes on human health-related attributes. The management actions assumed in Scenarios 3-5 have a primary focus on sediment and erosion control across the region, supplemented by the gradual implementation of *E. coli* mitigation measures, prioritised in the catchments of key recreational sites. The Panel considered these scenarios are consistent with the significance of the *E. coli* issue in the region and the presence of very high value / use recreational sites, such as the Rere Falls in the Wharekopae catchment.

The scenarios were modelled using a recently developed national model supporting the OLV Scenario Builder for rivers²⁸. The data, assumptions and methods supporting the scenario modelling, as well as the model outputs for each scenario are described in detail in technical documentation provided to the Panel²⁹.

The Panel notes the catchment-scale scenario modelling of *E. coli* is very uncertain and subject to a number of significant limitations, primarily associated with the current state of knowledge on processes and mechanisms controlling *E. coli* loss from different land uses and how these are affected by mitigation actions and other factors. Key limitations noted by the Panel include:

- *E. coli* mitigation methods and their effectiveness is an area of active, but relatively recent research, and current knowledge is very limited;
- Only a sub-set of mitigations known to be effective to reduce *E. coli* losses to waterways can realistically be modelled, and even then, with great uncertainty about their effectiveness;
- The NPS-FM defines two *E. coli* attributes.
 - Appendix 2A Table 9 attribute relies on four metrics: median, 95th percentile, %samples >260 cfu/100mL and % samples >540 cfu/100mL
 - Appendix 2B, 22 attribute is applicable to primary contact sites only and relies on the 95th percentiles of samples taken during the bathing season.
- The OLV Scenario Builder model is only able to estimate median *E. coli* concentrations and there cannot be used to estimate any changes in Bands of the future scenarios. This means that any assessment of scenario outcomes on NPS-FM *E. coli* attributes cannot be fully modelled and has to rely, to a large extent, on the Panel's expert opinion.
- At many sites the 95th percentile metric far exceeded the highest Band (>1200 MPN 100 mL⁻¹) and therefore would require reductions from 50 to 90% to reduce these concentrations to achieve Band C.
- The OLV Scenario Builder model cannot account for climate scenarios. Therefore, only the scenarios without climate change were assessed.
- Of particular relevance to the scenarios assessed by the Panel, there is a lack of national or regional data characterising *E. coli* losses from forested (native or exotic forest) areas, or how the presence of pest animal and pest control may affect these losses.

With specific regards to the modelling of scenarios, the use of the original Snelder et al., 2024 model predicted increases in *E. coli* in response to changes from pastoral land use to native forest. These results, showing most strongly for the Afforestation Scenario, were counterintuitive, and the Panel identified the model predictions for native vegetation as a key limitation of the model. A modified version of the model was developed in which the model parameter (ETC) for native vegetation was replaced with estimates from the national McDowell et al., 2013 reference state model for native vegetation. The Panel reviewed the method and decided to use the modified version of the model for the assessment.

Under each scenario, the actions modelled as influencing *E. coli* losses to waterways include:

- Changes in land use / land cover of some LO3B land,
- Stock exclusion from streams of order ≥ 3 , with 5-m wide vegetated buffers in the catchments of recreational sites and 3-m wide vegetated buffers elsewhere.

In addition, the scenarios assume active pest control and management of *E. coli* Critical Source Areas (CSA) through the implementation of Farm Environmental Plans, although these measures were not modelled.

Each scenario was modelled at 116 sites cross the region. The modelled outcomes (median *E. coli* concentrations) of each scenario for each site were provided to the Panel in the Assessment Spreadsheet and summarised in Appendix C3 of this report.

²⁸ <https://www.freshwater-scenario-builder.co.nz/rivers>

²⁹ Scenario modelling described in Ausseil & Heath, 2025. (TL#082). Model described in Snelder et al., 2024.

No water quality modelling of human health impacts in estuaries was undertaken. The model outputs at “terminal nodes”, i.e. in the freshwater reaches immediately upstream of each estuary was used by the Panel as a proxy for the potential level of change in *E. coli* concentrations in estuaries.

5.9.2 Full afforestation (Scenario 2)

The full afforestation scenario was predicted to result in large reductions in median *E. coli* concentrations at most sites (median reduction: 72%, interquartile range: 59%-81%). The model predicts relative increases at 6 sites, but closer examination shows that these sites have catchments dominated by forestry and have low current *E. coli* concentrations.

Under this scenario, the concentrations of *E. coli* in freshwater are likely to revert to close to the ‘reference state’ predicted by the McDowell, 2013 model, noting predictions are based on current state of water quality from areas of native vegetation, i.e. including the influence of current levels of warm-blooded animals (birds and mammals).

The median concentration of *E. coli* at the majority of sites is expected to reduce to below 130 cfu/100mL, which is consistent with Band A. Other metrics relevant to the NPS-FM attributes (e.g., 95th percentile concentrations) are also expected to improve, although it is not possible to quantify this improvement, and thus to predict the full attribute state outcome of this scenario. To an extent, the actual *E. coli* concentrations and attributes under this scenario will depend on the abundance of warm-blooded animals, which will in turn depend on the level of pest control. Whilst it is logical to expect active pest control is likely to reduce *E. coli* inputs into waterways, the Panel is not able to quantify this effect due to a lack of data nationally or regionally.

5.9.3 2040 (Scenario 3)

Under this scenario, the actions likely to influence *E. coli* losses to waterways include:

- Changes in land use / land cover of some LO3B land (10% of pastoral land classified as LO3B and 15% forestry land classified as LO3B³⁰),
- Stock exclusion from 15% of stream order 3 and above in the catchments of two priority recreational sites (Wharekopae at Rere falls and Hangaroa at Doneraile Park); and
- Stock exclusion from a small proportion (3%) of stream order 3 and above everywhere else.

Under this scenario, small reductions in median *E. coli* concentration, in the order of 2 to 3% are predicted at the targeted recreational sites and smaller (c. 1%) reductions elsewhere. These reductions are small, well within the uncertainty associated with *E. coli* measurements and are unlikely to influence median or 95th percentile concentrations sufficiently to lead to a change in *E. coli* attribute state at any site. Similarly, modelling results point to small improvements in estuaries.

These results are expected given the mitigation actions able to be modelled only refer to a relatively small proportion of the catchment. For example, only 8.5% of land in the catchment above Wharekopae at Rere Falls is classified as LO3B, of which only 10-15% is assumed to change land use / land cover under this scenario. Similarly, stock exclusion is only applied to 15% of streams in orders 3 and above, which “misses” stream orders 1 and 2, which in turn typically represent over 70% of the stream network by stream length.

The Panel is however confident that other mitigation actions (e.g., pest control, CSA mitigation) assumed in the scenarios would result in additional reductions in *E. coli* concentrations in waterways, although the benefits of these actions are not quantifiable (and therefore are not able to be modelled) with the current state of knowledge.

³⁰ Under this scenario, 20% of LO3B pastoral land and 30% of LO3B forestry land are assumed to be mitigated, but the mitigations assume only 50% of each will undergo a land use / land cover change.

5.9.4 Scenario 4 (2060)

Under this scenario, the actions likely to influence *E. coli* losses to waterways include:

- Changes in land use / land cover of some LO3B land (25% of pastoral land classified as LO3B and 20% forestry land classified as LO3B),
- Stock exclusion from 50% of $\geq$ 3rd order streams in the catchments of all recreational sites; and
- Stock exclusion from 10% of $\geq$ 3rd order streams everywhere else.

Under this scenario, reductions in median *E. coli* concentration were predicted to be in the order of:

- 6 to 7% recreational sites and
- 1 to 7% (median: 3%) elsewhere.

The Panel considered these predicted reductions would be too small to influence median or 95th percentile concentrations sufficiently to lead to a change in *E. coli* attribute state at any freshwater or estuarine sites, for the same reasons as explained for the 2040 scenario.

5.9.5 Scenario 5 (2090)

Under this scenario, the actions likely to influence *E. coli* losses to waterways include:

- Changes in land use / land cover of some LO3B land (50% of pastoral land classified as LO3B and 40% forestry land classified as LO3B),
- Stock exclusion from 80% of $\geq$ 3rd order streams in the catchments of all recreational sites; and
- Stock exclusion from 15% of $\geq$ 3rd order streams everywhere else.

Under this scenario, reductions in median *E. coli* concentration were predicted to be in the order of:

- 11 to 15 % recreational sites and
- 2 to 11% (median: 4%) elsewhere.

The Panel considered these predicted reductions would be too small to influence median or 95th percentile concentrations sufficiently to lead to a change in *E. coli* attribute state at any site, noting however the likely additional benefits of mitigation actions is not able to be quantified.

5.9.6 Influence of climate change

The Panel considered several climate change driven mechanisms potentially affecting *E. coli* in waterbodies:

- More runoff events delivering faecal matter to streams
- Higher temperature (animals driven to streams, *E. coli* survival) – also increased bacterial growth
- Lower baseflows potentially driving concentrations up (less dilution)

These mechanisms have the potential to increase *E. coli* concentrations in waterbodies, particularly the peak concentrations (95th percentile). The Panels considers it likely that climate change will offset any benefits of mitigations and *E. coli* attribute states will remain as described in the current state section in any future scenario; however, it must be acknowledged the actual impact of climate change is largely unknown and cannot be quantified.

5.9.7 Response timeframes and confidence

The Panel expects *E. coli* concentrations in waterbodies to respond relatively quickly – within weeks to months – once effective mitigations are in place, with improvements closely following implementation. However, due to the high natural variability of *E. coli* data, detecting these improvements through monitoring may be challenging and will likely require sustained monitoring effort.

The Panel rated confidence in model outputs as 'low to medium' and advises caution when applying these outputs beyond the scope of this assessment. The relatively modest improvements predicted by the model

reflect the limited proportion of land subject to land use change and the relatively small extent of the stream network affected by riparian restoration or stock exclusion. Additionally, *E. coli* modelling is constrained in the range of mitigation actions it can credibly represent. There are several mitigation actions that are likely to be effective but cannot currently be modelled. As a result, actual improvements could exceed modelled predictions, though this potential benefit cannot be quantified.

5.9.8 Key messages

The full afforestation scenario is predicted to significantly reduce the *E. coli* concentrations in streams to Band A for medians and likely Band A for the other metrics. This is expected due to the removal of all animal agriculture in the region.

Overall, the modelled improvements under Scenarios 3-5 are generally small to modest, even in catchments with recreational sites where mitigation actions are concentrated. Improvements of this magnitude are unlikely to result in changes to attribute states, except at sites that are already very close to a band threshold. Improvements in estuaries are estimated based on the modelled river site closest to the coast and hence we would expect only modest changes in the estuaries, and only if localised sources (e.g., wastewater, stormwater or high density of birds) is not the dominant source.

To an extent, these small, modelled improvements are driven by the relatively low level of assumed mitigation, which consists of excluding stock from a limited part of the stream network (i.e., ≥ 3 order streams). Stream orders 1 and 2 are a significant proportion of the stream network ($>70\%$ by length), which means that the assumed mitigations “miss” most of the stream network. Another important consideration is that stock exclusion and riparian buffers can only intercept locally generated *E. coli*, and have no impact on *E. coli* that has already entered the stream network from smaller order tributaries upstream. The Panel recommends that, where possible, stock exclusion and fencing along small streams be considered in priority catchments.

The relatively small, modelled improvements are also likely due to the fact that the effectiveness of many mitigation actions is not quantifiable and therefore were not able to be modelled, although the Panel is confident they would make a beneficial impact. For example, the scenarios assume that Farm Environmental Plans will be prepared and will include addressing critical source areas (CSAs) of *E. coli*. These were not able to be modelled, but recent research has indicated that CSA mitigation can reduce annual yield of *E. coli* by over 90% (Richard Muirhead, pers. comm.). Similarly, animal pest control is assumed under the scenarios and is expected to have a beneficial effect, but the Panel is not aware of data to support a quantification of this effect. The reversion of pastoral land use classified as LO3B to either forestry or native vegetation is also expected to result in some reductions in *E. coli* entering waterbodies; however, the Panel notes this only represents a small proportion of land area in each catchment.

The limitations and uncertainties associated with *E. coli* modelling highlight the importance of policy / mitigation effectiveness monitoring and reporting. The Panel recommends that, in addition to water quality monitoring, it will be very important to robustly record the actual implementation of actions (what, where, when) so their effectiveness at catchment scale can be analysed.

Lastly, the Panel notes that some of the mitigations targeting *E. coli* assumed in the scenarios have significant co-benefits for water quality, habitat and ecology. For example, stock exclusion and riparian buffers have benefits for stream habitat and sediment interception.

6 Poverty Bay Flats: Issues and drivers

As explained in section 2.6, the Panel were not asked to evaluate the outcomes of land management scenarios for the intensive land use areas of the Poverty Bay Flats, Te Arai and Gisborne Urban planning areas instead the Panel were asked to respond to a series of questions aimed at characterising key water quality and aquatic ecology issues and their sources and drivers, and, where possible, identify potential solutions and information gaps. This assessment is summarised here. Key information and data sources available for this assessment were summarised in a technical memo provided to the Panel³¹.

6.1 Taruheru catchment

The Taruheru River begins near Ormond and flows southeast through Gisborne city where it meets the Waimatā River to form the Tūrangānui Estuary. Three planning areas cover different parts of the Taruheru catchment: Waipaoa Hill Country FMU (upper catchment), Waipaoa Poverty Bay Flats FMU (middle catchment) and Waipaoa Urban FMU (lower catchment and estuary).

The hydrology of the Taruheru is heavily modified. Historical evidence indicates that the Taruheru River was previously connected to the lower Waipaoa River, functionally at least periodically as a branch of the lower Waipaoa River. However, flood protection schemes have since severed surface flow connection between the Waipaoa and Taruheru Rivers (Figure 3). Most of the low-lying, flat area of the Taruheru catchment is artificially drained, (including sub-surface mole and tile drainage), which is expected to lower summer low flows and create direct discharge pathways for land-generated contaminants into streams and drains. Most small streams and rivers in the catchment are heavily modified and actively managed to facilitate unobstructed flow, including by mechanical dredging and weed control, as part of the regional flood control scheme. There is little to no riparian vegetation along most of these streams. Summer low flows in the Taruheru are typically very low, in the order of 10 L/s³² at Tuckers Rd. The lower Taruheru is tidally influenced up to the Tuckers Rd bridge monitoring site, although the salt wedge is understood to reach up to Tuckers Rd Bridge.

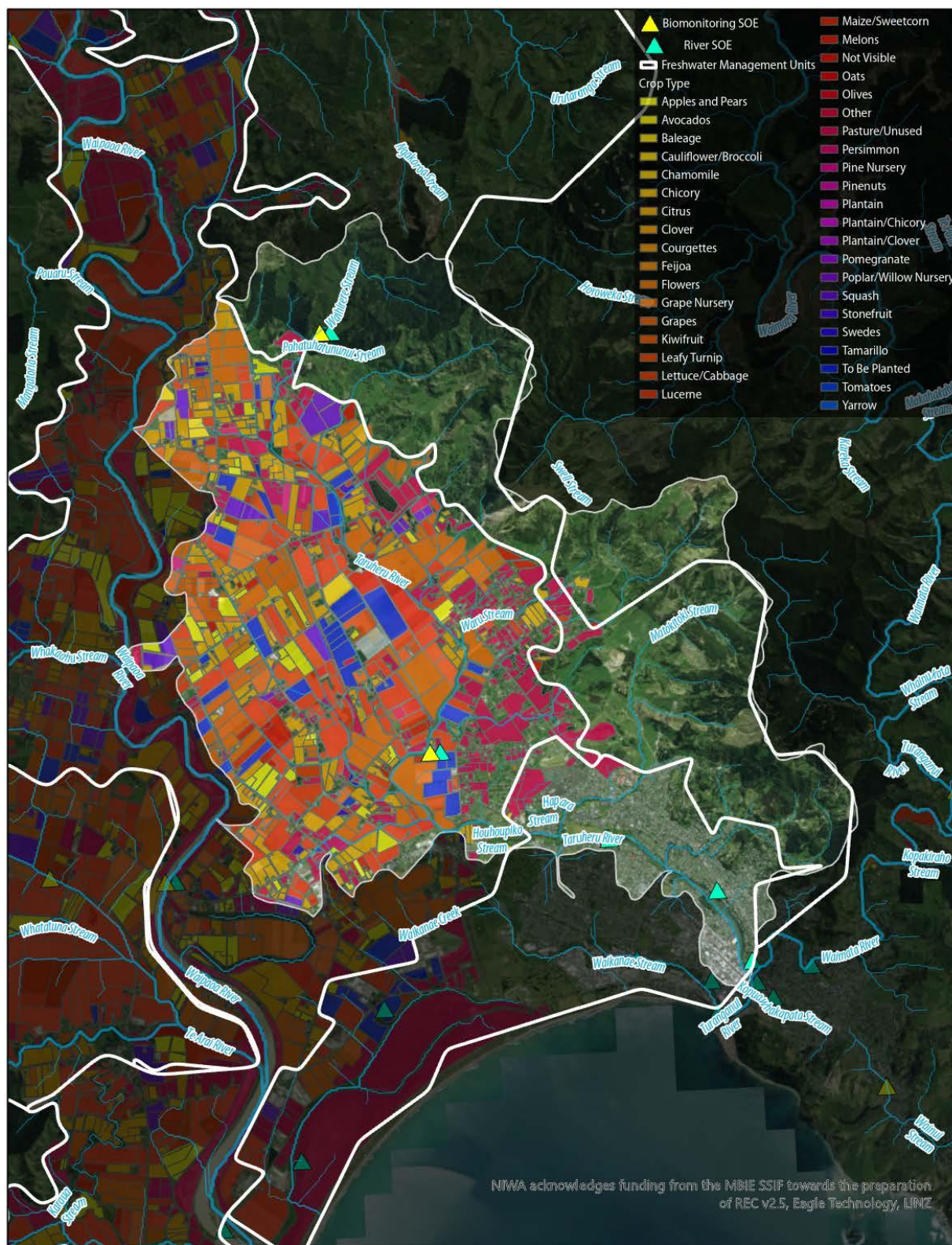
The lower reaches of the Taruheru River, from Tuckers Rd to the estuary are heavily used for contact recreation. Inanga spawning in the reach near Tuckers Road is also noted. The Panel understands that the Taruheru River was traditionally used for mahinga kai, although less so now due to the compounding impacts and issues. Values associated with the Taruheru River include ecosystem health, human health (secondary contact), Mauri, Animal drinking water, transport and tauranga waka and natural form and character.

The Taruheru River catchment, its main land uses and monitoring sites are shown on Figure 4.

This section should be read in conjunction with the State and Trends section (and Appendix C), which provides a more detailed description of the state and trends of the main freshwater and estuarine attributes and indicators.

³¹ Technical Library TL#087. Ausseil, 2025, technical memo.

³² Q90 is estimated at 10 l/s (Q90 is the flow exceeded 90% of the time).



Intensive land use and river monitoring sites / Taruheru Catchment
Scale: 1:80,000



Gisborne District Council does not make any representation or give any warranty as to the accuracy or exhaustiveness of the information provided. The information included on this site is indicative only and does not purport to be a complete database of all information in Gisborne District Council's possession or control. Gisborne District Council shall not be liable for any loss, damage, cost or expense (whether direct or indirect) arising from reliance upon or use of any information provided.

Figure 4: Intensive land use and water quality and ecology monitoring sites in the lower Taruheru catchment.

6.1.1 Key issues

The Panel identified seven key freshwater issues in the Taruheru catchment:

- Low dissolved oxygen (DO). There is clear evidence of regular hypoxic (low DO) and anoxic (no DO) conditions, which are unsuitable for most fish and sensitive macroinvertebrate species. Low oxygen levels also pose a significant risk of creating a barrier to migratory fish species attempting to move upstream from the sea to more suitable freshwater habitat further inland. From an ecological standpoint, low DO is likely the most significant impact among all issues identified in the Taruheru catchment. The Panel also notes a potential pH issue, as low DO levels often correlate with elevated pH; however, pH data were not explored to confirm a pH problem.
- High water temperature. Monitoring data provides clear evidence of chronic water temperature issues. In freshwater, the CRI was recorded as being above 25°C, indicating significant thermal stress to a range of species. High temperatures will limit range and abundance of species and affect fundamental in-stream processes (interaction with DO saturation for example). High temperature in lower reaches of rivers may also represent a barrier for migratory species. The Panel also notes that climate change is likely to further increase thermal stress, which could become critical in parts of the catchment in the absence of targeted mitigation.
- High nutrient concentrations (phosphorus and nitrogen). Regionally, the highest nitrogen concentrations are recorded in the Taruheru River at Tuckers Rd, and the NPS-FM National Bottom Line for nitrate (toxicity) and ammonia (toxicity) are exceeded at that site. Phosphorus is similarly very elevated, with median DRP concentrations being in Band D and the 5th most elevated in the region.
- Poor ecological health, as evidenced by degraded macroinvertebrate communities in the lower parts of the catchment. All three macroinvertebrate attributes (MCI, QMCI and ASPM) are in Band D, and estuarine species show low ecological health (sediment driven).
- Poor recreational water quality (*E. coli*) and elevated human health risks: The lower catchment has consistently poor water quality, with elevated *E. coli* levels posing a significant health risk to recreational users. At the Taruheru at Tuckers Rd site, *E. coli* concentrations are very high, both in median values and at the 95th percentile, indicating a consistently high health risk, not limited to periods following rainfall.
- High deposited and suspended sediment.
- Poor stream habitat quality, with low habitat and hydraulic diversity and limited bank and riparian vegetation (no shade)
- Very low summer flows. Whilst low summer flows are a natural feature of streams in the region, the modifications to the Taruheru hydrology, artificial drainage and water abstractions are understood to have reduced summer low flows in the Taruheru compared with natural levels. Summer low flows in the Taruheru will typically combine with other factors to lead to situations of high ecological stress (i.e., reduced in-stream habitat, higher water temperature and low DO).

Key issues affecting the tidal and estuarine reaches of the Taruheru River and estuary include:

- Sediment deposition in the Taruheru arm of the Tūranganui. Limited monitoring information is available, particularly on the extent of sediment issues in estuarine systems; however, what data is available indicates that the Taruheru arm of the Tūranganui Estuary is sediment stressed – i.e., there is, 12-70% mud content in the bed sediment, an absence of mud sensitive species, and dominance of species highly tolerant to mud. The presence of the Asian date mussel is indicative of a ‘stressed’ system. In the Waimatā arm, data indicates a sandier substrate (14-34% mud) and the presence of species highly sensitive to mud (*Microspio maori*). Overall, the Waimatā arm appears healthier than the Taruheru arm, although it is subject to moderate sediment stress.
- Poor ecological health, and estuarine species show low ecological health (likely sediment driven).

- Low DO. High frequency DO monitoring data from 2017-2018 at the Taruheru at Tuckers Rd site shows daily supersaturation peaks (up to ~270%) and hypoxic / anoxic minima (~0%), which is strongly indicative of active primary production (algae / cyanobacteria) leading to hypoxic and almost anoxic³³ night-time conditions.
- Eutrophication. Nutrient concentrations do not appear overly excessive for the estuarine waters (median nitrate 0.1mg/ L, TN median 0.3 mg/L, which indicates a 'moderate' risk based on BN expert opinion³⁴); however, this assessment may be skewed due to not having any information on algal growth (chlorophyll a). The DO monitoring data shows patterns that are characteristic of high or excessive plant and/or algae productivity in this system (e.g., extreme supersaturation during the day and anoxia/hypoxia overnight).
- High temperature. Based on discrete data at Tūranganui at Gladstone Rd, data indicates temperature up to 26.7 °C, indicative of thermal stress on some species at the upper level. Intertidal species are generally more resilient than transitory species (e.g., fish), but high temperature in estuarine reaches may represent a barrier for migratory fish species as already mentioned above as an issue for freshwater.

All of the above issues are considered significant both individually and collectively, as they are closely interrelated (with some acting as drivers of others) and tend to have cumulative impacts on ecological health and recreational values of the Taruheru River and estuary. The Panel concluded that the combination of issues and factors present in the Taruheru catchment create a highly degraded ecological system.

6.1.2 Sources and drivers

Regarding the potential sources and causes of the degraded water quality in the lower Taruheru catchment, the Panel considers the comparison between the Waihirere Stream @ domain and Taruheru at Tuckers Road monitoring sites to be a useful indicator of the impact of intensive land use on the water quality of the Taruheru River. This is on the basis that the Waihirere Stream @ domain is located on the main branch of the Taruheru River but upstream of the main area of intensive land use, whilst the Tuckers Road site is located downstream of the main area of intensive land use but upstream of potential inputs of contaminants or discharges (e.g., stormwater) from the Gisborne urban area.

Low DO: high frequency DO data provides evidence of night-time hypoxia and daytime DO supersaturation (>100% saturation). This suggests that the primary productivity of plants or algae is the primary cause of these diurnal DO fluctuations with daytime peaks and night-time troughs. Stream bed substrate in the lower Taruheru River and heavily modified tributaries is dominated by soft sediment and is not suitable for benthic periphyton accumulation, which points to phytoplankton as the likely primary cause of DO fluctuations, although macrophytes on side tributaries/ drains may also play a role. The biodegradation of organic matter can also be a cause of oxygen depletion, and it is possible that organic pollution from stormwater / wastewater (and possibly organic matter from horticultural systems given the lack of buffers) may be a contributor to low DO at times. However, stormwater and wastewater inputs are located downstream of Tuckers Rd, and thus would only contribute to the issue in the tidal /estuarine reaches, and supersaturation and low organic carbon in estuarine sediment point to primary production being the main driver of DO fluctuations.

High water temperature. A lack of riparian shading and channel modifications such as straightening and homogenous shallow depth are well-established drivers of high water temperature, which is likely to be further exacerbated by very low summer flows. Additional mechanisms may also be contributing to elevated water temperature, including the potential loss of hyporheic (shallow groundwater) connectivity caused by high sedimentation, which can reduce cooling from colder groundwater inputs, as well as the influence of overland flows and reduced water clarity.

³³ Hypoxia means low oxygen; anoxia means no oxygen. In this situation, both terms are applied to dissolved oxygen in the water column.

³⁴ Bulmer, 2022. Bayesian modelling of multiple stressors on six Hawke's Bay estuarine ecosystems.

High nutrients. Comparison between the Waihirere Stream and the Tuckers Rd monitoring sites indicates large increases in the median concentrations of both phosphorus and nitrogen between these two points:

- Waihirere at Domain: DIN = 0.110 mg/L (low) and DRP = 0.035 mg/L (moderate/high)
- Taruheru at Tuckers Rd: DIN = 1.570 mg/L (highest in the region) and DRP = 0.120 mg/L (very high). Ammonia and nitrate also exceed NBL.

This comparison indicates that the area of intensive land use between the two sites is the likely main source of the elevated nutrient concentrations measured at Tuckers Rd, which is consistent with the Panel's expectations based on their combined experience of assessing the effects of intensive land use on water quality nationally.

Sources of elevated in-stream DIN typically include drainage through the soil profile, then groundwater transport of dissolved nitrogen (generally nitrate) through to surface water bodies. In the Taruheru catchment, it is likely that a large part of the shallow groundwater is intercepted by artificial subsurface drains, which discharge directly into the surface drain / stream network.

Sources of in-stream phosphorus are likely to include:

- Soil bound P getting washed into stream/ drain network noting frequent lack of vegetated buffers between cultivated areas and streams / drains
- Potential P source legacy in bed sediment (noting anoxic conditions will cause re-solubilisation of sediment P into water column as bioavailable P)
- DRP through drainage water / tile drain

Low habitat quality. Key drivers of poor habitat in the mainstem and tributaries of the Taruheru River include the absence of riparian vegetation and shading, a loss of habitat diversity from channel straightening, and regular flood control maintenance activities such as mechanical dredging.

Low summer flows: Low summer flows are a natural feature of streams and rivers in the Tairāwhiti region. In the Taruheru catchment, summer low flows are likely to be reduced compared with their natural levels, due to the combined affects of historical hydrological modifications (i.e., physical separation from the Waipaoa River as mentioned previously), artificial drainage, water abstraction and the removal of riparian shading. Low summer flows combine with tidal influence to create significant areas of very slow moving, water in the Taruheru mainstem and tributaries that may not be refreshed on each tide. This is, thought to exacerbate the low DO and elevated water temperature issues.

Sediment sources in the Taruheru catchment are likely to include typical erosion processes from pastoral land in the upper catchment, but also soil losses from cultivated areas, noting the frequent lack of vegetated buffers between cultivated areas and streams / drains. The low gradient channel of the lower Taruheru behaves like a sediment trap accumulating deposited bed sediment that is seldom flushed.

Poor ecological health: The poor ecological health of the Taruheru River and estuary is likely driven by the combined effects of the multiple factors listed above, particularly sediment, low DO, elevated temperatures, poor habitat quality, and low summer flows.

High *E. coli*. The Panel considered the following summary of data available at three key sites:

- Waihirere at Domain: relatively low median (110 cfu/100mL), but high 95th percentile (5,600 cfu/100mL);
- Taruheru at Tuckers Rd: very high median (1,115 cfu/100mL) and high 95th percentile (7,360 cfu/100mL).
- Tūranganui Estuary: low median (103 cfu/100mL) and moderately elevated 95th percentile (1970 cfu/100mL).

The comparison of median and 95th percentile *E. coli* concentrations at the three key sites is indicative of significant *E. coli* inputs likely from the intensive land use area between Waihirere at Domain and Tuckers Bridge, followed by dilution by cleaner seawater in the estuary. The large increase in median concentrations

indicates that the *E. coli* inputs between Waihirere at Domain and Tuckers Bridge occur frequently, under most conditions. By contrast, the low median but high 95th percentile concentrations indicates that water quality at Waihirere at Domain is generally suitable for contact recreation but presents a higher health risk at times.

The exact sources of *E. coli* in the area are not definitively known; however, based on the Panel's collective experience, they are likely to include:

- Grazing animals on pastoral land
- Use of grazing sheep in horticultural areas and flood control areas
- Stockyards
- Stormwater and wastewater, noting these inputs are downstream of Tuckers Rd, and are thus not contributors to the high *E. coli* at that site
- Contributions from birds / waterfowl are also expected.

Further analysis of existing *E. coli* data and faecal source tracking would be useful to investigate any seasonal or rainfall / flow related patterns of *E. coli* concentrations across the area, which could help point to specific sources of *E. coli*.

6.1.3 Potential actions

The Panel were asked to comment on potential "levers" that could be pulled to improve water quality and ecological health issues in the Taruheru catchment. Overall, the Panel's view was that the Taruheru catchment is a complex system, subject to multiple drivers and stressors, so a measurable improvement in ecological health was likely to require the coordinated mitigation of these. The Panel recommends that the following six management actions be considered:

1. Riparian vegetation / Shading:

Shading of streams and drains would help regulate water temperature and reduce excessive primary production, while also providing additional benefits for habitat quality, ecological processes, and bank stability. Riparian vegetation would provide effective shading to streams above Tuckers Rd. There is a potential risk that water uptake by riparian vegetation could further reduce low flows in very small drains, so the inclusion of wetland creation should be considered. Additionally, there is a risk of temporary increases in sediment inputs from overland flow beneath closed canopy where ground cover is not retained. An increase in dissolved nutrient export to downstream reaches and the estuary is also possible. Therefore, it is important to concurrently implement measures to reduce nutrient losses and inputs from land use.

The Panel recognises the limitations and potential risks of establishing riparian vegetation along streams and drains within flood management scheme, including the risk of vegetation debris blocking culverts or damaging infrastructure and vegetation restricting machinery access. Potential solutions include careful selection of plant species, prioritising planting on the northern bank to maximise temperature control while maintaining machinery access from the opposite bank, and incorporating regular gaps in planting to provide access points along the waterway.

2. Nutrient management

Reducing nutrient loss from land use has the potential to reduce primary production and associated detrimental effects in streams and the estuary. A moderate reduction in nitrogen loss is also required to meet nitrate and ammonia NBLs; noting that DO improvement is also required to reduce ammonia.

Limitations: Based on available information and noting the knowledge gaps, the Panel concluded that they could not quantify the nutrient reductions required to materially limit or control the detriment effects of primary production. The Panel also recognised that significant reductions in nutrient loss would potentially place limitations on horticultural systems, but economic or feasibility considerations were outside the Panel's scope.

3. Low Flow augmentation/restoring natural flows

Augmenting low flows would provide additional in-stream habitat, dilute nutrient concentrations in the Taruheru mainstem, potentially reduce water temperatures, and moderately increase DO levels. To clarify, this refers specifically to low flow augmentation, not flushing flows.

Limitations: Extensive modifications mean that restoration of natural flows may not be possible. The availability of suitable surface or groundwater source/s is unknown, and both feasibility and costs remain uncertain. There is also limited understanding of the natural flow regime. Flow augmentation would only benefit reaches downstream of augmentation point, and there is a risk of introducing fine sediment if water is sourced from Waipaoa River.

4. Catchment sediment management

Reducing sediment losses from the catchment would improve estuary health, reduce phosphorus inputs – particularly sediment bound P from high producing agricultural systems – and reduce both deposited and suspended sediment within streams. This would provide benefits to ecological health, recreational use and overall amenity values.

5. Reduction of Wastewater inputs and overflows; improvement of stormwater quality.

While urban issues such as stormwater and wastewater overflows fall outside the direct scope of the Panel assessment, the Panel notes that reducing contaminant inputs from urban areas would qualitatively benefit a range of ecological values and improve human health outcomes in the lower Taruheru River. These inputs are downstream of Tuckers Rd, meaning improvements would primarily benefit tidal reaches and estuary.

6. Implement a range of “edge of field” mitigations

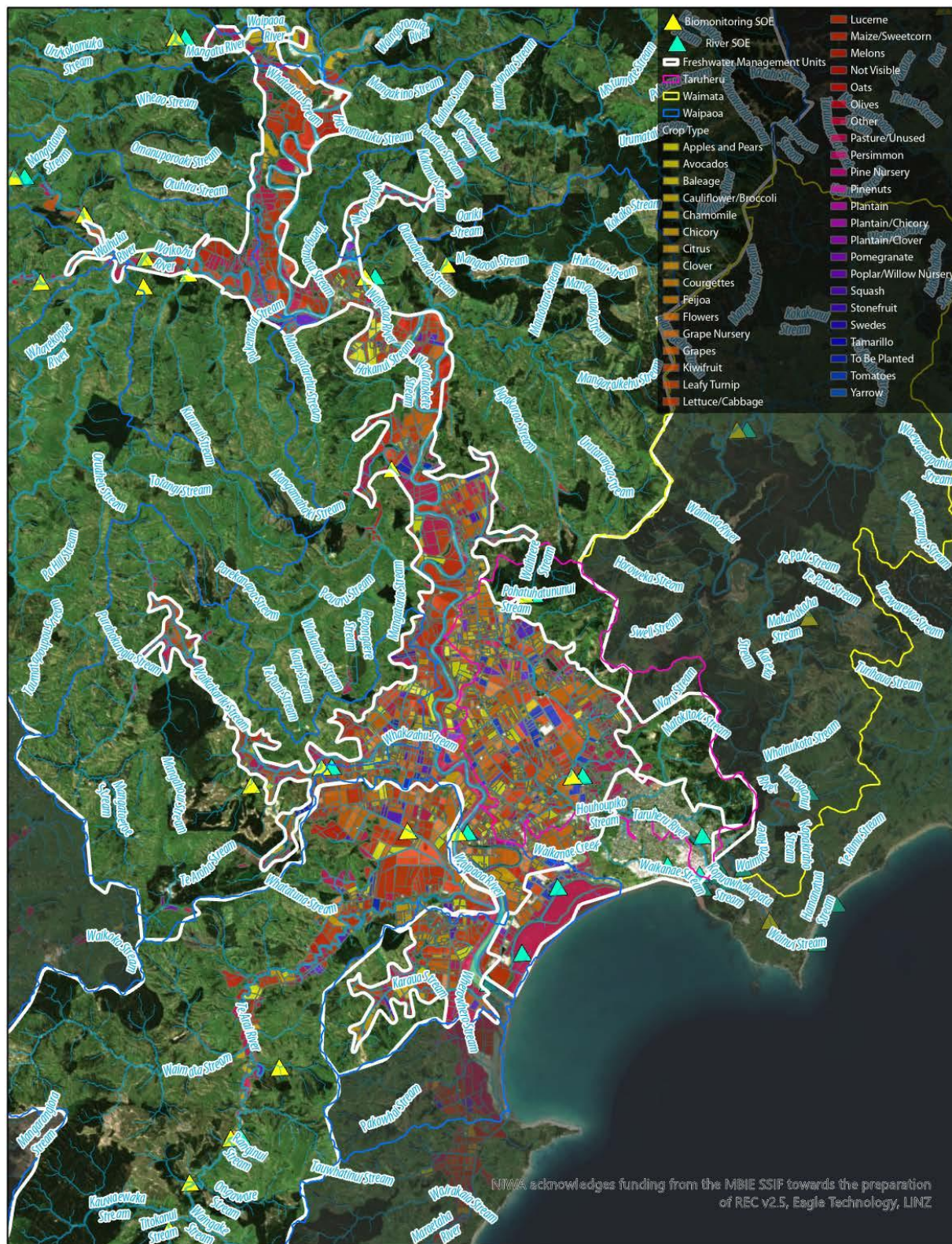
GDC commissioned NIWA to provide advice on edge of field mitigations³⁵ that could be applied in the Taruheru catchment to address multiple issues including sediment, nutrients, and to some degree, habitat). These types of mitigations fall largely outside the Panel’s area of expertise, and there is insufficient information to provide detailed recommendations on specific mitigation actions or their optimal placement.

6.2 Waipaoa catchment

The area and main water bodies considered by the Panel in this assessment include the lower reaches of the mainstem of the Waipaoa River and its estuary, and the lower reaches of Waihora, Waikohu and all of Whaakahu Stream. Whilst technically outside of the Waipaoa catchment, Te Wherowhero Lagoon was included in this assessment as it is understood to be hydrologically connected to the lower Waipaoa river.

The lower Waipaoa downstream of Te Karaka is primarily managed for flood control, with altered habitat, channelisation, poor fish passage (tidal flood gates), loss of floodplain connectivity, and little to no riparian and bank vegetation providing no shade on tributaries.

³⁵ Technical Library TL#054. Tanner, 2024. Also see associated publications (TL#051 and TL#53).



Intensive land use and river monitoring sites / Waipaoa Catchment
Scale: 1:185,000



Gisborne District Council does not make any representation or give any warranty as to the accuracy or exhaustiveness of the information provided. The information included on this site is indicative only and does not purport to be a complete database of all information in Gisborne District Council's possession or control. Gisborne District Council shall not be liable for any loss, damage, cost or expense (whether direct or indirect) arising from reliance upon or use of any information provided.

Figure 5: Intensive land use and water quality and ecology monitoring sites in the lower Waipaoa catchment.

6.2.1 Key issues

The current state and issues for Waipaoa catchment overall have been described previously. The Panel identified the following freshwater issues associated with the lower Waipaoa River and the Waipaoa Estuary:

- Sediment: Excessive sediment loads are the most significant catchment-wide issue for the Waipaoa River. High sediment levels alter in-stream habitat, with deposited sediment being a major driver of reduced ecological health.
- River flows: River flows are significantly impacted by abstraction in the Waipaoa catchment. This is likely to lead to a highly modified flow regime, with subsequent effects on stream habitat and ecology. This is not discussed further as outside the Panel's scope.
- Poor recreational water quality: Monitoring data (specifically 95th percentiles) show very high *E. coli* concentrations in the lower Waipaoa mainstem, including at the @Kanakanaia site.
- Poor ecological health: The lower Waipaoa mainstem exhibits poor ecological health, with macroinvertebrate communities consistently in Band D, indicating severe degradation. This reflects cumulative impacts from high sediment loads, poor habitat quality, and high temperatures, resulting in low biodiversity and dominance of insensitive species.
- High Temperature: The Waipaoa River experiences elevated water temperatures, largely due to its gravel-bed structure and high fine sediment loads, which increase heat absorption and retention. The absence of riparian shading along much of the river exacerbates thermal stress, contributing to reduced habitat suitability for temperature-sensitive aquatic species. Elevated temperatures can also lower DO levels, further impacting fish and macroinvertebrate communities.
- Restricted fish passage: Flood gates and in-stream structures are likely to be significantly restricting fish passage, particularly for migratory species, contributing to reduced fish diversity and abundance in the Waipaoa. While these structures currently pose barriers, it is noted they are subject to consent conditions that require improvements to fish passage over the lifetime of the consent. However, until upgrades are implemented, these barriers will continue to limit ecological connectivity and hinder fish movement between the estuary and upstream habitats.

There is currently no evidence of periphyton issues in the lower Waipaoa mainstem, most likely due to the mobile stream bed, and data available does not show any no clear increase in nutrient concentrations downstream of the main area of intensive land use. For example, Table 1 in Heath, 2023³⁶ shows very similar concentrations of nutrients (TN, TP, DRP, DIN) at Waipaoa at Kanakanaia and at Matawhero Bridge. The intensive LU area is small relative to the size of the whole catchment and the potential to cause significant water quality degradation appears relatively low.

In its current state, the Waipaoa River Estuary is strongly river dominated (SSRTRE estuary) with minimal intertidal area (2.33%) and moderate annual river discharge 25 m³/s³⁷, indicating low sensitivity to eutrophication. The Panel notes that the lower Waipaoa River and Estuary have been extensively modified, and river diversion and drainage are likely to have significantly altered habitat.

The Panel identified the following freshwater issues associated with the Whakaahu Stream:

- The Whakaahu stream is a soft bottom stream, which means periphyton is unlikely to be an issue. However, based on visual observations excessive macrophyte growth does appear to be an issue in the Whakaahu Stream (Paul Murphy, pers. Comm.)
- DRP concentrations are elevated (Band D), but DIN concentrations are very low.
- There are possible DO issues in the Whakaahu stream, potentially associated with macrophyte growth. These should be investigated.

³⁶ Technical Library TL#057

³⁷ Coastal Explorer – <https://data-niwa.opendata.arcgis.com/search?tags=coastal%2520explorer>. Accessed June 2025

- Elevated water temperature is an issue (maximum 29.4°C, CRI 22.4°C), indicating thermal stress (Band D). High temperature is likely due to the lack of riparian vegetation or shading.
- Poor ecological health, as evidenced by all three macroinvertebrate attributes in Band D. The MCI metric in particular is extremely low at 51.
- Poor habitat is evident in the Whakaahu stream, which is highly modified and widely managed like a drain, with very limited riparian vegetation.
- Whakaahu Stream has very low summer flows and is generally the first stream in the area to dry up. As such it could be considered a 'canary in the coal mine' for local waterways.

Te Wherowhero lagoon, while located in the Hangaroa-Ruakituri planning area, is likely to be influenced by groundwater flowing from the Waipaoa catchment. Historically, the primary water source for Te Wherowhero Lagoon was surface water from the Waipaoa catchment. However, flood control and drainage modifications have diverted most of this flow directly to the coast via the Waipaoa River mouth. As a result, the lagoon's main water source now comes from the Hangaroa-Ruakituri catchment. Despite these changes, some hydrological connection to the Waipaoa River and aquifer systems is still likely to persist.

The Panel considers Te Wherowhero Lagoon to be highly sensitive to sediment and nutrient impacts, due to its low-energy environment and long water residence times.

However, there is very limited information on the current condition of Te Wherowhero Lagoon, and the Panel is unable to assess the significance of issues, such as sediment deposition and DO levels, due to this data gap. The Panel recommends that ongoing monitoring of Te Wherowhero Lagoon be prioritised.

6.2.2 Sources and drivers

The main drivers of poor ecological health in the lower Waipaoa are likely to be:

- High levels of deposited sediment. These primarily originate from hill country erosion, and this issue is discussed elsewhere in this report.
- Altered flow regimes, noting river flow issues, including abstraction pressures are outside the Panel's scope.
- High water temperatures, noting that there is limited scope to directly influence water temperature in the lower Waipaoa mainstem or estuary due to the wide width of the river channel precluding shading by riparian vegetation. Any temperature mitigation action should focus on smaller tributaries and headwaters.

Sources of high *E. coli* concentrations are unknown but are likely to include:

- Point source discharges (Te Karaka WWTP),
- Grazing within stop banks,
- Grazing in the wider catchment pastoral use, and
- Potentially pest animals.

6.2.3 Potential actions

The Panel were asked to comment on potential actions that could be implemented to improve water quality and ecological health issues in the lower Waipaoa catchment. The Panel recommends that the following four management actions be considered:

1. Catchment-wide sediment management

Deposited sediment is likely to be the main driver of poor ecological health in the lower Waipaoa River. Sediment management is the main focus of the region-wide scenarios and is not discussed further here.

2. Manage stock access

Direct stock access to the Waipaoa River and its tributaries is likely to be a key driver of high observed *E. coli* concentrations. This issue is also a key focus the region-wide scenarios and is not discussed further here.

3. Riparian management

Stock exclusion and riparian planting are effective measures to improve ecological health by reducing water temperature, limiting in-stream plant growth (periphyton and macrophytes) via shading, reduced decreasing sediment inputs and enhancing stream habitat – especially in streams under 10-m wide. The Panel recommends prioritising riparian management actions in tributary streams, such as the Whakaahu.

4. Flow management

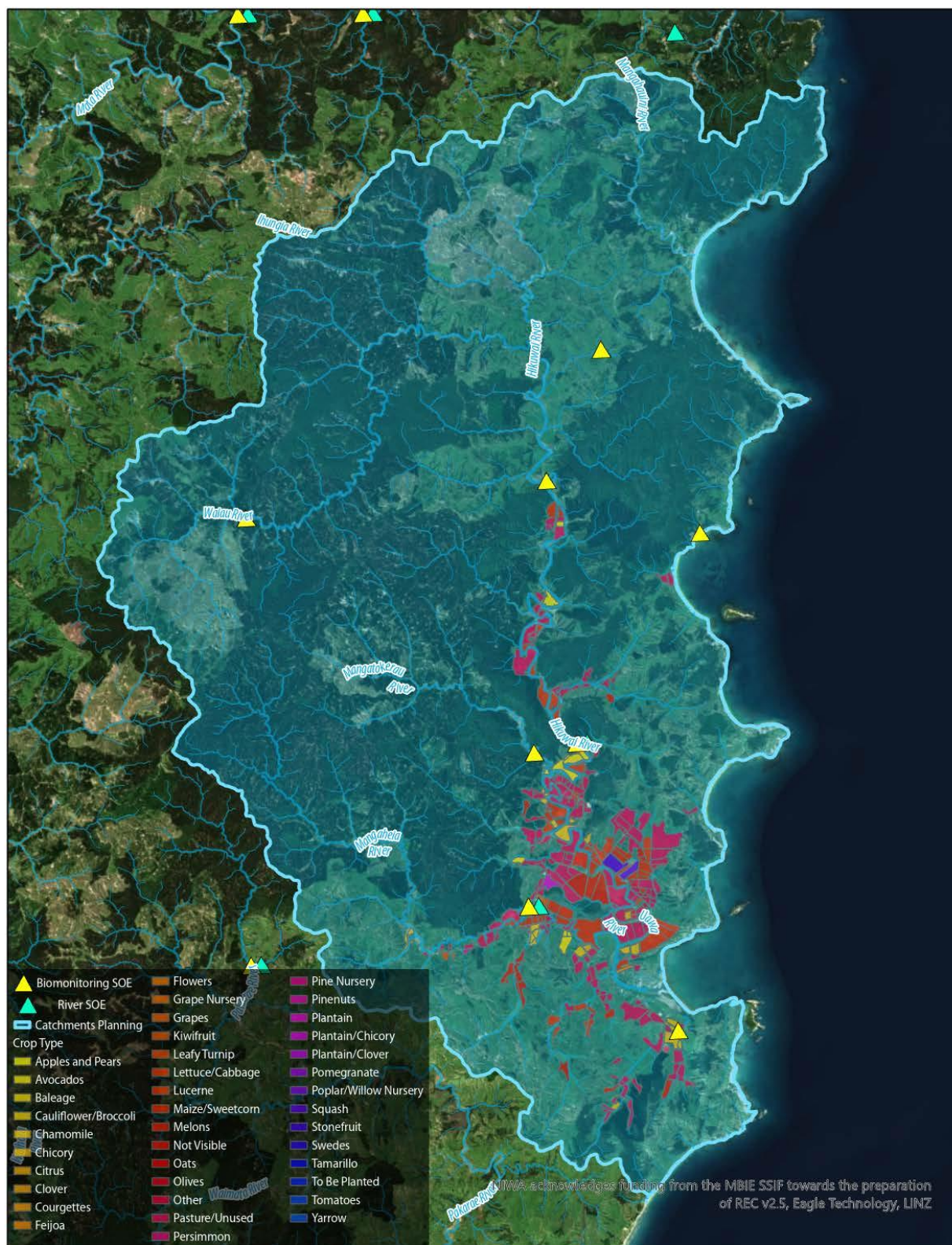
Modified flow regimes and abstraction pressure can contribute to multiple drivers of river ecological health such as temperature, DO and sediment accumulation. Flow management is however outside the Panel's scope and not discussed further.

6.3 Uawa Catchment

The area of intensive land use and freshwater monitoring sites in the Uawa catchment are shown in Currently, available water quality and ecology data is limited to sites upstream of the main intensive land use area (e.g., Uawa at Willow Flat). Whilst this data provides a useful reference (upstream) point, monitoring data at sites within or downstream of the intensive land use is not available, and thus the effects of intensive land use on the water quality and / or ecology of the Uawa River or its tributaries cannot be assessed.

The Panel notes the conclusion drawn in the Plant and Food report, indicating that the area of intensive land use is relatively small relative to the size of the whole catchment, and the nutrient losses from that area appear unlikely to significantly impact on the water quality of the Uawa River. The Panel is also not aware of any evidence of problematic eutrophication (e.g., visible algal blooms). These considerations indicate a relatively low risk currently of eutrophication in the Uawa River mainstem, although the Panel notes that smaller tributaries within the intensive land use area may be at greater risk and risk could increase if there is further expansion of intensive use.

Overall, in the absence of water quality or ecology data for the lower river, the Panel cannot confirm the presence or emergence of issue(s) associated with intensive land use. This is seen as a priority knowledge gap, especially if further land use intensification and/or expansion is likely. Monitoring in the lower river is recommended to establish a baseline of water quality and ecology.



Intensive land use and river monitoring sites / Uawa Catchment
Scale: 1:180,000



Gisborne District Council does not make any representation or give any warranty as to the accuracy or exhaustiveness of the information provided. The information included on this site is indicative only and does not purport to be a complete database of all information in Gisborne District Council's possession or control. Gisborne District Council shall not be liable for any loss, damage, cost or expense (whether direct or indirect) arising from reliance upon or use of any information provided.

Figure 6: Intensive land use and water quality and ecology monitoring sites in the Uawa catchment

7 Knowledge gaps and recommendations

Throughout their assessment, the Panel were asked to identify knowledge gaps, particularly data, information or tools that would have been useful to support the Panel's assessment of state, trends, issues and drivers, as well as outcomes of catchment management scenarios. The Panel were also asked, where possible to make recommendations for monitoring or investigations that could be undertaken by GDC to support future freshwater policy development and effectiveness monitoring. These are summarised below, for freshwater and estuaries.

Importantly, some of these knowledge gaps, such as a lack of monitoring data could realistically be addressed by GDC depending on resources, whilst others simply reflect the state of knowledge nationally and internationally and may not realistically be addressed in the short to medium term.

7.1 Freshwater

Whilst the freshwater monitoring programme implemented by GDC is extensive and comprehensive, the Panel has identified information gaps in assessing the current, baseline and reference state and temporal trends of key freshwater indicators. Knowledge gaps were also identified in relation to the assessment of scenarios, such as the lack of data relating to the effectiveness of mitigation measures or the absence of predictive models or relationships linking management actions to freshwater attributes.

7.1.1 Sediment related attributes

The Panel makes the following recommendations in relation to sediment attributes and indicators:

- The Panel notes that visual clarity is now monitored using the black disc method in addition to the black disc tube. The Panel supports this change as it is likely to provide greater confidence in assessing the state of suspended sediment.
- The poor agreement between measured and modelled visual clarity is problematic and, for example, would prevent the setting of robust baseline and target attribute states (TAS) at un-monitored sites or at planning area scale. Additional monitoring of visual clarity at un-monitored sites would be useful, particularly in catchments where there is disagreement between modelled and measured visual clarity data.
- Development of site-specific relationships between suspended sediment concentrations and visual clarity may improve estimates of sediment load reductions required to achieve TAS and is recommended for sub-catchments subject to future mitigation.
- To strengthen the assessment of current state and scenario outcomes on DFS, the Panel notes that more frequent deposited sediment data (e.g., monthly instead of annually) would improve the accuracy of estimates.
- The Panel recommends that the suitability of the NPS-FM sediment classifications and associated thresholds be reviewed for the Tairāwhiti region, including both DFS and visual clarity, and with particular attention to specific catchments such as the Waiapu. The Panel notes that some thresholds may not reflect the natural sediment dynamics of these catchments, especially where high natural sediment loads are driven by large gully systems. This is supported by modelled outcomes under the full afforestation scenario, where national bottom lines (NBL) are still not met, indicating a possible mismatch between national reference conditions and catchment-specific realities.

7.1.2 Physico-chemical and habitat attributes

Given the significance of the water temperature as a limiting factor in Tairāwhiti, the Panel recommends the implementation of additional high-frequency temperature monitoring, with the following objectives:

- Improved characterisation of state and trends: Increase understanding of water temperature patterns, particularly at sites likely to experience thermal stress. Existing discrete and high-frequency datasets should be used to prioritise locations for further investigation and on-going monitoring.
- Support for modelling and management planning: Water temperature dynamics, including responses to mitigation actions such as riparian shading, can be modelled. The Panel recommends exploring the use of existing models or developing a regional water temperature model. Developing or calibrating such models would require higher spatial resolution and high-frequency temperature data to accurately characterise spatial and temporal patterns and quantify the relative contribution of different temperature drivers, including the effectiveness to management interventions.
- Policy alignment: The Panel notes that water temperature management was not a central focus of mitigation actions in Scenarios 3-5. Given its importance, the Panel recommends strengthening policy measures specifically targeting water temperature management.
- Identification and protection of thermal refugia: Monitoring and research should also focus on identifying thermal refuge areas. Temperature mitigation efforts should prioritise these areas, particularly smaller streams (typically < 10-m wide), where riparian shading can meaningfully reduce water temperature and improve habitat condition. The Panel is not aware of any readily available guidance to systematically identify thermal refuge areas and suggests this could be the topic of a specific investigation.

Dissolved oxygen (DO) was also identified as a significant issue, particularly in lowland freshwater and tidal systems. The Panel recommends:

- High frequency DO monitoring and research: Expand monitoring to better understand the spatial and temporal extent of low oxygen conditions, along with the causes and drivers. Focus efforts on lowland systems with characteristics similar to known problem sites (e.g., slow-moving degraded habitats).
- Policy focus: Like temperature, DO management was not addressed in Scenarios 3-5, The Panel recommends increased policy attention on DO management where it is known stressor.

Given the widespread temperature and DO issues, the Panel considers it likely that pH may also be problematic in certain locations or periods. However, due to a lack of data, the extent or significance of pH impacts could not be assessed. The Panel recommends incorporating high-frequency pH monitoring alongside temperature and DO monitoring, using the same sites and timeframes.

A fundamental limitation of the stream habitat assessment is the focus of the RHA methodology on the site-scale and current state. To improve stream habitat assessment, the Panel recommends:

- Identify drivers of site-scale habitat condition: Apply the River Habitat Modification assessment alongside the RHA at degraded sites to identify potential management actions.
- Incorporate fish barrier assessments: Conduct catchment-wide fish passage assessments (e.g., using the NZ Fish Passage Assessment Tool) to identify and prioritise barriers, account for cumulative impacts on fish diversity and life cycles, and integrate fish passage into habitat quality assessments.
- Expand habitat assessment beyond site-scale: Incorporate catchment-scale assessments of longitudinal connectivity, geomorphology, and floodplain dynamics to better capture habitat condition and the cumulative impacts of channelisation, reduced sinuosity, and barriers. Develop a catchment-wide inventory of modified streams (e.g., channelisation, floodbanks, drained wetlands) to quantify legacy impacts, prioritise restoration (e.g., re-meandering, wetland reconnection), and assess soft-engineering options.

7.1.3 Ecological variables

The macroinvertebrate monitoring in Tairāwhiti is extensive and informative for freshwaters. The Panel identified some limitations and as such recommends:

- Refining monitoring coverage and consistency: Macroinvertebrate monitoring should be expanded to improve spatial representativeness, with additional sites in lowland and degraded catchments such as Waipaoa Hill Country, Poverty Bay Flats, and Waimatā, where Band D conditions are common. Routine monitoring should also be established in estuarine environments beyond Tūranganui Estuary to capture downstream responses. Increasing monitoring frequency at under-sampled sites, particularly those with fewer than five years of data, will improve confidence in baseline conditions and trend detection.
- Strengthening scenario modelling: Use modelled macroinvertebrate reference conditions to quantify recovery potential and track improvements towards reference state. Improving the links between key drivers such as sediment, temperature, and flow alteration and biological responses will enhance the reliability of scenario predictions.
- Prioritising long-term monitoring to track recovery and climate risks: Given the slow expected recovery of macroinvertebrate communities and added climate risks, long-term monitoring should be undertaken in representative and climate-sensitive catchments to improve detection of trends and responses to mitigation. Adaptive monitoring approaches are needed to refine management actions based on observed ecological changes over time.

Current fish assessments based on species presence/absence (e.g., F-IBI, eDNA) are insufficiently sensitive to detect ecological improvements or early declines, especially over decadal timeframes. The Panel recommends:

- Implementing quantitative monitoring at key sites: Shift from presence/absence measures to quantitative fish monitoring at priority sites to track changes in abundance and community structure, improving the ability to detect ecological responses to mitigation and climate stressors.
- Establishing a clear fish baseline: Compile a comprehensive baseline dataset by integrating historic NZFFD data, eDNA, and any quantitative records to better define current versus reference conditions, especially in lowland and modified catchments.
- Integrating connectivity and climate resilience assessments: Incorporate fish passage and climate refuge mapping into monitoring to track improvements in connectivity and identify critical habitats that support resilience for vulnerable and mahinga kai species like tuna.

7.1.4 Human health attributes (*E. coli*)

The Panel makes the following recommendations in relation to *E. coli*:

- Faecal source tracking would be useful in the urban recreational sites to inform management actions to improve *E. coli* results and contact recreation activities at these high use sites.
- The drivers of the high standard deviations of the *E. coli* data in the region should be investigated and if possible, compared with the rest of the country. An initial analysis of the conditions (e.g., flow, rainfall, season) driving the high percentile concentrations would be useful.
- The above investigations should focus on sites / areas where recreational values are being restricted, e.g., recreational sites that have frequent periods where they are deemed unsuitable for contact recreation.

7.1.5 Eutrophication

- Phytoplankton: Although there is clear evidence of phytoplankton blooms in the tidal areas of the Taruheru catchment, there is limited understanding of their composition, frequency, duration and key drivers. The Panel recommends improved characterisation of these blooms, including identification of algal or bacterial species, limiting nutrient and other contributing factors. This monitoring should be aligned with the high frequency DO and temperature monitoring recommended above to better understand ecosystem dynamics.
- Periphyton: The Panel considers that periphyton is not currently a significant issue in the region; however, future pressures, such as climate change and reduced sediment inputs, may increase its relevance over the medium to long term. The Panel recommends reducing current periphyton monitoring efforts while maintaining periodic surveillance. Specifically, the resource intensive monthly biomass programme required by the NPS-FM could be reviewed after three years of data collection, with the option to transition to less frequent visual assessments of periphyton cover at key sites.

7.1.6 Other knowledge gaps

The Panel recommends establishing regular water quality and ecological monitoring of the lower Uawa river, downstream of the area of intensive land use, and potentially in smaller tributaries within the area of intensive land use. The level of priority may depend on the likelihood of further land use intensification in this catchment.

The Panel noted limitations associated with the use of national models (especially when regional data was not used for the development of the model) to support regional or planning area-scale assessments, and recommends that GDC consider the development of regional models, prioritising key attributes, such as visual clarity and temperature.

7.2 Estuaries

Very little data or information were available to the Panel to assess the current state, reference state or temporal trends of estuarine water quality or ecology. The Panel recommends GDC consider the following:

- Undertake regular monitoring, prioritising sensitive estuaries, to support a better understanding of state and trends of estuarine water quality or ecology, and support the development and validation of models.
- Monitor sediment deposition and mud content as outlined in estuary monitoring plans. In addition, undertake spatial sediment assessments of mud content (silt/clays that make up the <63µm fraction of sediment throughout the estuary to determine the area of estuarine extent with mud content >25%. This will assist GDC to understand how widespread the issue of fine sediments is within the estuaries.
- Consider examining Waitangi Tribunal and Marine and Coastal Act Customary Title documents as sources of historical information to support an assessment of reference state of estuaries.
- The assessment of eutrophication risk in the region's estuaries was hampered by the apparent poor fit of modelled nutrient concentrations vs those measured in the river's terminal reaches. The Panel recommends developing estimates of nutrient loads entering estuaries, especially those with "at risk" features.
- The drivers of low DO in tidally-influenced freshwater reaches and estuarine reaches are poorly understood and should be investigated further. This may include further high frequency data collection and concurrent data collection throughout the system.

References

The following references were cited in this report, in addition to the documents contained in the Technical Library (refer to Appendix B).

- Ausseil O, Snelder T, Kittridge M and Keenan L. (2024). Freshwater Scenario Builder for Rivers: WebApp Technical Documentation and User Guide. October 2024. https://cdn.prod.website-files.com/66bbdf664a17b9832b6a9158/673143a06275fc7555574b7e_Freshwater_ScenarioBuilder_Rivers_UserGuide_updated_Oct2024.pdf
- Biessy L, Smith K, Wood S. 2024. Developing a monitoring plan to guide the management of algal blooms in the riverine and estuarine systems in Gisborne / Tūranganui-a-Kiwa. Nelson: Cawthron Institute. Cawthron Report . Prepared for Gisborne District Council.
- Clapcott, J., West, D., Goodman, J., Goodwin, E., Lander, R., Lucas, J., Crone, D., Murphy, P., Palmer, M., & Hughey, K. F. D. (2012). Native Fish: Development and Application of the River Values Assessment System (RiVAS and RiVAS+) Method to the Gisborne District Council Region. LEaP Research Paper No. 10, Lincoln University.
- Clapcott, J. National Rapid Habitat Assessment Protocol Development for Streams and Rivers. (2015). Prepared for Northland Regional Council. Cawthron Report No. 2649.
- Clapcott J, Casanovas P, and Doebling K. (2019). Indicators of freshwater quality based on deposited sediment and rapid habitat assessment. Cawthron Report No. 3402, Ministry for the Environment.
- Davies-Colley R., Franklin P, Wilcock B, Clearwater S and Hickey C. (2013). National Objectives Framework - Temperature, Dissolved Oxygen & pH. Proposed thresholds for discussion. NIWA Client Report: HAM2013-056.
- Depree, C, M Unwin, and R Young. (2016). Dissolved Oxygen (DO) Data Collation and Preliminary Analysis. Prepared for Ministry for the Environment. NIWA Client Report No. HAM2016-008.
- Devane, M. (2017). Faecal Source Tracking in the Taruheru River, Gisborne. ESR report prepared for Gisborne District Council. Envirolink report number CSC17012.
- Froude, V.A. (2003) Freshwater biodiversity in the East Coast – Hawke’s Bay Conservancy of the Department of Conservation: a compilation of existing information. Report prepared for the Department of Conservation. Pacific Eco-Logic Ltd.
- McDowell RW., Snelder TH, Cox N., Booker DJ, and Wilcock R.J. (2013) Establishment of reference or baseline conditions of chemical indicators in New Zealand streams and rivers relative to present conditions. Marine and Freshwater Research, 64: 387–400.
- Monaghan R, Manderson A, Basher L, Smith C, Burger D, Meenken E, McDowell R. (2021). Quantifying contaminant losses to water from pastoral landuses in New Zealand I. Development of a spatial framework for assessing losses at a farm scale. New Zealand Journal of Agricultural Research 64(3): 344–364.
- PCE (2024). A review of freshwater models used to support the regulation and management of water in New Zealand June 2024. Parliamentary Commissioner for the Environment Te Kaitiaki Taiao a Te Whare Pāremata.
- Plew, D., Dudley, B., Shankar, U., Zeldis, J. (2018). Assessment of the eutrophication susceptibility of New Zealand Estuaries. Report prepared for Ministry for the Environment. NIWA Client report 2018206CH. 64p.
- Robertson, B., Stevens, L., Robertson, B., Zeldis, J., Madarasz-Smith, A., Plew, D., Storey, R., Hume, T., Oliver, M. (2016). Estuary Trophic Index Screening Tool 1. Determining eutrophication susceptibility using physical and nutrient load data. Prepared for Envirolink Tools Project: Estuarine Trophic Index. MBIE/NIWA Contract No: C01X1420.
- Rutherford, JC, RJ Davies-Colley, JM Quinn, MJ Stroud, and AB Cooper. (1999). Stream Shade:

Towards a Restoration Strategy. Prepared for Department of Conservation. NIWA Client Report No. DOC303.
[Link](#)

Snelder T, Elliot S, Muirhead R, Fraser C (2024) Parameters for simple catchment water quality models for simulating *Escherichia coli* in New Zealand rivers. LWP Ltd, Christchurch, New Zealand.

Srinivasan MS, Muirhead RW, Singh SK, et al (2021) Development of a national-scale framework to characterise transfers of N, P and *Escherichia coli* from land to water. New Zealand Journal of Agricultural Research 64:286–313.

Whitehead, A.L., Fraser, C., Snelder, T.H. (2021). Spatial modelling of river water-quality state: Incorporating monitoring data from 2016 to 2020. NIWA Client Report 2021303CH prepared for Ministry for the Environment. NIWA, Christchurch. Attributes included

Appendix A Terms of reference



Terms of Reference

Tairāwhiti Freshwater Quality and Ecosystem Health

Expert Panel 2024/2025

Purpose, objectives and outputs

Gisborne District Council Freshwater Quality and Ecosystem Health expert panel has been established to set freshwater objectives for both the Waipaoa catchment and wider Gisborne Region catchments, as part of GDC's response to implementing the National Policy Statement for Freshwater Management (NPSFM 2020).

The **purpose** of the Freshwater Quality and Ecosystem Health Panel (the Panel) is to provide expert advice and judgement on the likely impacts to water quality and ecological indicators (i.e., sediment, nutrients, pathogens, MCI, fish) under different scenarios.

The **objectives** of the Panel are:

- Refine the assessment methodology developed by Gisborne District Council (GDC).
- Contribute as appropriate to a technical library which will include journal articles, reports, monitoring data, modelling information and any other publications relevant to the Waipaoa catchment and the wider Gisborne Regions catchments and/or which will inform the work of the Panel.
- Develop a shared understanding of the bio-physical state of surface water quality and ecology within the catchment, based on information in the technical library.
- Drawing on the technical library, evaluate different scenarios that may influence indicators of water quality and ecosystem health (primarily related to NPSFM attributes, but not limited to these).
- Produce a panel summary for each assessment unit for each of the various indicators which includes; using a set of criteria to determine the potential magnitude of change (in attribute state as per the NPSFM National Objectives Framework), the effect and level of confidence in the assessment, as well as some high-level explanatory comments.

The panel's **outputs** are intended to be high-level assessments that will be considered alongside other scientific, social, cultural and economic information to help the Freshwater Advisory and Tairāwhiti Resource Management Plan Committee(s) set freshwater objectives.

The expert panel's ultimate deliverable will be a consensus evidence paper/ report for each key issue or question. The primary objective is to create an evidential basis to support policy development (including S32 analysis).

The Panel's work will be supported by a body of existing scientific evidence and technical work conducted separately by GDC or its consultants. For example, assessing state and trends and determining baseline attribute states, especially in cases with no or limited monitoring (e.g. periphyton), has or will be undertaken by the science team through small technical reports, rather than by the expert panel.

The outputs from expert panel process will play an important role in informing decision-makers responsible for setting water quality targets, timelines, and limits. This ensures that their decisions are grounded in scientific evidence regarding what is achievable and at what cost.

A single report will be produced led by Traverse but supported by other panel members. The report will consist of three issues chapters as well as a process/methodology chapter.

Programme of Work

The overall programme of work consists of three workshops (two in person, one online) plus the associated preparation and individual assessments.

The general methodology in regard to assessing the scenarios is as follows:

1. As part of the preparation, each panel member is to individually assess each assessment unit for each of the various indicators
2. Panel members will pre-circulate their individual assessments one week before so panel members can see it before hand and then have it one document on the day
3. In the workshop, each panel member is to disclose and discuss their assessment (for the specified assessment unit and indicator)
4. The panel will then discuss and decide **by consensus** the final "panel summary" for that assessment unit and indicator (with any major disagreements being noted)
5. Steps 2-3 are to be repeated until all assessment units and indicators have been evaluated.

Full details of the methodology will be described in a document which will be presented and discussed at the first workshop. As a result, some refinements to the methodology may be made.

Responsibilities and Expectations

The Expert Panel will be coordinated by Traverse Environmental. Traverse is part of the panel of experts commissioned by GDC and has been involved in the GDC Freshwater programme since 2022.

The technical chair will be Dr Olivier Ausseil or Juliet Milne and technical meeting notes and resulting reporting will be undertaken by Dr Mark Heath and Laura Keenan. Waverley Jones will be the project coordinator and main contact for panel members.

There will be a total of six panel members and the intent is for each panel member to apply their expert knowledge to assess water quality and ecosystem health changes under different “management” scenarios.

It is expected that panel members will:

- Work in a timely manner to review appropriate information within the technical library and produce individual pre-assessments prior to the planned workshops.
- Operate without bias, prejudice or organisational agendas.
- Undertake the pre-assessments independently, using best judgement.
- Make a decision on all assessments, regardless of their level of confidence (which can be documented).
- Act professionally and respectfully towards other panel members during the workshops.
- Work together to come to a consensus decision on each of the final “panel summaries”.
 - If a panel member does not agree with a final panel summary and no resolution can be made, a note will be made expressing why there was disagreement and the workshop will progress. It is expected that disagreements will be noted with sufficient detail that each panel member can be confident in their assessments use in any consequential RMA processes.
- Stand by the process, their individual assessments and the final decisions made (excepting where disagreement has been expressed and noted as per the above and/or where further information becomes available that significantly impacts a panel member’s understanding of an issue).
- Act ethically and professionally, and conduct their practice in accordance with:
 - The New Zealand Code of Professional Standards and Ethics in Science, Technology, and the Humanities.
 - The Environment Courts Code of Conduct for Expert Witnesses.

Timeframe and Administration

The expected workshop schedule is outlined below (Table 1). Note that the exact timing of the workshops will be subject to both time and availability of panel members and critical delivery dates for the Freshwater Advisory Group and Tairāwhiti Resource Management Plan Committee(s).

Traverse Environmental will organise all workshops with support from the GDC Freshwater project team as required.

There will be a mix of in-person and online meetings, with the potential for sub-meetings as required. Ideally Gisborne will be the location in person, however alternative locations such as Auckland and Wellington will be considered based on member locations.

Table 1. Proposed workshop schedule

Date & Location	Activity	Workload
Gisborne City 7 November 2024	Workshop One – In person <ul style="list-style-type: none"> - Getting to know each other - Tairāwhiti Freshwater programme - Approve terms of reference - Discuss expert panel process - Current and baseline states - Required info, data and expectations - Q & A 	Attendance at full day workshop Preparation: Read - <ul style="list-style-type: none"> - Freshwater Information Pack - Expert Panel Terms of Reference - Memo x 2 Time: <ul style="list-style-type: none"> - 8 hours budgeted (including travel time) - \$800 budgeted for travel and accommodation
5 th December 2024	Online meeting – 1 hr <ul style="list-style-type: none"> - Discuss assessment framework template and prepare for 12 Dec workshop 	Optional (but desired) attendance on 1 hour teams call
12 th December 2024	Workshop two: Online follow up meeting - <ul style="list-style-type: none"> - Finalise process and methodology, including scenarios, questions and assessment framework- Populate technical library and share information gathered - Confirm schedule of remaining workshops 	Attendance on Teams Call (four hours – with break) Preparation: <ul style="list-style-type: none"> - Review actions from workshop one - Populating the assessment framework - Review final methodology document/ memos - Pre-circulate follow-up questions (if possible)
Individual assessments – late Feb – early March	Individual assessments Each panel member assesses scenarios and questions independently and submits them before workshop 3 (i.e., consensus workshop)	Issue 1 – 12 hours allocated Issue 2 – 12 hours allocated Issue 3 – 12 hours allocated Issue 4 – 12 hours allocated
TBA – Early May	Workshop Three – over three days, in person	Attendance at workshop (3 day)

Gisborne City (or Wellington)	Workshop to come to a joint consensus on each question. Each panel member presents their individual assessment and reasoning - Review and develop a shared understanding of the "current state" - Introduce business as usual scenarios	Time: 24 hours allocated \$800 budgeted for travel and accommodation Preparation: - Background reading of current state information
April – June 2025	Each expert panel member will review reports prepared	Time: 12 hours allocated
June – July 2025	Release Expert Panel reports	

Table 1 Proposed workshop schedule

The schedule presented in Table 1 is an indication of the likely workload, and it is estimated that the total process will involve approximately **100 hours** of work for each panel member.

Contracts and remuneration

Contracts will be entered into with each panel member, and payment for services will be on an "as-worked" basis (as per the panelist's hourly rate) and will include:

- Attendance at workshops
- Time spent on preparation and background reading
- Time spent on undertaking individual pre-assessments
- Reasonable administration time (such as communication, invoicing, organising travel, etc)
- Reimbursement of travel expenses, and food and accommodation where appropriate (ie, for multi-day workshops for panelists living outside of Tairāwhiti).

It is expected that the time spent on this expert panel process will be appropriate to the task, and in the event a panelist will exceed a total of 100 hours, they must contact the Traverse Project Coordinator (Waverley Jones) for approval prior to undertaking any further work.

Information sharing

GDC/ Traverse will provide access to a SharePoint folder where all relevant information will be filed.

Workshop agendas, prior reading and talking points will be pre-circulated one week before the scheduled workshop.

Panel Members and Key Contacts

Table 2 lists the panel members and various GDC support staff.

Person	Role	Organisation	Contact email	Phone
Dr Joanne Clapcott	Panel Member	Cawthron	Joanne.Clapcott@cawthron.org.nz	0272460517
Ned Norton	Panel Member	Land Water People	ned@landwaterpeople.co.nz	0272439546
Anna Madarasz-Smith	Panel Member	PDP	anna.madarasz-smith@pdp.co.nz	021 182 2082
Dr Richard Muirhead	Panel Member	AgResearch	richard.muirhead@agresearch.co.nz	021 589 261
Dr Andrew Neverman	Panel Member	Landcare Research	nevermana@landcareresearch.co.nz	027 268 2033
Paul Murphy	Panel Member	GDC	Paul.murphy@gdc.govt.nz	0275509008
Deb Rowland	Contracts and invoicing	GDC	Deb.rowland@gdc.govt.nz	06 869 2645
Waverley Jones	Project coordination, logistics	Traverse	waverley@traverse.co.nz	021875640
Dr Olivier Ausseil	Technical chair	Traverse	olivier@traverse.co.nz	0272277400
Juliet Milne	Technical chair	Traverse	juliet@traverse.co.nz	021 456 194
Dr Mark Heath	Technical support/ reporting	Traverse	mark@traverse.co.nz	0274646030
Laura Keenan	Technical writer/ reporting	Traverse	laura@traverse.co.nz	0211413716

Table 2 Contact details of panel members and GDC/ Traverse support staff

Conflicts of Interest

Conflicts of interest have been disclosed in the original RFP document. If there are additional conflicts to declare, panel members are expected to identify and manage any conflicts by:

- Declaring them to Deb Rowland (deb.rowland@gdc.govt.nz) and Waverley Jones (waverley@traverse.co.nz)
- Genuinely considering all options without bias, prejudice or organisational agendas
- Genuinely contributing to consensus decision-making.

Appendix B Technical Library

Electronic Appendix

Appendix C Summary tables and figures

Table 1: Metadata for the 116 Tairāwhiti monitoring sites assessed by the Panel, including monitoring programme, REC classification, substrate type, catchment size, suspended and deposited sediment classes, and periphyton productivity class. The table also indicates which sites were modelled for sediment, <i>E. coli</i> , and nutrients.	2
Table 2 Proportion of river and stream segments in each NPS-FM ammoniacal nitrogen attribute band	8
Table 3: Proportion of river and stream segments in each NPS-FM nitrate-nitrogen attribute band.....	8
Table 4: Proportion of river and stream segments in each NPS-FM DRP attribute band.....	9
Table 5: Proportion of river and stream segments in each NPS-FM Suspended Fine Sediment (SFS) attribute band, by suspended fine sediment class	9
Table 6:Proportion of river and stream segments in each NPS-FM macroinvertebrate (MCI only) attribute band	10
Table 7: Proportion of river and stream segments in each dissolved inorganic nitrogen (DIN, assumed equal to nitrate-nitrite nitrogen [NNN]) and total nitrogen (TN) concentration bin: 0–0.1 mg/L, 0.1–0.25 mg/L, 0.25–0.5 mg/L, and >0.5 mg/L.....	11
Table 8: Proportion of river and stream segments in each total phosphorus (TN) concentration bin: 0–0.06 mg/L, 0.06–0.15 mg/L, 0.15–0.3 mg/L, and >0.3 mg/L.	12
Table 9: Visual clarity NPS-FM attribute current state, associated confidence score, and scenario state estimates.	13
Table 10: Dissolved reactive phosphorus current NPS-FM attribute state, associated confidence score, and modeled scenario estimates of future state and load reductions. All concentrations are in mg/L.	25
Table 11: Dissolved inorganic nitrogen current numeric state, associated confidence score, and modeled scenario estimates of future state and load reductions. All concentrations are in mg/L.	36
Table 12: <i>E. coli</i> current median NPS-FM attribute state, associated confidence score, and scenario state estimates. All concentrations are in cfu/100 mL.	47
Table 13: Macroinvertebrate current NPS-FM attribute state (MCI only), associated confidence score, and scenario state estimates.	58
Table 14: Deposited fine sediment current NPS-FM attribute state, associated confidence score, and scenario state estimates.	64

C.1 Site metadata

Table 1: Metadata for the 116 Tairāwhiti monitoring sites assessed by the Panel, including monitoring programme, REC classification, substrate type, catchment size, suspended and deposited sediment classes, and periphyton productivity class. The table also indicates which sites were modelled for sediment, E. coli, and nutrients.

Planni ng area	Sites	Water qualit y	Mac roinve rtebra te	Perip hyton	Recre ation al (Fres hwate r)	DO (high frequ ency)	Temp eratur e (high frequ ency)	Sedi ment mode l	E. coli mode l	Nutri ent mode l	Strea m order	Catch ment area (ha)	REC	Hard/ Soft botto m	Depo sited sedi ment class	Susp ende d sedi ment class	Prod uctiv e river perip hyton
Te Arai	Te Arai River Bush Intake Above Weir	-	✓	-	-	-	✓	✓	✓	✓	3	1,127	CW/H/SS	Hard	4	1	✓
	Te Arai River at Pykes Weir	✓	✓	✓	-	-	✓	-	✓	✓	4	8,611	WW/L/SS	Hard	3	2	-
	Te Arai Rv at Waingake	-	✓	-	-	-	-	-	✓	✓	1	113	WW/L/SS	Hard	3	2	-
	Te Arai Trib at Waingake Rd	-	✓	-	-	-	-	-	✓	✓	3	394	WW/L/SS	Hard	3	2	-
	Te Arai Trib at Waugh Rd	-	✓	-	-	-	-	-	✓	✓	2	461	WW/L/SS	Hard	3	2	-
	Waipaoa Trib at Pipihakao Road	-	✓	-	-	-	✓	-	✓	✓	3	1,219	WD/L/SS	Soft	Soft	2	-
	Te Arai Trib Below Intake Weir	-	✓	-	-	-	-	-	✓	✓	2	383	WW/L/SS	Hard	3	2	-
Hill Countr y	Waimata River at Anzac Park	-	-	-	✓	-	-	-	✓	✓	5	22,757	WW/L/SS	Hard	3	2	-
	Mangatu River at Omapere Station	✓	✓	✓	-	-	✓	✓	✓	✓	5	18,358	CW/H/SS	Hard	4	1	✓
	Urukamuka Stream	-	-	-	✓	-	-	-	✓	✓	4	3,477	CW/H/SS	Hard	4	1	-
	Waihirere Str at Domain	✓	✓	✓	-	-	✓	-	✓	✓	2	345	WW/L/SS	Hard	3	2	-
	Waipaoa at Armstrong Rd	-	✓	-	-	-	-	✓	✓	✓	6	17,691	CW/H/HS	Hard	4	3	✓
	Parihihonou Str at SH2 Overbridge	-	✓	-	-	-	-	-	✓	✓	3	1,011	CW/H/SS	Hard	4	1	-
	Waihuka River at No3 Br	-	✓	-	-	-	-	✓	✓	✓	4	8,068	CW/L/SS	Hard	2	4	✓
	Kurunui Str at Holdsworth Br SH2	-	✓	-	-	-	-	-	✓	✓	3	1,624	WD/L/SS	Soft	Soft	2	-
	Waikohu River at Mahaki Station	✓	✓	✓	-	-	✓	✓	✓	✓	5	14,637	CW/H/SS	Hard	4	1	✓
	Waikohu Rv at Oliver Rd	-	✓	-	-	-	-	✓	✓	✓	4	3,983	CW/H/SS	Hard	4	1	✓
	Waingaromia River at Terrace Station	✓	✓	✓	-	✓	✓	✓	✓	✓	5	17,465	WW/L/SS	Hard	3	2	✓

Planni ng area	Sites	Water qualit y	Macr oinve rtebra te	Perip hyton	Recre ation al (Fres hwate r)	DO (high frequ ency)	Temp eratur e (high frequ ency)	Sedi ment mode l	E. coli mode l	Nutri ent mode l	Strea m order	Catch ment area (ha)	REC	Hard/ Soft botto m	Depo sited sedi ment class	Susp ende d sedi ment class	Prod uctiv e river perip hyton
	Rere falls	-	-	-	✓	-	-	-	✓	✓	5	11,978	CW/H/SS	Hard	4	1	-
	Rere rockslide (top)	-	-	-	✓	-	-	-	✓	✓	4	7,765	CW/H/SS	Hard	4	1	-
	Waihuka at No2 Br	-	✓	-	-	-	-	✓	✓	✓	1	29	WD/L/SS	Hard	Soft	2	✓
	Wharekopae River at Rangimoe	✓	✓	✓	-	-	✓	✓	✓	✓	6	17,699	CW/H/SS	Hard	4	1	✓
	Wharekopae above falls	-	✓	-	-	-	-	✓	✓	✓	3	2,168	CW/H/SS	Hard	4	1	✓
	Mangaoai Str at Mangaoai Rd	-	✓	-	-	-	-	✓	✓	✓	4	3,942	WW/L/SS	Hard	3	2	✓
	Waikohu Trib at Whakarau Rd	-	✓	-	-	-	-	-	✓	✓	2	350	WD/L/SS	Soft	Soft	2	-
	Mangatu Trib	-	✓	-	-	-	-	-	✓	✓	2	189	CW/H/HS	Hard	4	3	-
Poverty Bay Flats	Waipaoa River at Matawhero Bridge	✓	✓	✓	-	-	-	✓	✓	✓	7	192,955	WW/L/SS	Hard	3	2	✓
	Waipaoa River at Railway Bridge	✓	-	-	-	-	-	✓	✓	✓	7	24	WW/L/SS	Hard	3	2	✓
	Taruheru River at Tuckers Rd Bridge	✓	✓	-	-	✓	✓	✓	✓	✓	4	4,124	WD/L/SS	Soft	Soft	2	✓
	Whakaahu Str at Brunton Rd	✓	-	-	-	-	✓	✓	✓	✓	5	11,496	WD/L/SS	Soft	Soft	2	✓
	Waikohu River at No3 Br	-	✓	-	-	-	-	✓	✓	✓	6	59,853	WW/L/SS	Hard	3	2	✓
	Waipaoa Trib at Lavenham-Humphrey Rd	-	✓	-	-	-	✓	-	✓	✓	3	1,235	WD/L/SS	Soft	Soft	2	-
	Waikakariki Trib at Quarry	-	✓	-	-	-	-	-	✓	✓	3	440	WD/L/SS	Soft	Soft	2	-
	Turanganui River at Gladstone Rd Bridge	✓	-	-	✓	-	-	✓	✓	✓	5	8,714	WW/L/SS	Soft	3	2	✓
	Turanganui River at The Cut	✓	-	-	-	-	-	✓	✓	✓	3	753	WD/L/AI	Hard	Soft	1	✓
Urban	Waipaoa River at Kanakanaia	✓	✓	✓	✓	-	-	✓	✓	✓	1	157,897	WD/L/SS	Hard	Soft	2	✓
	Awapuni Drain Site 6 U/S Of Rayonier at Fenceline	✓	-	-	-	-	-	-	✓	✓	3	863	WD/L/AI	Soft	Soft	1	-
	Taruheru River at Lytton Rd Bridge	✓	-	-	-	-	-	✓	✓	✓	4	7,824	WD/L/SS	Soft	Soft	2	✓
	Taruheru River at Peel St Bridge	✓	-	-	-	-	-	✓	✓	✓	4	8,714	WD/L/SS	Soft	Soft	2	✓

Planni ng area	Sites	Water qualit y	Macr oinve rtebra te	Perip hyton	Recre ation al (Fres hwate r)	DO (high frequ ency)	Temp eratur e (high frequ ency)	Sedi ment mode l	E. coli mode l	Nutri ent mode l	Strea m order	Catch ment area (ha)	REC	Hard/ Soft botto m	Depo sited sedi ment class	Susp ende d sedi ment class	Prod uctiv e river perip hyton
	Taruhuru River at Wi Pere Pipe	✓	-	-	-	-	-	✓	✓	✓	4	8,565	WD/L/ SS	Soft	Soft	2	✓
	Waikanae Creek at Grey St Bridge	✓	-	-	-	-	-	-	✓	✓	3	753	WD/L/ AI	Soft	Soft	1	-
	Waikanae Creek at Stanley Rd Bridge	✓	-	-	-	-	✓	-	✓	✓	2	105	WD/L/ AI	Soft	Soft	1	-
	Sisterson Drain Site 1at Wetland Inflow Point	✓	✓	-	-	-	✓	-	✓	✓	1	62	WD/L/ AI	Hard	Soft	1	-
Hangar oa - Ruakitu ri	Hangaroa River at Donneraillie Park	✓	✓	-	✓	✓	✓	-	✓	✓	6	60,063	CW/H /SS	Hard	4	1	-
	Hauptapa Str at Tahora Settlement Rd	-	✓	-	-	-	-	-	✓	✓	3	1,430	CW/H /NA	Hard	2	1	-
	Mangaotara Str at Tiniroto Rd	-	✓	-	-	-	-	✓	✓	✓	4	2,496	WW/L /SS	Hard	3	2	✓
	Papokeka Str at Pehiri	-	✓	-	-	-	-	-	✓	✓	3	912	CW/H /SS	Hard	4	1	-
	Hangaroa River at Waimaha Station	-	✓	-	-	✓	✓	-	✓	✓	6	19,595	CW/H /NA	Hard	2	1	-
	Maraetaha Str at No2 Br	-	✓	-	-	✓	✓	✓	✓	✓	4	4,364	WW/L /SS	Soft	3	2	✓
	Wherowhero Lagoon at Muriwai	-	-	-	✓	-	-	-	✓	✓	3	1,971	WD/L/ SS	Hard	Soft	2	-
	Mangapoike Trib at Rabbit Road Pump Station	-	✓	-	-	-	-	-	✓	✓	2	224	CW/H /SS	Soft	4	1	-
Moutu	Koranga Rv at Koranga Valley Rd	-	✓	-	-	-	-	✓	✓	✓	4	1,906	CW/H /NA	Hard	2	1	✓
	Koranga Trib at Rakauaroa Rd	-	✓	-	-	-	-	-	✓	✓	2	105	CW/H /NA	Hard	2	1	-
	Marumoko Str at Marumoko Rd	-	✓	-	-	-	-	-	✓	✓	2	539	CW/H /HS	Hard	4	3	-
	Matawai Stream at Tawai	✓	✓	✓	-	✓	✓	-	✓	✓	2	220	CW/H /SS	Hard	4	1	-
	Motu River above Falls	✓	-	✓	-	✓	✓	✓	✓	✓	5	24,762	CW/H /SS	Hard	4	1	✓
	Motu River at Kotare Station Bridge	✓	✓	✓	-	✓	✓	✓	✓	✓	5	8,685	CW/H /NA	Hard	2	1	✓
	Motu River at Matawai Conservation Area	✓	✓	✓	-	✓	✓	✓	✓	✓	4	1,731	CW/H /SS	Hard	4	1	✓
	Upper Motu Trib at Mangatu	-	✓	-	-	✓	✓	-	✓	✓	1	26	CW/H /HS	Hard	4	3	-
	Whakarau Trib at Whakarau Rd	-	✓	-	-	✓	✓	-	✓	✓	2	91	CW/H /SS	Hard	4	1	-

Planni ng area	Sites	Water qualit y	Macr oinve rtebra te	Perip hyton	Recre ation al (Fres hwate r)	DO (high frequ ency)	Temp eratur e (high frequ ency)	Sedi ment mode l	E. coli mode l	Nutri ent mode l	Strea m order	Catch ment area (ha)	REC	Hard/ Soft botto m	Depo sited sedi ment class	Susp ende d sedi ment class	Prod uctiv e river perip hyton
Uawa	Hikuwai River at Willowflat	✓	-	✓	-	✓	✓	✓	✓	✓	6	30,833	WW/L/SS	Hard	3	2	✓
	Mangaheia River at Paroa Road Bridge	✓	-	✓	-	✓	✓	✓	✓	✓	5	8,405	WW/L/SS	Hard	3	2	✓
	Mangakino Str at Mangatokerau Rd	-	✓	-	-	-	-	-	✓	✓	2	361	WW/L/SS	Soft	3	2	-
	Mangahauini River at Tokomaru Bay	-	-	-	✓	-	-	-	✓	✓	3	2,569	WW/L/SS	Hard	3	2	-
	Anaura Bay Nth Lagoon	-	-	-	✓	-	-	-	✓	✓	3	304	WW/L/SS	Hard	3	2	-
	Hikuwai River at No 4 Bridge	-	✓	-	-	-	-	✓	✓	✓	6	23,832	WW/L/SS	Hard	3	2	✓
	Waiau River at Tauwhareparae	-	✓	-	-	-	-	✓	✓	✓	5	4,379	WW/H/SS	Hard	3	2	✓
	Uawa River at SH35 Bridge	-	-	-	✓	-	✓	-	✓	✓	6	53,980	WW/L/SS	Hard	3	2	-
	Waiotu Str at Waiotu Rd Bridge	-	-	-	✓	-	-	-	✓	✓	3	826	WW/L/SS	Hard	3	2	-
	Makokomuka Str at Waiapu Rd	-	✓	-	-	-	-	-	✓	✓	2	152	WW/L/SS	Hard	3	2	-
Waiapu	Karoronui Str at Anaura Bay Rd	-	✓	-	-	-	-	-	✓	✓	2	114	WW/L/SS	Hard	3	2	-
	Waitekaha Str at Tuparoa Rd	-	✓	-	-	-	-	-	✓	✓	3	590	WW/L/HS	Hard	2	2	-
	Ihungia River at Ihungia Rd Br	✓	✓	✓	-	✓	✓	✓	✓	✓	5	4,491	WW/L/SS	Hard	3	2	✓
	Kouetumara Str at Ihungia Rd	-	✓	-	-	-	-	-	✓	✓	2	354	WW/L/SS	Hard	3	2	-
	Makarika Str at Makarika Br	-	-	-	✓	-	-	-	✓	✓	4	7,428	WW/L/HS	Hard	2	2	-
	Mangaokura Stream	-	✓	-	-	-	-	✓	✓	✓	4	-	CW/M/HS	Hard	4	1	✓
	Mangaoparo River at Mangaoparo Road	-	✓	-	-	-	-	✓	✓	✓	4	4,053	CW/H/HS	Hard	4	3	✓
	Mangaoporo River at Tutumatai Bridge	✓	✓	✓	-	✓	✓	✓	✓	✓	4	6,629	WW/H/HS	Hard	4	2	✓
	Mata River at Aorangi (Makarika Road)	✓	-	✓	-	-	-	✓	✓	✓	1	82,613	WW/L/AI	Hard	Soft	2	✓
	Mata River at Pouturu Br	✓	✓	✓	-	✓	✓	✓	✓	✓	5	36,679	WW/L/SS	Hard	3	2	✓
	Mata Upper	-	✓	-	-	-	-	-	✓	✓	3	355	CW/M/HS	Hard	4	1	-

Planni ng area	Sites	Water qualit y	Macr oinve rtebra te	Perip hyton	Recre ation al (Fres hwate r)	DO (high frequ ency)	Temp eratur e (high frequ ency)	Sedi ment mode l	E. coli mode l	Nutri ent mode l	Strea m order	Catch ment area (ha)	REC	Hard/ Soft botto m	Depo sited sedi ment class	Susp ende d sedi ment class	Prod uctiv e perip hyton
	Poroporo River at Rangitukia Rd Bridge	✓	✓	✓	-	✓	✓	✓	✓	✓	4	6,838	WW/L /SS	Hard	3	2	✓
	Ratahi Lagoon at Sh35 Culvert	✓	-	-	-	-	-	-	✓	✓	1	81	WW/L /HS	Hard	2	2	-
	Tapuaeroa River at Tapuaeroa Rd	✓	-	✓	-	-	-	✓	✓	✓	2	441	WW/L /HS	Hard	2	2	✓
	Waiapu River at Rotokautuku Br (SH35)	✓	✓	✓	✓	-	✓	✓	✓	✓	6	137,982	CW/H /HS	Hard	4	3	✓
	Waipiro Str at Te Puia	-	✓	-	-	-	-	-	✓	✓	3	1,358	WW/L /SS	Hard	3	2	-
	Makarika Str at Keelan Rd	-	✓	-	-	-	-	✓	✓	✓	4	5,752	WW/L /HS	Hard	2	2	✓
	Huitatariki Str	-	✓	-	-	-	-	-	✓	✓	3	1,044	CW/H /HS	Hard	4	3	-
Waimat a	Hamanatua Stream at Okitu Bridge	✓	-	-	✓	-	-	-	✓	✓	3	874	WW/L /SS	Hard	3	2	-
	Kopuawhakatapa Stream at Hirini St	✓	-	-	-	-	-	-	✓	✓	1	208	WD/L/ SS	Hard	Soft	2	-
	Pakarae River at Pakarae Station Bridge	✓	-	✓	-	-	-	✓	✓	✓	5	23,425	WW/L /SS	Hard	3	2	✓
	Pakarae Trib at Whangara Rd	-	✓	-	-	-	-	-	✓	✓	2	348	WW/L /SS	Hard	3	2	-
	Pakarae trib Stevens Road	-	✓	-	-	-	-	-	✓	✓	3	342	WW/L /SS	Hard	3	2	-
	Whakauranga Br at West Ho Rd	-	✓	-	-	-	✓	✓	✓	✓	4	2,756	WW/L /SS	Hard	3	2	✓
	Waimata River at Goodwins Rd Bridge	✓	✓	✓	-	✓	✓	✓	✓	✓	2	260	WW/L /SS	Hard	3	2	✓
	Waimata River at Grant Rd	✓	-	-	-	-	-	✓	✓	✓	5	22,594	WW/L /SS	Hard	3	2	✓
	Waimata River at Monowai Bridge	✓	✓	✓	-	✓	✓	✓	✓	✓	5	10,570	WW/L /SS	Hard	3	2	✓
	Wainui Stream at Pare Street	✓	-	-	-	-	-	-	✓	✓	2	563	WD/L/ SS	Hard	Soft	2	-
	Hamanatua River at Williamson street	-	✓	-	-	-	-	-	✓	✓	3	874	WW/L /SS	Hard	3	2	-
	Turihaua Stream at Turihaua Station	✓	✓	-	-	-	✓	-	✓	✓	4	2,300	WW/L /SS	Soft	3	2	-
	Pouawa Rv at Christopher Rd Br	-	✓	-	-	-	-	-	✓	✓	4	3,311	WW/L /SS	Hard	3	2	-
	Waiomoko River at Andrews Rd Bridge	-	✓	-	-	-	-	-	✓	✓	4	6,005	WW/L /SS	Hard	3	2	-

Planni ng area	Sites	Water qualit y	Macr oinve rtebra te	Perip hyton	Recre ation al (Fres hwate r)	DO (high frequ ency)	Temp eratur e (high frequ ency)	Sedi ment mode l	E. coli mode l	Nutri ent mode l	Strea m order	Catch ment area (ha)	REC	Hard/ Soft botto m	Depo sited sedi ment class	Susp ende d sedi ment class	Prod uctiv e river perip hyton
	Sponge Bay Beach CHNES005	-	-	-	✓	-	-	-	✓	✓	2	30	WD/L/ SS	Hard	Soft	2	-
	Turihaua Bridge at D/S SH35 Bridge	-	-	-	✓	-	-	-	✓	✓	4	2,642	WW/L /SS	Soft	3	2	-
	Wainui Str at Heath Johnston Park	-	✓	-	-	-	✓	-	✓	✓	1	230	WD/L/ SS	Hard	Soft	2	-
	Makahakaha Stream	-	✓	-	-	-	-	-	✓	✓	5	881	WW/L /SS	Hard	3	2	-
	Waiomoko River at SH35 Bridge	-	✓	-	-	-	-	-	✓	✓	2	542	WW/L /SS	Hard	3	2	-
Wharek ahika - Waikur a	Awatere River at SH35 Bridge	✓	✓	✓	-	-	-	✓	✓	✓	5	13,267	WW/L /HS	Hard	2	2	✓
	Kopuapunamu Str Trib at Te Araroa	-	✓	-	-	-	-	-	✓	✓	1	120	WW/L /SS	Hard	3	2	-
	Karakatuwhero River at SH35 Br	✓	✓	✓	✓	-	✓	✓	✓	✓	4	7,921	WW/ H/VA	Hard	4	1	✓
	Karakatuwhero Trib at Karakatuwhero Rd	-	✓	-	-	-	-	-	✓	✓	3	354	WW/L /SS	Hard	3	2	-
	Lottin Point Road Stream	-	✓	-	-	-	-	-	✓	✓	2	160	WW/L /VA	Hard	2	1	-
	Mangatutu Str at Sh35-Waipahuru Bridge	✓	✓	✓	-	-	-	-	✓	✓	3	1,370	WW/ H/VA	Hard	4	1	-
	Oweka River at SH35 Bridge	✓	✓	✓	-	-	✓	✓	✓	✓	4	3,942	WW/L /SS	Hard	3	2	✓
	Wharekahika River U/S of Wharf Bridge	✓	✓	✓	✓	-	-	✓	✓	✓	5	14,986	WW/L /SS	Hard	3	2	✓
	Whangaparoa Trib at Waikura Road	-	✓	-	-	-	-	-	✓	✓	4	14,717	WW/L /SS	Hard	3	2	-

C.2 National-scale model estimates of NPS-FM attribute state and/or concentrations for each stream segment for the Tairāwhiti region.

Table 2 Proportion of river and stream segments in each NPS-FM ammoniacal nitrogen attribute band

Planning area	Percentage of segments in each concentration bin			
	Band A	Band B	Band C	Band D
Te Arai	99.8%	0.2%	0.0%	0.0%
Hill Country	100.0%	0.0%	0.0%	0.0%
Poverty Bay Flats	96.2%	3.8%	0.0%	0.0%
Urban	42.2%	57.8%	0.0%	0.0%
Hangaroa - Ruakituri	99.8%	0.2%	0.0%	0.0%
Motu	100.0%	0.0%	0.0%	0.0%
Uawa	99.9%	0.1%	0.0%	0.0%
Waiapu	100.0%	0.0%	0.0%	0.0%
Waimata	99.3%	0.7%	0.0%	0.0%
Wharekahika - Waikura	99.9%	0.1%	0.0%	0.0%

Table 3: Proportion of river and stream segments in each NPS-FM nitrate-nitrogen attribute band

Planning area	Percentage of segments in each concentration bin			
	Band A	Band B	Band C	Band D
Te Arai	100%	0%	0%	0%
Hill Country	100%	0%	0%	0%
Poverty Bay Flats	100%	0%	0%	0%
Urban	100%	0%	0%	0%
Hangaroa - Ruakituri	100%	0%	0%	0%
Motu	100%	0%	0%	0%
Uawa	100%	0%	0%	0%
Waiapu	100%	0%	0%	0%
Waimata	100%	0%	0%	0%
Wharekahika - Waikura	100%	0%	0%	0%

Table 4: Proportion of river and stream segments in each NPS-FM DRP attribute band

Planning area	Percentage of segments in each concentration bin			
	Band A	Band B	Band C	Band D
Te Arai	0.3%	28.2%	32.0%	39.5%
Hill Country	0.3%	26.4%	39.6%	33.8%
Poverty Bay Flats	0.4%	10.8%	17.1%	71.7%
Urban	0.0%	0.0%	4.8%	95.2%
Hangaroa - Ruakituri	8.7%	27.7%	45.1%	18.5%
Motu	3.9%	51.4%	42.4%	2.3%
Uawa	1.2%	51.2%	33.0%	14.6%
Waiapu	10.7%	66.0%	18.5%	4.7%
Waimata	0.0%	12.2%	47.2%	40.6%
Wharekahika - Waikura	3.4%	63.1%	31.8%	1.7%

Table 5: Proportion of river and stream segments in each NPS-FM Suspended Fine Sediment (SFS) attribute band, by suspended fine sediment class

Planning area	SFS Class	Percentage of segments in each concentration bin			
		Band A	Band B	Band C	Band D
Te Arai	1	65%	13%	21%	1%
	2	100.0%	0.0%	0.0%	0.0%
	3	-	-	-	-
	4	100.0%	0.0%	0.0%	0.0%
Hill Country	1	73%	23%	4%	1%
	2	99.7%	0.1%	0.0%	0.3%
	3	0.7%	13.9%	54.8%	30.5%
	4	91.7%	3.3%	5.0%	0.0%
Poverty Bay Flats	1	0%	37%	58%	5%
	2	85.9%	1.6%	1.4%	11.0%
	3	-	-	-	-
	4	0.0%	11.1%	66.7%	22.2%
Urban	1	0%	45%	43%	13%
	2	100.0%	0.0%	0.0%	0.0%
	3	-	-	-	-
	4	-	-	-	-
Hangaroa - Ruakituri	1	82%	13%	2%	3%
	2	100.0%	0.0%	0.0%	0.0%
	3	100.0%	0.0%	0.0%	0.0%

Planning area	SFS Class	Percentage of segments in each concentration bin			
		Band A	Band B	Band C	Band D
	4	100.0%	0.0%	0.0%	0.0%
Motu	1	96%	4%	0%	0%
	2	100.0%	0.0%	0.0%	0.0%
	3	46.8%	23.0%	18.5%	11.7%
	4	-	-	-	-
Uawa	1	83%	13%	5%	0%
	2	100.0%	0.0%	0.0%	0.0%
	3	-	-	-	-
	4	-	-	-	-
Waiapu	1	94%	5%	1%	1%
	2	100.0%	0.0%	0.0%	0.0%
	3	23.5%	24.4%	24.6%	27.5%
	4	-	-	-	-
Waimata	1	39%	20%	35%	6%
	2	100.0%	0.0%	0.0%	0.0%
	3	-	-	-	-
	4	-	-	-	-
Wharekahika - Waikura	1	79%	14%	6%	2%
	2	100.0%	0.0%	0.0%	0.0%
	3	35.4%	40.8%	22.3%	1.6%
	4	-	-	-	-

Table 6: Proportion of river and stream segments in each NPS-FM macroinvertebrate (MCI only) attribute band

Planning area	Percentage of segments in each concentration bin			
	Band A	Band B	Band C	Band D
Te Arai	0.0%	10.1%	64.6%	25.3%
Hill Country	0.0%	13.2%	75.0%	11.8%
Poverty Bay Flats	0.0%	0.0%	16.8%	83.2%
Urban	0.0%	0.0%	3.6%	96.4%
Hangaroa - Ruakituri	11.7%	16.2%	69.0%	3.1%
Motu	18.9%	56.5%	24.6%	0.0%
Uawa	0.0%	9.4%	71.9%	18.7%
Waiapu	6.2%	35.0%	57.1%	1.7%
Waimata	0.0%	4.7%	62.4%	32.9%
Wharekahika - Waikura	4.0%	50.3%	43.1%	2.7%

Table 7: Proportion of river and stream segments in each dissolved inorganic nitrogen (DIN, assumed equal to nitrate-nitrite nitrogen [NNN]) and total nitrogen (TN) concentration bin: 0–0.1 mg/L, 0.1–0.25 mg/L, 0.25–0.5 mg/L, and >0.5 mg/L.

Planning area	Percentage of segments in each concentration bin				
	Nitrogen type	0 to 0.1 mg/L	0.1 to 0.25 mg/l	0.25 to 0.5 mg/L	>0.5 mg/L
Te Arai	DIN (NNN)	81%	15%	4%	0.3%
	TN	0.0%	13.9%	42.8%	43.3%
Hill Country	DIN (NNN)	62%	37%	2%	0.0%
	TN	0.0%	17.2%	43.7%	39.1%
Poverty Bay Flats	DIN (NNN)	41%	47%	11%	0.7%
	TN	0.0%	3.4%	28.5%	68.1%
Urban	DIN (NNN)	33%	18%	45%	4.8%
	TN	0.0%	0.0%	2.4%	97.6%
Hangaroa - Ruakituri	DIN (NNN)	67%	33%	0%	0.0%
	TN	0.1%	25.4%	41.6%	32.9%
Motu	DIN (NNN)	72%	25%	3%	0.0%
	TN	5.5%	58.7%	22.5%	13.3%
Uawa	DIN (NNN)	91%	9%	0%	0.0%
	TN	0.0%	34.1%	50.5%	15.4%
Waiapu	DIN (NNN)	87%	13%	0%	0.0%
	TN	12.8%	47.0%	30.9%	9.3%
Waimata	DIN (NNN)	90%	10%	0%	0.1%
	TN	0.0%	6.3%	49.9%	43.7%
Wharekahika - Waikura	DIN (NNN)	94%	6%	0%	0.0%
	TN	9.5%	70.1%	16.5%	3.9%

Table 8: Proportion of river and stream segments in each total phosphorus (TN) concentration bin: 0–0.06 mg/L, 0.06–0.15 mg/L, 0.15–0.3 mg/L, and >0.3 mg/L.

Planning area	Percentage of segments in each concentration bin			
	0 to 0.06 mg/L	0.06 to 0.15 mg/l	0.15 to 0.3 mg/L	>0.3 mg/L
Te Arai	85.9%	14.1%	0.0%	0.0%
Hill Country	96.7%	3.3%	0.0%	0.0%
Poverty Bay Flats	55.7%	44.0%	0.2%	0.2%
Urban	34.9%	47.0%	10.8%	7.2%
Hangaroa - Ruakituri	98.1%	1.9%	0.0%	0.0%
Motu	100.0%	0.0%	0.0%	0.0%
Uawa	94.4%	5.6%	0.0%	0.0%
Waiapu	98.8%	1.2%	0.0%	0.0%
Waimata	90.1%	9.4%	0.5%	0.0%
Wharekahika - Waikura	99.9%	0.1%	0.0%	0.0%

C.3 Expert Panel current state and scenario predictions

Table 9: Visual clarity NPS-FM attribute current state, associated confidence score, and scenario state estimates.

Planning area	Site	Metric	Current state			Scenario estimates			
			Visual clarity (m)	State	Confidence	Afforestation	Modelled 2040	Modelled 2060	Modelled 2080
Te Arai	Te Arai River Bush Intake Above Weir	Median	3.0	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	75%	5%	18%	35%
	Te Arai River at Pykes Weir	Median	0.9	B	Medium - measured clarity uncertainty, near band threshold.	-	-	-	-
		% load	-	-	-	-	-	-	-
	Te Arai Rv at Waingake	Median	1.7	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Te Arai Trib at Waingake Rd	Median	1.7	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Te Arai Trib at Waugh Rd	Median	1.4	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Waipaoa Trib at Pipiwhakao Road	Median	1.4	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
Hill Country	Waimata River at Anzac Park	Median	0.4	D	Low (Estimated) - all upstream Waimata sites are D band	-	-	-	-
		% load	-	-	-	-	-	-	-
	Mangatu River at Omapere Station	Median	0.1	D	High	D	D	D	D
		% load	-	-	-	69%	10%	27%	41%

Planning area	Site	Metric	Current state			Scenario estimates			
			Visual clarity (m)	State	Confidence	Afforestation	Modelled 2040	Modelled 2060	Modelled 2080
	Urukokamuka Stream	Median	1.7	B	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Waihirere Str at Domain	Median	1.1	A	High	-	-	-	-
		% load	-	-	-	-	-	-	-
	Waipaoa at Armstrong Rd	Median		D	Low (Model) - local data missing from training data. Seems like a high numeric state for the Waipaoa.	-	-	-	-
		% load	-	-	-	55%	6%	23%	40%
	Parihihonou Str at SH2 Overbridge	Median	1.7	B	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Waihuka River at No3 Br	Median	1.6	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	85%	6%	20%	38%
	Kurunui Str at Holdsworth Br SH2	Median	1.5	A	Low (Model) - local data missing from training data	-	-	-	-
		Median	-	-	-	-	-	-	-
	Waikohu River at Mahaki Station	% load	0.8	D	Medium - measured clarity uncertainty	A	D	D	D
		Median	-	-	-	86%	6%	21%	40%
	Waikohu Rv at Oliver Rd	% load	0.8	D	Low (Estimated) -upstream measured Waikohu site is D band 0.8m	-	-	-	-
		Median	-	-	-	84%	5%	17%	35%
	Waingaromia River at Terrace Station	% load	0.2	D	High	C	D	D	D
		Median	-	-	-	78%	9%	35%	59%
	Rere falls	% load	1.6	B	Low (Model) - local data missing from training data. Wharaekopae at Rangimoe downstream has a much lower measured clarity than modelled.	-	-	-	-
		Median	-	-	-	-	-	-	-

Planning area	Site	Metric	Current state			Scenario estimates			
			Visual clarity (m)	State	Confidence	Afforestation	Modelled 2040	Modelled 2060	Modelled 2080
Poverty Bay Flats	Rere rockslide (top)	% load	1.6	B	Low (Model) - local data missing from training data. Wharaekopae at Rangimoe downstream has a much lower measured clarity than modelled.	-	-	-	-
		Median	-	-	-	-	-	-	-
	Waihuka at No2 Br	% load	1.6	A	Low (Model) - local data missing from training data	-	-	-	-
		Median	-	-	-	85%	5%	20%	38%
	Wharekopae River at Rangimoe	% load	0.7	D	Medium - measured clarity uncertainty	A	D	D	D
		Median	-	-	-	79%	6%	20%	36%
	Wharekopae above falls	Median	1.6	B	Low (Model) - local data missing from training data. Wharaekopae at Rangimoe downstream has a much lower measured clarity than modelled.	-	-	-	-
		% load	-	-	-	82%	6%	20%	38%
	Waipaoa River at Kanakanaia	Median	0.1	D	High	D	D	D	D
		% load	-	-	-	69%	7%	26%	45%
	Mangaoai Str at Mangaoai Rd	Median	1.8	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	37%	1%	10%	21%
	Waikohu Trib at Whakarau Rd	Median	0.8	B	Low (Estimated) -upstream measured Waikohu site is D band	-	-	-	-
		% load	-	-	-	-	-	-	-
	Mangatu Trib	Median	2.2	D	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
Poverty Bay Flats	Waipaoa River at Matawhero Bridge	Median	0.1	D	Medium - measured clarity uncertainty	D	D	D	D
		% load	-	-	-	70%	7%	26%	45%
		Median	0.2	D	Medium - measured clarity uncertainty	D	D	D	D

Planning area	Site	Metric	Current state			Scenario estimates			
			Visual clarity (m)	State	Confidence	Afforestation	Modelled 2040	Modelled 2060	Modelled 2080
	Waipaoa River at Railway Bridge	% load	-	-	-	70%	7%	25%	44%
	Taruhuru River at Tuckers Rd Bridge	Median	0.4	D	Medium - measured clarity uncertainty	A	D	D	D
		% load	-	-	-	82%	5%	18%	34%
	Whakaahu Str at Brunton Rd	Median	0.6	D	Medium - measured clarity uncertainty, near band threshold.	A	D	B	A
		% load	-	-	-	86%	4%	32%	61%
	Waikohu River at No3 Br	Median	0.8	B	Low (Estimated) -upstream measured Waikohu site is D band	-	-	-	-
		% load	-	-	-	85%	6%	20%	39%
	Waipaoa Trib at Lavenham-Humphrey Rd	Median		D	Low (estimated) - measured sites in PBF and urban FMUs are low clarity and D band	-	-	-	-
		% load	-	-	-	-	-	-	-
	Waikakariki Trib at Quarry	Median		D	Low (estimated) - measured sites in PBF and urban FMUs are low clarity and D band	-	-	-	-
		% load	-	-	-	-	-	-	-
	Turanganui River at Gladstone Rd Bridge	Median	0.4	D	Medium - measured clarity uncertainty	A	D	D	D
		% load	-	-	-	82%	6%	20%	37%
	Turanganui River at The Cut	Median	0.3	D	Low (Model) - local data missing from training data	A	D	D	D
		% load	-	-	-	82%	6%	20%	37%
Urban	Awapuni Drain Site 6 U/S Of Rayonier at Fenceline	Median	0.3	D	Medium - measured clarity uncertainty	-	-	-	-
		% load	-	-	-	-	-	-	-
	Taruhuru River at Lytton Rd Bridge	Median	0.3	D	Medium - measured clarity uncertainty	A	D	D	D
		% load	-	-	-	81%	5%	17%	33%

Planning area	Site	Metric	Current state			Scenario estimates			
			Visual clarity (m)	State	Confidence	Afforestation	Modelled 2040	Modelled 2060	Modelled 2080
	Taruhuru River at Peel St Bridge	Median	0.4	D	Medium - measured clarity uncertainty	A	D	D	D
		% load	-	-	-	81%	4%	18%	34%
	Taruhuru River at Wi Pere Pipe	Median	0.4	D	Medium - measured clarity uncertainty	A	D	D	D
		% load	-	-	-	81%	4%	18%	34%
	Waikanae Creek at Grey St Bridge	Median	0.3	D	Medium - measured clarity uncertainty	-	-	-	-
		% load	-	-	-	-	-	-	-
	Waikanae Creek at Stanley Rd Bridge	Median	0.2	D	Medium - measured clarity uncertainty	-	-	-	-
		% load	-	-	-	-	-	-	-
	Sisterson Drain Site 1at Wetland Inflow Point	Median	0.3	D	Low (Estimated) - models suggested this should be similar to other sites in catchment, so should align with measurements	-	-	-	-
		% load	-	-	-	-	-	-	-
Hangaroa - Ruakituri	Hangaroa River at Donneraille Park	Median	0.8	D	Medium - measured clarity uncertainty, near band threshold.	-	-	-	-
		% load	-	-	-	-	-	-	-
	Haupapa Str at Tahora Settlement Rd	Median	1.9	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Mangaotara Str at Tiniroto Rd	Median	1.8	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	81%	5%	19%	37%
	Papokeka Str at Pehiri	Median	2.0	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Hangaroa River at Waimaha Station	Median	1.9	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-

Planning area	Site	Metric	Current state			Scenario estimates			
			Visual clarity (m)	State	Confidence	Afforestation	Modelled 2040	Modelled 2060	Modelled 2080
Motu	Maraetaha Str at No2 Br	Median	2.0	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	60%	4%	14%	27%
	Wherowhero Lagoon at Muriwai	Median	1.1	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Mangapoike Trib at Rabbit Road Pump Station	Median	2.3	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Koranga Rv at Koranga Valley Rd	Median	1.7	B	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	83%	5%	18%	37%
	Koranga Trib at Rakauaroa Rd	Median	2.4	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Marumoko Str at Marumoko Rd	Median	2.2	D	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Matawai Stream at Tawai	Median	0.9	D	Medium - measured clarity uncertainty.	-	-	-	-
		% load	-	-	-	-	-	-	-
	Motu River above Falls	Median	0.8	D	Medium - measured clarity uncertainty.	A	D	D	D
		% load	-	-	-	76%	4%	15%	29%
	Motu River at Kotare Station Bridge	Median	1.1	D	Medium - measured clarity uncertainty, near band threshold.	A	D	D	D
		% load	-	-	-	70%	4%	13%	25%
	Motu River at Matawai Conservation Area	Median	1.5	C	Medium - measured clarity uncertainty, near band threshold.	B	C	C	C
		% load	-	-	-	10%	0%	1%	1%
		Median	2.2	C	Low (Model) - local data missing from training data	-	-	-	-

Planning area	Site	Metric	Current state			Scenario estimates			
			Visual clarity (m)	State	Confidence	Afforestation	Modelled 2040	Modelled 2060	Modelled 2080
Uawa	Upper Motu Trib at Mangatu	% load	-	-	-	-	-	-	-
	Whakarau Trib at Whakarau Rd	Median	2.1	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Hikuwai River at Willowflat	Median	0.4	D	Medium - measured clarity uncertainty	A	D	D	B
		% load	-	-	-	82%	10%	39%	65%
	Mangaheia River at Paroa Road Bridge	Median	0.8	B	Medium - measured clarity uncertainty	A	B	A	A
		% load	-	-	-	79%	9%	34%	57%
	Mangakino Str at Mangatokerau Rd	Median	1.9	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Mangahauini River at Tokomaru Bay	Median	1.7	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Anaura Bay Nth Lagoon	Median	1.5	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Hikuwai River at No 4 Bridge	Median		D	Low (estimated) - Measured site downstream is D band	-	-	-	-
		% load	-	-	-	83%	11%	40%	66%
	Waiau River at Tauwhareparae	Median	1.9	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	84%	9%	41%	71%
	Uawa River at SH35 Bridge	Median		D	Low (estimated) - sites upstream are D band	-	-	-	-
		% load	-	-	-	-	-	-	-
	Waiotu Str at Waiotu Rd Bridge	Median	1.7	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
		Median	1.8	A	Low (Model) - local data missing from training data	-	-	-	-

Planning area	Site	Metric	Current state			Scenario estimates			
			Visual clarity (m)	State	Confidence	Afforestation	Modelled 2040	Modelled 2060	Modelled 2080
Waiapu	Makokomuka Str at Waiapu Rd	% load	-	-	-	-	-	-	-
	Karoronui Str at Anaura Bay Rd	Median	1.7	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Waitekaha Str at Tuparoa Rd	Median	1.6	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Ihungia River at Ihungia Rd Br	Median	0.3	D	Low (Model) - local data missing from training data	B	D	D	D
		% load	-	-	-	78%	6%	27%	46%
	Kouetumara Str at Ihungia Rd	Median	2.0	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Makarika Str at Makarika Br	Median	1.7	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Mangaokura Stream	Median	4.1	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	82%	0%	41%	82%
	Mangaoparo River at Mangaoparo Road	Median	2.5	C	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	69%	6%	31%	56%
	Mangaoporo River at Tutumatai Bridge	Median	0.4	D	Medium - measured clarity uncertainty	C	D	D	D
		% load	-	-	-	56%	5%	24%	41%
	Mata River at Aorangi (Makarika Road)	Median	0.1	D	Medium - measured clarity uncertainty	D	D	D	D
		% load	-	-	-	77%	8%	28%	48%
	Mata River at Pouturu Br	Median	0.1	D	Low (Model) - local data missing from training data	D	D	D	D
		% load	-	-	-	82%	9%	29%	49%
	Mata Upper	Median	2.7	A	Low (Model) - local data missing from training data	-	-	-	-

Planning area	Site	Metric	Current state			Scenario estimates			
			Visual clarity (m)	State	Confidence	Afforestation	Modelled 2040	Modelled 2060	Modelled 2080
Waimata	Poroporo River at Rangitukia Rd Bridge	% load	-	-	-	-	-	-	-
		Median	0.4	D	Medium - measured clarity uncertainty	B	D	D	D
		% load	-	-	-	65%	7%	20%	33%
	Ratahi Lagoon at Sh35 Culvert	Median	2.0	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Tapuaeroa River at Tapuaeroa Rd	Median	0.2	D	Medium - measured clarity uncertainty	D	D	D	D
		% load	-	-	-	62%	6%	20%	35%
	Waiapu River at Rotokautuku Br (SH35)	Median	0.1	D	Medium - measured clarity uncertainty	D	D	D	D
		% load	-	-	-	69%	7%	25%	42%
	Waipiro Str at Te Puia	Median	1.8	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Makarika Str at Keelan Rd	Median	1.8	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	78%	6%	23%	42%
	Huitatariki Str	Median	2.9	B	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Hamanatua Stream at Okitu Bridge	Median	0.9	B	Medium - measured clarity uncertainty, near band threshold.	-	-	-	-
		% load	-	-	-	-	-	-	-
		Median	0.5	D	Medium - measured clarity uncertainty	-	-	-	-
		% load	-	-	-	-	-	-	-
		Median	0.6	C	Medium - measured clarity uncertainty, near band threshold.	A	C	C	B
		% load	-	-	-	84%	6%	21%	39%

Planning area	Site	Metric	Current state			Scenario estimates			
			Visual clarity (m)	State	Confidence	Afforestation	Modelled 2040	Modelled 2060	Modelled 2080
	Pakarae Trib at Whangara Rd	Median	1.5	A	Low (Model) - local data missing from training data	-	-	-	-
			-	-	-	-	-	-	-
	Pakarae trib Stevens Road	Median	1.5	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Whakauranga Br at West Ho Rd	Median	1.9	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	72%	4%	16%	33%
	Waimata River at Goodwins Rd Bridge	Median	0.5	D	Medium - measured clarity uncertainty	A	D	C	B
		% load	-	-	-	82%	6%	20%	37%
	Waimata River at Grant Rd	Median	0.4	D	Medium - measured clarity uncertainty	A	D	D	D
		% load	-	-	-	82%	6%	20%	37%
	Waimata River at Monowai Bridge	Median	0.7	C	Medium - measured clarity uncertainty, near band threshold.	A	C	B	A
		% load	-	-	-	84%	6%	20%	38%
	Wainui Stream at Pare Street	Median	0.9	B	Medium - measured clarity uncertainty, near band threshold.	-	-	-	-
		% load	-	-	-	-	-	-	-
	Hamanatua River at Williamson street	Median	-	B	Low - estimated from other site on same river	-	-	-	-
		% load	-	-	-	-	-	-	-
	Turihaua Stream at Turihaua Station	Median	1.5	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Pouawa Rv at Christopher Rd Br	Median	1.4	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-

Planning area	Site	Metric	Current state			Scenario estimates			
			Visual clarity (m)	State	Confidence	Afforestation	Modelled 2040	Modelled 2060	Modelled 2080
	Waiomoko River at Andrews Rd Bridge	Median	1.5	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Sponge Bay Beach CHNES005	Median	1.5	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Turihaua Bridge at D/S SH35 Bridge	Median	1.5	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Wainui Str at Heath Johnston Park	Median	1.3	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Makahakaha Stream	Median	1.8	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Waiomoko River at SH35 Bridge	Median	1.3	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
Wharekahika - Waikura	Awatere River at SH35 Bridge	Median	1.0	A	Medium - measured clarity uncertainty	A	A	A	A
		% load	-	-	-	61%	4%	19%	35%
	Kopuapunamu Str Trib at Te Araroa	Median	1.9	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Karakatuwhero River at SH35 Br	Median	2.4	A	Medium - measured clarity uncertainty	-	-	-	-
		% load	-	-	-	62%	4%	15%	29%
	Karakatuwhero Trib at Karakatuwhero Rd	Median	1.7	A	Low (Model) - local data missing from training data	-	-	-	-
		% load	-	-	-	-	-	-	-
	Lottin Point Road Stream	Median	1.6	B	Medium (Model)	-	-	-	-
		% load	-	-	-	-	-	-	-

Planning area	Site	Metric	Current state			Scenario estimates			
			Visual clarity (m)	State	Confidence	Afforestation	Modelled 2040	Modelled 2060	Modelled 2080
	Mangatutu Str at Sh35-Waipahuru Bridge	Median	2.4	A	Medium - measured clarity uncertainty	-	-	-	-
		% load	-	-	-	-	-	-	-
	Oweka River at SH35 Bridge	Median	2.0	A	Medium - measured clarity uncertainty	A	A	A	A
		% load	-	-	-	81%	5%	19%	38%
	Wharekahika River U/S of Wharf Bridge	Median	1.7	A	Medium - measured clarity uncertainty	A	A	A	A
		% load	-	-	-	80%	5%	19%	37%
	Whangaparoa Trib at Waikura Road	Median	-	-	-	-	-	-	-
		% load	-	-	-	-	-	-	-

Table 10: Dissolved reactive phosphorus current NPS-FM attribute state, associated confidence score, and modeled scenario estimates of future state and load reductions. All concentrations are in mg/L.

Planning area	Site	Metric	Current state			Scenarios							
			State		Confidence	Afforestation		Modelled 2040		Modelled 2060		Modelled 2080	
Te Arai	Te Arai River Bush Intake Above Weir	Median	0.006	B	Medium (Model)	0.006	A	0.006	B	0.006	B	0.006	B
		% load	-	-	-	8.8%	-	0.02%	-	0.06%	-	0.09%	-
	Te Arai River at Pykes Weir	Median	0.006	A	High	0.002	A	0.006	A	0.006	A	0.006	A
		% load	-	-	-	69.8%	-	1.21%	-	3.03%	-	4.75%	-
	Te Arai Rv at Waingake	Median	0.011	C	Medium (Model)	0.004	A	0.011	C	0.010	C	0.010	C
		% load	-	-	-	61.9%	-	0.48%	-	1.26%	-	1.64%	-
	Te Arai Trib at Waingake Rd	Median	0.014	C	Medium (Model)	0.011	C	0.014	C	0.014	C	0.014	C
		% load	-	-	-	23.9%	-	0.50%	-	1.33%	-	1.67%	-
	Te Arai Trib at Waugh Rd	Median	0.022	D	Medium (Model)	0.006	A	0.021	D	0.021	D	0.021	D
		% load	-	-	-	74.6%	-	1.00%	-	2.50%	-	4.01%	-
	Waipaoa Trib at Pipiwahakao Road	Median	0.054	D	Medium (Model)	0.026	D	0.054	D	0.053	D	0.053	D
		% load	-	-	-	51.2%	-	0.04%	-	0.10%	-	0.16%	-
	Te Arai Trib Below Intake Weir	Median	0.006	B	Medium (Model)	0.004	A	0.006	B	0.006	B	0.006	B
		% load	-	-	-	38.0%	-	0.76%	-	2.00%	-	2.57%	-
Hill Country	Waimata River at Anzac Park	Median	0.017	C	Medium (Model)	0.006	B	0.017	C	0.017	C	0.017	C
		% load	-	-	-	63.9%	-	0.98%	-	2.45%	-	3.86%	-
	Mangatu River at Omapere Station	Median	0.005	A	High	0.001	A	0.005	A	0.005	A	0.005	A
		% load	-	-	-	72.9%	-	0.77%	-	1.93%	-	3.08%	-
	Urukokamuka Stream	Median	0.010	C	Medium (Model)	0.003	A	0.010	C	0.010	C	0.010	C
		% load	-	-	-	70.2%	-	0.56%	-	1.40%	-	2.25%	-
	Waihirere Str at Domain	Median	0.036	D	High	0.010	B	0.036	D	0.035	D	0.035	D

Planning area	Site	Metric	Current state			Scenarios						
			State	Confidence		Afforestation	Modelled 2040	Modelled 2060	Modelled 2080			
		% load	-	-	-	72.9%	-	0.86%	-	2.16%	-	3.45%
		Median	0.007	B	Medium (Model)	0.004	A	0.007	B	0.007	B	0.007
	Waipaoa at Armstrong Rd	% load	-	-	-	45.9%	-	0.55%	-	1.43%	-	2.04%
		Median	0.018	D	Medium (Model)	0.005	A	0.018	D	0.018	C	0.018
	Parihohonou Str at SH2 Overbridge	% load	-	-	-	72.1%	-	0.70%	-	1.74%	-	2.79%
		Median	0.014	C	Medium (Model)	0.004	A	0.014	C	0.013	C	0.013
	Waihuka River at No3 Br	% load	-	-	-	71.2%	-	0.79%	-	1.97%	-	3.15%
		Median	0.021	D	Medium (Model)	0.012	C	0.021	D	0.020	D	0.020
	Kurunui Str at Holdsworth Br SH2	Median	-	-	-	41.1%	-	0.42%	-	1.04%	-	1.67%
		% load	0.008	B	High	0.002	A	0.008	B	0.008	B	0.008
	Waikohu River at Mahaki Station	Median	-	-	-	75.0%	-	0.79%	-	1.97%	-	3.15%
		% load	0.012	C	Medium (Model)	0.003	A	0.012	C	0.012	C	0.012
	Waikohu Rv at Oliver Rd	Median	-	-	-	75.2%	-	0.33%	-	0.84%	-	1.34%
		% load	0.006	A	High	0.003	A	0.006	A	0.006	A	0.006
	Waingaromia River at Terrace Station	Median	-	-	-	55.9%	-	0.95%	-	2.41%	-	3.63%
		% load	0.015	C	Medium (Model)	0.004	A	0.015	C	0.015	C	0.015
	Rere falls	Median	-	-	-	72.4%	-	0.63%	-	1.57%	-	2.51%
		% load	0.014	C	Medium (Model)	0.004	A	0.014	C	0.014	C	0.013
	Rere rockslide (top)	Median	-	-	-	72.7%	-	0.67%	-	1.67%	-	2.67%
		% load	0.022	D	Medium (Model)	0.011	C	0.021	D	0.021	D	0.021
	Waihuka at No2 Br	Median	-	-	-	49.2%	-	0.26%	-	0.64%	-	1.02%
		% load	0.016	C	High	0.005	A	0.016	C	0.016	C	0.016
	Wharekopae River at Rangimoe	Median	-	-	-	69.8%	-	0.69%	-	1.72%	-	2.75%

Planning area	Site	Metric	Current state			Scenarios							
			State		Confidence	Afforestation		Modelled 2040		Modelled 2060		Modelled 2080	
	Wharekopae above falls	Median	0.017	C	Medium (Model)	0.004	A	0.017	C	0.016	C	0.016	C
		% load	-	-	-	74.2%	-	0.67%	-	1.67%	-	2.68%	-
	Waipaoa River at Kanakanaia	Median	0.012	C	High	0.004	A	0.012	C	0.012	C	0.012	C
		% load	-	-	-	65.9%	-	0.70%	-	1.76%	-	2.77%	-
	Mangaoai Str at Mangaoai Rd	Median	0.019	D	Medium (Model)	0.010	B	0.019	D	0.019	D	0.019	D
		% load	-	-	-	50.3%	-	0.92%	-	2.36%	-	3.50%	-
	Waikohu Trib at Whakarau Rd	Median	0.018	C	Medium (Model)	0.005	A	0.018	C	0.017	C	0.017	C
		% load	-	-	-	69.4%	-	0.59%	-	1.48%	-	2.36%	-
	Mangatu Trib	Median	0.008	B	Medium (Model)	0.006	A	0.008	B	0.008	B	0.008	B
		% load	-	-	-	24.4%	-	0.70%	-	1.87%	-	2.34%	-
Poverty Bay Flats	Waipaoa River at Matawhero Bridge	Median	0.013	C	High	0.005	A	0.013	C	0.013	C	0.013	C
		% load	-	-	-	64.6%	-	0.66%	-	1.67%	-	2.62%	-
	Waipaoa River at Railway Bridge	Median	0.014	C	High	0.007	B	0.014	C	0.014	C	0.014	C
		% load	-	-	-	50.0%	-	0.00%	-	0.00%	-	0.00%	-
	Taruhuru River at Tuckers Rd Bridge	Median	0.105	D	High	0.053	D	0.105	D	0.104	D	0.103	D
		% load	-	-	-	49.7%	-	0.42%	-	1.06%	-	1.69%	-
	Whakaahu Str at Brunton Rd	Median	0.018	C	High	0.007	B	0.018	C	0.018	C	0.018	C
		% load	-	-	-	61.6%	-	0.67%	-	1.67%	-	2.63%	-
	Waikohu River at No3 Br	Median	0.015	C	Medium (Model)	0.005	A	0.015	C	0.014	C	0.014	C
		% load	-	-	-	68.6%	-	0.68%	-	1.71%	-	2.72%	-
	Waipaoa Trib at Lavenham-Humphrey Rd	Median	0.030	D	Medium (Model)	0.012	C	0.030	D	0.030	D	0.030	D
		% load	-	-	-	59.4%	-	0.29%	-	0.73%	-	1.17%	-
	Waikakariki Trib at Quarry	Median	0.014	C	Medium (Model)	0.008	B	0.014	C	0.014	C	0.014	C

Planning area	Site	Metric	Current state			Scenarios							
			State	Confidence		Afforestation		Modelled 2040		Modelled 2060		Modelled 2080	
Urban	Turanganui River at Gladstone Rd Bridge	% load	-	-	-	44.3%	-	0.66%	-	1.74%	-	2.33%	-
		Median	0.022	D	High	0.011	C	0.022	D	0.022	D	0.022	D
		% load	-	-	-	49.0%	-	0.27%	-	0.67%	-	1.07%	-
	Turanganui River at The Cut	Median	0.012	C	High	0.005	A	0.012	C	0.012	C	0.012	C
		% load	-	-	-	54.9%	-	0.00%	-	0.00%	-	0.00%	-
		Awapuni Drain Site 6 U/S Of Rayonier at Fenceline	Median	0.340	D	High	0.254	D	0.340	D	0.340	D	0.340
	% load		-	-	-	25.4%	-	0.00%	-	0.00%	-	0.00%	-
	Taruheru River at Lytton Rd Bridge		Median	0.090	D	High	0.048	D	0.090	D	0.089	D	0.089
		% load	-	-	-	47.0%	-	0.27%	-	0.68%	-	1.08%	-
		Taruheru River at Peel St Bridge	Median	0.031	D	High	0.016	C	0.031	D	0.031	D	0.031
	% load		-	-	-	49.0%	-	0.27%	-	0.67%	-	1.07%	-
	Taruheru River at Wi Pere Pipe		Median	0.052	D	High	0.027	D	0.052	D	0.052	D	0.051
		% load	-	-	-	48.4%	-	0.27%	-	0.69%	-	1.09%	-
		Waikanae Creek at Grey St Bridge	Median	0.064	D	High	0.029	D	0.064	D	0.064	D	0.064
	% load		-	-	-	54.9%	-	0.00%	-	0.00%	-	0.00%	-
	Waikanae Creek at Stanley Rd Bridge		Median	0.164	D	High	0.043	D	0.164	D	0.164	D	0.164
		% load	-	-	-	73.5%	-	0.00%	-	0.00%	-	0.00%	-
		Sisterson Drain Site 1at Wetland Inflow Point	Median	0.057	D	Medium (Model)	0.039	D	0.057	D	0.057	D	0.057
	% load		-	-	-	31.0%	-	0.00%	-	0.00%	-	0.00%	-
Hangaroa - Ruakituri	Hangaroa River at Donneraile Park		Median	0.014	C	High	0.004	A	0.014	C	0.014	C	0.014
		% load	-	-	-	70.7%	-	0.74%	-	1.85%	-	2.96%	-
	Haupapa Str at Tahora Settlement Rd	Median	0.015	C	Medium (Model)	0.003	A	0.015	C	0.015	C	0.015	C
		% load	-	-	-	81.9%	-	0.15%	-	0.36%	-	0.58%	-

Planning area	Site	Metric	Current state			Scenarios							
			State		Confidence	Afforestation		Modelled 2040		Modelled 2060		Modelled 2080	
	Mangaotara Str at Tiniroto Rd	Median	0.008	B	Medium (Model)	0.002	A	0.008	B	0.008	B	0.008	B
		% load	-	-	-	77.8%	-	0.87%	-	2.18%	-	3.49%	-
	Papokeka Str at Pehiri	Median	0.014	C	Medium (Model)	0.005	A	0.014	C	0.014	C	0.014	C
		% load	-	-	-	64.6%	-	0.68%	-	1.71%	-	2.73%	-
	Hangaroa River at Waimaha Station	Median	0.013	C	Medium (Model)	0.004	A	0.013	C	0.013	C	0.013	C
		% load	-	-	-	70.2%	-	0.23%	-	0.58%	-	0.92%	-
	Maraetaha Str at No2 Br	Median	0.007	B	Medium (Model)	0.003	A	0.007	B	0.006	B	0.006	B
		% load	-	-	-	58.3%	-	0.80%	-	2.04%	-	3.08%	-
	Wherowhero Lagoon at Muriwai	Median	0.020	D	Medium (Model)	0.006	B	0.020	D	0.020	D	0.019	D
		% load	-	-	-	68.6%	-	0.44%	-	1.11%	-	1.77%	-
	Mangapoike Trib at Rabbit Road Pump Station	Median	0.007	B	Medium (Model)	0.006	A	0.007	B	0.007	B	0.007	B
		% load	-	-	-	19.9%	-	0.40%	-	1.06%	-	1.32%	-
Motu	Koranga Rv at Koranga Valley Rd	Median	0.016	C	Medium (Model)	0.003	A	0.016	C	0.016	C	0.016	C
		% load	-	-	-	78.9%	-	0.19%	-	0.47%	-	0.75%	-
	Koranga Trib at Rakauroa Rd	Median	0.017	C	Medium (Model)	0.005	A	0.017	C	0.017	C	0.017	C
		% load	-	-	-	71.4%	-	0.04%	-	0.10%	-	0.16%	-
	Marumoko Str at Marumoko Rd	Median	0.009	B	Medium (Model)	0.002	A	0.009	B	0.009	B	0.008	B
		% load	-	-	-	81.2%	-	0.47%	-	1.18%	-	1.89%	-
	Matawai Stream at Tawai	Median	0.012	C	High	0.002	A	0.012	C	0.012	C	0.012	C
		% load	-	-	-	79.9%	-	0.12%	-	0.30%	-	0.48%	-
	Motu River above Falls	Median	0.016	C	High	0.004	A	0.016	C	0.016	C	0.016	C
		% load	-	-	-	75.8%	-	0.22%	-	0.55%	-	0.88%	-
	Motu River at Kotare Station Bridge	Median	0.019	D	High	0.006	A	0.019	D	0.019	D	0.019	D

Planning area	Site	Metric	Current state			Scenarios							
			State	Confidence		Afforestation		Modelled 2040		Modelled 2060		Modelled 2080	
Uawa	Motu River at Matawai Conservation Area	% load	-	-	-	69.6%	-	0.28%	-	0.69%	-	1.11%	-
		Median	0.012	C	High	0.011	C	0.012	C	0.012	C	0.012	C
		% load	-	-	-	9.8%	-	0.00%	-	0.01%	-	0.01%	-
	Upper Motu Trib at Mangatu	Median	0.009	B	Medium (Model)	0.002	A	0.009	B	0.009	B	0.009	B
		% load	-	-	-	82.2%	-	0.00%	-	0.00%	-	0.00%	-
	Whakarau Trib at Whakarau Rd	Median	0.018	C	Medium (Model)	0.004	A	0.018	C	0.017	C	0.017	C
		% load	-	-	-	79.4%	-	0.16%	-	0.41%	-	0.65%	-
	Hikuwai River at Willowflat	Median	0.005	A	High	0.002	A	0.005	A	0.005	A	0.005	A
		% load	-	-	-	65.6%	-	0.82%	-	2.08%	-	3.20%	-
	Mangaheia River at Paroa Road Bridge	Median	0.007	B	High	0.003	A	0.007	B	0.007	B	0.007	B
		% load	-	-	-	56.2%	-	0.72%	-	1.85%	-	2.72%	-
	Mangakino Str at Mangatokerau Rd	Median	0.013	C	Medium (Model)	0.010	C	0.013	C	0.013	C	0.013	C
		% load	-	-	-	20.9%	-	0.74%	-	1.98%	-	2.48%	-
	Mangahauini River at Tokomaru Bay	Median	0.007	B	Medium (Model)	0.002	A	0.007	B	0.007	B	0.007	B
		% load	-	-	-	77.2%	-	0.78%	-	1.94%	-	3.10%	-
	Anaura Bay Nth Lagoon	Median	0.011	C	Medium (Model)	0.005	A	0.011	C	0.011	C	0.011	C
		% load	-	-	-	55.6%	-	0.66%	-	1.66%	-	2.56%	-
	Hikuwai River at No 4 Bridge	Median	0.006	B	Medium (Model)	0.002	A	0.006	B	0.006	B	0.006	B
% load		-	-	-	66.3%	-	0.88%	-	2.21%	-	3.41%	-	
Waiau River at Tauwhareparae	Median	0.006	B	Medium (Model)	0.002	A	0.006	B	0.006	B	0.006	B	
	% load	-	-	-	62.8%	-	0.94%	-	2.38%	-	3.57%	-	
Uawa River at SH35 Bridge	Median	0.008	B	Medium (Model)	0.003	A	0.008	B	0.008	B	0.008	B	
	% load	-	-	-	63.1%	-	0.69%	-	1.75%	-	2.65%	-	

Planning area	Site	Metric	Current state			Scenarios							
			State		Confidence	Afforestation		Modelled 2040		Modelled 2060		Modelled 2080	
Waiapu	Waiotu Str at Waiotu Rd Bridge	Median	0.008	B	Medium (Model)	0.001	A	0.008	B	0.007	B	0.007	B
		% load	-	-	-	81.3%	-	0.79%	-	1.97%	-	3.15%	-
	Makokomuka Str at Waiapu Rd	Median	0.008	B	Medium (Model)	0.001	A	0.008	B	0.008	B	0.008	B
		% load	-	-	-	82.7%	-	0.59%	-	1.47%	-	2.35%	-
	Karoronui Str at Anaura Bay Rd	Median	0.012	C	Medium (Model)	0.004	A	0.011	C	0.011	C	0.011	C
		% load	-	-	-	63.9%	-	1.75%	-	4.36%	-	6.98%	-
	Waitekaha Str at Tuparoa Rd	Median	0.010	B	Medium (Model)	0.002	A	0.010	B	0.010	B	0.009	B
		% load	-	-	-	80.5%	-	1.25%	-	3.13%	-	5.01%	-
	Ihungia River at Ihungia Rd Br	Median	0.007	B	High	0.002	A	0.007	B	0.007	B	0.007	B
		% load	-	-	-	73.6%	-	1.06%	-	2.67%	-	4.18%	-
	Kouetumara Str at Ihungia Rd	Median	0.008	B	Medium (Model)	0.005	A	0.008	B	0.008	B	0.008	B
		% load	-	-	-	41.5%	-	0.82%	-	2.12%	-	3.02%	-
	Makarika Str at Makarika Br	Median	0.008	B	Medium (Model)	0.002	A	0.008	B	0.008	B	0.008	B
		% load	-	-	-	74.3%	-	0.64%	-	1.59%	-	2.52%	-
	Mangaokura Stream	Median	0.006	A	Medium (Model)	-	-	-	-	-	-	-	-
		% load	-	-	-	-	-	-	-	-	-	-	-
	Mangaoparo River at Mangaoparo Road	Median	0.010	B	Medium (Model)	0.002	A	0.010	B	0.009	B	0.009	B
		% load	-	-	-	77.1%	-	0.65%	-	1.62%	-	2.59%	-
	Mangaoporo River at Tutumatai Bridge	Median	0.011	C	High	0.003	A	0.011	C	0.011	C	0.011	C
		% load	-	-	-	73.9%	-	0.61%	-	1.54%	-	2.43%	-
	Mata River at Aorangi (Makarika Road)	Median	0.009	B	High	0.003	A	0.009	B	0.009	B	0.009	B
		% load	-	-	-	69.8%	-	0.86%	-	2.15%	-	3.40%	-
	Mata River at Pouturu Br	Median	0.005	A	High	0.001	A	0.005	A	0.005	A	0.005	A

Planning area	Site	Metric	Current state			Scenarios						
			State	Confidence		Afforestation	Modelled 2040	Modelled 2060	Modelled 2080			
Waimata	Mata Upper	% load	-	-	-	74.5%	-	1.14%	-	2.85%	-	4.52%
		Median	0.006	B	Medium (Model)	0.006	B	0.006	B	0.006	B	B
		% load	-	-	-	2.8%	-	0.02%	-	0.06%	-	0.08%
	Poroporo River at Rangitukia Rd Bridge	Median	0.008	B	High	0.002	A	0.008	B	0.008	B	B
		% load	-	-	-	73.1%	-	0.48%	-	1.20%	-	1.89%
	Ratahi Lagoon at Sh35 Culvert	Median	0.004	A	High	0.002	A	0.004	A	0.004	A	A
		% load	-	-	-	58.7%	-	0.10%	-	0.24%	-	0.39%
	Tapuaeroa River at Tapuaeroa Rd	Median	0.014	C	High	0.002	A	0.014	C	0.014	C	C
		% load	-	-	-	84.0%	-	0.41%	-	1.03%	-	1.65%
	Waiapu River at Rotokautuku Br (SH35)	Median	0.010	B	High	0.003	A	0.010	B	0.010	B	B
		% load	-	-	-	71.1%	-	0.72%	-	1.80%	-	2.85%
	Waipiro Str at Te Puia	Median	0.008	B	Medium (Model)	0.003	A	0.008	B	0.008	B	B
		% load	-	-	-	69.1%	-	0.30%	-	0.76%	-	1.19%
	Makarika Str at Keelan Rd	Median	0.007	B	Medium (Model)	0.002	A	0.007	B	0.007	B	B
		% load	-	-	-	73.6%	-	0.68%	-	1.71%	-	2.70%
	Huitatariki Str	Median	0.006	B	Medium (Model)	0.005	A	0.006	A	0.006	A	A
		% load	-	-	-	10.8%	-	0.16%	-	0.43%	-	0.53%
	Hamanatua Stream at Okitu Bridge	Median	0.013	C	High	0.008	B	0.013	C	0.013	C	C
		% load	-	-	-	39.4%	-	0.38%	-	0.95%	-	1.52%
	Kopuawhakapata Stream at Hirini St	Median	0.142	D	High	0.052	D	0.142	D	0.142	D	D
		% load	-	-	-	63.6%	-	0.01%	-	0.04%	-	0.04%
	Pakarae River at Pakarae Station Bridge	Median	0.010	B	High	0.003	A	0.010	B	0.010	B	B
		% load	-	-	-	67.4%	-	0.85%	-	2.14%	-	3.34%

Planning area	Site	Metric	Current state			Scenarios							
			State		Confidence	Afforestation		Modelled 2040		Modelled 2060		Modelled 2080	
	Pakarae Trib at Whangara Rd	Median	0.022	D	Medium (Model)	0.007	B	0.022	D	0.021	D	0.021	D
			-	-	-	68.6%	-	0.69%	-	1.73%	-	2.76%	-
	Pakarae trib Stevens Road	Median	0.020	D	Medium (Model)	0.007	B	0.020	D	0.020	D	0.020	D
		% load	-	-	-	64.6%	-	0.84%	-	2.10%	-	3.35%	-
	Whakauranga Br at West Ho Rd	Median	0.009	B	Medium (Model)	0.003	A	0.009	B	0.009	B	0.008	B
		% load	-	-	-	62.3%	-	1.00%	-	2.53%	-	3.83%	-
	Waimata River at Goodwins Rd Bridge	Median	0.014	C	High	0.010	C	0.014	C	0.014	C	0.014	C
		% load	-	-	-	28.5%	-	0.25%	-	0.61%	-	0.98%	-
	Waimata River at Grant Rd	Median	0.022	D	High	0.008	B	0.022	D	0.021	D	0.021	D
		% load	-	-	-	63.9%	-	0.98%	-	2.47%	-	3.88%	-
	Waimata River at Monowai Bridge	Median	0.014	C	High	0.004	A	0.014	C	0.014	C	0.013	C
		% load	-	-	-	68.2%	-	1.13%	-	2.83%	-	4.47%	-
	Wainui Stream at Pare Street	Median	0.239	D	High	0.116	D	0.239	D	0.239	D	0.239	D
		% load	-	-	-	51.4%	-	0.03%	-	0.09%	-	0.14%	-
	Hamanatua River at Williamson street	Median	-	-	-	-	-	-	-	-	-	-	-
		% load	-	-	-	39.4%	-	0.38%	-	0.95%	-	1.52%	-
	Turihaua Stream at Turihaua Station	Median	0.017	C	Medium (Model)	0.006	B	0.016	C	0.016	C	0.016	C
		% load	-	-	-	61.0%	-	0.74%	-	1.85%	-	2.96%	-
	Pouawa Rv at Christopher Rd Br	Median	0.017	C	Medium (Model)	0.006	B	0.017	C	0.017	C	0.016	C
		% load	-	-	-	62.3%	-	0.61%	-	1.55%	-	2.36%	-
	Waiomoko River at Andrews Rd Bridge	Median	0.015	C	Medium (Model)	0.005	A	0.015	C	0.015	C	0.015	C
		% load	-	-	-	67.1%	-	0.76%	-	1.92%	-	3.03%	-

Planning area	Site	Metric	Current state			Scenarios							
			State		Confidence	Afforestation		Modelled 2040		Modelled 2060		Modelled 2080	
Wharekahika - Waikura	Sponge Bay Beach CHNES005	Median	0.100	D	Medium (Model)	0.063	D	0.100	D	0.100	D	0.100	D
		% load	-	-	-	37.3%	-	0.00%	-	0.00%	-	0.00%	-
	Turihaua Bridge at D/S SH35 Bridge	Median	0.013	C	Medium (Model)	0.005	A	0.013	C	0.013	C	0.013	C
		% load	-	-	-	59.5%	-	0.73%	-	1.82%	-	2.91%	-
	Wainui Str at Heath Johnston Park	Median	0.097	D	Medium (Model)	0.039	D	0.097	D	0.097	D	0.097	D
		% load	-	-	-	59.3%	-	0.00%	-	0.01%	-	0.02%	-
	Makahakaha Stream	Median	0.016	C	Medium (Model)	0.008	B	0.016	C	0.015	C	0.015	C
		% load	-	-	-	47.3%	-	1.37%	-	3.54%	-	5.08%	-
	Waiomoko River at SH35 Bridge	Median	0.024	D	Medium (Model)	0.010	B	0.024	D	0.024	D	0.024	D
		% load	-	-	-								
	Awatere River at SH35 Bridge	Median	0.009	B	High	0.004	A	0.009	B	0.009	B	0.009	B
		% load	-	-	-	57.8%	-	0.38%	-	0.98%	-	1.48%	-
	Kopuapunamu Str Trib at Te Araroa	Median	0.009	B	Medium (Model)	0.004	A	0.009	B	0.009	B	0.009	B
		% load	-	-	-	52.3%	-	0.42%	-	1.06%	-	1.69%	-
Wharekahika - Waikura	Karakatuwhero River at SH35 Br	Median	0.011	C	High	0.005	A	0.011	C	0.011	C	0.011	C
		% load	-	-	-	56.0%	-	0.25%	-	0.65%	-	0.98%	-
	Karakatuwhero Trib at Karakatuwhero Rd	Median	0.011	C	Medium (Model)	0.003	A	0.011	C	0.010	C	0.010	C
		% load	-	-	-	75.8%	-	0.71%	-	1.78%	-	2.85%	-
	Lottin Point Road Stream	Median	0.010	B	Medium (Model)	0.002	A	0.010	B	0.010	B	0.010	B
		% load	-	-	-	82.2%	-	0.56%	-	1.40%	-	2.23%	-
	Mangatutu Str at Sh35-Waipahuru Bridge	Median	0.013	C	High	0.002	A	0.013	C	0.013	C	0.013	C
		% load	-	-	-	84.4%	-	0.55%	-	1.37%	-	2.19%	-
	Oweka River at SH35 Bridge	Median	0.010	B	High	0.002	A	0.010	B	0.010	B	0.010	B
		% load	-	-	-								

Table 11: Dissolved inorganic nitrogen current numeric state, associated confidence score, and modeled scenario estimates of future state and load reductions. All concentrations are in mg/L.

Planning area	Site	Metric	Current state		Scenarios			
			Concentration (mg/L)	Confidence	Afforestation	Modelled 20240	Modelled 2060	Modelled 2080
Te Arai	Te Arai River Bush Intake Above Weir	Median	0.030	Medium (Model)	0.028	0.030	0.030	0.030
		% load	-	-	5.2%	0.04%	0.10%	0.13%
	Te Arai River at Pykes Weir	Median	0.037	High	0.012	0.037	0.036	0.035
		% load	-	-	67.0%	1.26%	3.20%	4.79%
	Te Arai Rv at Waingake	Median	0.040	Medium (Model)	0.018	0.039	0.038	0.038
		% load	-	-	54.1%	1.50%	3.99%	5.01%
	Te Arai Trib at Waingake Rd	Median	0.099	Medium (Model)	0.050	0.098	0.096	0.095
		% load	-	-	49.7%	1.00%	2.67%	3.37%
	Te Arai Trib at Waugh Rd	Median	0.048	Medium (Model)	0.011	0.048	0.047	0.046
		% load	-	-	78.0%	1.07%	2.67%	4.27%
	Waipaoa Trib at Pipiwahakao Road	Median	0.259	Medium (Model)	0.039	0.259	0.259	0.259
		% load	-	-	84.9%	0.05%	0.13%	0.20%
	Te Arai Trib Below Intake Weir	Median	0.048	Medium (Model)	0.024	0.048	0.046	0.046
		% load	-	-	51.2%	1.62%	4.31%	5.42%
Hill Country	Waimata River at Anzac Park	Median	0.038	Medium (Model)	0.009	0.037	0.037	0.036
		% load	-	-	77.1%	1.20%	3.02%	4.70%
	Mangatu River at Omapere Station	Median	0.150	High	0.027	0.149	0.147	0.145
		% load	-	-	82.0%	0.87%	2.19%	3.47%
	Urukokamuka Stream	Median	0.097	Medium (Model)	0.018	0.096	0.095	0.094
		% load	-	-	81.7%	0.65%	1.62%	2.59%
	Waihirere Str at Domain	Median	0.190	High	0.044	0.188	0.186	0.183
		% load	-	-	-	-	-	-

Planning area	Site	Metric	Current state		Scenarios			
			Concentration (mg/L)	Confidence	Afforestation	Modelled 20240	Modelled 2060	Modelled 2080
	Waipaoa at Armstrong Rd	% load	-	-	76.8%	0.91%	2.27%	3.63%
		Median	0.065	Medium (Model)	0.027	0.064	0.063	0.063
		% load	-	-	58.2%	0.85%	2.22%	3.00%
	Parihihonou Str at SH2 Overbridge	Median	0.165	Medium (Model)	0.036	0.163	0.162	0.160
		% load	-	-	77.9%	0.74%	1.84%	2.95%
	Waihuka River at No3 Br	Median	0.105	Medium (Model)	0.021	0.104	0.103	0.101
		% load	-	-	80.1%	0.88%	2.19%	3.51%
	Kurunui Str at Holdsworth Br SH2	Median	0.044	Medium (Model)	0.013	0.044	0.043	0.043
		Median	-	-	69.5%	0.71%	1.76%	2.82%
	Waikohu River at Mahaki Station	% load	0.120	High	0.023	0.119	0.117	0.116
		Median	-	-	81.1%	0.84%	2.09%	3.35%
	Waikohu Rv at Oliver Rd	% load	0.261	Medium (Model)	0.045	0.260	0.258	0.257
		Median	-	-	82.6%	0.36%	0.89%	1.42%
	Waingaromia River at Terrace Station	% load	0.128	High	0.040	0.126	0.123	0.122
		Median	-	-	68.2%	1.26%	3.25%	4.70%
	Rere falls	% load	0.131	Medium (Model)	0.024	0.130	0.129	0.128
		Median	-	-	81.8%	0.71%	1.78%	2.84%
	Rere rockslide (top)	% load	0.108	Medium (Model)	0.019	0.107	0.106	0.104
		Median	-	-	81.9%	0.76%	1.89%	3.02%
	Waihuka at No2 Br	% load	0.053	Medium (Model)	0.011	0.053	0.052	0.052
		Median	-	-	79.8%	0.41%	1.04%	1.66%
	Wharekopae River at Rangimoe	% load	0.150	High	0.030	0.149	0.147	0.145

Planning area	Site	Metric	Current state		Scenarios			
			Concentration (mg/L)	Confidence	Afforestation	Modelled 20240	Modelled 2060	Modelled 2080
	Wharekopae above falls	Median	-	-	80.3%	0.79%	1.98%	3.17%
		Median	0.161	Medium (Model)	0.040	0.160	0.158	0.156
		% load	-	-	75.3%	0.69%	1.71%	2.74%
	Waipaoa River at Kanakanaia	Median	0.160	High	0.035	0.159	0.157	0.155
		% load	-	-	78.0%	0.84%	2.13%	3.31%
	Mangaoai Str at Mangaoai Rd	Median	0.047	Medium (Model)	0.017	0.046	0.045	0.045
		% load	-	-	64.5%	1.32%	3.41%	4.87%
	Waikohu Trib at Whakarau Rd	Median	0.103	Medium (Model)	0.019	0.102	0.101	0.100
		% load	-	-	81.8%	0.70%	1.74%	2.79%
	Mangatu Trib	Median	0.110	Medium (Model)	0.056	0.108	0.106	0.105
		% load	-	-	49.1%	1.41%	3.77%	4.71%
Poverty Bay Flats	Waipaoa River at Matawhero Bridge	Median	0.185	High	0.041	0.184	0.181	0.179
		% load	-	-	78.1%	0.79%	2.00%	3.11%
	Waipaoa River at Railway Bridge	Median	0.155	High	0.017	0.155	0.155	0.155
		% load	-	-	88.9%	0.00%	0.00%	0.00%
	Taruhuru River at Tuckers Rd Bridge	Median	1.200	High	0.234	1.196	1.189	1.182
		% load	-	-	80.5%	0.37%	0.92%	1.47%
	Whakaahu Str at Brunton Rd	Median	0.053	High	0.011	0.052	0.051	0.051
		% load	-	-	78.5%	0.79%	1.98%	3.09%
	Waikohu River at No3 Br	Median	0.102	Medium (Model)	0.021	0.101	0.100	0.099
		% load	-	-	79.1%	0.79%	1.97%	3.13%
	Waipaoa Trib at Lavenham-Humphrey Rd	Median	0.156	Medium (Model)	0.030	0.155	0.154	0.154

Planning area	Site	Metric	Current state		Scenarios			
			Concentration (mg/L)	Confidence	Afforestation	Modelled 20240	Modelled 2060	Modelled 2080
Urban	Waikakariki Trib at Quarry	% load	-	-	81.0%	0.37%	0.91%	1.46%
		Median	0.139	Medium (Model)	0.055	0.137	0.134	0.133
		% load	-	-	60.5%	1.20%	3.18%	4.13%
	Turanganui River at Gladstone Rd Bridge	Median	0.110	High	0.021	0.110	0.109	0.109
		% load	-	-	80.9%	0.23%	0.56%	0.90%
	Turanganui River at The Cut	Median	0.054	High	0.010	0.054	0.054	0.054
		% load	-	-	81.5%	0.00%	0.00%	0.00%
	Awapuni Drain Site 6 U/S Of Rayonier at Fenceline	Median	0.110	High	0.020	0.110	0.110	0.110
		% load	-	-	82.0%	0.00%	0.00%	0.00%
	Taruhuru River at Lytton Rd Bridge	Median	0.790	High	0.148	0.788	0.786	0.783
		% load	-	-	81.2%	0.22%	0.54%	0.86%
	Taruhuru River at Peel St Bridge	Median	0.130	High	0.025	0.130	0.129	0.129
		% load	-	-	80.9%	0.23%	0.56%	0.90%
	Taruhuru River at Wi Pere Pipe	Median	0.365	High	0.070	0.364	0.363	0.362
		% load	-	-	80.9%	0.23%	0.57%	0.91%
	Waikanae Creek at Grey St Bridge	Median	0.083	High	0.015	0.083	0.083	0.083
		% load	-	-	81.5%	0.00%	0.00%	0.00%
	Waikanae Creek at Stanley Rd Bridge	Median	0.235	High	0.021	0.235	0.235	0.235
		% load	-	-	90.9%	0.00%	0.00%	0.00%
	Sisterson Drain Site 1at Wetland Inflow Point	Median	0.390	High	0.065	0.390	0.390	0.390
		% load	-	-	83.4%	0.00%	0.00%	0.00%
Hangaroa - Ruakituri	Hangaroa River at Donneraile Park	Median	0.040	Medium (Model)	0.008	0.039	0.039	0.038

Planning area	Site	Metric	Current state		Scenarios			
			Concentration (mg/L)	Confidence	Afforestation	Modelled 20240	Modelled 2060	Modelled 2080
	Haupapa Str at Tahora Settlement Rd	% load	-	-	79.6%	0.83%	2.09%	3.32%
		Median	0.140	Medium (Model)	0.028	0.140	0.139	0.139
		% load	-	-	80.1%	0.15%	0.37%	0.60%
	Mangaotara Str at Tiniroto Rd	Median	0.103	Medium (Model)	0.025	0.102	0.101	0.100
		% load	-	-	76.2%	0.88%	2.19%	3.51%
	Papokeka Str at Pehiri	Median	0.057	Medium (Model)	0.020	0.057	0.056	0.056
		% load	-	-	64.5%	0.66%	1.64%	2.63%
	Hangaroa River at Waimaha Station	Median	0.071	Medium (Model)	0.015	0.070	0.070	0.070
		% load	-	-	78.1%	0.26%	0.64%	1.02%
	Maraetaha Str at No2 Br	Median	0.030	Medium (Model)	0.010	0.030	0.030	0.029
		% load	-	-	65.6%	1.06%	2.73%	3.90%
	Wherowhero Lagoon at Muriwai	Median	0.084	Medium (Model)	0.014	0.084	0.083	0.082
		% load	-	-	82.7%	0.43%	1.07%	1.70%
	Mangapoike Trib at Rabbit Road Pump Station	Median	0.101	Medium (Model)	0.057	0.100	0.099	0.098
		% load	-	-	43.2%	0.84%	2.25%	2.81%
Motu	Koranga Rv at Koranga Valley Rd	Median	0.124	Medium (Model)	0.017	0.123	0.123	0.123
		% load	-	-	86.0%	0.21%	0.51%	0.82%
	Koranga Trib at Rakauroa Rd	Median	0.055	Medium (Model)	0.007	0.055	0.055	0.055
		% load	-	-	88.1%	0.05%	0.13%	0.20%
	Marumoko Str at Marumoko Rd	Median	0.086	Medium (Model)	0.017	0.085	0.085	0.084
		% load	-	-	80.2%	0.47%	1.16%	1.86%
	Matawai Stream at Tawai	Median	0.445	High	0.063	0.444	0.444	0.443

Planning area	Site	Metric	Current state		Scenarios			
			Concentration (mg/L)	Confidence	Afforestation	Modelled 20240	Modelled 2060	Modelled 2080
	Motu River above Falls	% load	-	-	85.9%	0.13%	0.32%	0.52%
		Median	0.295	High	0.052	0.294	0.293	0.292
		% load	-	-	82.3%	0.24%	0.59%	0.95%
	Motu River at Kotare Station Bridge	Median	0.290	High	0.065	0.289	0.288	0.286
		% load	-	-	77.7%	0.31%	0.78%	1.24%
	Motu River at Matawai Conservation Area	Median	0.017	High	0.016	0.017	0.017	0.017
		% load	-	-	8.8%	0.00%	0.01%	0.01%
	Upper Motu Trib at Mangatu	Median	0.112	Medium (Model)	0.017	0.112	0.112	0.112
		% load	-	-	84.5%	0.00%	0.00%	0.00%
	Whakarau Trib at Whakarau Rd	Median	0.153	Medium (Model)	0.020	0.152	0.152	0.152
		% load	-	-	86.9%	0.19%	0.47%	0.75%
Uawa	Hikuwai River at Willowflat	Median	0.036	High	0.010	0.036	0.035	0.035
		% load	-	-	73.1%	1.02%	2.59%	3.85%
	Mangaheia River at Paroa Road Bridge	Median	0.026	High	0.008	0.026	0.025	0.025
		% load	-	-	70.0%	1.01%	2.62%	3.71%
	Mangakino Str at Mangatokerau Rd	Median	0.089	Medium (Model)	0.050	0.088	0.085	0.084
		% load	-	-	43.6%	1.58%	4.22%	5.28%
	Mangahauini River at Tokomaru Bay	Median	0.037	Medium (Model)	0.006	0.037	0.037	0.036
		% load	-	-	82.9%	0.81%	2.03%	3.22%
	Anaura Bay Nth Lagoon	Median	0.033	Medium (Model)	0.012	0.033	0.032	0.032
		% load	-	-	62.5%	0.72%	1.84%	2.67%
	Hikuwai River at No 4 Bridge	Median	0.022	Medium (Model)	0.006	0.022	0.021	0.021

Planning area	Site	Metric	Current state		Scenarios			
			Concentration (mg/L)	Confidence	Afforestation	Modelled 20240	Modelled 2060	Modelled 2080
	Waiau River at Tauwhareparae	% load	-	-	73.1%	1.07%	2.74%	4.07%
		Median	0.040	Medium (Model)	0.011	0.039	0.038	0.038
		% load	-	-	73.0%	1.26%	3.25%	4.68%
	Uawa River at SH35 Bridge	Median	0.026	Medium (Model)	0.007	0.026	0.025	0.025
		% load	-	-	73.7%	0.88%	2.24%	3.28%
	Waiotu Str at Waiotu Rd Bridge	Median	0.058	Medium (Model)	0.011	0.058	0.057	0.056
		% load	-	-	80.2%	0.74%	1.85%	2.96%
	Makokomuka Str at Waiapu Rd	Median	0.033	Medium (Model)	0.009	0.033	0.033	0.032
		% load	-	-	73.2%	0.52%	1.30%	2.08%
	Karoronui Str at Anaura Bay Rd	Median	0.033	Medium (Model)	0.014	0.032	0.032	0.031
		% load	-	-	58.2%	1.59%	3.98%	6.36%
Waiapu	Waitekaha Str at Tuparoa Rd	Median	0.041	Medium (Model)	0.006	0.040	0.040	0.039
		% load	-	-	85.3%	1.19%	2.98%	4.77%
	Ihungia River at Ihungia Rd Br	Median	0.043	High	0.016	0.043	0.042	0.041
		% load	-	-	63.0%	1.04%	2.68%	3.88%
	Kouetumara Str at Ihungia Rd	Median	0.036	Medium (Model)	0.017	0.036	0.035	0.035
		% load	-	-	53.4%	1.18%	3.11%	4.09%
	Makarika Str at Makarika Br	Median	0.050	Medium (Model)	0.010	0.049	0.049	0.048
		% load	-	-	80.0%	0.69%	1.73%	2.71%
	Mangaokura Stream	Median	0.023	Medium (Model)	-	-	-	-
		% load	-	-	-	-	-	-
	Mangaoparo River at Mangaoparo Road	Median	0.044	Medium (Model)	0.009	0.043	0.043	0.042

Planning area	Site	Metric	Current state		Scenarios			
			Concentration (mg/L)	Confidence	Afforestation	Modelled 20240	Modelled 2060	Modelled 2080
	Mangaoporo River at Tutumatai Bridge	% load	-	-	80.3%	0.68%	1.71%	2.70%
		Median	0.089	High	0.019	0.088	0.087	0.087
		% load	-	-	78.9%	0.67%	1.69%	2.64%
	Mata River at Aorangi (Makarika Road)	Median	0.073	High	0.017	0.072	0.071	0.070
		% load	-	-	76.2%	0.97%	2.44%	3.80%
	Mata River at Pouturu Br	Median	0.049	High	0.009	0.048	0.047	0.047
		% load	-	-	81.0%	1.25%	3.14%	4.92%
	Mata Upper	Median	0.038	Medium (Model)	0.035	0.038	0.038	0.038
		% load	-	-	7.9%	0.06%	0.17%	0.22%
	Poroporo River at Rangitukia Rd Bridge	Median	0.070	High	0.014	0.070	0.069	0.069
		% load	-	-	79.4%	0.52%	1.31%	2.02%
	Ratahi Lagoon at Sh35 Culvert	Median	0.320	High	0.074	0.320	0.319	0.318
		% load	-	-	77.0%	0.14%	0.35%	0.56%
	Tapuaeroa River at Tapuaeroa Rd	Median	0.085	High	0.015	0.085	0.084	0.084
		% load	-	-	82.2%	0.42%	1.05%	1.69%
	Waiapu River at Rotokautuku Br (SH35)	Median	0.110	High	0.024	0.109	0.108	0.107
		% load	-	-	77.8%	0.81%	2.03%	3.16%
	Waipiro Str at Te Puia	Median	0.045	Medium (Model)	0.013	0.045	0.044	0.044
		% load	-	-	70.5%	0.36%	0.90%	1.39%
	Makarika Str at Keelan Rd	Median	0.048	Medium (Model)	0.011	0.047	0.047	0.046
		% load	-	-	77.9%	0.72%	1.81%	2.81%
	Huitatariki Str	Median	0.045	Medium (Model)	0.033	0.045	0.045	0.044

Planning area	Site	Metric	Current state		Scenarios			
			Concentration (mg/L)	Confidence	Afforestation	Modelled 20240	Modelled 2060	Modelled 2080
Waimata		% load	-	-	26.6%	0.39%	1.05%	1.31%
	Hamanatua Stream at Okitu Bridge	Median	0.056	High	0.019	0.056	0.055	0.055
		% load	-	-	65.5%	0.66%	1.65%	2.64%
	Kopuawahakapata Stream at Hirini St	Median	0.680	High	0.154	0.680	0.680	0.679
		% load	-	-	77.3%	0.02%	0.07%	0.08%
	Pakarae River at Pakarae Station Bridge	Median	0.034	High	0.007	0.034	0.033	0.033
		% load	-	-	78.2%	1.03%	2.59%	3.97%
	Pakarae Trib at Whangara Rd	Median	0.051	Medium (Model)	0.009	0.050	0.050	0.049
			-	-	81.8%	0.82%	2.04%	3.27%
	Pakarae trib Stevens Road	Median	0.042	Medium (Model)	0.008	0.041	0.041	0.040
		% load	-	-	79.9%	1.04%	2.60%	4.15%
	Whakauranga Br at West Ho Rd	Median	0.033	Medium (Model)	0.012	0.033	0.032	0.032
		% load	-	-	64.4%	1.23%	3.17%	4.47%
	Waimata River at Goodwins Rd Bridge	Median	0.043	High	0.013	0.043	0.042	0.042
		% load	-	-	69.2%	0.60%	1.49%	2.38%
	Waimata River at Grant Rd	Median	0.093	High	0.021	0.092	0.090	0.089
		% load	-	-	77.1%	1.21%	3.04%	4.73%
	Waimata River at Monowai Bridge	Median	0.058	High	0.012	0.057	0.056	0.055
		% load	-	-	79.3%	1.33%	3.34%	5.24%
	Wainui Stream at Pare Street	Median	0.270	High	0.076	0.270	0.270	0.269
		% load	-	-	71.9%	0.06%	0.15%	0.24%

Planning area	Site	Metric	Current state		Scenarios			
			Concentration (mg/L)	Confidence	Afforestation	Modelled 20240	Modelled 2060	Modelled 2080
	Hamanatua River at Williamson street	Median	-	-	-	-	-	-
		% load	-	-	65.5%	0.66%	1.65%	2.64%
	Turihaua Stream at Turihaua Station	Median	0.036	Medium (Model)	0.009	0.035	0.035	0.034
		% load	-	-	75.2%	0.91%	2.27%	3.64%
	Pouawa Rv at Christopher Rd Br	Median	0.040	Medium (Model)	0.009	0.039	0.039	0.039
		% load	-	-	78.0%	0.78%	1.99%	2.97%
	Waiomoko River at Andrews Rd Bridge	Median	0.028	Medium (Model)	0.005	0.028	0.028	0.027
		% load	-	-	81.0%	0.91%	2.29%	3.59%
	Sponge Bay Beach CHNES005	Median	0.086	Medium (Model)	0.024	0.086	0.086	0.086
		% load	-	-	72.2%	0.00%	0.00%	0.00%
	Turihaua Bridge at D/S SH35 Bridge	Median	0.029	Medium (Model)	0.007	0.029	0.029	0.028
		% load	-	-	75.8%	0.93%	2.32%	3.71%
	Wainui Str at Heath Johnston Park	Median	0.128	Medium (Model)	0.031	0.128	0.128	0.128
		% load	-	-	76.0%	0.01%	0.02%	0.03%
	Makahakaha Stream	Median	0.041	Medium (Model)	0.019	0.040	0.039	0.038
		% load	-	-	54.2%	2.00%	5.26%	6.92%
	Waiomoko River at SH35 Bridge	Median	0.062	Medium (Model)	0.010	0.062	0.062	0.062
		% load	-	-	84.4%	0.14%	0.36%	0.58%
Wharekahika - Waikura	Awatere River at SH35 Bridge	Median	0.060	High	0.019	0.060	0.059	0.059
		% load	-	-	67.8%	0.54%	1.39%	2.03%
	Kopuapunamu Str Trib at Te Araroa	Median	0.033	Medium (Model)	0.017	0.033	0.033	0.033
		% load	-	-	47.0%	0.38%	0.95%	1.52%

Planning area	Site	Metric	Current state		Scenarios			
			Concentration (mg/L)	Confidence	Afforestation	Modelled 20240	Modelled 2060	Modelled 2080
	Karakatuwhero River at SH35 Br	Median	0.049	High	0.020	0.049	0.049	0.048
		% load	-	-	60.1%	0.32%	0.83%	1.18%
	Karakatuwhero Trib at Karakatuwhero Rd	Median	0.032	Medium (Model)	0.007	0.031	0.031	0.031
		% load	-	-	78.2%	0.74%	1.85%	2.95%
	Lottin Point Road Stream	Median	0.040	Medium (Model)	0.011	0.040	0.040	0.040
		% load	-	-	73.2%	0.50%	1.24%	1.99%
	Mangatutu Str at Sh35-Waipahuru Bridge	Median	0.022	High	0.005	0.022	0.022	0.022
		% load	-	-	78.8%	0.49%	1.24%	1.98%
	Oweka River at SH35 Bridge	Median	0.051	High	0.009	0.051	0.050	0.050
		% load	-	-	82.7%	0.48%	1.20%	1.90%
	Wharekahika River U/S of Wharf Bridge	Median	0.061	High	0.011	0.060	0.060	0.059
		% load	-	-	81.8%	0.47%	1.18%	1.88%
	Whangaparoa Trib at Waikura Road	Median	-	-	-	-	-	-
		% load	-	-	82.7%	0.71%	1.77%	2.83%

Table 12: *E. coli* current median NPS-FM attribute state, associated confidence score, and scenario state estimates. All concentrations are in cfu/100 mL. Note – the modelling is based on median values only and therefore, the only grades calculated are A, D and E.

Planning area	Site	Metric	Current state			Scenarios							
			Concentration	State	Confidence	Afforestation		Modelled 2040		Modelled 2060		Modelled 2080	
Te Arai	Te Arai River Bush Intake Above Weir	Median	45	A	Medium (Model)	43	A	44	A	44	A	44	A
		% load	-	-	-	4%	-	0%	-	1%	-	2%	-
	Te Arai River at Pykes Weir	Median	160	D	High	56	A	158	D	154	D	151	D
		% load	-	-	-	65%	-	1%	-	4%	-	6%	-
	Te Arai Rv at Waingake	Median	89	A	Medium (Model)	262	E	97	A	110	A	116	A
		% load	-	-	-	-196%	-	-9%	-	-25%	-	-31%	-
	Te Arai Trib at Waingake Rd	Median	106	A	Medium (Model)	403	E	112	A	123	A	127	A
		% load	-	-	-	-281%	-	-6%	-	-16%	-	-20%	-
	Te Arai Trib at Waugh Rd	Median	174	D	Medium (Model)	49	A	173	D	170	D	168	D
		% load	-	-	-	72%	-	1%	-	2%	-	4%	-
	Waipaoa Trib at Pipihakao Road	Median	332	E	Medium (Model)	61	A	331	E	329	E	328	E
		% load	-	-	-	82%	-	0%	-	1%	-	1%	-
	Te Arai Trib Below Intake Weir	Median	64	A	Medium (Model)	251	D	72	A	85	A	90	A
		% load	-	-	-	-290%	-	-12%	-	-32%	-	-40%	-
Hill Country	Waimata River at Anzac Park	Median	208	D	Medium (Model)-	69	A	206	D	194	D	184	D
		% load	-	-	-	67%	-	1%	-	7%	-	12%	-
	Mangatu River at Omapere Station	Median	99	A	High	19	A	98	A	91	A	87	A
		% load	-	-	-	81%	-	1%	-	8%	-	12%	-
	Urukamuka Stream	Median	102	A	Medium (Model)	21	A	100	A	91	A	85	A
		% load	-	-	-	79%	-	1%	-	11%	-	17%	-
	Waihirere Str at Domain	Median	280	E	High	78	A	278	E	274	E	270	E

Planning area	Site	Metric	Current state			Scenarios								
			Concentr ation	State	Confidence	Afforestation		Modelled 2040		Modelled 2060		Modelled 2080		
Waikato	Waipaoa at Armstrong Rd	% load	-	-	-	72%	-	1%	-	2%	-	3%	-	
		Median	45	A	Medium (Model)	16	A	45	A	41	A	38	A	
		% load	-	-	-	66%	-	2%	-	10%	-	15%	-	
	Parihihonou Str at SH2 Overbridge	Median	251	D	Medium (Model)	42	A	248	D	235	D	226	D	
		% load	-	-	-	83%	-	1%	-	6%	-	10%	-	
	Waihuka River at No3 Br	Median	189	D	Medium (Model)	43	A	187	D	166	D	152	D	
		% load	-	-	-	77%	-	1%	-	12%	-	20%	-	
	Kurunui Str at Holdsworth Br SH2	Median	182	D	Medium (Model)	51	A	180	D	170	D	163	D	
		% load	-	-	-	72%	-	1%	-	7%	-	11%	-	
	Waikohu River at Mahaki Station	Median	130	A	High	28	A	128	A	114	A	104	A	
		% load	-	-	-	79%	-	2%	-	12%	-	20%	-	
	Waikohu Rv at Oliver Rd	Median	283	E	Medium (Model)	48	A	281	E	266	E	256	D	
		% load	-	-	-	83%	-	1%	-	6%	-	9%	-	
	Waingaromia River at Terrace Station	Median	130	A	High	63	A	128	A	118	A	111	A	
		% load	-	-	-	52%	-	1%	-	9%	-	15%	-	
	Rere falls	Median	250	D	High	43	A	244	D	233	D	222	D	
		% load	-	-	-	83%	-	2%	-	7%	-	11%	-	
	Rere rockslide (top)	Median	250	D	High	44	A	244	D	232	D	221	D	
		% load	-	-	-	82%	-	2%	-	7%	-	12%	-	
	Waihuka at No2 Br	Median	186	D	Medium (Model)	52	A	186	D	185	D	184	D	
		% load	-	-	-	72%	-	0%	-	1%	-	1%	-	
			Median	270	E	High	63	A	266	E	232	D	209	D

Planning area	Site	Metric	Current state			Scenarios							
			Concentr ation	State	Confidence	Afforestation		Modelled 2040		Modelled 2060		Modelled 2080	
	Wharekopae River at Rangimoe	% load	-	-	-	77%	-	2%	-	14%	-	23%	-
	Wharekopae above falls	Median	268	E	Medium (Model)	44	A	262	E	250	D	240	D
		% load	-	-	-	84%	-	2%	-	6%	-	10%	-
	Waipaoa River at Kanakanaia	Median	280	E	High	81	A	277	E	253	D	237	D
		% load	-	-	-	71%	-	1%	-	10%	-	15%	-
	Mangaoai Str at Mangaoai Rd	Median	102	A	Medium (Model)	65	A	101	A	101	A	99	A
		% load	-	-	-	36%	-	0%	-	1%	-	3%	-
	Waikohu Trib at Whakarau Rd	Median	170	D	Medium (Model)	47	A	169	D	167	D	166	D
		% load	-	-	-	72%	-	1%	-	2%	-	2%	-
	Mangatu Trib	Median	36	A	Medium (Model)	18	A	36	A	35	A	35	A
		% load	-	-	-	51%	-	1%	-	4%	-	5%	-
Poverty Bay Flats	Waipaoa River at Matawhero Bridge	Median	410	E	High	124	A	406	E	399	E	393	E
		% load	-	-	-	70%	-	1%	-	3%	-	4%	-
	Waipaoa River at Railway Bridge	Median	176	D	Medium (Model)	49	A	176	D	176	D	176	D
		% load	-	-	-	72%	-	0%	-	0%	-	0%	-
	Taruhuru River at Tuckers Rd Bridge	Median	820	E	High	201	D	815	E	774	E	747	E
		% load	-	-	-	75%	-	1%	-	6%	-	9%	-
	Whakaahu Str at Brunton Rd	Median	120	A	High	37	A	119	A	117	A	115	A
		% load	-	-	-	69%	-	1%	-	3%	-	4%	-
	Waikohu River at No3 Br	Median	173	D	Medium (Model)	48	A	171	D	157	D	147	D
		% load	-	-	-	72%	-	1%	-	9%	-	15%	-
		Median	222	D	Medium (Model)	48	A	220	D	218	D	216	D

Planning area	Site	Metric	Current state			Scenarios							
			Concentr ation	State	Confidence	Afforestation		Modelled 2040		Modelled 2060		Modelled 2080	
Urban	Waipaoa Trib at Lavenham-Humphrey Rd	% load	-	-	-	79%	-	1%	-	1%	-	2%	-
	Waikakariki Trib at Quarry	Median	156	D	Medium (Model)	263	E	162	D	171	D	175	D
		% load	-	-	-	-69%	-	-4%	-	-10%	-	-13%	-
	Turanganui River at Gladstone Rd Bridge	Median	255	D	High	48	A	254	D	237	D	227	D
		% load	-	-	-	81%	-	1%	-	7%	-	11%	-
	Turanganui River at The Cut	Median	42	A	High	4	A	42	A	41	A	41	A
		% load	-	-	-	90%	-	0%	-	1%	-	2%	-
	Awapuni Drain Site 6 U/S Of Rayonier at Fenceline	Median	265	E	High	44	A	264	E	263	E	262	E
		% load	-	-	-	83%	-	0%	-	1%	-	1%	-
	Taruhuru River at Lytton Rd Bridge	Median	605	E	High	125	A	602	E	566	E	542	E
		% load	-	-	-	79%	-	1%	-	6%	-	10%	-
	Taruhuru River at Peel St Bridge	Median	120	A	High	22	A	119	A	112	A	107	A
		% load	-	-	-	81%	-	1%	-	7%	-	11%	-
	Taruhuru River at Wi Pere Pipe	Median	295	E	High	57	A	293	E	276	E	265	E
		% load	-	-	-	81%	-	1%	-	6%	-	10%	-
Waikanae Creek at Grey St Bridge	Median	310	E	High	32	A	309	E	306	E	304	E	
	% load	-	-	-	90%	-	0%	-	1%	-	2%	-	
Waikanae Creek at Stanley Rd Bridge	Median	600	E	High	52	A	600	E	600	E	600	E	
	% load	-	-	-	91%	-	0%	-	0%	-	0%	-	
Sisterson Drain Site 1at Wetland Inflow Point	Median	445	E	Medium (Model)	69	A	445	E	445	E	445	E	
	% load	-	-	-	84%	-	0%	-	0%	-	0%	-	
		Median	100	A	High	22	A	97	A	90	A	84	A

Planning area	Site	Metric	Current state			Scenarios							
			Concentr ation	State	Confidence	Afforestation		Modelled 2040		Modelled 2060		Modelled 2080	
Hangaroa - Ruakituri	Hangaroa River at Donneraillie Park	% load	-	-	-	78%	-	3%	-	10%	-	16%	-
	Haupapa Str at Tahora Settlement Rd	Median	196	D	Medium (Model)	36	A	196	D	195	D	194	D
		% load	-	-	-	82%	-	0%	-	1%	-	1%	-
	Mangaotara Str at Tiniroto Rd	Median	157	D	Medium (Model)	39	A	155	D	151	D	147	D
		% load	-	-	-	75%	-	2%	-	4%	-	7%	-
	Papokeka Str at Pehiri	Median	61	A	Medium (Model)	15	A	60	A	59	A	59	A
		% load	-	-	-	76%	-	1%	-	2%	-	4%	-
	Hangaroa River at Waimaha Station	Median	149	D	Medium (Model)	34	A	147	D	142	D	137	D
		% load	-	-	-	77%	-	2%	-	5%	-	8%	-
	Maraetaha Str at No2 Br	Median	128	A	Medium (Model)	125	A	128	A	129	A	128	A
		% load	-	-	-	2%	-	0%	-	-1%	-	0%	-
	Wherowhero Lagoon at Muriwai	Median	197	D	Medium (Model)	42	A	195	D	186	D	180	D
		% load	-	-	-	79%	-	1%	-	5%	-	9%	-
	Mangapoike Trib at Rabbit Road Pump Station	Median	45	A	Medium (Model)	23	A	44	A	43	A	43	A
		% load	-	-	-	48%	-	1%	-	3%	-	3%	-
Motu	Koranga Rv at Koranga Valley Rd	Median	156	D	Medium (Model)	26	A	156	D	154	D	153	D
		% load	-	-	-	83%	-	1%	-	2%	-	2%	-
	Koranga Trib at Rakauaroa Rd	Median	47	A	Medium (Model)	8	A	47	A	47	A	47	A
		% load	-	-	-	84%	-	0%	-	0%	-	0%	-
	Marumoko Str at Marumoko Rd	Median	103	A	Medium (Model)	18	A	103	A	102	A	101	A
		% load	-	-	-	82%	-	0%	-	1%	-	2%	-
	Matawai Stream at Tawai	Median	260	D	High	42	A	260	D	259	D	259	D

Planning area	Site	Metric	Current state			Scenarios							
			Concentr ation	State	Confidence	Afforestation		Modelled 2040		Modelled 2060		Modelled 2080	
Uawa	Motu River above Falls	% load	-	-	-	84%	-	0%	-	0%	-	1%	-
		Median	240	D	High	46	A	239	D	236	D	234	D
		% load	-	-	-	81%	-	1%	-	2%	-	3%	-
	Motu River at Kotare Station Bridge	Median	245	D	High	62	A	243	D	240	D	237	D
		% load	-	-	-	75%	-	1%	-	2%	-	3%	-
	Motu River at Matawai Conservation Area	Median	100	A	High	89	A	100	A	99	A	98	A
		% load	-	-	-	11%	-	0%	-	1%	-	2%	-
	Upper Motu Trib at Mangatu	Median	70	A	Medium (Model)	12	A	70	A	70	A	70	A
		% load	-	-	-	83%	-	0%	-	0%	-	0%	-
	Whakarau Trib at Whakarau Rd	Median	202	D	Medium (Model)	33	A	202	D	202	D	201	D
		% load	-	-	-	84%	-	0%	-	0%	-	1%	-
Uawa	Hikuwai River at Willowflat	Median	110	A	High	55	A	109	A	108	A	106	A
		% load	-	-	-	50%	-	1%	-	2%	-	3%	-
	Mangaheia River at Paroa Road Bridge	Median	66	A	High	32	A	66	A	62	A	60	A
		% load	-	-	-	52%	-	0%	-	5%	-	9%	-
	Mangakino Str at Mangatokerau Rd	Median	87	A	Medium (Model)	229	D	93	A	102	A	105	A
		% load	-	-	-	-162%	-	-6%	-	-16%	-	-20%	-
	Mangahauini River at Tokomaru Bay	Median	93	A	Medium (Model)	23	A	92	A	85	A	81	A
		% load	-	-	-	76%	-	1%	-	9%	-	14%	-
	Anaura Bay Nth Lagoon	Median	102	A	Medium (Model)	41	A	101	A	96	A	92	A
		% load	-	-	-	60%	-	1%	-	6%	-	10%	-
		Hikuwai River at No 4 Bridge	Median	89	A	Medium (Model)	44	A	88	A	87	A	86

Planning area	Site	Metric	Current state			Scenarios							
			Concentration	State	Confidence	Afforestation		Modelled 2040		Modelled 2060		Modelled 2080	
	Waiau River at Tauwhareparae	% load	-	-	-	50%	-	1%	-	2%	-	3%	-
		Median	70	A	Medium (Model)	37	A	69	A	68	A	66	A
		% load	-	-	-	47%	-	1%	-	4%	-	5%	-
	Uawa River at SH35 Bridge	Median	126	A	Medium (Model)	60	A	126	A	119	A	115	A
		% load	-	-	-	52%	-	0%	-	5%	-	9%	-
	Waiotu Str at Waiotu Rd Bridge	Median	143	D	Medium (Model)	28	A	142	D	132	D	125	A
		% load	-	-	-	80%	-	1%	-	8%	-	13%	-
	Makokomuka Str at Waiapu Rd	Median	111	A	Medium (Model)	31	A	110	A	109	A	108	A
		% load	-	-	-	72%	-	1%	-	1%	-	2%	-
	Karoronui Str at Anaura Bay Rd	Median	96	A	Medium (Model)	40	A	94	A	92	A	89	A
		% load	-	-	-	58%	-	2%	-	4%	-	6%	-
Waiapu	Waitekaha Str at Tuparoa Rd	Median	92	A	Medium (Model)	26	A	91	A	89	A	88	A
		% load	-	-	-	72%	-	1%	-	3%	-	4%	-
	Ihungia River at Ihungia Rd Br	Median	155	D	High	77	A	153	D	137	D	126	A
		% load	-	-	-	50%	-	1%	-	12%	-	19%	-
	Kouetumara Str at Ihungia Rd	Median	58	A	Medium (Model)	19	A	58	A	56	A	55	A
		% load	-	-	-	68%	-	1%	-	4%	-	5%	-
	Makarika Str at Makarika Br	Median	88	A	Medium (Model)	35	A	87	A	82	A	78	A
		% load	-	-	-	60%	-	1%	-	7%	-	12%	-
	Mangaokura Stream	Median	8	A	Medium (Model)	8	A	8	A	8	A	8	A
		% load	-	-	-	0%	-	0%	-	5%	-	8%	-
		Median	23	A	Medium (Model)	6	A	23	A	22	A	22	A

Planning area	Site	Metric	Current state			Scenarios							
			Concentr ation	State	Confidence	Afforestation		Modelled 2040		Modelled 2060		Modelled 2080	
	Mangaoparo River at Mangaoparo Road	% load	-	-	-	72%	-	1%	-	4%	-	6%	-
	Mangaoporo River at Tutumatai Bridge	Median	34	A	High	17	A	34	A	33	A	33	A
		% load	-	-	-	51%	-	1%	-	2%	-	4%	-
	Mata River at Aorangi (Makarika Road)	Median	66	A	High	17	A	65	A	61	A	58	A
		% load	-	-	-	75%	-	1%	-	7%	-	12%	-
	Mata River at Pouturu Br	Median	110	A	High	23	A	108	A	101	A	96	A
		% load	-	-	-	79%	-	2%	-	8%	-	13%	-
	Mata Upper	Median	19	A	Medium (Model)	18	A	19	A	19	A	19	A
		% load	-	-	-	10%	-	0%	-	1%	-	2%	-
	Poroporo River at Rangitukia Rd Bridge	Median	150	D	High	62	A	149	D	147	D	145	D
		% load	-	-	-	59%	-	1%	-	2%	-	3%	-
	Ratahi Lagoon at Sh35 Culvert	Median	7	A	High	1	A	7	A	7	A	7	A
		% load	-	-	-	79%	-	0%	-	0%	-	0%	-
	Tapuaeroa River at Tapuaeroa Rd	Median	19	A	High	5	A	19	A	19	A	18	A
		% load	-	-	-	75%	-	1%	-	2%	-	3%	-
	Waiapu River at Rotokautuku Br (SH35)	Median	140	D	High	35	A	138	D	129	A	123	A
		% load	-	-	-	75%	-	1%	-	8%	-	12%	-
	Waipiro Str at Te Puia	Median	106	A	Medium (Model)	53	A	106	A	105	A	104	A
		% load	-	-	-	50%	-	0%	-	1%	-	2%	-
	Makarika Str at Keelan Rd	Median	78	A	Medium (Model)	33	A	77	A	72	A	69	A
% load		-	-	-	57%	-	1%	-	7%	-	11%	-	
Huitatariki Str	Median	13	A	Medium (Model)	9	A	12	A	12	A	12	A	

Planning area	Site	Metric	Current state			Scenarios							
			Concentr ation	State	Confidence	Afforestation		Modelled 2040		Modelled 2060		Modelled 2080	
	Hamanatua River at Williamson street	% load	-	-	-	81%	-	1%	-	8%	-	12%	-
	Turihaua Stream at Turihaua Station	Median	210	D	Medium (Model)	58	A	207	D	198	D	190	D
		% load	-	-	-	72%	-	1%	-	6%	-	9%	-
	Pouawa Rv at Christopher Rd Br	Median	179	D	Medium (Model)	68	A	178	D	176	D	174	D
		% load	-	-	-	62%	-	1%	-	2%	-	3%	-
	Waiomoko River at Andrews Rd Bridge	Median	198	D	Medium (Model)	61	A	196	D	193	D	190	D
		% load	-	-	-	69%	-	1%	-	3%	-	4%	-
	Sponge Bay Beach CHNES005	Median	467	E	Medium (Model)	65	A	467	E	467	E	467	E
		% load	-	-	-	86%	-	0%	-	0%	-	0%	-
	Turihaua Bridge at D/S SH35 Bridge	Median	190	D	Medium (Model)	53	A	188	D	179	D	172	D
		% load	-	-	-	72%	-	1%	-	6%	-	9%	-
	Wainui Str at Heath Johnston Park	Median	686	E	Medium (Model)	64	A	686	E	685	E	685	E
		% load	-	-	-	91%	-	0%	-	0%	-	0%	-
	Makahakaha Stream	Median	86	A	Medium (Model)	130	D	88	A	92	A	92	A
		% load	-	-	-	-52%	-	-3%	-	-7%	-	-7%	-
	Waiomoko River at SH35 Bridge	Median	228	D	Medium (Model)	64	A	227	D	227	D	226	D
		% load	-	-	-	72%	-	0%	-	0%	-	1%	-
Wharekahika - Waikura	Awatere River at SH35 Bridge	Median	40	A	High	15	A	40	A	39	A	39	A
		% load	-	-	-	62%	-	1%	-	2%	-	3%	-
	Kopuapunamu Str Trib at Te Araroa	Median	109	A	Medium (Model)	66	A	108	A	108	A	107	A
		% load	-	-	-	39%	-	0%	-	1%	-	1%	-
		Median	56	A	High	26	A	56	A	51	A	47	A

Planning area	Site	Metric	Current state			Scenarios							
			Concentration	State	Confidence	Afforestation		Modelled 2040		Modelled 2060		Modelled 2080	
	Karakatuwhero River at SH35 Br	% load	-	-	-	54%	-	1%	-	10%	-	16%	-
	Karakatuwhero Trib at Karakatuwhero Rd	Median	105	A	Medium (Model)	39	A	104	A	98	A	94	A
		% load	-	-	-	63%	-	1%	-	7%	-	11%	-
	Lottin Point Road Stream	Median	149	D	Medium (Model)	42	A	149	D	148	D	146	D
		% load	-	-	-	72%	-	0%	-	1%	-	2%	-
	Mangatutu Str at Sh35-Waipahuru Bridge	Median	40	A	High	10	A	39	A	33	A	28	A
		% load	-	-	-	76%	-	1%	-	18%	-	29%	-
	Oweka River at SH35 Bridge	Median	78	A	High	22	A	77	A	73	A	71	A
		% load	-	-	-	71%	-	1%	-	6%	-	9%	-
	Wharekahika River U/S of Wharf Bridge	Median	140	D	High	45	A	139	D	131	D	125	A
		% load	-	-	-	68%	-	1%	-	6%	-	10%	-
	Whangaparoa Trib at Waikura Road	Median	-	-	-	-	-	-	-	-	-	-	-
		% load	-	-	-	72%	-	1%	-	3%	-	4%	-

Table 13: Macroinvertebrate current NPS-FM attribute state (MCI only), associated confidence score, and scenario state estimates.

Planning area	Site	Current state			Scenario estimates			
		MCI	State	Confidence	Afforestation	2040	2060	2080
Te Arai	Te Arai River Bush Intake Above Weir	118	B	High	B	B	-	B
	Te Arai River at Pykes Weir	94	C	High	B	C	C	B
	Te Arai Rv at Waingake	89	D	High	B	D	D	C
	Te Arai Trib at Waingake Rd	100	C	High	B	C	C	B
	Te Arai Trib at Waugh Rd	82	D	High	C	D	D	C
	Waipaoa Trib at Pipiwahakao Road	62	D	High	C	D	D	D
	Te Arai Trib Below Intake Weir	105	C	Medium (Model)	B	C	C	B
Hill country	Waimata River at Anzac Park	77	D	Medium (Model)	-	-	-	-
	Mangatu River at Omapere Station	100	C	High	B	C	C	B
	Urukokamuka Stream	106	C	Medium (Model)	-	-	-	-
	Waihirere Str at Domain	111	B	High	B	B	B	B
	Waipaoa at Armstrong Rd	103	C	High	B	C	C	C
	Parihihonou Str at SH2 Overbridge	113	B	High	B	B	B	B
	Waihuka River at No3 Br	81	D	High	C	D	D	D
	Kurunui Str at Holdsworth Br SH2	59	D	High	C	D	D	D
	Waikohu River at Mahaki Station	104	C	High	C	C	C	C
	Waikohu Rv at Oliver Rd	114	B	High	B	B	B	B
	Waingaromia River at Terrace Station	82	D	High	C	D	D	C
	Rere falls	104	C	Medium (Model)	-	-	-	-
	Rere rockslide (top)	106	C	Medium (Model)	-	-	-	-
	Waihuka at No2 Br	97	C	High	B	C	C	C
	Wharekopae River at Rangimoe	97	C	High	B	C	C	C

Planning area	Site	Current state			Scenario estimates			
		MCI	State	Confidence	Afforestation	2040	2060	2080
	Wharekopae above falls	95	C	High	A	C	C	C
	Waipaoa River at Kanakanaia	71	D	High	C	D	D	C
	Mangaoai Str at Mangaoai Rd	103	C	Medium (Model)	B	C	C	B
	Waikohu Trib at Whakarau Rd	91	C	Medium (Model)	C	D	D	D
	Mangatu Trib	114	B	Medium (Model)	A	C	c	B
Poverty bay flats	Waipaoa River at Matawhero Bridge	77	D	High	D	D	D	D
	Waipaoa River at Railway Bridge	79	D	Medium (Model)	-	-	-	-
	Taruhuru River at Tuckers Rd Bridge	63	D	High	C	D	D	D
	Whakaahu Str at Brunton Rd	68	D	Medium (Model)	B	D	D	C
	Waikohu River at No3 Br	94	C	Medium (Model)	C	D	D	D
	Waipaoa Trib at Lavenham-Humphrey Rd	75	D	Medium (Model)	C	D	D	D
	Waikakariki Trib at Quarry	88	D	Medium (Model)	-	-	-	-
	Turanganui River at Gladstone Rd Bridge	72	D	Medium (Model)	-	-	-	-
	Turanganui River at The Cut	70	D	Medium (Model)	-	-	-	-
Urban	Awapuni Drain Site 6 U/S Of Rayonier at Fenceline	70	D	Medium (Model)	-	-	-	-
	Taruhuru River at Lytton Rd Bridge	72	D	Medium (Model)	-	-	-	-
	Taruhuru River at Peel St Bridge	72	D	Medium (Model)	-	-	-	-
	Taruhuru River at Wi Pere Pipe	72	D	Medium (Model)	-	-	-	-
	Waikanae Creek at Grey St Bridge	70	D	Medium (Model)	-	-	-	-
	Waikanae Creek at Stanley Rd Bridge	76	D	Medium (Model)	-	-	-	-
	Sisterson Drain Site 1at Wetland Inflow Point	75	D	Medium (Model)	-	-	-	-
Hangaroa - ruakituri	Hangaroa River at Donneraile Park	92	C	High	B	C	C	C
	Haupapa Str at Tahora Settlement Rd	102	C	High	A	C	C	C

Planning area	Site	Current state			Scenario estimates			
		MCI	State	Confidence	Afforestation	2040	2060	2080
	Mangaotara Str at Tiniroto Rd	116	B	High	B	B	B	B
	Papokeka Str at Pehiri	117	B	High	A	B	B	B
	Hangaroa River at Waimaha Station	112	B	Medium (Model)	-	-	-	-
	Maraetaha Str at No2 Br	80	D	Medium (Model)	B	D	D	D
	Wherowhero Lagoon at Muriwai	75	D	Medium (Model)	-	-	-	-
	Mangapoike Trib at Rabbit Road Pump Station	113	B	Medium (Model)	-	-	-	-
Motu	Koranga Rv at Koranga Valley Rd	119	B	High	A	B	B	B
	Koranga Trib at Rakauora Rd	118	B	High	A	B	B	B
	Marumoko Str at Marumoko Rd	126	B	High	A	A	A	A
	Matawai Stream at Tawai	95	C	High	B	C	C	C
	Motu River above Falls	107	C	Medium (Model)	A	C	C	C
	Motu River at Kotare Station Bridge	106	C	High	A	C	C	C
	Motu River at Matawai Conservation Area	127	B	High	A	B	B	B
	Upper Motu Trib at Mangatu	124	B	High	A	B	B	B
	Whakarau Trib at Whakarau Rd	106	C	High	A	C	C	C
Uawa	Hikuwai River at Willowflat	83	D	Medium (Model)	C	D	D	C
	Mangaheia River at Paroa Road Bridge	72	D	Medium (Model)	C	D	D	C
	Mangakino Str at Mangatokerau Rd	94	C	High	B	C	C	B
	Mangahauini River at Tokomaru Bay	92	C	Medium (Model)	-	-	-	-
	Anaura Bay Nth Lagoon	96	C	Medium (Model)	-	-	-	-
	Hikuwai River at No 4 Bridge	89	D	Medium (Model)	C	D	D	C
	Waiau River at Tauwhareparae	97	C	Medium (Model)	B	C	C	B
	Uawa River at SH35 Bridge	80	D	Medium (Model)	-	-	-	-

Planning area	Site	Current state			Scenario estimates			
		MCI	State	Confidence	Afforestation	2040	2060	2080
Waiapu	Waiotu Str at Waiotu Rd Bridge	89	D	Medium (Model)	-	-	-	-
	Makokomuka Str at Waiapu Rd	98	C	Medium (Model)	-	-	-	-
	Karoronui Str at Anaura Bay Rd	106	C	Medium (Model)	-	-	-	-
	Waitekaha Str at Tuparoa Rd	99	C	High	B	C	C	B
	Ihungia River at Ihungia Rd Br	97	C	High	B	C	C	C
	Kouetumara Str at Ihungia Rd	92	C	High	A	C	C	B
	Makarika Str at Makarika Br	92	C	Medium (Model)	-	-	-	-
	Mangaokura Stream	145	A	High	A	A	A	A
	Mangaoparo River at Mangaoparo Road	98	C	High	B	C	C	B
	Mangaoporo River at Tutumatai Bridge	102	C	High	B	C	C	B
	Mata River at Aorangi (Makarika Road)	104	C	Medium (Model)	B	C	C	B
	Mata River at Pouturu Br	89	D	High	B	D	D	C
	Mata Upper	148	A	High	A	A	A	A
	Poroporo River at Rangitukia Rd Bridge	94	C	High	B	C	C	C
	Ratahi Lagoon at Sh35 Culvert	100	C	Medium (Model)	-	-	-	-
	Tapuaeroa River at Tapuaeroa Rd	108	C	Medium (Model)	-	-	-	-
	Waiapu River at Rotokautuku Br (SH35)	104	C	High	B	C	C	B
	Waipiro Str at Te Puia	90	C	High	B	C	C	C
	Makarika Str at Keelan Rd	89	D	Medium (Model)	B	D	D	C
Waimata	Huitatariki Str	124	B	Medium (Model)	A	B	B	A
	Hamanatua Stream at Okitu Bridge	75	D	Medium (Model)	-	-	-	-
	Kopuawhakapata Stream at Hirini St	74	D	Medium (Model)	-	-	-	-
	Pakarae River at Pakarae Station Bridge	72	D	Medium (Model)	A	D	D	C

Planning area	Site	Current state			Scenario estimates			
		MCI	State	Confidence	Afforestation	2040	2060	2080
	Pakarae Trib at Whangara Rd	76	D	High	C	D	D	C
	Pakarae trib Stevens Road	92	C	High	B	C	C	B
	Whakauranga Br at West Ho Rd	110	B	High	B	C	C	B
	Waimata River at Goodwins Rd Bridge	84	D	High	B	D	D	C
	Waimata River at Grant Rd	76	D	Medium (Model)	-	-	-	-
	Waimata River at Monowai Bridge	79	D	High	A	D	D	C
	Wainui Stream at Pare Street	72	D	Medium (Model)	-	-	-	-
	Hamanatua River at Williamson street	-	-	-	-	-	-	-
	Turihaua Stream at Turihaua Station	77	D	Medium (Model)	-	-	-	-
	Pouawa Rv at Christopher Rd Br	79	D	Medium (Model)	-	-	-	-
	Waiomoko River at Andrews Rd Bridge	77	D	Medium (Model)	-	-	-	-
	Sponge Bay Beach CHNES005	74	D	Medium (Model)	-	-	-	-
	Turihaua Bridge at D/S SH35 Bridge	77	D	Medium (Model)	-	-	-	-
	Wainui Str at Heath Johnston Park	73	D	Medium (Model)	A	D	D	D
	Makahakaha Stream	97	C	Medium (Model)	B	C	C	B
	Waiomoko River at SH35 Bridge	82	D	Medium (Model)	-	-	-	-
Wharekahika - Waikura	Awatere River at SH35 Bridge	94	C	High	B	C	C	B
	Kopuapunamu Str Trib at Te Araroa	103	C	High	B	C	C	B
	Karakatuwhero River at SH35 Br	92	C	High	B	C	C	C
	Karakatuwhero Trib at Karakatuwhero Rd	102	C	High	B	C	C	B
	Lottin Point Road Stream	110	B	High	B	B	B	B
	Mangatutu Str at Sh35-Waipahuru Bridge	119	B	High	B	B	B	B

Planning area	Site	Current state			Scenario estimates			
		MCI	State	Confidence	Afforestation	2040	2060	2080
	Oweka River at SH35 Bridge	102	C	High	B	C	C	B
	Wharekahika River U/S of Wharf Bridge	111	B	High	B	B	B	B
	Whangaparoa Trib at Waikura Road	84	D	High	B	D	D	C

Table 14: Deposited fine sediment current NPS-FM attribute state, associated confidence score, and scenario state estimates.

Planning area	Site	Current state			Scenario estimates							
		%cover	State	Confidence	Afforestation		2040	2060		2080		
Te Arai	Te Arai River Bush Intake Above Weir	45	D	Medium - one off measure with support from RHA data but way above BL	13	B	43	D	37	D	29	D
	Te Arai River at Pykes Weir	80	D	Medium - one off measure with support from RHA data but way above BL	-	-	-	-	-	-	-	-
	Te Arai Rv at Waingake	21	C	Medium - one off measure with support from RHA data, small exotic forest tributary	-	-	-	-	-	-	-	-
	Te Arai Trib at Waingake Rd	56	D	Medium - one off measure with support from RHA data but way above BL	-	-	-	-	-	-	-	-
	Te Arai Trib at Waugh Rd	33	D	Medium - one off measure with support from RHA data but way above BL	-	-	-	-	-	-	-	-
	Waipaoa Trib at Pipiwahakao Road	57	D	Medium - one off measure with support from RHA data but way above BL, classified as SB	-	-	-	-	-	-	-	-
	Te Arai Trib Below Intake Weir	74	D	Medium - one off measure with support from RHA data but way above BL	-	-	-	-	-	-	-	-
Hill country	Waimata River at Anzac Park	-	-	-	-	-	-	-	-	-	-	-
	Mangatu River at Omapere Station	22	C	Medium - one off measure with support from RHA data	7	A	19	C	16	B	13	B
	Urukokamuka Stream	-	-	-	-	-	-	-	-	-	-	-
	Waihirere Str at Domain	52	D	Medium - one off measure with support from RHA data	-	-	-	-	-	-	-	-
	Waipaoa at Armstrong Rd	21	C	Medium - one off measure with support from RHA data	9	A	20	C	16	B	13	B
	Parihihonou Str at SH2 Overbridge	71	D	Medium - one off measure with support from RHA data, way beyond BL	-	A	-	D	-	D	-	D

Planning area	Site	Current state			Scenario estimates							
		%cover	State	Confidence	Afforestation		2040		2060		2080	
	Waihuka River at No3 Br	100	D	Medium - one off measure with support from RHA data, way beyond BL	15	B	94	D	80	D	62	D
	Kurunui Str at Holdsworth Br SH2	-	-	-	-	-	-	-	-	-	-	-
	Waikohu River at Mahaki Station	42	D	Medium - one off measure with support from RHA data, way beyond BL	6	A	40	D	33	D	25	C
	Waikohu Rv at Oliver Rd	65	D	Medium - one off measure with support from RHA data, way beyond BL	11	B	62	D	54	D	42	D
	Waingaromia River at Terrace Station	74	D	Medium - one off measure with support from RHA data, way beyond BL	16	B	67	D	48	D	30	D
	Rere falls	-	-	-	-	-	-	-	-	-	-	-
	Rere rockslide (top)	-	-	-	-	-	-	-	-	-	-	-
	Waihuka at No2 Br	54	-	High		-		-		-		-
	Wharekopae River at Rangimoe	58	D	Medium - one off measure with support from RHA data, way beyond BL	12	A	55	D	47	D	37	D
	Wharekopae above falls	94	D	Medium - one off measure with support from RHA data, way beyond BL	17	B	89	D	75	D	58	D
	Waipaoa River at Kanakanaia	39	-	High		-		-		-		-
	Mangaoai Str at Mangaoai Rd	-	-	-		-		-		-		-
	Waikohu Trib at Whakarau Rd	52	-	High	-	-	-	-	-	-	-	-
	Mangatu Trib	-	-	-	-	-	-	-	-	-	-	-
Poverty bay flats	Waipaoa River at Matawhero Bridge	67	D	Medium - one off measure with support from RHA data, way beyond BL	20	B	62	D	50	D	37	D

Planning area	Site	Current state			Scenario estimates							
		%cover	State	Confidence	Afforestation		2040		2060		2080	
	Sisterson Drain Site 1at Wetland Inflow Point	-	-	-	-	-	-	-	-	-	-	-
Hangaroa - ruakituri	Hangaroa River at Donneraille Park	-	-	-	-	-	-	-	-	-	-	-
	Haupapa Str at Tahora Settlement Rd	23	C	Medium - one off measure with support from RHA data	-	-	-	-	-	-	-	-
	Mangaotara Str at Tiniroto Rd	41	D	Medium - one off measure with support from RHA data, way beyond BL	8	A	39	D	33	D	26	C
	Papokeka Str at Pehiri	36	D	Medium - one off measure with support from RHA data, which suggests better condition however way beyond BL	-	-	-	-	-	-	-	-
	Hangaroa River at Waimaha Station	-	-	-	-	-	-	-	-	-	-	-
	Maraetaha Str at No2 Br	77	D	Medium - one off measure with support from RHA data, way beyond BL	31	D	74	D	66	D	56	D
	Wherowhero Lagoon at Muriwai	-	-	-	-	-	-	-	-	-	-	-
	Mangapoike Trib at Rabbit Road Pump Station	-	-	-	-	-	-	-	-	-	-	-
Motu	Koranga Rv at Koranga Valley Rd	22	C	Medium - one off measure with support from RHA data	4	A	21	C	18	B	14	B
	Koranga Trib at Rakauaroa Rd	22	C	Medium - one off measure with support from RHA data	-	A	-	-	-	-	-	-
	Marumoko Str at Marumoko Rd	27	C	Medium - one off measure with support from RHA data, close to BL	-	A	-	-	-	-	-	-
	Matawai Stream at Tawai	50	D	Medium - one off measure with support from RHA data, way beyond BL	-	C	-	D	-	D	-	D

Planning area	Site	Current state			Scenario estimates							
		%cover	State	Confidence	Afforestation		2040		2060		2080	
	Waiotu Str at Waiotu Rd Bridge	-	-	-	-	-	-	-	-	-	-	-
	Makokomuka Str at Waiapu Rd	-	-	-	-	-	-	-	-	-	-	-
	Karoronui Str at Anaura Bay Rd	-	-	-	-	-	-	-	-	-	-	-
Waiapu	Waitekaha Str at Tuparoa Rd	17	B	Medium - one off measure with support from RHA data	-	-	-	-	-	-	-	-
	Ihungia River at Ihungia Rd Br	62	D	Medium - one off measure with support from RHA data	14	B	58	D	45	D	33	D
	Kouetumara Str at Ihungia Rd	66	D	Medium - one off measure with support from RHA data	-	-	-	-	-	-	-	-
	Makarika Str at Makarika Br	-	-	-	-	-	-	-	-	-	-	-
	Mangaokura Stream	13	A	Medium - one off measure with support from RHA data	2	A	13	A	8	A	2	A
	Mangaoparo River at Mangaoparo Road	12	A	Medium - one off measure with support from RHA data	4	A	11	A	8	A	5	A
	Mangaoporo River at Tutumatai Bridge	10	A	Medium - one off measure with support from RHA data	4	A	9	A	8	A	6	A
	Mata River at Aorangi (Makarika Road)	-	-	-	-	-	-	-	-	-	-	-
	Mata River at Pouturu Br	25	C	Medium - one off measure with support from RHA data	5	A	23	C	18	B	13	B
	Mata Upper	11	A	Medium - one off measure with support from RHA data	-	-	-	-	-	-	-	-
	Poroporo River at Rangitukia Rd Bridge	32	D	Medium - one off measure with support from RHA data	11	B	30	D	26	C	21	C

Planning area	Site	Current state			Scenario estimates							
		%cover	State	Confidence	Afforestation		2040		2060		2080	
Waimata	Ratahi Lagoon at Sh35 Culvert	-	-	-	-	-	-	-	-	-	-	-
	Tapuaeroa River at Tapuaeroa Rd	-	-	-	-	-	-	-	-	-	-	-
	Waiapu River at Rotokautuku Br (SH35)	31	D	Medium - one off measure with support from RHA data	10	A	29	D	23	C	18	B
	Waipiro Str at Te Puia	99	D	Medium - one off measure with support from RHA data	-	-	-	-	-	-	-	-
	Makarika Str at Keelan Rd	-	-	-	-	-	-	-	-	-	-	-
	Huitatariki Str	-	-	-	-	-	-	-	-	-	-	-
	Hamanatua Stream at Okitu Bridge	-	-	-	-	-	-	-	-	-	-	-
	Kopuawhakatapa Stream at Hirini St	-	-	-	-	-	-	-	-	-	-	-
	Pakarae River at Pakarae Station Bridge	81	D	Medium - one off measure with support from RHA data, way above BL	14	B	76	D	63	D	49	D
	Pakarae Trib at Whangara Rd	36	D	Medium - one off measure with support from RHA data	-	-	-	-	-	-	-	-
	Pakarae trib Stevens Road	35	D	Medium - one off measure with support from RHA data	-	-	-	-	-	-	-	-
	Whakauranga Br at West Ho Rd	61	D	Medium - one off measure with support from RHA data, way above BL	14	B	59	D	51	D	41	D
	Waimata River at Goodwins Rd Bridge	31	D	Medium - one off measure with support from RHA data	14	B	29	D	25	C	19	C
	Waimata River at Grant Rd	-	-	-	-	-	-	-	-	-	-	-
	Waimata River at Monowai Bridge	63	D	Medium - one off measure with support from RHA data, way above BL	14	B	59	D	50	D	39	D

Planning area	Site	Current state			Scenario estimates							
		%cover	State	Confidence	Afforestation		2040		2060		2080	
	Wainui Stream at Pare Street	-	-	-	-	-	-	-	-	-	-	-
	Hamanatua River at Williamson street	-	-	-	-	-	-	-	-	-	-	-
	Turihaua Stream at Turihaua Station	-	-	-	-	-	-	-	-	-	-	-
	Pouawa Rv at Christopher Rd Br	-	-	-	-	-	-	-	-	-	-	-
	Waiomoko River at Andrews Rd Bridge	-	-	-	-	-	-	-	-	-	-	-
	Sponge Bay Beach CHNES005	-	-	-	-	-	-	-	-	-	-	-
	Turihaua Bridge at D/S SH35 Bridge	-	-	-	-	-	-	-	-	-	-	-
	Wainui Str at Heath Johnston Park	-	-	-	-	-	-	-	-	-	-	-
	Makahakaha Stream	-	-	-	-	-	-	-	-	-	-	-
	Waiomoko River at SH35 Bridge	-	-	-	-	-	-	-	-	-	-	-
Wharekahika - Waikura	Awatere River at SH35 Bridge	20	C	High	14	B	19	C	16	B	13	A
	Kopuapunamu Str Trib at Te Araroa	60	D	Medium - one off measure, way above BL	-	-	-	-	-	-	-	-
	Karakatuwhero River at SH35 Br	43	D	Medium - one off measure, way above BL	14	B	41	D	36	D	31	D
	Karakatuwhero Trib at Karakatuwhero Rd	62	D	Medium - one off measure, way above BL	-	-	-	-	-	-	-	-

Planning area	Site	Current state			Scenario estimates							
		%cover	State	Confidence	Afforestation		2040		2060		2080	
	Lottin Point Road Stream	69	D	Medium - one off measure, way above BL	-	-	-	-	-	-	-	-
	Mangatutu Str at Sh35-Waipahuru Bridge	26	C	Medium - one off measure	-	-	-	-	-	-	-	-
	Oweka River at SH35 Bridge	51	D	Medium - one off measure, way above BL	14	B	48	D	41	D	32	D
	Wharekahika River U/S of Wharf Bridge	34	D	Medium - one off measure	14	B	32	D	28	D	22	C
	Whangaparoa Trib at Waikura Road	66	D	Medium - one off measure, way beyond BL	-	-	-	-	-	-	-	-