Mahere Whakamārama mo te Kohinga Wai o Waimatā-Pakarae

Waimatā - Pakarae Catchment Plan Background Document

JUNE 2022

CONTENTS

INTRODUCTION
HE KUPU ARATAKI

This background document provides a snapshot of the Waimatā-Pakarae Catchment Plan area and its sub-catchments, their values and status relating to water quality and ecological health.

The document provides a starting point for understanding the catchment area and a context to discussions on the setting of future freshwater objectives and associated limits.

These discussions will support the development of the Waimatā-Pakarae Catchment Plan.

The catchment plan is being developed under the National Policy Statement for Freshwater Management 2020 (NPS-FM) and the Tairawhiti Resource Management Plan (TRMP). These documents set the high-level direction for Council to manage land and water resources.

Some of the key terminology from the NPS-FM is attached as Appendix 1.

WHAT IS A CATCHMENT PLAN?

A catchment plan is a tool that focuses on managing freshwater and landuses at a catchment scale. Catchment plans provide a way to:

- identify and understand the freshwater values relevant to the catchment area,
- set a vision for how we want to see the catchment area in the future, and
- outline the requirements and actions needed for achieving that vision.

The Waimatā – Pakarae Catchment Plan will provide a pathway for managing freshwater quality and quantity into the future. This pathway will be set in conjunction with tangata whenua, stakeholders and the community and will help Council make better decisions about land and water use within this area.

WHERE DOES THE WAIMATĀ AREA CATCHMENT PLAN APPLY?

The Waimatā-Pakarae Catchment Plan area represents eight freshwater catchments that flow to the eastern coastline from Gisborne city at its southern extent to Waihau Bay just south of Tolaga Bay (Figure 1). These catchments include:

- the Waimatā River which is located directly north of Gisborne City,
- the Pakarae River which is located south of Tolaga Bay,
- several smaller catchments located along the coastal margin between the Pakarae River and Gisborne City. These catchments include the Waiomoko River, Pouawa River, Hamanatua Stream, Wainui Stream and Kopuawhakapata Stream .

Their combined total area is 650km^2. The two largest are the Waimatā (227km2) and the Pakarae (243km^2).

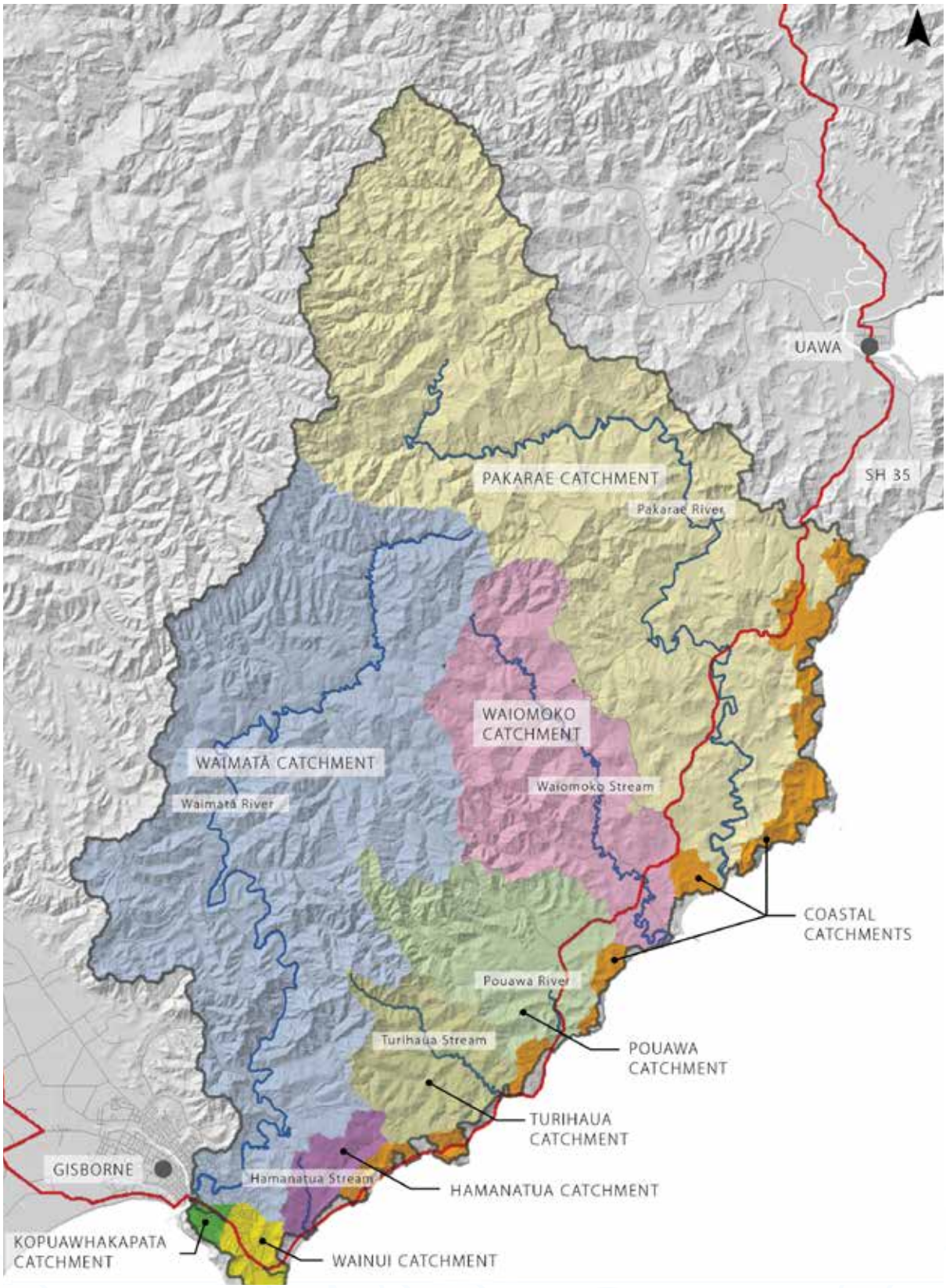
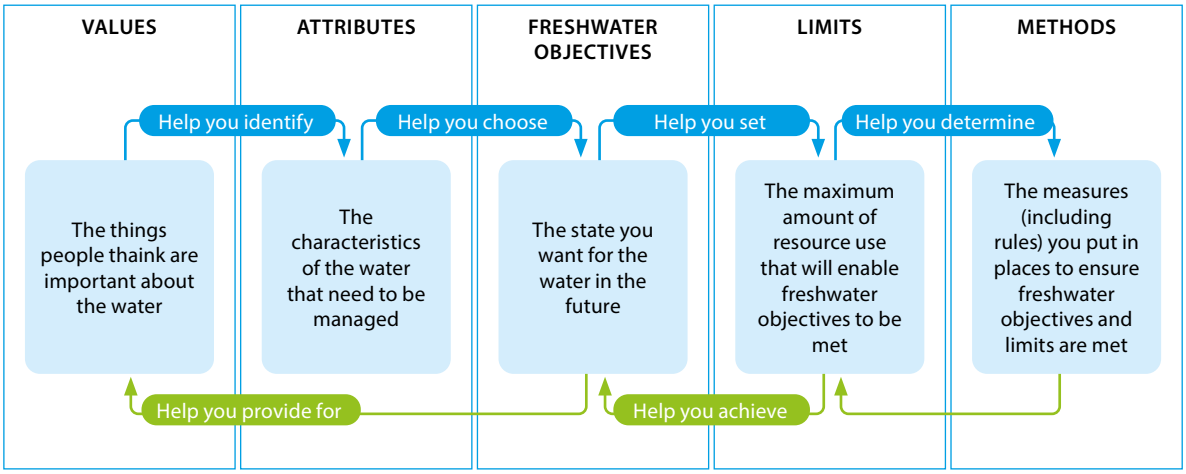


Figure 1: Waimatā-Pararae Catchment Area

WHAT'S REQUIRED IN A CATCHMENT PLAN?

Catchment plans identify the freshwater values objectives, limits and targets that apply to waterways (or groups of waterways) within each catchment area. They will also set out any action plans and projects to achieve the objectives, limits and targets.

The NPS-FM provides a framework that must be followed to achieve this - the National Objectives Framework (NOF). It is intended to be a nationally consistent approach to setting freshwater objectives, with flexibility to recognise and provide for local circumstances.



The following summarises the steps required to meet the NOF:

- Identify Freshwater Management Units (FMU) – whether and how we split up the Catchment Plan area for management;
- Within each FMU identify:
  - monitoring sites
  - swimming sites
  - locations of habitats of threatened species
  - outstanding waterbodies
  - natural wetlands
  - freshwater values for each FMU (e.g. ecosystem health, human contact, threatened species, mahinga kai, fishing, animal drinking water).
- Set environmental outcomes and objectives for each value
- Identify water quality attributes for each value
- Identify the baseline states for each attribute
- Set target states for attributes
- Set target states for environmental flows and water levels
- Set limits for water quality attributes
- Develop Action Plans to achieve the environmental outcomes.

The NPS-FM also requires that long-term visions are developed for each catchment. This includes:

- Setting ambitious but achievable goals
- Identifying a timeframe to achieve those goals
- Identifying how to give effect to Te Mana o Te Wai
- Identifying any Māori freshwater values that apply.

NATIONAL REGULATIONS

In September 2020, the Resource Management (National Environmental Standards for Freshwater) Regulations and the Resource Management (Stock Exclusion) Regulations were introduced. The new regulations cover a range of activities that may relate to the Waimatā – Pakarae Catchment Plan area including standards for dairy farming, winter intensive grazing, stock exclusion, natural wetlands and culverts. The impacts of these new regulations and standards will be considered as we move through the process.

COMMUNITY INPUT

The Waimatā -Pakarae Catchment Plan will provide a way to assist in meeting Council's obligations under the NPS-FM.

The Council will use a range of ways to seek community views during the development of the catchment plan. This will include engaging with tangata whenua, utilising existing community groups or establishing community groups where neccesary, and working with a stakeholder advisory group through the detailed development of the catchment plan. The project enable everyone to input their thoughts and ideas into the development of the plan.

There are many different catchment groups working throughout New Zealand. Regional Councils are engaging communities and iwi in the planning process as a way to manage multiple interests and increasing demands on fresh water. A more collaborative approach emphasises the sharing of knowledge and working together at the front end of the planning process.

TIMELINE

May – November 2022

- **Engagement with tangata whenua**
- **Catchment group hui**
- **Stakeholder consultation**

May – June 2022

- **Urban drop in sessions**

November - December 2022

- **Final draft catchment plan and s32 report**

DESCRIPTION AND KEY VALUES
HE WHAKAMĀRAMA ME NGĀ UARATANGA MATUA

CATCHMENT CONTEXT

Several iwi and hapu rohe intersect and overlap in the Waimatā area, including Ngāti Porou, Ngāti Oneone, Rongowhakaata, Te Aitanga-ā-Māhaki and Te Aitanga-ā-Hauiti. These tribes often used the Taruheru, Tūranganui and Waimatā Rivers as boundaries[1].

The Waimatā River also served as an inland highway linking Tūranga to the East Coast, especially Whāngārā and Uawa. Those who lived on the North, West and East Waimatā blocks had close relationships with Ngāti Konohi at Whāngārā and Te Aitanga-ā-Hauiti at Uawa. It was also used as an escape route during the inter-iwi wars from 1700-1800, and the upper reaches of the river served as a refuge[2].

The coastal margin was well settled and provided access to forest and freshwater resources as well as kaimoana. The higher slopes of the rugged hills provided forest resources of timber, fruits, kiekie (***Freycinetia banksii***) for weaving and birds and invertebrates for food. The waterways provided eeling grounds and, where slightly swampier ground existed, sources of flax/harakeke (***Phormium tenax*** and ***Phormium cookianum***) and raupō (***Typha orientalis***) used for making fishing nets, baskets and many other necessary items[1,3].

The geology of the Waimatā-Pakarae catchment area is mainly mudstone, with small pockets of sandstone and melange (a mixture of marine sediments, fragments and blocks of various rock types embedded in a fine grain material). In some places, the catchment has interesting geological features that include mud volcanoes, which are upwellings of fine bentonite material. Most of the catchment area is classified as having a warm-wet climate[4] . The area has a mean annual temperature of over 12°C and mean annual rainfall between 500-1500mm.

Historic landcover[5] was predominantly Tawa (***Beilschmiedia tawa***), Kohekohe (***Didymocheton spectabilis***), Titoki (***Alectryon excelsus***) and Podocarp (***Podocarpaceae sp.***) forest.

The coastal margins of the catchment area included Titoki, Kohekohe and Ngaio (***Myoporum sp.***) and throughout the catchment there were fragmented areas of Kahikatea (***Dacrycarpus dacrydioides***) and Pukatea (***Laurelia novae-zelandiae***), with Puriri (***Vitex lucens***) and Totara (***Podocarpus totara***) along river margins.

There are now few remaining indigenous forest remnants and many of these are recorded as Protected Management Areas (PMAs) or protected under QEII covenant and DOC estate reserves. Appendix 2 shows the key natural values in the area. Current landuses are predominantly pastoral with large forestry blocks within the Waimatā and Pakarae catchments and the upper Waimoko and Pouawa catchments.

1 Reeve, M. (2015) A place belonging to the heart: Spatially and temporally changing social connections to the Waimatā River and its tributaries. Te Awaroa report No.4.

2 Salmond, A. Phillips, C. (2015) Native Land Court Record of Blocks on the Waimatā River, Gisborne. Te Awaroa report No.2

3 Salmond, A. (2018) Biodiversity in the Waimatā River catchment. Te Awaroa: Restoring 1000 Rivers. Te Awaroa report No.4

4 Based on the NIWA River Environment Classification (REC), a database with spatial attributes summarised for river segments across the country.

5 based off Singers and Lawrence (2016) map of the predicted pre-human ecosystems of the Gisborne District. Appendix 2.2 shows the historic landcover for the catchment area.

The Tairawhiti Resource Management Plan (TRMP) identifies land overlays that broadly reflect the landscape's susceptibility to erosion. The land overlays are an amalgamation of land use capability (LUC) units and take into consideration geology, soil type, steepness, climate and vegetation cover. Land overlay 1 is land least likely to erode, followed by land overlay 2 and land overlay 3 being more susceptible to erosion. Land overlay 3a is the most erosion prone land in the country.

The Waimatā catchment area mainly comprises land overlay 3, with some areas of land overlay 3a. This reflects the area's vulnerability to erosion. Appendix 2 shows the land overlay areas for the Waimatā area.

WAIMATĀ RIVER CATCHMENT

The Waimatā River catchment is 24,336 hectares (ha) in area and has a maximum elevation of 590 metres. The catchment is located directly north of Gisborne city. The Waimatā River flows southward into the city where it converges with the Taruheru River, forming the 1200m long Turanganui River which flows past Eastland Port before entering Poverty Bay.

The landscape is composed of high, steep-sided v-shaped valleys that grade to low relief steep terrain and then into lowland hills.

Major tributaries of the Waimatā River include the Makahakaha Stream, Kokakonui Stream, Te Pahi Stream, Horoweka Stream, Whainukota Stream, Mangaehu Stream, Mangaorangi Stream, Waewaetapahia Stream.

Land use

The dominant land use in the catchment is extensive sheep and beef farming (49% of land area), with one intensive cattle feedlot. The catchment has large areas of Kānuka - Mānuka shrubland (11% of land area), sections of the river have fragmented indigenous riparian vegetation (6% of land area) and there is approximately 6,123 ha (30% of land area) of exotic forest located predominantly in the catchment headwaters and in a concentrated area in the centre of the catchment.

The river flows through residential area at the very bottom end of the catchment (1% of land area).

The land use and vegetation types of the catchment are shown in Appendix 2.

Freshwater Ecology

Known freshwater species in the Waimatā River catchment include:

- At Risk – Declining; torrent fish (Cheimarrichthys foster), longfin eel (Anguilla dieffenbachii), bluegill bully (Gobiomorphus hubbs), inanga (Galaxias maculatus) and freshwater mussel (Kakahi; Echyridella menziesii)
- Not threatened; Shortfin eel (Anguilla australis), common bully (Gobiomorphus cotidianus), redfin bully (Gobiomorphus huttoni) cran's bully (Gobiomorphus basalis) and common smelt (Retropinna retropinna).

The connectivity with the marine area also means the river provides habitat for species that live in the intertidal environment.

Catchment Activities

There is currently a Waimatā Catchment Group established for the Waimatā River, and the project aims to achieve conservation, recreation, and community education outcomes in the Waimatā Catchment. The project has included fencing, pest control, monitoring, and planting. The catchment group's goals include the improvement of water quality, recreational values and biodiversity.

KOPUAWHAKAPATA STREAM

The Kopuawhakapata Stream sits within an urbanised catchment that includes the area of Kaiti (population of 3,000 people), and the eastern side of Kaiti hill/ Titirangi (elevation -129m). The stream is two km long and flows through both stormwater drains and pipes (from residential properties and the Eastland Port), and residential areas before it enters the sea at the top end of the Gisborne harbour as a first order stream.

Land Use

The catchment is 191 ha in area, and incorporates a high proportion of impervious surface and residential area (63% of land area) with parks and open space areas (17% of land area) and a mixture of indigenous and scattered exotic vegetation on Kaiti Hill/Titirangi (20% of land area).

Freshwater Ecology

Known freshwater fish species in the Kopuawhakapata catchment include

- At Risk – Declining; longfin eel and inanga and
- Not threatened - Shortfin eel and unidentified bully species.

The Kopuawhakapata Stream is chronically polluted. It regularly has rubbish dumped in it, including household waste, batteries and green waste, which accumulates at the stream mouth before it enters the Harbour. Intensive water quality studies have also been undertaken in this catchment to gain understanding of the sources of contaminants including E.coli and the quality of freshwater habitat.

WAINUI STREAM CATCHMENT

The Wainui Stream starts from stormwater runoff in the urban area of Tamarau and Kaiti, (suburbs of Gisborne City). It covers an area of 595 ha and flows southeast and into the sea at the southern end of Wainui beach as a second order stream. The stream catchment includes the area of Wheatstone Road as well as the Sponge Bay suburb. The highest point in the catchment is 193m which is located up Wheatstone Road. The elevation in the surrounding urban areas is less than 20 m above sea level.

Land Use

The catchment land use is a mixture of urban (32% of land area) and rural (63% of land area), with a combination of horse, sheep and cattle grazing and some fragmented vegetation (5% of land area). The Wainui stream flows through residential backyards, in both the reticulated and unreticulated wastewater areas.

Freshwater Ecology

There are two constructed wetlands in the catchment. One is located in the headwaters of the stream in Tamarau, (the Tamarau Wetland), and was created by the Gisborne District Council to mitigate effects of stormwater and wastewater overflow events. The other wetland is in Sponge Bay which is the drainage area of the Sponge Bay suburb.

Known freshwater species in the Wainui catchment include:

- At Risk – Declining; longfin eel and inanga
- Not threatened - Shortfin eel, cran's bully (Gobiomorphus basalis) and pest fish; mosquito fish (Gambusia affinis).

Intensive water quality studies have been undertaken in this catchment to gain an understanding of the sources of contaminants including E.coli (particularly human sourced E.coli) in both surface water and ground water.

HAMANATUA STREAM CATCHMENT

The Hamanatua Stream is a third order stream that drains an area of 873 ha northwest of Gisborne city.

The stream has its highest elevation at 235m. The stream starts in the hills behind the Okitu settlement and includes the Te Rimu Stream. The Te Rimu Stream flows from the southwest behind the Okitu hills and joins the Hamanatua Stream at Lysnar Road. The stream flows into the sea at the Wainui surf club, where the stream is often blocked by a sand bar and a lagoon is formed at the stream outlet.

Land Use

The catchment includes a mixture of rural (93% of land use) and residential land use (3% of land use) with small areas of fragmented indigenous vegetation (3.5%) and scattered exotic trees. The predominant landuse in the upper catchment is extensive sheep and beef farming, the mid reaches include horse grazing and lifestyle properties, and the lower area of the catchment is residential development with on-site wastewater treatment (septic tanks).

Freshwater Ecology

There are no official records of freshwater fish species for this catchment, however the connectivity and proximity to the sea means it is likely there is a diverse fish community in the stream.

The Hamanatua lagoon is a popular swimming location, and the lagoon often exceeds swimming recreational guidelines for bacteria.

TURIHAUA STREAM CATCHMENT

The Turihaua Catchment is a coastal catchment in soft sedimentary geology that drains an area of 2,606 ha. The catchment's highest point in elevation is 380m, and the stream enters the sea just south of Turihaua point as a fourth order stream. A lagoon is often formed at the stream mouth when the sand blocks the stream outlet.

The lower half of the stream (Turihaua station) has been fenced off, stock has been excluded and a riparian planting programme has been established (and is almost complete).

Land Use

The catchment's main land use is sheep and beef farming (87% of land area) and has fragments of exotic vegetation including mainly pine trees and willow and poplar species (8% of land area) with some scattered indigenous vegetation (5% of land area).

Freshwater Ecology

Known freshwater species in the Turihaua catchment include:

- At Risk – Declining; longfin eel and inanga,
- At Risk – Naturally Uncommon; Giant Bully (Gobiomorphus gobioides)
- Not threatened - Shortfin eel and Cran's bully, Mullet (Mugilidae sp.) and Black flounder (Rhombosolea retiaria).

POUAWA RIVER CATCHMENT

The Pouawa River catchment includes 4,235 ha and covers the area north-west of Pariokonohi point, north of Gisborne. The highest elevation of the catchment is 469m above sea level. The two main tributaries of the Pouawa River are the Tarewarewa Stream and the Tangamatai Stream. The Tarewarewa Stream begins and flows through exotic forest and extensive farmland in the northwest area of the catchment. The Tangamatai Stream flows from the north through extensive agricultural land. The confluence of the two streams forms the Pouawa River, 1.5km before it enters the sea at the southern end of the Te Tapuwae o Rongokako marine reserve.

Land Use

Farmland dominates the catchment land use (69% of land area) and there is 1,074 hectares of exotic forest (25% of land area) which is mainly concentrated in the headwaters of the catchment.

Freshwater Ecology

The Pouawa River is important freshwater habitat for:

- At Risk – Declining; longfin eel, inanga
- Not threatened - Shortfin eel and common bully.

The connectivity with the marine area also means the river provides habitat for species that live in the intertidal environment.

WAIOMOKO RIVER CATCHMENT

The Waiomoko River Catchment includes 7,243 ha in soft sedimentary geology and begins inland of Waihau Bay. The river flows south-eastwards and enters the sea just south of the Whangara settlement. The highest elevation in the catchment is 405m above sea level. The upper areas of the catchment are steep and as the river moves down the catchment the channel becomes incised within a wide floodplain.

The main tributaries of the river include the Wharekiri Stream, Otawaiwai Stream and Wairoa Stream.

Land Use

The catchment land use is predominantly sheep and beef farming (75% of land use), with some deer farming. Exotic forest makes up 18% of the catchment area and is located mainly in the headwaters with some small areas of forest fragmented through the catchment area.

Freshwater Ecology

The Waiomoko River is important freshwater habitat for:

- At Risk – Declining; longfin eel, inanga, bluegill bully
- Not threatened - Shortfin eel, Cran's bully and common bully.

PAKARAE RIVER CATCHMENT

The Pakarae catchment covers an area of 24,336 ha. Its headwaters are inland from Tolaga Bay, and it flows southeast becoming a fifth order river and enters the sea north of Whangara settlement. Main tributaries of the Pakarae River are and the Mangarara Stream and the Mangamohoao Stream, both located in exotic forest, and the Mangapapa Stream and Makatote Stream which flow through farmland.

Land Use

The predominant land use in the catchment is agricultural (58% of land area) extensive sheep and beef farming and deer farming, with exotic forest (28% of land area) concentrated in the headwaters of the catchment and fragmented areas of Kānuka - Mānuka shrubland (5% of land area) scattered throughout the catchment area. Rainfall varies from 2000mm in the headwaters to about 1450mm towards the coast.

Freshwater Ecology

Four regionally significant wetlands are present in the catchment including Rototahi wetland, Waihau Road (a) wetland, Waihau Road (b) wetland and Kings farm wetland.

The Pakarae River is important freshwater habitat for:

- At Risk – Declining; longfin eel
- Not threatened - Shortfin eel, Cran's bully and mullet.

The saltwater wedge and intertidal area of the river extends approximately 3km from the river mouth.

Catchment Activities

A catchment group is currently being established for the catchments including Turihaua, Pouawa, Waiomoko and Pakarae catchments. A steering group has been established which is currently represented by landowners including farmers and forestry companies with discussion being undertaken with Maori landowners and iwi about how the catchment group will be set up and function.

SMALLER COASTAL CATCHMENTS

The coastal catchment includes all the small streams along the coast from the Pakarae catchment to the Hamanatua Stream. This includes a total land area of 2,236 ha; however, each individual catchment has a relatively small catchment area. The catchment has a mixture of land use which is predominantly farmland (88% of land area), with fragmented indigenous vegetation, and exotic trees including pine trees, willow and poplar species. These streams are all first order streams.

HYDROLOGY
MĀTAI AROWAI

Rainfall

Gisborne District Council (GDC) has rain gauges at six sites in the Waimatā area. Two of these sites are located at water quality and quantity sites on the Waimatā River (Goodwins Road Bridge and Monowai Bridge); the other four sites are located at Panikau Road – Reed Road (Pakarae catchment), Paraone Rroad and Wheatsone Road (Wainui catchment), and Tatapouri Hill (small coastal catchments). GDC also manages a rural fire weather station (Pouawa Fire), located in the Turihaua catchment).

The average annual rainfall for the Waimatā area ranges from around 900mm to 1600mm, depending on location.

Water levels & flows

Water level and flow data are available from GDC's sites on the Waimatā River at Monowai Bridge (located in the mid area of the catchment) and at Goodwins Road Bridge (located in the lower catchment). Flow is inferred from water level using rating curves. GDC has a site on the Waimatā River at William Pettie Bridge where only water level data are available.

Summary flow statistics have been calculated for the Waimatā River at Goodwins Road Bridge (Table 1). The data used is from July 1987 to June 2021 (34 years), as the record is nearly complete between these dates. The Mean Annual Low Flow (MALF)[6] has been estimated using hydrological years (July to June), as the low flows are not separated (as they would be in a calendar year).

Table 1. Summary of flow data (m3/s) for the Waimatā River at Goodwins Road bridge monitoring site for the period July 1987 to June 2021

Mean	Median	d-MALF	Upper Quartile	Lower Quartile	Q5 (flow exceeded 5% of the time).
4.663	1.380	0.146	3.613	0.490	15.741

There has been no analysis completed on any of the catchments to confirm the requirements for freshwater habitat and flow conditions. As such, the default values of 90% of MALF (minimum flow) and an allocation of 30% of MALF would apply.

For scheduled rivers in the TRMP the values are 100% of MALF for minimum flow and 30% of MALF for allocation applies.

A map of the monitoring sites can be found in Appendix 2.

6 Mean Annual Low Flow (MALF) is "a statistic that describes the average amount of water in a river during times of low flow" (Land Air Water Aotearoa (LAWA). Undated. Available online at: https://www.lawa.org.nz/learn/glossary/m/mean-annual-low-flow-malf/).

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Water Allocation

There are currently four consented water takes in the Waimatā catchment area. Three of the consented takes have conditions that require monitoring to be undertaken by the applicant. These conditions include monitoring water level and flow. When the water take consents were applied for there was no available hydrological data for the sites

The Tangamatai Stream, which is a tributary of the Pouawa River, has a water take on it of 1.9l/s. There is no MALF available for this stream. A consent condition of this water take is to undertake hydrological monitoring including low flow measurements.

There is a water take on the Tatapouri Spring which is in the coastal catchment. Consent conditions require comprehensive flow and water level monitoring before any further water is abstracted. From that, minimum flows will be developed for this water resource.

A map of the locations of these water takes is provided in Appendix 2.

HE WHAKAMĀRAMA KOUNGA WAI
WATER QUALITY INFORMATION

MONITORING SITES

Gisborne District Council undertakes monthly State of the Environment (SOE) water quality monitoring at sites throughout the region. This involves a monthly collection of water quality samples using national standardised methodology. Samples are sent to a lab for analysis of a range of chemical, physical and bacterial parameters. Field data such as water temperature and clarity are recorded at the same time.

Biomonitoring sites are also included in the monitoring network. These sites are sampled annually in summer. A field assessment of the habitat quality, deposited sediment and density of periphyton is conducted, and a sample of macroinvertebrates and periphyton are collected. The samples collected are analysed in a laboratory.

Table 2 shows the number of sites monitored for SOE and biomonitoring in each catchment in the Waimatā - Pakarae catchment area. Some sites are monitored for both aquatic ecosystem health and water quality.

A map of monitoring sites is attached in Appendix 2.

The Hamanatua, Wainui and Kopuawhakapata Streams have also had intensive surface water quality studies undertaken in addition to any regular monitoring as part of the SOE and biomonitoring programmes. These water quality studies have been undertaken to identify any specific issues with water quality (such as E.coli) and the sources of these pollutants. This has included faecal source tracking which is a test that identifies where the source of E.coli (e.g. dog, birds, horse or human sourced E.coli).

Table 2. Number of monthly SOE and annual biomonitoring site locations in the Waimatā – Pakarae catchment area.

Catchment	Annual Biomonitoring Sites	Monthly Water Quality Sites (SOE)
Waimatā	3	3
Pakarae	4	1
Pouawa	-	-
Waiomoko	1	-
Hamanatua	-	1
Wainui	1	1
Kopuawhakapata	-	1
Coastal	-	-

WATER QUALITY

An analysis of the monthly water quality monitoring data for 2015-2020 and 2016-2021 for aquatic ecosystem monitoring data is shown in Appendix 4. This includes a comparison with the NPS-FM attribute states.

The NPS-FM attribute states provide a nationally consistent reference for a range of water quality and ecosystem health indicators. Contaminant levels are graded into a series of bands with A-Band being the lowest contaminant level and hence being indicative of good water quality (for that parameter). Lower bands are indicative of progressively higher contaminant concentrations and hence lower water quality. D -Band represents the level at which contaminant concentrations occur at levels that have been identified as being unacceptable nationally – these are called national bottom lines. Where a site is indicated as being below a national bottom line, actions are required to improve water quality over time.

It is worth noting that a site may have good water quality for some parameters, but poor water quality for others. This may reflect the nature of the contributing catchment and its geology and land use.

A summary of the data for the Waimatā – Pakarae catchment area is shown in Figure 2 and Figure 3.

Water Quality Overview

The following summary is the overview of the monthly State of Environment Water quality monitoring results:

- In general, apart from Nitrate and Dissolved Inorganic Nitrogen (DIN), water quality across the Waimatā – Pakarae catchment area is degraded and many water quality parameters are below the national bottom line for a number of water quality and ecosystem health attribute states.
- Nitrate levels in the catchment area are very low (A Band), with nitrate being unlikely to be having effects even on sensitive species.
- Dissolved inorganic nitrogen levels are low across the catchment with all sites being in the A or B band, having low impacts on habitat degradation.
- Across the catchment area there are high suspended sediment, deposited sediment, and turbidity levels.
    - All sites fall below the bottom line for turbidity and will require an Action Plan.
    - All sites apart from the Wainui Stream fall below the bottom line for suspended sediment and will require an Action Plan.
    - The Kopuawhakapata, Pakarae tributary and the Waimatā River at Monowai bridge are below the national bottom line for deposited sediment and will require an Action Plan.
- All sites are below the national bottom line for E.coli and will require an Action Plan.
- Dissolved reactive Phosphorus (DRP) is below the national bottom line at the Kopuawhakapata Stream, Wainui Stream, Hamanatua Stream and Waimatā River at Goodwins Road sites. The Waimatā at Monowai Bridge and Pakarae River sites have moderately elevated levels of DRP with a downward trend and are very likely degrading.

- Ammonia toxicity is variable across the catchment. The Hamanatua and lower Waimatā River monitoring sites have very low ammonia levels (A band) and the Kopuawhakapata and Pakarae River have levels that will occasionally impact the most sensitive species. The Wainui Stream has ammonia toxicity that regularly will impact sensitive species.
- Ecosystem health is degraded across the catchment area where monitoring occurs.
    - Six of the seven monitored sites fall below the national bottom line for QMCI and have species that represent severe pollution (organic or nutrient pollution), with the Whakauranga Bridge at West Ho Road (Pakarae catchment) site being in the C band reflecting a moderately polluted stream. All six sites in the D band will require an Action plan to enhance stream habitat and water quality.
    - Five of the seven sites in the catchment fall below the national bottom line for MCI, reflecting significant degradation. The Whakauranga Bridge at West Ho Road (Pakarae catchment) and Waimatā River at Monowai bridge are in the C band reflecting moderately degradation. These five sites will require an action plan.
    - The ASPM score which encompasses the amount and diversity of sensitive macroinvertebrate species also reflects severe stream degradation at the Wainui Stream, Pakarae River, two Pakarae tributaries and the lower Waimatā River (Waimatā river at Goodwins rd. Bridge). The upper Waimatā site (Waimatā River at Monowai Bridge) and the Pakarae tributary (Whakauranga Bridge at West Ho Road) have mild to moderate loss of ecological integrity.

As well as the State of Environment monitoring, there has also been monitoring completed on the Wainui, and Kopuawhakapata streams. These are summarised as follows.

Wainui Stream

- Wainui stream monitoring included data loggers installed at multiple locations to measure continuous dissolved oxygen.
    - The Wainui stream has low oxygen levels, that are regularly at critical levels for freshwater fish and have resulted in fish deaths.
    - The causes of the low oxygen levels are linked to organic material being dumped in the stream, from both stream bank clearance including grass cutting and weeds. The decomposition of the vegetation reduces dissolved oxygen levels in the stream.
    - The second cause of low oxygen levels occurs mainly in the lower reaches. The sediment is anoxic (no oxygen) and produces sulphur. When there are rainfall events, sediment is stirred up and the oxygen levels in the stream are severely reduced, becoming extremely stressful for freshwater species.
- The Wainui stream E.coli levels were regularly above 260 cfu/100ml, and sites sampled in the upper catchment were regularly above 550 cfu/100ml, which would put the upper section as well as the lower section of the stream in the D band for E.coli as per the NPS-FM.

Kopuawhakapata Stream

- The Kopuawhakapata stream has high levels of Ecoli from the headwaters to the stream mouth. The stream has stormwater and wastewater pipes that have the potential to be contaminating the stream.
- A stream survey completed by Morphum Environmental highlighted that there are indigenous fish species present in the stream, with potential spawning habitat for inanga. Longfin and shortfin eels were present, and this included females ready to spawn.
- The findings of the report also highlighted that the stream is degraded with water pollution, rubbish dumping, weed infestations, and bank and channel modification including the stream flowing through pipes. The macroinvertebrate health was low with the sample dominated by pollution tolerant species.

Faecal source tracking results

Water quality analysis has been completed on some of the streams in the Waimatā – Pakarae catchment area to understand the source of the E.coli pollution. The following is a summary of the data:

- Waimatā River (sampled in the very lower reaches): Ruminant and Avian (birds) sourced E.coli.
- Wainui Stream at the upper reaches of the stream has human, and dog sourced E. coli, and in the lower reaches, dog, avian and ruminant sourced E. coli.
- Hamanatua Stream E. coli sources were human, ruminant and avian.

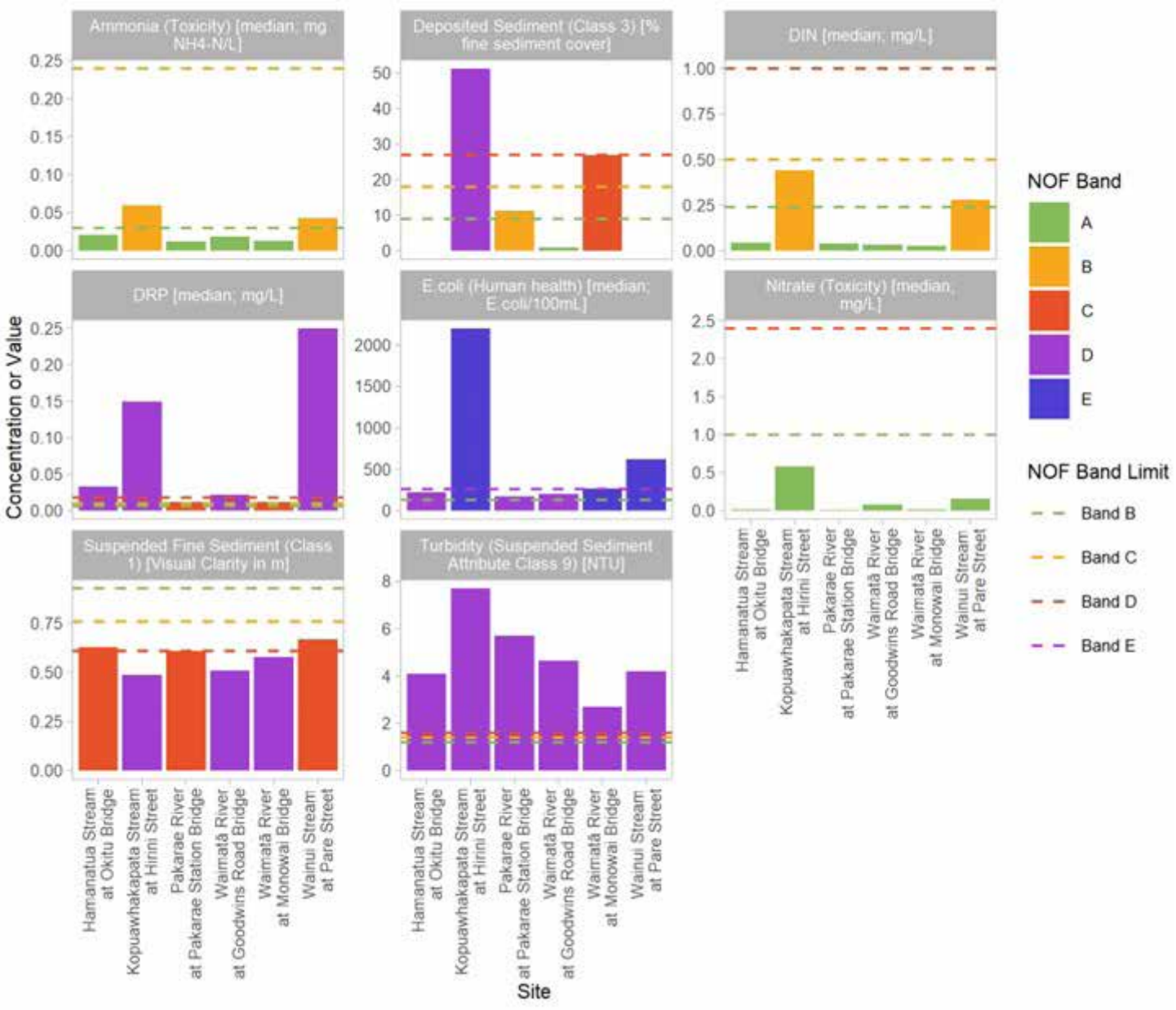


Figure 2: Summary of water quality data for the Waimatā – Pakarae catchment area and the NPS-FM attributes.

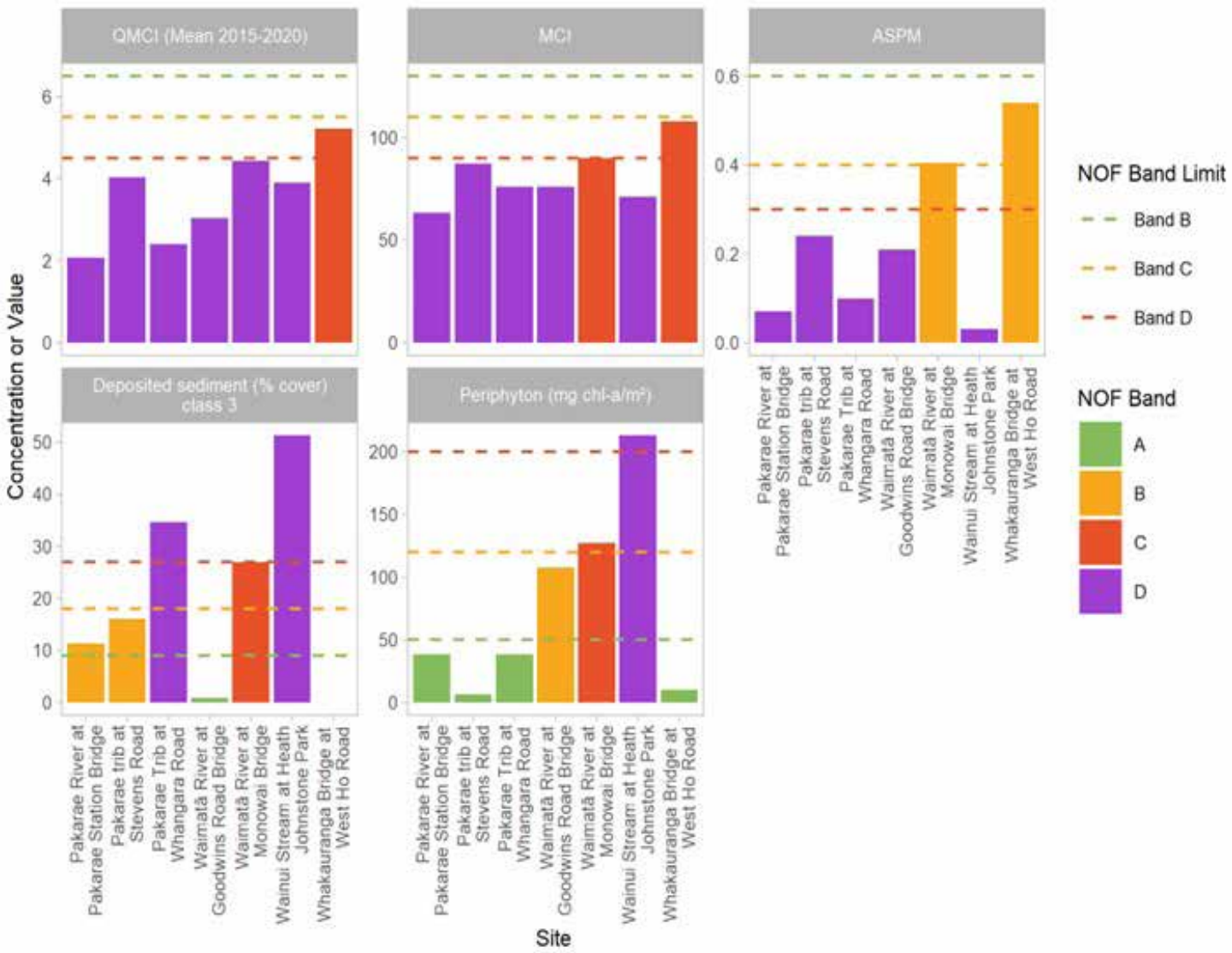


Figure 3: Summary of the Waimatā – Pakarae catchment area aquatic ecosystem monitoring data for the period of 2015-2020 and the NPS-FM attributes

POTENTIAL CONTRIBUTORS TO WATER QUALITY AND ECOSYSTEM DEGRADATION

There are several issues in the Waimatā Pakarae catchment area that are adversely affecting water quality. The main drivers for degraded water quality are sediment and E. coli. The aquatic ecosystem health results reflect the degraded water quality and habitat. The following are contributors to the degraded water quality:

- Land use
  - Land use in the catchment has changed from indigenous forest to predominantly agricultural use with some exotic forest, lifestyle, properties, and urban land use. Changes in land use effect hydrological processes, stream morphology, degrade water quality, reduce woody debris, increase sediment loads and nutrients and reduce levels of leaf litter instream. These changes cause fundamental changes in habitat structure for freshwater fauna and water quality.
  - Loss of riparian vegetation de stabilises riverbanks, increases sediment inputs and reduces stream shading.
- Sediment
  - The catchments are all situated in soft sedimentary geology and in some areas of the catchments the land is severely erosion prone (land overlay 3 or 3a). The erodibility of the land coupled with the land use can result in large areas of erosion, and transportation of sediment into the streams and rivers.
  - Land use activities such as; stock crossings, culvert maintenance and construction, track maintenance, dam maintenance are all potential sources for sediment to enter the catchments.
  - Many of the catchments have exotic forest, especially in the headwaters. Afforestation is known to improve and stabilise erosion; however, forestry harvesting, especially clear fell harvest is known to contribute large sediment loads to rivers. Sediment mobilisation following clear fell forestry harvest is likely a large contributor to sediment loads in the catchments.
  - The presence of mud volcanoes in the Waimatā – Pakarae catchment area, will be contributing to sediment levels in the river where the mud volcanoes are leaching into streams.
- E.coli
  - Elevated levels of E. coli in the catchment are likely to be predominantly driven from stock access through directly from paddocks and at stock crossings, and stock having direct access to waterways.
  - In the urban areas, E. coli levels have been shown to be sourced from a mixture of human, bird and dog sourced E. coli. Human sourced E. coli may be a result of cross-connections from the wastewater to the stormwater system or potentially septic tanks discharges in some areas. The lower reach of the Waimatā River can be affected by wastewater overflows in very heavy rain.
- Ecosystem health
  - Ecosystem health is a more holistic measure of water quality and captures many parameters such as sediment, shade, nutrient and periphyton levels. These parameters drive the overall ecosystem health metrics and are influenced predominantly by land use (e.g loss of stream shade, increased areas of exposed sediment, reduced catchment vegetated cover, nutrient inputs etc).

GAPS IN MONITORING DATA

Water quality and ecosystem health is assessed at representative rivers across Tairāwhiti as it is not feasible or affordable to collect this information everywhere. It is also noted that assessing attribute states under the NPS-FM can require monitoring to be undertaken differently to that collected in current monitoring programmes.

In developing catchment plans, the best available information is utilised – including applying relevant and applicable information from similar catchments elsewhere. As the catchment planning process progresses, key information gaps will be identified and programmes to collect the information will be put in place to help inform future versions of the catchment plan.

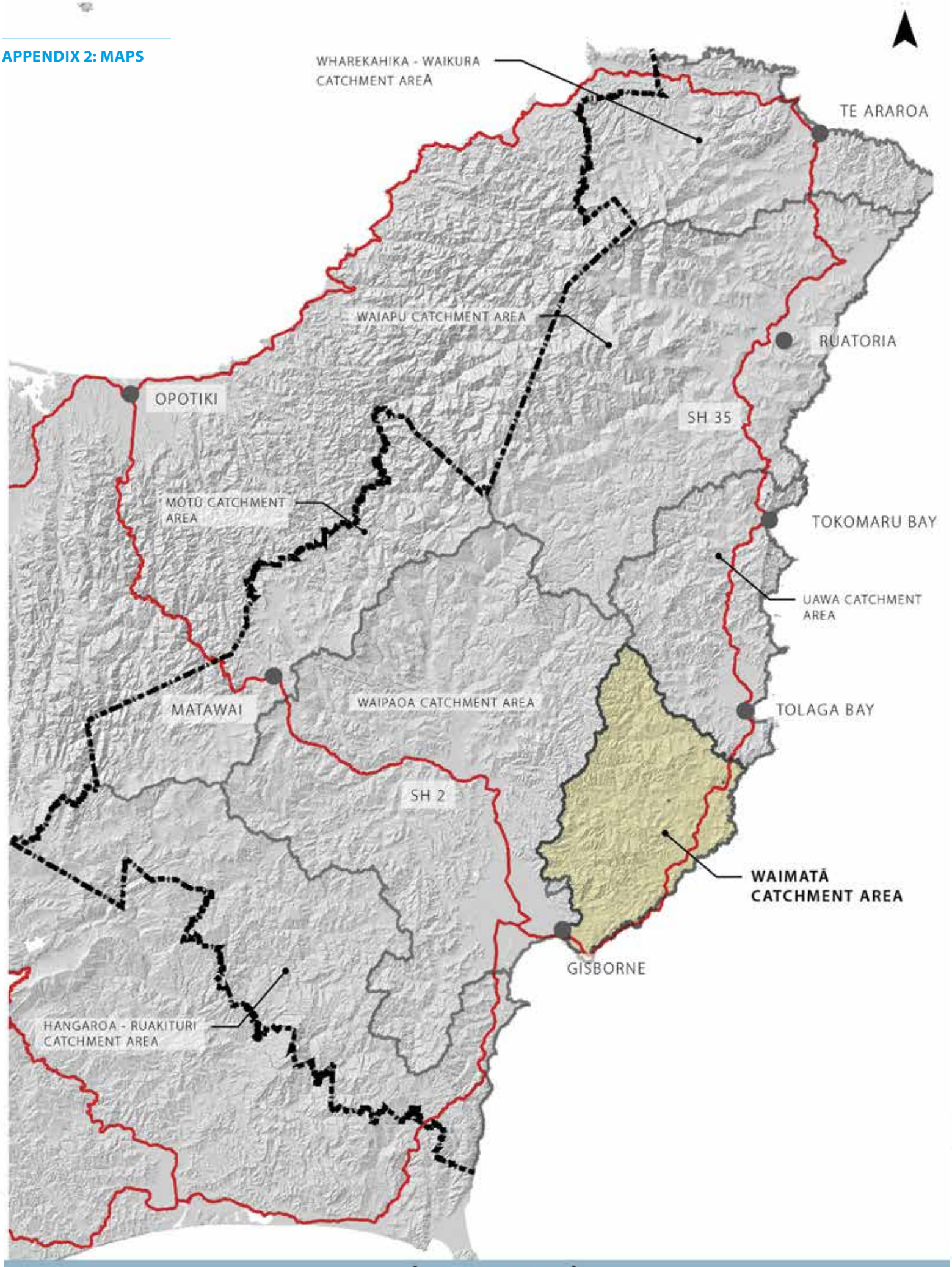
Potential information gaps are identified below, recognising that not all of this information is required to develop the Waimatā-Pakarae Catchment Management Plan. Future monitoring requirements will need to be confirmed and prioritised through the catchment plan process.

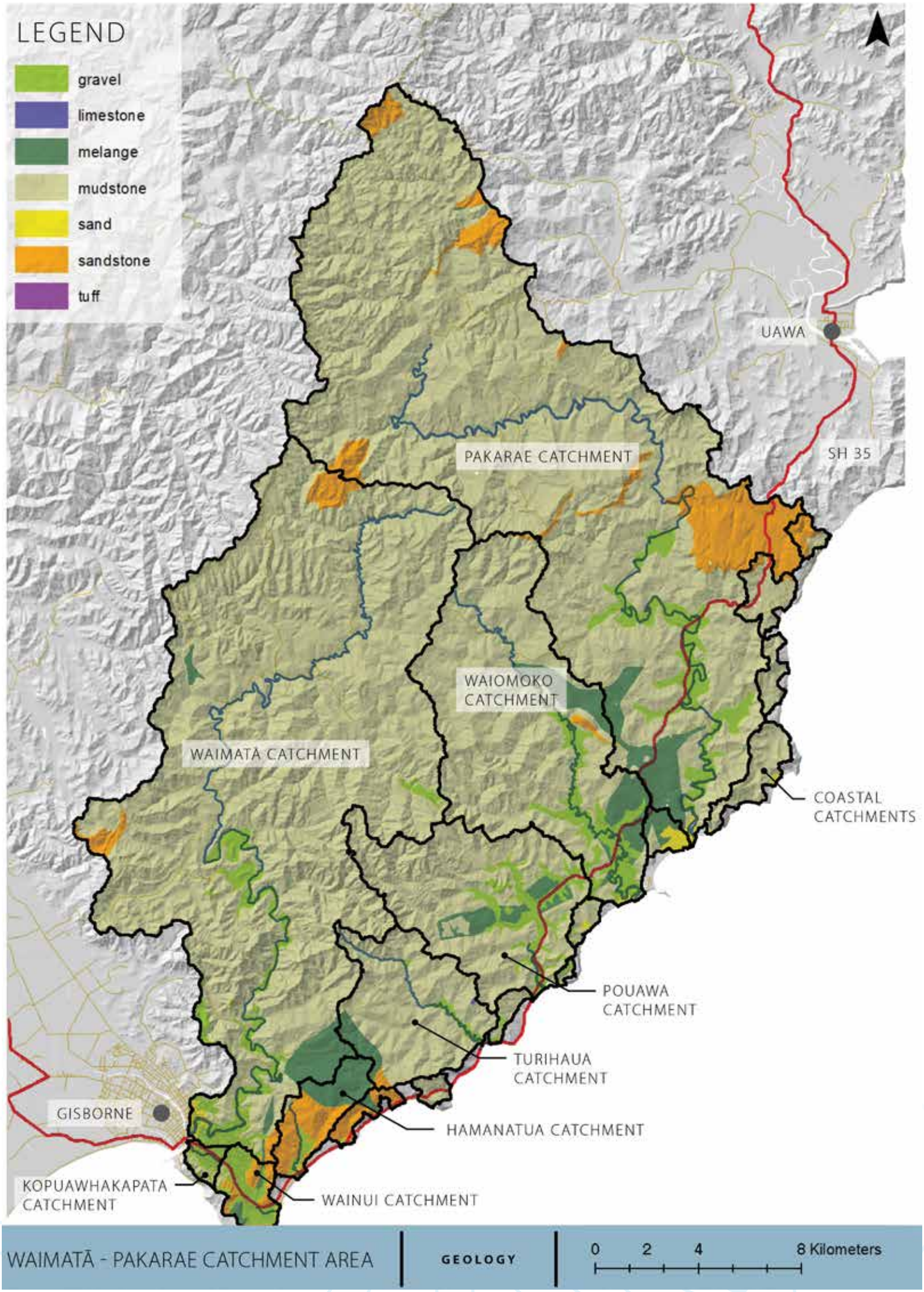
- Water quality data for the Waiomoko, Pouawa, Turihaua or coastal catchments.
- Hydrology monitoring data for the sub-catchments, apart from the main stem of the Waimatā River.
- Continuous dissolved oxygen data to enable grading against the NPS-FM attribute states.
- Periphyton is not monitored monthly at any sites, which is required to enable periphyton bands to be set as per the NPS-FM. Currently the periphyton levels in this report are based off annual one-off samples.
- Deposited sediment data in the water quality tables was from annual samples. To enable accurate site grading as per the NPS-FM, monthly deposited sediment measurements are required from 5 years' worth of data. Monthly monitoring would be recommended to ensure accuracy with site grading and to understand trends going forward.
- Fish data was used from the available data in the New Zealand National Fish database (NZFFD). There is no State of Environment monitoring undertaken for fish monitoring in Gisborne. The data used from the NZFFD is not an exhaustive list and many data were one off observations and not targeted fish surveys. There is no Fish Index Biotic Integrity (F-IBI) data for the catchment area.
- It is likely that not all wetlands are included in the maps for the Waimatā-Pakarae catchment area and further wetland mapping will be needed to meet the requirements of the NPS-FM to map wetlands down to a size (area) of 500 m2.

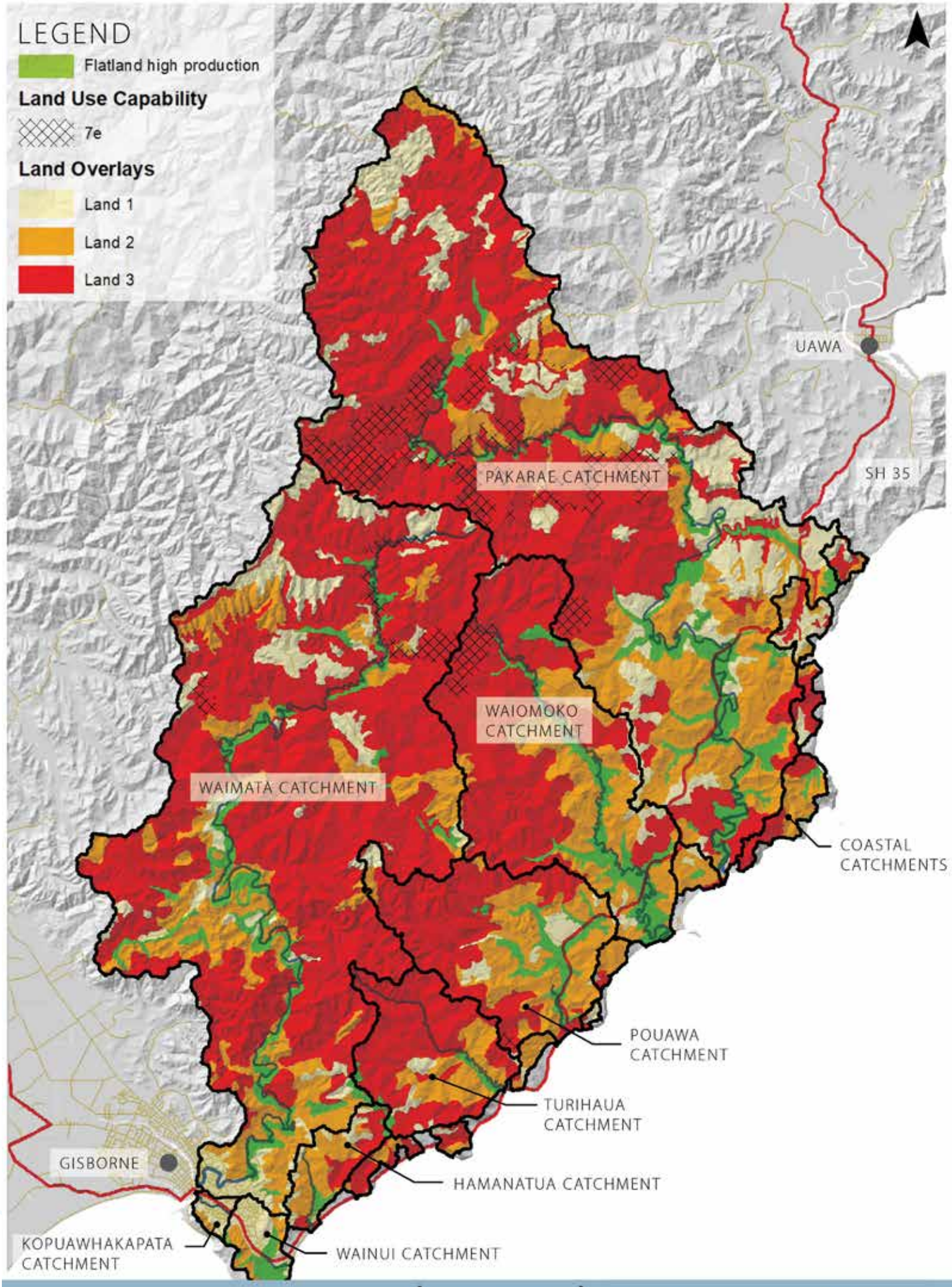
HE KUPU PITI
APPENDICES

APPENDIX 1: GLOSSARY OF TERMS

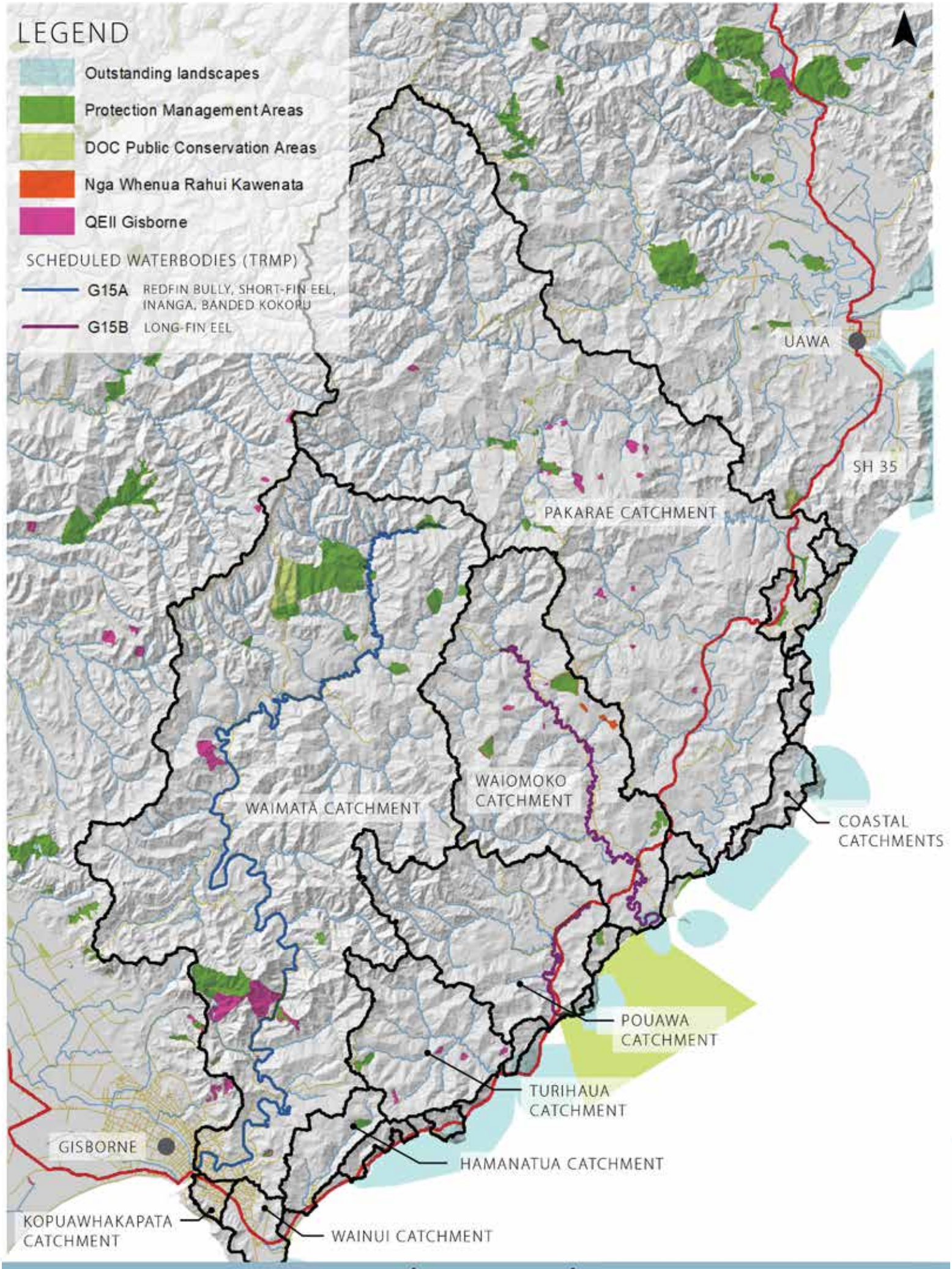
Action Plan	A part of the Catchment Plan which identifies how we are going to get attributes that are degraded from their current state to where we want them to be. Can include rules or other types of methods.
Attribute	A water quality indicator used to help us understand if the values of the water are being provided for e.g. the amount of E.coli bacteria in the water tells us if it is safe for swimming. This will be measured in a standard way. E.g. E.coli is measured in cfu/100 mL of water.
Target Attribute state	What we want the water quality to be like for that indicator.
Baseline state	What the water quality was like on 7 September 2017.
Catchment Plan	A regional plan under the Resource Management Act that determines how freshwater and land uses within specific catchment areas are managed.
Degraded	Water quality that is below a national bottom line or is not achieving a target attribute state.
Degrading	Water quality that is showing a deteriorating trend.
Environmental outcome	A desired outcome that a regional Council identifies for a freshwater value and then includes as an objective in its regional plan.
Freshwater Management Unit (FMU)	A management area (e.g. site, river reach, water body, part of a water body or groups of water bodies). They are often quite big – for example the Waipaoa Catchment has 4 Freshwater Management Units.
Freshwater values	The sorts of things and uses we value waterbodies for. e.g. ecosystem health, human contact, threatened species, mahinga kai, fishing, animal drinking water.
Limit	A type of rule for water. Can be the amount of pollutant allowed in the water e.g. amount of nitrate nitrogen, or a flow limit –e.g. a minimum flow below which water takes cannot occur.
National Bottom Line	An attribute state that we are not allowed to let water quality fall below.
Outstanding waterbody	A water body or part of a water body that has outstanding values and is identified for special protection.
Over-allocation	Where resource use exceeds a limit or where an FMU is degraded or degrading.
Primary contact site	An area where lots of people swim or do things which mean they are likely to end up drinking the water or getting spray in their mouth.

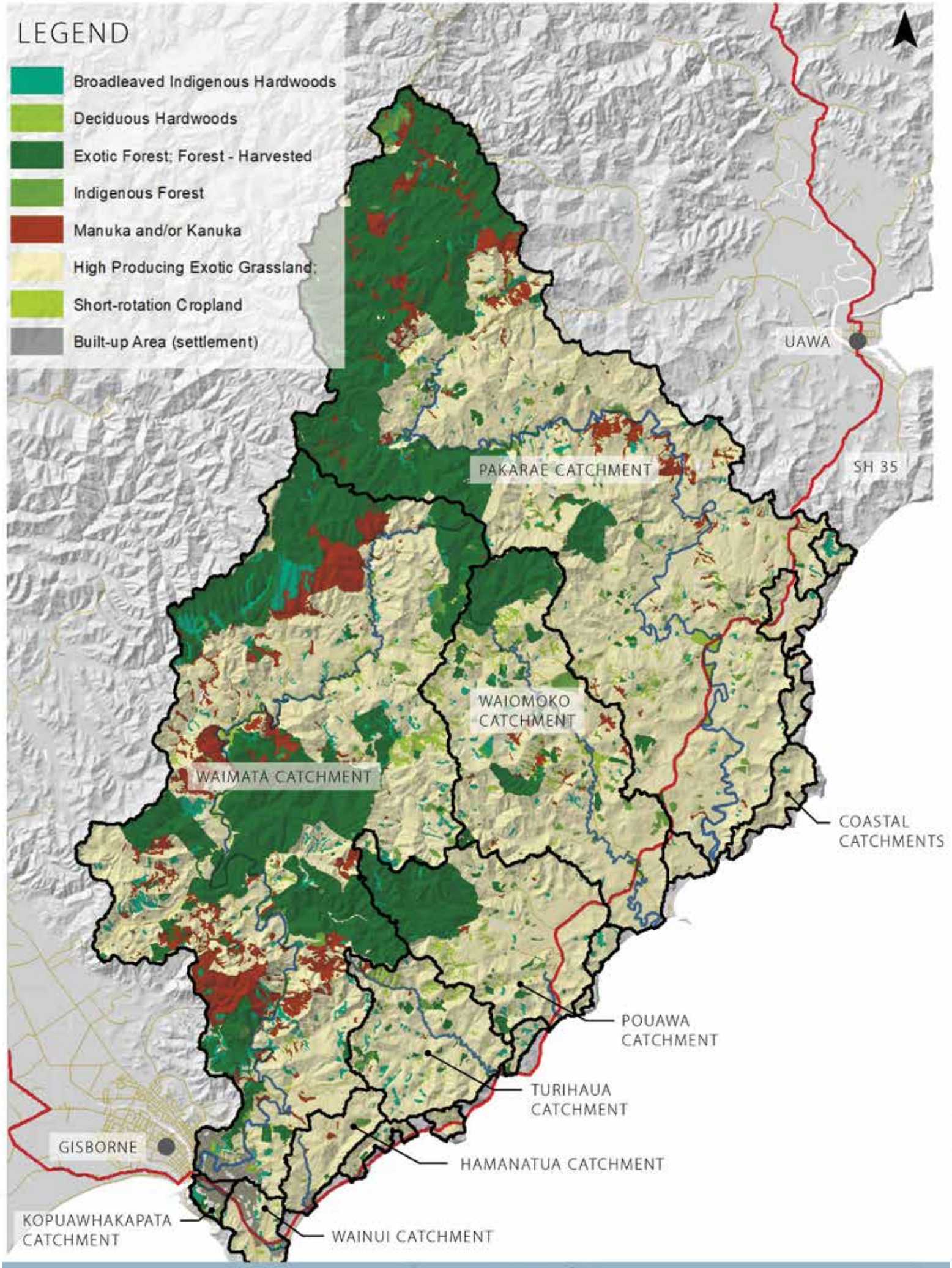

WHAREKAHIKA - WAIKURA CATCHMENT AREA
TE ARAROA
WAIAPU CATCHMENT AREA
RUATORIA
OPOTIKI
SH 35
MOTU CATCHMENT AREA
TOKOMARU BAY
UAWA CATCHMENT AREA
MATAWAI
WAIPAOA CATCHMENT AREA
TOLAGA BAY
SH 2
WAIMATĀ CATCHMENT AREA
GISBORNE
HANGAROA - RUAKITURI CATCHMENT AREA
WAIMATĀ - PAKARAE CATCHMENT AREA
REGIONAL CONTEXT
0 5 10 20 Kilometers

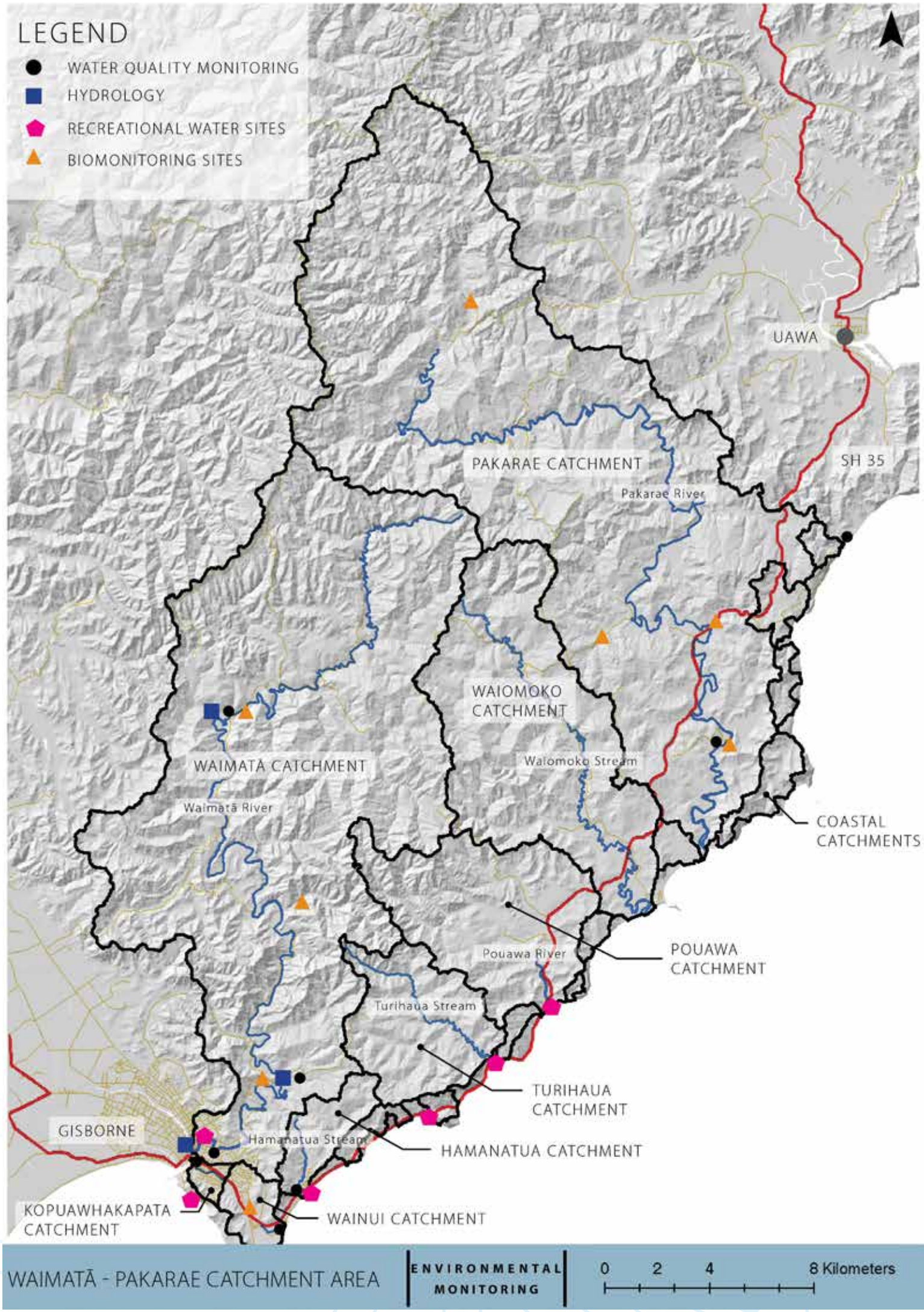

LEGEND
gravel
limestone
melange
mudstone
sand
sandstone
tuff
UAWA
SH 35
PAKARAE CATCHMENT
WAIOMOKO CATCHMENT
WAIMATĀ CATCHMENT
COASTAL CATCHMENTS
POUAWA CATCHMENT
TURIHAUA CATCHMENT
HAMANATUA CATCHMENT
GISBORNE
KOPUAWHAKAPATA CATCHMENT
WAINUI CATCHMENT
WAIMATĀ - PAKARAE CATCHMENT AREA
GEOLOGY
0 2 4 8 Kilometers

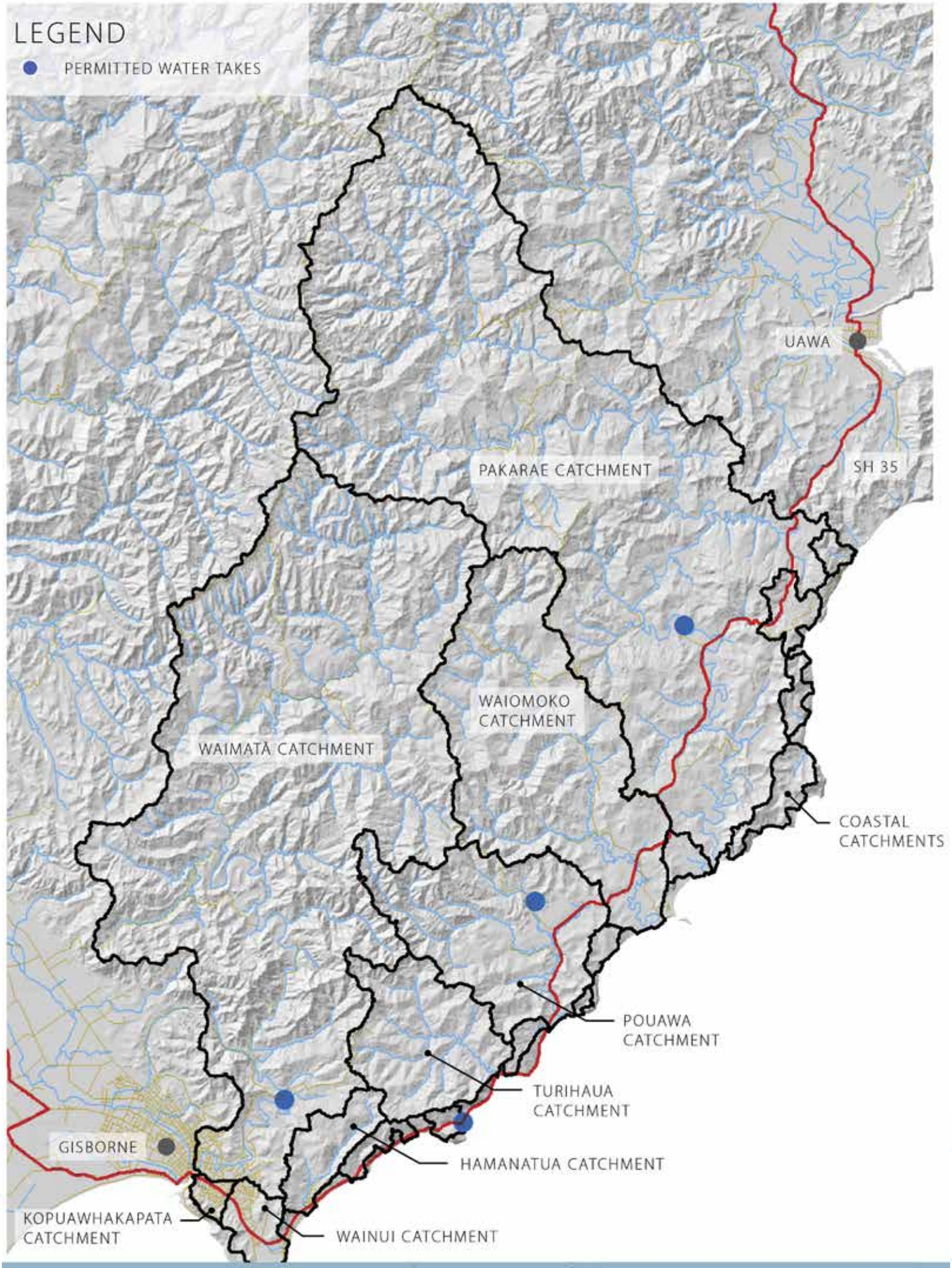


WAIMATĀ - PAKARAE CATCHMENT AREA | LAND USE CAPABILITY | 0 2 4 8 Kilometers


LEGEND
Outstanding landscapes
Protection Management Areas
DOC Public Conservation Areas
Nga Whenua Rahui Kawenata
QEII Gisborne
SCHEDULED WATERBODIES (TRMP)
G15A REDFIN BULLY, SHORT-FIN EEL, INANGA, BANDED KOKOPU
G15B LONG-FIN EEL
UAWA
SH 35
PAKARAE CATCHMENT
WAIOMOKO CATCHMENT
WAIMATA CATCHMENT
COASTAL CATCHMENTS
POUAWA CATCHMENT
TURIHAUA CATCHMENT
GISBORNE
HAMANATUA CATCHMENT
KOPUAWHAKAPATA CATCHMENT
WAINUI CATCHMENT
WAIMATĀ - PAKARAE CATCHMENT AREA
PROTECTED AREAS
0 2 4 8 Kilometers


LEGEND
Broadleaved Indigenous Hardwoods
Deciduous Hardwoods
Exotic Forest; Forest - Harvested
Indigenous Forest
Manuka and/or Kanuka
High Producing Exotic Grassland;
Short-rotation Cropland
Built-up Area (settlement)
UAWA
SH 35
PAKARAE CATCHMENT
WAIOMOKO CATCHMENT
WAIMATA CATCHMENT
COASTAL CATCHMENTS
POUAWA CATCHMENT
TURIHAUA CATCHMENT
GISBORNE
HAMANATUA CATCHMENT
KOPUAWHAKAPATA CATCHMENT
WAINUI CATCHMENT
WAIMATĀ - PAKARAE CATCHMENT AREA
LAND CLASS DATABASE
0 2 4 8 Kilometers


LEGEND
WATER QUALITY MONITORING
HYDROLOGY
RECREATIONAL WATER SITES
BIOMONITORING SITES
UAWA
SH 35
PAKARAE CATCHMENT
Pakarae River
WAIOMOKO CATCHMENT
Waiomoko Stream
WAIMATĀ CATCHMENT
Waimatā River
COASTAL CATCHMENTS
Pouawa River
POUAWA CATCHMENT
Turihaua Stream
TURIHAUA CATCHMENT
GISBORNE
Hamanatua Stream
HAMANATUA CATCHMENT
KOPUAWHAKAPATA CATCHMENT
WAINUI CATCHMENT
WAIMATĀ - PAKARAE CATCHMENT AREA
ENVIRONMENTAL MONITORING
0 2 4 8 Kilometers



WAIMATĀ - PAKARAE CATCHMENT AREA | **WATER ALLOCATION** | 0 2 4 8 Kilometers

APPENDIX 3: WATER QUALITY DATA

Attribute (REC Class (Warm Wet Hill)	NPSFM Limit	Kopuawhakapata Stream at Hirini Street	Wainui Stream at Pare Street	Hamanatua Stream at Okitu Bridge	Pakarae River at Pakarae Station Bridge	Waimatā River at Goodwins Road Bridge	Waimatā River at Monowai Bridge
DRP Median mg/L	A ≤0.006 B >0.006 and ≤0.010 C >0.010 and ≤0.018 D >0.018	0.15 Below national bottom line	0.25 Below national bottom line	0.033 Below national bottom line	0.012 C Band	0.022 Below national bottom line	0.012 C Band
	What does this mean?	Phosphate levels are high in the catchment, with slightly lower levels at the site located in the middle of the Waimatā catchment and on the Pakarae River. Phosphate is bound to sediment, and the high phosphate levels reflect the soft sedimentary geology and erosion occurring in the catchments. Action plans are required for all sites in the D band.					
Ammonia (Toxicity) Median mg NH4-N/L	A ≤0.03 B >0.03 and ≤0.24 C >0.24 and ≤1.30 D >1.30	0.06 B Band	0.043 B Band	0.021 A Band	0.012 A Band	0.0185 A Band	0.013 A Band
	What does this mean?	Ammonia is highly toxic to aquatic life, increasing levels of ammonia will negatively affect freshwater habitat.					
Nitrate (Toxicity) Median mg/L	A ≤1.0 B >1.0 and ≤2.4 C >2.4 and ≤6.9 D >6.9	0.58 A Band	0.153 A Band	0.019 A Band	0.012 A Band	0.085 A Bandz	0.014 A Band
	What does this mean?	All sites are in the A band and have low levels of nitrate.					
Dissolved Oxygen mg/L 7 day mean minimum (1 Nov – 30 April)	A >8.0 B 7.0-8.0 C 5.0 – 7.0 D <5.0	Not monitored					
Suspended Fine Sediment (Class 2) Visual Clarity in metres	A ≥0.93 B <0.93 and ≥0.76 C <0.76 >0.61 D <0.61	0.49 Below national bottom line	0.67 C Band	0.63 C Band	0.61 C Band	0.51 Below national bottom line	0.58 Below national bottom line
	What does this mean?	Visual clarity was measured using a clarity tube. All sites will have a moderate to high impact of suspended sediment on instream species. Those waterways below the national bottom line will have ecological communities that are significantly impacted.					

APPENDIX 3: WATER QUALITY DATA

Attribute (REC Class (Warm Wet Hill)	NPSFM Limit	Kopuawhakapata Stream at Hirini Street	Wainui Stream at Pare Street	Hamanatua Stream at Okitu Bridge	Pakarae River at Pakarae Station Bridge	Waimatā River at Goodwins Road Bridge	Waimatā River at Monowai Bridge
Deposited Sediment Class 3) % fine sediment cover*	A ≤9 B >9 and ≤18 C >18 and <27 D >27	51.3 Below national bottom line	Not monitored	Not monitored	11.3 B Band	0.9 A Band	27 C Band
	What does this mean?	Sites in the C and D bands will have a high impact of deposited sediment on instream habitat and species and will require an Action Plan. *Deposited sediment measurements are taken once annually, and these have been averaged over the five-year monitoring period. Because there is no monthly monitoring data the bands are more indicative rather than definitive as per the NPS-FM.					
Human health E.coli/100mL median	A ≤130 B ≤130 C ≤130 D >130 E >260	2200	625	225	170	205	270
	What does this mean?	All sites are below national bottom line for E.coli indicating a high risk for infection of campylobacter. All sites will require an action plan.					
Human health E.coli/100mL 95th Percentile (Swimming)	A ≤130 B >130 and ≤260 C >260 and ≤540 D >540	2400 Below national bottom line	730 Below national bottom line	16410 Below national bottom line	170	230	260
	What does this mean?	Kopuawhakapata, Wainui and Hamanatua Streams are below national bottom line for E.coli indicating a high risk for infection of campylobacter. These sites will require an action plan.					

APPENDIX 4: AQUATIC ECOSYSTEM HEALTH DATA

Attribute (REC Class (Warm Wet Hill)	NPSFM Limit	Wainui Stream at Heath Johnston Park	Pakarae River at Pakarae Station Bridge	Whakauranga Bridge at West Ho Road	Pakarae trib at Stevens Road	Pakarae Trib at Whangara Road	Waimatā River at Goodwins Road Bridge	Waimatā River at Monowai Bridge
Macroinvertebrates QMCI (Mean 2015 -2020)	A ≥6.5 B ≥5.5-<6.5 C ≥4.5-<5.5 D <4.5	3.9 Below national bottom line	2.08 Below national bottom line	5.21 C Band	4.03 Below national bottom line	2.41 Below national bottom line	3.04 Below national bottom line	4.44 Below national bottom line
What does this mean?		All sites reflect poor water quality and do not support a diverse range of sensitive macroinvertebrate species. All sites apart from Whakauranga Bridge at West Ho Road are below national bottom line						
Macroinvertebrates MCI	A ≥130 B ≥110-<130 C ≥90-<110 D <90	71 Below national bottom line	63.5 Below national bottom line	108 C Band	87.5 Below national bottom line	76 Below national bottom line	76 Below national bottom line	90 C Band
What does this mean?		All sites reflect poor water quality and degraded habitat, with few sensitive species. All sites apart from Whakauranga Bridge at West Ho Road and Waimatā River at Monowai Bridge are below the national bottom line.						
Macroinvertebrates ASPM	A ≥0.6 B <0.6-≥0.4 C <0.4-≥0.3 D <0.3	0.03 Below national bottom line	0.07 Below national bottom line	0.54 B Band	0.24 Below national bottom line	0.1 Below national bottom line	0.210 Below national bottom line	0.405 B Band
What does this mean?		Five sites are below national bottom line, with streams having low diversity and numbers of sensitive invertebrates reflecting degraded habitat. Two sites are in the B band which reflects a mild to moderate loss of ecological habitat and integrity.						
Deposited sediment (% cover) class 3	A ≤9 B >9 and ≤18 C >18 and <27 D >27	51.3 Below national bottom line	11.3 B Band	No data	16.1 B Band	34.7 Below national bottom line	0.9 A Band	27 C Band
Fish		Not monitored						
Ecosystem Metabolism		Not monitored						
Periphyton mg chl-a/m2**	A ≤50 B >50 -≤120 C >120 - ≤200 D >200	213 Below national bottom line	38.2 A Band	9.91 A Band	6.06 A Band	38.2 A Band	107.25 B Band	127 C Band
What does this mean?		The sites in the Pakarae catchment are all in the A band for periphyton indicating negligible nutrient enrichment. The Waimatā River sites reflect moderate enrichment and the Wainui stream periphyton levels reflects high nutrient enrichment. **Periphyton measurements are based off annual measurements over 5 years. There is no monthly periphyton monitoring data. It is worth noting that due to this, these bands are more indicative and are not definitive.						

APPENDIX 5- WATER QUALITY EXPLANATIONS

Parameter	Explanation
Phosphorus	Phosphorus is an element with the symbol P that attaches to soil particles and is naturally present in water in low concentrations. Together with nitrogen, it is an essential nutrient for plant life and is measured as either total phosphorus (TP) or dissolved reactive phosphorus (DRP).
Dissolved Reactive Phosphorus	This is a measure of the dissolved (soluble) phosphorus compounds that are readily available for use by plants and algae. Dissolved reactive phosphorus concentrations are an indication of a waterbody's ability to support nuisance algal or plant growths (algal blooms).
Nitrogen	Nitrogen is a naturally occurring substance, with the chemical symbol N. In its gas form (N2), nitrogen makes up about 80% of the Earth's atmosphere. In other forms it is one of the most important fertilisers for plant growth. It is also found in amino acids that make up proteins, in nucleic acids (that make up DNA) and in many other organic and inorganic compounds. Nitrogen is a great fertiliser but too much of it can cause aquatic weeds and algae to grow too fast. This increased plant growth can reduce oxygen in the water during nighttime when dead plant material decomposes. This can eventually remove the oxygen present in lakes, posing a threat to aquatic life. Nitrite-nitrogen and ammonia become toxic at high concentrations which are more likely under certain temperature and pH conditions. This can cause direct harm to fish and macroinvertebrates. The most common sources are wastewater treatment plants, run-off from pasture, croplands and fertilised lawns, leaky septic systems, run-off from animal manure/urine, and industrial discharges.
Nitrate	A highly soluble molecule made up of nitrogen and oxygen with the chemical formula NO32-. It is a very important plant fertiliser but because it is highly water soluble, it leaches through soils very easily, particularly after heavy rainfall. It is one of the most common contaminants in waterways in rural and urban areas. NO3-N can be transformed to other forms of nitrogen. Sources of NO3-N include excessive application of inorganic fertilizer, septic tanks and leaking sewage systems. Nitrate also enters waterways as a result of nitrification of the ammonia in animal waste by bacteria in soil.
Nitrite	Nitrite-nitrogen is an ion with the chemical formula NO2-. Concentrations of nitrite-nitrogen are normally low compared to nitrate-nitrogen and ammoniacal nitrogen. However, too much nitrite-nitrogen can be toxic. In drinking water it can be harmful to young infants or young livestock.
Ammoniacal Nitrogen	Also called total ammoniacal nitrogen, covers two forms of nitrogen; ammonia (NH3) and ammonium (NH4). NH4-N can be transformed to other forms of nitrogen and is a very important plant fertiliser but is less mobile in the soil than nitrate-nitrogen. It enters waterways primarily through point source discharges, such as raw sewage or dairy shed effluent. It is toxic to aquatic life at high concentrations.
Dissolved Inorganic Nitrogen	This is the sum of nitrite (NO2), nitrate (NO3) and ammonia (NH3).

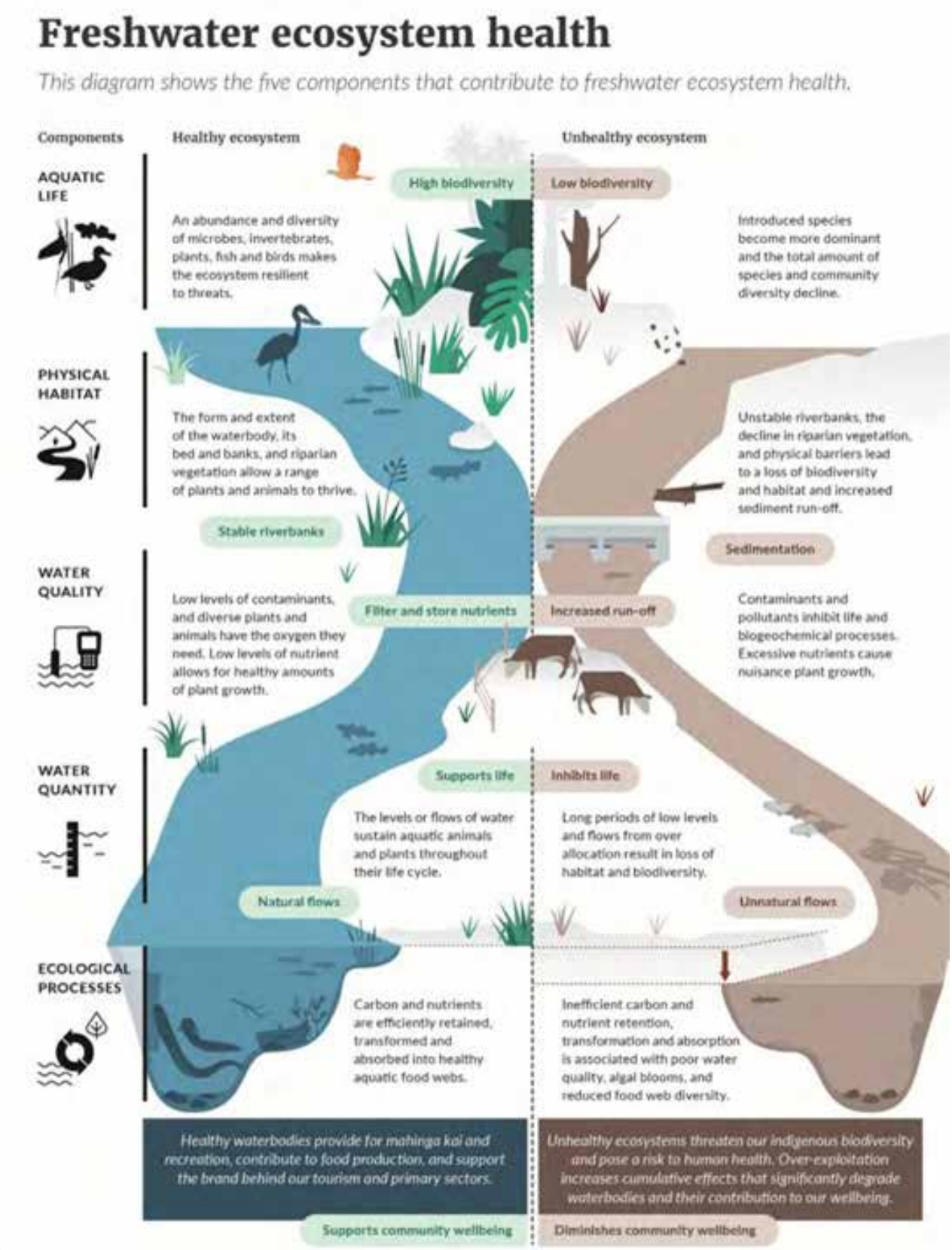
APPENDIX 5- WATER QUALITY EXPLANATIONS

Parameter	Explanation
	Water clarity refers to the ability of light to travel through water and has two important aspects: light penetration and visual clarity. Light penetration is important as it controls the amount of light in the water needed for aquatic plants to grow. Visual clarity indicates how much suspended sediment (soil) is in the water. Poor water clarity can have many adverse effects on stream and lake ecosystems. For example, murky water can make the water unsuitable for drinking by stock and make areas unsafe for swimming. High sediment can also harm aquatic life by clogging their gills which reduces their ability to take up oxygen. As fine particles settle in slower-moving downstream areas, the spaces between rocks and gravel are filled making the bottom habitat unsuitable for fish and other aquatic species. Poor water clarity will also affect the amount of light reaching the river bottom, potentially limiting plant growth.
Turbidity	Turbidity is an index of cloudiness of water and measures how light is scattered by fine particles in waterways. Turbidity is an alternative measurement for suspended sediment and/or visual clarity and is measured in nephelometric turbidity units (NTU).
Suspended Sediment	As erosion occurs, tiny particles of clay, silt or small organic particles are washed into waterways. These tiny particles can be supported in the water current and are termed suspended sediment. The faster the water is moving the larger the amount and size of suspended sediment particles it can carry. Soil type in the catchment can affect the amount of suspended sediment.
Deposited Sediment	Deposited sediment is a measure of the percentage of the stream bed covered in fine sediment. Deposited sediment smothers the stream bed and can change and degrade habitat, change the assemblage of macroinvertebrate species and reduce fish habitat and fish species.
Dissolved Oxygen	The oxygen content of water. Dissolved oxygen is important for fish and other aquatic life to breathe. For example, water quality guidelines recommend that water should be more than 80 percent saturated with DO for aquatic plants and animals to be able to live in it.
E.coli	E. coli (Escherichia coli) is a type of bacteria commonly found in the guts of warm-blooded mammals (including people) and birds. High E. coli concentrations in freshwater can be harmful to humans. Common sources of E. coli bacteria are untreated human wastewater discharges, stormwater run-off and animal waste. E. coli survives outside the body and can survive for up to four to six weeks in fresh water making it a useful indicator of faecal presence and therefore of disease-causing organisms in a river or lake. Faecal concentrations are typically higher in pastoral streams but even near-pristine streams are not totally free from E. coli because of faecal deposition by birds and wild animals.
Macroinvertebrates	Any organisms without a backbone or internal skeleton large enough to be visible to the naked eye (>500µm), such as insects, worms, and snails. Macroinvertebrates are sampled to provide an indication of stream water quality. Generally, the greater the diversity, the better the water quality in the stream. Macroinvertebrate communities are widely used as indicators of stream ecosystem health because they include a wide range of species, each with relatively well-known sensitivity or tolerance to stream conditions. The most common stream health indices are taxa richness, percentage of EPT taxa and the macroinvertebrate community index (MCI).

APPENDIX 5- WATER QUALITY EXPLANATIONS

Parameter	Explanation
MCI (Macroinvertebrate Community Index)	MCI stands for Macroinvertebrate Community Index which is an index where macroinvertebrates are used for monitoring and reporting on stream health in New Zealand. The MCI assigns a score to each species or taxon (from 1 to 10), based on its tolerance or sensitivity to organic pollution, then calculates the average score of all taxa present at a site. It is a semi qualitative sampling method, which means it will tell you which species are present or absent in your sample. The MCI is based on the tolerance or sensitivity of species (taxa) to organic pollution and nutrient enrichment. For example, mayflies, stoneflies and caddis flies are sensitive to pollution, and are only abundant in clean and healthy streams, whereas worms and snails are more tolerant and can be found in polluted streams. Most benthic invertebrate taxa were assigned a tolerance value ranging from 1 (very tolerant) to 10 (very sensitive). An invertebrate sample is typically collected from within a representative section of a stream (a reach). Higher MCI scores indicate better habitat and water quality at the sampled site. In theory MCI values can range between 0 and 200, but in practice it is rare to find MCI values greater than 150 and only extremely polluted or sandy/muddy sites score under 50.
QMCI (Quantitative Macroinvertebrate Community Index)	Similar to MCI but includes an assessment of the abundance of the different species.
% EPT Taxa	The invertebrate community is usually dominated by three orders of insects: the mayflies, stoneflies, and caddis flies. Together, these insects are known as EPT, referring to their scientific names Ephemeroptera, Plecoptera and Trichoptera, respectively. These freshwater insects are generally intolerant of pollution, so the fewer found in a sample, the poorer the stream health. The percentage of EPT-taxa (or %EPT) is most commonly calculated by counting the total number of mayfly, stonefly and caddis fly taxa in a sample, then dividing that number by the taxa richness and multiplying by 100. This is known as the %EPT by taxa. A high percentage of EPT taxa indicates good stream health. However, in some New Zealand streams there are naturally few mayflies, stoneflies, or caddis flies present. Ecologists need to be aware of these factors when using the %EPT to assess the ecological health of a river or stream
ASPM (Average Score Per Metric)	The Average Score Per Metric is made up of a combination of metrics that are found to have low variability among undeveloped reference sites in native forest: number of sensitive species: mayflies + stoneflies + caddisflies (EPT), percentage of sensitive taxa -%EPT, tolerance of taxa to pollution – MCI.

APPENDIX 6: FRESHWATER ECOSYSTEM HEALTH EXPLANATION



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