Meeting of the Regional Planning Committee

LATE ITEM

Date: Wednesday 19 August 2020

Time: 1.30pm

Venue: Council Chamber
Hawke's Bay Regional Council
159 Dalton Street
NAPIER

Agenda

Item 12

HAWKE'S BAY REGIONAL COUNCIL

REGIONAL PLANNING COMMITTEE

Wednesday 19 August 2020

Subject: OUR HAWKE'S BAY ENVIRONMENT 2013-18 KEY ISSUES REPORT

Reason for Report

1. This item introduces the *Our Hawke's Bay Environment 2013-2018 – Key Issues Report.* This report summarises key issues from a suite of 5-year State of the Environment (SoE) reports recently published by the HBRC Science section for 2013 to 2018 and will be adopted by Council on 26 August for publication.

Background

2. Five-yearly State of the Environment reporting at HBRC has traditionally been delivered via a suite of highly technical reports, with relatively low uptake internally and in the wider community. Technical reports have also been generated by authors working largely in isolation, with little connection made between each domain.
3. This Key Issues report is intended to distil the major findings from the most recent technical reports into a document that makes connections between domains, links issues to HBRC activities and is more easily understood by readers with a fundamental understanding of contemporary environmental issues.
4. Technical reports are listed in Section 5 of the Key Issues report and available at https://www.hbrc.govt.nz/documents-and-forms/ .

Discussion

5. The Key Issues report is placed-based and organises catchments into three subregions:
   - 5.1. Northern
   - 5.2. Heretaunga
   - 5.3. Southern subregions.
6. The report includes key information from technical reports, bounded between an introductory summary at the beginning of each subregional section and a longer summary at the end of each section.
7. This Key Issues report is considered to be a large step in the direction required by the recently published National Policy Statement for Freshwater Management (NPS-FM) 2020. Section 3.30 of the NPS-FM 2020 directs regional councils to publish a report at least every five years, with content including:
   - 7.1. Assessment of attribute states compared with target attribute states
   - 7.2. Likely causes of degraded or degrading freshwater bodies
   - 7.3. Descriptions of environmental pressures on freshwater bodies
   - 7.4. Predictions of changes that are likely to affect water bodies and freshwater ecosystems
   - 7.5. Assessment of regulatory or non-regulatory actions to implement the NPS-FM
   - 7.6. An ecosystem health scorecard that is easily understood by members of the public.

Next Steps

8. In future, rather than developing a suite of largely descriptive technical reports, the HBRC Science section is proposing to publish a State of the Environment synthesis report that is similar to, but more comprehensive than, the 2013-2018 Key Issues report.

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9. Future synthesis reports will fully meet requirements of the NPS-FM and, we believe, will provide more value to Council and Hawke's Bay communities than previous technical reports have achieved.

Decision Making Process

10. Staff have assessed the requirements of the Local Government Act 2002 in relation to this item and have concluded that, as this report is for information only, the decision making provisions do not apply.

Recommendation

That the Regional Planning Committee receives and notes the "draft *Our Hawke's Bay Environment 2013-18 Key Issues Report*".

Authored by:

Dr Jeff Smith
MANAGER SCIENCE

Approved by:

Iain Maxwell
GROUP MANAGER INTEGRATED CATCHMENT MANAGEMENT

Attachment/s

⇩**1** draft Our HB Environment 2013-18 -Key Issues Report

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Our Hawke's Bay Environment

Key Issues Report 2013-2018

July 2020
Hawkes Bay Regional Council Publication No. 5461

HAWKES BAY REGIONAL COUNCIL
TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI

ISSN 2703-2051 (Online)
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Attachment 1

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Environmental Science

Our Hawke's Bay Environment

Key Issues Report 2013-2018

July 2020
Hawkes Bay Regional Council Publication No. 5461

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Telarc. Registered
HBRC Environmental Science Section is ISO 9001:2015 certified

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1 Introduction

This report is a summary of key biophysical information from 5-year (2013-18) State of the Environment (SoE) technical reports published by Hawke's Bay Regional Council (HBRC). This Key Issues report is intended as a ready-reference overview of the most noteworthy issues for Hawke's Bay communities, stakeholders and decision makers.

The technical reports provide much greater details and additional information, including comprehensive reporting of broader environmental indicators. Technical reports are listed in the *Further Information* section at the end of this report and are available for download on the HBRC website[1].

The technical reports cover the following scientific fields that are drawn upon in this Key Issues summary report:

- Air quality and climate
- Land science
- Surface water flows (hydrology)
- Surface water quality and ecology, including lakes
- Groundwater resources and quality
- Marine and coast

To assist Hawke's Bay readers who are most interested in the geographical areas they live, work and play, the report has been structured around three subregions:

- **Northern subregion**. Includes major catchments of the Mohaka and Wairoa Rivers, and the four smaller catchments of Waikari, Aropaoanui, Te Ngarue and Esk.
- **Heretaunga subregion**. Includes the Tūtaekurī, Ahuriri, Ngaruroro and Karamū (TANK) catchments.
- **Southern subregion**. Includes the Tukituki catchment, along with the Pōrangahau River and Southern Coastal catchments.

The locations of these catchments are shown in Figure 1-1.

It is intentional that this report does not have an Executive Summary section. Instead, each subregion has its own summary:

[1] https://www.hbrc.govt.nz/documents-and-forms (accessed 31 May 2020)

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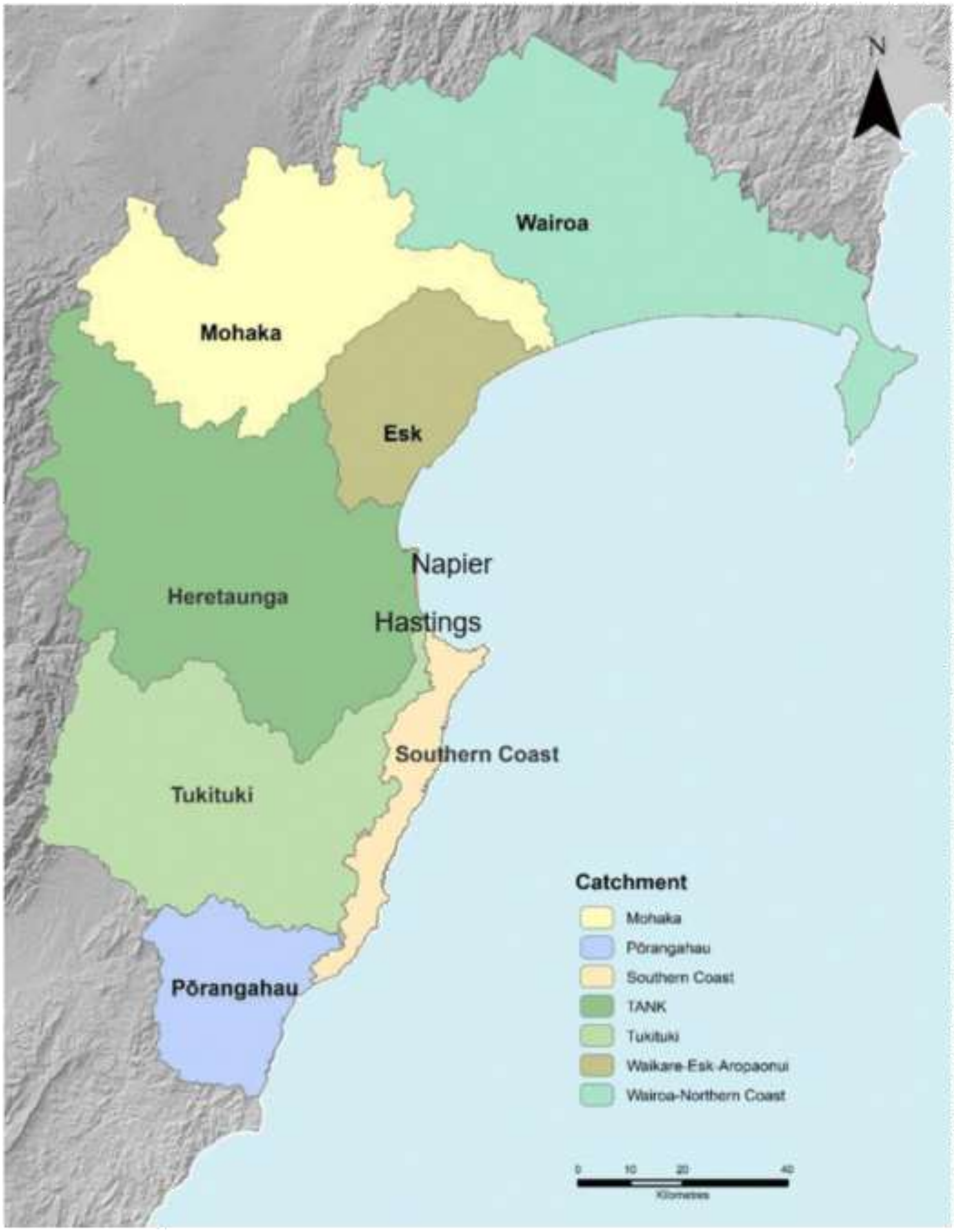

Figure 1-1: Locations of catchment areas that define the three subregions for this report. Northern subregion = Wairoa, Mohaka and Esk; Heretaunga subregion shown in dark green; Southern subregion = Tukituki, Pōrangahau and Southern Coastal catchments.

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1.1 Climate 2013-2018 and climate change

The backdrop to this report is the region's climate, which helps shape the landscape that HBRC oversees and influences the health and productivity of our environment. During the period of this five year report, annual rainfall was mostly close to long-term averages but summers were predominantly drier than normal. Summer rainfall across the region was typically normal or below normal across the region for the five years and biased towards below normal. The reporting period featured an El Niño summer (2015-16) and ended with a La Niña summer (2017-18) which is the one year that had summer rainfall greater than the median.

There were significant storm events, such as a localised downpour in the Esk catchment in March 2018, which delivered 325.5 mm of rain in one day at Glengarry and caused flooding in the area. In April 2017, ex-tropical cyclones Debbie and Cook hit the region in quick succession, bringing significant rain and strong, damaging winds respectively. A severe snow storm occurred in August 2016 (70cm in places) as well as heavy rain that caused slips. All of the hydrological years[2] 2013-14 to 2017-18 had positive mean maximum and minimum temperature anomalies that fell either within the normal range or were above normal (Table 1-1). For example, in 2013-14, the regional average maximum temperature was 0.7°C greater than the long term mean maximum temperature. Also in 2013-14, the regional average minimum temperature was 0.8°C greater than the long term mean minimum temperature. The summer of 2017-18 was remarkably warm, reaching 2-4°C above monthly averages, and driven by a marine heatwave in that season.

Table 1-1: Annual mean maximum and annual mean minimum temperature anomalies for the Hawke's Bay region.

Year	Annual Mean Maximum Temperature Anomaly (°C)	Annual Mean Minimum Temperature Anomaly (°C)
2013-14	0.7	0.8
2014-15	0.1	0.2
2015-16	0.5	0.3
2016-17	0.2	0.4
2017-18	0.5	1.0

As the climate changes under the influence of greenhouse gas emissions we can expect temperatures to increase. We are likely to spend more time in dry conditions as well as experience rainfall events of greater intensity. Climate permeates most aspects of HBRC's operations and underpins many of its strategies and polices but often hasn't been regarded as a resource that HBRC safeguards or manages. That view is changing as the human influence on climate becomes increasingly apparent. This is evident in the declaration of a "climate emergency" in the region and the strategic goal of the region being carbon neutral by 2050. Mitigating the risks of climate change is also foremost in HBRC's strategic goals. They include protecting areas from erosion and flood risk, planning for sea level rise and coastal erosion, and investigating options for water storage.

[2] A hydrological year is from July to June. Hydrological years are used to avoid splitting summer events, which occurs when calendar years are used for analysis.

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1.2 Current statutory context on freshwater limits

Water quality thresholds are used to help describe where water quality may be impacting the values that people hold. In some cases the thresholds may be statutory (e.g. policy statements) regulatory (regional plans) or biological. These thresholds are used throughout the report to provide context to water quality data. This report focuses particularly on the National Policy Statement for Freshwater Management (NPS-FM) and National Objectives Framework (NOF) attributes as key reference points for managing water quality. At the time of writing this report, the NPS-FM was in a process of major reform and this section describes the context around this.

National Policy Statement for Freshwater Management

HBRC is responsible for giving effect to the National Policy Statement for Freshwater Management (NPS-FM) in our region. The NPS-FM includes limit bands within a National Objectives Framework (NOF) for attributes relating to ecosystem health and human health for recreation. There is a requirement to improve or at least maintain the current state of water quality in our waterways.

First introduced in 2011, the NPS-FM has been revised as part of the Government's 2019 Action for healthy waterways proposals and will be in force later this year. The proposed NPS-FM 2020 attribute tables are used in this report, despite it not yet being in force, because the Resource Management Amendment bill has passed its third and final reading in parliament and the NPS-FM 2020 is enacted as part of these freshwater reforms.

There are 22 compulsory attributes in the new NPS-FM, many of which have a minimum standard, or national bottom line. HBRC and community must set target attribute states at or above bottom lines and plan what actions they will take to meet these targets.

As an example, the NPS-FM attribute table for swimmability is shown in Table 1-2. The table is used to identify NOF categories for swimmability using observations of faecal indicator bacteria *Escherichia coli* (commonly abbreviated *E. coli*). The *E. coli* attribute table has five categories, or attribute states (i.e. A, B, C, D and E) that are each associated with a predicted average risk of infection to swimmers based on random exposure on a random day. Actual risk will generally be less if swimming does not occur during high river flows.

Each attribute state has four criteria, or 'statistical tests', that need to be satisfied for water quality to be in that attribute state. Higher attribute states provide lower levels of infection risk for each activity type. All four criteria are necessary to establish an attribute state. If one criterion (or more) can't be satisfied, a lower attribute state must apply.

Where appropriate, results from estuarine and coastal waters of Hawke's Bay are compared to information held for other sites in New Zealand, using reference documents to provide some context as to the approximate level of impact.

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Table 1-2: National Objective Framework (NOF) categories for swimmability attribute under the NPS-FM 2020.

Category	% Exceedances over 540 *E. coli*/100mL	% Exceedances over 260 *E. coli*/100mL	Median *E. coli*/100mL	95th percentile of *E. coli*/100mL
A (Blue) Average infection risk 1%	<5%	<20%	≤ 130	≤540
B (Green) Average infection risk 2%	5-10%	20-30%	≤ 130	≤1000
C (Yellow) Average infection risk 3%	10-20%	20-34%	≤ 130	≤ 1200
D (Orange) Average infection risk >3%	20-30%	>34%	>130	>1200
E (Red) Average infection risk >7%	>30%	>50%	>260	>1200

1.3 Other statutory limits

Groundwater quality measurements in this report are primarily compared with the Drinking Water Standards of New Zealand (DWSNZ) maximum acceptable values (MAV) for water used for human consumption.

The National Environmental Standards for Air Quality (NESAQ) came into effect in 2004 and includes five standards for ambient air quality. In Hawke's Bay, the most relevant ambient standard is for particulate matter that is smaller than 10 microns diameter (PM_{10}). Research has identified that the PM_{10} standard is unlikely to be exceeded in the Northern and Southern subregions, so PM_{10} monitoring is not required in those subregions under the NESAQ.

The Ministry for the Environment has also proposed an amendment to the NESAQ, which would introduce an ambient standard for fine airborne particulates less than 2.5 microns diameter ($PM_{2.5}$). This proposal is a response to growing evidence that exposure to $PM_{2.5}$ is damaging to human health. Although this report does not include $PM_{2.5}$ observations, survey monitoring has suggested that the proposed $PM_{2.5}$ standard may not currently be met in Hastings, Napier, Wairoa and Waipukurau. If the NESAQ amendments are adopted as proposed, additional monitoring would be required in these airsheds to evaluate whether further management of air emissions is required to achieve compliance with the $PM_{2.5}$ ambient air standard.

1.4 Data summaries and visualisation

Box and whisker plots have been used to summarise data from 2013 to 2018 in this report. For water quality in freshwater catchments, the sites are ordered from left to right in descending order based on distance from the sea along the river channel. Sites are grouped by their position in the same major sub-catchment. For example, the Tukituki River at Black Bridge monitoring site is closer to the sea than the Tukituki River at SH50, so the Tukituki River at Black Bridge site appears to the right of the Tukituki River at SH50 monitoring site in the graphs

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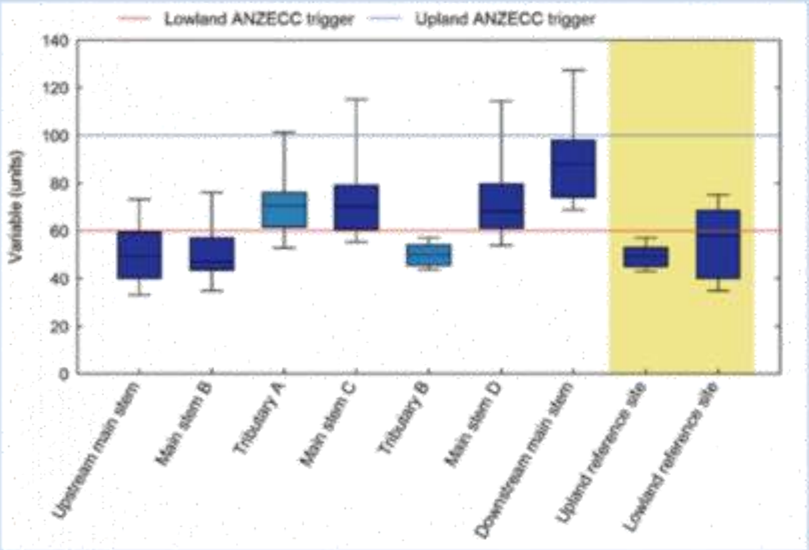
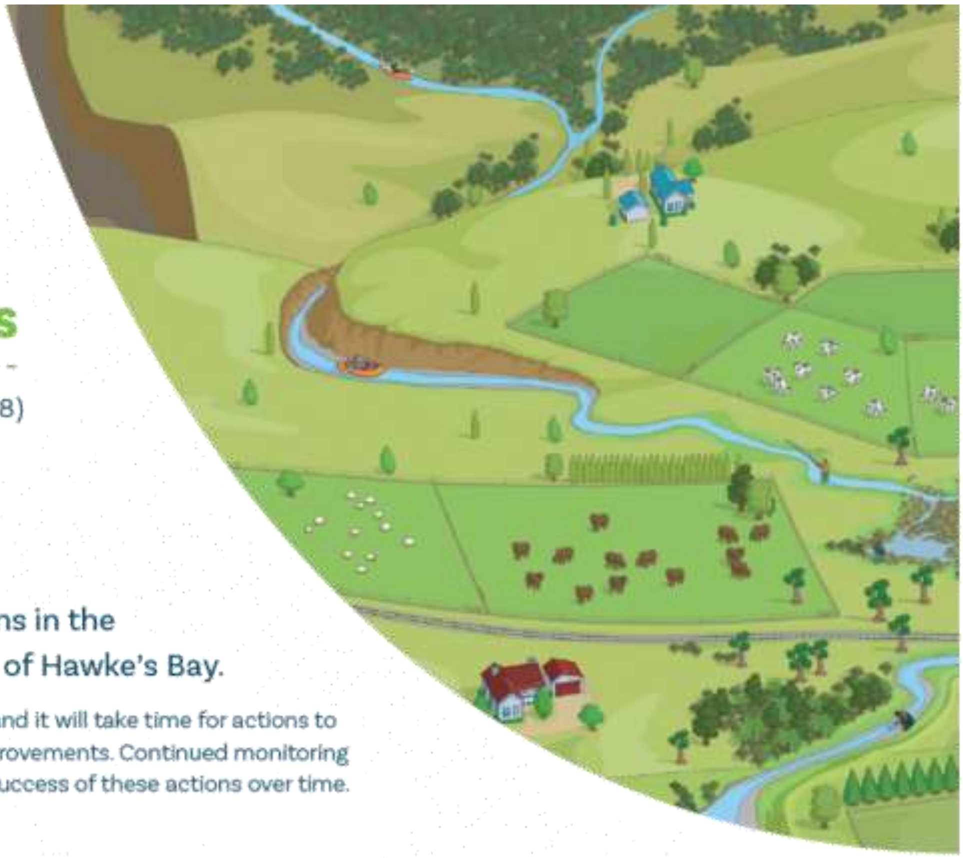
KEY POINT: Box plots graph data as a box representing statistical values. The lower boundary of each box indicates the 25th percentile, a line within the box marks the median, and the higher boundary of each box indicates the 75th percentile. The line at the end of the whiskers (error bars) above and below the box indicate the 90th and 10th percentiles respectively (the whiskers represent the "interdecile" range).



Box plots have also been used to summarise water quality data for coastal and marine environments. Data in these boxplots were collected between November 2016 and June 2018 for estuarine water quality, and for the five-year period between July 2013 and June 2018 for nearshore sites.

Water quality data are also shown on catchment maps, based on the median value of observations taken over the last five years for the water quality indicator in question (from July 2013 to June 2018).



NORTHERN CATCHMENTS

SUMMARY (2013-2018)

Key issues and actions in the Northern sub-region of Hawke's Bay.

These are long-term issues and it will take time for actions to generate environmental improvements. Continued monitoring is essential to evaluate the success of these actions over time.

Key Issues

- River, stream and lake water quality are tied to land use
- Degraded waterway habitats and swimmability are linked to land use
- Nutrients and fine sediment in estuaries are linked to land use
- Groundwater supply is limited and quality is sometimes poor because of smaller, shallow aquifers

Key Actions

- New government rules for freshwater will require stock exclusion from waterways and other actions to improve freshwater quality
- $30 million Erosion Control Scheme targeting 250,000 ha of highly erodible land
- Riparian management programme supports fencing and planting around waterways
- Over $3 million of Regional Council and government Freshwater Improvement funding to improve Whakakī Lake, for a weir, wetland and fencing
- $3.3 million over four years to complete Farm Plans, fencing and planting around Tūtira's lakes – from Regional Council and the government's Freshwater Improvement Fund
- A Regional Council office in Wairoa, delivering support and advice on good land use practices

Te whakapakari tahi i tō tātau **taiao**.
Enhancing our **environment** together.

HAWKES BAY REGIONAL COUNCIL
TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI

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Northern Subregion

The Northern subregion has two major catchments: the Wairoa and Mohaka (Figure 2-1). There are also several smaller catchments in the southern part of this subregion, including the Waikari, Esk, Te Ngarue and the Aropaoanui (Figure 2-1).

The Wairoa catchment extends from the indigenous forest of Te Urewera, including Lake Waikaremoana, to the Pacific Ocean at the town of Wairoa. The catchment is approximately 3,670 km^2 which is the largest in Hawke's Bay. Aside from indigenous forest in the upper parts of the Wairoa catchment, the dominant land use is high producing exotic grassland – i.e. pastoral grazing. A number of coastal catchments in the vicinity of the Wairoa River include the Waihua, Waikatuku, Nuhaka, Kopuawhara and Opoutama. The Waikatuku Stream enters the Rahui channel which drains Whakaki Lake into the ocean.

The Mohaka River is a large river approximately 160 km in length with its headwaters originating in the Kaimanawa Forest Park. It discharges to sea near the Mohaka Settlement 22 km southwest of Wairoa. The river has a catchment of 2440 km^2 and is highly valued for its scenic, cultural, and recreational qualities. A Water Conservation Order (WCO) is in place on the upper part of the Mohaka River upstream of Willow Flat. Generally, the Mohaka catchment has not been subject to intensive land-use pressures and the conservation order was granted in 2004 to protect the outstanding characteristics and features of the Mohaka River.

The combined Waikari, Aropaoanui, Te Ngarue and Esk catchments cover a total area of 815 km^2, with the Waikari River being the largest (at 324 km^2) and Te Ngarue Stream being the smallest (54 km^2) of the four catchments. The Esk River has reasonably good quality habitat for most of its length, with regular riffles, pools and bends and a mostly large cobble/ gravel streambed. Riparian margins are well protected in the upper reaches, however the soft sedimentary geology and steep gorge mean slip erosion contributes a moderate amount of sediment into the river channel. The lower reaches are characterised by less riparian protection with intermittent patches of stream bank erosion.

Te Ngarue stream is a runoff fed system with a steep gradient, moderate velocities and a bed dominated by cobbles and gravel in the upper reaches. In the lower reaches where the gradient is gentler, velocities are slower and the bed is dominated by soft sediments.

In the Aropaoanui catchment, Sandy Creek is spring-fed with slow water and a muddy bottom substrate with some aquatic macrophyte communities. Sandy Creek is an artificial channel diverting flows from Papakiri Stream before it enters Lake Tūtira. This diversion was established in 1980-1981 due to ongoing water quality problems in the lake that were attributed to nutrient enriched water flowing from the Papakiri catchment. Sandy Creek joins the Mahiaruhe Stream at the outlet of Lake Tūtira. The Mahiaruhe Stream forms the outflow of Lake Tūtira, then joins the Waikoau River approximately 2 km south of the lake, and then becomes the Aropaoanui River which flows to the sea approximately 29 km north of Napier.

The Aropaoanui and Waikari rivers are runoff fed systems with moderate water velocities that are dominated by cobble/gravel bottom substrates, interspersed with boulder riffles. Both rivers contain periphyton growth with aquatic macrophytes occasionally appearing at the edges during low flow periods.

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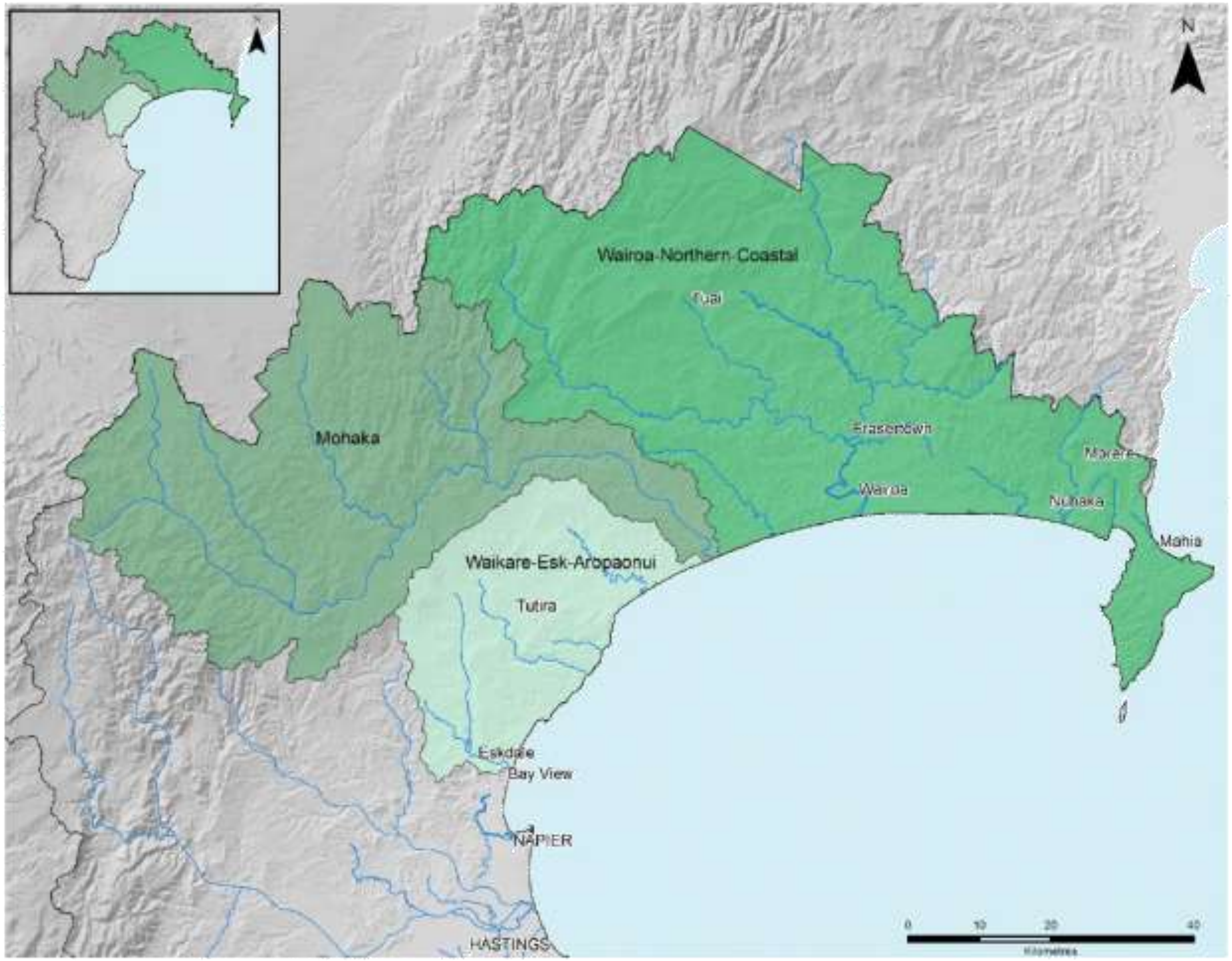

Figure 2-1: Catchments in the Northern subregion.

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The rivers and streams of the Northern Catchment terminate at the coast through the Maungawhio Lagoon, the Wairoa Estuary, and several smaller systems. Estuaries represent the downstream receiving environment of the freshwater drainage network, so it is understandable that they are sensitive to the same effects of land-use activities as streams and rivers throughout the catchment. In New Zealand, estuaries are being recognised as the most at risk coastal environments, as they are the depositional end-point for the cumulative contaminants (e.g. nutrients, sediments) from the surrounding catchment.

Land Science

Many key environmental issues in Hawke's Bay are a consequence of land use that contributes to erosion and discharge of nutrients to waterways.

A SedNetNZ model of the region has been created for HBRC by Manaaki Whenua Landcare Research. The model has identified that the Northern subregion is particularly susceptible to erosion and there are large areas that show high sediment yields (Figure 2-2), with more than 55% of the region's sediment load coming from these catchments. The areas of highly erodible land occur mostly in the steeper headwaters of the Wairoa and Nuhaka catchments, along with steep subcatchments on Mahia Peninsula.

According to the most recent HBRC land use map (Figure 2-3), the main land use type identified in this subregion is sheep and beef, which is about 26.3% of the Northern subregion area. A large area of the subregion is also covered by indigenous forest (32.3% of total area), exotic forest (14.5% of the total area), and also mānuka and/or kānuka (10.4% of the total area).

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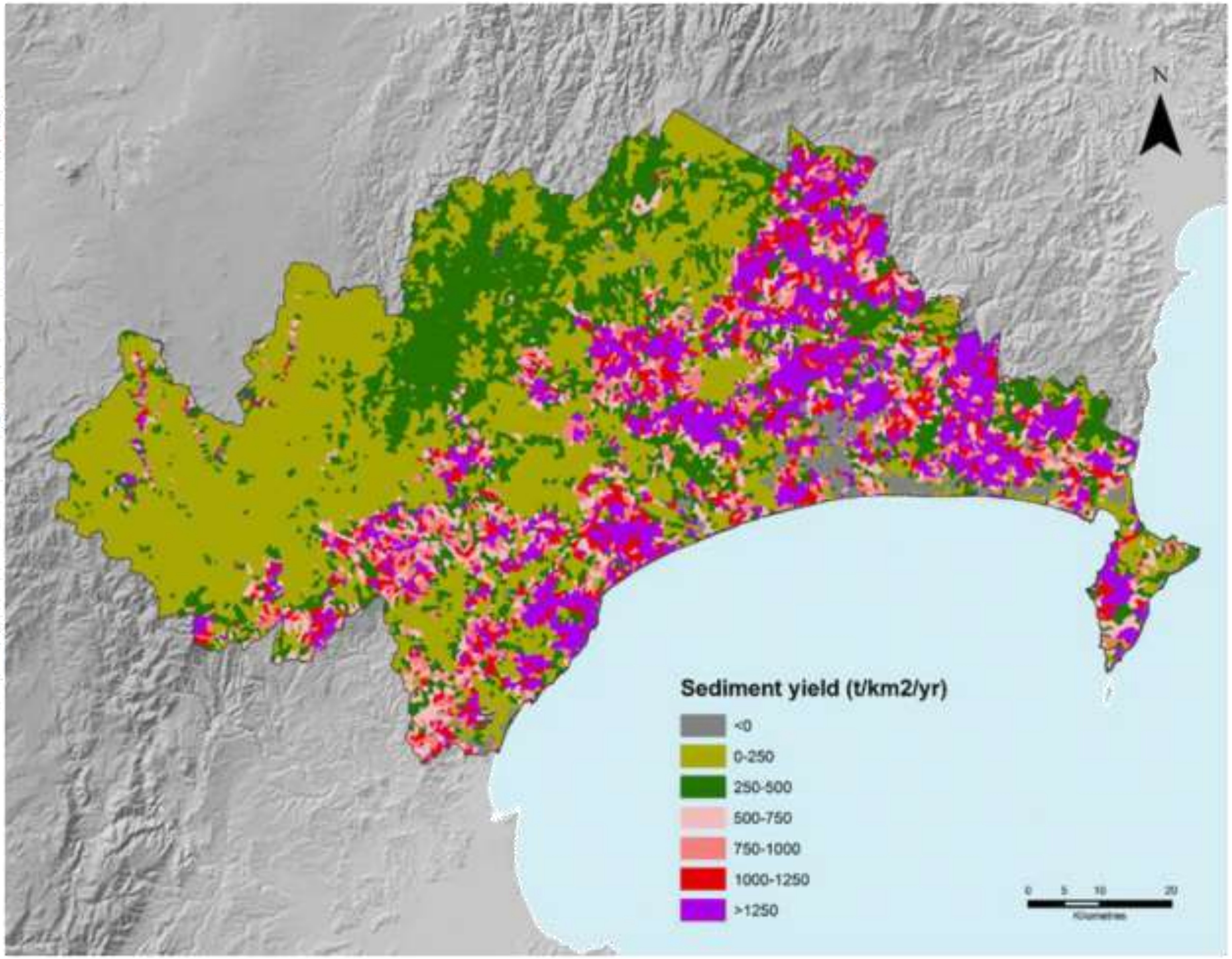

Figure 2-2: Northern Hawke's Bay sediment yield (t/km²/yr) modelled with SedNetNZ for REC2 stream links.

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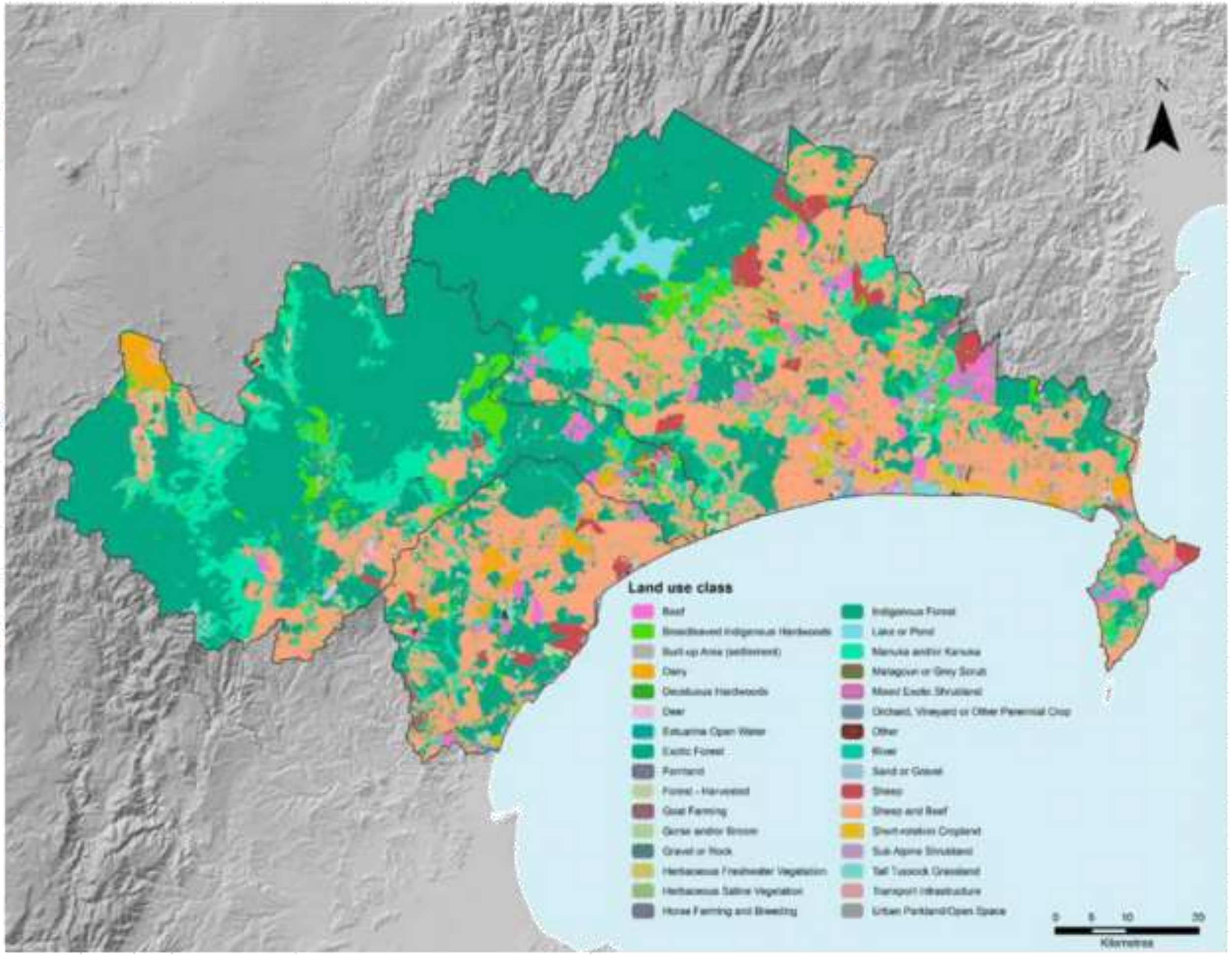

Figure 2-3: Land use map for the Northern subregion, from 2020 data.

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2.1 Water quality

2.1.1 Groundwater quality

Whereas the large alluvial (gravel and sand) aquifer systems of the Heretaunga and Ruataniwha Plains are the most highly productive groundwater systems in Hawke's Bay, smaller localised aquifer systems are also found along river valleys and coastal margins. These include the groundwater resources of the Wairoa River valley, Mahia tombolo and Esk River valley.

For Hawke's Bay, groundwater is influenced by the sedimentary geological environment which includes greywacke, sandstone, limestone and calcareous mudstone. The chemical composition of the geology can influence groundwater quality. Groundwater in Wairoa and Mahia is often dominated by sodium chloride and sodium carbonate, due to well depths close to the inter-tidal area and proximity to the coast.

Compared to aquifer systems of the Ruataniwha and Heretaunga Plains', aquifers in the Northern subregion are minor and there is a much smaller number of wells (Figure 2-4). This is likely to reflect the limited availability and sometimes naturally poorer quality of shallow groundwater in the Northern subregion.

Two aquifers in the Wairoa valley are between 12 m and 22 m deep and approximately 26 m and 54 m deep respectively. There are two main aquifer systems in the Mahia Peninsula area. The Mahia sand aquifer is a strip of sand that connects the mainland with the Mahia Peninsula and the Mahia alluvial aquifer. The aquifer is unconfined and about 20 m deep, with most bores less than 17 m deep. Bores in the sand aquifer are generally used for domestic purposes such as garden watering, washing and toilet flushing and, because it is unconfined, it is at risk of contamination from surface infiltration from rainfall recharge.

A second alluvial aquifer is located at the southern east end of Mahia Beach town and north of Opoutama, with the aquifer composed of sand, silt and clay. Due to the fine-grain sediments, bore yields are likely to be low, which restricts most bores in this aquifer to domestic uses such as garden watering, washing and toilet flushing. Groundwater bores that are drilled into the Mahia rock aquifer are typically used for domestic irrigation of gardens, because the water quality is relatively low due to high dissolved ions.

The locations of bores used by HBRC for monitoring groundwater quality are shown in Figure 2-5.

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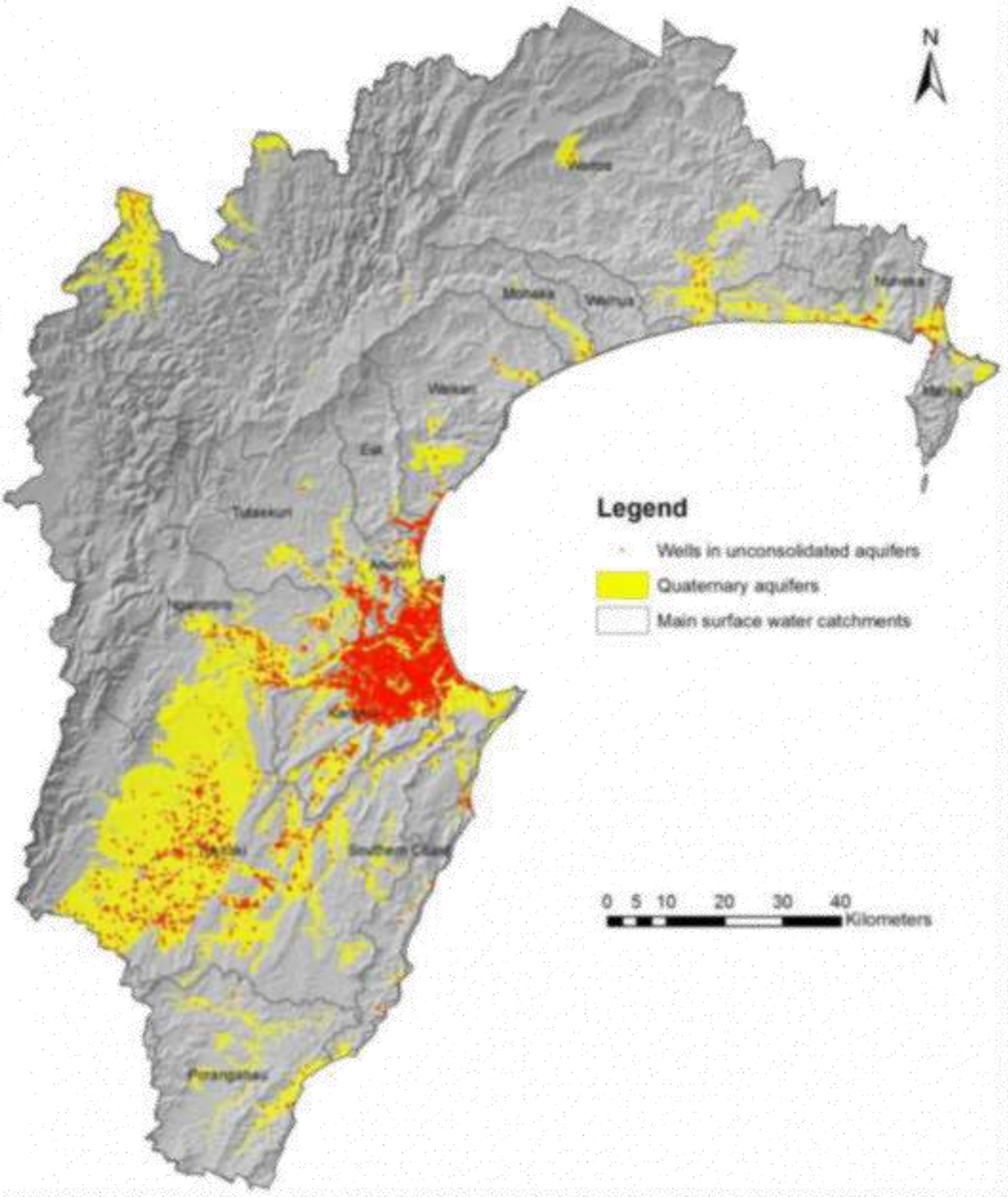

Figure 2-4: Locations of unconsolidated aquifers in Hawke's Bay, along with groundwater wells. Text labels identify surface water catchments.

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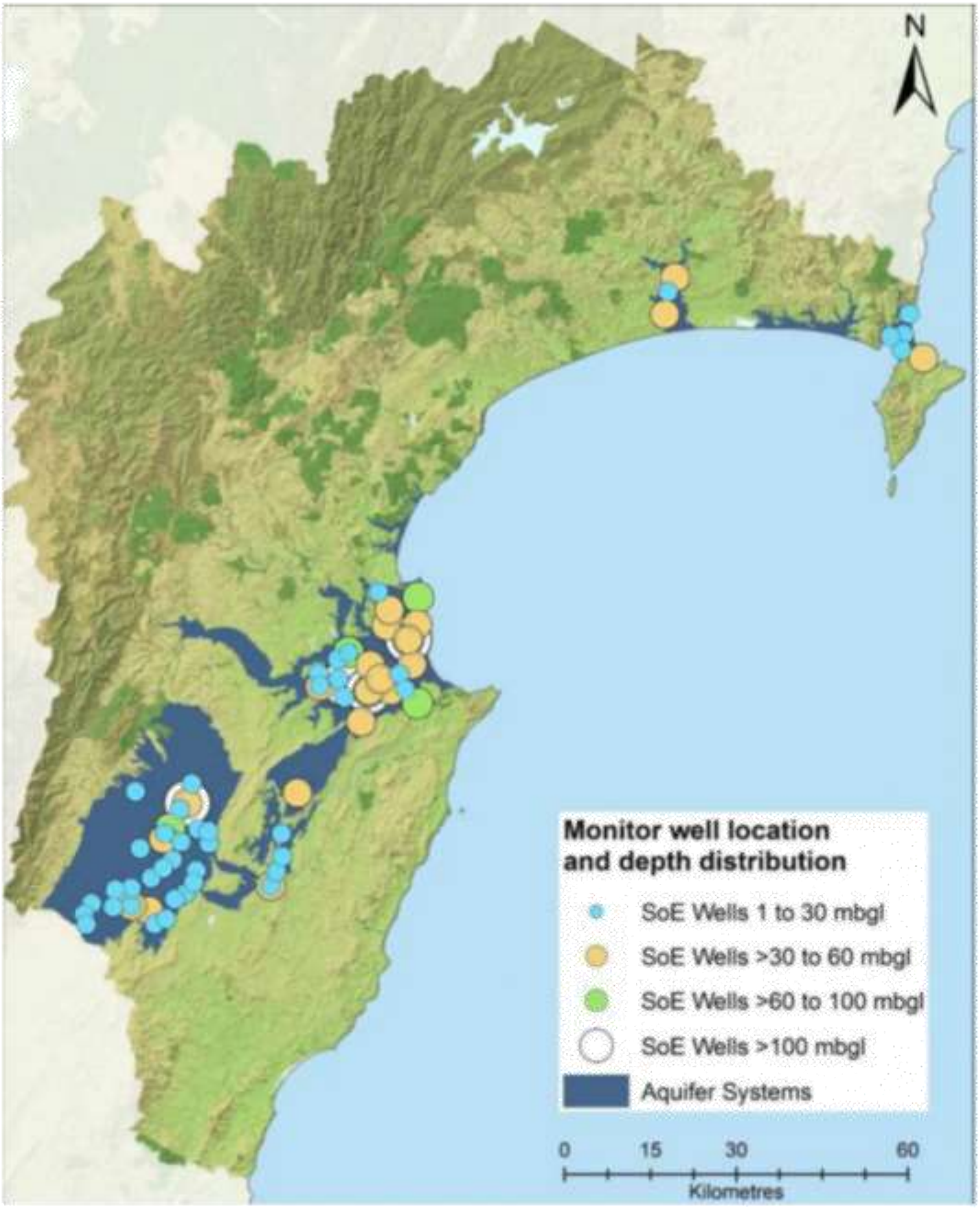

Figure 2-5: Groundwater quality monitor well location and depth distribution. (mbgl = metres below ground level).

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The Drinking Water Standards of New Zealand (DWSNZ) specifies maximum acceptable values (MAV) for determinands in groundwater that is used for drinking water supply. Under the DWSNZ, the MAV for microbial determinands uses levels of *Escherichia coli* (*E. coli*) in water as an indicator for pathogenic contamination. This determinand has a particular focus on drinking water for human consumption without water treatment.

The DWSNZ specify that there shall be no colony forming units (cfu) of *E. coli* per 100 mL of groundwater and this criterion was exceeded at several monitoring bores in the Wairoa and Mahia aquifers (Figure 2-6). *E. coli* in groundwater was commonly detected in shallow bores, screened in unconfined groundwater less than 30m depth below ground level.

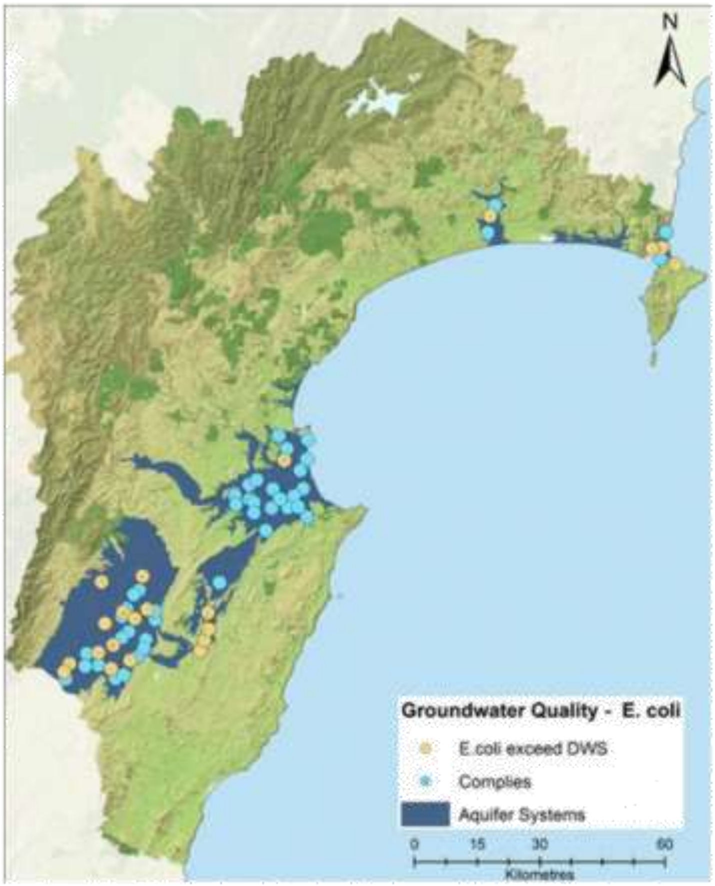

Figure 2-6: SoE well locations showing DWSNZ *E. coli* exceedances and compliance for the Hawke's Bay region between 2013 and 2018. Orange dots have exceeded the DWSNZ for *E. coli* at least once over the 5-year period. Blue dots comply with DWSNZ.

The presence of *E. coli* in these bores is not unexpected: the DWSNZ regards shallow groundwater as equivalent to surface water and Ministry of Health guidance on drinking water management[3] states that "*Surface water is frequently contaminated by micro-organisms*". While not unexpected, the detection of *E.*

[3] Ministry of Health (2017) *Guidelines for Drinking-water Quality Management for New Zealand* (3rd edition). Wellington: Ministry of Health.

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coli in shallow groundwater of the Wairoa and Mahia aquifers demonstrates the vulnerability of the shallow groundwater systems to pathogenic contamination and private bore owners should have their groundwater tested if used for potable supply.

While pathogens may be present in shallow bores, some of the deeper wells in Hawke's Bay have high levels of naturally occurring manganese and some also have naturally occurring arsenic levels that are greater than the DWSNZ MAV. The MAV for manganese was exceeded at three monitoring bores in the Northern subregion, along with an exceedance of arsenic at one monitoring bore (Figure 2-7). Investigations undertaken by HBRC have identified that arsenic and manganese in groundwater is invariably a result of naturally occurring processes within the groundwater system, rather than a contaminant plume generated by human activities. The natural processes occur when arsenic that is found in some rock types is mobilised under certain groundwater conditions that are independent of human activities.

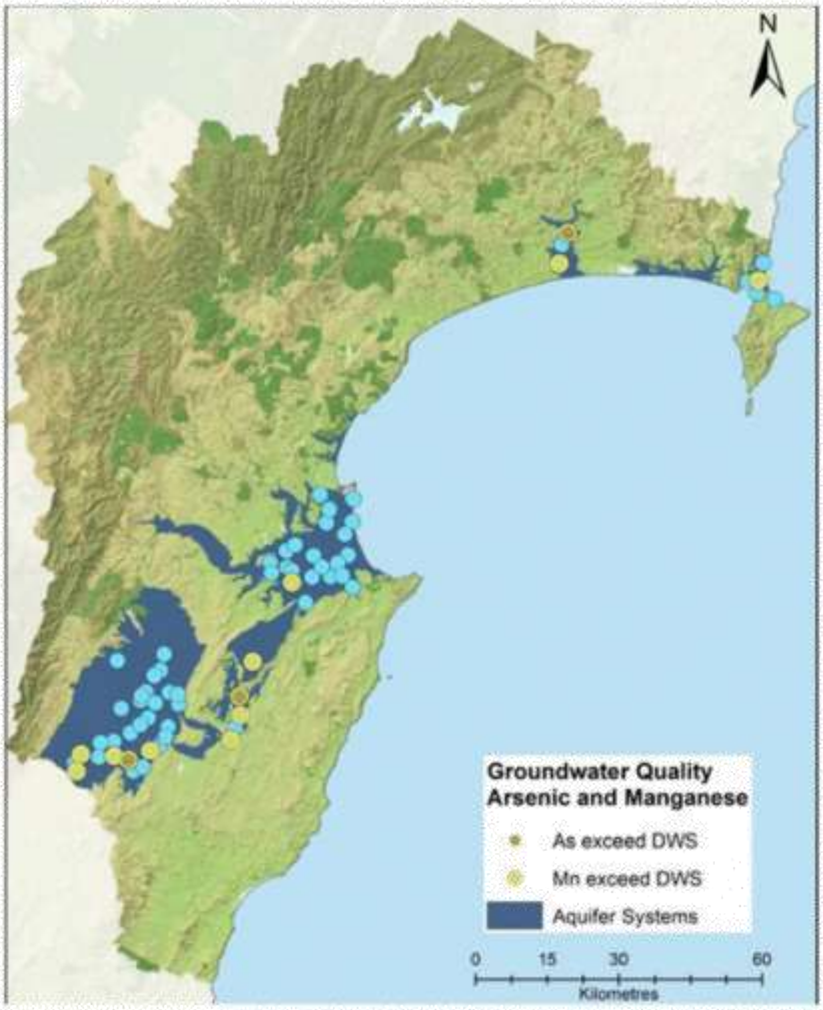

Figure 2-7: Monitor well locations showing where the DWSNZ MAV for arsenic (As) or manganese (Mn) are exceeded. Orange dot - arsenic exceeds DWSNZ MAV 0.010 mg/L. Yellow dot - manganese exceeds DWSNZ MAV 0.40 mg/L. Blue dot - monitor wells that are less than these limits.

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The presence of arsenic in groundwater is not spatially uniform and international research has shown that it is quite common for wells in close proximity to have large variations in arsenic concentrations. Consequently, it isn't possible to identify every location in the Northern subregion aquifers where naturally occurring arsenic may be present in groundwater. This is another reason why it is recommended that private bore owners should have their groundwater tested if it is used for potable supply.

2.1.2 Surface water quality

a) The Wairoa and nearby coastal catchments

The Macroinvertebrate Community Index (MCI) was developed as a biomonitoring tool to assess stream health based on the presence or absence of certain invertebrate species. The MCI of a site can be used to assess the likely level of ecosystem degradation. A higher MCI score indicates that more pollution 'intolerant' or sensitive species are present, and indicates better water quality.

Overall ecological health as characterised by the MCI varied across sites of the Wairoa River and nearby catchments (Figure 2-8). As the MCI provides an integrated view of all aspects of river health, only one site was determined to be of poor quality on that basis (Opoutama Stream – Northern Coastal). The low MCI score for that stream is a consequence of the soft, fine sediment stream bed that does not provide suitable habitat for macroinvertebrates. A further four of the twelve sites had fair MCI scores, which is regarded as an indicator of moderate pollution

Figure 2-8: 5-year median Macroinvertebrate Community Index (MCI) observed at SoE monitoring sites of the Wairoa and nearby coastal catchments. MCI classes have been defined as: Dark blue circles – Excellent quality, clean water; Light blue circles - Good quality, possible mild pollution; Yellow circles - Fair quality, probable moderate pollution; Orange circles - Poor quality, probable severe pollution.

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While there was an absence of MCI data for Waikatuku Stream, habitat and water quality suggest that macroinvertebrate communities would be poor in that catchment. This is discussed below.

Water clarity is generally used as an indicator of fine suspended sediment in waterways and is measured as the proportion of light transmitted through water. The concept has two important aspects, which are (1) visual clarity (sighting range for humans and aquatic animals), and (2) light penetration for growth of aquatic plants. Water clarity is of considerable importance for the protection of contact recreation values, because it is perceived by recreational water users as directly affecting the aesthetic quality of the water. In addition, adequate visual clarity allows swimmers to estimate depth and identify subsurface hazards. Changes (generally reductions) of water clarity can also affect the foraging ability of fish, such as trout, by reducing their ability to see food drifting in the water column.

Water clarity at SoE sites is measured using a black disc. The measurement consists of measuring the horizontal distance that a black disc of standard size can be distinguished under water. Where the size of streams allow, black disc measurements are carried out routinely on a monthly basis across all HBRC SoE monitoring sites.

In general, water clarity at Northern subregion monitoring sites is degraded, with median black disc sighting distances at nine of the twelve sites less than the guideline for recreational waters (Figure 2-9).

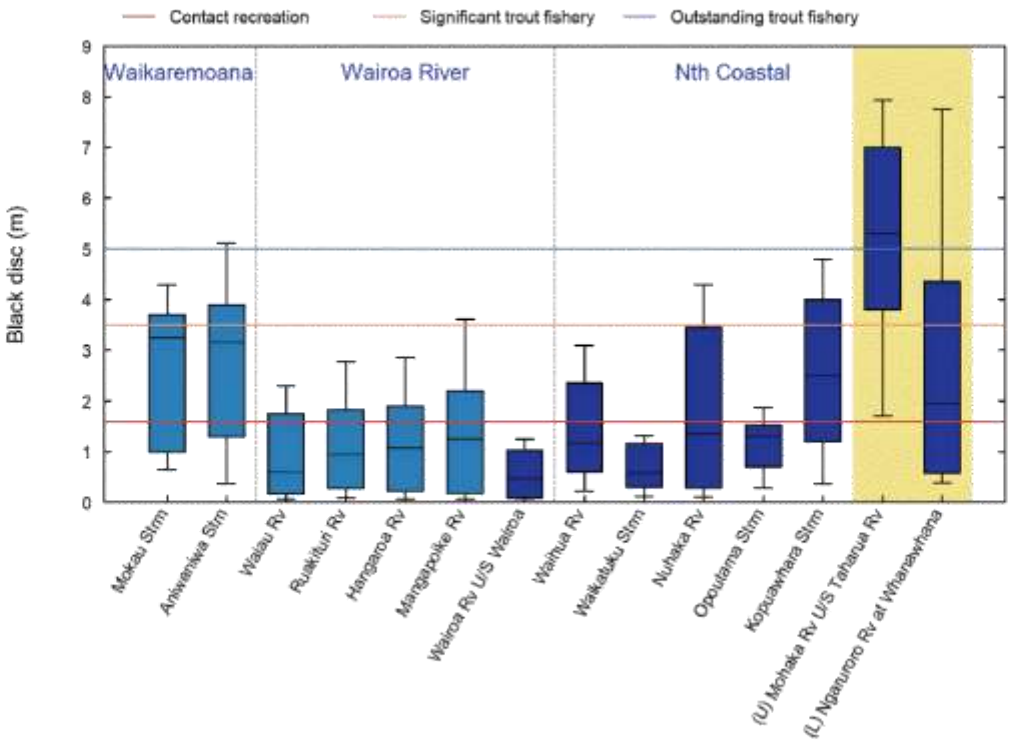

Figure 2-9: Boxplots of black disk (water clarity) for the Wairoa and nearby coastal catchments. The horizontal lines are guidelines for contact recreation and trout fisheries. Yellow shading identifies Hawke's Bay upland (U) and Lowland (L) reference sites for comparison.

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Along with water clarity, swimmability of Hawke's Bay water bodies is also affected by levels of faecal contamination. The bacterium *Escherichia coli* (commonly abbreviated *E. coli*) is used as an indicator to assess the level of health risk to water users having direct contact with water.

Table 2-1 is a summary of NOF categories for the *E. coli* attribute allocated to sites. For the calculation of NOF bands, there was insufficient *E. coli* data for the upstream of Lake Waikaremoana sites, and all of the Northern Coastal sites except for Kopuawhara Stream. However, attributes were calculated for the all of sites in the Wairoa catchment downstream of Lake Waikaremoana.

For the Wairoa catchments, the main stem and three of its tributaries (Hangaroa, Ruakituri and Mangapoike rivers) were considered not swimmable (band D). The Waiau River (B band, Wairoa catchment) and Kopuawhara Stream (C band) were scored as the least risky sites for campylobacter infection based on *E. coli* levels.

Table 2-1: NOF swimmability categories for *E. coli* at the Wairoa SoE sites. Monitoring period 2013 to 2018. Overall grade A, B and C bands are categories suitable for primary contact recreation. Blank indicates insufficient data.

Site	Overall grade for *E. coli*
Aniwaniwa Stream	
Hangaroa River	D
Kopuawhara Stream	C
Mangapoike River	D
Mokau Stream	
Nuhaka River	
Opoutama Stream	
Ruakituri River	D
Waiau River	B
Waihua Stream	
Waikatuku Stream	
Wairoa River	D

The microbiological data that is available indicates that faecal contamination is a problem in the Wairoa catchment downstream of Lake Waikaremoana. The same sites with faecal contamination issues also have poor water quality as a result of land erosion delivering sediment to waterways. Faecal source tracking for the samples taken from the Wairoa River has highlighted the dominance of ruminant sources of faecal material, with avian sources also detected at times. Consequently, erosion and agricultural runoff are considered to be the key environmental pressure across the Wairoa and Northern Coastal subregion.

While there was insufficient data to assign NOF grades for the *E. coli* attribute at most of the Northern Coastal sites, poor water clarity (Figure 2-9) and dissolved reactive phosphorus (DRP) in high concentrations (Figure 2-10) indicate that those sites are also subject to the effects of erosion and agricultural runoff.

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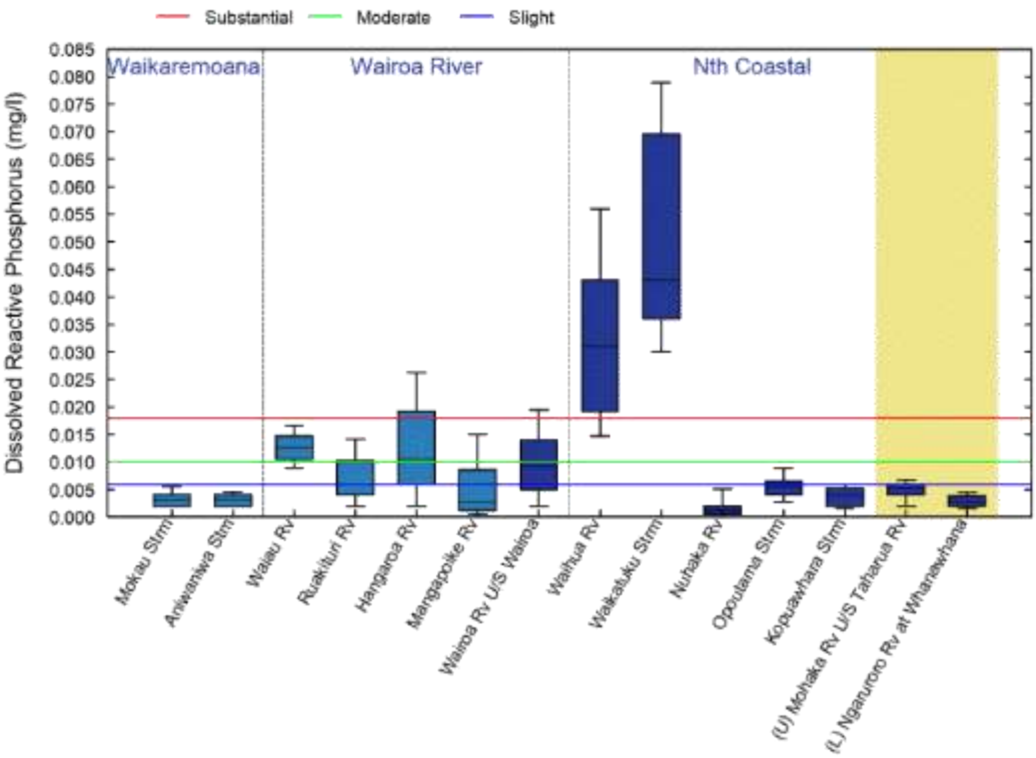

Figure 2-10: Dissolved reactive phosphorus (DRP) levels at Wairoa SoE monitoring sites. The horizontal lines identify where median values: above the red line are considered to be substantially elevated; between red and green lines are moderately elevated; between green and blue lines are slightly elevated; and below the blue line are similar to natural conditions.

To address issues associated with erosion and agricultural runoff throughout Hawke's Bay, HBRC is implementing an erosion control scheme. This initiative encourages tree planting and erosion control work on vulnerable land. The erosion control scheme also includes a riparian programme, providing advice and assistance to landowners about planting alongside waterways to minimise streambank erosion and to improve the ecological health of waterways.

The $30 million (over 10 years) fund targets Hawke's Bay's 252,000 hectares of land at high risk of erosion, estimated to lose, on average, more than 3 million tonnes of sediment to the region's waterways every year. The scheme aims to reduce soil erosion, improve terrestrial and aquatic biodiversity, provide community and cultural benefits through forest ecosystem services, and improve water quality through the reduction of sedimentation in waterways.

The estimate of sediment loss that informs the erosion control scheme is generated from the SedNetNZ model, to identify highly erodible land and to prioritise activities of the scheme. SedNetNZ identified that mitigation (via farm plans) on 100 farms in the Northern subregion with the greatest areas of highly erodible land could reduce sediment load by 1,400,000 t/yr, which represents a 37% reduction of total load for this subregion. This approach enables mitigation strategies to be targeted at farms that will produce the greatest reduction in sediment load.

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HBRC now has a team based in Wairoa, with staff typically in the field working with landowners to give support and provide advice on good land use practices. This includes assisting landowners to develop Erosion Control Plans and then to implement the actions in the plans to help control erosion and improve water quality.

While these erosion control efforts are underway, improvements in water quality and aquatic habitats will take time to manifest. Continued monitoring is essential for evaluating the efficacy of these efforts over time.

b) The Mohaka catchment

The upstream extreme of the Mohaka catchment is represented by the Mohaka River upstream of the Taharua confluence (see Figure 2-11). This site is one of the healthiest in the region and is used as an upland reference site for water quality SoE reporting across all sub-regions. There is a lack of intensive and widespread human activity throughout the catchment which means that the Mohaka catchment has the potential to support high quality ecosystem and recreational values.

Water quality monitoring in the Mohaka River catchment has been carried out by since 1980 as part of the SoE programme. Land use related water quality issues in the Taharua sub-catchment, located in the upper Mohaka catchment, have resulted in the Mohaka catchment becoming the subject of a special investigation programme, with monthly sampling occurring at key sites since 2008.

Overall the Mohaka catchment was of good quality, especially the area upstream of the Taharua confluence. The main exception is the Taharua River which is eutrophic.

Dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) concentrations are important because they represent the two most significant nutrients that stimulate or limit periphyton growth, since they are immediately available to fuel plant and algal growth (they are 'bioavailable'). All four Taharua sites had substantially elevated DIN concentrations (Figure 2-11).

Furthermore, nitrate-nitrogen levels at two sites in the Taharua subcatchment fail the proposed NOF bottom line for nitrogen toxicity, which is proposed to achieve 95% species protection (Figure 2-12).

For the Mohaka River, there was a clear difference in nutrient levels downstream of the Taharua River confluence. The Mohaka site downstream of the Taharua confluence had a median DIN concentration that is considered to be moderately elevated, with the contribution of DIN from the Taharua subcatchment causing a decline in the Mohaka mainstem from natural background DIN levels upstream of the Taharua confluence (Figure 2-11).

Periphyton cover was rated as 'good' in the Mohaka River downstream of Taharua, but was excellent upstream of the Taharua confluence (Figure 2-13). While this does not represent a concern in absolute terms of periphyton observations at other Hawke's Bay catchments, the increase in periphyton cover is consistent with nutrient enrichment at the site downstream of the Taharua confluence.

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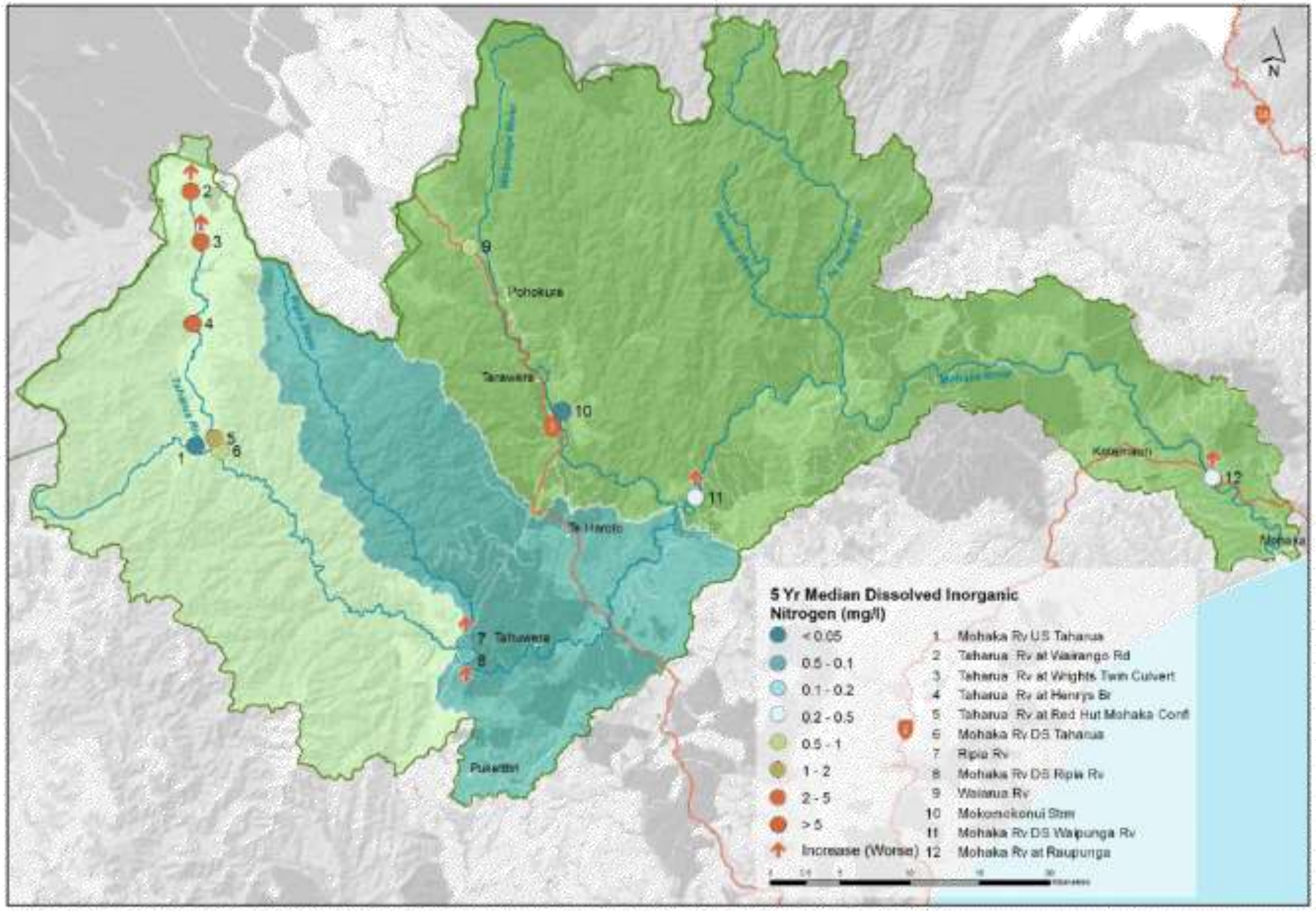

Figure 2-11: 5-year median dissolved inorganic nitrogen (DIN) levels at Mohaka sites. Arrows indicate direction of statistically significant trends, with blue arrows for improvement and red arrows indicating deterioration. Only six years of monthly data were available for trend analysis, so caution is strongly advised with interpretation of trends. DIN concentrations greater than 1 mg/L are considered to be substantially elevated.

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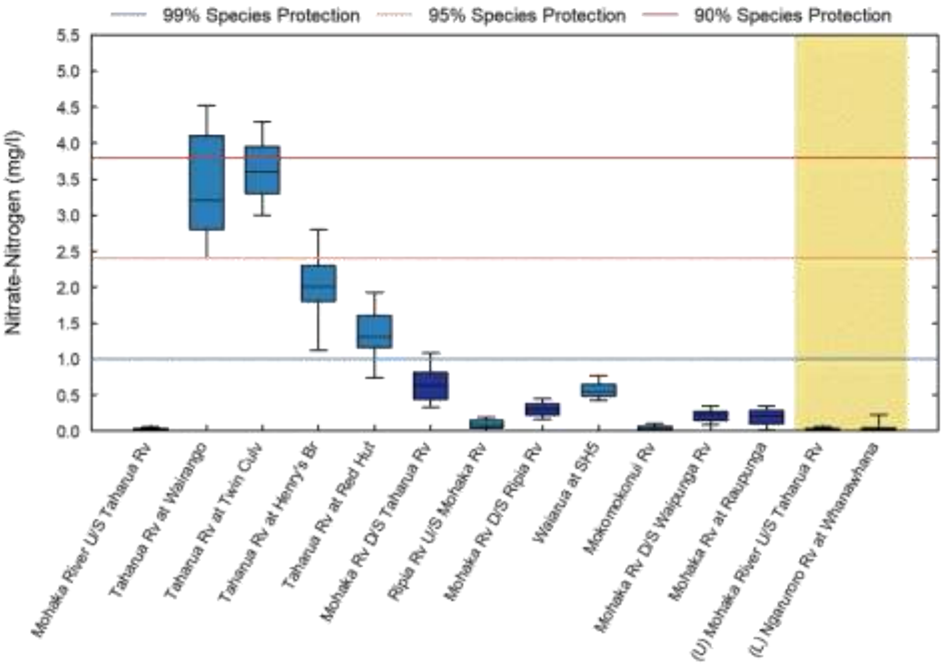

Figure 2-12: Nitrate-nitrogen (NO_3-N) levels at Mohaka monitoring sites. SoE sites for the Mohaka River U/S Taharua confluence and the Ngaruroro River at Whanawhana (shaded yellow) are included as Upland (U) and Lowland (L) reference sites for comparison purposes. The blue, orange and red lines relate to nitrate toxicity limits for 99%, 95% and 90% species protection respectively. The proposed NOF bottom line for nitrate toxicity is 95% species protection.

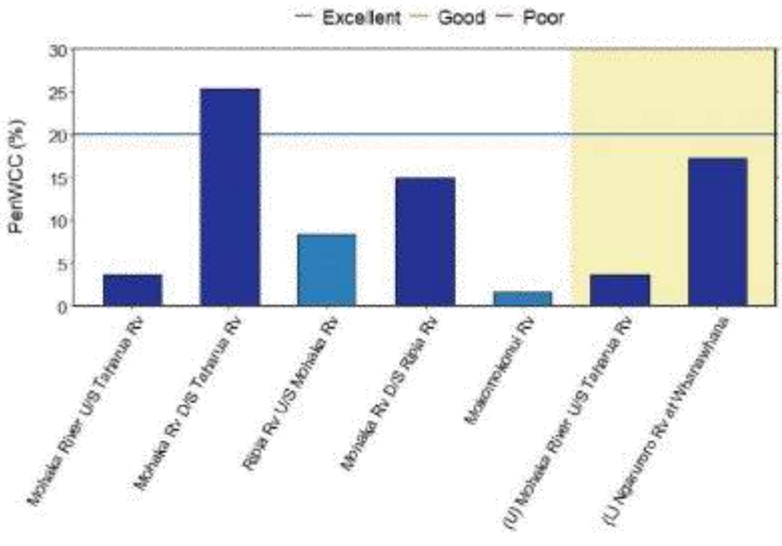

Figure 2-13: Periphyton Weighted Composite Cover (PeriWCC) at Mohaka SoE sites. Below the blue line represents excellent quality and above it good. No sites were poor.

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Swimmability, in terms of the NOF bands for the microbiological indicator *E. coli*, was excellent at all sites apart from the Taharua River at Wairango which was rated as good (Table 2-2).

Table 2-2: NOF swimmability categories for *E. coli* at Mohaka SoE sites. Monitoring period 2013 to 2018. Overall grade A, B and C bands are categories suitable for primary contact recreation. Blank indicates insufficient data.

Site	Overall grade for *E. coli*
Mohaka River at Raupunga	
Mohaka River D/S Ripia River	A
Mohaka River D/S Taharua River	A
Mohaka River D/S Waipunga River	A
Mohaka River U/S Taharua River	A
Mokomokonui Stream	A
Ripia River	A
Taharua River at Henry's Bridge	A
Taharua River at Red Hut	A
Taharua River at Wairango	B
Taharua River at Twin Culverts	A
Waiarua Stream	A

The lower reaches of the Mohaka main stem (as represented by the Raupunga site) are likely to be impacted by sediment loading from erosion as indicated by poor water clarity (Figure 2-14) and elevated total phosphorus at times (Figure 2-15).

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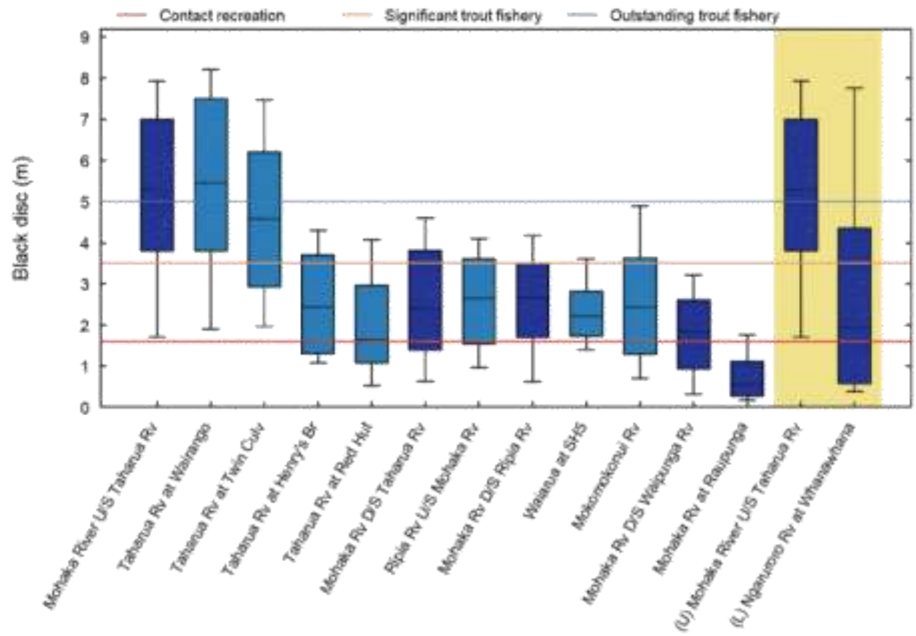

Figure 2-14: Water clarity (black disc measurements) at Mohaka SoE sites. The horizontal lines are guidelines for contact recreation and trout fisheries. Yellow shading identifies Hawke's Bay upland (U) and Lowland (L) reference sites for comparison.

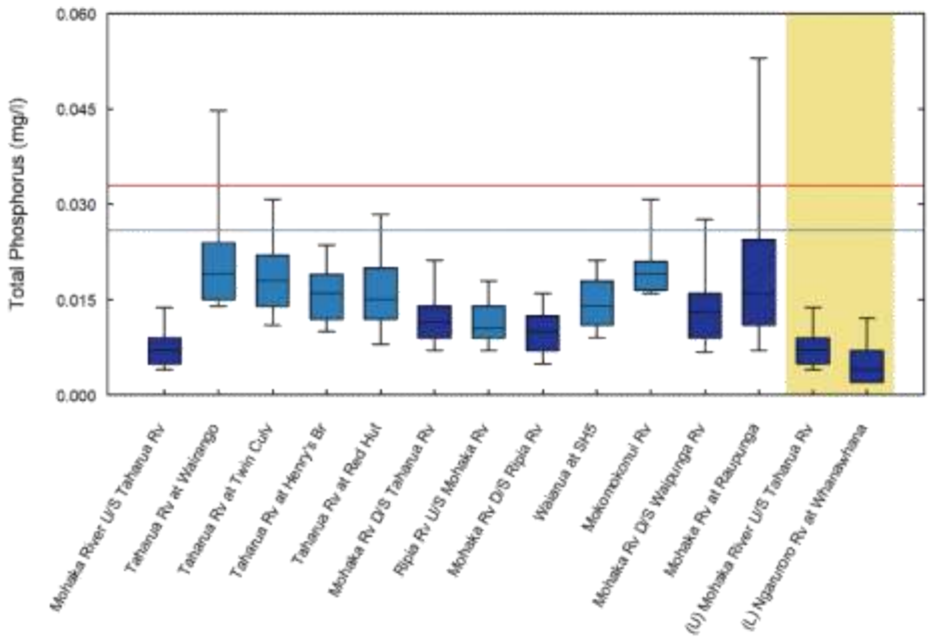

Figure 2-15: Total phosphorus (TP) levels at Mohaka sites. The blue line relates to ANZECC (2000) 'Upland' TP trigger value; the red line is the ANZECC (2000) 'Lowland' TP trigger value.

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c) The Waikari, Esk, Te Ngarue and Aropaoanui catchments

Overall, river and stream health is reasonably good at the monitoring sites in the Waikari, Esk, Te Ngarue and Aropaoanui catchments.

Nitrogen concentrations were mostly low to moderate, and nitrogen toxicity levels were well below problematic levels. Dissolved reactive phosphorus (DRP) was the most elevated nutrient, with enrichment at all sites (Figure 2-16).

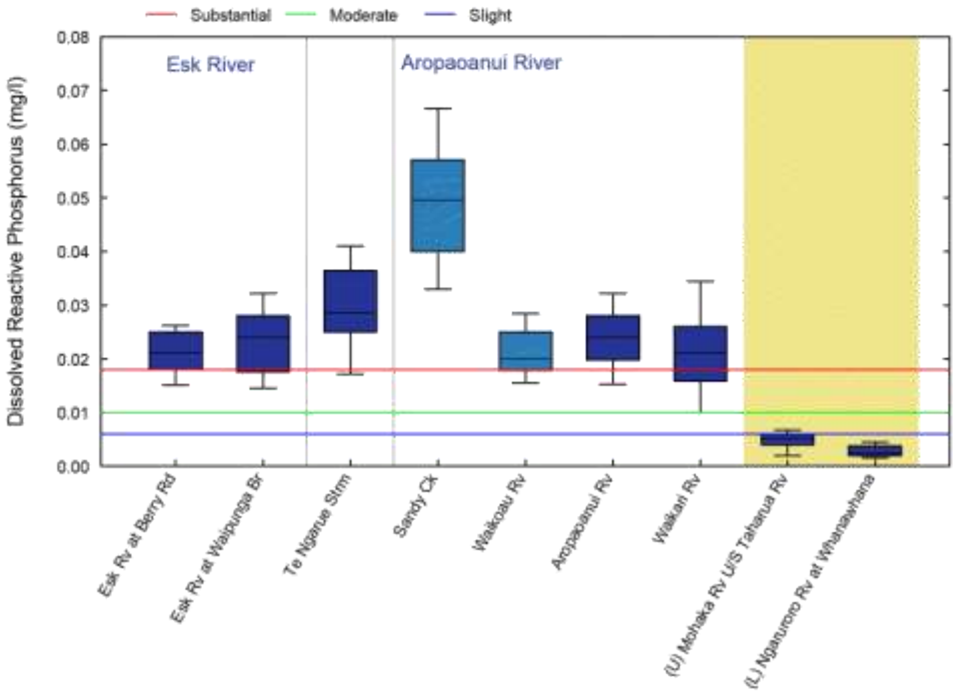

Figure 2-16: Dissolved reactive phosphorus (DRP) levels at SoE monitoring sites in Esk and nearby catchments. The horizontal lines identify where median values: above the red line are considered to be substantially elevated; between red and green lines are moderately elevated; between green and blue lines are slightly elevated; and below the blue line are similar to natural conditions..

Rather than being assimilated by plants and algae, phosphorus may remain in a dissolved form in these catchments due to a lack of uptake by periphyton, which at many sites is limited by light and/or substrate type. Low periphyton coverage, coupled with good hydrological heterogeneity, varying substrate and diverse fish and invertebrate habitat types all contribute to generally good Macroinvertebrate Community Indices (MCI) and habitat scores in the catchments.

Water clarity at most sites was fair (Figure 2-17), likely due to erosion in the upper catchment. A potential source of this sediment may be from forestry practices and this warrants further investigation, given that plantation forestry makes up over 30% of the landuse in the catchments (Figure 2-18). *E. coli* contamination was notable in Sandy Creek, with a NOF band D for contact recreation (Table 2-3) and this also warrants further investigation.

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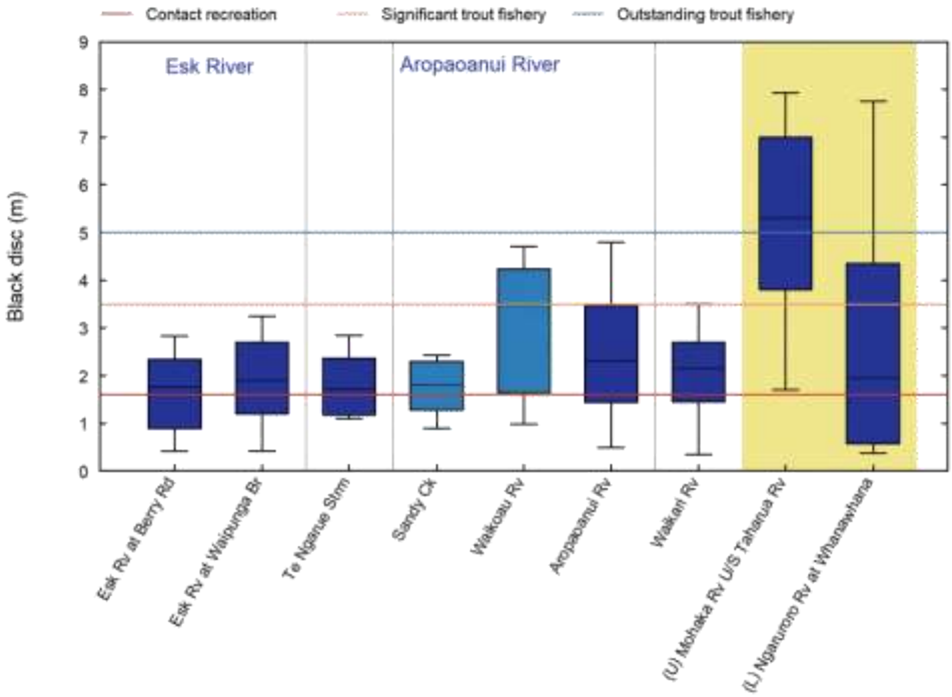

Figure 2-17: Boxplots of black disk (water clarity) for the Waikari, Esk, Te Ngarue and Aropaoanui catchments. The horizontal lines are guidelines for contact recreation and trout fisheries. Yellow shading identifies Hawke's Bay upland (U) and Lowland (L) reference sites for comparison.

Table 2-3: NOF swimmability categories for *E. coli* at Esk and nearby catchments. Monitoring period 2013 to 2018. Overall grade A, B and C bands are categories suitable for primary contact recreation. Blank indicates insufficient data.

Site	Overall grade for *E. coli*
Aropaoanui River	C
Esk River at Berry Road	B
Esk River at Waipunga Bridge	B
Sandy Creek	D
Waikari River	B

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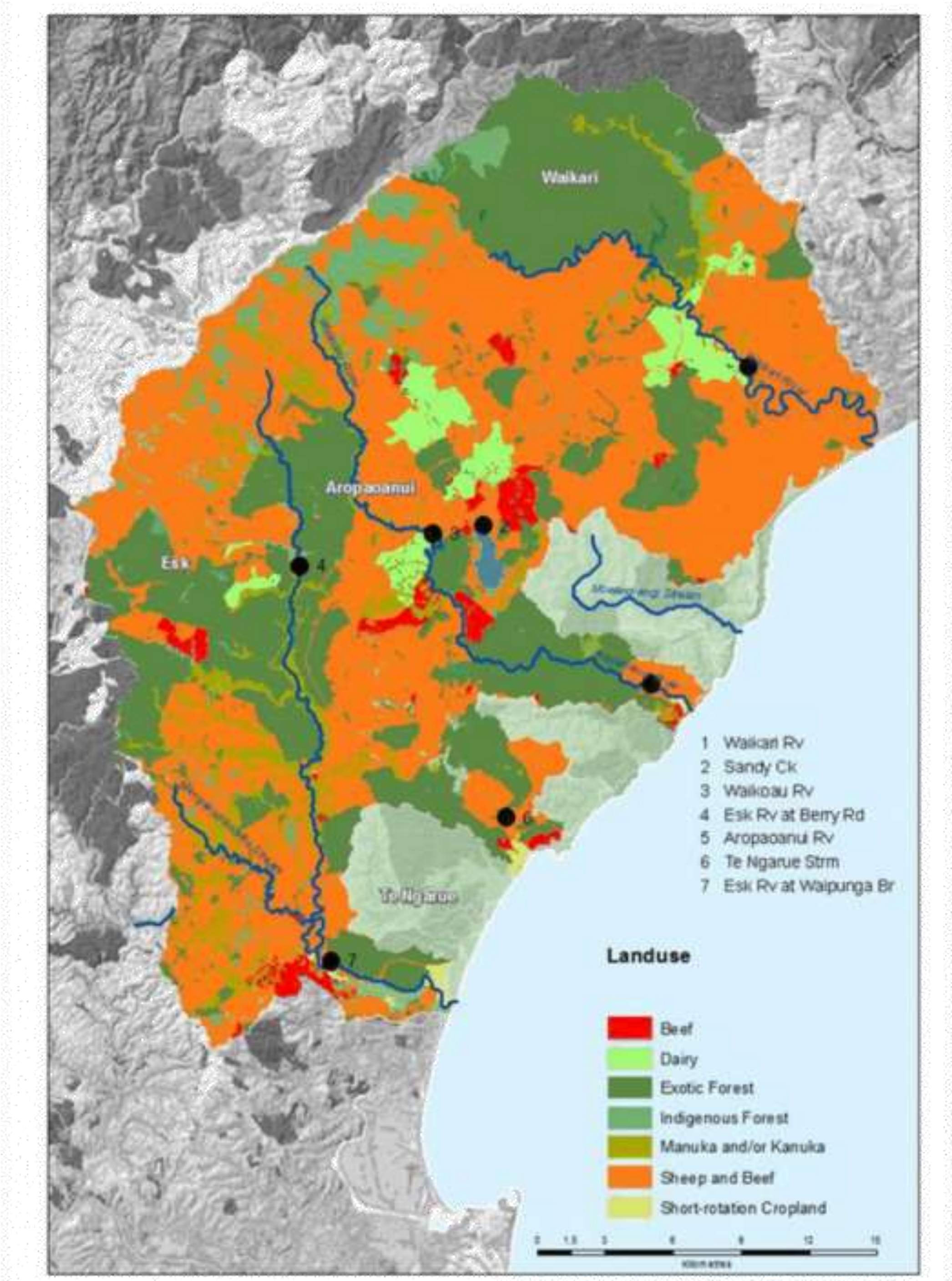

Figure 2-18: Waikari, Esk, Te Ngarue and Aropaoanui catchment Land Cover Database classes.

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Tūtira lakes

In the upper reaches of the Aropaoanui catchment, four lakes known as the Tūtira Lakes (Figure 2-19) are subject to algal blooms that continue to cause concern. Fish kills that have affected both trout and tuna (freshwater eels) recently have added to the concerns.

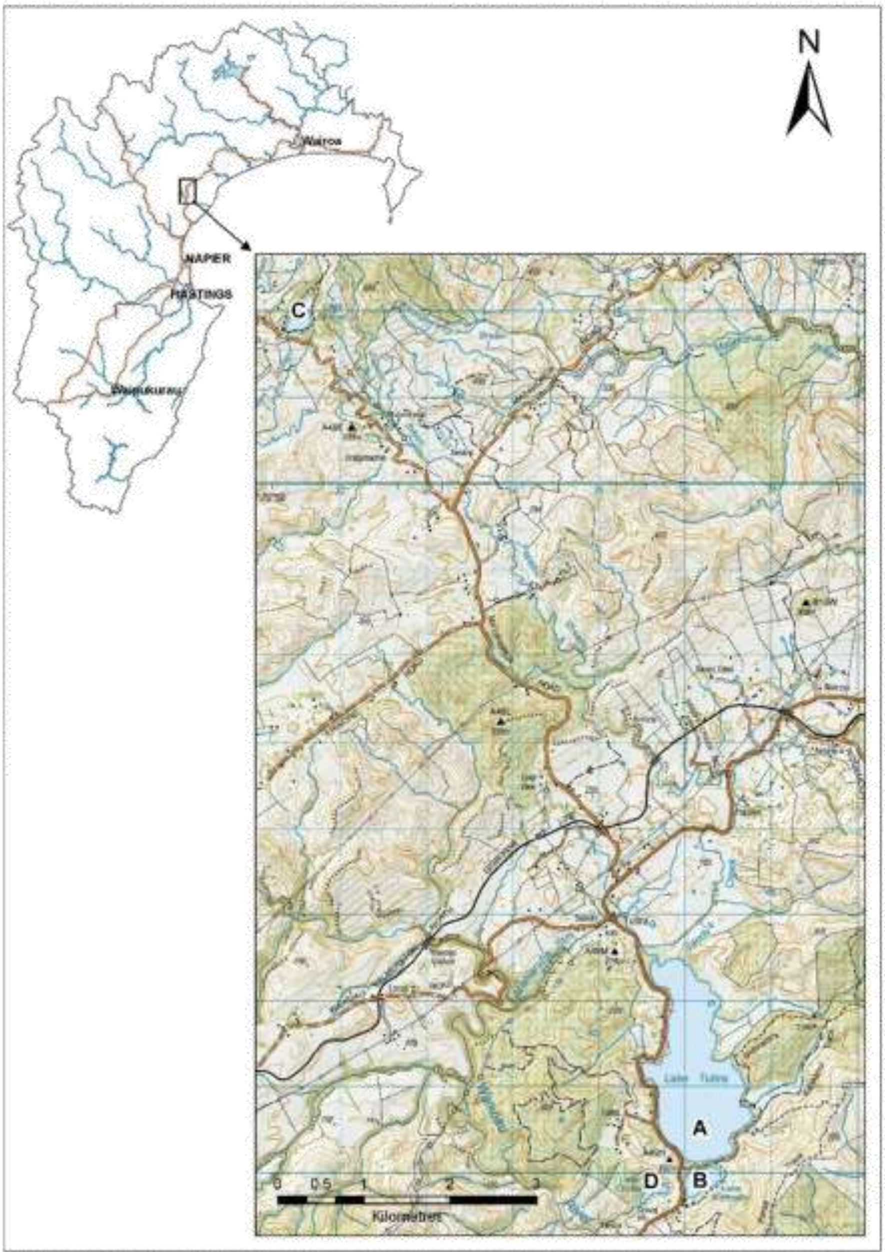

Figure 2-19: Locations of Tūtira lakes. Shown are lakes Tūtira (A), Waikōpiro (B), Opouahi (C) and Orakai (D).

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The first documented water quality concerns for Tūtira Lake are from 1959, shortly after aerial top dressing began in the catchment. Lakes are vulnerable to eutrophication, because nutrients are trapped and recycled in the natural sediment traps that lakes provide. Tūtira was particularly susceptible to eutrophication because of its long residence time and limited flushing, with its inlet and outlet being in the same part of the lake.

HBRC undertakes water quality and ecology monitoring to better understand possible causes for these issues as well as help identify solutions. The initial monitoring programme, sponsored by MPI, has since been expanded by HBRC in partnership with tāngata whenua when two large scale restoration projects started. These are the Tūtira Mai Ngā Iwi ($644,000) and Te Waiū o Tūtira ($3.6M), which seek to improve water quality of the Tūtira lakes. The costs of the expanded monitoring programme are being met by HBRC, Maungaharuru-Tangitū Trust (MTT) and the Ministry for the Environment (MfE). The expanded programme provides water quality information used for ecological modelling and to help select mitigation options, as well as evaluating the performance of restoration projects and help determine whether the projects are on track to meet their objectives for improved conditions in the lakes.

The trophic status of a lake is quantified using the 'trophic level index' or TLI, which combines four separate water quality variables: nitrogen, phosphorus, chlorophyll-a (algal biomass), and water clarity. For the first time, Lake Tūtira was assessed to be in a better state than Lake Opouahi (both eutrophic), while Waikōpiro remains the most trophic of the three lakes (Figure 2-20).

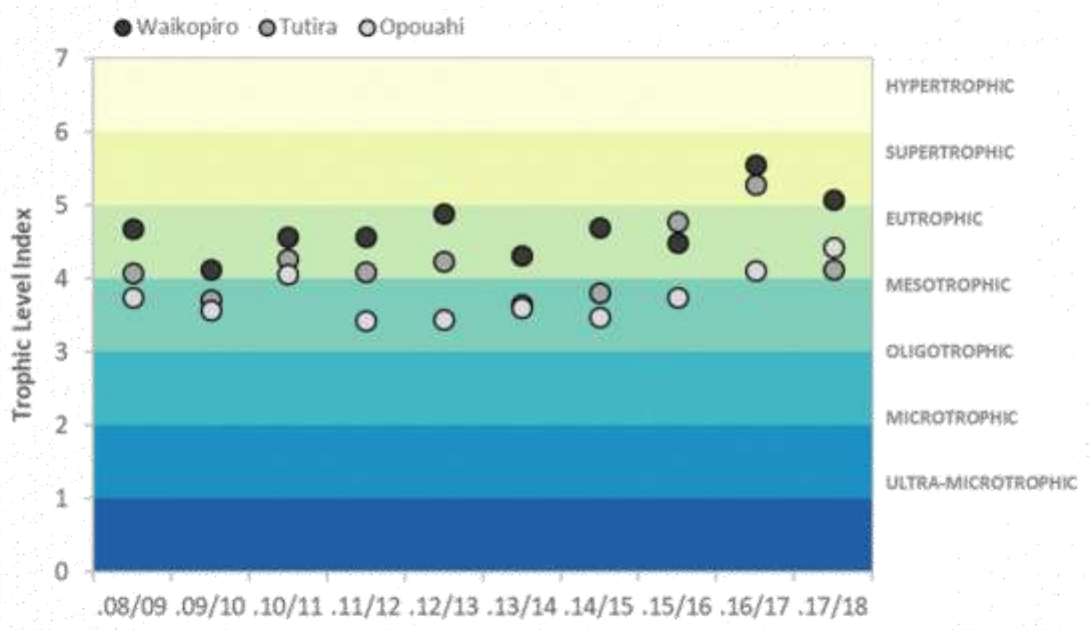

Figure 2-20: Trophic Level Index (TLI) for Lake Tūtira, Lake Opouahi and Lake Waikōpiro. Data are from July 2008 to June 2018.

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Momentum continues to grow for restoration efforts in the Tūtira Lakes catchments. The MfE funded Tūtira Mai Ngā Iwi project led by MTT has been completed and Te Waiū o Tūtira (also MfE funded and co-led by HBRC and MTT), is in the final development phase and will look to extend restoration efforts to improve water quality throughout the lakes' catchments.

The earlier work focused on removing exotic species and planting natives around the lake margins and may not be expected to have resulted in substantial improvements. The proposed new mitigations in the Te Waiū o Tūtira programme include developing farm environmental management plans throughout the catchment, mitigating critical source areas of sediment and nutrients, reconnecting Papakiri Stream at low flows, sediment traps beneath forest harvest areas and providing a southern outlet to increase flow through Lakes Tūtira and Waikōpiro. These future works are more likely to have a noticeable influence on lake water quality. Continued monitoring is required to identify whether these efforts are successful at achieving water quality improvements.

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2.1.3 Marine and coast, and recreation water quality

There are five nearshore and three estuarine water quality monitoring sites in the Northern subregion (Figure 2-21).

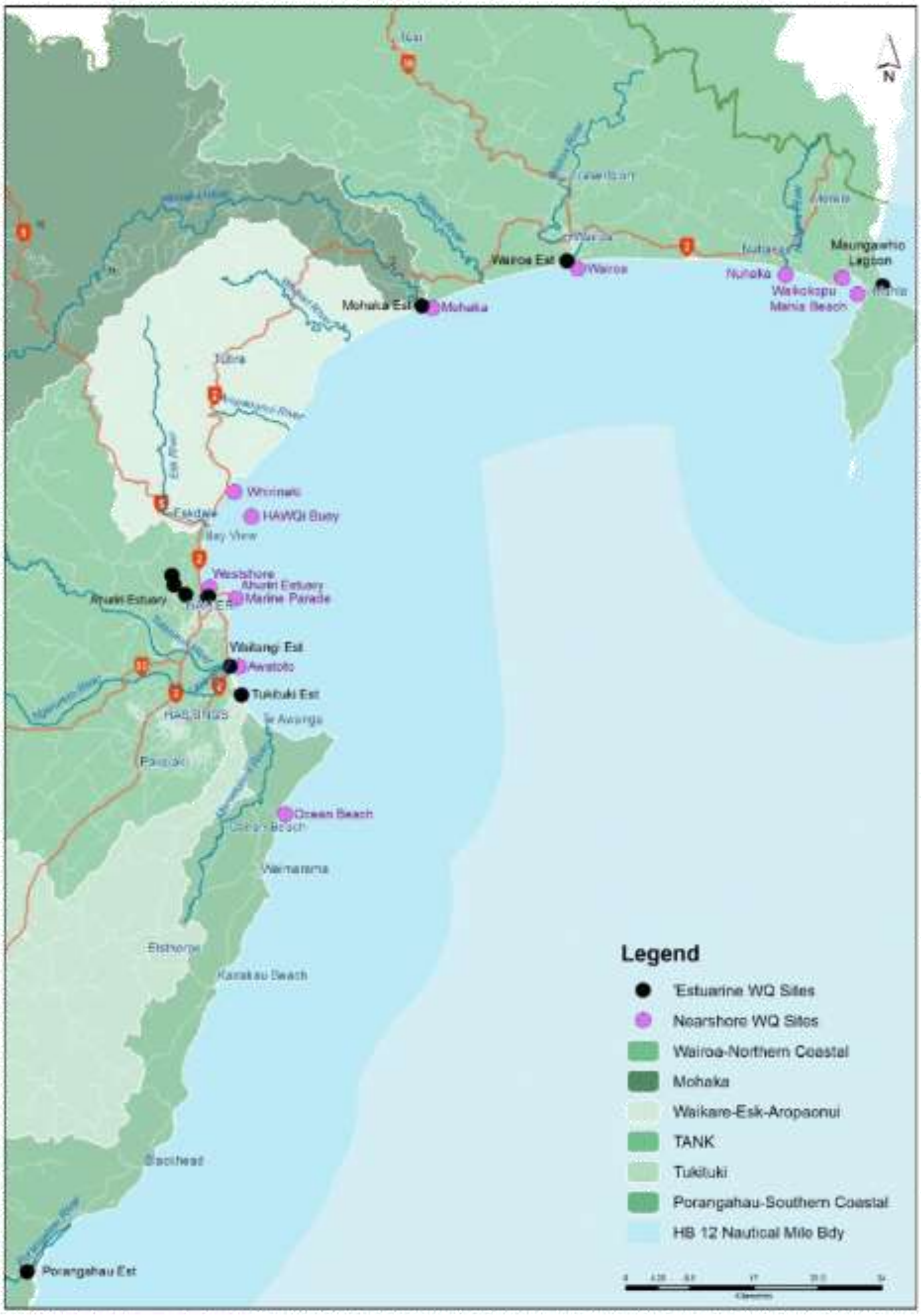

Figure 2-21: Estuarine (black circles) and nearshore (pink circles) water quality monitoring sites in Hawke's Bay.

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As noted in section 2.1.2a), the Northern subregion is particularly susceptible to land erosion and there are large land areas that deliver high sediment yields (Figure 2-2), with more than 55% of the region's sediment load coming from these catchments. The fate of sediment in waterways is ultimately to coastal receiving environments including estuaries, nearshore coastal areas and the marine environment in extreme cases (Figure 2-22).

Figure 2-22: The influence of a rain event on turbidity in the Hawke Bay Coastal Marine Area. Satellite imagery shown: (left) prior to Cyclone Pam; and (right) after Cyclone Pam in March 2015.

Median levels of 'mud' in Wairoa Estuary sediments exceed published literature for mud content thresholds that support healthy, diverse communities (<25% mud content). Median mud content for the Wairoa Estuary is approximately 40% and most samples were greater than the 25% mud threshold (Figure 2-23). At this site, sensitive species are largely absent and this can compromise the integrity and resilience of the estuary, as well as reducing its value for other species such as birds and fish

As noted in section 2.1.2.a), HBRC is implementing an erosion control scheme to address issues associated with erosion and agricultural runoff throughout Hawke's Bay. While these erosion control efforts are underway, improvements in water quality and habitat at Wairoa Estuary will take time to manifest. Continued monitoring is essential for evaluating the efficacy of these efforts over time.

While beach water quality is generally very good, estuary and lagoon sites in Hawke's Bay have the highest probability of exceeding the national microbiological guidelines for contact recreation. Between 2013 and 2018, estuary and lagoon sites in Hawke's Bay were suitable for swimming 81% of the time, unsuitable 10% of the time, and caution was advised 9% of the time. Of the Northern subregion lagoon sites, Te Mahia Harbour had the most exceedances and was considered unsuitable for swimming 10% of the time (Figure 2-24). The Wairoa River had the most exceedances of all freshwater sites within the region, with 15% of samples considered unsuitable for swimming. This indicates that, on average, the river was considered unsuitable for contact recreation for one day per week.

A deteriorating trend in microbiological water quality was also observed for the Wairoa River, with an average 2.8% annual change that indicates ongoing and persistent issues with microbiological water quality at this site.

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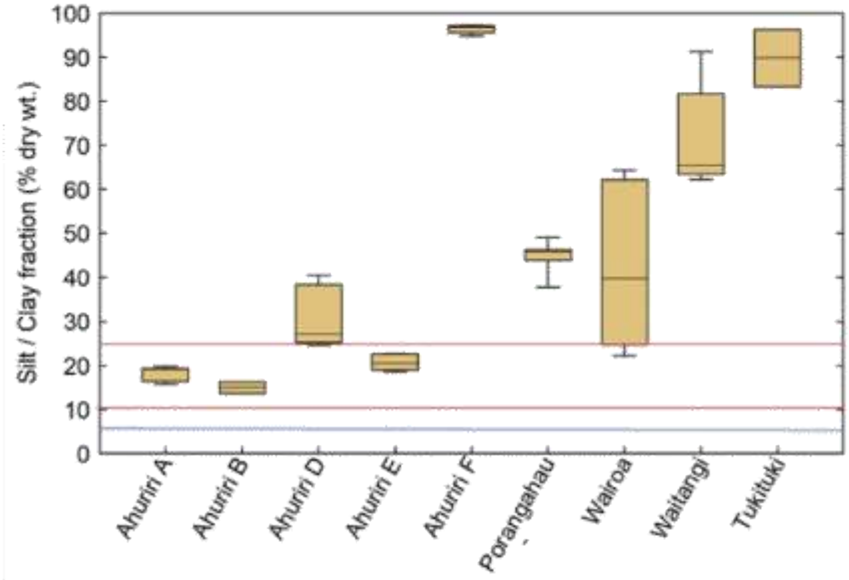

Figure 2-23: 5 year median levels of silt/clay (mud) in estuarine sediments 2013-2018. Blue line refers to 5% mud, amber line 10% mud content, red line 25% mud content. Medians based on 5 years 2013-2018 (Ahuriri A, D, E, Pōrangahau, and Wairoa), 4 years (Waitangi), 3 years (Ahuriri B, F), 2 years (Tukituki). Boxes represent 25th, 50th and 75th percentiles and whiskers represent 10th and 90th percentiles.

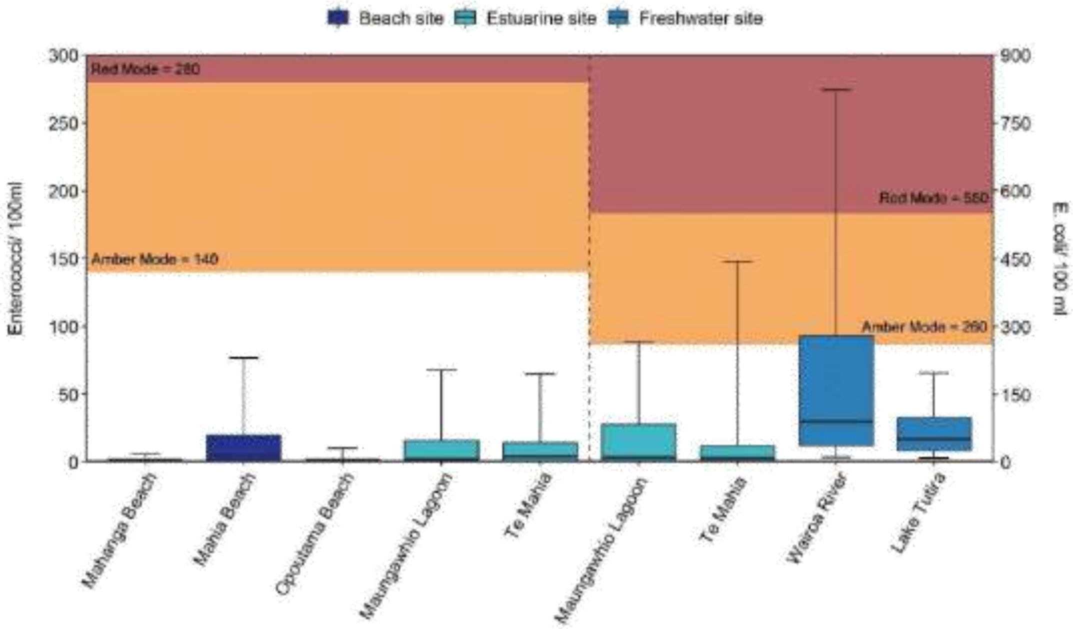

Figure 2-24: Faecal indicators for northern recreational water quality monitoring sites (2013-2018). Red and amber areas indicate the MfE and MoH (2003) trigger values for the Red and Amber Modes respectively. The concentrations of indicator bacteria (cfu/100ml) associated with these modes are written above the line.

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A popular boat launching area, Te Mahia Harbour is the mouth of the Whangawehi catchment. The catchment comprises forestry and agricultural activities and peaks of faecal contamination can occur following heavy rain. Faecal source tracking between 2013 and 2018 identified the influence of ruminant and avian sources at Te Mahia Harbour. Faecal source tracking undertaken on the Wairoa River between 2015 and 2018 highlighted the influence of ruminant sources of faecal material, with avian sources also detected at times.

HBRC continues to support the Whangawehi Catchment Management Group who, under a community-led approach, are helping to restore the streams that flow into the Whangawehi River and ultimately to Te Mahia Harbour.

2.2 Surface water flows

A range of summary river flow statistics were calculated for Northern subregion catchments for the hydrological years[4] 2013-2014 through to 2017-2018 and for the available long-term record. Annual mean flows at all sites in the Northern Hawke's Bay area were below the long-term mean flow for the first three years (July 2013 to June 2016) and above the long-term mean between July 2016 and June 2018.

Plots of monthly mean flows for these rivers identify seasonal variation for each year between 2013 and 2018; compared with long term averages, long term range (maxima and minima), and normal flow ranges (± 25% of the long-term mean).

The locations of State of the Environment river flow sites in Hawke's Bay are shown in Figure 2-25.

[4] A hydrological year is from July to June. Hydrological years are used to avoid splitting summer low flow events, which commonly occurs when calendar years are used for analysis.

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Figure 2-25: Locations of Hawke's Bay SoE river flow monitoring sites.

During summer periods between 2013 and 2018, monthly mean flows in the Wairoa River at Marumaru were often below the normal range for that time of year (Figure 2-26). A similar phenomenon was observed in the Mohaka River during summer periods (Figure 2-27), along with the Esk River (Figure 2-28).

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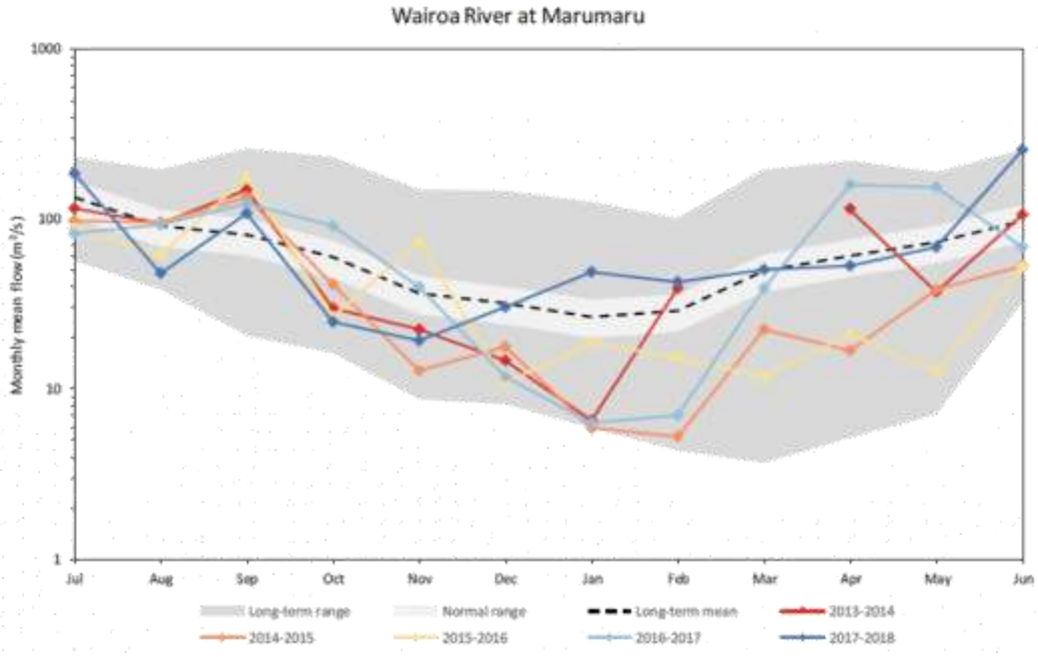

Figure 2-26: Wairoa River at Marumaru monthly mean flow. Annual time series' from 2013-2014 to 2017-2018 are shown with the long-term mean, long-term range and normal range (1980-2018).

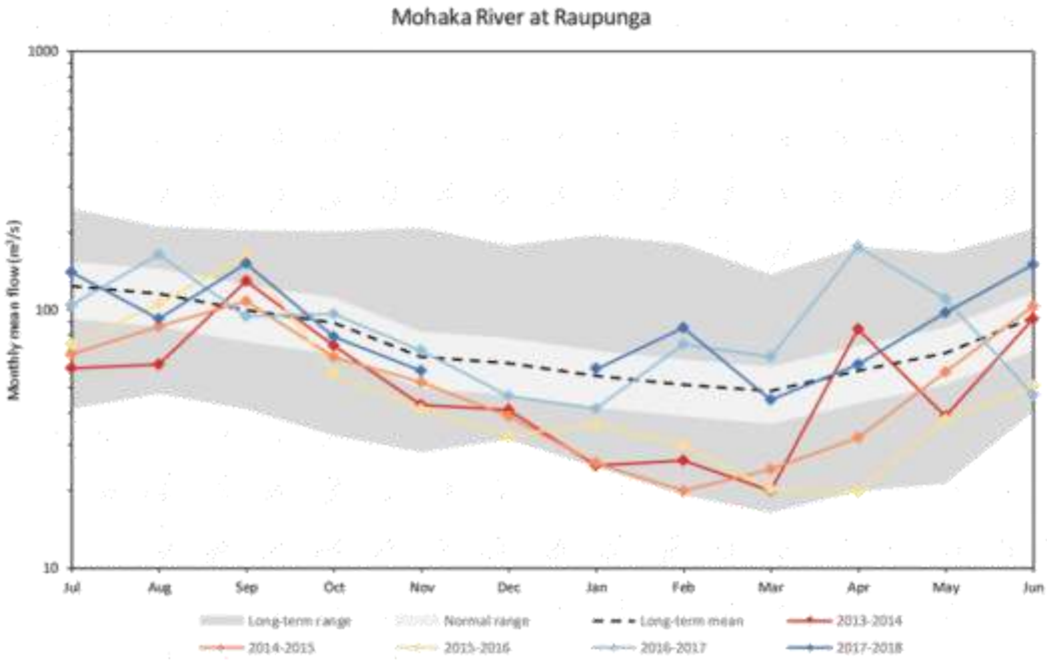

Figure 2-27: Mohaka River at Raupunga monthly mean flow. Annual time series' from 2013-2014 to 2017-2018 are shown with the long-term mean, long-term range and normal range (1980-2018).

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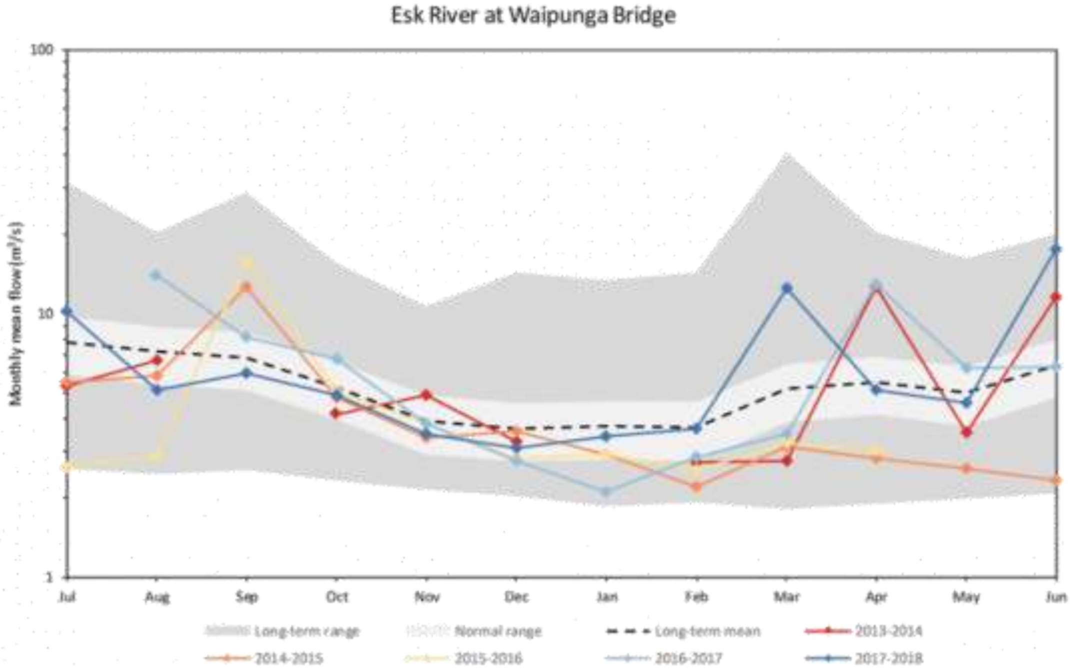

Figure 2-28: Esk River at Waipunga Bridge monthly mean flow. Annual time series' from 2013-2014 to 2017-2018 are shown with the long-term mean, long-term range and normal range (1980-2018).

Two plausible explanations for the low summer flows during this 5-year period are: 1) abstraction for out of stream use; or 2) climatic influence.

There is no abstraction upstream of the Aniwaniwa Stream at Aniwaniwa, yet the same phenomenon of low summer flows was also observed at the Aniwaniwa site (Figure 2-29). Therefore the low summer flows are less likely to be a consequence of abstraction effects.

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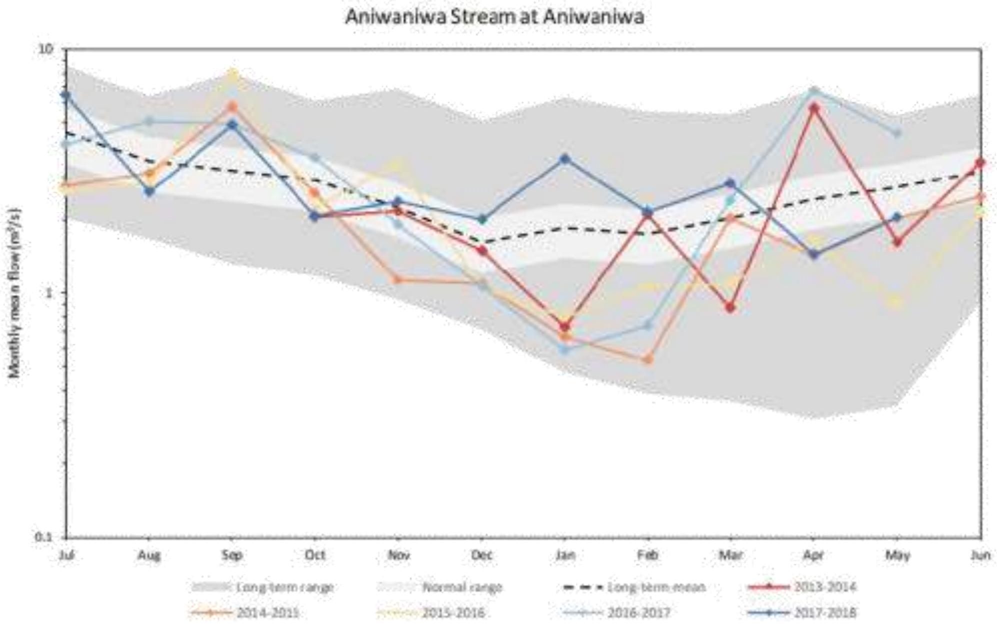

Figure 2-29: Aniwaniwa Stream at Aniwaniwa monthly mean flow. Annual time series' from 2013-2014 to 2017-2018 are shown with the long-term mean, long-term range and normal range (1980-2018).

As discussed in section 1.1, summer rainfall across the region was typically normal or below normal for the five year reporting period, which featured an El Niño summer in 2015-16. The reporting period ended with a La Niña summer (2017-18), which is the one year in most of these river flow graphs that had summer rainfall greater than the median.

To explore large-scale climate patterns, some data standardisation was adopted. To better compare across sites, flow at each site was divided by its long-term mean flow. So, regardless of the size of the catchment, flow in an average year would have a value about 1, and greater than 1 in a wet year. The sites can then all be over-plotted without the largest rivers dominating the plot. The next step was generating 5-year moving average annual low flows, to filter out short-term variability resulting from localised rain events.

The IPO Tripole (Interdecadal Pacific Oscillation Tripole index) was selected as an indicator of large-scale climate patterns. In general, negative IPO phases are characterised by weaker westerly winds over northern New Zealand, with wetter conditions and possibly more frequent and intense storm surge events. Conversely, positive IPO phases are generally associated with drier conditions in the north and east of New Zealand.

The IPO Tripole was over-plotted with annual low river flows for a range of Hawke's Bay rivers and streams (Figure 2-30). The peaks and troughs do not always coincide, and this mismatch could result from stochastic processes, a lagged response, or a more complex response than a simple linear relationship of flow with the IPO. There tends to be more scatter in low-flow data, which makes the climate pattern more obscure.

However, the IPO phase has been predominantly neutral post 2012, and this was associated with below-normal annual low flows at most sites (Figure 2-30). Therefore it is plausible that the low summer flows observed from 2013 to 2018 are a consequence of large-scale climate drivers.

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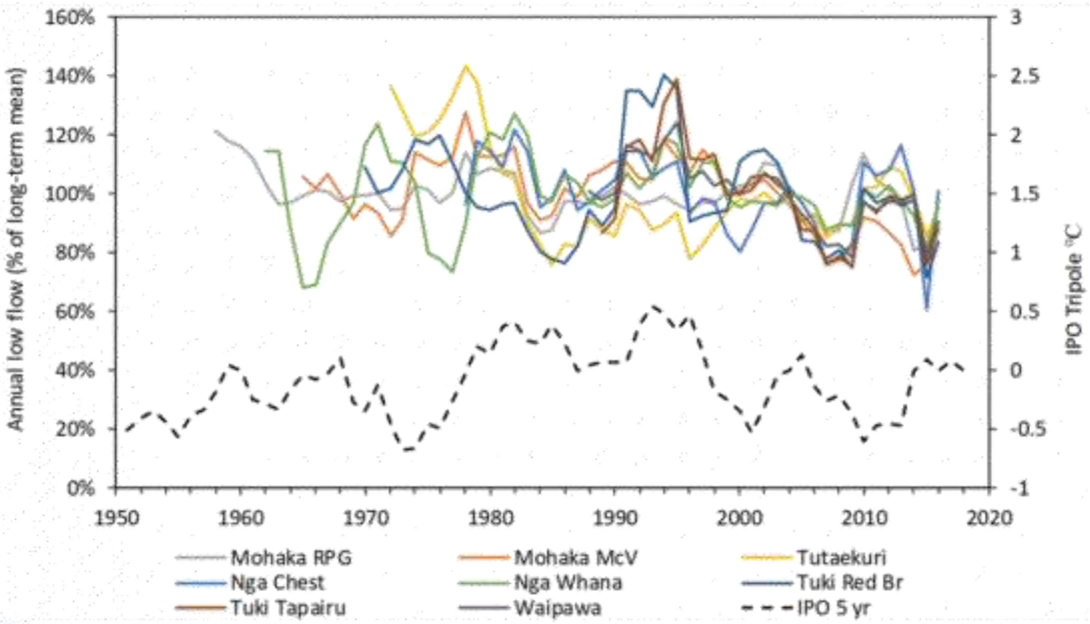
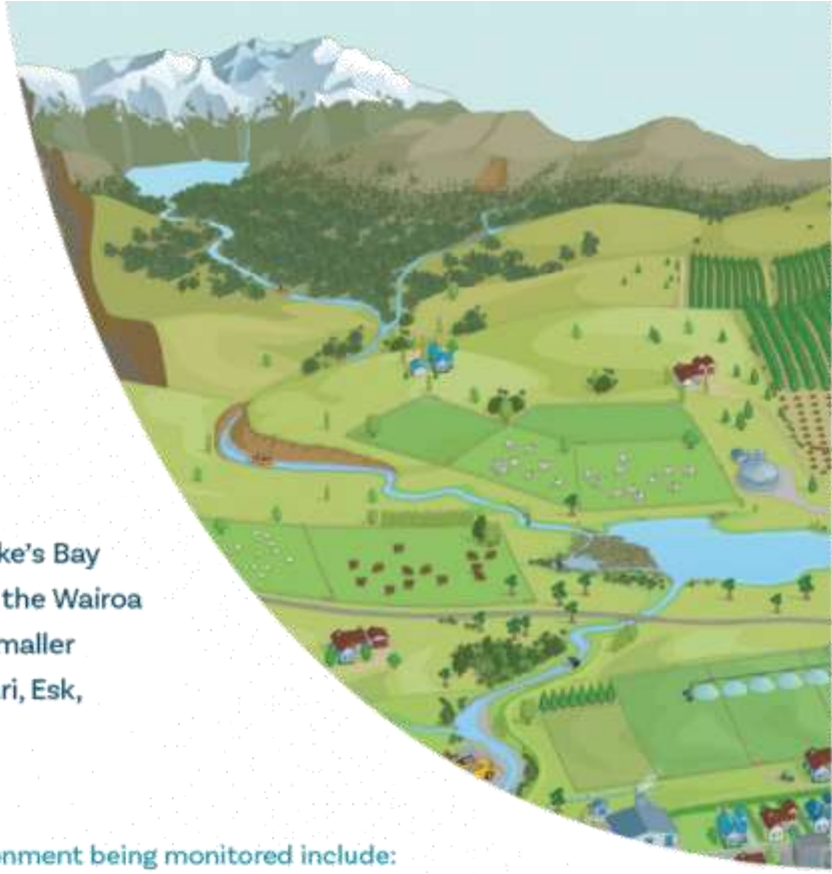


Figure 2-30: Long-term patterns in river flow for many Hawke's Bay rivers and streams (1960-2018) along with IPO Tripole. River flows are presented here using a 5-year moving average of the 7-day annual low flow time series'. Flows are standardized by the long-term mean for each site so rivers of different size can be compared directly. Climate drivers are compared using the dashed black line (right Y-axis), which represents the 5-year moving average IPO Tripole (Interdecadal Pacific Oscillation Tripole index).



NORTHERN CATCHMENTS

SUMMARY (2013-2018)

The Northern sub-region of Hawke's Bay includes two major catchments, the Wairoa and Mohaka, as well as several smaller catchments, including the Waikari, Esk, Te Ngarue and the Aropaoanui.

Key aspects of the Northern environment being monitored include:

- Groundwater quality
- Surface water (river, stream & lake) quality
- Surface water flows (hydrology)
- Marine & coastal environments

Land use

Many key environmental issues in Hawke's Bay are a consequence of land use that contributes to erosion and discharge of nutrients to waterways. A SedNetNZ model has identified that the Northern subregion is particularly susceptible to erosion, with more than 55% of the region's sediment load coming from these catchments. The areas of highly erodible land occur mostly in the steeper headwaters of the Wairoa and Nuhaka catchments, along with steep subcatchments on Mahia Peninsula. The main land use type identified in this subregion is sheep and beef, which is about 26.3% of the Northern subregion area.

Groundwater quality

Small, localised aquifer systems are found along the Wairoa River valley, Mahia tombolo and Esk River valley. Compared to the extensive aquifer systems of the Ruataniwha and Heretaunga Plains, aquifers in the Northern sub-region are minor and there are fewer wells. This is likely to reflect the limited availability and sometimes naturally poorer quality of shallow groundwater in this part of the region.

E. coli, a faecal indicator species, was detected at several monitoring bores in the Wairoa and Mahia aquifers. This is not unexpected since the Drinking Water Standards of New Zealand (DWSNZ) regards shallow groundwater as equivalent to surface water. Ministry of Health guidelines suggest that surface water is frequently contaminated by micro-organisms. However, the detection of *E. coli* demonstrates the vulnerability of shallow, unconfined groundwater systems to pathogenic contamination. Private bore owners should have their groundwater tested if it is used as drinking water.

Some of the deeper wells have high levels of naturally occurring manganese and some also have arsenic levels greater than the DWSNZ maximum acceptable values for long term consumption.

Item 12

Attachment 1

NORTHERN CATCHMENTS SUMMARY

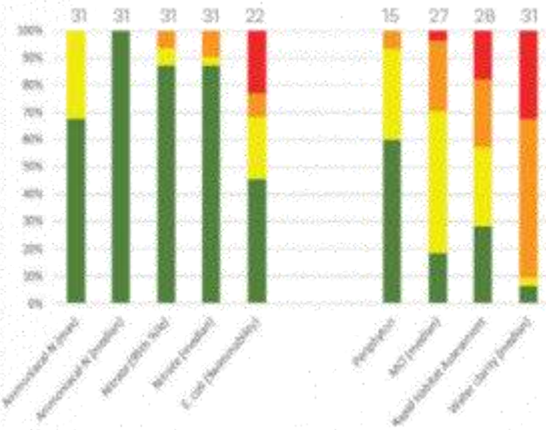
These heavy metals are a result of naturally occurring processes, not human activities. However, because concentrations can vary considerably over small distances, it is again important that private bore owners have potable supplies of groundwater tested.

River and stream water quality

Signs of degraded water quality include high levels of nutrients such as nitrogen and phosphorus, the excessive growth of aquatic plants or algae, a reduction in macroinvertebrate diversity, a reduction in water clarity due to higher levels of suspended sediments, and high levels of faecal contamination.

A summary of key water quality metrics for the Northern subregion is shown below. This plot identifies the percentage of SoE monitoring sites that fall within different categories for each metric.

Summary of freshwater quality state for rivers and streams of the Northern Subregion: 2013-2018.



Bars on the left are applicable to the NOF bands, with colours:

- = band A
- = band B
- = band C
- = band D

Bars on the right do not have NOF bands, so general categories apply to colours:

- = Excellent
- = Good
- = Fair
- = Poor

The number at top of each bar identifies the number of sites in the analysis.

Wairoa and nearby coastal catchments

Only one site, Opoutama Stream – Northern Coastal, is rated as poor quality based on the Macroinvertebrate Community Index (MCI), which is a bio-monitoring tool used to assess stream health according to the presence or absence of certain invertebrate species. A further four of the twelve sites have fair MCI scores, which indicates moderate pollution. While there was an absence of MCI data for Waikatuku Stream, habitat and water quality suggest that macroinvertebrates communities are likely also poor in that catchment.

In general, water clarity is degraded across these catchments, and swimmability is affected by high levels of faecal contamination. Faecal contamination due to ruminants is a problem in the Wairoa catchment downstream of Lake Waikaremoana. The Wairoa mainstem and three of its tributaries (Hangaroa, Ruakituri and Mangapoike rivers) are considered not swimmable. The Waiau River and Kopuawhara Stream are the least risky sites for Campylobacter infection based on *E. coli* levels.

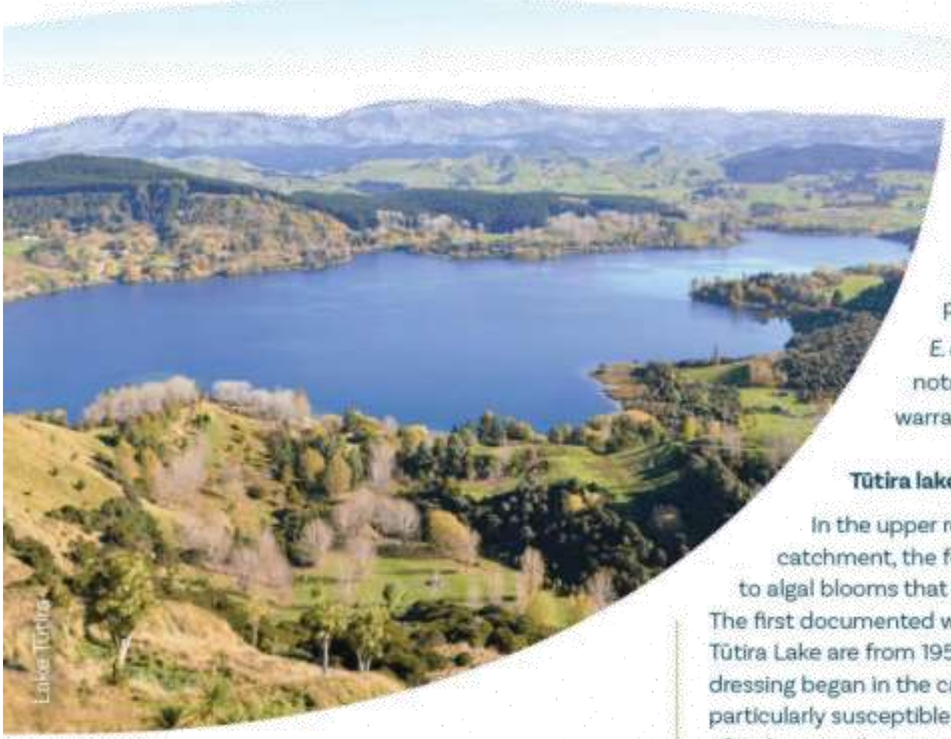
There was insufficient *E. coli* data for sites upstream of Lake Waikaremoana and all of the Northern Coastal sites except for Kopuawhara Stream. However, poor water clarity and high dissolved reactive phosphorus (DRP) indicate that those coastal sites are also subject to the effects of erosion and agricultural run-off.

The sites with faecal contamination issues also have poor water quality as a result of agricultural run-off and land erosion that delivers sediment to waterways. The SedNetNZ model has identified that mitigation, such as farm plans and/or tree planting, on 100 farms in the Northern sub-region with the greatest areas of highly-erodible land could reduce sediment load by 37%.

Mohaka catchment

The Mohaka River upstream of the Taharua confluence is one of the healthiest in the region, with no intensive and widespread human activity in the sub-catchment. Overall, the entire Mohaka catchment has good water quality, apart from the Taharua River which

NORTHERN CATCHMENTS SUMMARY



is eutrophic. Nitrate-nitrogen levels at two sites in the Taharua sub-catchment fail the proposed national standard for freshwater bottom-line for nitrogen toxicity. Periphyton (algae) cover and nutrient enrichment increases in the Mohaka mainstem downstream of the Taharua confluence. Swimmability is also excellent at all sites apart from the Taharua River at Wairango, which was rated 'good'.

The lower reaches of the Mohaka mainstem at times have poor water clarity and elevated total phosphorus, indicating sediment loading from erosion.

Waikari, Esk, Te Ngarue, and Aropaoanui catchments

Overall, river and stream health is reasonably good at the monitoring sites in the Waikari, Esk, Te Ngarue and Aropaoanui catchments. Nitrogen concentrations are mostly low to moderate, while dissolved reactive phosphorus (DRP) is the most elevated nutrient, with enrichment at all sites. Low periphyton (algae) coverage, good hydrological heterogeneity, varying substrate and diverse fish and invertebrate habitat types all contribute to generally good Macroinvertebrate Community Indices (MCI) and habitat scores.

Water clarity at most sites is fair, likely due to erosion in the upper catchment. Forestry is a potential source of this sediment, given that over 30% of the land in the catchments is in plantation forestry.

E. coli contamination was only notable in Sandy Creek, and this warrants further investigation.

Tūtira lakes

In the upper reaches of the Aropaoanui catchment, the four Tūtira Lakes are subject to algal blooms that continue to cause concern. The first documented water quality concerns for Tūtira Lake are from 1959, shortly after aerial top-dressing began in the catchment. Tūtira Lake was particularly susceptible to eutrophication because of its long residence time and limited flushing. The lake inlet and outlets are close together, which doesn't help.

Despite more than 40 years of efforts to improve the water quality and ecology, the lakes remain eutrophic and still experience frequent algal blooms. Proposed new mitigations include:

- developing farm environmental management plans throughout the catchment
- mitigating critical source areas of sediment and nutrients
- reconnecting Papakiri Stream at low flows
- creating sediment traps beneath forest harvest areas
- providing a southern outlet to increase flow through Lakes Tūtira and Waikōpiro

River and stream flows

Annual mean flows at all sites in the Northern sub-region were below the long-term mean flow between July 2013 and June 2016 and above the long-term mean between July 2016 and June 2018. Unusually low observed summer flows are less likely to be caused by abstraction and more likely a consequence of large-scale climate drivers.

NORTHERN CATCHMENTS SUMMARY

Marine and coastal water quality

The Northern sub-region is particularly susceptible to erosion and there are large land areas that deliver high sediment yields. The fate of sediment in waterways is ultimately the coastal receiving environments including estuaries, nearshore coastal areas, and the marine environment in extreme cases.

Median mud content in sediments of the Wairoa Estuary is approximately 40% and most samples were greater than the 25% mud content threshold understood to support healthy, diverse communities. Sensitive species are largely absent, which may compromise the integrity and resilience of the estuary, as well as reducing its value for other species, such as birds and fish.

While beach water quality is generally very good, estuary and lagoon sites in Hawke's Bay have the highest probability of exceeding the national microbiological guidelines for contact recreation. Between 2013 and 2018, estuary and lagoon sites in Hawke's Bay were suitable for swimming 81% of the time, unsuitable 10% of the time, and caution was advised 9% of the time.

Of the Northern sub-region lagoon sites, Te Mahia Harbour had the most exceedances and was considered unsuitable for swimming 10% of the time. A popular boat launching area, Te Mahia harbour is the mouth of the Whangawehi catchment, which has forestry and agricultural activities. Peaks of faecal contamination from ruminant and avian sources can occur following heavy rain.

Hawke's Bay Regional Council continues to support the Whangawehi Catchment Management Group, who are using a community-led approach to restore the streams that flow into the Whangawehi River and ultimately to Te Mahia Harbour.

Land and water management activities

To address issues associated with erosion and agricultural run-off throughout Hawke's Bay, the Regional Council is implementing an Erosion Control Scheme. This initiative encourages tree planting and erosion control work on pastoral or retired land. The Erosion Control Scheme also includes a riparian programme, providing advice and assistance to landowners about planting beside waterways to minimise streambank erosion and to improve the ecological health of waterways.

The $30 million fund targets Hawke's Bay's 252,000 hectares of land at high risk of erosion, estimated to lose, on average, more than 3 million tonnes of sediment to the region's waterways every year.

The scheme aims to reduce soil erosion, improve terrestrial and aquatic biodiversity, provide community and cultural benefits through forest ecosystem services, and improve water quality through the reduction of sedimentation in waterways.

While these erosion control efforts are underway, improvements in water quality and aquatic habitats will take time to manifest. Continued State of the Environment monitoring is essential for evaluating the efficacy of these efforts over time.

The scheme aims to reduce soil erosion, improve terrestrial and aquatic biodiversity, provide community and cultural benefits through forest ecosystem services, and improve water quality through the reduction of sedimentation in waterways.

HERETAUNGA CATCHMENTS

SUMMARY (2013-2018)

Key issues and actions in the Heretaunga sub-region of Hawke's Bay.

These are long-term issues and it will take time for actions to generate environmental improvements. Continued monitoring is essential to evaluate the success of these actions over time.

Key Issues

- Groundwater supply is connected to rivers and streams - flows are affected by groundwater abstraction
- River and stream water quality are linked to land use
- Degraded waterway habitats and swimmability are linked to land use
- Nutrients and fine sediment in estuaries are linked to land use
- Air quality from domestic fires

Key Actions

- The TANK Plan Change will deal with the effects of land and water use on the quality and quantity of Heretaunga Plains water
- $30 million Erosion Control Scheme targeting 250,000 ha of highly erodible land
- Managing land use activities using Farm Plans and resource consents
- Riparian management programme supports fencing and planting around water ways
- Regional Water Security programme, includes 3D Aquifer Mapping and community-led storage investigations
- The Regional Council has developed sophisticated computer models to inform decisions on enhancing environmental flows and water quality
- Regulations and financial assistance to transition to cleaner domestic heating and improve urban air quality

Te whakapakari tahi i tō tātau **taiao**.
Enhancing our **environment** together.

HAWKES BAY REGIONAL COUNCIL
TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI

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Heretaunga Subregion

The Heretaunga subregion has four main catchments: the Tūtaekurī, Ahuriri, Ngaruroro and Karamū, which are collectively known as the TANK catchments (Figure 3-1).

Figure 3-1: Locations of TANK catchments and their position within the Hawke's Bay regional boundary (inset).

The Tūtaekurī and Ngaruroro are large 6th order rivers and the catchments cover an area of approximately 836 km^2 and 2,000 km^2 respectively. The mainstems of both rivers are characterised by gravel beds that form wide, braided channels in the lower catchment.

The headwaters of the Ngaruroro River are in the forested areas of the Kaweka Range (north) and the Ruahine Range (south). In its upper catchment the Ngaruroro River is a fast flowing river in a bed of rocks, boulders and coarse gravel. This area is predominantly in native vegetation with some pasture

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down to Whanawhana. Between Whanawhana and Maraekakaho, the river is braided, flowing in a relatively wide and flat channel bordered by steep hill country and high river terraces. The land use in this part of the catchment is predominantly dry stock farming with land use changes occurring in the last 15 years. There were two large intensive dairy operations, one on either side of the Ngaruroro River downstream of Whanawhana. The dairy farm on the true left bank was converted to viticulture in 2016, although the monitoring site still retains the name *Ngaruroro at Hawke's Bay Dairies* to avoid confusion over the continuity of this long-term site

Downstream of Maraekakaho the river runs through plains and low rolling hill country where land use becomes more varied, including viticulture and cropping. The river channel is wide and flat, with a low gradient and a semi-braided morphology, constrained on each side by stopbanks. The area is a zone of groundwater recharge, losing river flow between Roys Hill and Fernhill to the Heretaunga aquifer system. The Heretaunga groundwater resource is important to the region, providing water for multiple uses including irrigation, processing and industrial use, and is the water source for Hastings and Napier.

The Tūtaekurī catchment headwaters are in native vegetation of the Kaweka Range before passing through commercial pine forest. The river has good quality habitat for most of its length, with regular occurrence of riffles, pools and bends and a predominantly cobble streambed.

Dry stock farming dominates the middle catchment although approximately 7,000 ha of dairy farming has been established over the last 10 to 15 years, mostly around Patoka. Downstream of the Mangaone River confluence, the Tūtaekurī valley widens and flattens, and the river takes a braided morphology. Land use here is predominantly vineyards and orchards, with dry stock farming in the surrounding hills as well as peri-urban/commercial development.

The Karamū and Ahuriri catchments are smaller, approximately 500 km^2 and 86 km^2 respectively. The Karamū catchment covers most of the surface area of the Heretaunga Plains. The Ahuriri catchment, north of Napier, has small tributaries flowing into the Ahuriri Estuary. Most of the tributaries of both catchments drain lowland country, and have very low gradients with slow flowing water, with the streambed often made up of fine gravel or sandy/silty substrate. This provides ideal growing conditions for aquatic plants (macrophytes). By contrast, algae are more commonly found in streams with faster flowing, stony substrates.

The rivers and streams of the Heretaunga catchments terminate at the coast through the Ahuriri/Te Whanganui-a-Orutū, Waitangi and Tukituki Estuaries, along with several smaller systems.

Estuaries represent the downstream receiving environment of the freshwater drainage network, so it is understandable that they are sensitive to the same effects of land-use activities as streams and rivers throughout the catchment. In New Zealand, estuaries are being recognised as the most at risk coastal environments, as they are the depositional end-point for cumulative contaminants (e.g. nutrients, sediments) from the surrounding catchment.

Land Science

Many key environmental issues in Hawke's Bay are a consequence of land use that contributes to erosion and discharge of nutrients to waterways. Other than the indigenous forest and native forest covering the western parts of the subregion, the main land use type of this area is sheep and beef, which occupies approximately 31% of the area according to the latest HBRC land use map (Figure 3-2). There are also 18,655 ha of beef grazing, 12,520 ha of orchards and vineyards and 11,711 ha of short-rotation cropland identified in the latest HBRC land use map generated in 2020.

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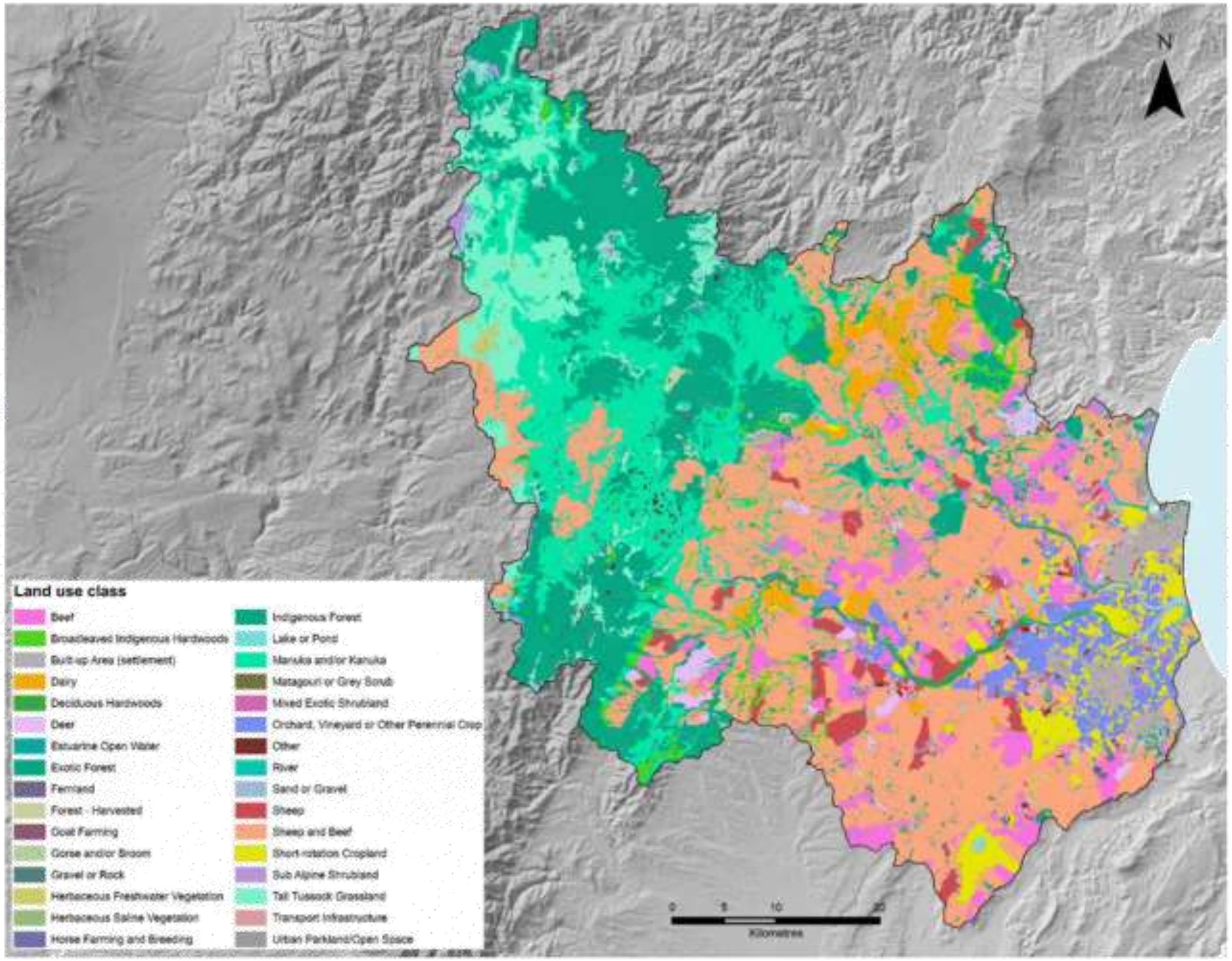

Figure 3-2: Land use map for the Heretaunga subregion (2020).

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3.1 Water quality

3.1.1 Groundwater quality

One of the region's major productive groundwater resources is the Heretaunga Plains aquifer system. The locations of bores used by HBRC for monitoring groundwater quality are shown in . The main focus for groundwater quality sampling is to identify good sources of potable water and to understand the natural concentrations of determinands in groundwater along with impacts of human activities on the resource.

Figure 3-3: Heretaunga Plains bores used for monitoring groundwater quality. Bore numbers are shown next to yellow circles that show the location.

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Key groundwater quality issues in Hawke's Bay aquifer systems are *E. coli* and nitrate concentrations that exceed the Drinking Water Standards of New Zealand (DWSNZ) in some shallow bores less than 30m below ground level. Vulnerability of groundwater to contamination from micro-organisms is evaluated from sampling for the faecal indicator species *E. coli*. The presence of nitrate-nitrogen is invariably a consequence of intensive land use activities including the application of fertiliser that may be leached into the groundwater system.

The maximum acceptable value (MAV) for nitrate-nitrogen in the DWSNZ is 11.3 mg/L and this was not exceeded at any monitoring bores in the Heretaunga aquifer system (Figure 3-4). Trend analysis was also undertaken for nitrates, but did not identify increasing trends of concern in the Heretaunga Plains.

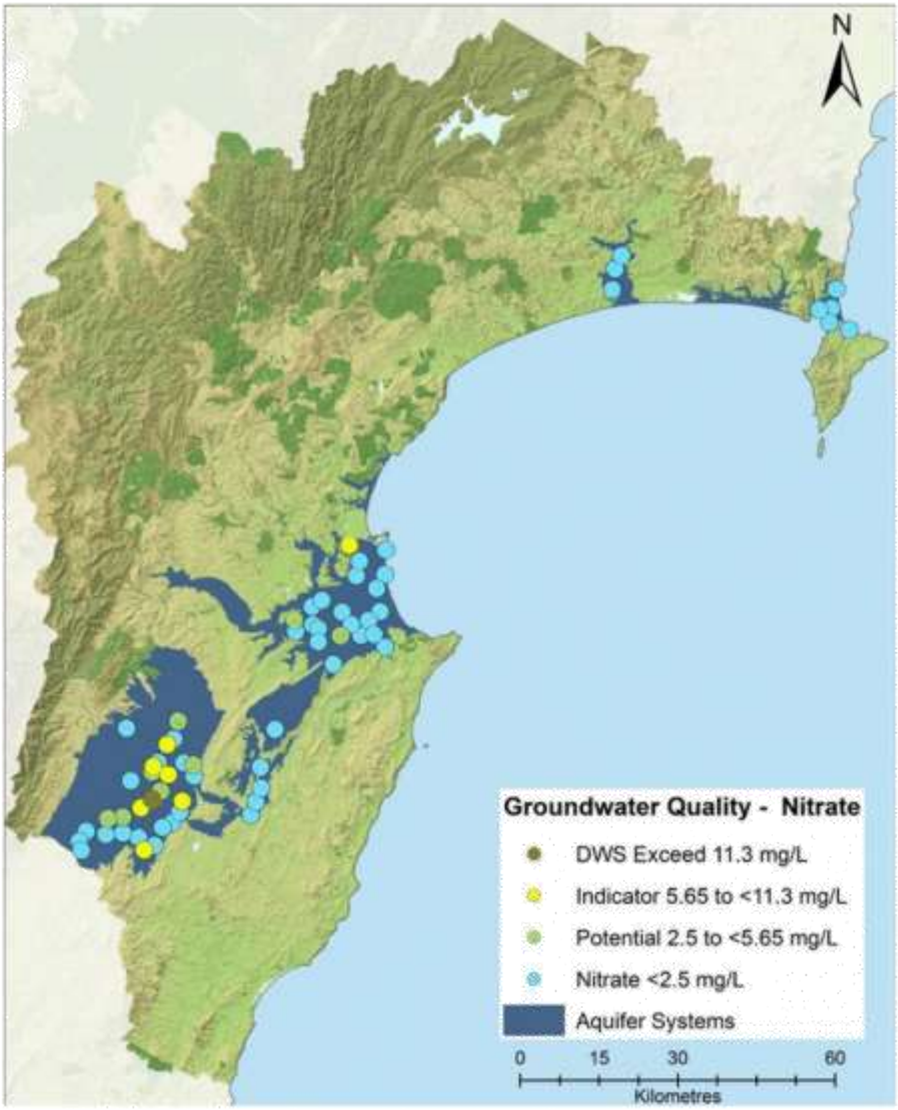

Figure 3-4: Nitrate-nitrogen concentrations in Hawke's Bay SoE monitoring bores.

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The DWSNZ specify that there shall be no colony forming units (cfu) of *E. coli* per 100 mL of groundwater and this criterion was exceeded at one monitoring bore in the Heretaunga aquifer system (Figure 3-5). This exceedance occurred at bore number 611 for 1 of the 21 samples taken at that site. Investigation revealed that the bore had insecure headworks and casing that allowed stormwater with *E. coli* to enter the well. This was immediately resolved and no further *E. coli* exceedances have been observed.

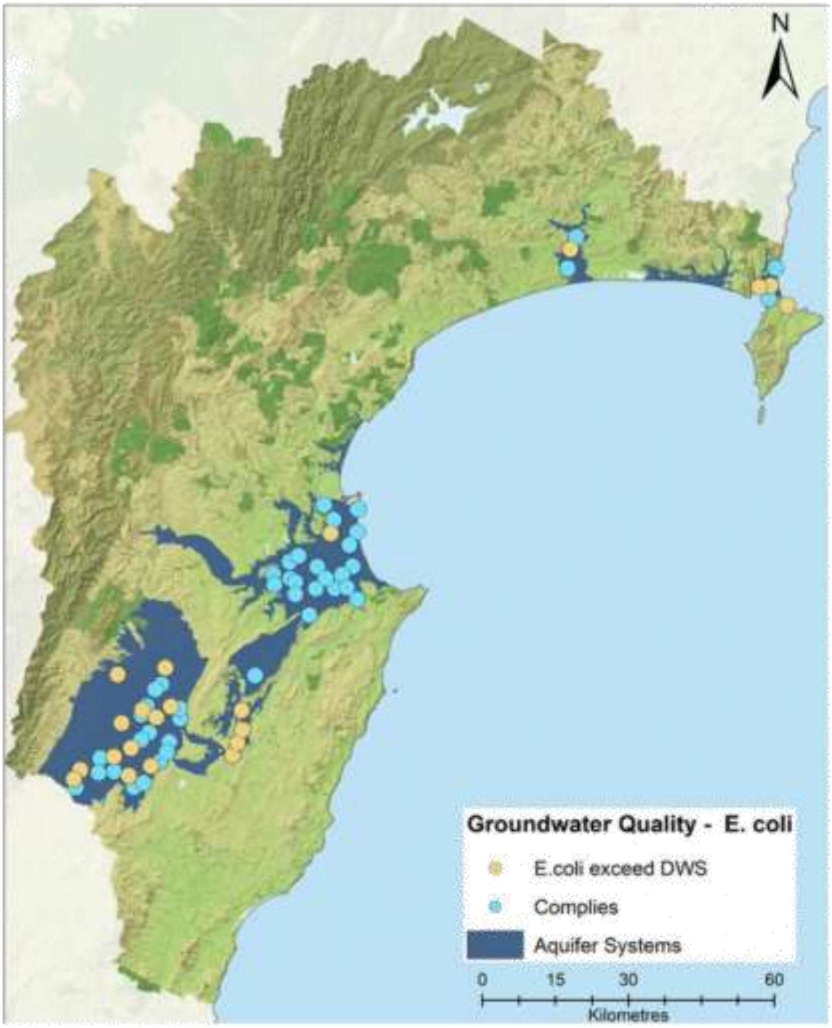

Figure 3-5: SoE well locations showing DWSNZ *E. coli* exceedances and compliance for the Hawke's Bay region between 2013 and 2018. Orange dots exceeded the DWSNZ for *E. coli* at least once over the 5-year period. Blue dots comply with DWSNZ.

During 2018 groundwater samples were taken from shallow wells located within areas of intensive land use and analysed for the presence of pesticides. Pesticides were not detected in any of the shallow groundwater wells that were sampled, which is consistent with previous surveys undertaken in 2010 and 2015.

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The Heretaunga groundwater quality is generally very good, although some of the deeper wells do have high levels of naturally occuring manganese. During 2017/2018, some private well owners also reported arsenic levels greater than the DWSNZ MAV, after they had their groundwater supplies analysed. Investigations undertaken by HBRC identified that the arsenic was a result of natural processes within the groundwater system, rather than a contaminant plume. The natural processes occur when arsenic that is found in some rock types is mobilised under certain groundwater conditions that are independent of human activities.

The presence of arsenic in groundwater is not spatially uniform and it is quite common for wells in close proximity to have large variations in arsenic concentrations. Consequently, it isn't possible to identify every location in the Heretaunga Plains where naturally occuring arsenic may be present, and this is one reason why it is recommended that private bore owners should have their groundwater supplies tested.

3.1.2 Surface water quality

a) Ngaruroro and Tūtaekurī catchments

Toxicity effects on aquatic organisms from nitrate and ammonia were not an issue anywhere in the Ngaruroro and Tūtaekurī catchments, as concentrations were always low with respect to toxicity. Ammonia levels were mostly below detection limit.

Escherichia coli (*E. coli*) levels were very low in both catchments and were below the lowest guideline ('alert'-) level. All mainstem sites in the Ngaruroro and Tūtaekurī rivers were suitable for primary contact recreation under the NOF framework. Some tributaries fell into the D Band (not suitable for primary contact recreation), but when full immersion activity is limited to normal flows (i.e. less than median flows, when most recreation takes place), all sites were suitable for contact recreation.

The Ngaruroro mainstem is in excellent condition in the upper to middle catchment. The lower mainstem reaches showed some enrichment in nutrients. Water quality parameters in general showed a minor upstream to downstream decline, which was reflected in the macroinvertebrate community. Periphyton cover was indicative of a good ecological condition, but recreational guidelines were exceeded on rare occasions at Fernhill. Overall water quality and ecology of the Ngaruroro River mainstem was healthy.

Water clarity decreased while turbidity increased from upstream to downstream in the Ngaruroro catchment. Ngaruroro at Kuripapango and Tūtaekurī at Lawrence Hut have the clearest water measured in the Hawke's Bay region (Figure 3-6). However, the mid to lower Ngaruroro mainstem water clarity was below contact recreation guidelines. Sediment appears to enter the Ngaruroro from the tributaries, along with erosion of the mainstem riparian margins. Sediment loads are relevant to the receiving Waitangi Estuary.

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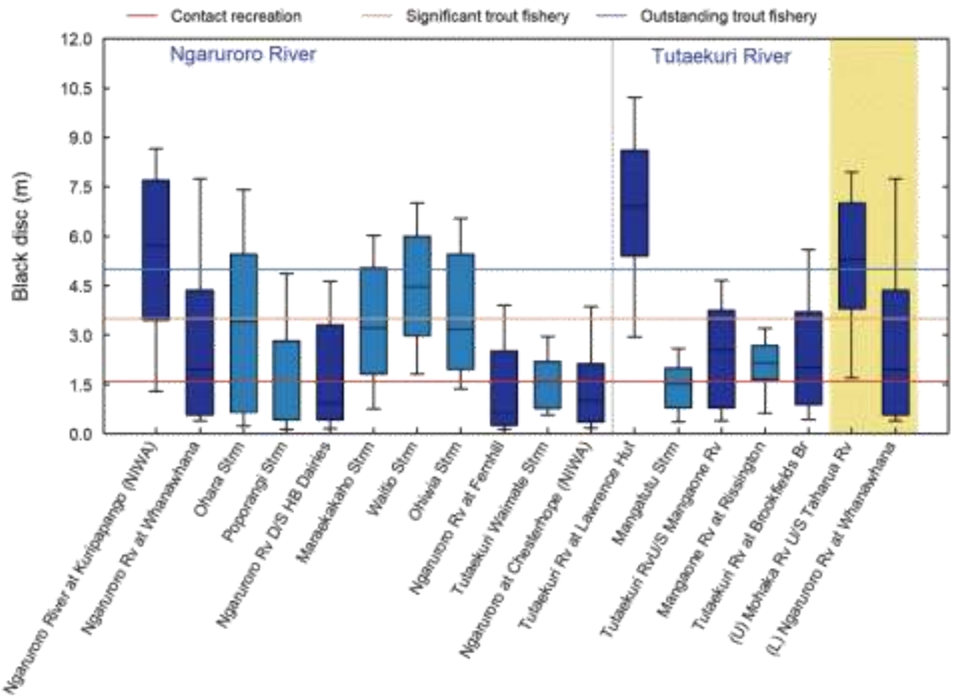

Figure 3-6: Water clarity (black disc measurements) at Ngaruroro and Tūtaekurī SoE sites. Mainstem sites are shown with dark blue boxes, while light blue boxes are tributary sites. The blue line is the 'Outstanding trout fishery' limit; the amber line the 'Significant trout fishery' limit. The red line is the recreational amenity limit. The sites Ngaruroro at Kuripapango and Tūtaekurī at Lawrence Hut are upland sites. All other sites are lowland according to ANZECC guidelines. SoE sites for the Mohaka River U/S Taharua confluence and the Ngaruroro River at Whanawhana (shaded) are included as Upland (U) and Lowland (L) reference sites for comparison.

All Ngaruroro tributaries other than the Ohara Stream were enriched in nutrients, especially phosphorus which was either moderately elevated (DRP between 0.01 and 0.02 mg/L) or substantially elevated (DRP greater than 0.02 mg/L) for all Ngaruroro tributaries with SoE monitoring sites (Figure 3-7).

The influence of nutrient loads from tributaries flowing into the Ngaruroro mainstem had only a minor effect on the water quality in the mainstem, because large volumes of high quality water from the pristine upper catchment dilutes the influence of the tributaries. However, nutrient loads from the tributaries are relevant for health of the Waitangi Estuary as the receiving environment.

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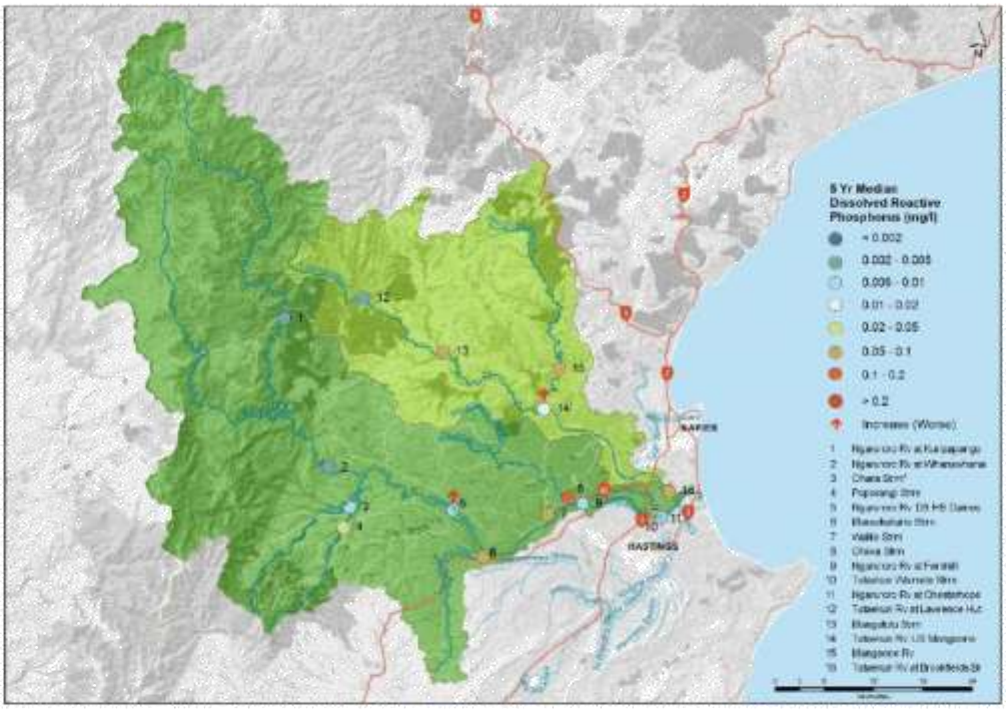

Figure 3-7: 5-year median dissolved reactive phosphorus (DRP) levels at Ngaruroro and Tūtaekurī SoE sites. The map includes trend direction, shown with arrows. Blue arrows indicate improvement over time and red arrows deterioration. Only six years of monthly data were available for trend analysis, so caution is strongly advised with interpretation of trends.

The Macroinvertebrate Community Index (MCI) is a biomonitoring tool to assess stream health based on the presence or absence of certain invertebrate species. A higher MCI score indicates that more pollution 'intolerant' or sensitive species are present. In the Ngaruroro mainstem, MCI was excellent in the upper catchment, good in the mid catchment and at the threshold between good and fair in the lower catchment (Figure 3-8). MCI in tributaries of the upper Ngaruroro catchment were between good and excellent. Further downstream, the tributaries Maraekakaho, Waitio and Ohiwa streams all had MCI scores at or below the "good" class, while the Tūtaekurī-Waimate stream was in the poor MCI class.

The Tūtaekurī mainstem showed some enrichment in nutrients from upstream to downstream, particularly with phosphorus (Figure 3-7), which was substantially elevated at the most downstream site at Brookfields Bridge. The Macroinvertebrate Community Index (MCI) also showed a gradient from upstream to downstream and declined from excellent in headwaters to fair towards the lower reaches (Figure 3-8).

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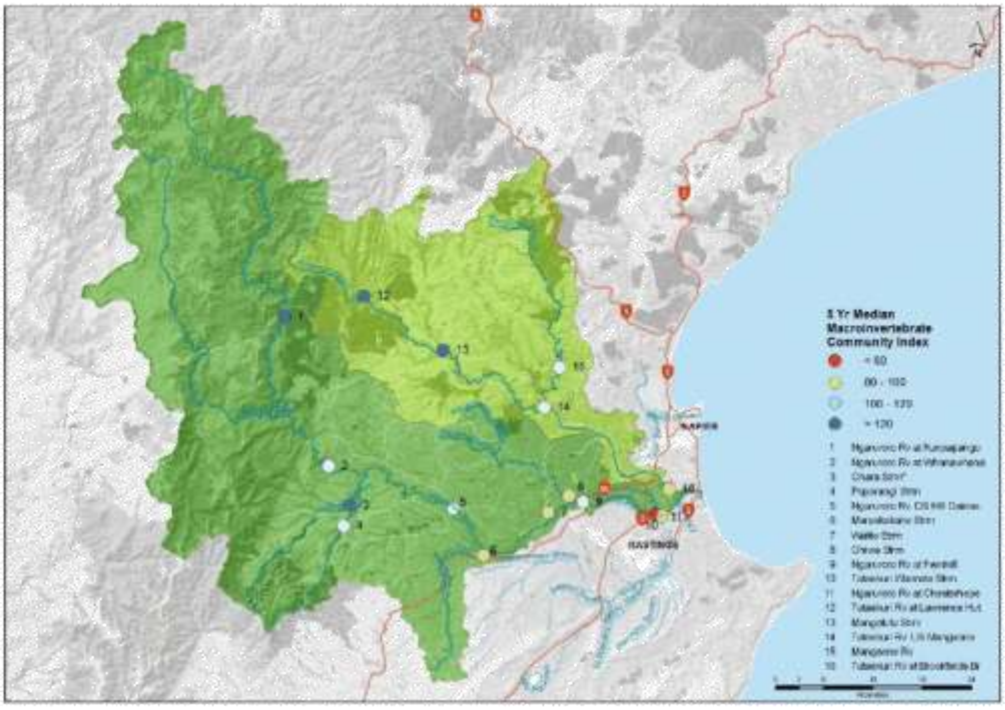

Figure 3-8: MCI levels at Ngaruroro and Tūtaekurī SoE sites. Circle colours indicate MCI classes: dark blue is excellent; light blue is good; amber is fair; and red is poor.

Tūtaekurī tributaries had water quality issues similar to the Ngaruroro tributaries, with elevated nutrient concentrations. Phosphorus concentrations in both the Mangaone and Mangatutu tributaries were substantially elevated (Figure 3-7). MCI was good across all tributary sites (Figure 3-8). Periphyton biomass was high at the SoE site in the Mangatutu Stream, and low at the sites in the upper Mangaone River. The effect of tributary nutrient loads on mainstem water quality was greater in the Tūtaekurī than in the Ngaruroro, because the volume of water coming from the pristine upper catchment is lower and the dilution effect is therefore less than in the Ngaruroro. Nutrient loads are also important to manage with regards to the health of the receiving Waitangi estuary.

Physical habitat condition was evaluated using a Rapid Habitat Assessment (RHA) which assigns a score of 100 for the best habitat (or 90 for the best habitat in soft bottomed streams). Habitat condition ranged between the highest RHA score of 85 for the Ohara Stream and the lowest score of 35 for the Tūtaekurī–Waimate Stream (Figure 3-9). The near natural sites scored lower than expected because the RHA focusses on biodiversity, not naturalness. Also, the wide channels were not shaded (even by mature trees), resulting in a lower score. Lowland streams (Waitio, Ohiwa and Tūtaekurī-Waimate) have the lowest RHA score out of SoE sites in the Ngaruroro and Tūtaekurī catchments.

The predominant factor scoring particularly low at most sites is the lack of riparian vegetation, with consequential reduction of habitat quality due to sunlight exposure.

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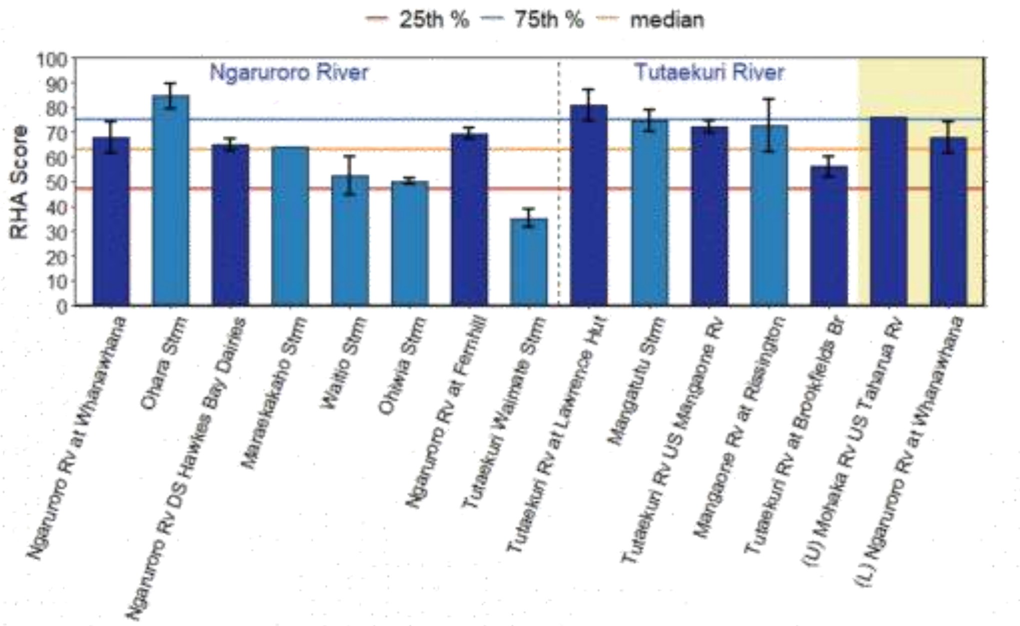

Figure 3-9: Rapid Habitat Assessment score (RHA score) at Ngaruroro and Tūtaekurī SoE sites. Mainstem sites are shown with dark blue boxes, while light blue boxes are tributary sites. The horizontal lines are thresholds for physical habitat condition, with the 25th percentile = 47, median = 63, and 75th percentile = 75, of the distribution of 560 New Zealand sites. SoE sites for the Mohaka River U/S Taharua confluence and the Ngaruroro River at Whanawhana (shaded yellow) are included as Upland (U) and Lowland (L) reference sites for comparison.

b) Karamū and Ahuriri catchments

Streams in the Karamū and Ahuriri catchments are compromised in terms of ecosystem health and life supporting capacity. Overall, the condition at SoE sites in the Karamū and Ahuriri catchments ranked poorest of Hawke's Bay in many factors. Most sites in the Karamū had amongst the highest concentrations of nutrients and *E. coli*, and lowest MCI and habitat scores, of all sites in Hawke's Bay.

Nutrient concentrations were generally high at the Karamū and Ahuriri SoE sites. Median dissolved inorganic nitrogen (DIN) concentrations were substantially elevated (>1 mg/L) at the Karewarewa and Awanui SoE monitoring sites (Figure 3-10). Meanwhile, median DRP concentrations at all sites were either moderately elevated (between 0.01 and 0.02 mg/L) or substantially elevated (greater than 0.02 mg/L) (Figure 3-11). For soft-bottomed streams, these concentrations of nutrients may cause excessive growth of macrophytes in the stream.

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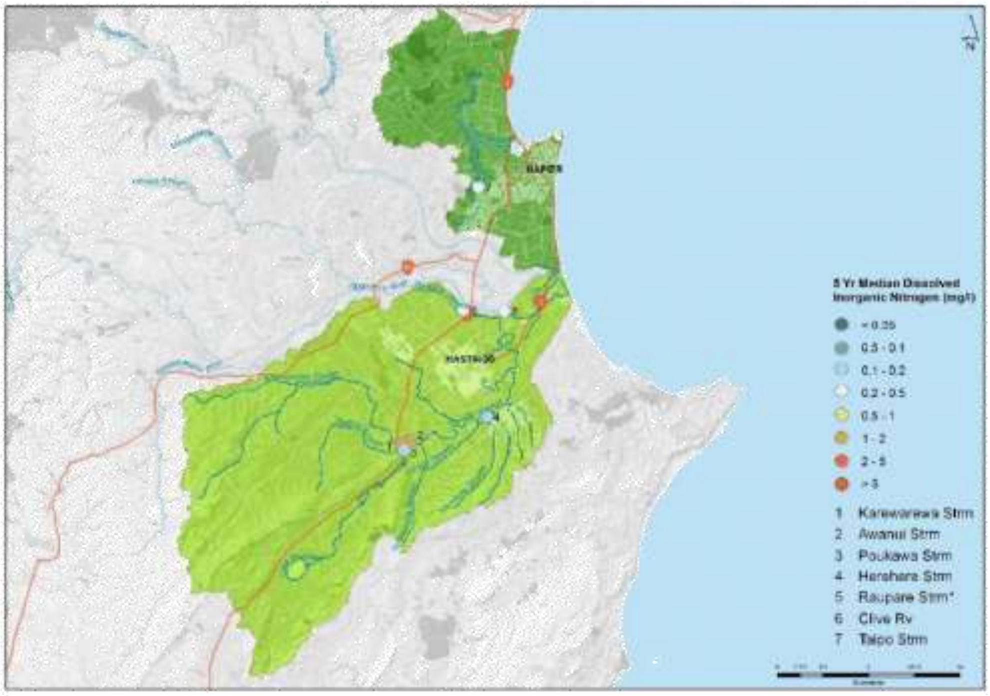

Figure 3-10: **5 year median DIN levels at Karamū and Ahuriri SoE sites.**

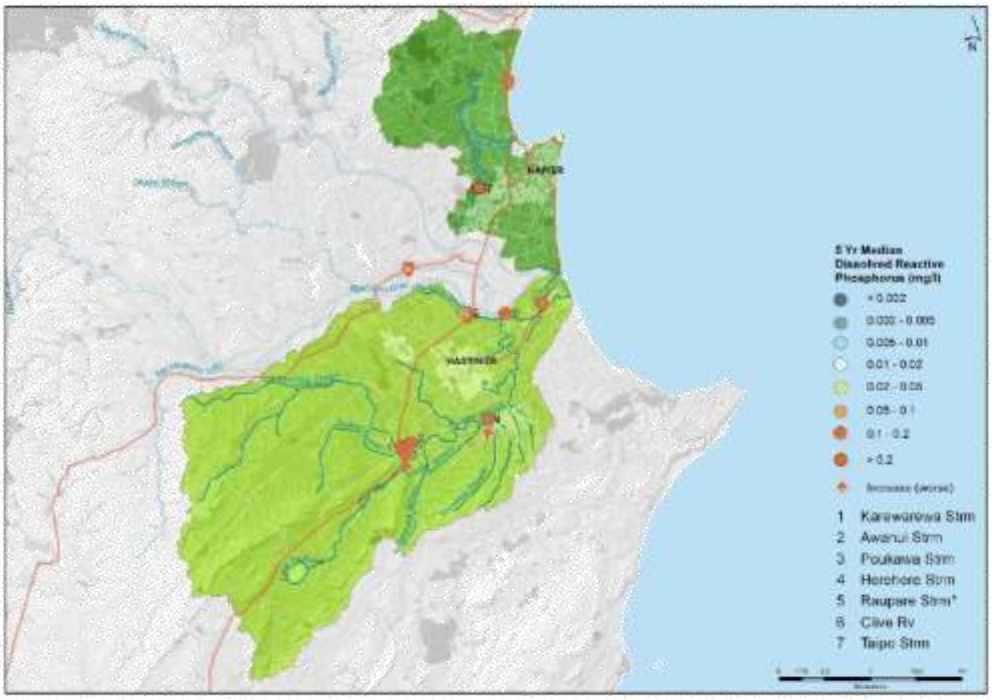

Figure 3-11: 5 year median DRP levels at Karamū and Ahuriri SoE sites. The map includes trend direction, shown with arrows. Blue arrows indicate improvement over time and red arrows deterioration. Only six years of monthly data were available for trend analysis, so caution is strongly advised with interpretation of trends.

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Several SoE sites may be at risk of low oxygen levels that are likely to stress fish, invertebrates and other aquatic organisms. Figure 3-12 summarises 5-year median dissolved oxygen saturation at Karamū and Ahuriri sites. Wilding[5] (2016) recommended that 40% oxygen saturation is an appropriate standard to protect adult native freshwater fish in low-gradient streams where aquatic plants drive oxygen dynamics; such as streams in the Karamū and Ahuriri catchments.

However, Wilding's assessment is based on daily minimum oxygen levels from continuous flow monitoring. The data in Figure 3-12 are medians from five years of monthly observations and are not directly comparable to the daily minimum standard that Wilding recommended. Notwithstanding, the observations in Figure 3-12 and a study of continuous oxygen measurements in 2016 indicate that the Karewarewa, Awanui, Poukawa, and Taipo streams are at risk of oxygen problems for aquatic ecosystems.

Excessive macrophyte growth is contributing to this at the Karewarewa, Awanui and Taipo sites, and breakdown of organic matter may be another cause for low oxygen levels at the Poukawa site. Riparian shading is one option to improve oxygen levels in these streams. Planting appropriate riparian vegetation can reduce excess growth of plants and algae that consume oxygen at night, along with cooling water temperatures which increases oxygen saturation and reduces the oxygen demand that fish require for metabolic requirements.

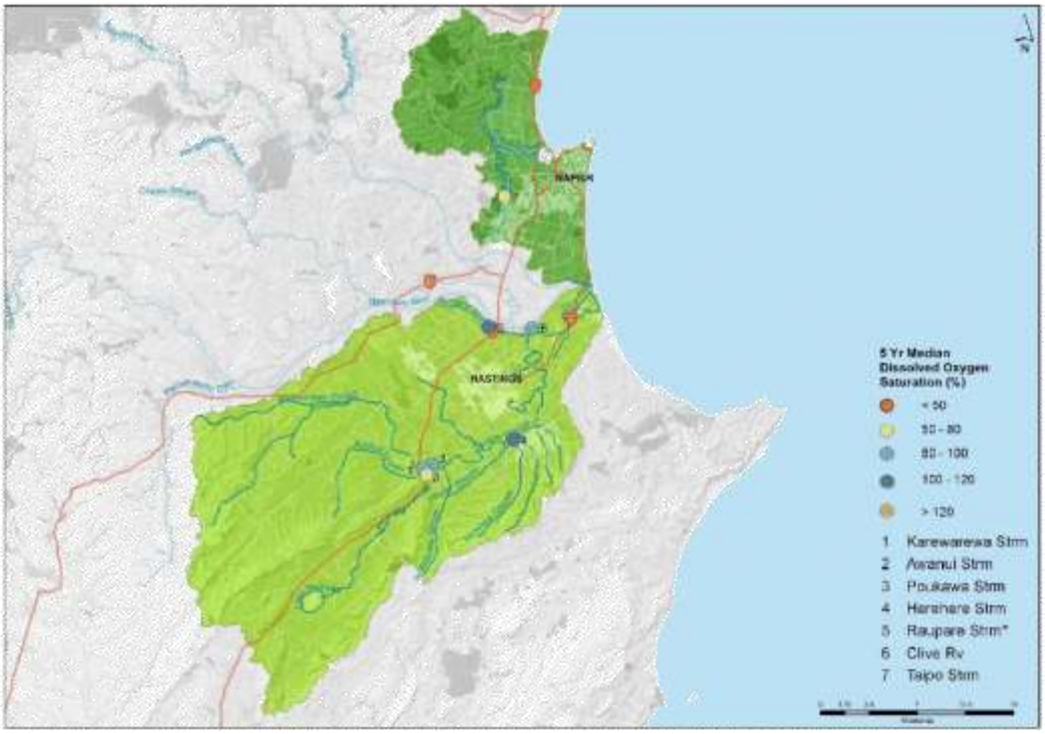

Figure 3-12: 5 year median dissolved oxygen saturation at Karamū and Ahuriri SoE sites.

[5] Wilding T. (2016) *Spatial oxygen-flow models for streams of the Heretaunga Plains*. HBRC report number 4744.

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Biological indicators showed that most Karamū and Ahuriri SoE sites were highly compromised. The macroinvertebrate community was in a poor condition at all sites (Figure 3-13).

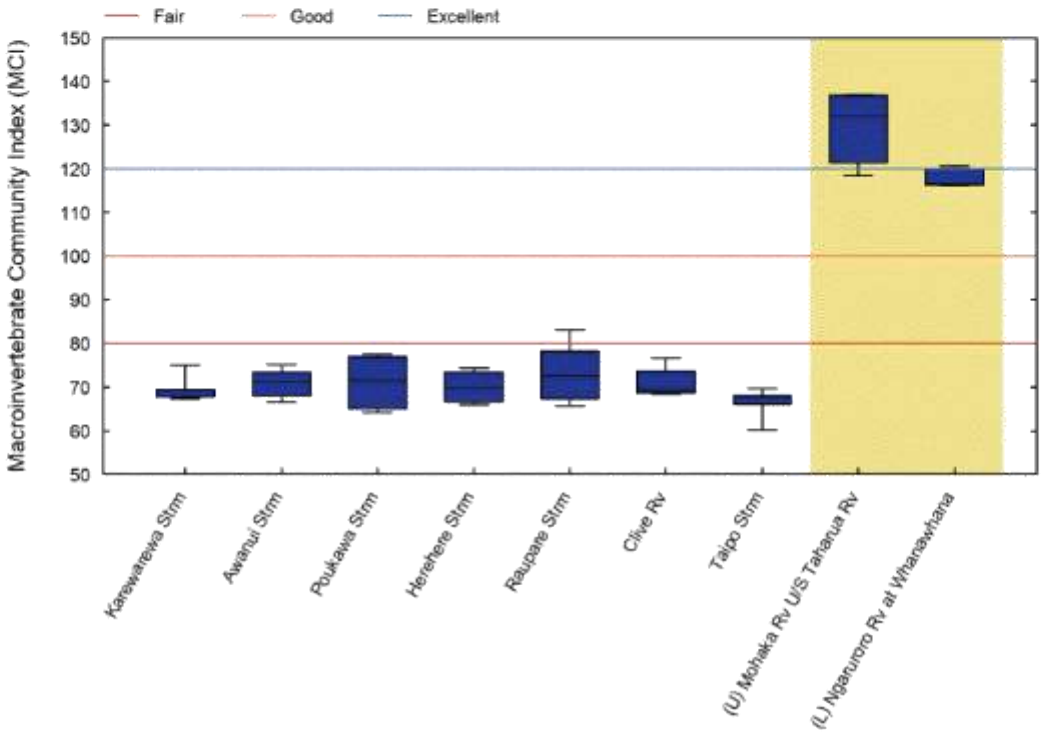

Figure 3-13: MCI levels at Karamū and Ahuriri SoE sites. Lines are boundaries between MCI quality classes: Blue line: boundary between classes excellent and good; Orange line: boundary between good and fair; Red line: boundary between fair and poor. SoE sites for the Mohaka River U/S Taharua confluence and the Ngaruroro River at Whanawhana (shaded) are included as Upland (U) and Lowland (L) reference sites for comparison.

There was excessive macrophyte growth at the Karewarewa, Awanui and Poukawa Streams and this generates adverse effects on water quality; particularly dissolved oxygen. The Taipo Stream was observed to have nuisance macrophyte biomass at times, but spraying and cutting occurs in the urban reaches. Low oxygen levels in the Taipo may be a consequence of decaying plant matter from the cutting or spraying.

Physical habitat was poor at most Karamū and Ahuriri SoE sites, particularly in terms of habitat heterogeneity and riparian condition (Figure 3-14).

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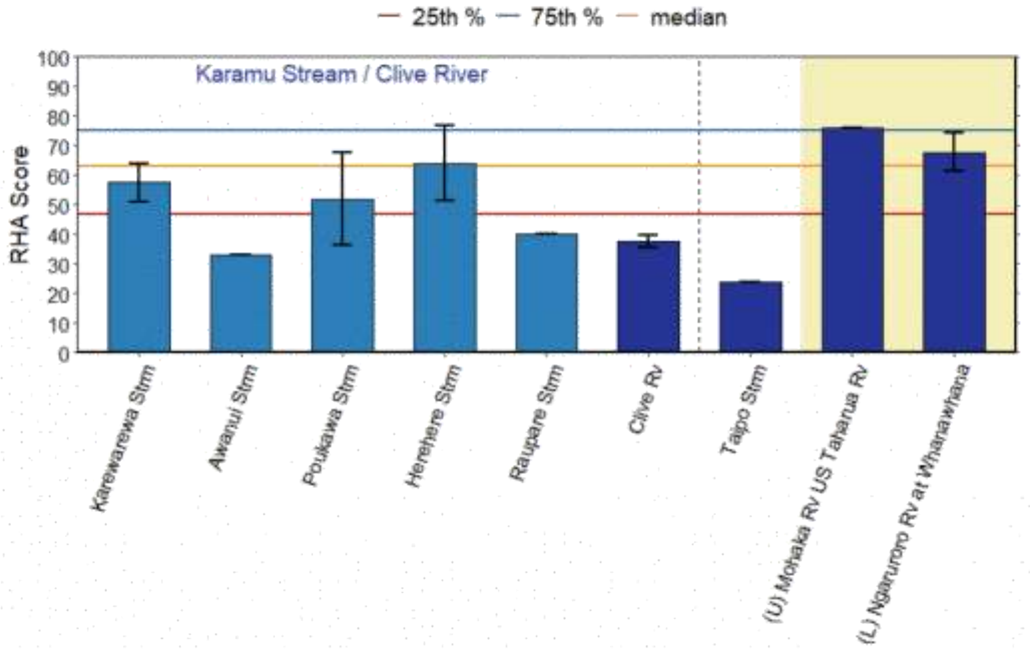

Figure 3-14: Rapid Habitat Assessment score (RHA score) at Karamū and Ahuriri SoE sites. The horizontal lines are thresholds for physical habitat condition, with the 25th percentile = 47, median = 63, and 75th percentile = 75, from the distribution of 560 New Zealand sites. SoE sites for the Mohaka River U/S Taharua confluence and the Ngaruroro River at Whanawhana (shaded yellow) are included as Upland (U) and Lowland (L) reference sites for comparison.

Only the Poukawa Stream was graded swimmable in the NPS-FM framework (Table 3-1). All other Karamū and Ahuriri SoE sites have *E. coli* concentrations categorised as not suitable for primary contact recreation. High *E. coli* concentrations were not limited to high flow events: the sites were also graded not swimmable under average flow conditions. A study is underway to identify the sources of bacteria by using genetic faecal source tracking to identify whether the bacteria originate from ruminant, avian, human or other sources.

Table 3-1: NOF swimmability categories for *E. coli* at Karamū and Ahuriri SoE sites. Monitoring period 2013 to 2018. Overall grade A, B and C bands are categories suitable for primary contact recreation.

Site	Overall grade for *E. coli*
Karewarewa Stream	E
Awanui Stream	E
Poukawa Stream	B
Herehere Stream	E
Raupare Stream	E
Clive River	D
Taipo Stream	E

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The poor ecosystem condition and life supporting capacity in the Karamū and Ahuriri catchments was highlighted in the previous SoE technical report 2009-13. A subsequent investigation identified the main stressors on ecosystem health: high water temperature; low dissolved oxygen levels; and poor habitat conditions. A workshop in 2017 with HBRC staff and external freshwater scientists from different research institutes identified riparian vegetation as the best option to achieve long-term improvement of ecosystem health in the lowland catchments.

Riparian plants that shade streams protect water from getting too warm in summer, reduce macrophyte growth (which also improves dissolved oxygen levels) and provide habitat. Riparian management can also help to stabilise stream banks and filter sediment and *E. coli* before they reach streams. As a response to this, Karamū Stream planting continues as part of a long-term enhancement programme to improve water quality. HBRC works with community groups, iwi, landowners, schools and local businesses in this catchment.

The Ahuriri Estuary enhancement programme also continues with its yearly removal of the invasive tubeworm, winter planting and environmental monitoring. HBRC continues to work closely with Napier City Council, Mana Ahuriri, the Department of Conservation and other key partners on a wider plan to improve the health of Ahuriri Estuary for fish, birds and people.

Nutrient concentrations were also very high in the Karamū and Ahuriri Streams. While a reduction in nutrient concentrations is not likely to achieve a significant reduction in macrophyte growth, nutrient loads need to be managed for receiving environments: the Ahuriri and Waitangi estuaries. A preliminary investigation was carried out that identified high nutrient losses from some tile drains in the Karamū catchment, which drains to Waitangi estuary. More research is needed to identify where, when and how nutrients are lost from land in lowland catchments like the Karamū, to be able to identify effective ways of managing nutrient losses to estuaries.

3.1.3 Marine and coast, and recreational water quality

The coastal inshore waters of Hawke's Bay provide for a range of biological, social, economic and recreational activities. However, these areas are also the receiving environment for almost all land-based activities via the freshwater drainage network, and are therefore susceptible to water quality issues. In Hawke's Bay, large river systems contribute to the direct transport of contaminants to the nearshore coastal environment, and therefore monitoring coastal water quality is required to ensure that key functions and services remain intact. Locations of marine and coastal monitoring sites are shown in Figure 3-15.

Many of the attributes that can describe the quality of coastal waters in Hawke's Bay are within levels observed elsewhere in New Zealand. Exceptions to this include sediment in estuarine waters, and water quality adjacent to Awatoto. Hawke's Bay estuaries appear to have high median turbidity levels compared to other national sites, likely due to the highly erodible nature of Hawke's Bay landscapes, the current land use, and flood events which can transport large quantities of sediments to regional estuaries and nearshore.

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Figure 3-15: Estuarine, nearshore and HAWQi water quality monitoring sites in Te Matau-a-Māui - Hawke's Bay.

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Sediment stress is one of the key issues observed through estuarine state of the environment monitoring. Sediment composition is a key driver in the macroinvertebrate community composition present within estuary sites. Estuary systems with silt/clay content <25-30% generally exhibit communities with higher diversity and abundance than those with >25-30% silt/clay, although lower concentrations have been shown to impact on the health of macroinvertebrate communities. Systems with silt/clay fractions of 10% or under generally have been shown to have conditions suitable for 11 of the most sensitive taxa, while those with silt/clay fractions of 5% or under have been shown to have conditions suitable for the 5 most sensitive macrofaunal taxa.

Sediments in the lower Ahuriri Estuary (A B, D and E) are generally dominated by medium sands, with lower levels of muds (silt/clay) compared to other regional estuaries (Figure 3-16). This is typical of transitory systems where channels and currents transport finer grained sediments offshore, and shallow intertidal areas where muds can be resuspended by waves and wind. Moderate sediment stress was observed at sites in mid Ahuriri Estuary, with higher levels of sediment stress observed at the upper Ahuriri and other regional estuarine sites.

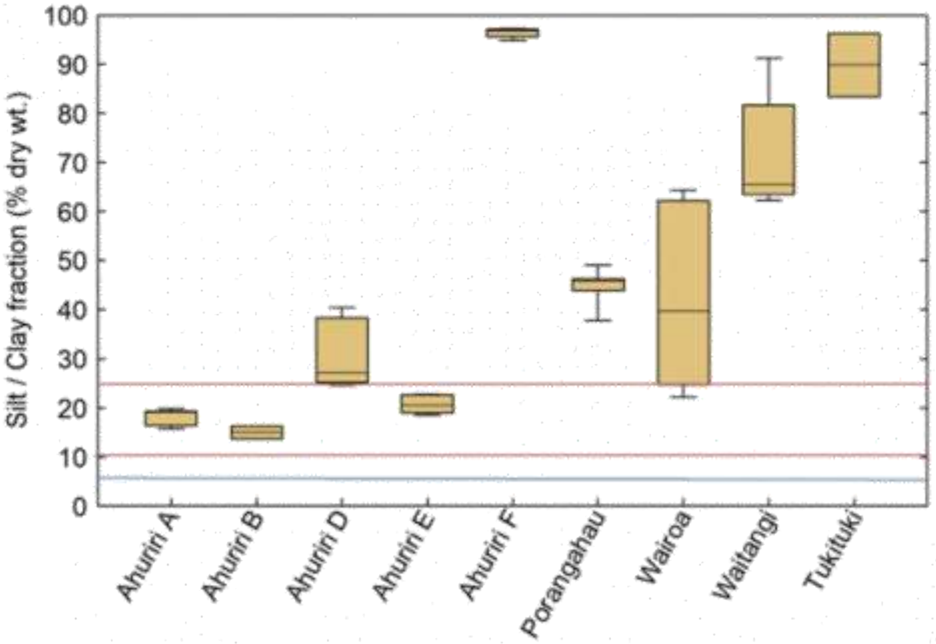

Figure 3-16: 5 year median levels of silt/clay (mud) in estuarine sediments (2013-2018). Blue line refers to 5% mud, amber line 10% mud content, red line 25% mud content. Medians based on 5 years 2013-2018 (Ahuriri A, D, E, Pōrangahau, and Wairoa), 4 years (Waitangi), 3 years (Ahuriri B, F), 2 years (Tukituki). Boxes represent 25th, 50th and 75th percentiles and whiskers represent 10th and 90th percentiles.

Median levels of 'mud' in the lower and upper Ahuriri and Waitangi Estuaries exceed published literature for mud content thresholds that support healthy, diverse communities (<25% mud content). Median mud content for the Waitangi and upper Ahuriri exceed 60% (Figure 3-16). At these sites, sensitive species are largely absent, and this can compromise the integrity and resilience of the estuary, as well as reducing its value for other species such as birds and fish.

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The nutrients Nitrogen (N) and Phosphorus (P) can influence the health of the community structure found in nearshore coastal waters. As with sediments, nitrogen and phosphorus can be added to the marine environment through transport from land based activities and geological weathering. Additionally, waters can rise to the nearshore surface through a process of upwelling, which can supply cooler, nutrient rich water to the surface, to replace warmer, nutrient poor waters.

As with rivers, lakes and estuaries, the addition of nutrients into coastal waters can fuel the growth of marine plants. Specifically, at times phytoplankton can grow in abundance when sufficient nutrients are present. In most marine systems, nitrogen (specifically nitrate) tends to be the limiting nutrient (i.e. there is not enough nitrogen in the water to support further algal growth). Therefore the addition of nitrogen into nitrogen limited systems can 'fuel' algal growth

The waters offshore of Awatoto have the highest median levels of total nitrogen in the region. The accompanying high levels of chlorophyll *a* at this site (Figure 3-17) indicates that these nutrients are contributing to higher localised primary production. Levels of chlorophyll *a* at Awatoto exceed the ANZECC guidelines, although levels are still within those described as 'slight' risk of eutrophication, and fall on the national median for open coast waters.

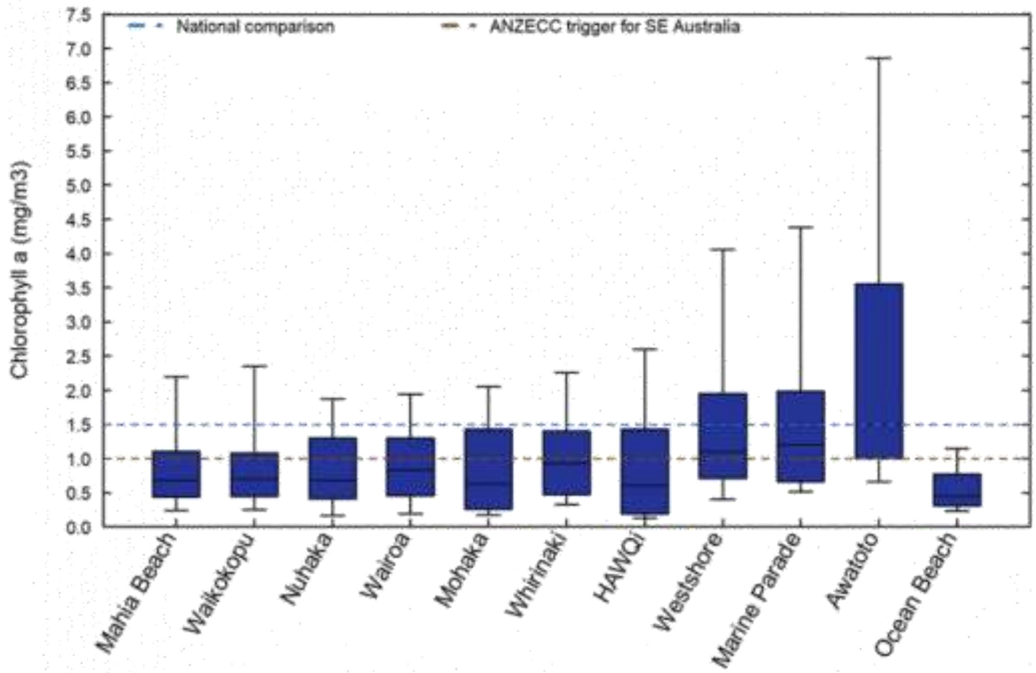

Figure 3-17: Chlorophyll *a* levels at nearshore water quality sites (2013-2018). Boxes represent 25th, 50th and 75th percentiles. Whiskers represent 10th and 90th percentiles. Blue dashed line indicates NZ median for open coast sites, orange dashed line indicates ANZECC default guideline for South-East Australia.

The quality of the waters offshore of Awatoto are conspicuously different to other sites along the coastline. This area receives freshwater from the Tūtaekurī and Ngaruroro Rivers, the Karamū Stream and two municipal sewerage outfalls. Source apportionment work would contribute to a greater understanding of the relative influence these may have on water quality.

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3.2 Groundwater resources

Monitoring of groundwater levels in the Heretaunga aquifer system show that declines have manifested slowly over time. In many areas, the long-term changes are masked by the natural variability between seasons. The most persistent changes in Hawke's Bay have occurred in the Heretaunga and Ruataniwha Plains, where most trends indicate declining water levels. Results like these are expected in productive aquifer systems and are consistent with previously identified changes in patterns and trends.

On the Heretaunga Plains, groundwater level declines are mainly located in the unconfined zone northwest of Hastings (Figure 3-18) and a persistent decline in groundwater levels between Roy's Hill and Fernhill has been observed. Overall, Heretaunga groundwater levels during summer have declined by an average of 5 cm per year, between 1989 and 2018

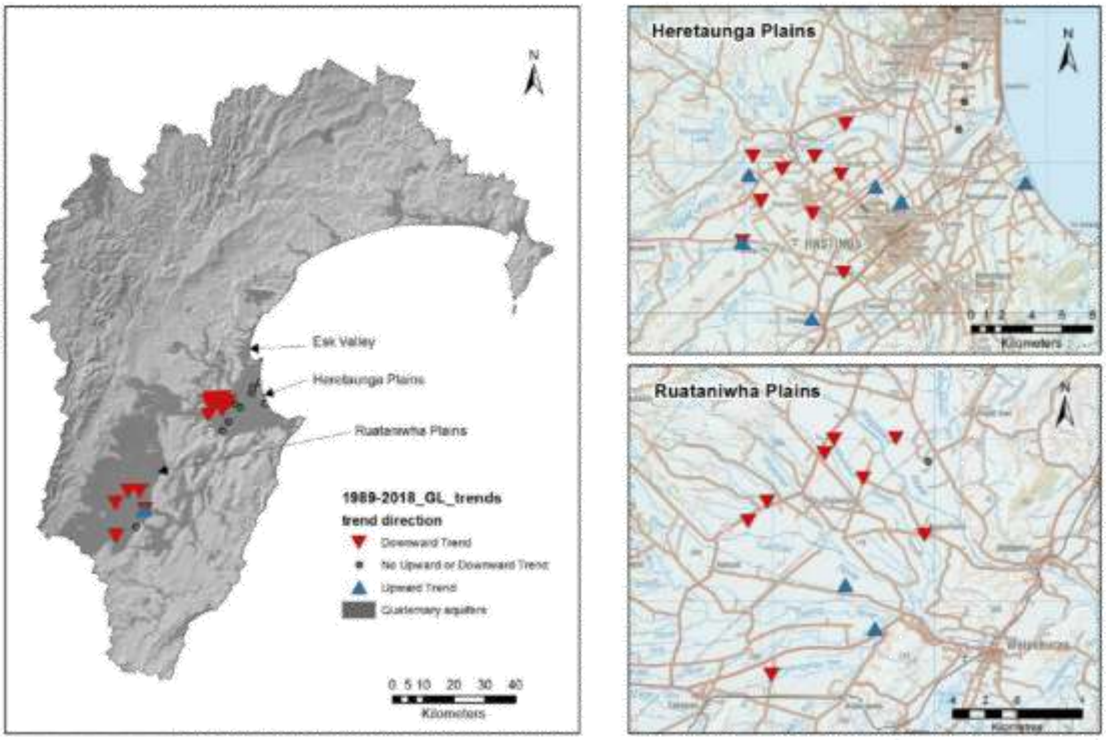

Figure 3-18: Locations of statistically significant trends in groundwater levels for 30 years between 1989 and 2018.

While climatic influences may have played a part in the groundwater declines, abstraction from the aquifer system has also increased over this period (Figure 3-19) and has contributed to the declining groundwater levels. The abstraction significantly increased from 1980 until about 2005 when it showed signs of levelling off, as shown in Figure 3-19.

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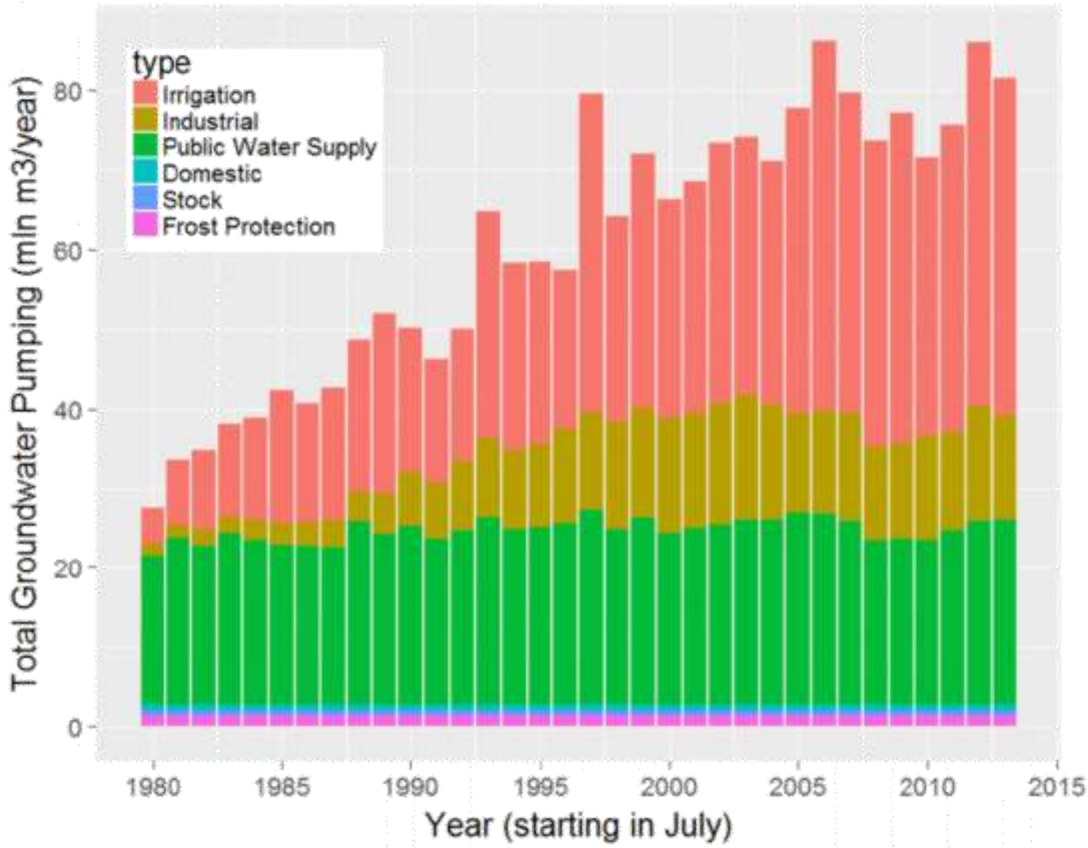

Figure 3-19: Annual groundwater abstraction from the Heretaunga aquifer system, by sector. [6]

Numerical groundwater models were developed to inform a plan change for the TANK catchments and were used to investigate the effects of pumping from the Heretaunga aquifer system. A key objective for modelling was to evaluate current and future impacts caused by groundwater pumping; including the time needed to reach a new equilibrium under various management scenarios. The models identified that the effects on surface water and changes in groundwater storage, as a consequence of abstraction from the Heretaunga aquifer system, quickly stabilise under stable pumping conditions.

When trends in groundwater levels were evaluated for 20 years from 1999 to 2018 (Figure 3-20), declining trends did not appear to be as widespread as they were for the 30 year period from 1989 to 2018 (Figure 3-18). This may be an indication that the groundwater system is approaching a new equilibrium as the rate of increasing abstraction has reduced since around 2005. Further monitoring and trend analysis is required to confirm whether this is the case.

[6] For details see: Rakowski P. and Knowling M. (2018) *Heretaunga Aquifer Groundwater Model Development Report*. HBRC report number 4997. Available at https://www.hbrc.govt.nz/documents-and-forms/details/9279 (accessed 14 June 2020)

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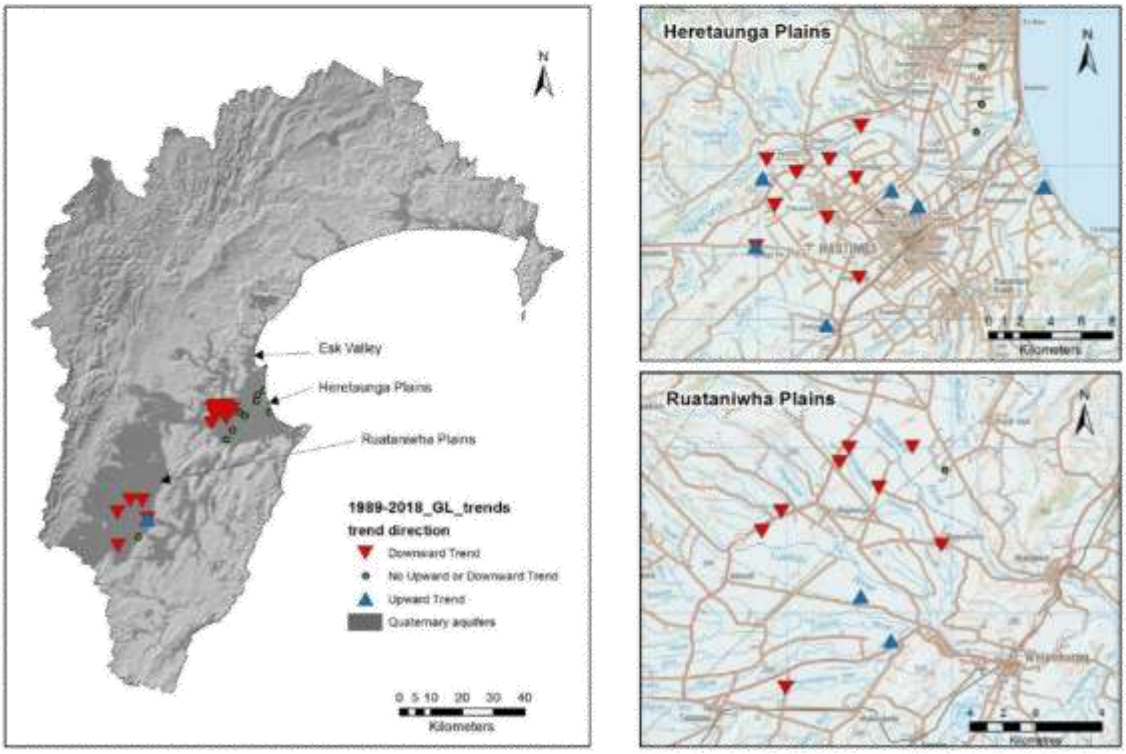

Figure 3-20: Locations of statistically significant trends in groundwater levels for 20 years between 1999 and 2018.

The groundwater models also provided a new understanding of the stream depleting effects of groundwater abstraction from the Heretaunga Plains and, consequently, HBRC has ceased issuing resource consents for further abstraction. In addition, the proposed TANK plan change aims to limit groundwater allocation from the Heretaunga Plains to actual and reasonable use prior to 2017. This will stabilise groundwater abstraction and long-term declines in groundwater levels are anticipated to cease as a consequence. Future monitoring of groundwater levels will be used to identify whether the groundwater system does reach a new equilibrium as predicted by the numerical groundwater models.

In addition to capping the groundwater allocation from the Heretaunga aquifer system as part of the proposed TANK plan change, HBRC is also working to identify and implement solutions to manage the effects of groundwater abstraction and build resilience of water supplies to climate change. HBRC is investing heavily in a Regional Water Security programme and the government has committed substantial additional finance from the Provincial Growth Fund to support this programme. Options currently being investigated for the Heretaunga area include small- to medium-scale out-of-stream water storage, to deliver environmental outcomes and resilient water supplies for current and future climatic conditions.

As part of the Regional Water Security programme, an airborne 3D aquifer survey was flown in February 2020. 3D aquifer mapping and knowledge gained from the survey, due in 2022, will deliver a far greater understanding of the Heretaunga groundwater system so that the resource can continue to be managed sustainably into the future.

The same computer models, developed to inform the TANK plan change process, are also being used to evaluate options for the Regional Water Security programme.

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3.3 Surface water flows

A range of summary river flow statistics were calculated for Heretaunga catchments for the hydrological years[7] 2013-2014 through to 2017-2018 and for the available long-term record. The locations of State of the Environment river flow sites in Hawke's Bay are shown in Figure 3-21.

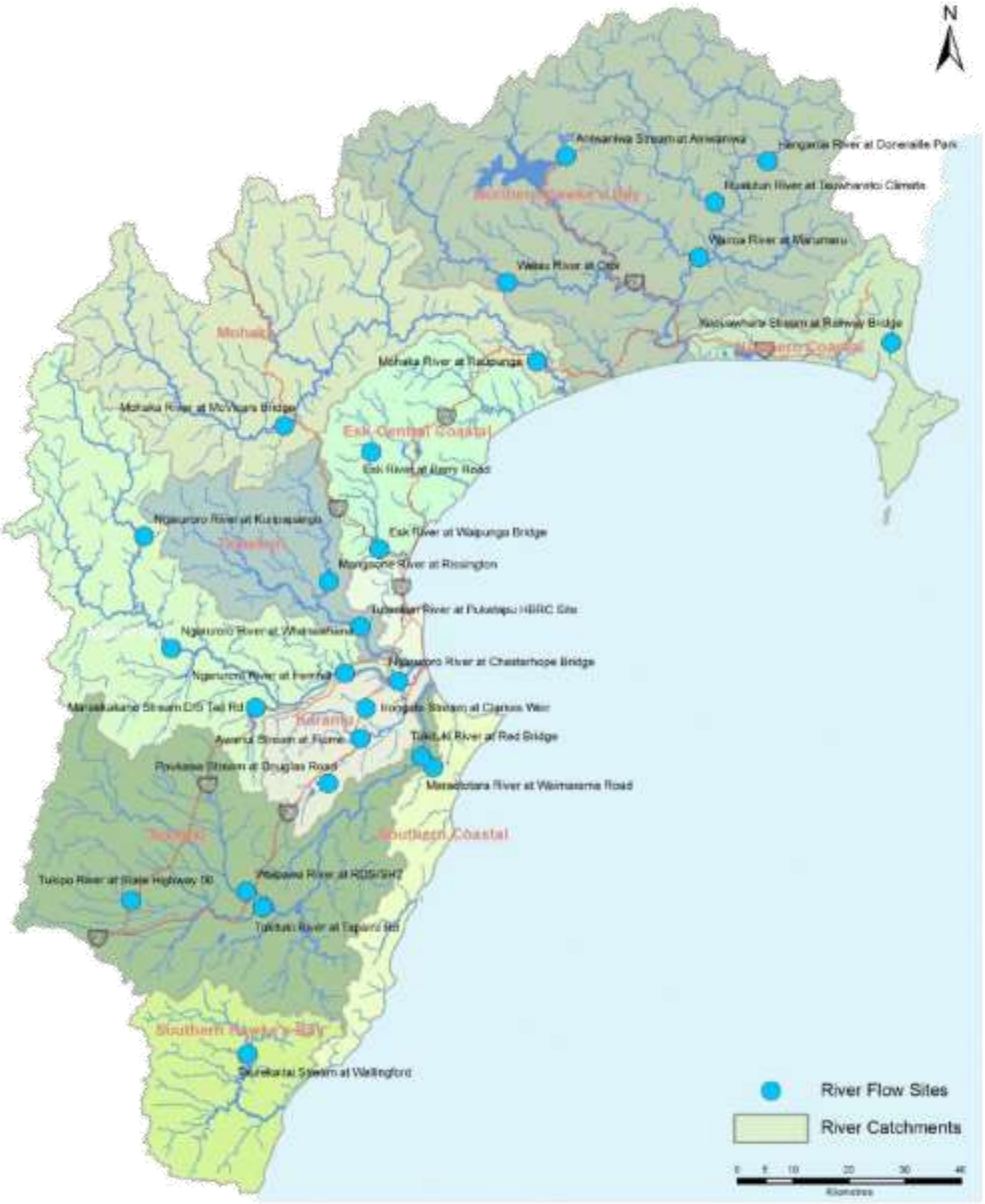

Figure 3-21: Locations of long-term SoE river flow monitoring sites.

[7] A hydrological year is from July to June. Hydrological years are used to avoid splitting summer low flow events, which commonly occurs when calendar years are used for analysis.

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Plots of monthly mean flows for these rivers identify seasonal variation for each year between 2013 and 2018; compared with long term averages, long term range (maxima and minima), and normal flow ranges (± 25% of the long-term mean).

During summer periods between 2013 and 2018, monthly mean flows in the Ngaruroro River at Chesterhope were often below the normal range for that time of year (Figure 3-22).

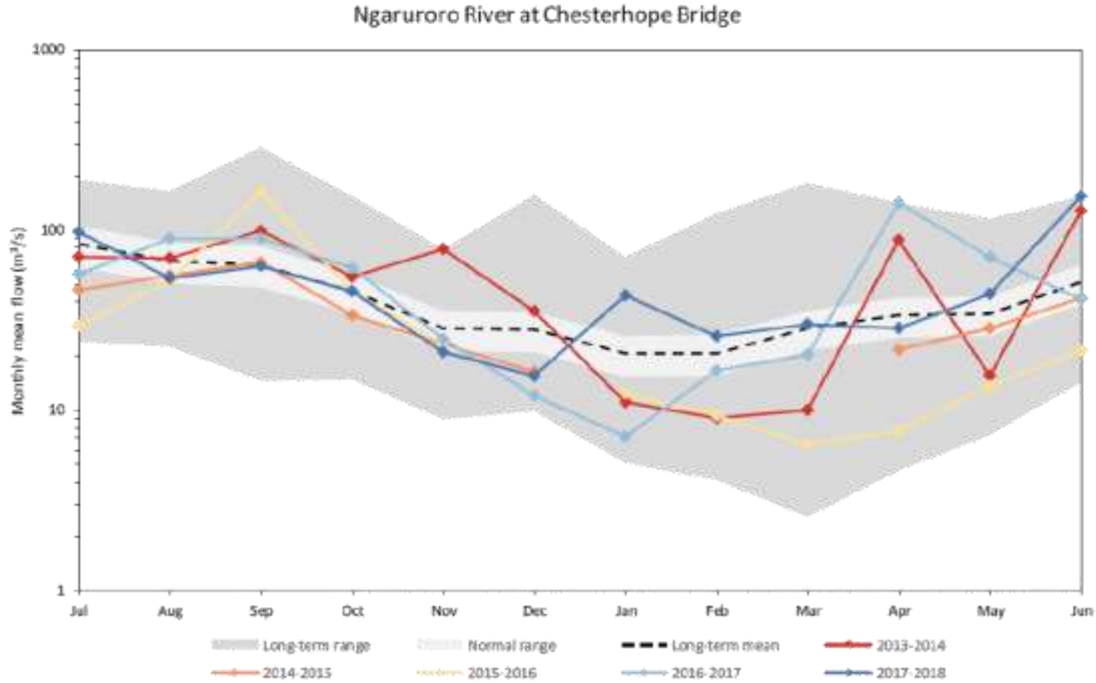

Figure 3-22: Ngaruroro River at Chesterhope Bridge monthly mean flow (2013-2014 to 2017-2018). Flows are shown with the long-term mean, long-term range and normal range (1976-2018). Note the y-axis has a logarithmic scale.

A similar phenomenon was observed in the Tūtaekurī River at Puketapu during summer periods (Figure 3-23), along with sites in the Karamū catchment including the Irongate Stream at Clarke's Weir (Figure 3-24).

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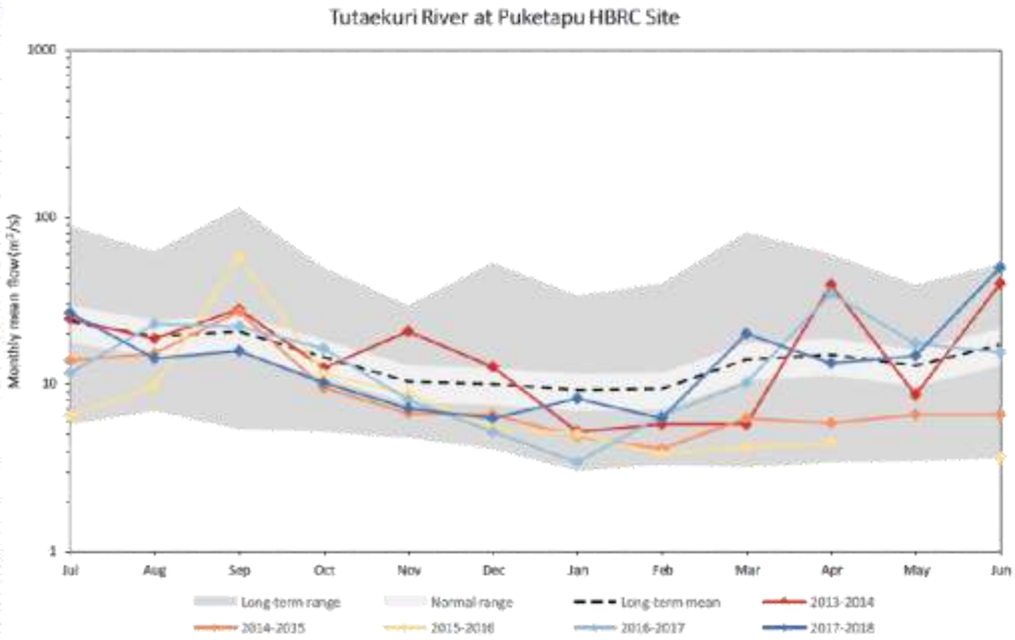

Figure 3-23: Tūtaekurī River at Puketapu HBRC Site monthly mean flow (2013-2014 to 2017-2018). Flows are shown with the long-term mean, long-term range and normal range. Note the y-axis has a logarithmic scale.

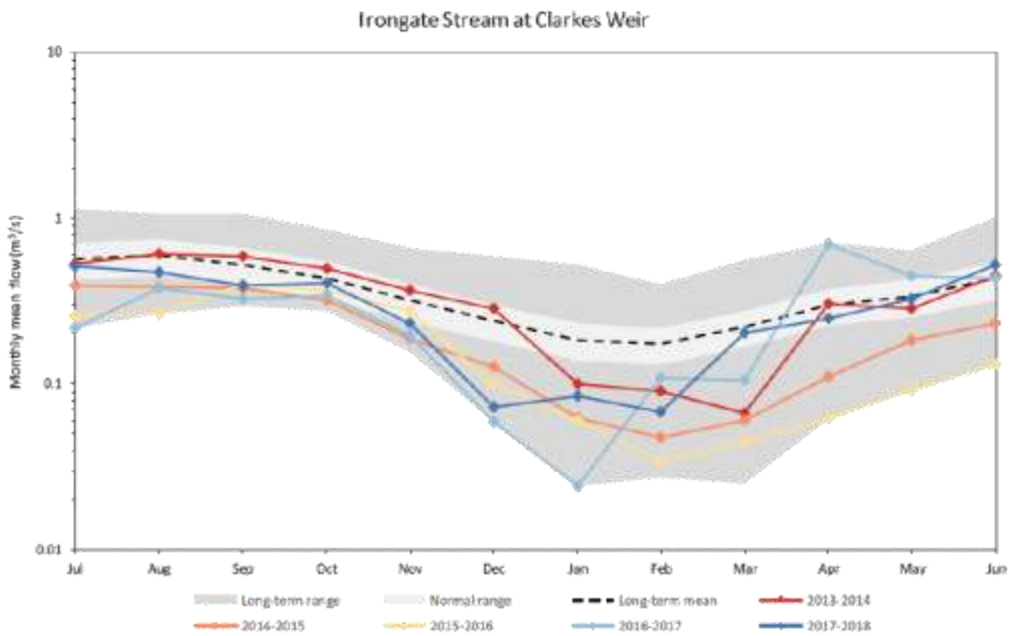

Figure 3-24: Irongate Stream at Clarkes Weir monthly mean flow (2013-2014 to 2017-2018). Flows are shown with the long-term mean, long-term range and normal range (1978-2018). Note the y-axis has a logarithmic scale.

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Two plausible explanations for the low summer flows during this 5-year period are: 1) abstraction for out of stream use; or 2) climatic influence. There is relatively little abstraction upstream of the Ngaruroro River at Whanawhana, yet low summer flows were also observed at the Whanawhana site (Figure 3-25). Therefore the low summer flows are less likely to be a consequence of abstraction effects

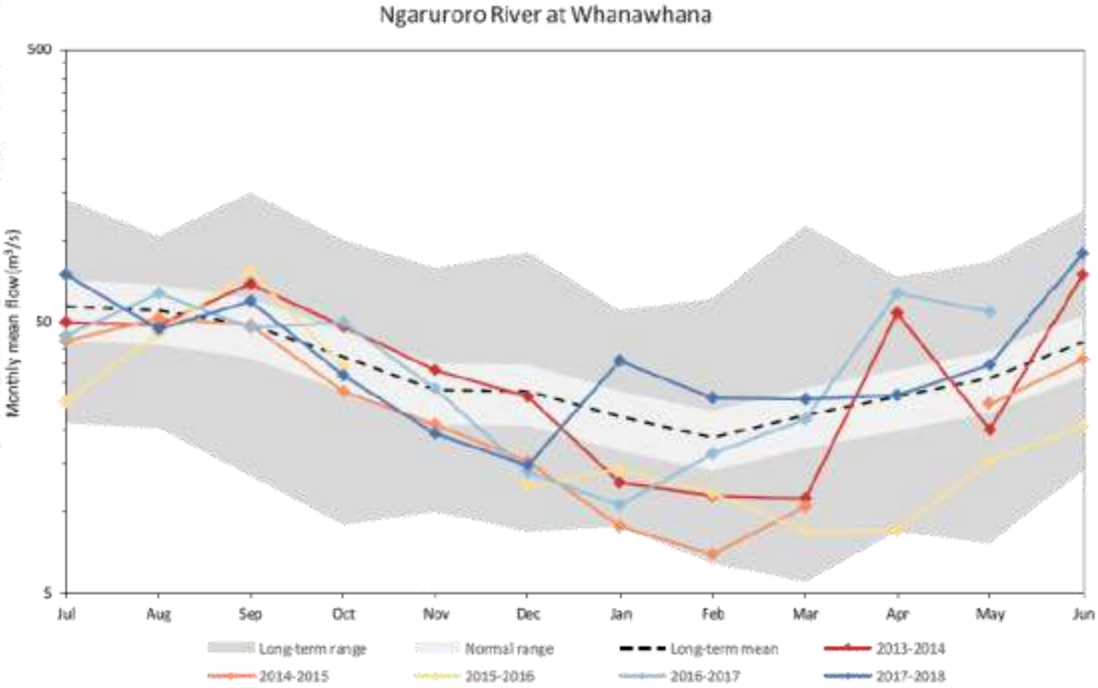

Figure 3-25: Ngaruroro River at Whanawhana monthly mean flow (2013-2014 to 2017-2018). Flows are shown with the long-term mean, long-term range and normal range (1960-2018). Note the y-axis has a logarithmic scale.

As discussed in section 1.1, summer rainfall across the region was typically normal or below normal for the five year reporting period, which featured an El Niño summer in 2015-16. The reporting period ended with a La Niña summer (2017-18), which is the one year in most of the river flow graphs that had summer rainfall greater than the median.

To explore large-scale climate patterns, some data standardisation was adopted. To better compare across sites, flow at each site was divided by its long-term mean flow. So, regardless of the size of the catchment, flow in an average year would have a value about 1, and greater than 1 in a wet year. The sites can then all be over-plotted without the biggest rivers dominating the plot. The next step was generating 5-year moving average annual low flows, to filter out short-term variability resulting from localised rain events.

The IPO Tripole (Interdecadal Pacific Oscillation Tripole index) was selected as an indicator of large-scale climate patterns and over-plotted with annual low river flows for a range of Hawke's Bay rivers and streams (Figure 3-26). The peaks and troughs do not always coincide, and this mismatch could result from stochastic processes, a lagged response, or a more complex response than a simple linear relationship of flow with the IPO. There tends to be more scatter in low-flow data, which makes the climate pattern more obscure.

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However, the IPO phase has been predominantly neutral post 2012, and this was associated with below-normal annual low flows at most sites (Figure 3-26). Therefore it is plausible that the low summer flows observed from 2013 to 2018 are a consequence of large-scale climate drivers

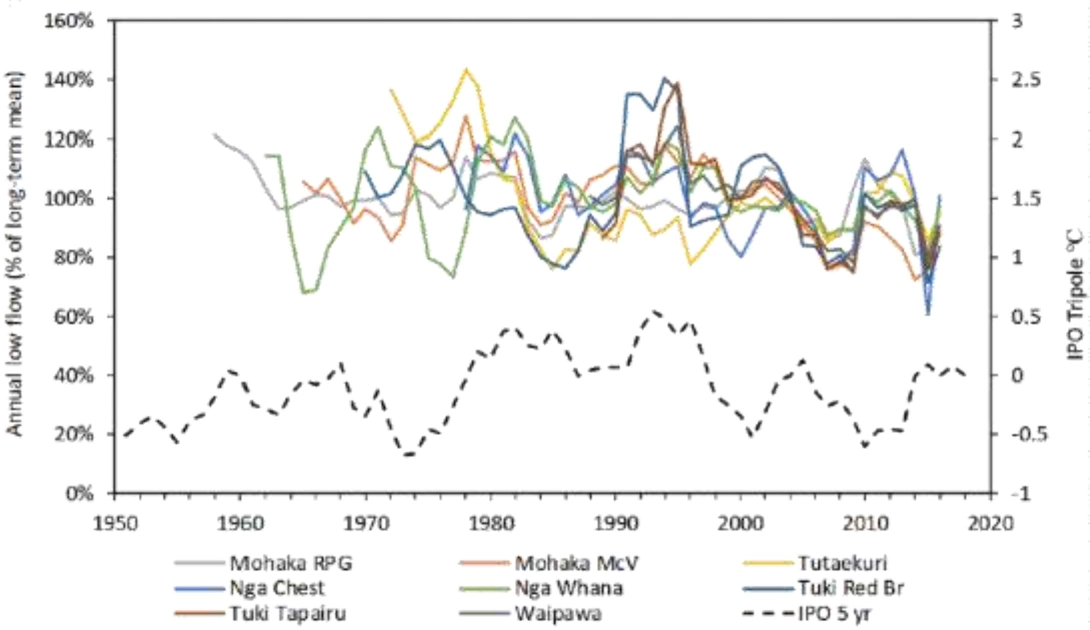

Figure 3-26: Long-term patterns in river flow compared with the Interdecadal Pacific Oscillation Tripole index (IPO Tripole). Flows are a 5-year moving average of 7-day annual low flow time series' for many Hawke's Bay rivers and streams. Flows are standardized by the long-term mean for each site so rivers of different size can be compared directly. Climate drivers are compared using the dashed black line (right Y-axis), which represents the 5-year moving average IPO Tripole.

3.4 Air Quality

State of the Environment monitoring of air quality occurs in Hawke's Bay within the Napier, Hastings and Awatoto airsheds (Figure 3-27) with a focus on levels of airborne particulates (PM_{10}) in those airsheds. Evaluation of other gases listed in the National Environmental Standards for air quality (NESAQ) has identified that levels of those contaminants are within acceptable levels. As discussed in section 1.3, research has identified that the PM_{10} standard is unlikely to be exceeded in the Northern and Southern subregions, so PM_{10} monitoring is not required in those subregions under the NESAQ.

Hawke's Bay residents can be largely confident that the region's air is safe to breathe, though particulate air pollutants during winter can occasionally exceed health-based standards. In Napier and Hastings, PM_{10} exceedances during winter are mostly a consequence of emissions from domestic home heating.

The Awatoto airshed has few residential dwellings and some industrial activities, with airborne particulates being largely generated from natural sources. While Napier and Hastings PM_{10} exceedances occur during winter, sea breezes at any time of year can cause PM_{10} exceedances from salt spray at Awatoto. Furthermore, while PM_{10} exceedances in Napier and Hastings invariably occur on calm winter days, exceedances at Awatoto are most likely to occur on days with a moderate onshore wind and have been spread across all seasons.

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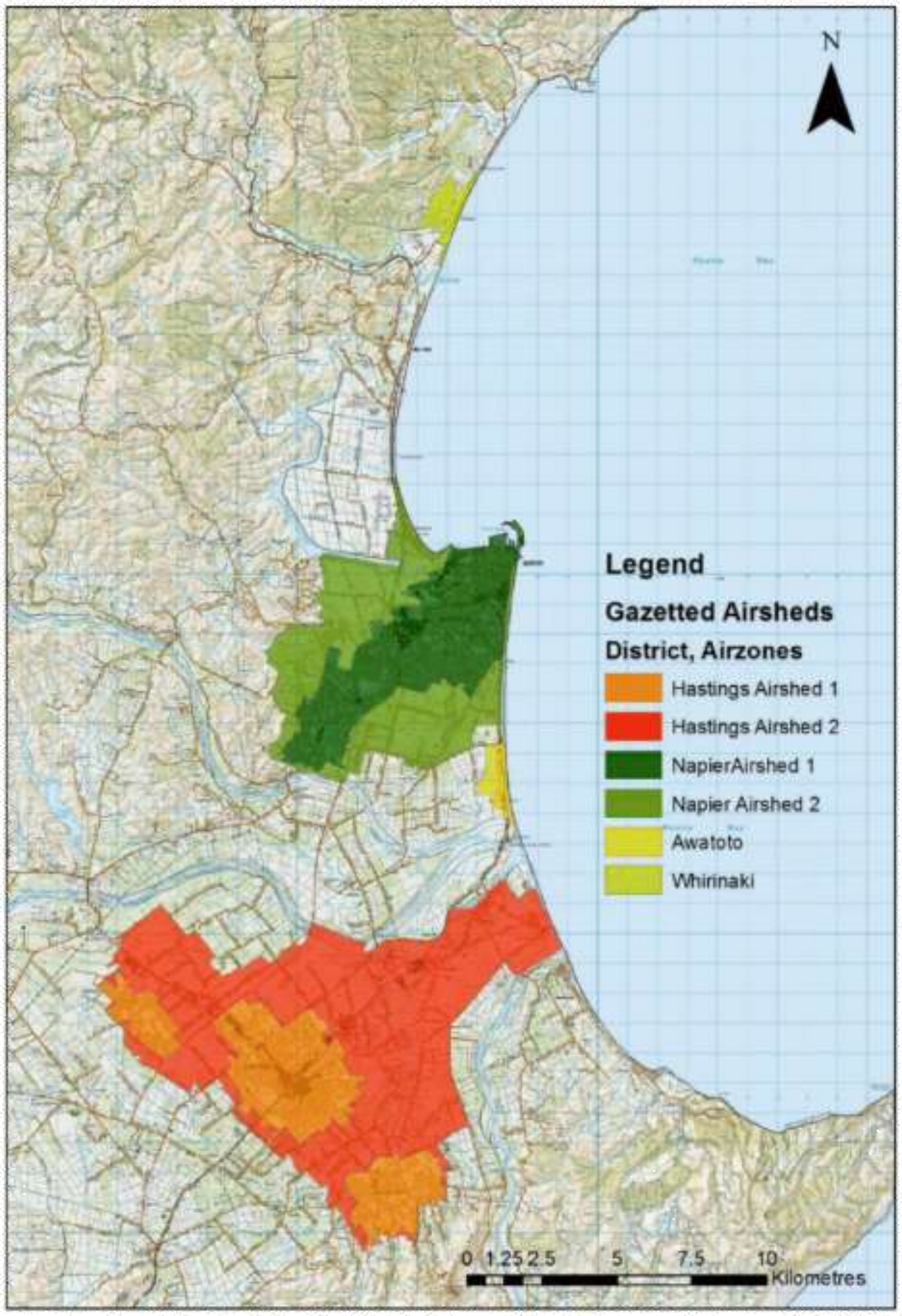

Figure 3-27: Hawke's Bay airsheds. Napier and Hastings airsheds are divided into Airzones 1 and 2 for management purposes. The Whirinaki Airshed is dominated by one industry: timber processing. Emissions from that industry are controlled through an air discharge consent, with ambient monitoring undertaken by the consent holder for compliance purposes. Therefore the airshed is not included in State of the Environment monitoring and reporting.

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Under the NESAQ, one exceedance of the PM_{10} standard is allowed per year in the Awatoto airshed and this was breached twice between 2013 and 2018 (Figure 3-28).

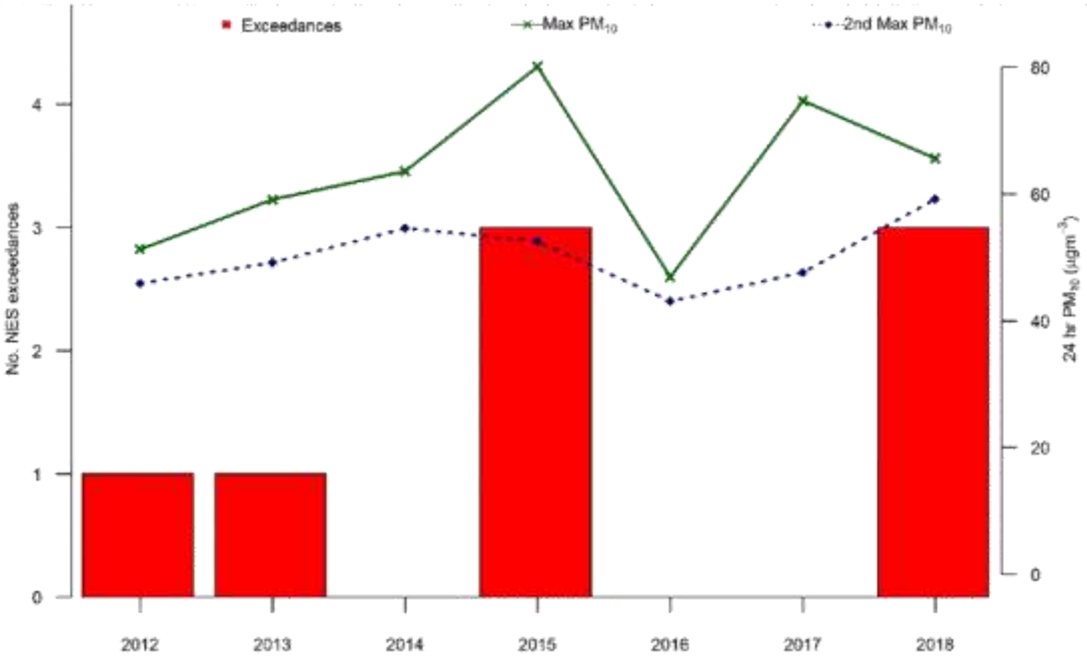

Figure 3-28: PM_{10} exceedances at Awatoto (2012-2018). This plot shows the number of times each year when the daily mean PM_{10} exceeded the NESAQ (50 µg/m^3), along with the maximum and second highest maximum PM_{10} concentrations recorded each year (secondary y-axis).

The majority of particulates measured in the Awatoto airshed is attributable to natural sources that are unmanageable. This makes achieving the NESAQ for PM_{10} in the Awatoto airshed challenging, because the NESAQ does not account for different source types, except when circumstances surrounding an exceedance are considered "exceptional" and "beyond the reasonable control of the regional council". However, not all of the exceedances can be attributed exclusively to exceptional levels of sea salt. Therefore good management of other contributors to particulate concentrations is important; such as minimising fugitive emissions of dust and processing materials from properties in the Awatoto airshed.

Air quality in Napier and Hastings has improved over time (Figure 3-29), with Napier no longer considered a polluted airshed under the NESAQ. Furthermore, between 2013 and 2018, the number of exceedances in Hastings has been within the number allowed in the NESAQ regulations, including meeting the target of reducing PM_{10} exceedances to no more than three per year since 2016 (Figure 3-29).

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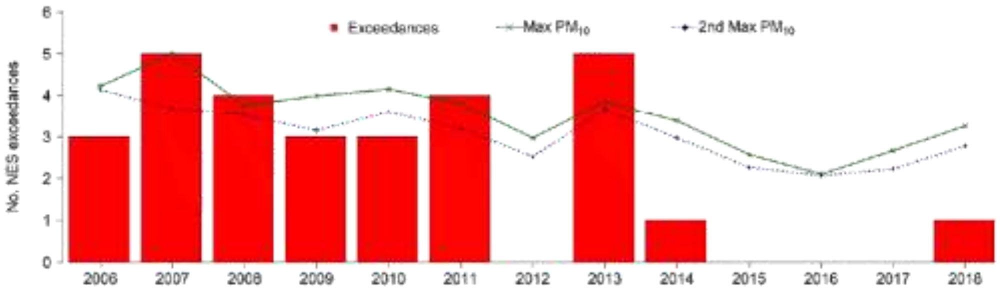

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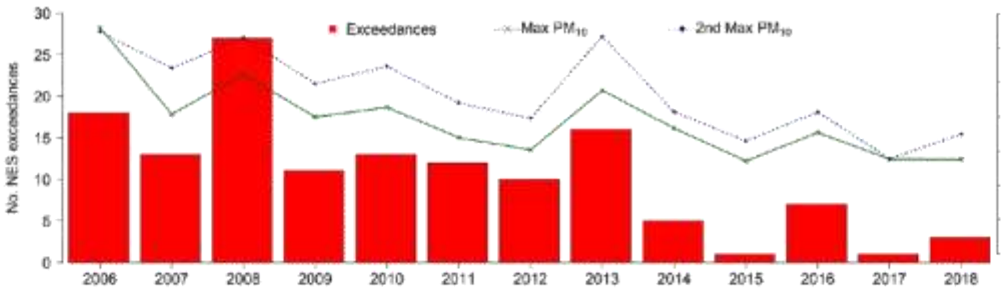

Figure 3-29: PM_{10} exceedances from 2006 to 2018 in: a) Napier and b) Hastings. This plot shows the number of times each year when the daily mean PM_{10} exceeded the NESAQ (50 μg/m³), along with the maximum and second highest maximum PM_{10} concentrations recorded each year (secondary y-axis).

The number of PM_{10} exceedances in Hastings has declined from a high of 27 in 2008 to below 10 in each of the years from 2013 to 2018 (Figure 3-29). The Hastings Airshed was not alone nationally in recording a large number of exceedances in the initial years of monitoring and the NESAQ acknowledged the effort required to reduce the number of exceedances. Airsheds with large numbers of exceedances were given time under the NESAQ to meet the target of one or less per year. For that reason, Hastings airshed was given until September 2020 to achieve compliance but had to reduce the number to three from 1 September 2016. This was achieved, with only one exceedance recorded in 2017 and three in 2018. From 1 September 2020, the NESAQ allows a maximum of one PM_{10} exceedance for Hastings.

The improved air quality is largely a consequence of considerable effort by residents to decrease emissions of particulates by more than 60% between 2005 and 2015. This has been achieved by widespread change to cleaner forms of home heating, which is supported by HBRC with rules, regulations and financial assistance through the Sustainable Homes programme to make the transition to cleaner heating.

The Government is proposing amendments to the NESAQ that take into account improved scientific understanding and evidence about the health impacts of particulate matter. The proposal includes introduction of $PM_{2.5}$ (very fine particulate matter) as the primary regulatory tool to manage ambient particulate matter, with both a daily and an annual standard for $PM_{2.5}$. The proposal also retains the PM_{10} standard for managing potential issues for coarse particulates.

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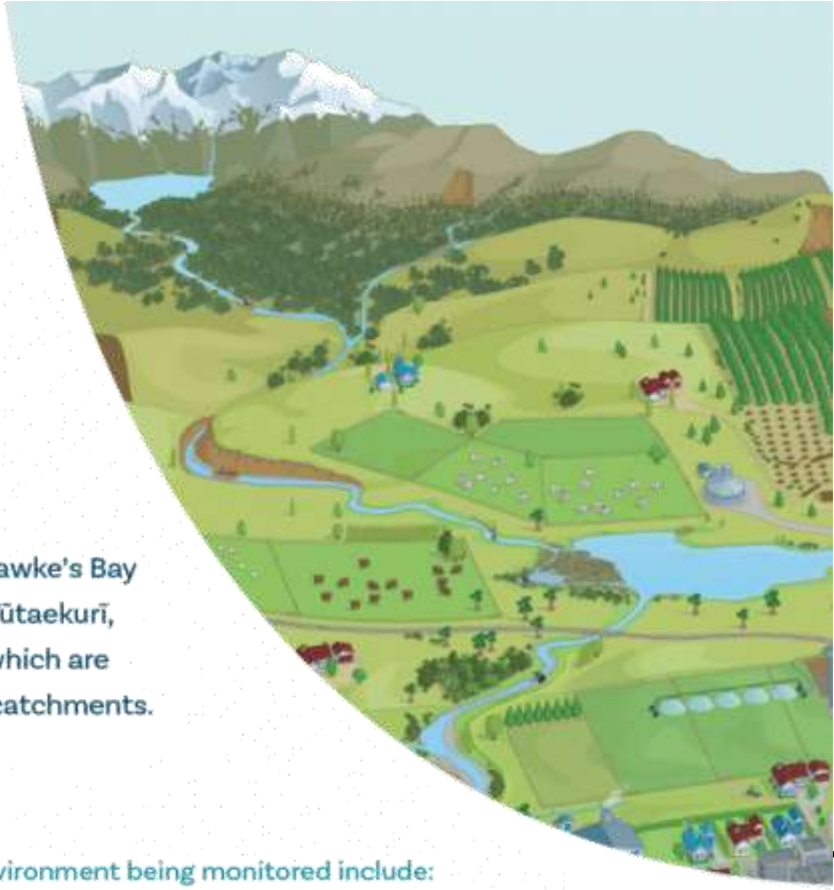
Although SoE monitoring for this report does not include $PM_{2.5}$ observations, survey monitoring has suggested that the proposed $PM_{2.5}$ standard may not currently be met in Hastings, Napier, Wairoa and Waipukurau. If the NESAQ amendments are adopted as proposed, additional monitoring would be required in these airsheds to evaluate whether further management of air emissions is required to achieve compliance with the $PM_{2.5}$ ambient air standard.

HERETAUNGA CATCHMENTS

SUMMARY (2013-2018)



The Heretaunga sub-region of Hawke's Bay has four main catchments: the Tūtaekurī, Ahuriri, Ngaruroro and Karamū, which are collectively known as the TANK catchments.

Key aspects of the Heretaunga environment being monitored include:

- Groundwater quality & supplies
- Surface water (river & stream) quality
- Surface water flows (hydrology)
- Marine & coastal environments
- Air quality

Land use

Many key environmental issues in Hawke's Bay are a consequence of land use that contributes to erosion and discharge of nutrients to waterways. Other than the indigenous and native forest covering the western parts of the Heretaunga subregion, the main land use type of this area is sheep and beef, which occupies approximately 31% of the area. There are also 18,655 ha of land used for beef, 12,520 ha of orchards and vineyards and 11,711 ha of short-rotation cropland.

Groundwater quality

One of the region's major productive groundwater resources is the Heretaunga Plains aquifer system.

Overall, the quality of Heretaunga Plains groundwater is very good. Key findings from Hawke's Bay Regional Council monitoring include:

1. *E. coli*, a faecal indicator species, was detected in just one sample at a single site. Further investigations revealed that the bore had insecure headworks and casing, which allowed stormwater with *E. coli* to enter the well. This was immediately resolved and no further *E. coli* exceedances have been observed.
2. Pesticides are not present in any of the shallow groundwater wells that were sampled, which is consistent with previous surveys undertaken in 2010 and 2015.
3. Some of the deeper wells have high levels of naturally occurring manganese and some also have arsenic levels greater than the Drinking Water Standards of New Zealand (DWSNZ) maximum acceptable values for long term consumption. These heavy metals are a result of naturally occurring processes, not human activities. However, because concentrations can vary considerably over small distances, it is important that private bore owners have all potable supplies of groundwater tested.

HERETAUNGA CATCHMENTS SUMMARY

Groundwater levels

Monitoring of groundwater levels in the Heretaunga aquifer system show that declines have manifested slowly over time, with an average loss during summer of 5 centimetres per year between 1989 and 2018.

On the Heretaunga Plains, groundwater declines are mainly located in the unconfined zone northwest of Hastings, and groundwater levels between Roy's Hill and Fernhill have persistently declined.

One of the most significant impacts of declining groundwater levels is the effect on rivers and stream flows. Computer modelling has shown the combined effects of groundwater abstraction include reduced flows in the Ngaruroro River and lowland streams of the Heretaunga Plains.

While climatic influences may have played a part in the groundwater declines, abstraction from the aquifer system has also increased over this period and has contributed to the declining groundwater levels. The abstraction significantly increased from 1980 until about 2005, when it showed signs of developing an equilibrium.

Hawke's Bay Regional Council has ceased issuing resource consents for further abstraction, and the proposed TANK Plan Change aims to limit groundwater allocation from the Heretaunga Plains to the 'actual and reasonable' level of use prior to 2017. This will stabilise groundwater abstraction. As a result, declines in groundwater levels are expected to cease.

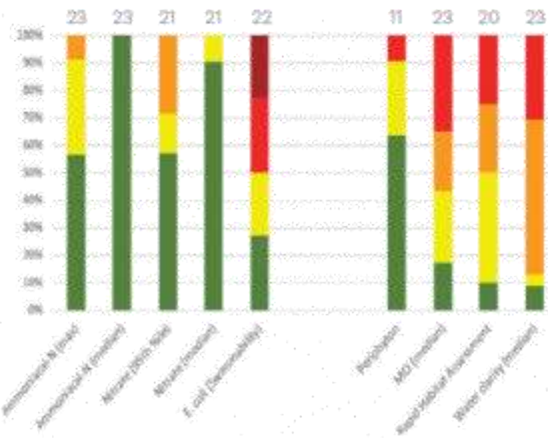
The Regional Council is also working to identify and implement solutions to manage the effects of groundwater abstraction and to build the resilience of water supplies to climate change. Small to medium scale out-of-stream water storage is being investigated to improve environmental outcomes and build resilient water supplies for current and future climatic conditions.

River and stream water quality

Signs of degraded water quality include high levels of nutrients such as nitrogen and phosphorus, the excessive growth of aquatic plants or algae, a reduction in macroinvertebrate diversity, a reduction in water clarity due to higher levels of suspended sediments, and high levels of faecal contamination.

A summary of key water quality metrics for the Heretaunga subregion is shown below. This plot identifies the percentage of SoE monitoring sites that fall within different categories for each metric.

Summary of freshwater quality state for rivers and streams of the Heretaunga Subregion: 2013-2018.



Bars on the left are applicable to the NOF bands, with colours:

- = band A
- = band B
- = band C
- = band D
- = band E (for E. coli measures only)

Bars on the right do not have NOF bands, so general categories apply to colours:

- = Excellent
- = Good
- = Fair
- = Poor

The number at top of each bar identifies the number of sites in the analysis.

Ngaruroro and Tūtaekurī Catchments

Aquatic organisms do not experience toxicity effects from nitrate and ammonia anywhere in the Ngaruroro or Tūtaekurī catchments. Nutrient concentrations are low. *E. coli* levels are also very low in both catchments, and as a result, all mainstem sites in the Ngaruroro and Tūtaekurī rivers are suitable for primary contact recreation.

HERETAUNGA CATCHMENTS SUMMARY

Some tributaries are not suitable for contact recreation during high flows, but all sites were suitable during normal flows.

The Ngaruroro mainstem is in excellent condition in the upper to middle catchment. Water quality measures show a minor upstream to downstream decline, with some minor nutrient enrichment in the lower reaches and water clarity below contact recreation guidelines in the mid to lower Ngaruroro mainstem. Sediment appears to enter the Ngaruroro from the tributaries, along with erosion of the mainstem riparian margins.

All Ngaruroro tributaries other than the Ohara Stream are nutrient enriched, especially in phosphorus. Nutrient loads from tributaries have only a minor effect on the water quality in the Ngaruroro mainstem, because large volumes of high quality water from the pristine upper catchment dilute the influence of the tributaries.

The Tūtaekurī mainstem shows some nutrient enrichment from upstream to downstream, particularly in phosphorus, with significant impact on ecological communities at the most downstream site at Brookfields Bridge. The Macroinvertebrate Community Index (MCI) also declines from excellent in the headwaters to fair towards the lower reaches.

Tūtaekurī tributaries have elevated nutrient concentrations, similar to the Ngaruroro tributaries. The effect of these tributary nutrient loads on mainstem water quality is greater in the Tūtaekurī than in the Ngaruroro, because the volume of water coming from the pristine upper Tūtaekurī catchment is lower.

Karamū and Ahuriri Catchments

The water quality and ecological health of streams in the Karamū and Ahuriri catchments are the poorest in Hawke's Bay. Most sites in the Karamū had among the highest concentrations of nutrients and *E. coli* and the lowest MCI and habitat scores of all sites in the region.

Only the Poukawa Stream is swimmable. All other Karamū and Ahuriri sites have high *E. coli* concentrations that mean they are not suitable for primary contact recreation. A study is underway to identify whether the bacteria originate from ruminant, avian, human or other sources.

Karewarewa, Awanui, Poukawa and Taipo streams are at risk of low oxygen levels that are likely to stress fish, invertebrates and other aquatic organisms. Planting appropriate riparian vegetation is one option to improve oxygen levels and the long-term ecosystem health in these streams. Stream planting continues as part of a long-term enhancement programme to improve water quality throughout the Karamū and Ahuriri catchments.

River and stream flows

During summer periods between 2013 and 2018, monthly mean flows in the Ngaruroro River at Chesterhope were often below the normal range for that time of year. A similar phenomenon was observed in the Tūtaekurī River at Puketapu during summer periods, along with sites in the Karamū catchment, including the Irongate Stream at Clarke's Weir.

There is relatively little abstraction upstream of the Ngaruroro River at Whanawhana, where unusually low summer flows were also observed. So, the low summer flows in Heretaunga catchments are less

HERETAUNGA CATCHMENTS SUMMARY

and flood events that transport large quantities of sediments to estuaries and nearshore environments.

Sediment stress is one of the key issues observed through estuarine monitoring. Median levels of 'mud' in sediments of the Ahuriri and Waitangi Estuaries are in places higher than 60%, which exceeds the accepted mud content threshold (<25%) to support healthy, diverse communities. This may compromise the integrity and resilience of the estuaries, as well as reducing their value for other species such as birds and fish.

The quality of the waters offshore from Awatoto are conspicuously different to other sites along the coastline, with the highest median levels of total nitrogen in the region. This area receives freshwater from the Tūtaekurī and Ngaruroro Rivers, the Karamū Stream and two municipal sewerage outfalls. Further investigations will determine the relative influence these may have on water quality.

Air quality

Air quality in Napier and Hastings has improved over time, and Hawke's Bay residents can be largely confident that the region's air is safe to breathe. Particulate air pollutants during winter only occasionally exceed health-based standards as a consequence of emissions from domestic home heating. The improved air quality is largely because of considerable effort by residents to decrease emissions of particulates, which is supported by Hawke's Bay Regional Council with regulations and financial assistance to transition to cleaner heating.

In contrast, airborne particulates in the Awatoto airshed are largely generated from salt spray, and sea breezes at any time of year can cause PM10 exceedances. Exceedances at Awatoto are most likely to occur on days with a moderate onshore wind and are spread across all seasons. However, not all of the exceedances can be attributed exclusively to sea spray. Minimising fugitive emissions of dust and processing materials from industries in the Awatoto airshed is also important to reduce the exceedances of health-based air standards.

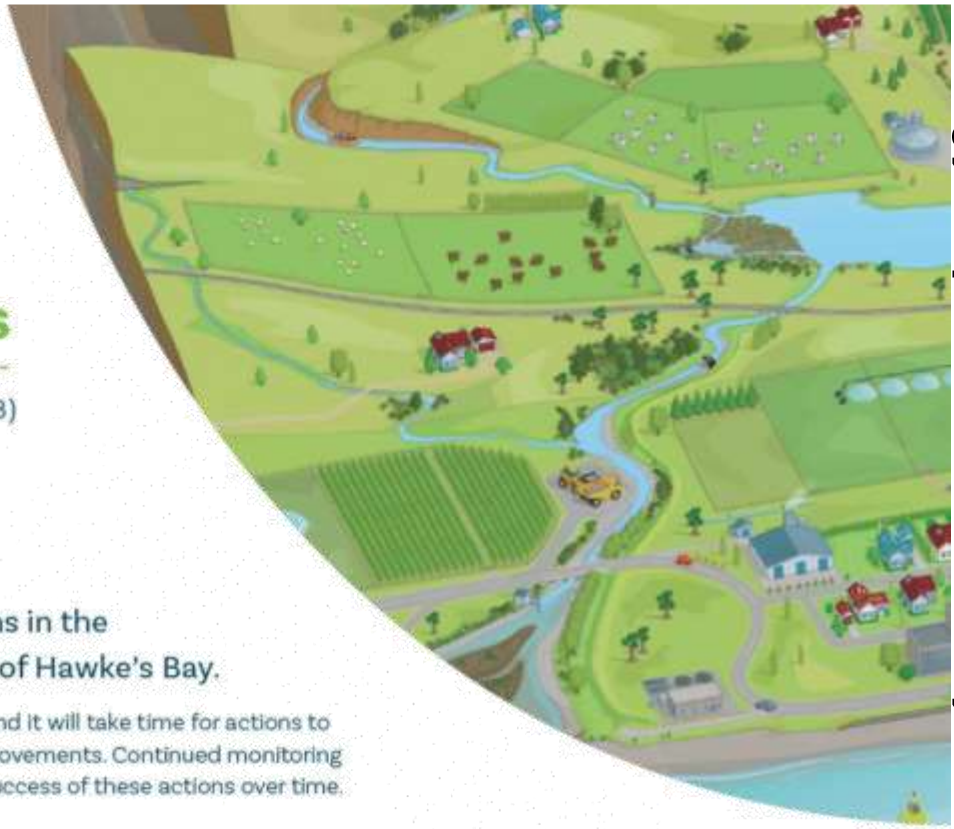
Tūtaekurī River

Addressing key issues

While limiting allocation from the Heretaunga aquifer system will prevent further environmental degradation from groundwater abstraction, the Regional Water Security programme will enable better outcomes from the limited resource that is available. This programme includes sophisticated 3D mapping and computer models to deliver a greater understanding of the Heretaunga groundwater system so that the resource can be managed sustainably into the future. Options for small to medium scale water storage are also being investigated, to help improve environmental outcomes and increase resilience of water supplies.

To address issues associated with erosion and agricultural runoff, Hawke's Bay Regional Council has invested in an erosion control scheme with a $30 million fund. The scheme incentivises and encourages tree planting, erosion control work on pastoral or retired land, and a riparian enhancement programme. Improvements are also expected via land use and nutrient management initiatives that the Regional Council will implement as part of the proposed TANK plan change.

Improvements in water quality, aquatic habitats and estuarine environments are expected to occur progressively, and continued monitoring is necessary to determine how effective these efforts are over time.



SOUTHERN CATCHMENTS

SUMMARY (2013-2018)

Key issues and actions in the Southern sub-region of Hawke's Bay.

These are long-term issues and it will take time for actions to generate environmental improvements. Continued monitoring is essential to evaluate the success of these actions over time.

Key Issues

- Groundwater quality and supply are connected to rivers and streams - flows are affected by groundwater abstraction
- Groundwater, river and stream water quality are linked to land use
- Degraded waterway habitats and swimmability are linked to land use
- Nutrients and fine sediment in estuaries are linked to land use

Key Actions

- Limits and regulations in the Tukituki Plan
- A Regional Council office in Waipawa, delivering support and advice on good land use practices
- $30 million Erosion Control Scheme targeting 250,000 ha of highly erodible land
- Managing land use activities using Farm Plans and resource consents
- Riparian management programme supports fencing and planting around waterways
- Regional Water Security programme, includes 3D Aquifer Mapping and community-led storage investigations
- The Regional Council is developing sophisticated computer models to inform decisions on enhancing environmental flows and water quality

Te whakapakari tahi i tō tātau **taiao**.
Enhancing our **environment** together.

HAWKES BAY REGIONAL COUNCIL
TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI

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Southern Subregion

The Southern subregion has two major catchments: the Tukituki and Pōrangahau (Figure 4-1). There are also several smaller coastal catchments in the Southern subregion, including Mangakuri Stream, Pouhokio Stream and the Maraetotara River (Figure 4-1).

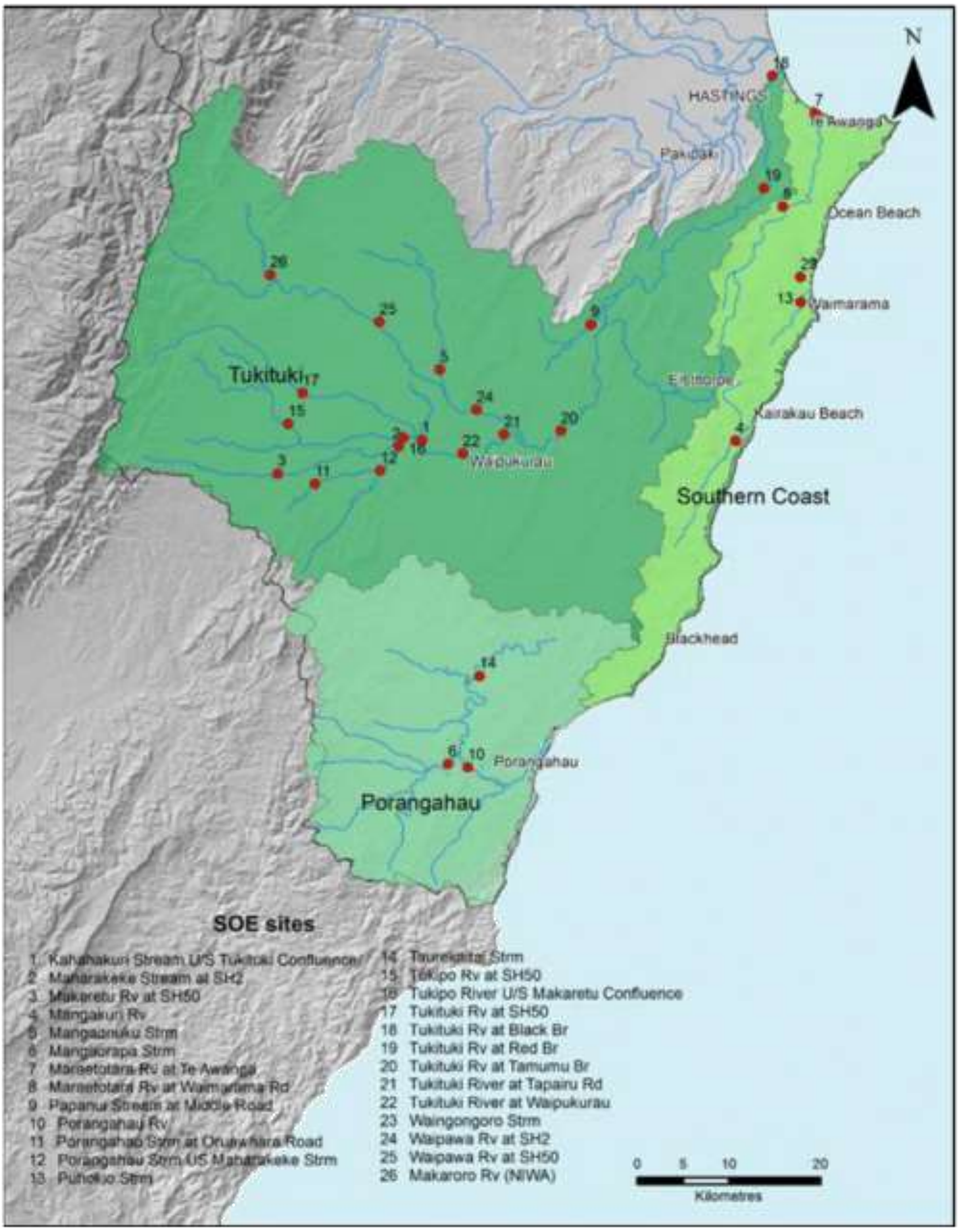

Figure 4-1: Tukituki, Pōrangahau and Southern Coastal catchments, showing SoE monitoring sites for freshwater quality and ecology.

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The Tukituki catchment is approximately 2,500 km^2, while the Pōrangahau catchment is 850 km^2 and the Southern Coastal catchments have a combined area of 509 km^2.

The main land use type identified in this area is sheep and beef, accounting for approximately 62% of the total area in the Southern subregion (Figure 4-2). There are also approximately 23,838 ha of beef farming, 23,076 ha of indigenous forest and 18,425 ha of exotic forest identified in this area.

The Tukituki catchment extends from the Ruahine Range – the source of the Tukituki and Waipawa Rivers, to the Pacific Ocean at the coast of Hawke Bay. A key feature of the Tukituki catchment is the degree of interaction between surface water and groundwater of the Ruataniwha Aquifer, which influences both the hydrology and the water quality of streams and rivers within the Ruataniwha Plains, and of the middle and lower reaches of the Tukituki River itself.

The rivers and streams of the Southern Catchment terminate at the coast through the Kairākau and Pōrangahau Estuaries, along with several smaller systems.

Estuaries represent the downstream receiving environment of the freshwater drainage network, so it is understandable that they are sensitive to the same effects of land-use activities as streams and rivers throughout the catchment. In New Zealand, estuaries are being recognised as the most at risk coastal environments, as they are the depositional end-point for the cumulative contaminants (e.g. nutrients, sediments) from the surrounding catchment.

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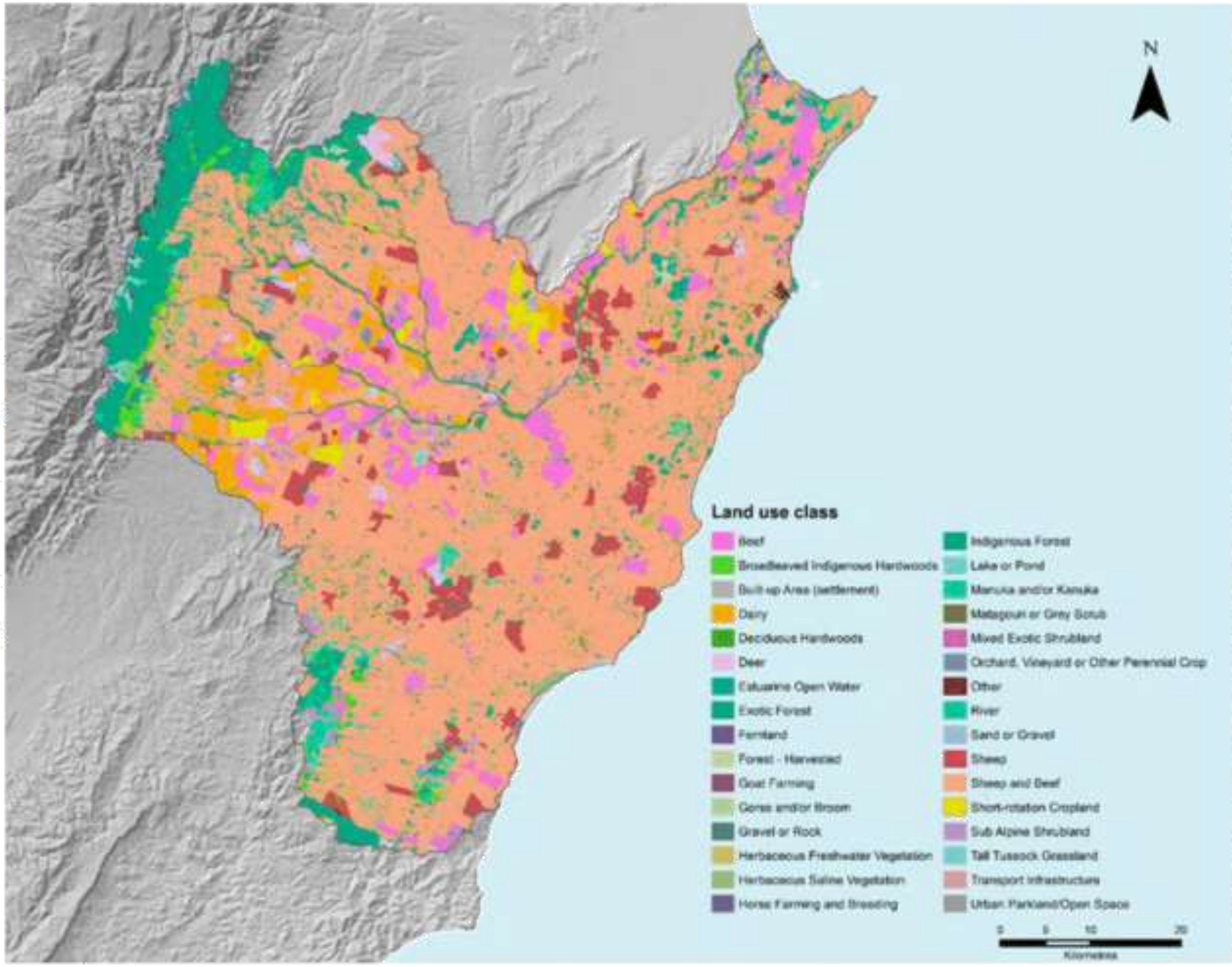

Figure 4-2: Land use for the Southern subregion, from 2020 data.

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4.1 Water quality

4.1.1 Groundwater quality

One of the region's major productive groundwater resources is within the Ruataniwha aquifer system. The locations of Ruataniwha bores used by HBRC for monitoring groundwater quality are shown in Figure 4-3. Groundwater is also abstracted for consumptive use from aquifers in the Papanui and Poukawa catchments (Figure 4-4).

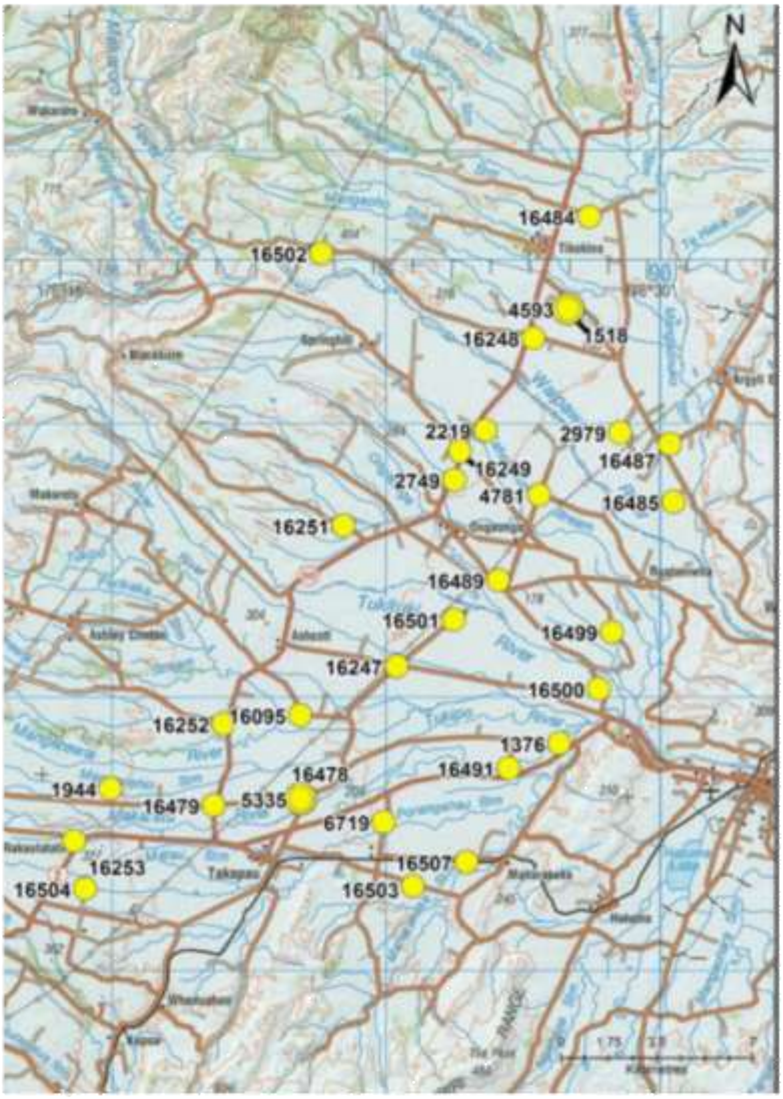

Figure 4-3: Bores used for monitoring groundwater quality in the Ruataniwha Plains. Bore numbers are shown next to yellow circles that show the locations.

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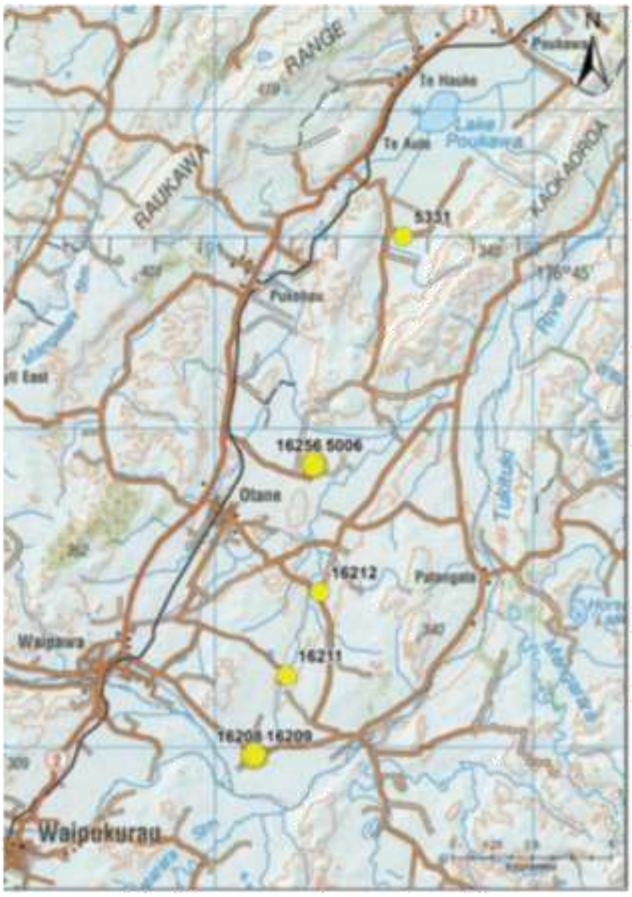

Figure 4-4: Papanui and Poukawa bores used for monitoring groundwater quality. Bore numbers are shown next to yellow circles that show the locations.

The main focus for groundwater quality sampling is to identify good sources of potable water and to understand the natural concentrations of determinands in groundwater along with impacts of human activities on the resource.

Key groundwater quality issues in Hawke's Bay aquifer systems are *E. coli* and nitrate concentrations that exceed the Drinking Water Standards of New Zealand (DWSNZ) in some shallow bores. Vulnerability of groundwater to contamination from microorganisms is evaluated from sampling for the faecal indicator species *E. coli*. The presence of nitrate-nitrogen is invariably a consequence of intensive land use activities including the application of fertiliser that may be leached into the groundwater system. The maximum acceptable value (MAV) for nitrate-nitrogen in the DWSNZ is 11.3 mg/L and this is consistently exceeded at monitoring bore 16501 in the Ruataniwha Basin (Figure 4-5).

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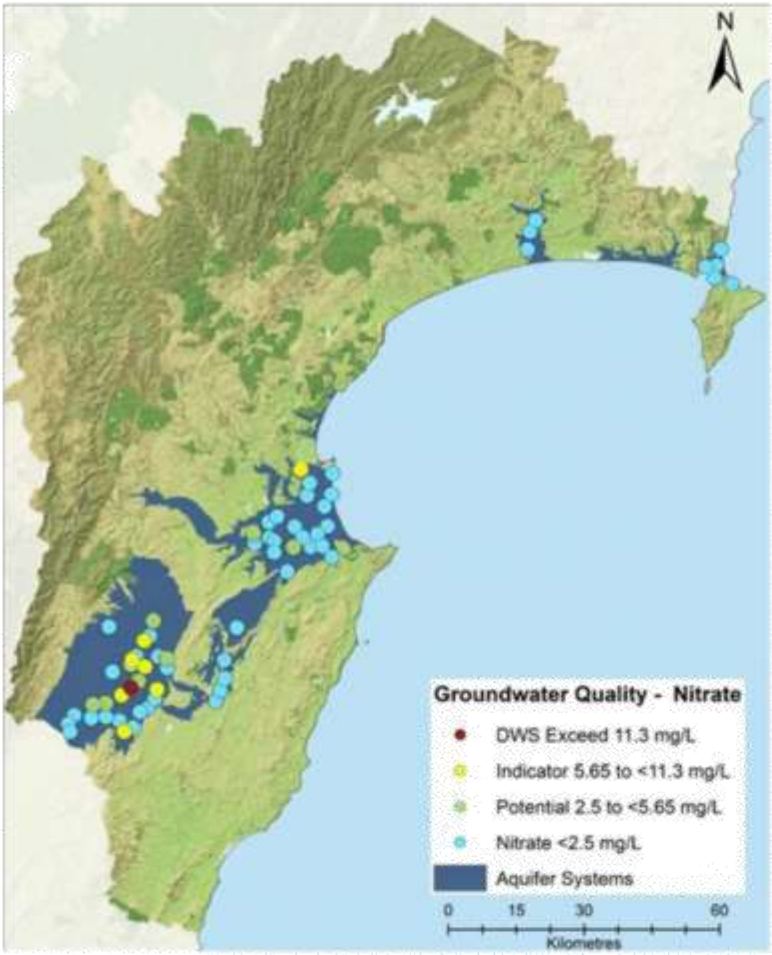

Figure 4-5: Nitrate-nitrogen concentrations in Hawke's Bay SoE monitoring bores.

Bore 16501 is a shallow (16m below ground) well that is downgradient of a large dairy farming operation (Figure 4-6). It is likely that the source of nitrate at bore 16501 is related to land use activities in the area.

Trend analysis was also undertaken for nitrates, but did not conclusively identify increasing trends of concern in the Ruataniwha Plains. Although exceedances of the DWSNZ for nitrate in groundwater are not widespread in the Southern subregion, there are several localised exceedances of the Regional Plan trigger (5.65 mg/L nitrate-nitrogen) which is equivalent to 50% of the 11.3 mg/L MAV (Figure 4-5). These nitrate issues will be addressed by land use and nutrient management initiatives that HBRC is implementing as part of the catchment policy.

Working with landowners, HBRC has received more than 1,000 Farm Environment Management Plans (FEMPs) for the Tukituki catchment. Along with resource consents, the FEMPs will drive nutrient and land use management to address water quality issues in water bodies. HBRC has invested heavily in catchment advisor relationships with landowners and there is also a regulatory requirement to monitor and manage landowner compliance.

Attachment 1

Item 12

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Figure 4-6: Location of monitoring bore number 16501.

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Under the DWSNZ, the maximum acceptable value (MAV) for microbial determinands focus on levels of *Escherichia coli* (*E. coli*) in water as an indicator organism for pathogenic contamination. This determinand has a particular focus on drinking water for human consumption without water treatment.

The DWSNZ specify that there shall be no colony forming units (cfu) of *E. coli* per 100 mL of groundwater and this criterion was exceeded at several monitoring bores in the Ruataniwha and Papanui/Poukawa aquifer systems (Figure 4-7). *E. coli* in groundwater was commonly detected in shallow bores, screened in unconfined groundwater less than 30m depth below ground level. The presence of *E. coli* in these bores is not unexpected: the DWSNZ regards shallow groundwater as equivalent to surface water and Ministry of Health guidance on drinking water management[8] states that "*Surface water is frequently contaminated by micro-organisms*".

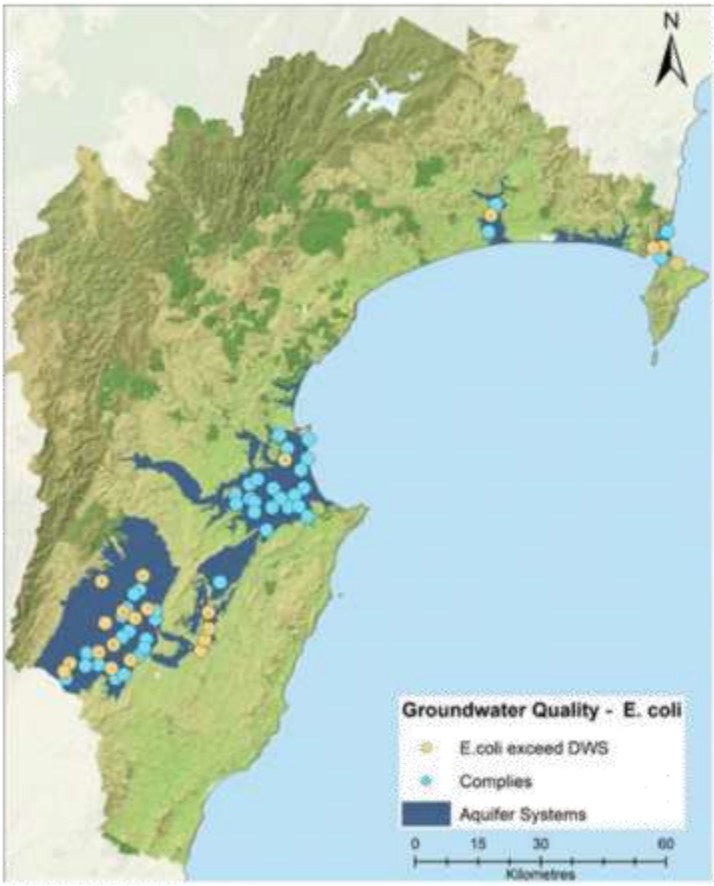

Figure 4-7: SoE well locations showing DWSNZ *E. coli* exceedances for the Hawke's Bay region between 2013 and 2018. Orange dots have exceeded the DWSNZ for *E. coli* at least once over the past 5-year period. Blue dots comply with DWSNZ.

While not unexpected, the detection of *E. coli* in shallow groundwater of the Ruataniwha and Papanui aquifer systems demonstrates the vulnerability of the shallow, unconfined groundwater systems to pathogenic contamination and private bore owners should have their groundwater tested if used for potable supply.

[8] Ministry of Health (2017) *Guidelines for Drinking-water Quality Management for New Zealand* (3rd edition). Wellington: Ministry of Health.

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During 2018 groundwater samples were taken from shallow wells located within areas of intensive land use and analysed for the presence of pesticides. Pesticides were not detected in any of the shallow groundwater wells that were sampled, which is consistent with previous surveys undertaken in 2010 and 2015.

The Ruataniwha groundwater quality is generally good, although some of the deeper wells have high levels of naturally occuring manganese and some also had arsenic levels greater than the DWSNZ MAV (Figure 4-8). Manganese and arsenic exceedances have also been observed in the Papanui groundwater system, along with Manganese at the Poukawa monitoring bore. Investigations undertaken by HBRC have identified that arsenic and manganese in groundwater is invariably a result of naturally occuring processes within the groundwater system, rather than a contaminant plume. The natural processes occur when arsenic that is found in some rock types is mobilised under certain groundwater conditions that are independent of human activities.

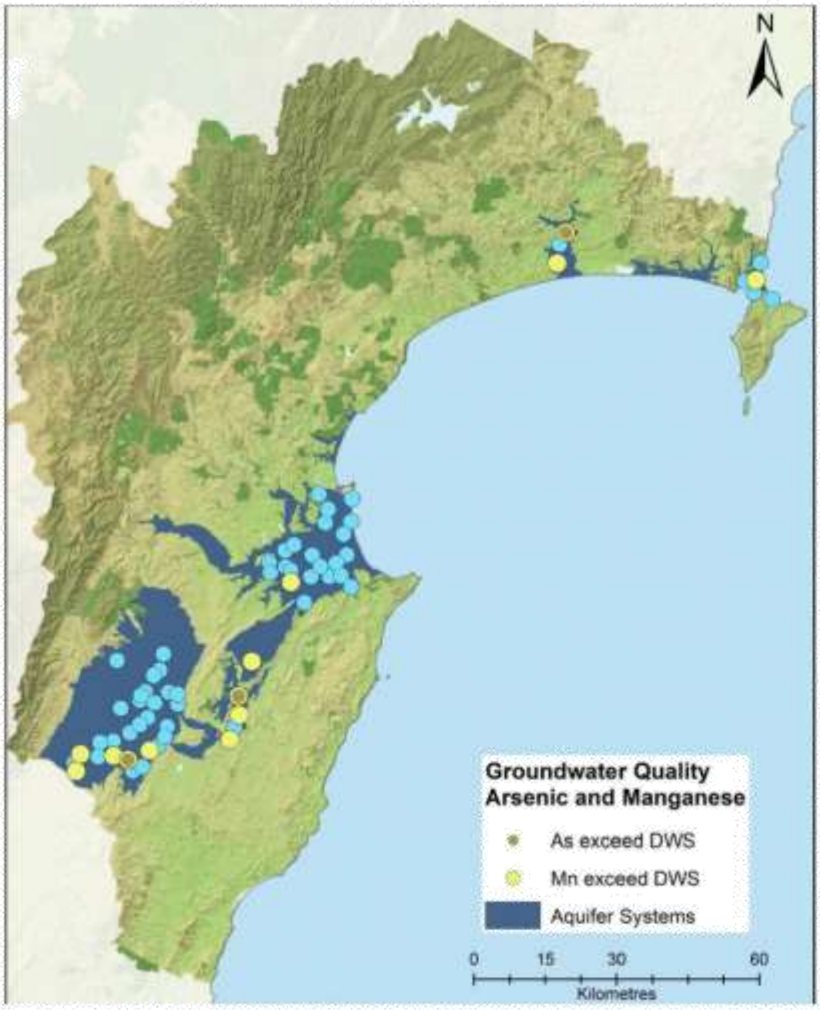

Figure 4-8: Monitor well locations showing where the DWSNZ MAV for arsenic (As) or manganese (Mn) are exceeded. Orange dot - arsenic exceeds DWSNZ MAV 0.010 mg/L. Yellow dot - manganese exceeds DWSNZ MAV 0.40 mg/L. Blue dot - monitor wells that are less than these limits.

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The presence of arsenic in groundwater is not spatially uniform and international research has shown that it is quite common for wells in close proximity to have large variations in arsenic concentrations. Consequently, it isn't possible to identify every location in the Tukituki and Poukawa catchments where naturally occuring arsenic may be present in groundwater. This is another reason why it is recommended that private bore owners should have their groundwater tested if it is used for potable supply.

4.1.2 Surface water quality

a) The Tukituki catchment

The Hawke's Bay Regional Resource Management Plan (RRMP) prescribes limits and targets for water quality attributes for the Tukituki catchment. These limits and targets are therefore referenced here, rather than defaulting to NOF bands in the NPS-FM. Nitrogen (N) and phosphorus (P) are key growth limiting nutrients that influence the growth rate and biomass of algae (or periphyton) and aquatic plants. Low availability of these two nutrients often limits plant biomass development.

The RRMP has set a long term average target of 0.8 mg/L for Dissolved Inorganic Nitrogen (DIN) at all waterways except those in the Upper Tukituki and Waipawa subcatchments (represented by the Makororo River monitoring site). The DRP targets in the RRMP vary by catchment, with five year average targets of 0.004 mg/L for the Upper Tukituki/Waipawa, and 0.010 mg/L and 0.015 mg/L for mainstem and tributary sites, respectively, at other Tukituki locations. These targets have been set to try and reduce excessive growth of periphyton.

Eutrophication is the term used to describe the enrichment of water bodies by inorganic plant nutrients such as nitrate or phosphate. Eutrophication may occur naturally, but is often the result of human activity. Land-use change and intensification can generate elevated levels of nitrogen and phosphorus, particularly in areas where appropriate farming practices are not followed. Nuisance periphyton growth may be managed by reducing or eliminating inputs of N and P from point-source discharges and/or diffuse sources such as discharges from land-use.

The RRMP DIN target of 0.8 mg/L is required to be met by 2030. This target is currently exceeded at all monitoring sites that have the majority of their water sourced from the Ruataniwha Plains, or are immediately downstream of this influence (Figure 4-9). Most of the intensive land use in the Tukituki catchment is focused around the Ruataniwha Plains area. Moving downstream from Ruataniwha, DIN concentrations decrease due to instream nutrient assimilation. The instream assimilation is driven by rapid algal growth which results in excessive growths of periphyton in the Tukituki River between Waipawa and the coast. In other words, a nutrient issue beginning in the Ruataniwha Plains transitions to a periphyton problem in the Tukituki River downstream of the Plains.

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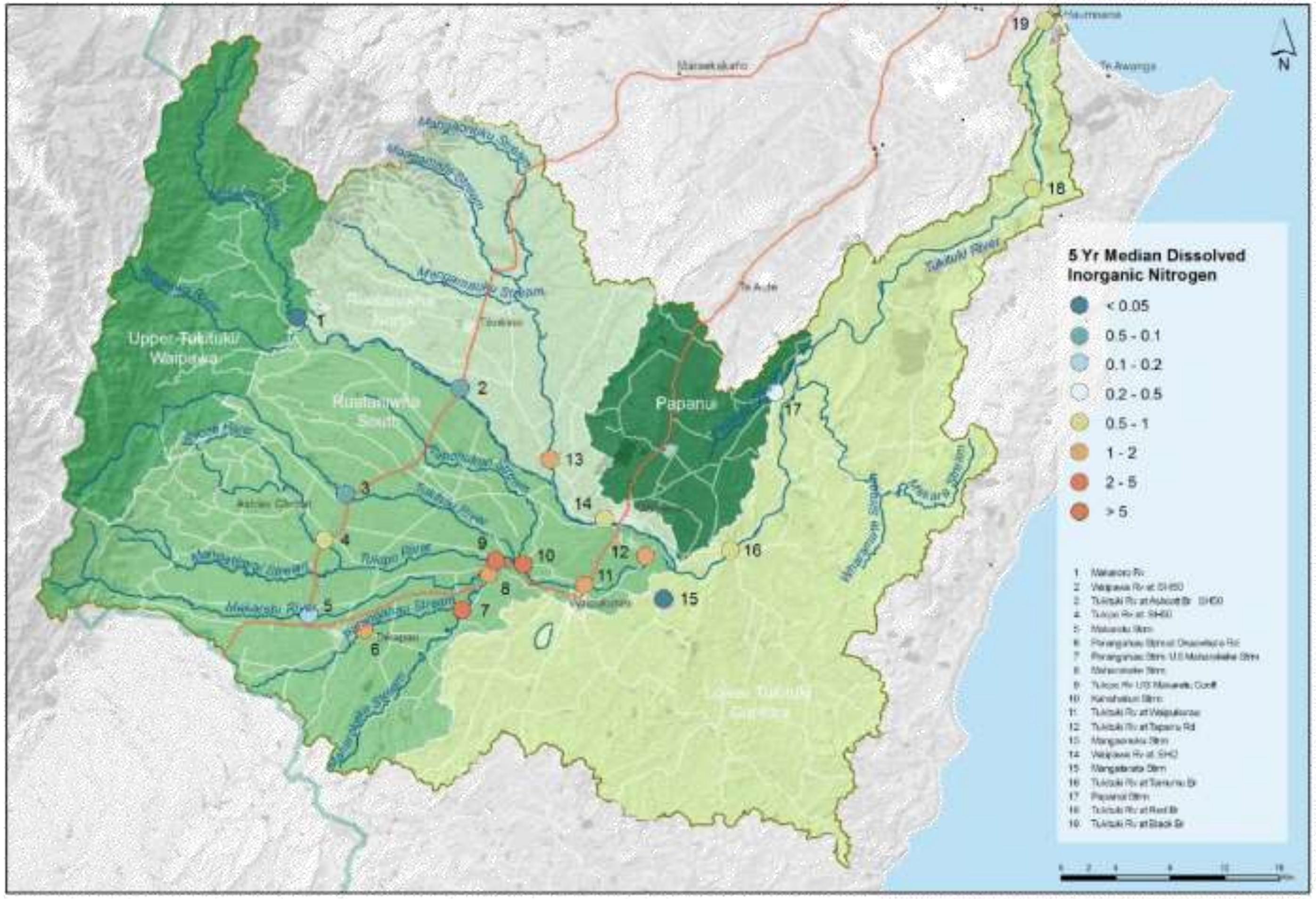

Figure 4-9: Map of 5 year median DIN concentrations in the Tukituki catchment.

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Dissolved Reactive Phosphorus (DRP) follows a similar pattern to nitrogen, i.e. concentrations are high in many Ruataniwha Plain tributaries and mainstem concentrations are highest around central Hawke's Bay (Figure 4-10). The RRMP specifies DRP targets of 0.010 mg/L for most mainstems of the Tukituki and Waipawa Rivers, and 0.015 mg/L for tributaries including the Papanui River. DRP concentrations are particularly high in the Mangatarata and Papanui tributaries of the Tukituki River.

To quantify periphyton, the Periphyton Weighted Composite Cover (PeriWCC) is used as a measure of algal growth and eutrophication, in relation to aesthetic, recreational, angling and ecological condition values. The PeriWCC assessment cannot be undertaken in soft bottomed streams or in deeper rivers that cannot be safely waded. As such, PeriWCC data is only available for the subset of our SoE monitoring sites shown in Figure 4-11.

The Mangaonuku Stream and Tukituki at Red Bridge had a median periWCC score indicative of 'poor', the Pōrangahau Stream and the Tukituki at Tamumu Bridge were 'fair', and the seven other sites were classed as excellent or good in terms of periphyton cover. The lowest periphyton was in the Tukituki River at SH50, but this increased steadily from SH2 to Tamumu Bridge and Red Bridge before dropping again at Black Bridge. This pattern of degradation with regards to periphyton loosely follows a similar pattern for many observations in this report: e.g. nitrogen, phosphorus and the Macroinvertebrate Community Index (MCI).

Low flows and hot summers may mean the Tukituki River will always experience some periods of extensive periphyton growth. However, the high nutrient concentrations evident from SoE monitoring suggests that reducing both nitrogen and phosphorus may help to decrease the magnitude of this problem.

Working with landowners, HBRC has received more than 1,000 Farm Environment Management Plans (FEMPs) for the Tukituki catchment. Along with resource consents, the FEMPs will drive nutrient and land use management to address water quality issues in water bodies. HBRC has invested heavily in catchment advisor relationships with landowners and there is also a regulatory requirement to monitor and manage landowner compliance, with the explicit objective of improving the quality of surface water bodies.

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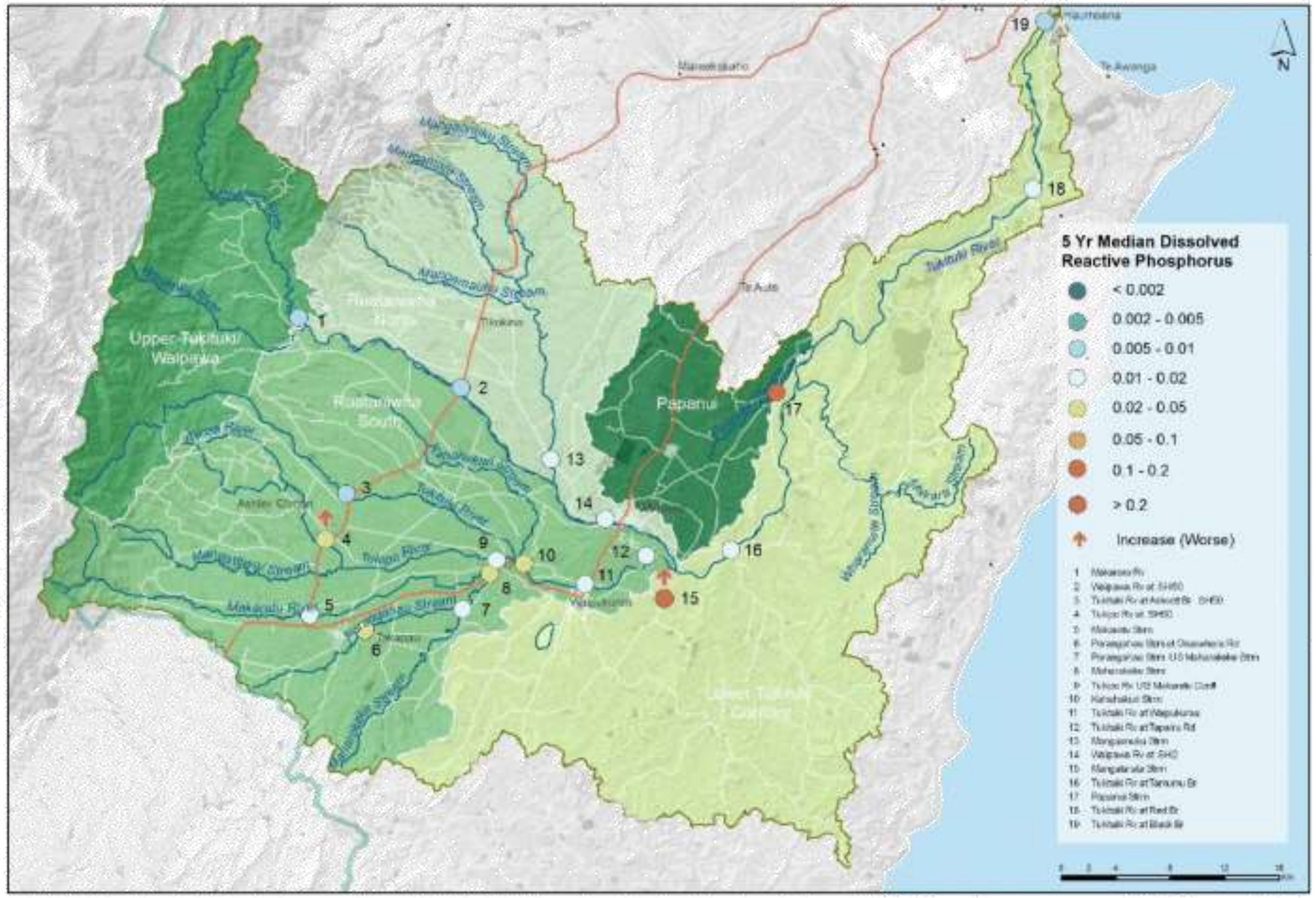

Figure 4-10: 5-year median dissolved reactive phosphorus (DRP) concentrations in the Tukituki catchment. Red arrows identify sites where statistically significant increasing trends in DRP concentrations have been observed. Only six years of monthly data were available for trend analysis, so caution is strongly advised with interpretation of trends.

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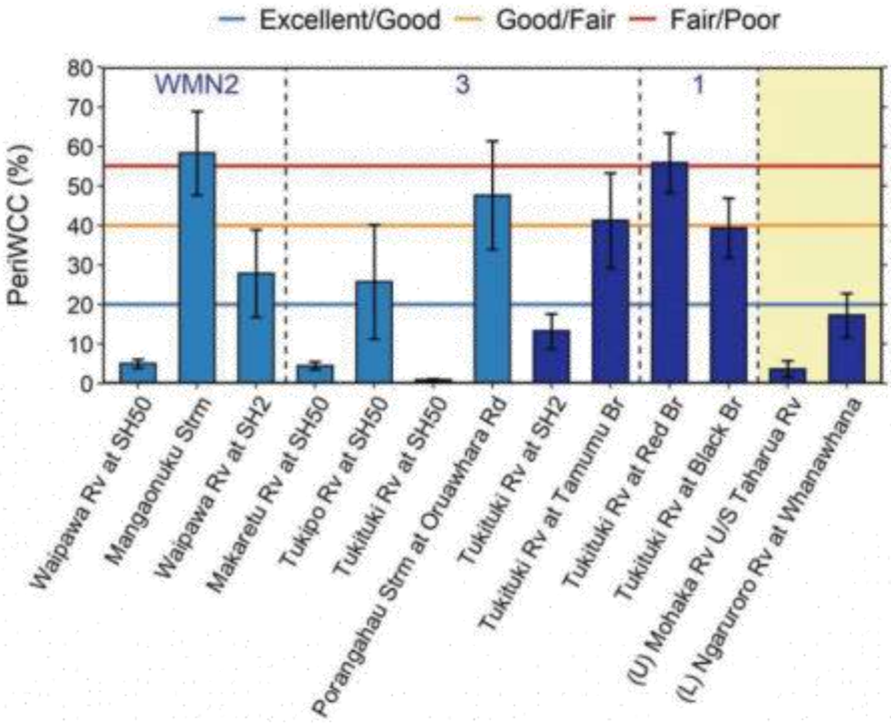

Figure 4-11: Box plots of Periphyton Weighted Composite Cover (PeriWCC) for Tukituki SoE monitoring sites. Yellow shading identifies Hawke's Bay upland (U) and Lowland (L) reference sites for comparison.

The Macroinvertebrate Community Index (MCI) was developed as a biomonitoring tool to assess stream health based on the presence or absence of certain invertebrate species. The MCI of a site can be used to assess the likely level of ecosystem degradation. A higher MCI score indicates that more pollution 'intolerant' or sensitive species are present, and indicates better water quality.

With respect to the MCI, monitoring sites in the Tukituki River catchment were mostly in the fair to good range, although the MCI score decreased with distance from the mountains (Figure 4-12). The highest median MCI was observed in the Makororo River, which is representative of a more pristine part of the catchment. The sites with lowest MCI scores were the Papanui and Mangatarata Streams, which are both severely affected by a lack of riparian shading and excessive macrophyte growth.

Physical habitat condition was evaluated using a Rapid Habitat Assessment (RHA) which ranged between the highest RHA scores in the Upper Tukituki/Waipawa WMZ, to lowest scores at the Mangatarata, Papanui and Pōrangahau Streams (Figure 4-13). Natural characteristics may prevent a site receiving the highest RHA scores, although better riparian management can improve habitat everywhere; including vegetation planting to provide shading to streams.

HBRC is implementing an erosion control scheme which includes a riparian programme; providing advice and assistance to landowners about planting alongside waterways to minimise streambank erosion and to improve the ecological health of waterways.

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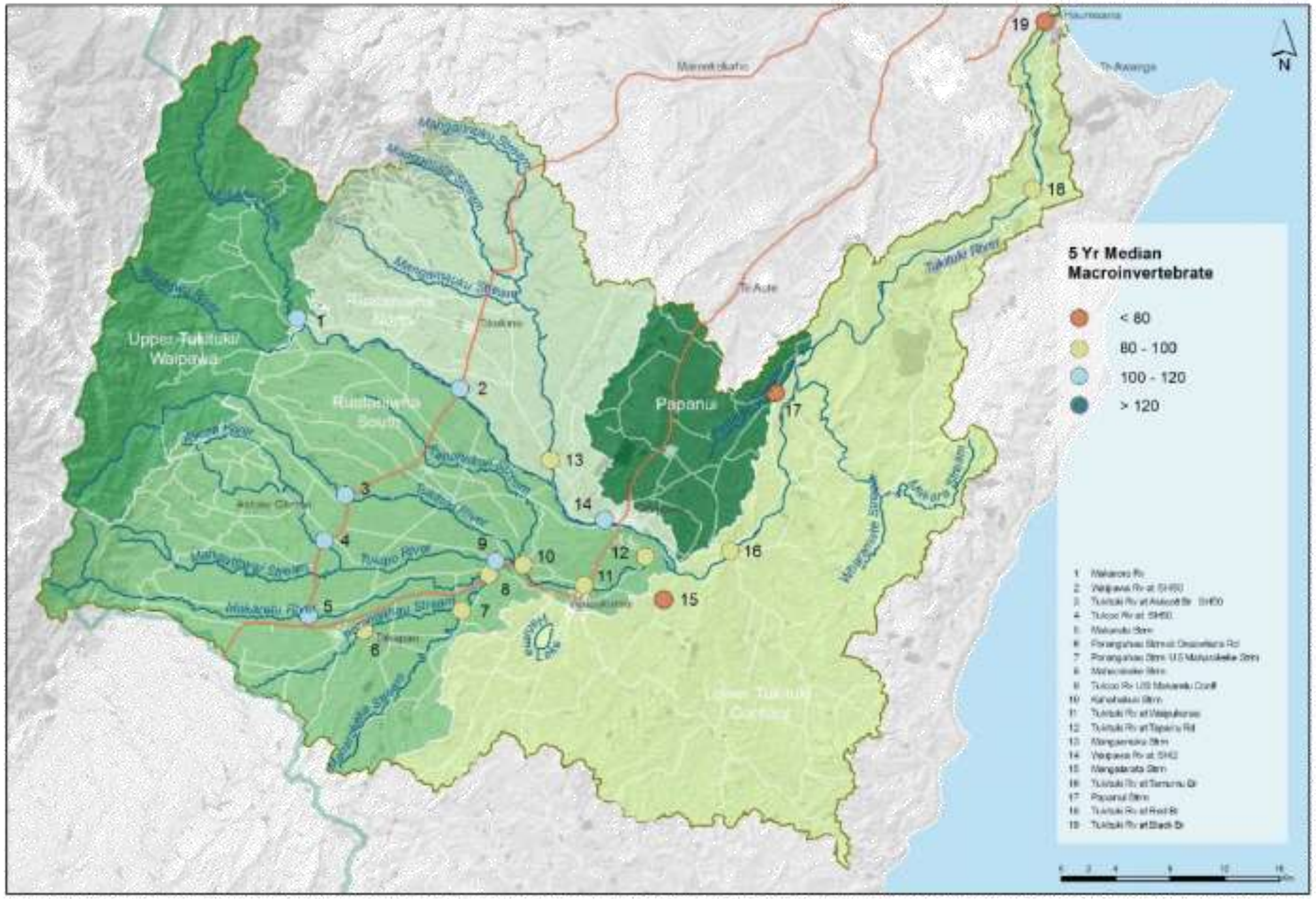

Figure 4-12: 5 year median MCI scores for the Tukituki catchment. Scores indicate: ≥120 Excellent; 100-120 Good; 80-100 Fair; <80 Poor.

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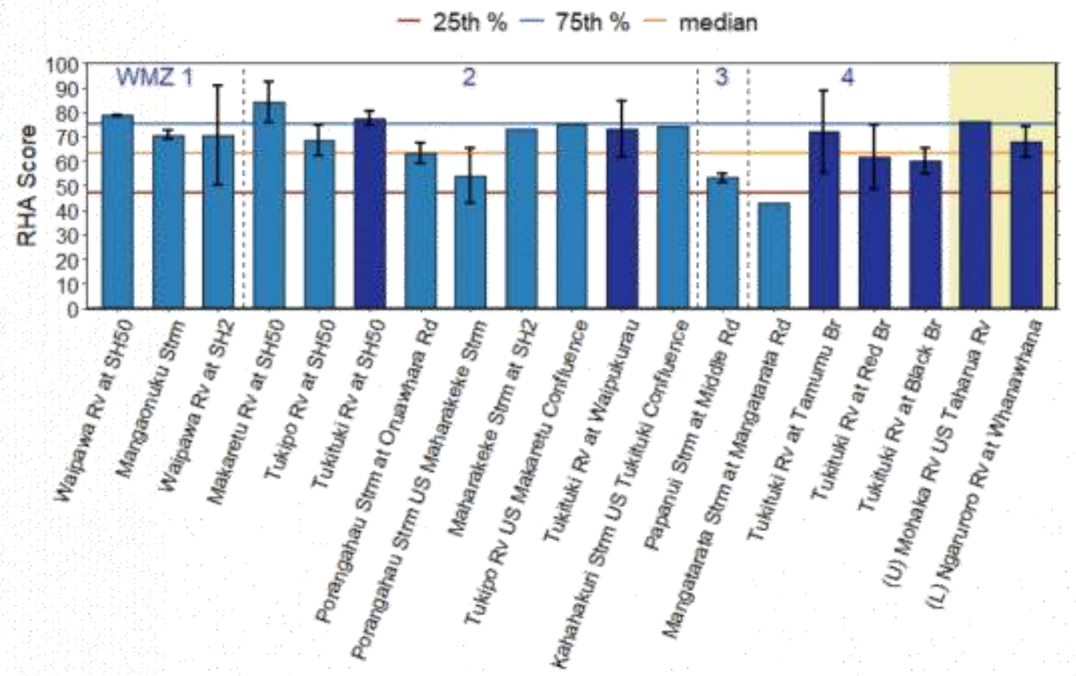

Figure 4-13: Rapid Habitat Assessment (RHA) scores for Tukituki monitoring sites. Mainstem sites are shown with dark blue boxes, while light blue boxes are tributary sites. The horizontal lines are thresholds for physical habitat condition, with the 25th percentile = 47, median = 63, and 75th percentile = 75, of the distribution of 560 New Zealand sites. Yellow shading identifies Hawke's Bay upland (U) and Lowland (L) reference sites for comparison.

Overall, the water clarity at most SoE monitoring sites in the Tukituki catchment is neither particularly high nor is it failing to meet guidelines for contact recreation (Figure 4-14). Mountain fed sites with modified catchments had lower water clarity. This probably reflects sediment remaining in suspension in the steeper parts of the mainstems. The mainstem sites show extremely elevated turbidity during high flow events, which reflects the large sediment loads being carried down the Tukituki River during floods.

The Makororo River, with its largely unmodified catchment, did not exhibit the extreme elevations in turbidity during higher flows. This suggests that high sediment loads in the Tukituki catchment are due to land cover modification.

To manage sediment issues throughout the region, HBRC is implementing an erosion control scheme, which encourages tree planting and erosion control work on pastoral or retired land. This $30 million fund (over ten years) targets Hawke's Bay's 252,000 hectares of land at high risk of erosion and estimated to lose, on average, more than 3 million tonnes of sediment to the region's waterways every year. The scheme aims to reduce soil erosion, improve terrestrial and aquatic biodiversity, provide community and cultural benefits through forest ecosystem services, and improve water quality through the reduction of sedimentation in waterways.

HBRC now has a team of five based in Waipawa, with staff typically in the field working with Central Hawke's Bay landowners to give support and provide advice on good land use practices. This includes assisting landowners to develop Erosion Control Plans and then to implement the actions in the plans to help control erosion and improve water quality.

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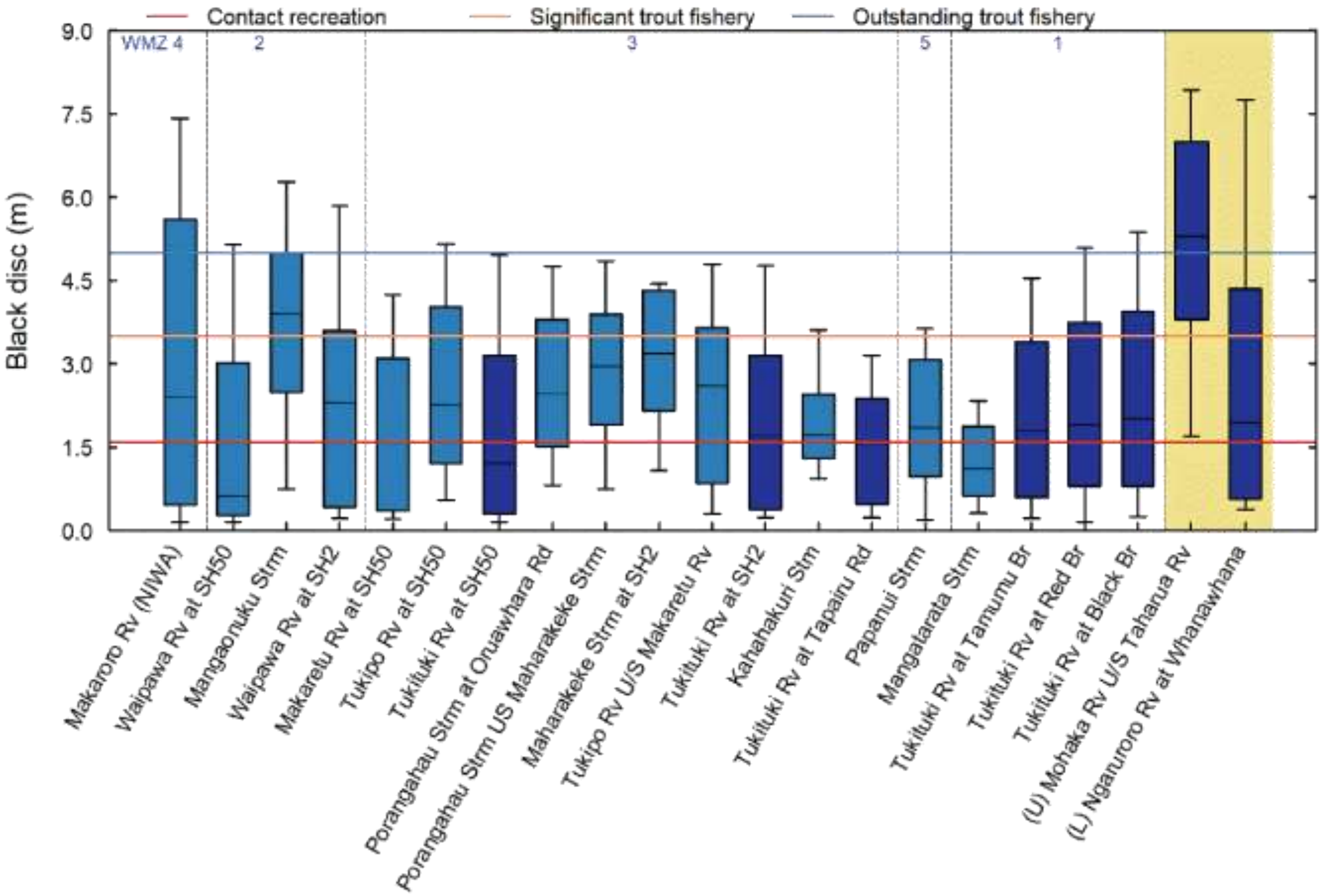

Figure 4-14: Boxplots of black disk (water clarity) for Tukituki monitoring sites. Mainstem sites are shown with dark blue boxes, while light blue boxes are tributary sites. The horizontal lines are guidelines for contact recreation and trout fisheries. Yellow shading identifies Hawke's Bay upland (U) and Lowland (L) reference sites for comparison.

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The estimate of sediment loss that informs the erosion control scheme is generated from a SedNetNZ model of the region that was been created for HBRC by Manaaki Whenua Landcare Research, to identify highly erodible land and to prioritise activities of the scheme. While the SedNetNZ model provides estimates of annual sediment yield and load, along with spatial distributions of erosion processes, determining the effectiveness of land management efforts is best achieved through direct measurement of in-stream sediment concentrations.

The installation of an auto-sampler in the Tukituki River at Red Bridge has captured suspended sediment concentrations at a range of flood flows (Figure 4-15), including an event in September 2018 with peak flow 1,407 m^3/s having a 1-in-5 year recurrence interval (Figure 4-16). Using results from the auto-sampler, total sediment load in the Tukituki River was estimated at 386,000 tonnes during this one event from 4-10 September 2018. Along with degrading instream water quality and habitat, this fine sediment is ultimately deposited in estuarine and coastal environments, with adverse effects on those habitats and ecosystems

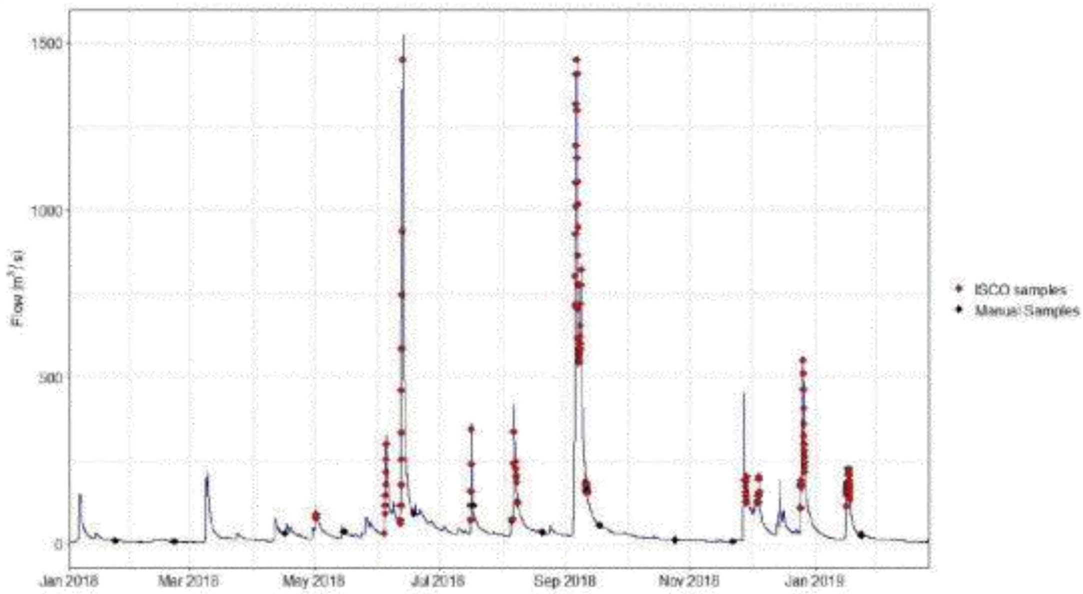

Figure 4-15: River flow and suspended sediment concentrations observed at Tukituki at Red Bridge between January 2018 and March 2019. The timing of suspended sediment sampling is shown with black circles (manual samples) and red circles (automated samples). Note that manual sampling only occurs during lower flows.

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Figure 4-16: Tukituki River at Red Bridge during the September 2018 flood event.

Along with water clarity, swimmability of Hawke's Bay water bodies is also affected by levels of faecal contamination. The bacterium *E. coli* is used as an indicator to assess the level of health risk to water users having direct contact with water. Three sites in the Tukituki catchment received D gradings against the NPS-FM swimmability framework (Table 4-1), which relates to a predicted average infection risk of more than 3%. This included the Tukituki River at Red Bridge which is a popular swimming location.

For the Tukituki at Red Bridge, infrequent elevations of *E. coli* associated with high river flow events resulted in the D swimmability grade. Faecal source tracking for the Papanui and Pōrangahau catchments identified a range of potential contributors, but ruminant (especially bovine) sources were most commonly indicated. Trend analysis identified there was no statistically significant evidence of deteriorating swimmability at any sites.

Stock exclusion rules under the RRMP and imminent reform of the Resource Management Act requires fencing so that stock are denied access to waterways. Improvements to swimmability are expected as a consequence of stock exclusion from rivers and streams in the Tukituki catchment.

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Table 4-1: NOF swimmability categories for *E. coli* at Tukituki SoE sites. Monitoring period 2013 to 2018. Overall grade A, B and C bands are categories suitable for primary contact recreation.

Site	Overall grade for *E. coli*
Kahahakuri Stream	A
Makaretu River at SH50	A
Mangaonuku Stream	A
Mangatarata Stream	D
Papanui Stream	D
Pōrangahau Stream	C
Tukipo River at SH50	B
Tukituki River at SH50	A
Tukituki River at Black Bridge	B
Tukituki River at Red Bridge	D
Tukituki River at Tamumu Bridge	C
Tukituki River at Waipukurau	B
Waipawa River at SH2	B
Waipawa River at SH50	B

b) Pōrangahau and Southern Coastal catchments

Land use within both the Pōrangahau and Southern Coastal catchments is predominantly sheep and beef farming, with coastal settlements by the beaches. Sites monitored for water quality (Figure 4-1) in these catchments generally have extensive stream bank erosion and unrestricted stock access.

While limits relating to dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) are used to manage periphyton growth, this is generally applicable to waterways with hard substrate that periphyton attach to. Excessive periphyton growth is unlikely to develop in soft-bottomed rivers such as those in the Pōrangahau catchment and Mangakuri River, regardless of dissolved nutrient concentrations.

While nutrient management for trophic state is intended to avoid nuisance growth of periphyton, the monitoring site in the hard-bottomed Waingongoro Stream has very high levels of DIN and DRP (Figure 4-17), but does not have a periphyton issue (Figure 4-18). The relatively high nutrient concentrations in Waingongoro Stream may be due to the lack of instream attenuation of nutrients by periphyton growth instream, because the stream is light-limited as a consequence of good riparian canopy cover. This demonstrates that nutrient limits are not always required to manage excessive growth of periphyton, as long as other periphyton-limiting factors are present: for example riparian shading that restricts sunlight availability.

Conversely, the Mangaorapa Stream had the highest periphyton coverage of all eight sites (Figure 4-18), yet DIN and DRP concentrations were relatively very low (Figure 4-17). Given the wide channel of the Mangaorapa Stream, riparian shade is unlikely to be an effective periphyton control measure, and other management may be needed if periphyton is to be controlled in this waterway.

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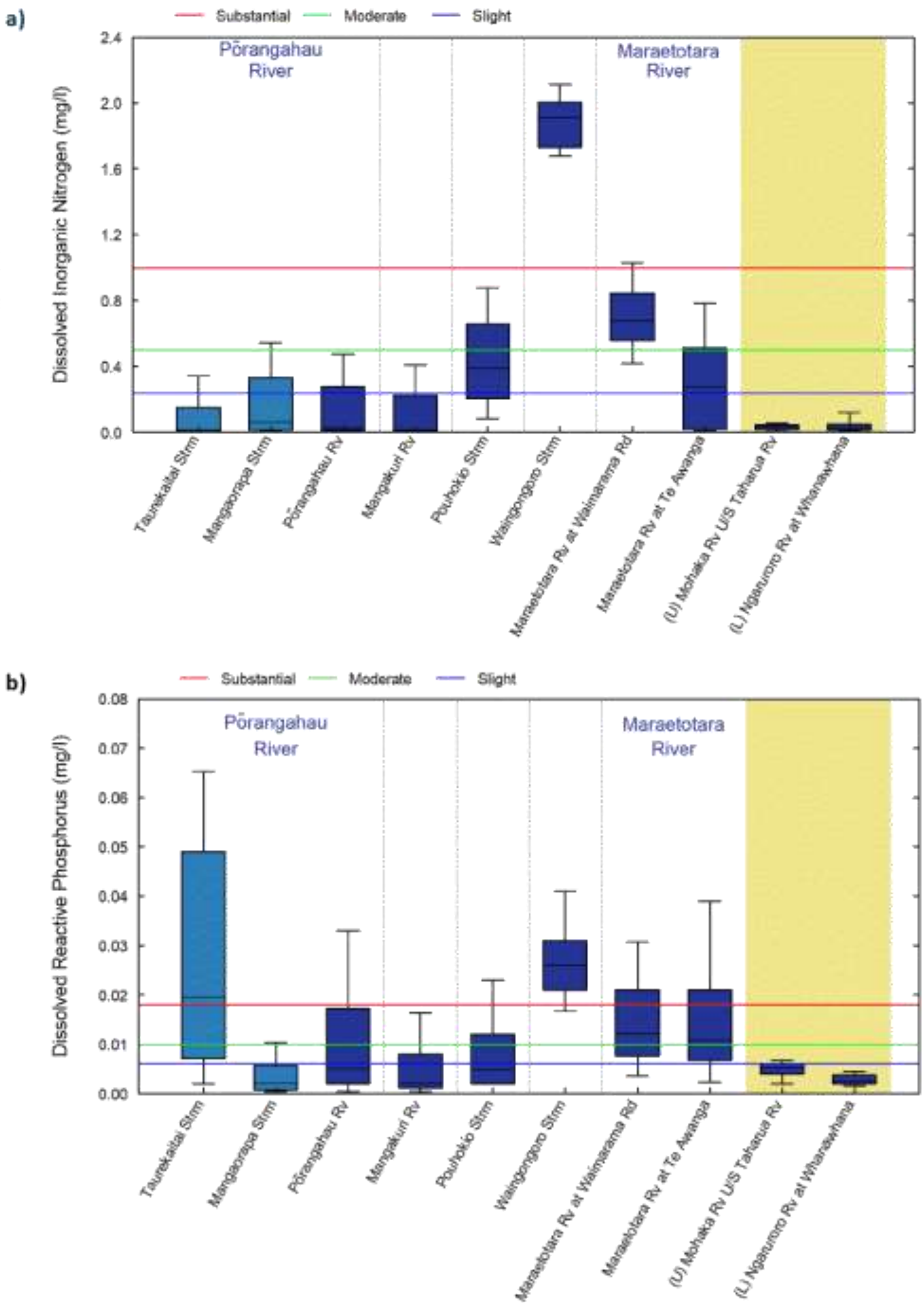

Figure 4-17: Dissolved nutrient concentrations at Pōrangahau and Southern Coastal monitoring sites. Median values above the red line are substantially elevated; between red and green lines are moderately elevated; between green and blue lines are slightly elevated; and below the blue line are similar to natural conditions.

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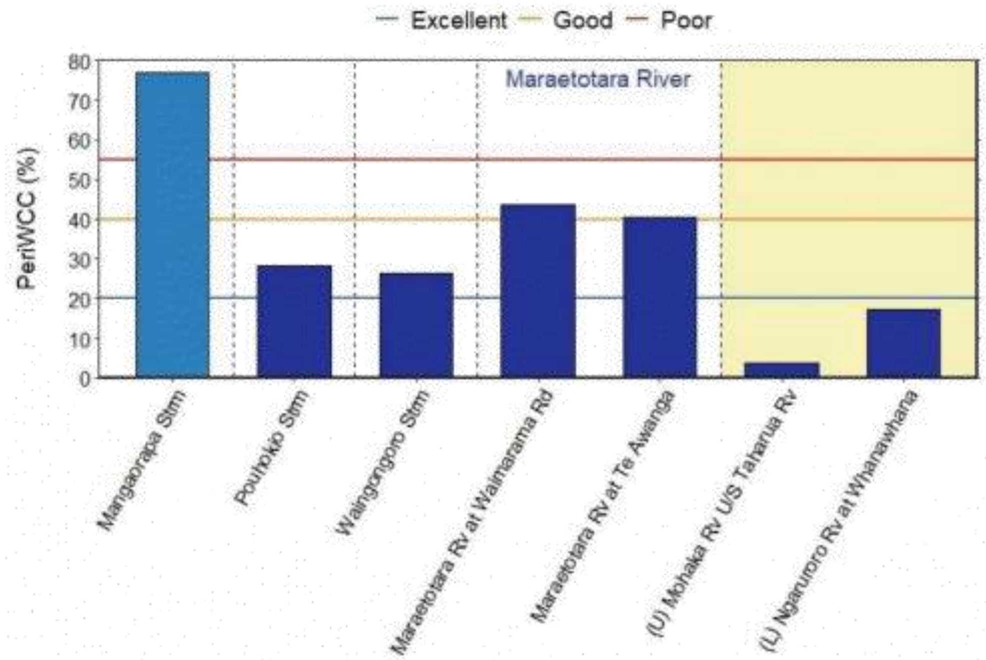

Figure 4-18: Periphyton Weighted Composite Cover (PeriWCC) scores for monitoring sites in the Pōrangahau River and Southern Coastal catchments. The blue line represents 'excellent' ecological condition (<20%); the amber line 'good' (20-39%); and the red line 'poor' (>55%).

At all sites, nitrate and ammoniacal-nitrogen concentrations were within the NPS-FM limits to protect 95% of aquatic species from the toxic effects of nitrogen.

With respect to the MCI, all monitoring sites in the Pōrangahau and Southern Coastal catchments had low MCI scores relative to the rest of the region. Most sites ranked in the lower 50% of sites regionally, displaying scores indicative of 'poor' or 'fair' water quality (Figure 4-19). Pōrangahau Catchment sites invariably had 'poor' MCI scores (<80), which are likely to be a consequence of excessive macrophyte or periphyton growth, and sedimentation of the river bed.

The Waingongoro Stream and Maraetotara at Waimarama Rd had the highest MCI scores of the eight sites. This may be attributable to their relatively cool spring fed water temperatures and good riparian shade, and larger substrates which are mostly free of periphyton and silt coverage. This is reflected in the Rapid Habitat Assessment (RHA) scores that identify good habitat quality at these sites (Figure 4-20); with good riparian communities and shade, heterogeneous channel hydrology, varying substrate size, along with diverse fish and invertebrate habitat.

All other sites have poorer habitat quality, due to their lack of riparian habitat, unrestricted stock access, stream bank erosion and/or high sedimentation. Targeted efforts around riparian fencing and planting in these catchments will help to improve stream health

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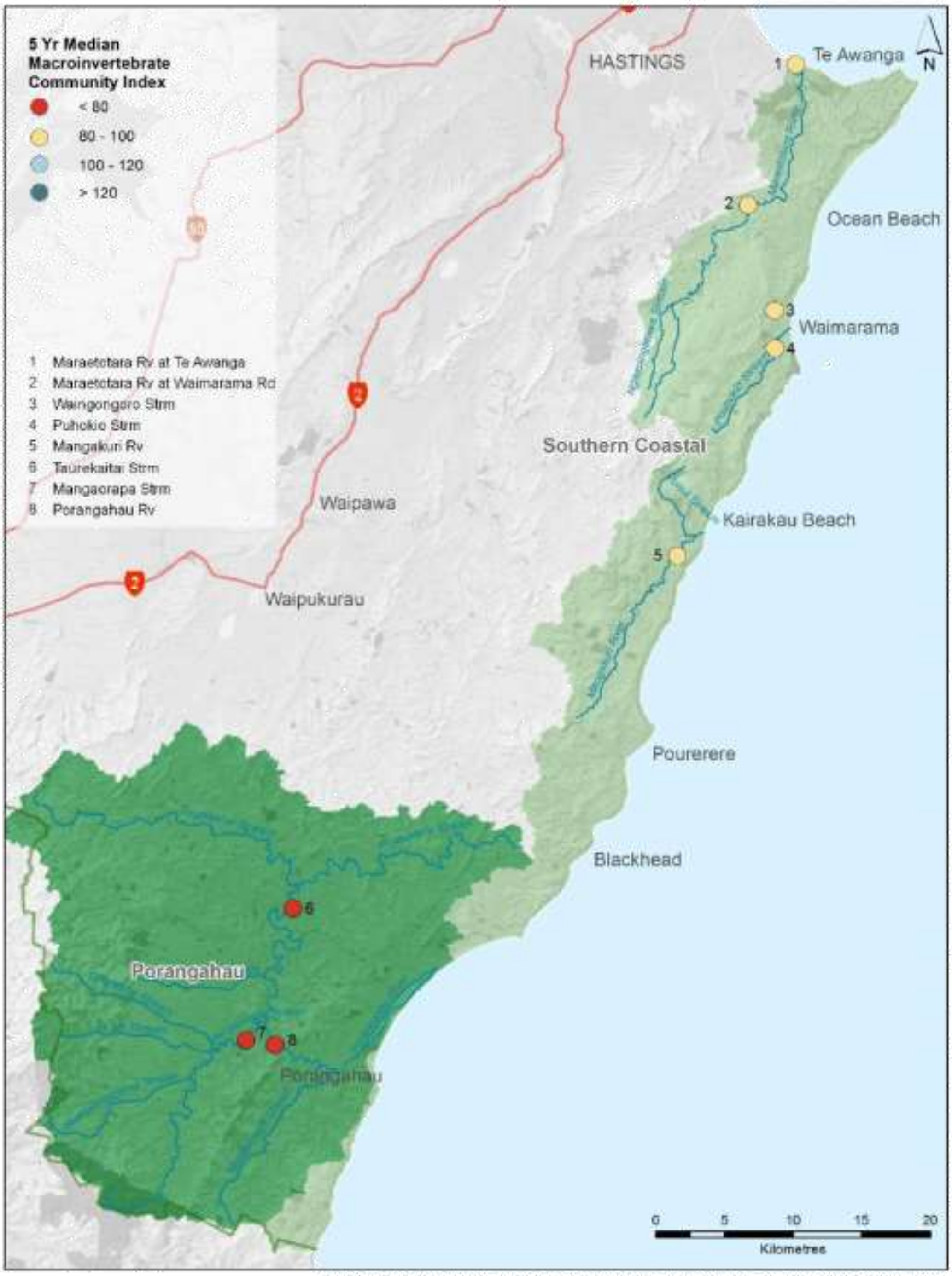

Figure 4-19: 5 year median MCI scores for the Pōrangahau and Southern Coastal catchments. Scores indicate: ≥120 Excellent; 100-120 Good; 80-100 Fair; <80 Poor.

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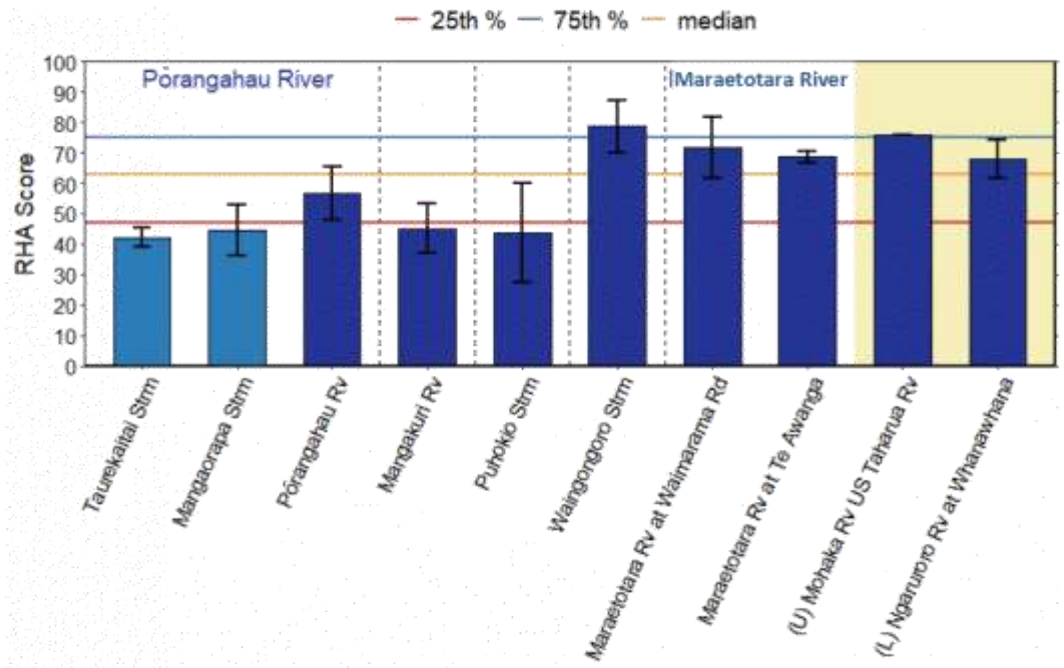

Figure 4-20: Rapid Habitat Assessment scores for Pōrangahau and Southern Coastal catchments. The horizontal lines are thresholds for physical habitat condition, with the 25th percentile = 47, median = 63, and 75th percentile = 75, of the distribution of 560 New Zealand sites. Yellow shading identifies Hawke's Bay upland (U) and Lowland (L) reference sites for comparison.

Water clarity in the Pōrangahau and Southern Coastal catchments was generally poor, with median black disc sighting distances at six of the eight sites similar to, or less than, the guideline for recreational waters (Figure 4-21). Sites on the Maraetotara River at Waimarama Rd and Te Awanga had the highest median black disc sighting distances, although these were below the recommended minimum 3.5 m for significant trout fisheries.

Along with water clarity, swimmability of Hawke's Bay water bodies is also affected by levels of faecal contamination. The bacterium *E. coli* is used as an indicator to assess the level of health risk to water users having direct contact with water.

E. coli concentrations were relatively high and unsuitable for contact recreation at all sites except for the Maraetotara River at Waimarama Rd (Table 4-2). For the Mangakuri, Mangaorapa, Pōrangahau and Waingongoro sites, the Overall Grade 'D' was due to high median values, suggesting that elevated *E. coli* levels are not exclusively associated with high rainfall events. In the Pōrangahau, Mangakuri and Pouhokio catchments, stock access to streams is often unrestricted. It is expected that targeted efforts with riparian fencing and planting in these catchments will help to improve swimmability. Faecal source tracking may be used to determine the source of this contamination (e.g. ruminant, avian or human) and guide management decisions such as stock exclusion.

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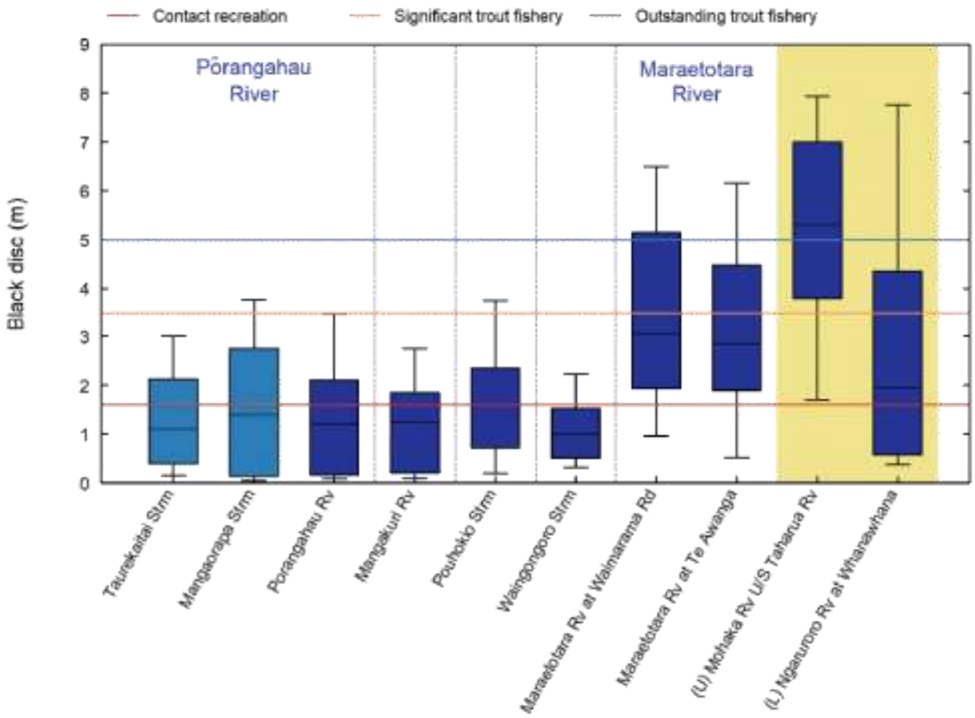

Figure 4-21: Boxplots of black disk (water clarity) for Pōrangahau and Southern Coastal catchments. The horizontal lines are guidelines for contact recreation and trout fisheries. Yellow shading identifies Hawke's Bay upland (U) and Lowland (L) reference sites for comparison.

Table 4-2: NOF swimmability categories for *E. coli* at Pōrangahau and Southern Coastal SoE sites. Monitoring period 2013 to 2018. Overall grade A, B and C bands are categories suitable for primary contact recreation.

Site	Overall grade for *E. coli*
Mangakuri River	D
Mangaorapa Stream	D
Maraetotara River at Te Awanga	D
Maraetotara River at Waimarama Road	B
Pōrangahau River	D
Pouhokio Stream	D
Taurekaitai Stream	D
Waingongoro Stream	D

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Significant efforts in erosion control have begun in the Pōrangahau and Southern Coastal catchments. Recent land management efforts in the Pōrangahau catchment include extensive tree planting for hillslope stability (e.g. 9,200 willow and poplar poles planted in 2019), 6 km of riparian fencing, and targets for a further 3 km of fencing for the Pōrangahau Estuary with the million metres programme[9]. The Maraetotara River has a history of riparian retirement and fencing, and in reaches where this has occurred, habitat values are higher. The same is also true in the upper reaches of the Waingongoro Stream, which is protected by a Queen Elizabeth II covenant and is surrounded by native bush.

While these erosion control efforts are underway, improvements in water quality and aquatic habitats will take time to manifest. Continued SoE monitoring is essential for evaluating the efficacy of these efforts over time.

4.1.3 Marine and coast, and recreational water quality

The coastal inshore waters of Hawke's Bay provide for a range of biological, social, economic and recreational activities. However, these areas are also the receiving environment for almost all land-based activities via the freshwater drainage network, and are therefore susceptible to water quality issues. In Hawke's Bay, large river systems transport contaminants to the nearshore coastal environment, and therefore monitoring coastal water quality is required to ensure that key functions and services remain intact.

Hawke's Bay estuaries are defined as one of two hydrosystem types: 1) Shallow Intertidal Dominated Estuaries (SIDE) such as Pōrangahau Estuary; or 2) Shallow, Short Residence Tidal River Estuaries (SSRTRE) such as Tukituki Estuary. SIDE estuaries typically have a higher residence time than SSRTRE estuaries, and therefore may be more susceptible to land based influences.

As water enters estuaries from the turbulent water that has entrained them, they can either settle out in the calmer waters and become part of the substrate, or can remain in the water column making the estuarine water turbid: lowering visibility for predators and light penetration for photosynthesis. Pōrangahau Estuary had the highest 75th and 90th percentile for suspended sediments in Hawke's Bay estuaries (Figure 4-22) indicating that at times, this estuary can be subjected to some of the highest delivery of sediments in the region

[9] www.millionmetres.org.nz

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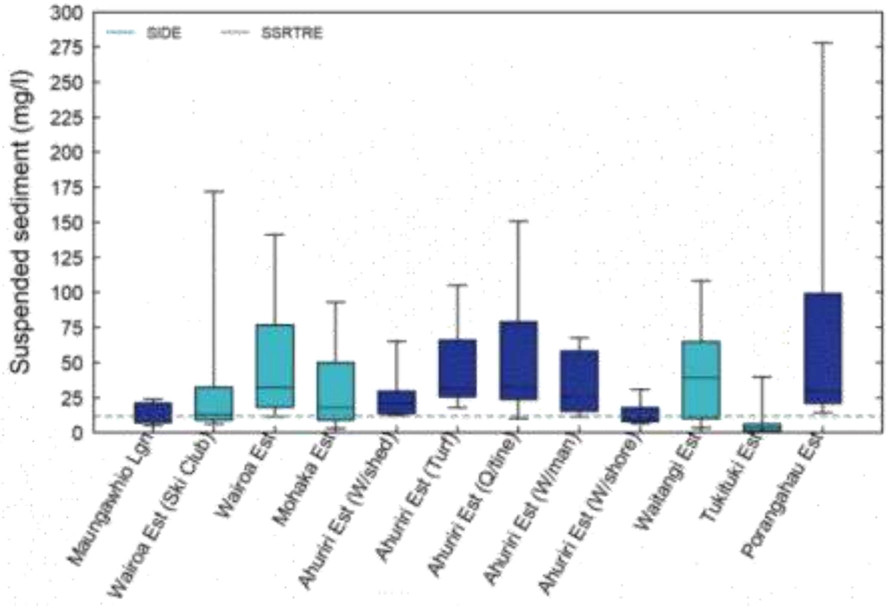

Figure 4-22: Suspended sediment concentrations for Hawke's Bay estuaries Nov-16 to June-18. (n=19) Boxes represent 25th, 50th and 75th percentiles. Whiskers represent 10th and 90th percentiles. The median concentration for New Zealand estuaries is shown with a horizontal dashed line.

Similarly to the pattern observed for sediments, Pōrangahau Estuary has a moderate median level of total nitrogen, but a larger spread of data between the 50th and 90th percentiles (Figure 4-23). This indicates higher levels of total nitrogen at the top end of the data which is likely to be associated with flood events. Total phosphorus levels are also relatively high at Pōrangahau.

Total nitrogen concentrations in the Tukituki Estuary were also high (Figure 4-23). Interestingly, while levels of total nitrogen in both estuaries were high, levels of dissolved inorganic nitrogen in the Pōrangahau Estuary did not follow the same pattern (Figure 4-24). This would suggest that for the Pōrangahau, a considerable portion of the total nitrogen is made up of organic nitrogen (e.g. urea, amino acids, peptides, proteins etc and dead organic material). This is not the case for Tukituki Estuary which shows a similar pattern between both the total and dissolved nutrient fraction, indicating that the majority of nitrogen at this site is in the inorganic form.

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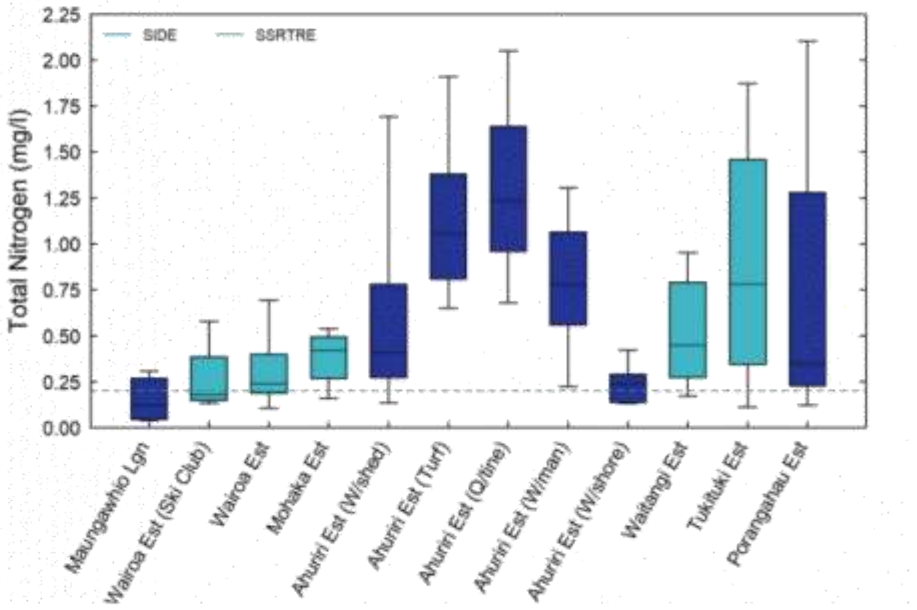

Figure 4-23: Concentrations of total nitrogen (TN) for Hawke's Bay estuaries Nov-16 to June-18. (n=19) Boxes represent 25th, 50th and 75th percentiles. Whiskers represent 10th and 90th percentiles. The median concentration for New Zealand estuaries is shown with a horizontal dashed line.

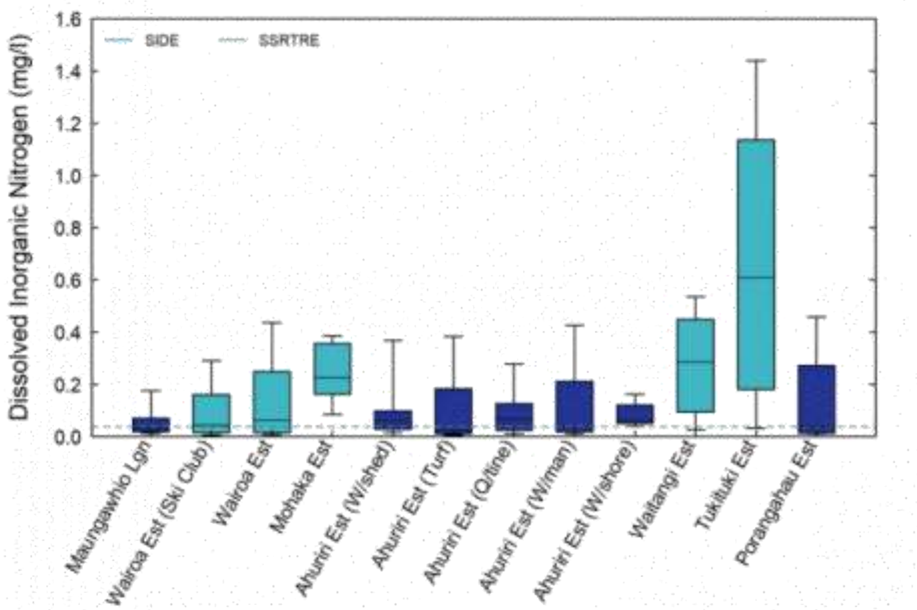

Figure 4-24: Concentrations of dissolved inorganic nitrogen (DIN) for Hawke's Bay estuaries Nov-16 to June-18. (n=19) Boxes represent 25th, 50th and 75th percentiles. Whiskers represent 10th and 90th percentiles. The median concentration for New Zealand estuaries is shown with a horizontal dashed line.

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Sediment stress within the benthic environment is one of the key issues observed through estuarine state of the environment monitoring. Sediment composition is a key driver in the macroinvertebrate community composition present within estuary sites. Median levels of 'mud' in the Pōrangahau and Tukituki Estuaries (Figure 4-25) exceed published literature for mud content thresholds that support healthy, diverse communities (<25% mud content).

Investigation of infaunal communities that inhabit Hawke's Bay estuaries has shown a loss of species where mud concentrations exceed 25%. These species are valued as important food sources for fish, birds and people, along with having an influential role in ecosystem dynamics including nutrient cycling and bioturbation. Therefore, loss of these species can have associated effects on site health and integrity.

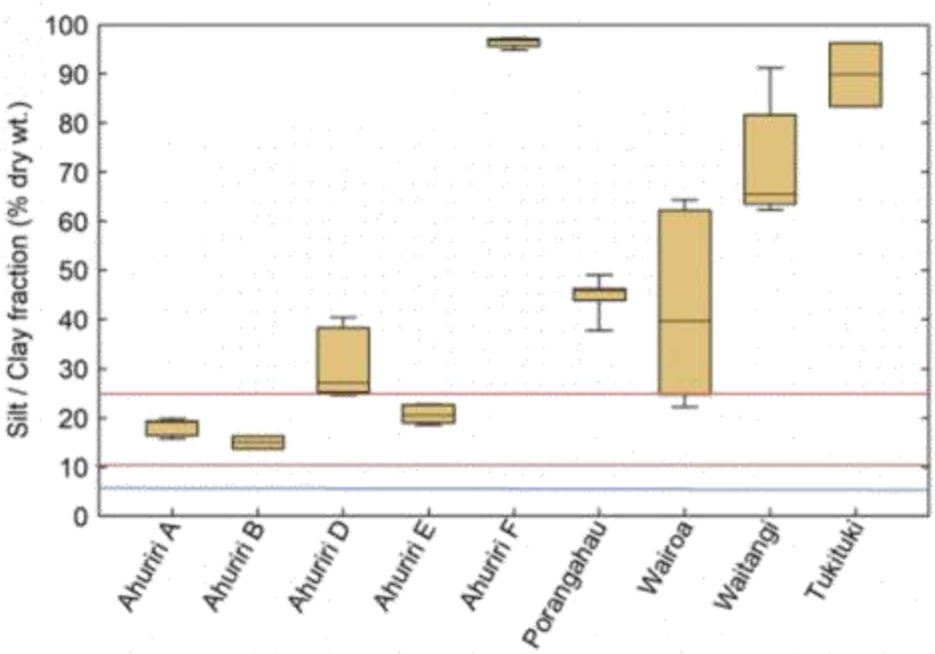

Figure 4-25: 5 year median levels of silt/clay (mud) in estuarine sediments (2013-2018). Blue line refers to 5% mud, amber line 10% mud content, red line 25% mud content. Medians based on 5 years 2013-2018 (Ahuriri A, D, E, Pōrangahau, and Wairoa), 4 years (Waitangi), 3 years (Ahuriri B, F), 2 years (Tukituki). Boxes represent 25th, 50th and 75th percentiles and whiskers represent 10th and 90th percentiles.

The source of sediment and nutrients to the Tukituki and Pōrangahau Estuaries is clear. Section 4.1.2 identifies that these catchments are subject to erosion and runoff processes that deliver sediment and nutrients to streams and rivers, with effects on instream water quality and aquatic habitats. The fate of these contaminants is ultimately the receiving environments: the Tukituki and Pōrangahau Estuaries.

As discussed in previous sections, HBRC is implementing an erosion control scheme to address these issues by encouraging and incentivising tree planting and erosion control work on pastoral or retired land. This $30 million fund (over 10 years) targets Hawke's Bay's 252,000 hectares of land at high risk of erosion, estimated to lose, on average, more than 3 million tonnes of sediment to the region's waterways every year. The

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scheme aims to reduce soil erosion, improve terrestrial and aquatic biodiversity, provide community and cultural benefits through forest ecosystem services, and improve water quality through the reduction of sedimentation in waterways. Obviously, the estuarine environments will also benefit substantially from the erosion control scheme.

HBRC also continues work at the Pōrangahau Estuary alongside the local community, to identify and protect inanga spawning sites, fence for stock exclusion, plant vulnerable sites for erosion control and to improve the ecological health of the estuary.

While these erosion control and other efforts are underway, improvements in water quality, aquatic habitats and estuarine environments will take time to manifest. Continued SoE monitoring is essential for evaluating the efficacy of these efforts over time.

Because much of the erosion occurs during high rainfall periods, HBRC is installing a suite of auto-samplers throughout Hawke's Bay to record suspended sediment concentrations during a range of different flood events. Over the long-term, results will be used to identify the beneficial effects of land use management on erosion control and suspended sediment in waterways. Continued monitoring of the estuarine and coastal systems is also essential, to be sure that the erosion control scheme and riparian management efforts are delivering improvements to the receiving environments.

While lagoon recreational water quality in the southern sub-region was relatively poor, the beaches in these areas have an excellent standard of recreational water quality, with no exceedances of national guidelines recorded for the 2013-2018 period (Figure 4-26). This indicates that while faecal material may be delivered to the coast via the lagoons and estuaries, it is not causing an impact on recreational activities on the coast.

Kairākau Lagoon had the highest number of exceedances of national guidelines of the lagoon sites in both the southern sub-region, but also in the combined sub-regions. Water quality at this site was unsuitable for contact recreation in 19% of the samples over the five year period. Waipuka Stream at Ocean Beach also had a high number of exceedances, and was unsuitable for recreation in 10% of the samples. This was followed by Pōrangahau Estuary and Puhokio Stream at 7% and 5% of samples unsuitable for recreation respectively.

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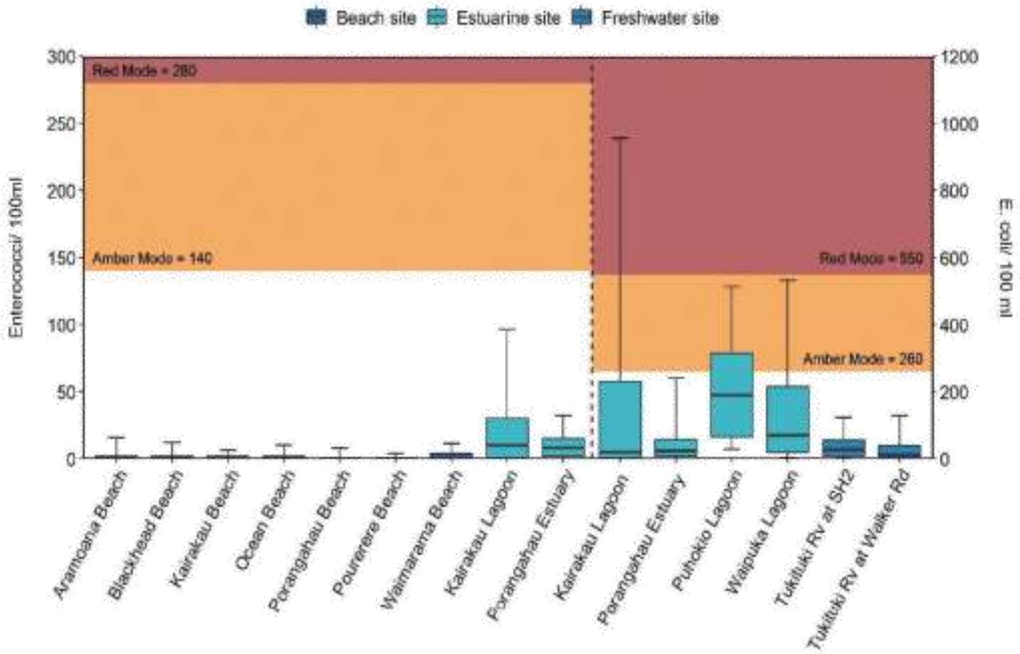

Figure 4-26: Faecal indicators for northern recreational water quality monitoring sites (2013-2018). Red and amber areas indicate the MfE and MoH (2003) trigger values for the Red and Amber Modes respectively. The concentrations of indicator bacteria (cfu/100ml) associated with these modes are written above the line.

4.2 Groundwater resources

Monitoring of groundwater levels in the major Hawke's Bay aquifer systems show that declines have manifested slowly over time. In many areas, the long-term changes are masked by the natural variability between seasons. The most persistent changes have occurred in the Heretaunga and Ruataniwha Plains, where most trends indicate declining water levels. Results like these are expected in productive aquifer systems and are consistent with previously identified changes in patterns and trends.

The greatest changes in groundwater levels occur in areas of the Ruataniwha Plains with the largest pumping interference. Compared with the Heretaunga aquifer system, groundwater in the Ruataniwha Basin is sourced from less transmissive aquifers, with lower storage properties, and is pumped at greater rates resulting in deeper drawdown impacts and slower recovery. In contrast, the declines have been smaller on the Heretaunga Plains; despite greater volumes of groundwater pumped annually. Here, highly transmissive aquifers with strong surface water connections result in shallow and widespread drawdown impacts with relatively swift recovery.

Many of the long-term declines are associated with groundwater abstraction and are an expected response to pumping. Groundwater use in Hawke's Bay has steadily increased over the last 30-40 years. On the Ruataniwha Plains, groundwater use began accelerating in the late 1990s and quadrupled between 1998 and 2008, from approximately 5 Mm^3/year to 20 Mm^3/year.

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Figure 4-27 shows the locations of Ruataniwha monitoring wells that have been declining over the past 30 years. To address the declining groundwater levels and associated effects on connected surface water bodies, the new policy for the catchment in the RRMP has limited groundwater abstraction and there has been no further allocation of the resource since the policy became operative in 2015.

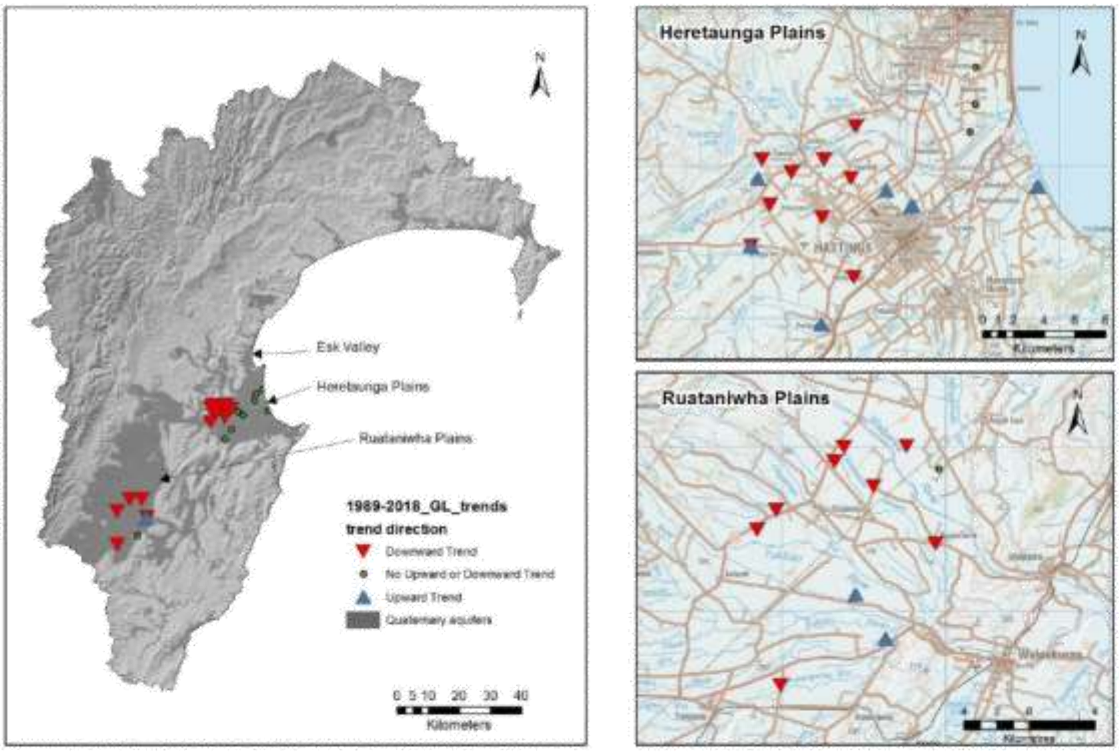

Figure 4-27: Locations of statistically significant trends in groundwater levels for 30 years between 1989-2018.

When trends in groundwater levels were evaluated for 20 years from 1999 to 2018 (Figure 4-28), declining trends did not appear to be as widespread as they were for the 30 year period from 1989 to 2018 (Figure 4-27). This may be an indication that the Ruataniwha groundwater system is approaching a new 'equilibrium' associated with stabilised pumping since the allocation was capped. Further monitoring and trend analysis will be undertaken to confirm whether this is the case.

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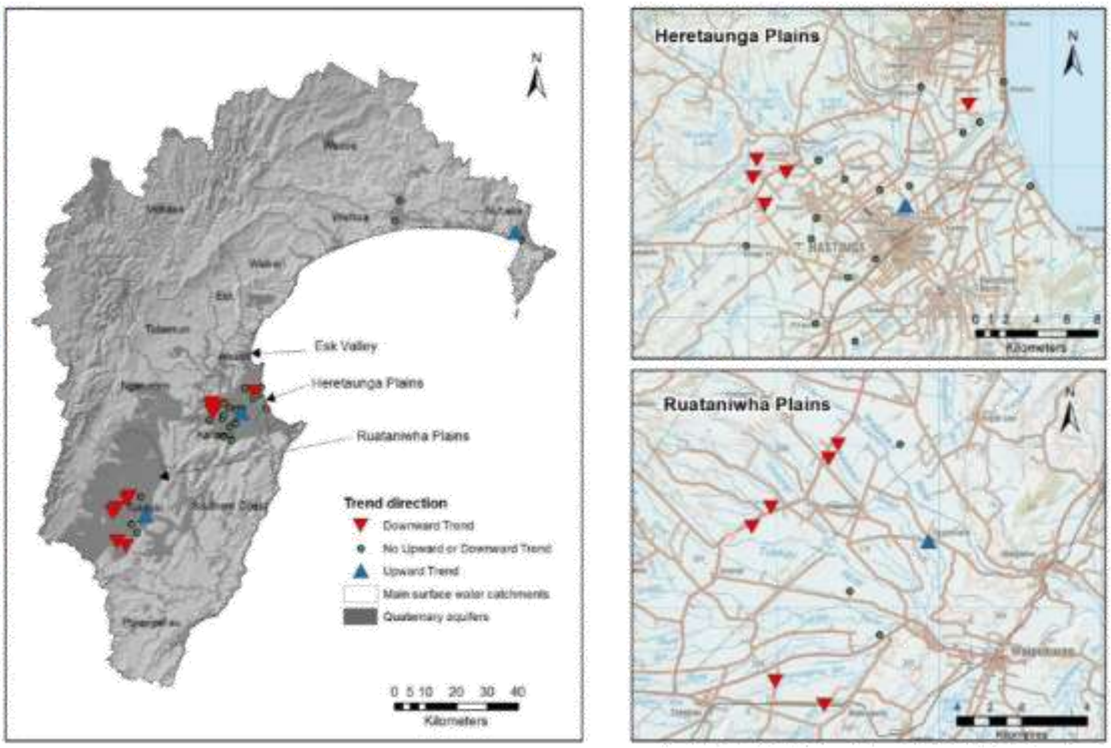

Figure 4-28: Locations of statistically significant trends in groundwater levels for 20 years between 1999 and 2018.

In addition to capping the groundwater allocation from the Ruataniwha aquifer system, HBRC is also working with local community leaders to identify and implement solutions to manage the effects of groundwater abstraction and build resilience of water supplies to climate change. HBRC is investing heavily in a Regional Water Security programme and the government has committed substantial additional finance from the Provincial Growth Fund to support this programme. Options currently being investigated for Central Hawke's Bay include managed aquifer recharge and small- to medium-scale out-of-stream water storage.

As part of the Regional Water Security programme, an airborne 3D aquifer survey was flown in February 2020. 3D aquifer mapping and knowledge gained from the survey will deliver a far greater understanding of the Ruataniwha groundwater system so that the resource can continue to be managed sustainably into the future.

HBRC is also developing sophisticated computer models to simulate the benefits and effects of various water management scenarios for Central Hawke's Bay. The numerical models have very similar features and architecture to those developed for the Heretaunga aquifer system (see section 3.2) and will enable water resource management decisions to be made with greater confidence in outcomes.

While limiting allocation from the Ruataniwha aquifer system will prevent further environmental effects from groundwater abstraction, the Regional Water Security programme will enable better outcomes from the limited resource that is available.

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4.3 Surface water flows

A range of summary river flow statistics were calculated for the Tukituki and Southern Coastal catchments for the hydrological years[10] 2013-2014 through to 2017-2018 and for the available long-term record. The locations of State of the Environment river flow sites in Hawke's Bay are shown in Figure 4-29.

Figure 4-29: Locations of Hawke's Bay SoE river flow monitoring sites.

[10] A hydrological year is from July to June. Hydrological years are used to avoid splitting summer low flow events, which commonly occurs when calendar years are used for analysis.

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Plots of monthly mean flows for these rivers identify seasonal variation for each year between 2013 and 2018; compared with long term averages, long term range (maxima and minima), and normal flow ranges (± 25% of the long-term mean).

While annual mean flows for the Tukituki and Southern Hawke's Bay catchments were mostly within the normal range, monthly mean flows for several sites were lower than average during summer periods. For example, during summer periods between 2013 and 2018, monthly mean flows in the Tukituki at Red Bridge were often below the normal range for that time of year (Figure 4-30).

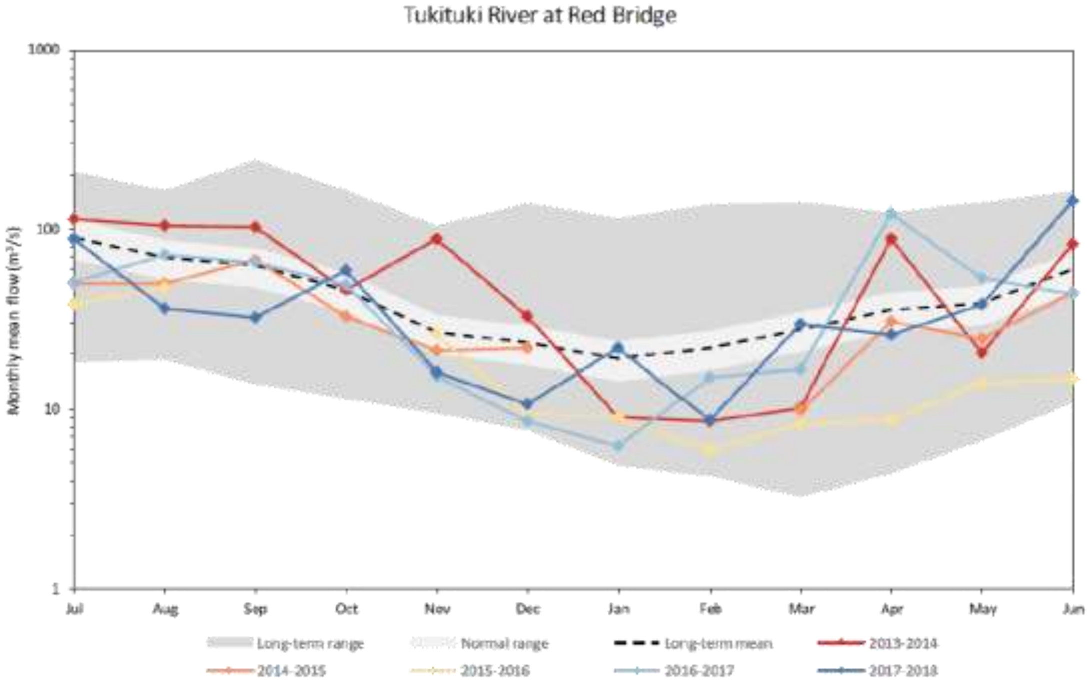

Figure 4-30: Tukituki River at Red Bridge monthly mean flow (2013-2014 to 2017-2018). Flows are shown with the long-term mean, long-term range and normal range (1968-2018). Note the y-axis has a logarithmic scale.

A similar phenomenon was observed in the Taurekaitai Stream at Wallingford during summer periods, with few occasions when flows approached normal monthly means for January to March (Figure 4-31).

As discussed in section 1.1, summer rainfall across the region was typically normal or below normal for the five year reporting period, which featured an El Niño summer in 2015-16. The reporting period ended with a La Niña summer (2017-18), which is the one year in most of these river flow graphs that had summer rainfall greater than the median.

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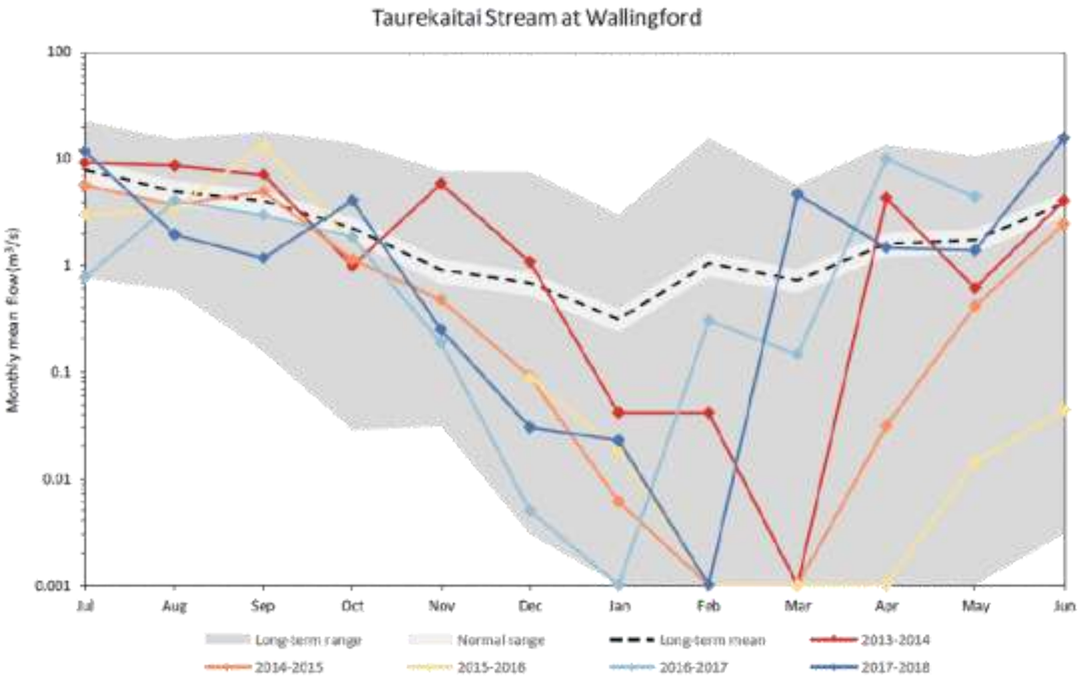

Figure 4-31: Taurekaitai Stream at Wallingford monthly mean flow (2013-2014 to 2017-2018). Flows are shown with the long-term mean, long-term range and normal range (1980-2018). Note the y-axis has a logarithmic scale.

To explore large-scale climate patterns, some data standardisation was adopted. To better compare across sites, flow at each site was divided by its long-term mean flow. So, regardless of the size of the catchment, flow in an average period would have a value about 1, and greater than 1 in a wet period. The sites can then all be over-plotted without the biggest rivers dominating the plot. The next step was generating 5-year moving average annual low flows, to filter out short-term variability resulting from localised rain events.

The IPO Tripole (Interdecadal Pacific Oscillation Tripole index) was selected as an indicator of large-scale climate patterns and over-plotted with annual low river flows for a range of Hawke's Bay rivers and streams (Figure 4-32). The peaks and troughs do not always coincide, and this mismatch could result from stochastic processes, a lagged response, or a more complex response than a simple linear relationship of flow with the IPO. There tends to be more scatter in low-flow data, which makes the climate pattern more obscure.

However, the IPO phase has been predominantly neutral post 2012, and this was associated with below-normal annual low flows at most sites (Figure 4-32). Therefore it is plausible that the low summer flows observed from 2013 to 2018 are a consequence of large-scale climate drivers.

While our rivers are vulnerable to climatic variability, HBRC is investing heavily in a Regional Water Security programme and the government has committed substantial additional finance from the Provincial Growth Fund to support this programme. As discussed in section 4.2, options currently being investigated for the Tukituki catchment include managed aquifer recharge and small-scale to medium-scale out-of-stream water storage, to deliver environmental outcomes and resilient water supplies for current and future climatic conditions

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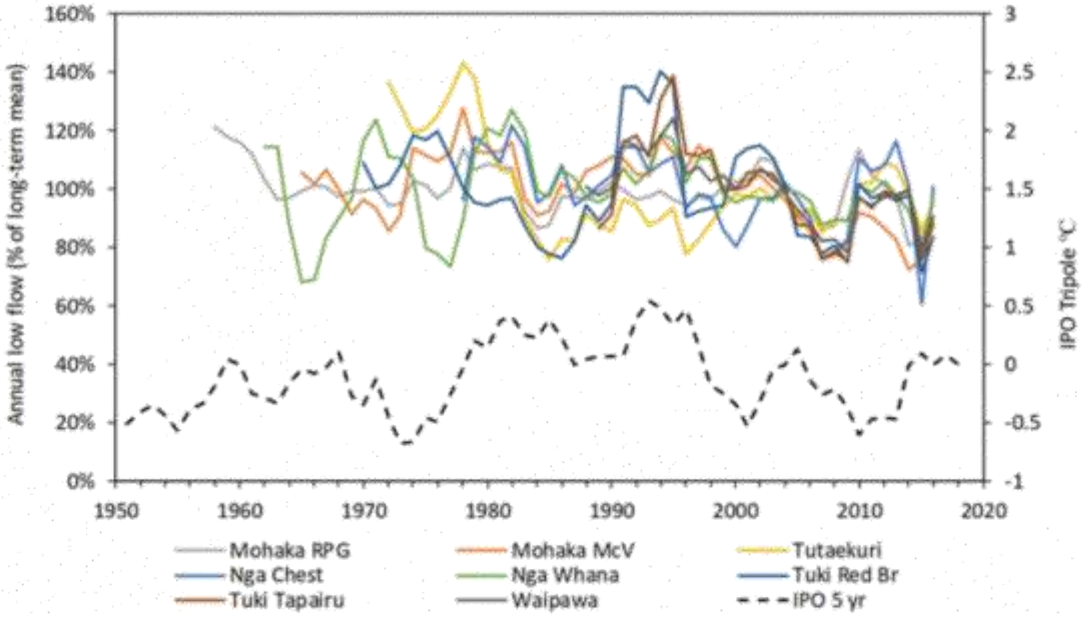
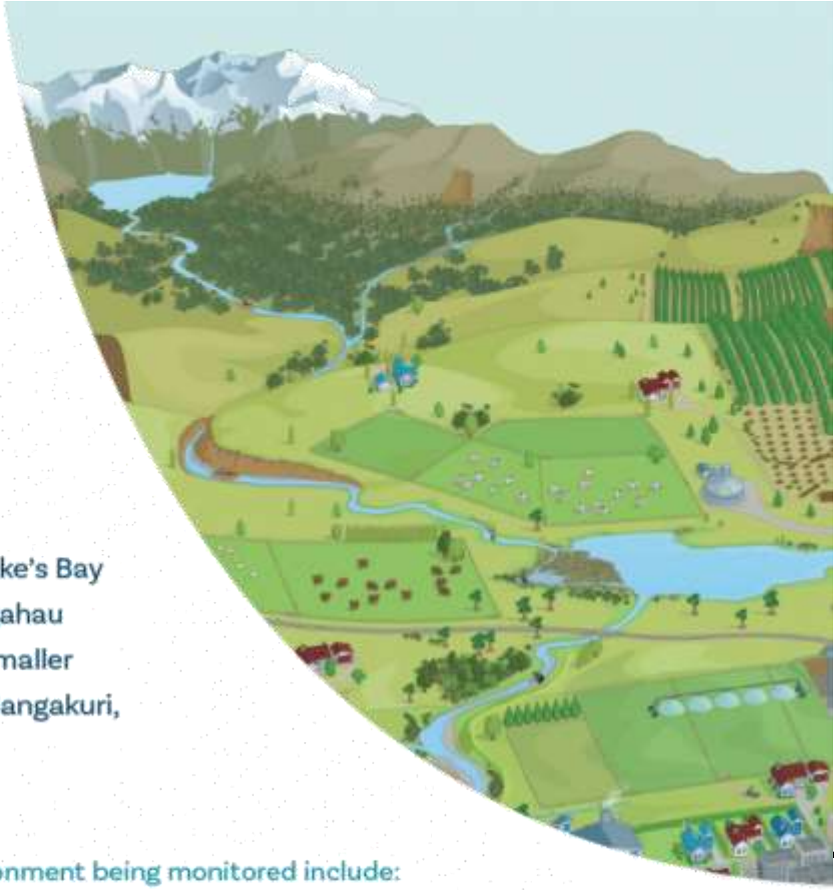


Figure 4-32: Long-term patterns in river flow compared with the Interdecadal Pacific Oscillation Tripole index (IPO Tripole). Flows are a 5-year moving average of 7-day annual low flow time series' for many Hawke's Bay rivers and streams. Flows are standardized by the long-term mean for each site so rivers of different size can be compared directly. Climate drivers are compared using the dashed black line (right Y-axis), which represents the 5-year moving average IPO Tripole.

SOUTHERN CATCHMENTS

SUMMARY (2013-2018)



The Southern sub-region of Hawke's Bay includes the Tukituki and Pōrangahau catchments, as well as several smaller coastal catchments, including Mangakuri, Pouhokio and the Maraetotara.

Key aspects of the Southern environment being monitored include:

- Groundwater quality
- Surface water (river, stream & lake) quality
- Surface water flows (hydrology)
- Marine & coastal environments

Land use

Many key environmental issues in Hawke's Bay are a consequence of land use that contributes to erosion and discharge of nutrients to waterways. The main land use type in the Southern subregion is sheep and beef, accounting for approximately 62% of the total area. There are also approximately 23,838 ha of beef farming, 23,076 ha of indigenous forest and 18,425 ha of exotic forest identified in this area.

Groundwater quality

One of the region's major productive groundwater resources is the Ruataniwha aquifer. This system influences the hydrology and water quality of streams and rivers in the Ruataniwha Plains, as well as the middle and lower reaches of the Tukituki River. Ruataniwha groundwater quality is generally good, although some areas are affected by micro-organisms, nitrates and naturally-occurring heavy metals.

Key findings from Hawke's Bay Regional Council groundwater monitoring include:

1. *E. coli*, a faecal indicator species, is commonly detected in unconfined groundwater less than 30m below ground. This is not unexpected since the Drinking Water Standards of New Zealand (DWSNZ) regard shallow groundwater as equivalent to surface water. Ministry of Health guidelines suggest that surface water is frequently contaminated by micro-organisms. However, the detection of *E. coli* demonstrates the vulnerability of shallow, unconfined groundwater systems to pathogenic contamination. Private bore owners should have their groundwater tested if it is used as drinking water.

2. High nitrate concentrations are generally a consequence of intensive farming and the

SOUTHERN CATCHMENTS SUMMARY

application of fertilisers. The national drinking water standard for nitrate was exceeded at one monitoring site in the Ruataniwha Basin. The shallow well (16m below ground) is located near a large dairy farming operation and this the most likely source of nitrates. There is no evidence to suggest that nitrates are still increasing at most sites in the sub-region through time.

3. Pesticides are not present in any of the shallow groundwater wells that were sampled. This is consistent with previous surveys undertaken in 2010 and 2015.
4. Some of the deeper wells have high levels of naturally-occurring manganese. Some also have arsenic levels greater than the DWSNZ maximum acceptable value for long term consumption. This arsenic and manganese is a result of naturally-occurring processes, not human activities. As concentrations can vary widely over small distances, it is again important that private bore owners have all potable supplies of groundwater tested.

Groundwater levels

Groundwater use in Hawke's Bay has steadily increased over the last 30-40 years. As a result, groundwater levels in the major Hawke's Bay aquifer systems have declined slowly over the same period, with the greatest reduction in areas of the Ruataniwha Plains. Groundwater abstraction has affected flows in connected rivers and streams.

To address declining groundwater levels and associated effects on waterways, the Tukituki Plan has limited groundwater abstraction with no further allocation of the resource since the plan change became operative in 2015. Hawke's Bay Regional Council is also working with local community leaders to identify and implement solutions to manage the effects of groundwater abstraction and build resilience of water supplies to climate change.

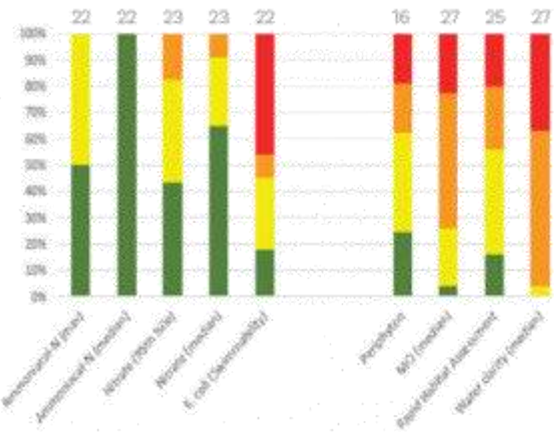
While limiting allocation from the Ruataniwha aquifer system will prevent further environmental degradation from groundwater abstraction, the Regional Water Security programme will enable better outcomes from the limited resource that is available. This programme includes sophisticated 3D aquifer mapping and computer models to deliver a greater understanding of the Ruataniwha groundwater system so that the resource can be managed sustainably into the future.

River and stream water quality

Signs of degraded water quality include high levels of nutrients such as nitrogen and phosphorus, the excessive growth of aquatic plants or algae, a reduction in macroinvertebrate diversity, a reduction in water clarity due to higher levels of suspended sediments, and high levels of faecal contamination.

A summary of key water quality metrics for the Southern subregion is shown below. This plot identifies the percentage of SoE monitoring sites that fall within different categories for each metric.

Summary of freshwater quality state for rivers and streams of the Southern Subregion: 2013-2018.



Bars on the left are applicable to the NOF bands, with colours:

- = band A
- = band B
- = band C
- = band D

Bars on the right do not have NOF bands, so general categories apply to colours:

- = Excellent
- = Good
- = Fair
- = Poor

The number at top of each bar identifies the number of sites in the analysis.

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Riparian zone near Tukituki

Sites along the Tukituki River also have very elevated sediment concentrations during floods, likely due to erosion from pastoral hill country and agricultural activities on the Ruataniwha Plains.

Tukituki Catchment

Most intensive land use in the Tukituki catchment is focused around the Ruataniwha Plains area. This is reflected in water quality, which generally declines from the mountain headwaters to the coast.

Measures of inorganic nitrogen and phosphorus are highest in the Ruataniwha Plains tributaries. Many monitoring sites with the majority of their water sourced from the Ruataniwha Plains, or immediately downstream of this influence, exceed current nutrient target levels. Similarly, Macroinvertebrate Community Index (MCI) scores in the Tukituki catchment decrease with distance from the mountains. The Papanui and Mangatarata Streams had the lowest MCI scores: both are affected by a lack of riparian shading and excessive macrophyte growth.

The high nutrient levels in the Ruataniwha Plains area have led to excessive algal growth downstream, particularly in the Tukituki River between Waipawa and the coast. Low flows and hot summers may mean the Tukituki River will always experience some periods of extensive algal growth, but reducing nitrogen and phosphorus may help to decrease the magnitude of this problem in the future.

Sites along the Tukituki River also have very elevated sediment concentrations during floods, likely due to erosion from pastoral hill country and agricultural activities on the Ruataniwha Plains.

Three sites in the Tukituki catchment, including the popular Red Bridge swimming area, also had high levels of *E. coli*, indicating faecal contamination that makes these areas unsuitable for swimming at times. However, there is no evidence that swimmability is deteriorating at any of the sites in the catchment. Improvements are expected as a consequence of stock exclusion from rivers and streams.

Pōrangahau and southern coastal catchments

Land use in both the Pōrangahau and Southern Coastal catchments is predominantly sheep and beef farming, with scattered settlements along the coast. Sites monitored here generally have issues associated with land erosion, agricultural runoff and unrestricted stock access.

At all sites, nitrate and ammoniacal-nitrogen concentrations are within the accepted limits to protect 95% of aquatic species from the toxic effects of nitrogen. However, all monitoring sites in these catchments have relatively low MCI scores. Most scores indicate 'poor' or 'fair' water quality. Pōrangahau catchment sites all have 'poor' MCI scores (<80), which is probably due to excessive algal growth and sedimentation of the river bed. Current

SOUTHERN CATCHMENTS SUMMARY

efforts to fence and plant riparian areas in these catchments will improve stream health over time.

Water clarity in the Pōrangahau and Southern Coastal catchments is also generally poor. *E. coli* concentrations are relatively high, making swimming unsuitable at all sites except for the Maraetotara River at Waimarama Road. Faecal source tracking may be used to determine the source of this contamination, e.g. ruminant, avian or human, and guide management decisions such as stream bank enhancement.

River and stream flows

While annual mean flows for the Tukituki and Southern Hawke's Bay catchments are mostly in the normal range, monthly mean flows for several sites were lower than average during summer periods. It is plausible that the low summer flows observed are a consequence of large-scale climate drivers of rainfall over time.

While our rivers are vulnerable to climatic variability, the Regional Water Security programme is investigating options such as managed aquifer recharge and small to medium scale out-of-stream water storage to help improve environmental outcomes and increase resilience of water supplies.

Marine and coastal water quality

In Hawke's Bay, large river systems transport contaminants to coastal inshore waters. Therefore monitoring coastal water quality is required to ensure key ecosystem functions and services remain intact.

Erosion and runoff in the Southern sub-region's waterways has led to high concentrations of sediments and nutrients entering the Tukituki and Pōrangahau Estuaries. Pōrangahau Estuary has the highest suspended sediments measured in the sub-region indicating that, at times, this estuary can be subjected to some of the highest delivery of fine sediments in Hawke's Bay. The composition of deposited sediments in the Pōrangahau and Tukituki estuaries is also problematic - more than 25% is classified as 'mud'. Such high levels of mud contribute to a loss of invertebrate (including shellfish) species, which are necessary to help nutrient cycling and are an important food source for fish, birds and people.

The Regional Council in Waipawa work with Central Hawke's Bay landowners to give support and advice on good land use practices.

Addressing the key issues

To address these key issues, Hawke's Bay Regional Council has invested in an Erosion Control Scheme with a $30 million fund. The scheme incentivises and encourages tree planting, erosion control work on pastoral or retired land, and a riparian programme. Improvements are also expected via land use and nutrient management initiatives that the Regional Council is implementing as part of the Tukituki Plan.

Working with landowners, the Regional Council has received more than 1,000 Farm Environmental Management Plans for the Tukituki catchment and some farms will require resource consents to operate. The Regional Council has invested heavily in catchment advisor relationships with landowners and there is also a regulatory requirement to monitor and manage landowner compliance. The Regional Council has a team of five based in Waipawa, with staff typically in the field working with Central Hawke's Bay landowners to give support and advice on good land use practices.

Improvements in water quality, aquatic habitats and estuarine environments are expected to occur progressively and continued monitoring is necessary to determine the effectiveness of these efforts over time.

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5 Further Information

The information in this Key Issues Summary report is from a series of State of the Environment technical reports. The technical reports have greater detail of the analyses referred to in this report, along with other environmental phenomena that aren't currently regarded as key issues for resource management in Hawke's Bay.

Readers are encouraged to consult the following technical reports for more details on the state of Hawke's Bay environments. The technical reports also provide lists of further references that informed them.

The following technical reports are available from https://www.hbrc.govt.nz/documents-and-forms/ :

Barber J. (2019) *Groundwater Quality 5-yearly State of the Environment Report*. HBRC technical report number 5396

Fake D. (2020) *Pōrangahau and Southern Coastal Catchments: State and Trends of River Water Quality and Ecology*. HBRC technical report 5442

Fake D. (2020) *Waikari, Aropaoanui, Te Ngarue and Esk Catchments: State and Trends of River Water Quality and Ecology*. HBRC technical report number 5441

Haidekker S. and Madarasz-Smith A. (2020) *Ngaruroro, Tūtaekurī, Karamū River and Ahuriri Estuary Catchments - State and Trends of River Water Quality and Ecology*. HBRC technical report number 5422

Harper S. (2020) *State of the Environment 5-yearly Report: Groundwater Level Trends and Patterns (1989-2018)*. HBRC technical report number 5399

Hicks A. (2020) *Tukituki Catchment State and Trends of River Water Quality 2013-2018*. HBRC technical report number 5423

Hicks A. and Kozyniak K. (2020) *Tūtira Lakes Water Quality: July 2008 - June 2018*. HBRC technical report number 5395

Kozyniak K. (2019) Air Quality State of the Environment 2014-2018. HBRC technical report number 5415

Madarasz-Smith A. and Shanahan B. (2020) *State of the Hawke's Bay Coastal Marine Environment: 2013 to 2018*. HBRC technical report number 5403

Madarasz-Smith A., Shanahan B., and Ellmers J. (2019) *Recreation Water Quality in Hawke's Bay – State of the Environment: 2013 – 2018.* HBRC technical report number 5403

Norris T. (2019) *Sediment Monitoring Using Automatic ISCO Samplers for State of the Environment Reporting in Hawke's Bay*. HBRC technical report number 5398

Rushworth G. (2020) *Mohaka River Catchment - State and Trends of River Water Quality and Ecology*. HBRC technical report number 5434

Rushworth G. (2020) *Wairoa and Northern Coastal Catchments: State and Trends of River Water Quality and Ecology*. HBRC technical report 5443

Waldron R., Kozyniak K. and Wilding T. (2019) *Hawke's Bay Rainfall and River Flow 2013-2018 - State of the Environment Technical Report*. HBRC technical report number 5418

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6 Acknowledgements

This report would not be possible without the enthusiasm and dedication of the HBRC Environmental Information section who measure, record and manage large volumes of environmental data.

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7 Glossary of abbreviations and terms

Abstraction	the act of taking water from a water body such as an aquifer, river or stream
Airshed	a geographical area where air quality could exceed national air quality standards. These areas are identified based on existing air quality data and factors that affect the spread of pollution such as local geography and weather
Aquifer	an underground layer of water-bearing rock or sediment
Attribute	in the context of the National Policy Statement for Freshwater Management, an attribute is any measurable characteristic of fresh water (including physical, chemical and biological properties) which supports particular values. Examples include total nitrogen, nitrate toxicity and periphyton cover
Bore	a hole that is drilled into the ground for the purposes of extracting groundwater, monitoring groundwater levels, or monitoring groundwater quality
Catchment	an area bounded by natural features such as hills or mountains from which surface and sub-surface water flows into streams, rivers, lakes and wetlands
Chlorophyll *a*	a pigment present in most algae and plant species that is crucial for photosynthesis. Chlorophyll *a* provides a surrogate measure of biomass or rate of growth of species such as periphyton
Climate	average weather conditions over a long period (generally 30 years or more)
Climate Change	the change in climate over relatively long periods due to a combination of natural and human causes
Cyanobacteria	also known as blue-green bacteria, blue-green algae, and Cyanophyta, these are bacteria-like organisms that obtain their energy through photosynthesis
Drinking Water Standards of New Zealand (DWSNZ)	most recently revised in 2018, the DWSNZ specifies the maximum amounts of substances, organisms or contaminants in drinking water, to provide safety for human consumption. See also – **MAV**
Drought	prolonged periods of below-average precipitation, resulting in water shortage, which can last for weeks, months or even years
DWSNZ	see Drinking Water Standards of New Zealand
Ecology	the study of how organisms interact with one another and their physical environment
Erosion	process by which earth and soil is worn away by the action of water, wind, river flow or other elements
***Escherichia coli* (*E. coli*)**	a type of faecal bacteria commonly found in the intestines of humans, other warm-blooded mammals and birds, and is normally excreted in their waste. *E. coli* is commonly used as an indicator bacteria to identify the likely presence of disease causing organisms that occur in faecal material

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Farm Environmental Management Plan (FEMP)	a plan that summarises the potential environmental risks in a farming operation, and describes how these risks will be managed and reduced over time
Freshwater	naturally occurring water that includes ice, glaciers, lakes, rivers streams and groundwater, but excludes seawater or brackish water
Geology	the study of earth, the rocks of which it is composed, and the processes by which it forms
HBRC	Hawke's Bay Regional Council
Headwaters	the upper reaches of a river close to or forming part of its source
Highly Erodible Land (HEL)	land classified as having moderate to severe risk of erosion due to landslide, earthflow or gully erosion
Hill country	country side that predominantly consists of hills for grazing, rather than flat areas
Hydrology	the study of earth's water and its movement, particularly in relation to land
Macroinvertebrate	aquatic animals such as insects, worms and snails
Macroinvertebrate Community Index (MCI)	an index that provides us with information on water quality based on the number and type of macroinvertebrates found at a site. It is calculated by assigning a score to aquatic species depending on their tolerance to organic enrichment
MAV	In the Drinking Water Standards of New Zealand, the Maximum Acceptable Value (MAV) of a determinand in drinking-water represents the concentration of a determinand which, on the basis of present knowledge, is not considered to cause any significant risk to the health of the consumer over a lifetime of consumption of the water
Mean	often referred to as the "average", the arithmetic mean is the central value of a discrete set of numbers, calculated as the sum of the values divided by the number of values
Median	another statistic to describe central tendency, the median is the middle number in a set of numbers ranked from highest to lowest. When extreme events or observations skew the mean, the median is often used as the measure of central tendency
MfE	the Ministry for the Environment
Minimum flow	in relation to surface water allocation, this is the measured flow in the river at which nonessential abstractions must cease
Model	a representation of a process or system used to describe complex data and relationships
MoH	the Ministry of Health
National bottom line	Under the National Policy Statement for Freshwater Management (proposed 2019) this is defined as the minimum acceptable attribute state for specified compulsory values

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National Objectives Framework (NOF)	a framework in the NPS-FM that directs the process councils must use to set freshwater objectives (using attributes), to provide for the values that are held for water bodies in a region. Objectives must, as a minimum, be set for two compulsory values: ecosystem health and human health for recreation. Some national bottom lines were introduced for the compulsory values and regional objectives must be set above the national bottom lines
National Policy Statement (NPS)	policy documents that set out objectives and policies for matters of national significance, such as freshwater management, coastal policy, and indigenous biodiversity (the latter is in development)
Natural resource	materials or substances occurring in nature, such as air, land and water, which can be used for human benefit.
NOF	see National Objectives Framework
Non-regulatory	non-legislated approaches to environmental management
NPS-FM	the National Policy Statement for Freshwater Management, first introduced in 2011 and subsequently amended in 2014 and 2017. This report refers to the NPS-FM proposed in 2019 as part of the government's Essential Freshwater package of reforms for freshwater management. The NPS-FM requires maintenance and improvement of water quality through establishment of "bottom lines" and "bands" for the management of water quality and ecosystem health attributes, along with allocation objectives for both water quality and quantity
Parameter (or variable)	refers to a physical, chemical or biological measure, such as temperature, dissolved oxygen or nitrogen
Particulate Matter (PM)	liquids and solid particles found in the air
Pathogen	a bacterium, virus, or other microorganism that can cause disease
Periphyton	the collective of diatoms, fungi and algae found on the beds of rivers and streams
Plan Change	a variation to the RRMP. In this report, plan changes usually apply to specific subregional areas or catchments
PM_{10}	a measure of air quality, PM_{10} is particulate matter that is less than 10 microns in diameter. Known to cause human health effects and premature death
$PM_{2.5}$	a measure of air quality, $PM_{2.5}$ is very fine particulate matter that is less than 2.5 microns in diameter. Known to cause human health effects and premature death, but is small enough to get deeper into lungs than PM_{10}
Point-source discharge	a discharge that can be attributed to a specific outlet such as a pipe or drain and can be sampled for physical, chemical and biological components
Precipitation	a component of the water cycle that distributes fresh water on the plant. Types of precipitation include rainfall, snow, hail and sleet

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Regional Resource Management Plan (RRMP)	Hawke's Bay Regional Council's combined resource management plan and policy statement. It sets out policies and rules around the way in which we interact with our natural environment in order to balance the need to use natural resources for cultural, economic and social wellbeing while keeping the environment in good health
Regulatory	comprising rules and requirements, such as standards and practices, associated with environmental management many of which are established through legislation
Resource Management Act (RMA)	New Zealand's main piece of legislation which sets out how we should manage our environment
Riparian	the area alongside waterways that acts as a margin between land and water
River catchment	all the land from the mountains to the sea that is drained by a single river and its tributaries
RRMP	see Regional Resource Management Plan
Sediment	soil or other fine-grained weathered rock
SedNetNZ	a model developed by Manaaki Whenua – Landcare Research that provides sediment budgets and predicts sediment supply from erosion
State	the average condition of an environmental variable for a given period of time. For water quality indicators this is often the average concentration over five, ten or twenty years
Statistically significant trend	a trend that is statistically significant has no more than 5% chance of occuring due to random distribution of samples
Substrate	the surface or material on or from which an organism lives, grows, or obtains its nourishment. Including stones, rocks, gravel, logs and sediment on the river bed that provide a home for fish and insects
Surface water	water that collects on or moves across land, for example streams, rivers, lakes and wetlands
Telemetry	an automated means of returning environmental monitoring or water use data to HBRC via radio or cell-phone networks
Trend	a pattern determined by the statistical analysis of a data series, often representing change over time
Tributary	a stream that flows into a larger stream or body of water
Trigger value	in relation to surface water allocation, this is the measured flow in the river at which some form of action is required to be taken. For water quality, it is the parameter measure that triggers some form of action. Examples of actions include (but not limited to): further investigation; augmentation of river flow; abstraction ceases; or abstraction is limited

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Trophic State	the trophic state of a water body is the amount of living material (biomass) that it supports. Healthy freshwater ecosystems have low (oligotrophic) to intermediate (mesotrophic) levels of living material and primary production (growth of plants or algae). High levels of nutrients, primarily nitrogen (nitrate) and phosphorus (phosphate), can cause water bodies to become eutrophic. Eutrophic states are commonly associated with poor ecosystem health due to adverse fluctuations in dissolved oxygen and pH, smothering of habitat and alteration of ecological community composition
Water take	the abstraction of water from a waterbody for use
Well	a hole that is dug, drilled, or otherwise excavated into the ground for the purposes of extracting groundwater, monitoring groundwater levels, or monitoring groundwater quality