Baseline Environmental Assessment: Rural Tributaries of the Ahuriri Catchment 2024

Prepared for

Ahuriri Tributaries Catchment Group Trust

November 2024

pdp

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Quality Control Sheet

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Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Ahuriri Tributaries Catchment Group. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

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Community Summary

This report was prepared by PDP for the Ahuriri Tributaries Catchment Group Trust (ATCGT), to provide a high-level snapshot of the current health of the rural waterways feeding into the Ahuriri Estuary – Te Whanganui-a-Orotū, as well as recommendations for the community, to implement mitigation measures to improve the health of the tributaries.

This community summary condenses the report into the key concerns, and the key mitigation measures that have been identified by this baseline assessment. For further detail, please refer to the relevant sections of this report.

Key Concerns and Mitigation Options

The results of the baseline assessments showed that the Ahuriri catchment has levels of sediment, nutrient and bacteria inputs, that are likely to be affecting the health of the tributaries and may be contributing to the issues within the broader Ahuriri Estuary. Additionally, habitat quality is generally considered 'poor' and is considered likely to be an area where improvements may be able to be made.

These key stressors are summarised below.

Sediment

High sediment loads were evident in the streams during wet weather (see Figure below).

Photographs of Site T6 during dry (left) and wet (right) weather, showing the decreased water clarity during wet weather as a result of increased sediment load, that was a common occurence across all lower catchment sites (see Appendix A).

Nutrients

Bioavailable nutrient concentrations (nutrients that are easily able to be used by plants for growth) were above the regional guideline values (TANK Schedule 26), particularly during wet weather. While an input of nutrients is essential for a healthy, functioning ecosystem, over supply of nutrients can lead to a lack of balance and excessive growth of macrophytes.

Escherichia coli (E. coli)

Escherichia coli (E. coli – a bacterium that indicates the presence of faecal material) levels were higher than the regional guideline values at all of the measured sites during both dry and wet weather. This indicates that sources of faeces are making their way into the tributaries either by direct deposition (stock in waterways – dry and wet weather) or overland flow (wet weather).

Habitat Quality

The streams were assessed for the quality of habitat for plants and animals, using Rapid Habitat Assessments (RHA's - see methodology section of this report for further information) and publicly available eDNA data (environmental DNA). These assessments found that the tributaries were considered to have 'poor' habitat quality in relation to:

- The width of riparian zones.
- Lack of suitable fish and invertebrate habitats.
- A lack of stream heterogeneity (complexity); and
- High levels of deposited sediment on the stream bed in the lower catchment.

Table 1 below summarises the attributes of key concern from the baseline assessment and identifies associated mitigation options as represented by the coloured symbols (see key at the bottom of the table).

Table 1 - Attributes of Key Concern and the Associated Mitigation Options

Attribute	Why is this a Key Concern	Key Mitigation Options
Sediment inputs e.g. erosion	- Smothers aquatic organisms - Blocks sunlight from plants - Sediment carries nutrients - Poor recreational quality (clarity) and ecosystem health	  
Nutrient inputs e.g. fertiliser, erosion and stock	- Causes excessive growth of aquatic plants that can deplete oxygen	  
***E. coli* inputs** i.e. Faecal matter	- Faecal inputs, including pathogens, poses health risks to water users e.g. swimming and kai collection in the Estuary	  
Lack of riparian width and shade	- Stream temperatures get too high without shade - Excessive plant growth when not enough shade	
Lack of stream flow diversity e.g. riffles and rapids	- Poor fish and invertebrate habitat - Poor stream aeration	  
Minimal fish and invertebrate habitat	- Poor biodiversity - Poor energy flow to sustain ecosystems	
High levels of deposited sediment (on stream bed)	- Smothers aquatic organisms - Smothers habitat - Carries bound nutrients - Reduces recreational quality	  

Key: Mitigation Symbol Meanings

 *Increased riparian buffer zones*

 *Stock exclusion from waterways*

 *Wider catchment planting*

 *Targeted nutrient application*

Key Recommendations

In addition to those mitigation measures identified in Table 1, several other recommendations are made to assist the ATCGT meet its objectives. These include:

Further Investigation

To help refine mitigation options that may have the greatest effect, and to ensure the most cost-effective approach, PDP recommends the following:

Sediment

- Identify critical source areas for erosion control planting using modelled outputs for the Ahuriri Catchment (e.g., SedNet).
- Undertake an assessment of riparian margins, and critical sediment source areas, to identify where plantings and/or filter strips may be most effective.

E. coli

- Undertake an assessment of where stock exclusion would be beneficial and align with key riparian planting areas where possible.

Nutrients

- Assess opportunities for targeted nutrient application on a case-by-case basis when implementing the Freshwater Farm Plan initiative.
- Investigate how key nutrient parameters move through the landscape, to ensure the use of the correct riparian buffer zones to filter nutrients from surface and subsurface flows.

Effective riparian planting and stock exclusion is likely to have a positive impact on many of the issues identified in this report. Further investigation and environmental monitoring will also be required to provide a broader knowledge of baseline conditions, to identify critical source areas within the catchment, and to assess the effectiveness of the mitigation and remediation strategies.

Existing Data Sources

PDP recommends that ATCGT make use of the existing, publicly available monitoring information that is collected by Hawke's Bay Regional Council (HBRC) and other groups in the Ahuriri Catchment:

Hawkes Bay Regional Council (HBRC) – State of the Environment (SoE) Monitoring at 'Wharerangi Stream U/S Ahuriri Estuary'
See Data

HBRC conduct monthly State of the Environment monitoring along the Wharerangi Stream approximately 650m downstream from site B1 (site

known as 'Wharerangi Stream U/S Ahuriri Estuary'). The historical data (extending back to 2015) for *E. coli*, nitrogen and phosphorus provide a significant baseline or "starting point". With monthly monitoring, the SoE results for this site will provide suitable, accessible data for use in education, and driving community involvement and funding.
There are also data sets available for estuary health, at four monitoring sites within the Ahuriri Estuary. For interest, there is also data available for an urban tributary to the Ahuriri Catchment, called 'Taipo Stream at Church Road'. A full SoE report is available every 3 years.

Wilderlab eDNA – Collated data from eDNA assessments across the catchment
See map

Wilderlab is an environmental DNA (eDNA) testing lab, that tests DNA found in stream water to detect organisms that are living within, or close to, the waterway. Much of the data processed by Wilderlab is publicly available on their website, including data for the Ahuriri Catchment. Of particular interest, is the data for 'Wharerangi Stream U/S Ahuriri Estuary' and 'Wharerangi at 597 Puketitiri Rd', that were taken at approximately the same site as the HBRC SoE monitoring discussed above. These samples were taken on the 11th of April 2023, and the 20th of March 2022 respectively, both indicate poor stream condition. This collation of data provides a good starting point identifying species that are currently present, to then assess for the potential introduction of new native species to the area that may be a result of mitigation and remediation efforts, in particular the removal of fish passage barriers. Note that this data cannot be used to assess changes in population sizes.

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1.0 Introduction: *What did we do, and why?*

Pattle Delamore Partners Limited (PDP) have been engaged by the Ahuriri Tributaries Catchment Group Trust (ATCGT) to provide professional environmental services in establishing the baseline environmental conditions within the western rural freshwater tributaries (the tributaries) of Te Whanganui-a-Orotū (Ahuriri Estuary or Te Whanga).

The Ahuriri Tributaries Catchment Group were formed in recent years to recognise the effect of rural catchment activities on the freshwater tributaries and estuarine receiving environment within the western sub-catchments of Te Whanga. PDP understands the core visions of the group, specific to the catchment, are:

- To improve freshwater management, biodiversity & climate resilience.
- Improve water quality standards in local tributaries and ultimately in Te Whanga.
- To establish and expand relationships with landowners, organisations and iwi; and,
- To provide extension activities and environmental education to the community.

The baseline monitoring conducted by PDP aims to provide a “snapshot” of the current health of the tributaries to support decisions around the best strategies to use to most effectively improve the water quality, biodiversity and climate resilience of the tributaries and Te Whanga. This data will also provide a baseline from which to measure the potential impacts of remediation and mitigation measures brought in by ATCGT and the community. In effect, this will enable a better connection between the community and the tributaries, through the increased understanding of the condition of the catchment, what lives in the catchment, and how these data compare on a national and regional scale.

This report presents the findings of baseline monitoring carried out within the catchment, a limited assessment of existing publicly accessible data relevant to the catchment, along with PDP’s recommendations for ATCGT to consider in relation to their core visions and goal.

2.0 Sample Locations: *Where did we do it?*

2.1 Site Description

The Ahuriri Catchment, adjacent to Napier City covers 14,500 hectares. The majority of the catchment is in exotic grassland associated with sheep and beef farming. The rural land area is situated to the West of Te Whanga, and spans approximately 9,000 hectares, predominantly made up of small parcels of less than 20 hectares, with 232 landowners living adjacent to (within 5m of) a waterway (highlighted in Figure 1). The land uses range from lifestyle blocks to commercial farming and horticultural activities. During rainfall, contaminants associated with these land uses are washed into the, more than 70kms of tributary streams, flowing to Te Whanganui-a-Orotū.

Te Whanganui-a-Orotū was formed in the wake of the 1931 earthquake, as a remnant of the former Ahuriri Lagoon (HBRC, 2016; 2017). The estuary plays significant roles in ecological, cultural and recreational services, and is the interface between land and sea, supporting habitats of high ecological value. As a result of its exposure to rapid chemical and physical changes over tidal cycles, the estuary provides some of the most important and diverse habitats for a wide range of plants, birds and fish. Estuaries are significant reproductive habitats, and play an important role in water regulation and nutrient cycling. The Estuary also has significant cultural value for local iwi and provides a range of recreational services. Te Whanga also plays a key role in buffering stormwater discharges from the wider catchment and preventing flooding and associated social and economic costs during high rainfall weather events (HBRC, 2016; 2017).

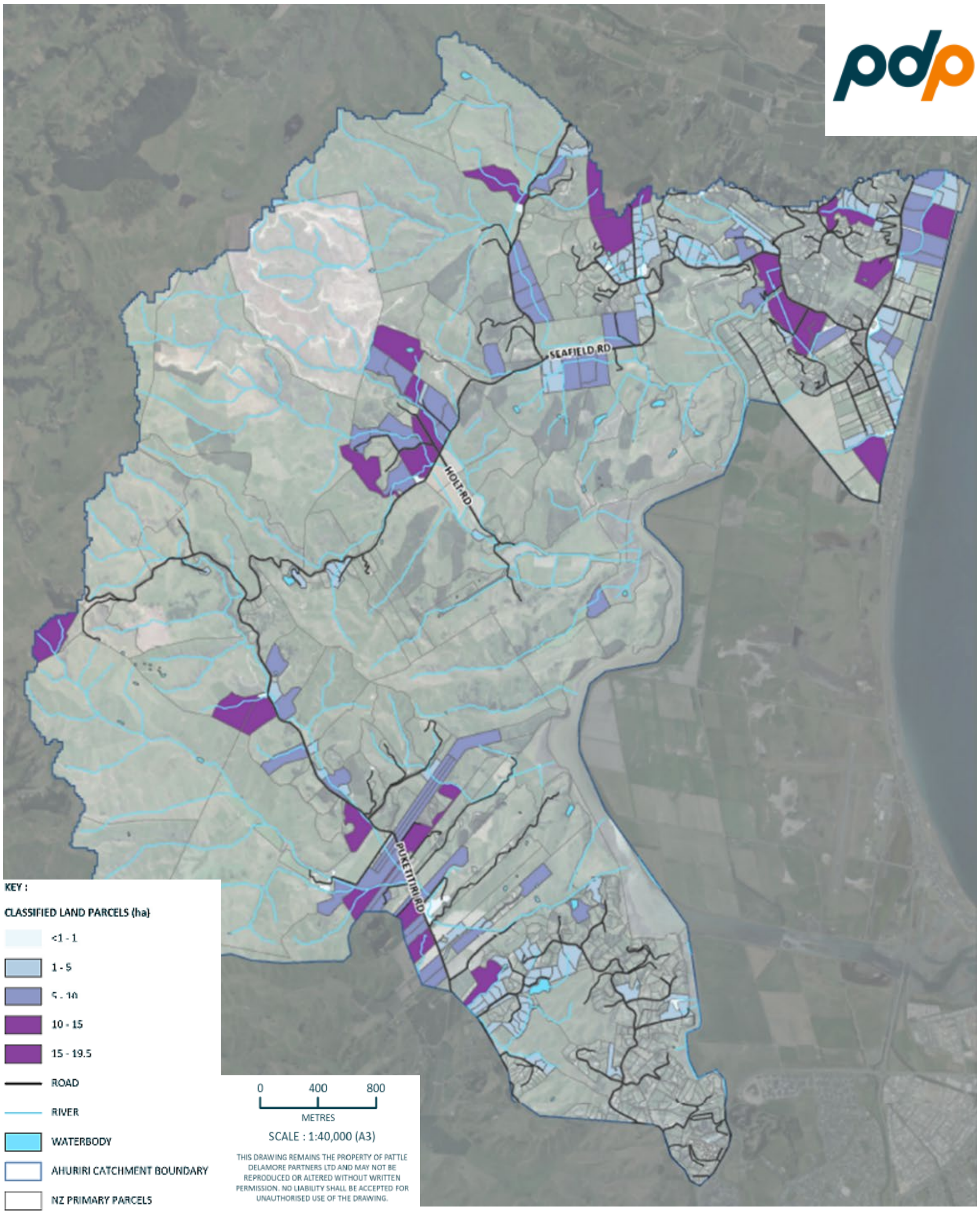

Figure 1: Ahuriri Tributaries Catchment Area

2.2 Monitoring Locations

Monitoring locations were divided into two groups, mid-catchment and lower catchment sites. Mid catchment sites, or Baseline Sites (B-Sites) were monitored to provide a general baseline understanding of habitat quality and water health, in a cost-effective manner. Lower catchment sites, or Testing Sites (T sites) were monitored to a greater degree of detail than the B sites, with a wider range of water quality parameters, under a range of conditions. This is because these sites are closer to the estuary, encompass water and sediments from a greater area of the catchment, and provided a more cost-effective starting point for identifying critical stressors in the Ahuriri tributaries.

Mid-Catchment Baseline or “B-sites” were monitored for in-situ (on-site) physicochemical water quality parameters (such as dissolved oxygen, temperature, pH, and electrical conductivity). The lower catchment testing, or “T-Sites”, were sampled and tested for a wide variety of contaminants. Both surface water and sediments were sampled at the T-sites, as well as the physicochemical parameters. Rapid Habitat Assessments (see Appendix E) were also conducted at all sites, to better understand the condition of the streams as habitat for freshwater organisms and provide an assessment of the riparian margins.

The mid catchment sites are depicted as Sites B1 to B8 (Figure 2). These sites are situated in the middle reaches of the tributaries, at steeper elevations above sea level (on average 45.5m) than those of the lower catchment sites (12.5m average elevation). The T-Sites are depicted as T1 to T6, and situated on low lying land, typically within a kilometre of the stream’s confluence with Te Whanga.

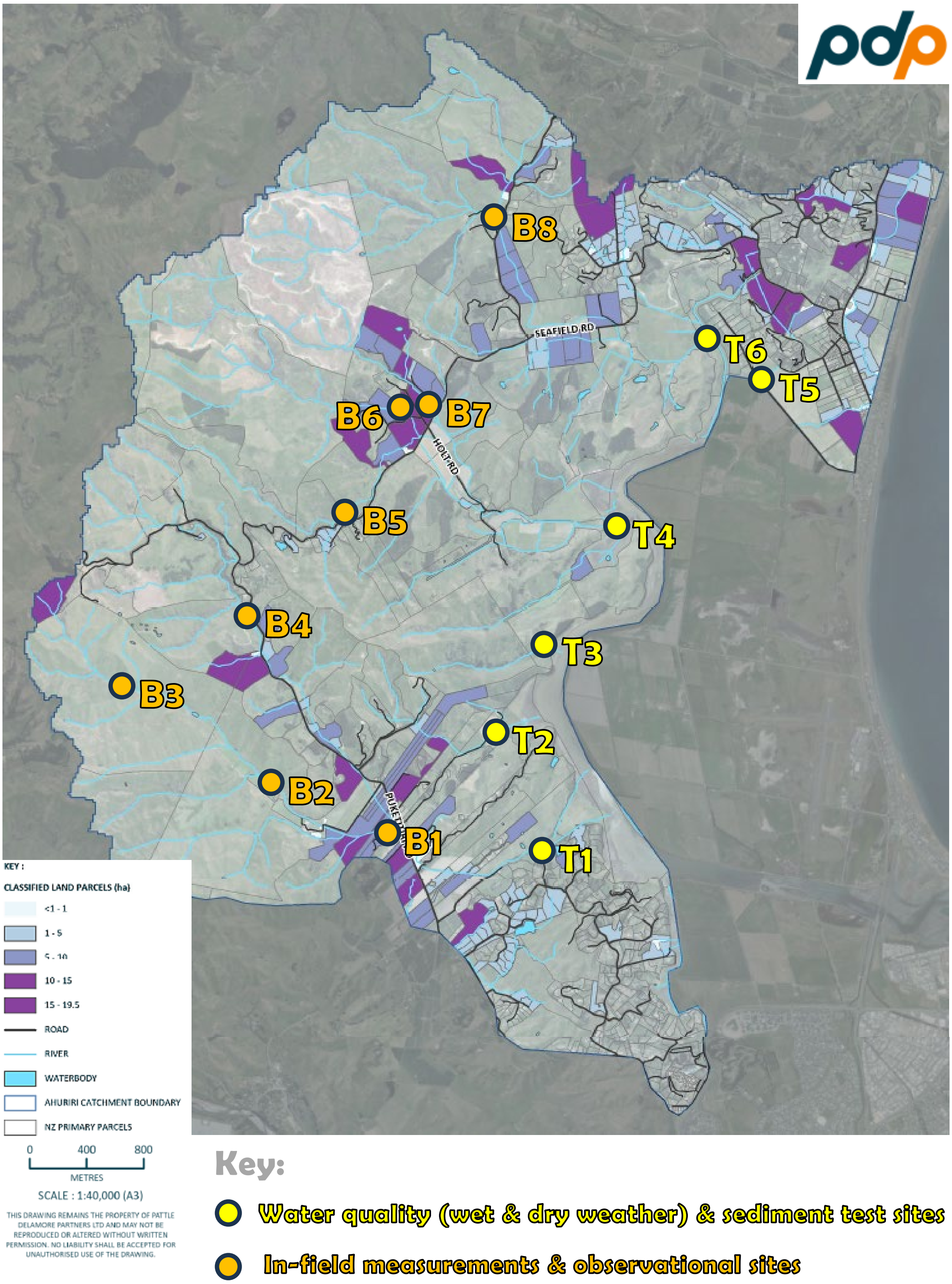

Figure 2: Ahuriri Tributaries Sampling Locations in the Mid and Lower Catchment

3.0 Methodology: *How did we do it?*

3.1 Field work

3.1.1 Water Quality

In order to gain an understanding of water quality in the Ahuriri catchment, PDP sampled the following analytes (Table 2), under dry weather (to identify base contaminant levels) and wet weather (to understand peak contaminant levels) conditions:

Table 2: Water Quality Parameters

Turbidity	The measure of sediment in water and how it effects light.
pH	How acidic or alkaline the water is.
Total Suspended Solids (TSS)	How much sediment is in the water.
Volatile Suspended Solids (VSS)	How much of the sediment in the water is organic.
Total Phosphorus (TP)	How much phosphorus of all types is in the water.
Dissolved Reactive Phosphorus (DRP)	How much phosphorus in the water is in the dissolved form (the most bioavailable forms).
Nitrate, Nitrite, Ammoniacal Nitrogen	Forms of nitrogen in the water.
Dissolved Inorganic Nitrogen (DIN)	The total of nitrate, nitrite and ammoniacal nitrogen (the most bioavailable forms).
Chlorophyll a	The concentration of microscopic plants in the water
Dissolved Organic Carbon (DOC)	How much organic material is in the water that is small in size.
Escherichia coli (E. coli)	Bacteria of faecal origin.

Surface water sampling was carried out in accordance with the National Environmental Monitoring Standards (NEMS) *Water Quality Part 2 – Sampling, Measuring, Processing and Archiving of Discrete River Water Quality Data* (NEMS, 2019). Field physicochemical parameters (temperature, dissolved oxygen, conductivity, pH and turbidity) were collected using a calibrated and verified ProDSS YSI multi meter. Samples were collected using an unpreserved laboratory bottle and extendable sample pole to reach the middle of the water column (approximately 30cm below the water surface where possible) and away from the side of the waterbody. Bottles containing preservative (such as those for testing for nitrogen species) were filled from an unpreserved bottle and not dipped in the water so as not to cause the preservative to run out. Samples were stored in a chilly bin with ice and dispatched to an IANZ accredited laboratory within 12 hours of collection under full chain of custody procedures.

Surface water was collected at the Lower Catchment "T-Sites" under dry conditions on the 18th of April 2024 (a period with no rain 5 days prior to sampling) in order to capture the baseline conditions of the tributaries. These T-Sites were also sampled under wet weather conditions on the 21st of May 2024, following 82mm of rainfall (as recorded at Newstead by HBRC rainfall gauge), in order to capture the effect of overland flow carrying runoff from the catchment area.

The Mid Catchment "B-Sites" were only monitored for in-situ physicochemical measurements during dry weather on the 11th of July 2024. No wet weather sampling was undertaken as part of the baseline assessment for these sites.

3.1.2 Sediment

On the 18th of April 2024, PDP collected composite sediment samples at the T sites during the dry weather surface water monitoring round. Sampling was carried out in accordance with the Ministry for the Environment's (MfE) Contaminated Land Management Guidelines No. 5 (MfE, 2021). These guidelines state that at least three representative samples are to be composited after the (potential) discharge has undergone reasonable mixing within the receiving environment.

At all sediment sampling locations, four sediment samples were taken from a transect within the stream channel and composited (mixed) on site. Composite sediment sampling is standard practice to reduce the effect of 'hot spotting' within the results. 'Hot spotting' is where, in particular areas of a stream, heavy metals tend to build in concentration levels compared to other areas (i.e. higher concentrations of heavy metals may be found).

Sediment samples were then placed into uniquely labelled laboratory provided containers for analysis.

3.1.3 Rapid Habitat Assessments

Rapid Habitat Assessments (RHA's) were conducted at each of the B and T Sites during dry weather. The RHA is a tool used to visually assess a number of physical characteristics of a stream reach against specified condition categories. This provides a 'habitat quality score' for that reach, indicating general stream habitat condition for the physical aspect, such as the structure of the stream banks or the nature of the stream bed. A blank copy of an RHA can be found in Appendix F.

3.2 Desktop assessment

PDP undertook a brief desktop review of the publicly available environmental DNA (eDNA) information relating to the rural Ahuriri Tributaries. eDNA refers to the traces of genetic material that remain in the environment as living organisms pass through a certain medium (i.e. soil or water). eDNA is useful in gaining a deeper understanding of life supporting capacity of a waterway as it calculates the overall Taxon-Independent Community Index (TICI) score. TICI is based on the tolerance values of organisms (similar to that of the Macroinvertebrate Community Index (MCI)) and is used to generate a score ranging from <80 (very poor), to 120 (pristine).

3.3 Guidelines

To better understand and contextualise the data collected from the Ahuriri Tributaries; the sampling results were assessed against relevant regionally derived, and national water quality guidelines and plans. Specifically, this included the:

- Proposed Plan Change 9, Hawkes Bay Regional Resource Management Plan, TANK Catchments (Tūtaekurī, Ahuriri, Ngaruroro, and Karamū) (HBRC, 2022) – referred to as TANK Guidelines.
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Default Guideline Values (ANZG, DGV) 2018; and
- National Policy Statement for Freshwater Management (NPS-FM) 2020 National Objective Framework (NOF).

These guidelines are summarised below.

3.3.1 TANK Catchments (Tūtaekurī, Ahuriri, Ngaruroro, and Karamū)

The Hawke's Bay Regional Council released a proposed plan change following amendments to the Regional Resource Management Plan in September 2022. Chapter 5.10 outlines the objectives and policies for managing land and water in the Tūtaekurī, Ahuriri, Ngaruroro, and Karamū (TANK) catchments. These include attribute bands based on the National Policy Statement for Freshwater

Management (NPS-FM). The guidelines include baseline, target and long-term attribute states for ecosystem health, and human contact. Schedule 26.2 contains the guidelines values relevant to the Ahuriri Catchment. The guideline values used to contextualise this report are those of the Taipo stream, as this monitoring site has sufficient data for a baseline attribute state to be identified, whereas the Wharerangi Monitoring Site has not been operating for sufficient length of time.

There are limitations with using this data, including;

- The Taipo stream is an urban lowland stream, as opposed to a rural lowland stream.
- The values in the TANK guidelines have been acquired from long term datasets, hence is not directly comparable to the discrete sample results of this report.

While the TANK Guidelines have limitations, they still provide valuable context to the data collated in this project, particularly with the provision of long-term targets, as is highly relevant to the Ahuriri Tributaries Community Group.

3.3.2 The Australian and New Zealand Guidelines (ANZG) for Fresh and Marine Water Quality 2018, Default Guideline Values

The ANZG 2018 (formerly ANZECC 2000) default guideline values (DGV) provide a national framework for assessing water quality based on physical, chemical, and biological characteristics. These characteristics are specific to river environment classification zones. The River Environment Classification (REC class) for the rural Ahuriri tributaries is “Warm, Dry Low-Elevation” coded WD-L (MfE, 2010).

The main focus of the ANZG 2018 DGVs for physical and chemical stressors is on water quality within the context of broader ecosystem health management and comparison to natural ‘reference conditions’. Two percentiles have been calculated for the DGVs, based on the stressor: 80th percentile for stressors (indicators) that are harmful at high values and 20th percentile for stressors that are harmful at low values. Water quality values that fall within the DGVs are reflective of reference conditions that can be expected in rivers and streams of that type (i.e., ‘Warm, Dry Low-Elevation’) with minimal or no anthropogenic influence.

3.3.3 National Policy Statement – Freshwater Management (NPS-FM 2020)

The NPS-FM 2020 national objectives framework (NOF) allows some parameters to be assessed against nationally consistent standards with water quality and ecological attribute bands and ‘national bottom lines’ for grading waterways based on the level of degradation. In this report, NPS-FM 2020 values have been applied where possible. It should be noted that many limits are designed to be calculated through monthly monitoring over a five-year timeframe and any comparisons to smaller data sets, such as that of this report, are indicative only.

4.0 Results: *What did we find?*

4.1 Water Quality – Mid Catchment

4.1.1 Mid Catchment

The physicochemical results from the mid-catchment B-Sites are presented below, with full results available in Appendix B Table B1.

Dissolved oxygen in the mid-catchment sites were all greater than the TANK guideline values, meeting the target attribute state (Figure 3). Dissolved oxygen at the B2 site (111.8%) was notably higher than the other sites (ranging from 95.4% to 100.1%). The range measured is within a healthy range for freshwater streams, however as the measurements were taken in the late morning, they are likely to miss the Dissolved Oxygen minima that is experienced in the early morning.

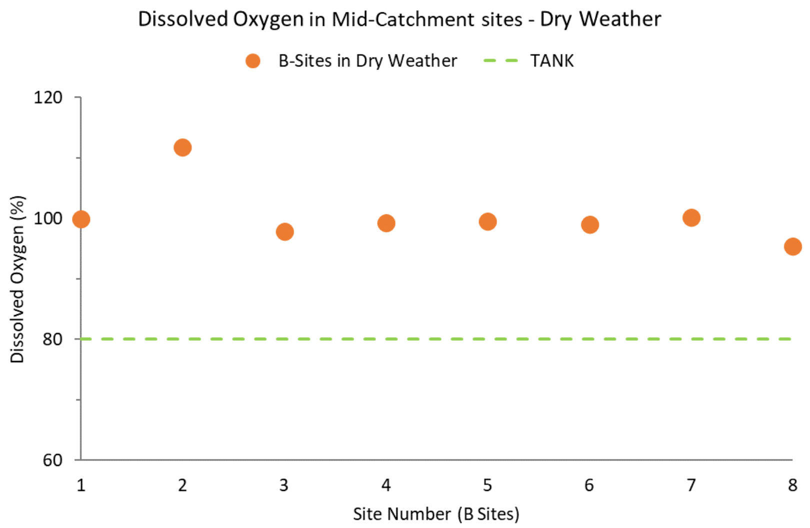

Figure 3: Dissolved Oxygen (DO) levels across the mid catchment sites (B sites), as compared to TANK guidelines.

Turbidity for the mid catchment sites in dry weather, as shown by Figure 4 tended to measure at low levels (below 3 FNU) for all but one of the mid catchment sites during dry weather. B7 had a higher turbidity of 13.8 FNU.

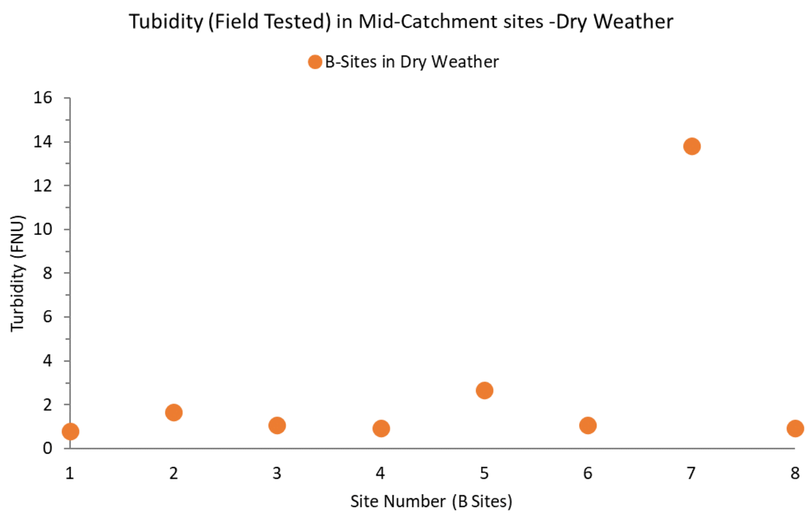

Figure 4: Turbidity of the mid catchment sites (B sites)

4.1 Water Quality – Lower Catchment

The water quality results from the lower catchment T-sites during both wet and dry weather against relevant guidelines, are presented as figures below. For full results, please see Appendix C. Note that there is no result for T5 in dry weather, as there was insufficient surface water available to sample at the time of monitoring.

The guidelines used include medians from the target attribute state (TAS) for Taipo stream from the TANK guidelines (HBRC, 2022). These values indicate a target value that the community has decided to aim for by 2040. Where TANK values are not available, ANZG DGV's have been used to contextualise the data as available.

Turbidity (as tested at the laboratory) in the lower catchment is shown below (Figure 5). All but one of the dry weather sites met ANZG DGV of 4.2 NTU, with T3 having a turbidity reading higher than the guideline value, at 6.5 NTU. During wet weather, none of the sites were below the ANZG guideline value (4.2), with the lowest reading of 21 NTU at T5, and the highest of 940 NTU at T1. The difference between the closed (dry weather) and open circles (wet weather) indicates the influence that wet weather has on turbidity levels in these waterways.

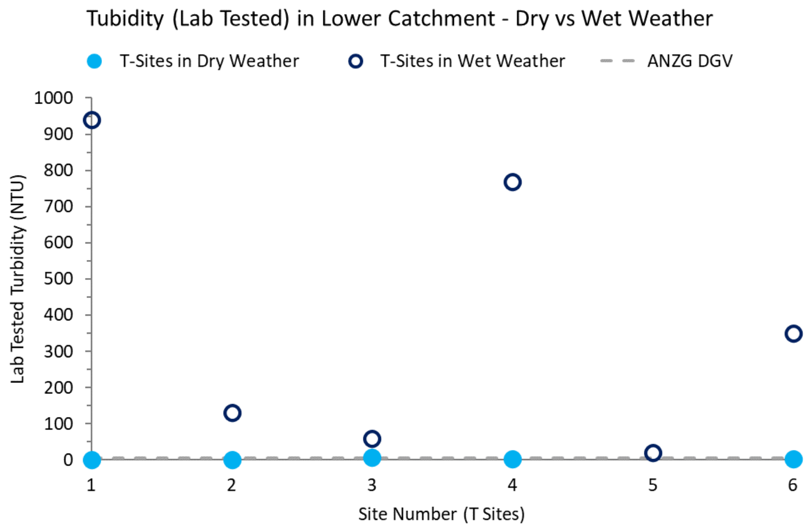

Figure 5: Lab tested turbidity in the lower catchment (T sites) against ANZG DGV guidelines. A comparison between dry and wet conditions.

Escherichia coli (E. coli) exceeded the TANK Target Attribute State (TAS) median at all sites in both weather conditions (Figure 6). The laboratory upper detection limit for *E. coli* (2,420 MPN/100mL) was reached in all wet weather samples, and at T3 in dry weather. This suggests high levels of faecal material can be transported to the waterways during rainfall.

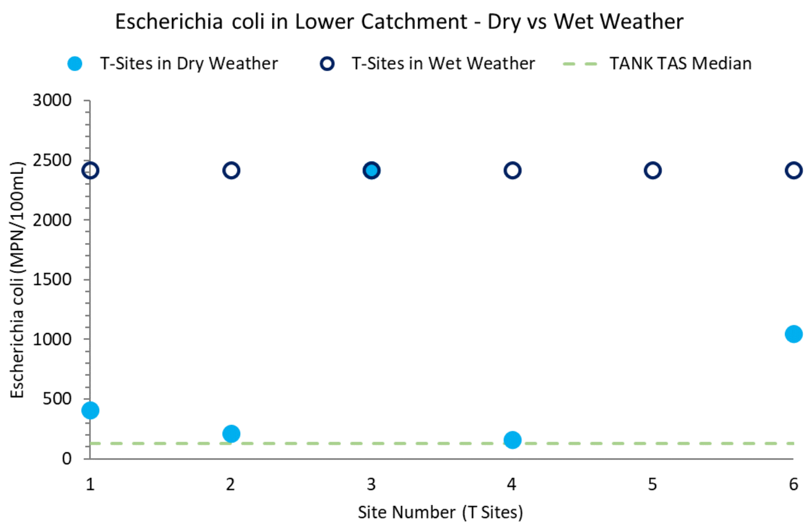

Figure 6: *Escherichia coli (E. coli)* in the lower catchment (T sites) against TANK guidelines. A comparison between dry and wet conditions.

Dissolved oxygen in dry weather conditions was within the target attribute state for all sites, however in wet weather conditions, sites T5 (78.2%) and T6 (79.9%) were below the guideline value (80%) (Figure 7). The dissolved oxygen at T4 is noticeably high in dry weather, with a reading of 170.9%. High levels of macrophyte growth at these sites may provide further information about these levels (discussed below).

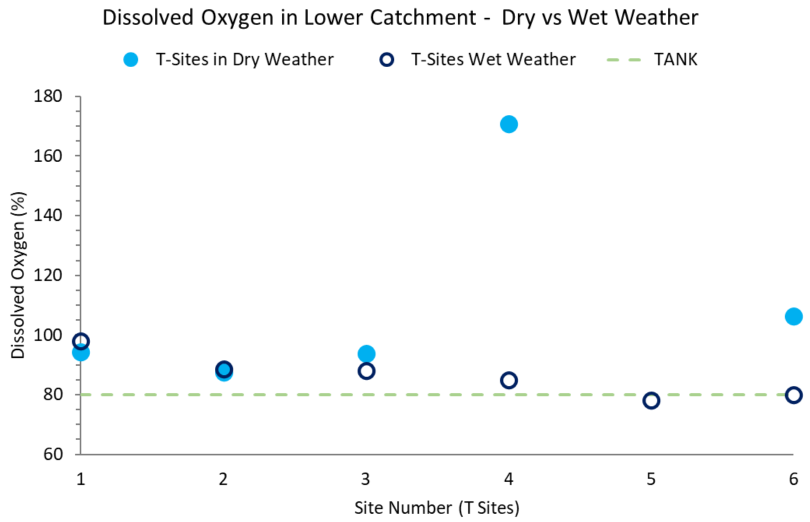

Figure 7: Dissolved Oxygen (DO) in the lower catchment (T sites) against TANK guidelines. A comparison between dry and wet conditions.

Nitrate levels were below the TANK TAS value for toxicity at all sites under both weather conditions. Nitrate values were noticeably higher under wet weather conditions, as demonstrated in Figure 8. It is important to note that the values associated with nitrate toxicity are higher than the levels of nitrate that can promote excessive algal growth. These are detailed below for the combined bioavailable nitrogen DIN level (*see* Figure 17).

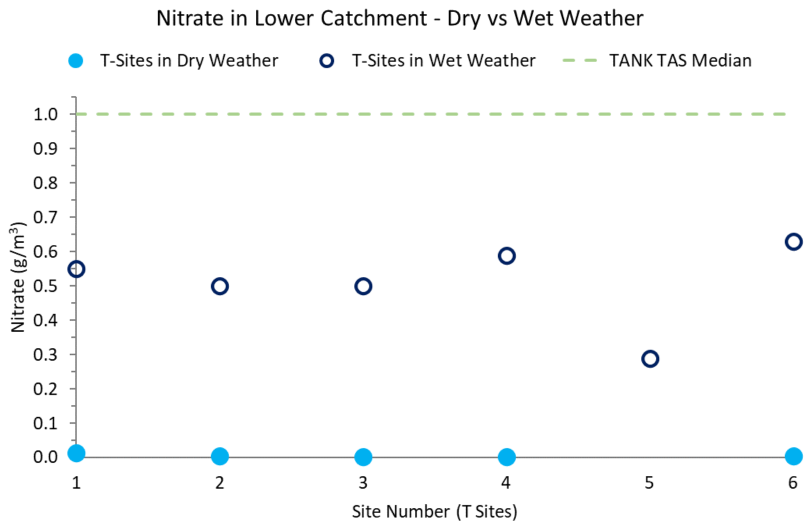

Figure 8: Nitrate in the lower catchment (T sites) against TANK TAS median. A comparison between dry and wet conditions.

Total ammoniacal nitrogen (NH4N) levels were below the TANK TAS Median (0.03 g/m^3) for all samples, aside from T5 in wet weather conditions (0.049 g/m^3)(Figure 9).

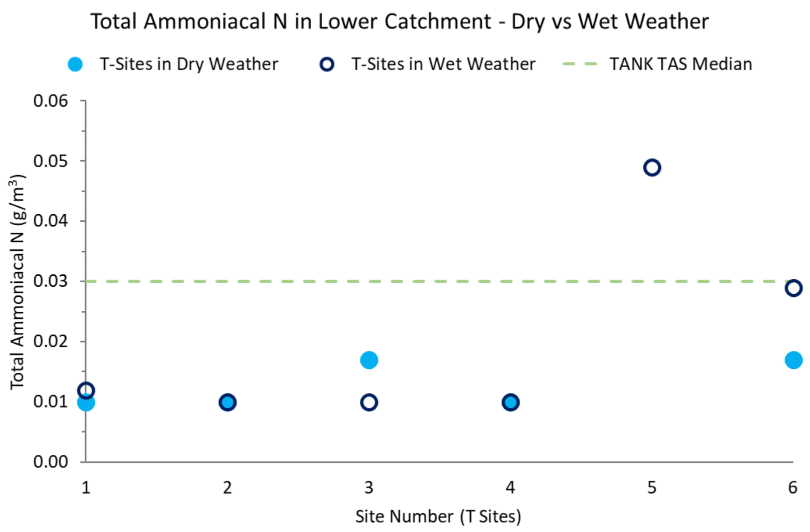

Figure 9: Total ammoniacal nitrogen (NH4N) in the lower catchment (T sites) against TANK TAS median. A comparison between dry and wet conditions.

Dissolved inorganic nitrogen (DIN) levels were below the TANK TAS Median (0.356 g/m3) for all dry weather samples, as well as at T5 in wet weather. This data distribution pattern shown in Figure 10 is similar to that of nitrate shown in Figure 8.

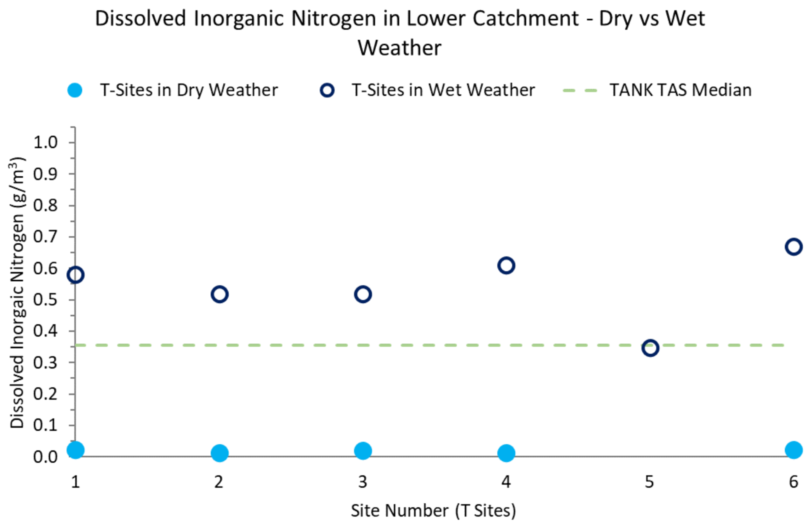

Figure 10: Dissolved Inorganic Nitrogen (DIN) in the lower catchment (T sites) against TANK TAS median. A comparison between dry and wet conditions.

Total phosphorus (TP) in the lower catchment sites all exceeded the ANZG DGV (0.023 g/m3), with values noticeably higher in wet weather conditions (Figure 11). During dry weather, the highest reading was measured at T3 (0.21 g/m3), and during wet weather, the highest value was measured at T1 (0.98 g/m3).

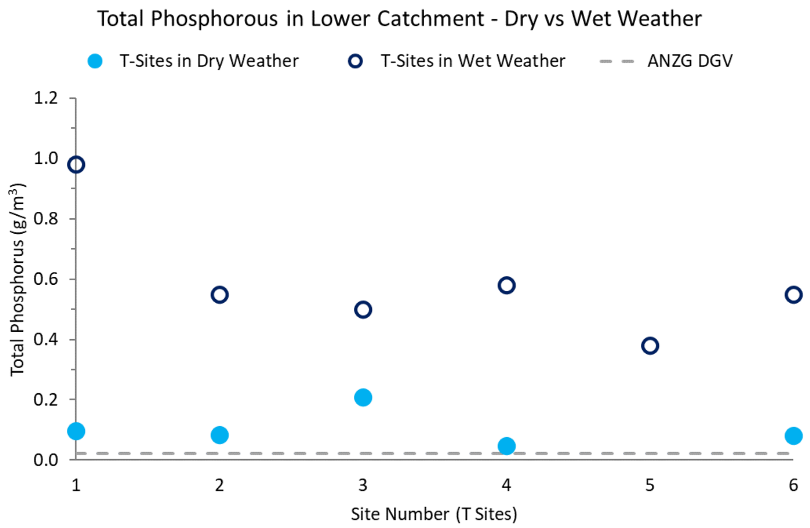

Figure 11: Total Phosphorus (TP) in the lower catchment (T sites) against TANK TAS median. A comparison between dry and wet conditions.

Dissolved reactive phosphorus (DRP) was higher than the TANK TAS Median value (0.018 g/m3) for all samples (Figure 12). As with TP, the highest value for DRP in dry weather was recorded at T3 (0.168 g/m3), however in wet weather the highest value was measured at T2 (0.35).

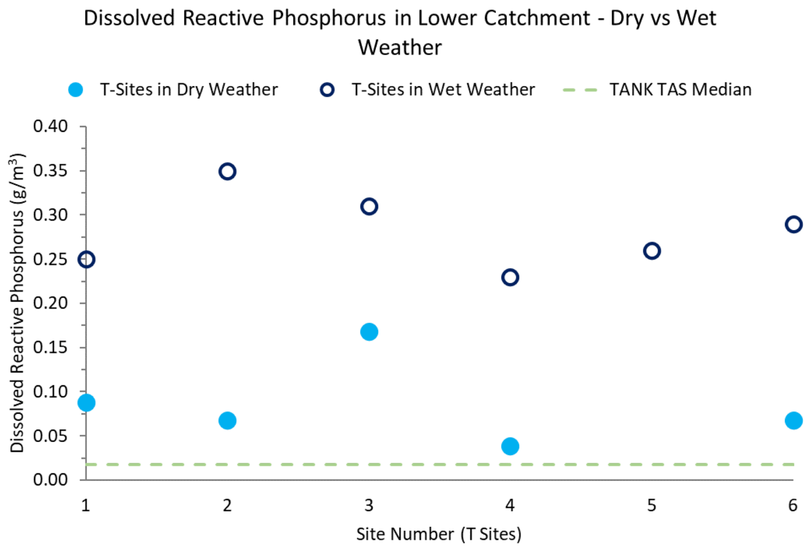

Figure 12: Dissolved Reactive Phosphorus (DRP) in the lower catchment (T sites) against TANK TAS median. A comparison between dry and wet conditions.

Total phosphorus (TP) is made up of all the phosphorus found in a water sample, some of which is in the dissolved form as dissolved reactive phosphorus (DRP). Whether the phosphorus is in particulate form, or the dissolved form can have implication for the best way to manage phosphorus to reduce levels getting into waterways.

Table 3 below, shows the proportion of total phosphorus (TP) that was present in dissolved form (DRP) at the time of sampling, in wet and dry conditions. In dry conditions, the percentage of total phosphorus found as DRP ranged from 80% to 91%, while in wet conditions, this ranged from 26% to 68%.

Table 3: Percentage of total phosphorus as dissolved form in wet vs dry conditions.

Weather condition	Parameter	T1	T2	T3	T4	T5	T6
Dry Weather	Total Phosphorus	0.097	0.084	0.210	0.049	-	0.082
	Dissolved Reactive Phosphorus	0.088	0.068	0.168	0.039	-	0.068
	Percentage of TP as DRP	**91%**	**81%**	**80%**	**80%**	**-**	**83%**
Wet Weather	Total Phosphorus	0.98	0.55	0.5	0.58	0.38	0.55
	Dissolved Reactive Phosphorus	0.25	0.35	0.31	0.23	0.26	0.29
	Percentage of TP as DRP	**26%**	**64%**	**62%**	**40%**	**68%**	**53%**

4.1.1.1 TANK Attribute Bands

This section presents the results of the lower catchment sites in both wet and dry weather, against an overlay of attribute bands from the TANK guidelines. The bands start with Band A, depicted as blue, indicating the most optimal state, and recedes to Band D, coloured red. It should be noted that the *E. coli* figure below (Figure 13) uses values from the NPS-FM Table 9 to distinguish the band ranges.

E. *coli* in the lower catchment had values within three different attribute band ranges. In dry weather, T1, T2 and T4 had E. *coli* levels within the A Band range, while T6 was within the range of Band C. T3 had values in the range of Band D for both dry and wet weather, with all wet weather samples presenting E. *coli* levels coinciding with the Band D value range. Again, it is important to note that the NPS-FM and TANK bands are expected to be used for longer term monitoring datasets, where medians, and percentiles that comply with different requirements can be calculated. The bands depicted below are for the 95th percentiles of data, and therefore longer term monitoring data may indicate that dry weather levels do not comply with Band A for other statistics.

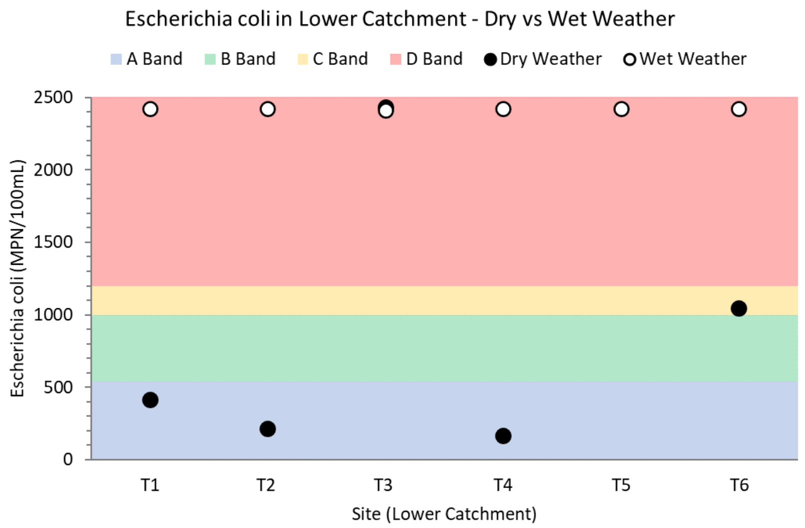

Figure 13: *Escherichia coli (E. coli)* in the lower catchment (T sites) against TANK TAS attribute bands. A comparison between dry and wet conditions.

Dissolved oxygen was within the A attribute band range for all lower catchment sites (Figure 14); however, it is important to note that dissolved oxygen under the NPS-FM is identified by the minimum level, which typically occurs during the early morning. The spot samples taken during this sampling were taken throughout the day and would therefore not represent the minima.

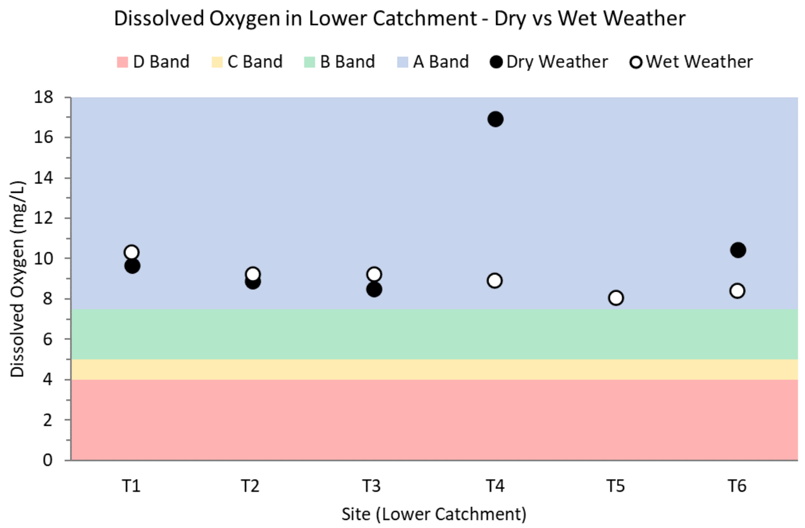

Figure 14: Dissolved Oxygen (DO) in the lower catchment (T sites) against TANK TAS attribute bands. A comparison between dry and wet conditions.

Nitrate levels measured against toxicity criteria (rather than where levels may increase the risk of eutrophication) measured within the A Band range for all samples taken (Figure 15).

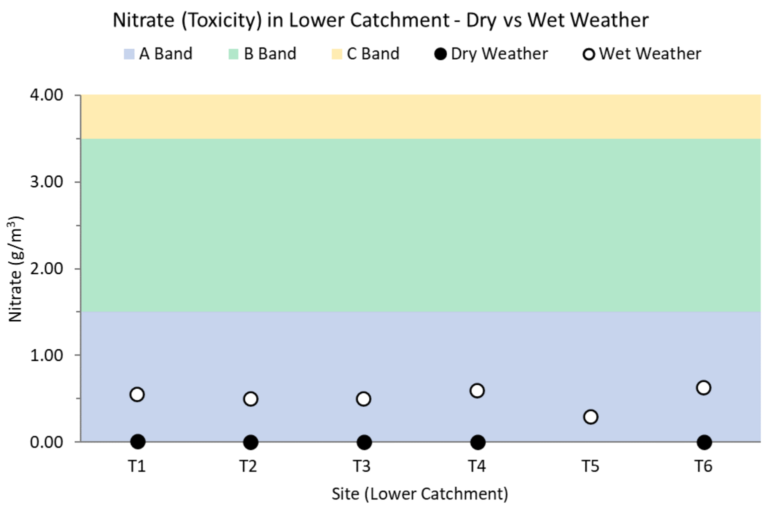

Figure 15: Nitrate in the lower catchment (T sites) against TANK TAS attribute bands. A comparison between dry and wet conditions.

Ammonia toxicity was measured as within the range of attribute Band A, for all sites under both weather conditions (Figure 16). Again, this is a measure of toxic effects as opposed to nutrient enrichment.

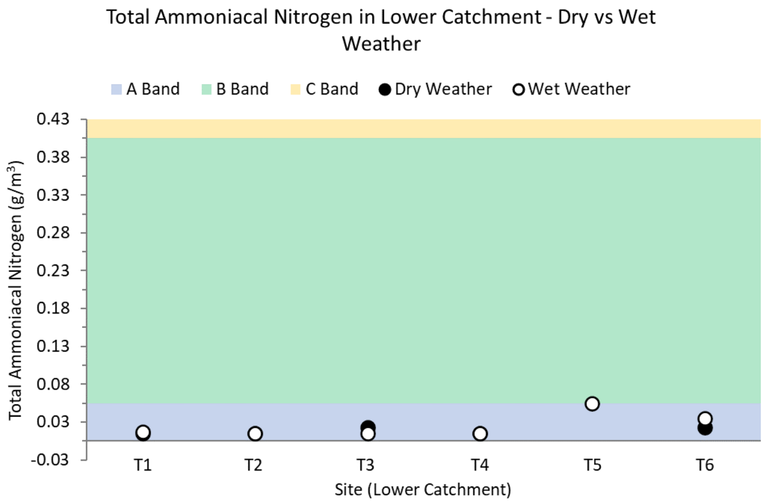

Figure 16: Total ammoniacal nitrogen (NH4N) in the lower catchment (T sites) against TANK TAS attribute bands. A comparison between dry and wet conditions.

Dissolved Inorganic Nitrogen (DIN) is represented in the TANK Guidelines sourced from ANZG guidelines rather than the NPS-FM. Under TANK levels within the green are considered ‘unlikely to be concerning’ whereas levels in the orange are considered ‘investigation/management recommended’. The dashed line represents the target attribute state which, in this case, reflects the current baseline state (0.356 mg/L) which is to be ‘maintained’.

All dry, and the wet weather sample at T5, were within the range of Band A (Figure 17). The remainder of the wet weather samples were within the range of Band B.

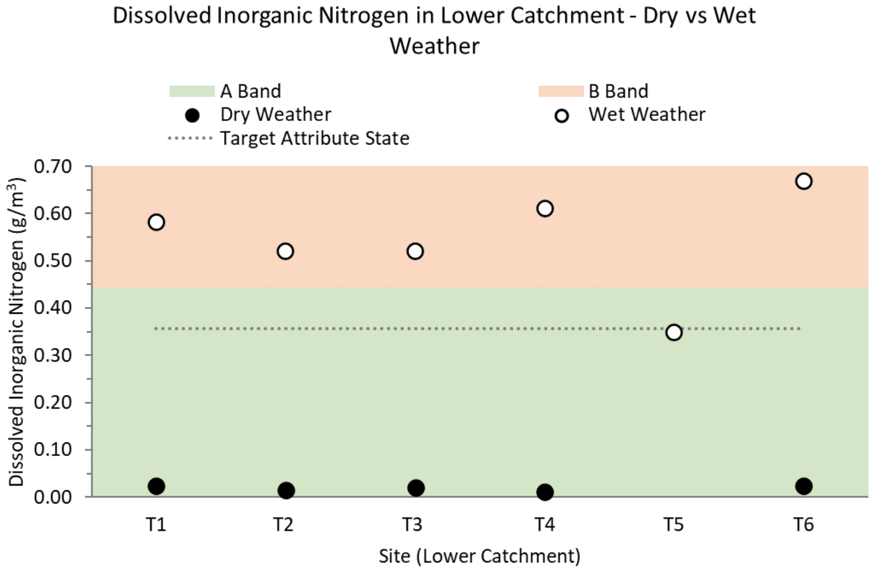

Figure 17: Dissolved inorganic nitrogen (DIN) in the lower catchment (T sites) against TANK TAS attribute bands. A comparison between dry and wet conditions.

The results for DRP (Figure 18) show that all but the T4 dry weather sample value, fall within the D Band range. The dry weather T4 sample is within the C Band range.

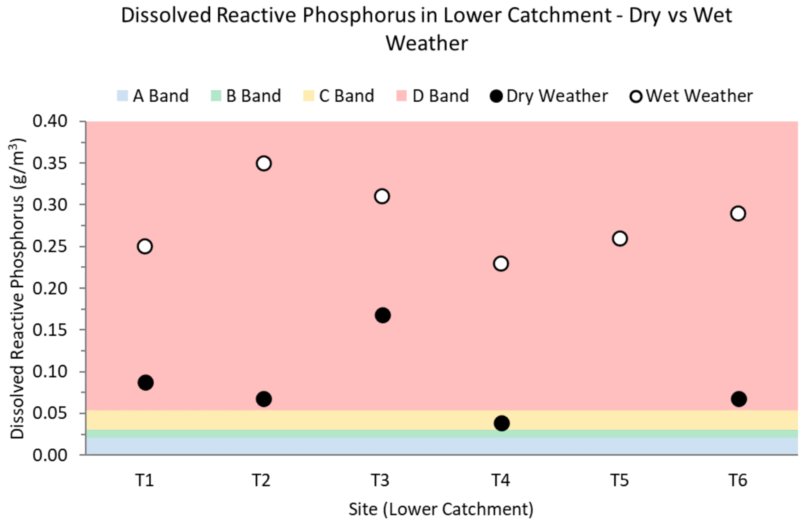

Figure 18: Dissolved reactive phosphorus (DRP) in the lower catchment (T sites) against TANK TAS attribute bands. A comparison between dry and wet conditions.

4.2 Sediment

This section presents the key results of the sediment sampling. For the full results table, see Table D1, Appendix D.

Total recoverable zinc was present below ANZG values for all sites but approached the guidelines at site T5 (Figure 19).

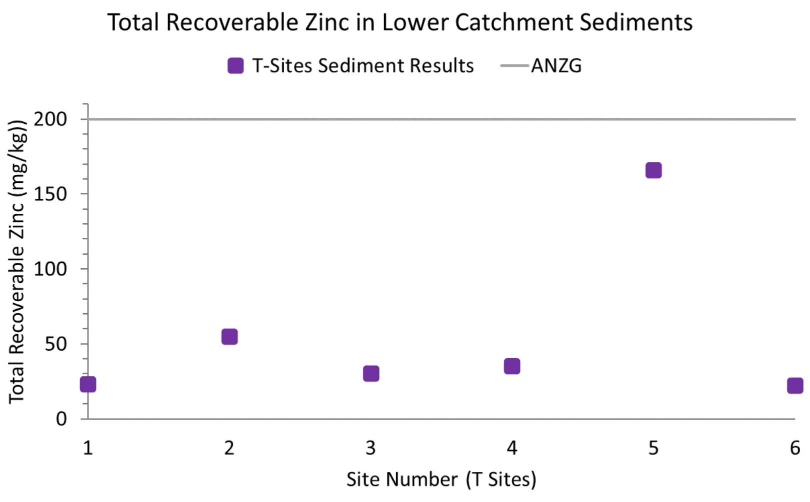

Figure 19: Total Recoverable Zinc in the lower catchment sediments (T sites), compared against ANZG DGV guidelines

Total recoverable copper was present at levels below ANZG guidelines at all sites, (Figure 20). A similar peak was observed at site T5 and may require further investigation.

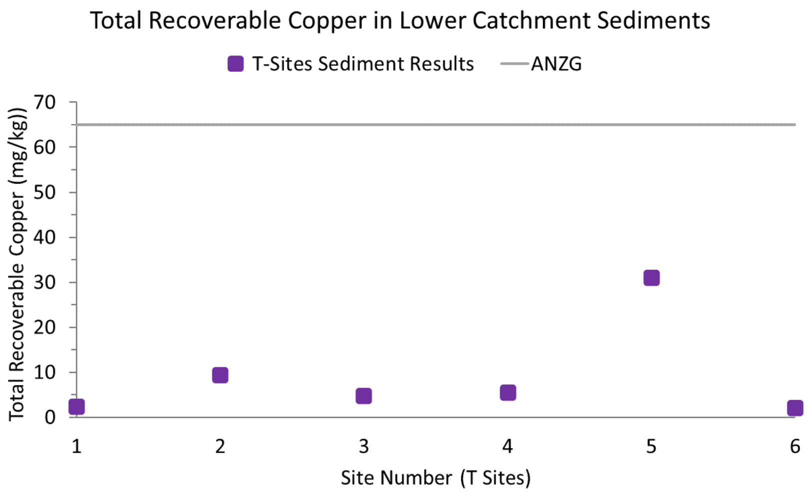

Figure 20: Total Recoverable Copper in the lower catchment sediments (T sites), compared against ANZG DGV guidelines

Four of the five sediment sites showed relatively low Total Recoverable Phosphorus (Figure 21), with higher levels observed at sites T2 and T5.

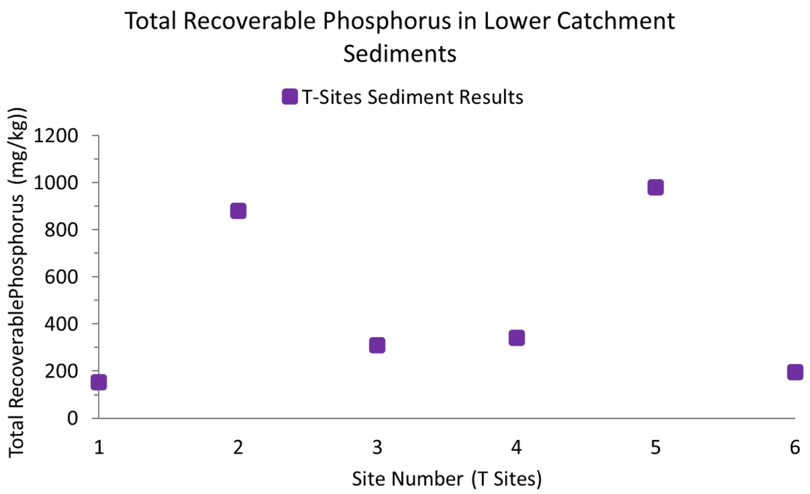

Figure 21: Total Recoverable Phosphorus in the lower catchment sediments sites (T sites)

The results for metals, as well as phosphorus, all appear to follow a similar pattern with higher levels at sites T2 and T5 (see appendix D for all figures). All values were below relevant guidelines. As per Table D1, there were no traces of total petroleum hydrocarbons (TPH's), polycyclic aromatic hydrocarbons (PAH's), or organochlorine pesticides (OCP's).

4.3 Rapid Habitat Assessments

Summary results of the RHA's are presented in Tables 4 and 5 below. For the full results, see Appendix E. Photographs of the sites can be found in Appendix A.

Table 4 shows the total Habitat Quality Scores for each site from their respective RHA assessments. The total score is out of 100. Values above 75% indicate 'optimal' stream habitat; 50-75% indicates 'suboptimal' stream habitat; 25-50% indicates 'marginal' stream habitat and <25% indicates 'poor' stream habitat.

As shown in Table 4, the lowest scoring sites were B2 (18) and B5 (26), while the highest scoring sites were B3 (71) and B6 (61).

Table 4: Rapid Habitat Assessment (RHA) Summary of Habitat Quality Scores

B Sites							
B1	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**
47	18	71	42	26	61	48	47
T Sites							
T1	**T2**	**T3**	**T4**	**T5**	**T6**		
40	44	34	36	36	54		

Notes:
The total score is out of 100. Values above 75% indicate 'optimal' stream habitat; 50-75% indicates 'suboptimal' stream habitat; 25-50% indicates 'marginal' stream habitat and <25% indicates 'poor' stream habitat.

The lowest vs highest scoring sites, B2 and B3 respectively, are visually represented in Figure 22 below. Site B2 (left) is situated in a sheep holding paddock, with no visible flow. It is seen to be a soft bottomed stream bed (sediment covered), with no riparian margin. Site B3 has sparse plantings of young, native vegetation growing in a fenced riparian margin. The stream has visible flow, including runs, riffles and rapids, over a hard bottomed stream bed of gravel, cobbles and boulders. There are visible undercut banks and encroaching vegetation from elevated stream banks.

Figure 22: Photographs of lowest scoring vs highest scoring sites for Rapid Habitat Assessments. Site B2 on the left, a score of 18. Site B3 on the right, a score of 71.

Table 5 shows the average scores recorded for B-sites and T sites. The scores recorded at each stream represent the condition of the stream against each physical stream attribute (e.g. deposited sediment, or bank erosion). These scores are known as condition scores. The average condition scores provide a summary of the attribute conditions over the mid and lower catchment. All attribute categories are scored out of 10. Values above 7.5 indicate 'optimal' stream habitat; 5.0-7.5 indicates 'suboptimal' stream habitat; 2.5-5.0 indicates 'marginal' stream habitat and <2.5 indicates 'poor' stream habitat.

The B sites are seen to range from 2.9 to 5.9, while T-sites ranged from an average score of 1.3 to 7.7 for any one attribute. On average, the worst scoring attributes for the mid catchment B-sites were riparian shade and bank vegetation, with average scores of 2.9 and 3.0 respectively. The lowest scoring attributes for the lower catchment T-sites were invertebrate habitat abundance, hydraulic heterogeneity, and deposited sediment, with scores of 1.3, 1.7 and 1.8 respectively.

Bank erosion in the B sites was on average scored 4.6, while the T sites had an average of 7.7 for this attribute. The T sites had on average higher scores for fish cover diversity and abundance (6.0 and 6.8 respectively) than the B sites (4.9 and 4.0 respectively). Both B and T sites had low scores for riparian width and riparian shade, with scores below 3.6.

Table 5: Average RHA Condition Scores for mid catchment B-Sites and lower catchment T-Sites

Attribute	B Sites average score	T Sites average score
1. Deposited sediment (<2mm)	5.9	1.8
2. Invertebrate habitat diversity	5.5	5.0
3. Invertebrate habitat abundance	5.4	1.3
4. Fish cover diversity	4.9	6.0
5. Fish cover abundance	4.0	6.8
6. Hydraulic Heterogeneity	5.3	1.7
7. Bank Erosion	4.6	7.7
8. Bank vegetation	3.0	4.3
9. Riparian width	3.6	2.8
10. Riparian shade	2.9	3.2
Total	45.0	41.0

Notes:
All categories are scored out of 10, the total score is out of 100. Values above 75% indicate 'optimal' stream habitat; 50-75% indicates 'suboptimal' stream habitat; 25-50% indicates 'marginal' stream habitat and <25% indicates 'poor' stream habitat.

4.4 Ecology – eDNA

This section presents the results of the desktop assessment of available eDNA data for the Ahuriri Rural Catchment.

The eDNA data was sourced from the Wilderlab website, using all comprehensive sample data available at the time (accessed September 2024). This included 9 sample sites.

All eDNA results in the Ahuriri catchment scored between 'poor' and 'average' on the taxon independent community index (TICI). The results show a large presence of worms, midges, flies and moths. There are also a number of sensitive species that appear on the eDNA sequences, including Koura (freshwater crayfish), Tuna (Shortfin and Longfin eel), and the Common Bullies (toitoi). Long-fin eels (*Anguilla dieffenbachia*), koara (*Galaxias brevipinnis*), inanga (*Galaxias maculatus),* giant bully (*Gobiomorphus gobioides)*, bluegill bully (*Gobiomorphus hubbsi*), and torrentfish (*Cheimarrichthys fosteri*) were all identified in these samples and are all currently classified as 'At risk – Declining'. Results also indicate the presence of caddisflies; a macroinvertebrate included in the 'EPT', or 'pollution sensitive' taxa.

5.0 Discussion: *What does this mean?*

5.1 Mid Catchment

Key areas of concern in the mid catchment include:

- Dissolved Oxygen
- Turbidity
- Fish Habitat
- Riparian Margins
- Bank Erosion

5.1.1 Habitat condition

The mid-catchment sites showed areas of concern with regards to low RHA condition scores for riparian shade, riparian width, bank vegetation, fish cover abundance and fish cover diversity attributes. Site B2 had the low scores of riparian width, riparian shade and bank vegetation that coincided with a high dissolved oxygen reading. Unshaded streams allow sunlight to reach the stream bed and allow for increased photosynthesis and subsequent growth of plants and algae. Increased plant growth can result in high DO concentrations during the day and very low DO concentrations overnight. These diurnal fluctuations in oxygen levels are caused by photosynthesis during daylight hours producing oxygen, and respiration at night-time consuming oxygen. Oxygen concentration peaks in the afternoon with photosynthesis and minimum concentrations occur in the early morning hours due to oxygen consumption. While the remainder of the sites had appropriate levels of DO, this is not to say that they are not also experiencing cyclical DO levels, as monitoring occurred during morning hours, with DO maximum typical in the afternoon. To further assess this, 24-hour monitoring of DO levels would need to be conducted, as opposed to the spot measurements conducted in this project.

B sites on average provided marginal fish cover abundance and diversity. This aligns closely with the poor riparian attributes. Fish cover refers to substrates such as woody debris, root mats, undercut banks, over hanging/encroaching vegetation, macrophytes, boulders and cobbles. While many of the B sites had macrophytes and undercut banks providing for some amount of fish cover diversity, there was a general lack of woody debris, root mats and encroaching vegetation, as would be provided by riparian vegetation, resulting in low fish cover diversity scores. Fish cover abundance refers to the percentage of the stream reach covered by the substrates mentioned above. Once again, a riparian buffer with encroaching vegetation was generally lacking, reducing the cover percentage of the streams.

A number of 'At Risk – Declining' freshwater fish species were detected in the eDNA sampling. This indicates the ability for these habitats, if restored further, to support populations of these important species.

5.1.2 Suspended sediment

Site B7 had higher turbidity than the other B sites. This indicates a potential sediment source. At the time of monitoring, there were visual indicators suggesting that earthworks had been conducted in the stream at this site, the likely cause of the increased turbidity.

5.2 Lower Catchment

Key areas of concern in the lower catchment include:

- Turbidity
- Escherichia coli
- Dissolved Oxygen
- Nutrients (both N and P)
- Riparian Margins
- Invertebrate Habitat
- Hydraulic Heterogeneity (stream complexity)

- Deposited Sediment

5.2.1 Habitat condition

In contrast to the B sites, the RHA assessments highlighted invertebrate habitat abundance, hydraulic heterogeneity (stream complexity), and deposited sediment as attributes of the most concern in the lower catchment, in addition to riparian width and shade. Invertebrate habitat abundance and hydraulic heterogeneity are closely related. Hydraulic heterogeneity simply means the different number of ways water can flow down a stream. Examples include fast and slow runs, pools, rapids, backwater, riffles and waterfalls. Invertebrate habitat abundance refers to the percentage of a stream bed that are favourable to invertebrates. This includes flowing water over gravel, and cobbles clear of periphyton and macrophytes. For a habitat to be favourable to invertebrates, it typically requires flowing water, or hydraulic heterogeneity, to bring new food material from upstream, prevent the deposition of smothering sediments and reduce the growth of algae. This lack of hydraulic heterogeneity, and hence invertebrate habitat, may be the result of being lowland streams, with low energy, and slow flowing water. Low energy water readily deposits sediment, which is another key concern for the lower catchment sites, scoring “poor” on average for the T site RHA assessments. While lowland streams may naturally be depositional environments for sediment, reducing the overall sediment load is likely to improve the habitat quality of the streams. Further assessment of deposited sediment coverage could provide further understanding of the areas of concern within the catchment.

Riparian planting encroaching the stream can increase hydraulic heterogeneity over time (Cornacchia et al., 2023). Riparian vegetation adds woody debris, adjusting where sediment is retained within the stream bed, which portions of a stream bank are more stable than others, and adds barriers to stream flow that can result in modification to stream flow over time, through the formation of any combination of riffles, runs, pools, and/or cascades.

5.2.2 Oxygen

As was observed at the B Sites, diurnal dissolved oxygen fluctuations are likely to be occurring in the lower catchment, because of high macrophyte and periphyton growth. Unlike the mid catchment sites, nutrient data was collected in the lower catchment that further supports this, indicating elevated levels of DIN and DRP, nutrients in bioavailable (plant accessible) form. Excess bioavailable nutrients present in unshaded streams supports macrophyte and periphyton growth, further driving the diurnal fluctuations of oxygen in the stream. If oxygen in the stream overnight gets too low, this can impact negatively on the species in the waterways that require dissolved oxygen to respire.

Sites T5 and T6 had dissolved oxygen levels below guideline values during wet weather conditions. This is also an indicator of high macrophyte growth. During wet weather conditions, rainfall increases flow within the stream, and allows for greater interaction between the water and the atmosphere, creating aeration as it moves through the stream channel, resulting in oxygenation of the water. For dissolved oxygen levels to be lower under wet weather conditions, indicates that dissolved oxygen is likely being consumed by respiring plants and organisms, more quickly than oxygen is being gained. There are also visual observations represented in both the RHA's and photographs from T5 and T6 that support the observation of high macrophyte growth. In the RHA's, macrophytes are recorded in the fish cover abundance attribute, with condition scores of 6 (T5) and 9 (T6) (see appendix E, Tables E13 and E14). T5 (Appendix A, photographs 17 and 18) has visible reed like macrophytes growing within the stream bed and along the banks. While at T6 (Appendix A, photographs 19 and 20) there are visible aquatic plants along both the stream bed and stream banks.

5.2.3 Nutrients

Nitrogen (N) and phosphorus (P) are key 'growth limiting' macronutrients that influence the growth rate and coverage of algae (or periphyton) and aquatic plants (macrophytes) (HBRC, 2016a). Dissolved Inorganic Nitrogen (DIN) and Dissolved Reactive Phosphorus (DRP) are dissolved inorganic forms of the nutrients N and (P respectively. DIN includes nitrate-nitrogen (NO3-N), nitrite-nitrogen (NO2-N) and ammoniacal-nitrogen (NH4-N). DRP includes phosphate. Although numerous other forms of nitrogen and phosphorus exist, it is DIN and DRP as the dissolved forms that are most readily available for uptake by plants, hence are most relevant for assessing nuisance plant growth. The terms total nitrogen (TN) and total phosphorus (TP) refer to the sum of all forms of N and P respectively. At sufficiently elevated concentrations, nitrate and ammonia forms of nitrogen have toxic effects on aquatic organisms (and on humans when it comes to nitrate). This effect is independent of their significance as plant nutrients (HBRC, 2016a).

5.2.3.1 Nitrogen

From a toxicity perspective, nitrogen as both ammonia and nitrate were below TANK guideline values, indicating that the levels of nitrogen in the streams are not toxic to the aquatic organisms. However, regarding plant growth, DIN did exceed TANK guidelines during wet weather. As DIN is a key driver of plant growth, this plays a key role on the extent of periphyton and macrophytes in the streams. As DIN is elevated in wet weather conditions, it is likely that the source of the nitrogen is from land use, with excess nutrients being carried into the stream by run-off. Sources of DIN include effluent, fertilisers, the breakdown of plant material, atmospheric inputs, and sediment recycling.

5.2.3.2 Phosphorus

Phosphorus in the lower catchment sites, as TP and DRP, were above relevant guidelines in both dry and wet weather. Both DRP and TP were found in greater concentrations during wet weather. TP refers to a sum of all P found in the sample, whether bound to sediment or dissolved in the water column. DRP is the dissolved P that is bioavailable to periphyton and aquatic plants. The proportion of TP in the form of DRP, was on average greater during dry weather (83%) than in wet weather (52%). This indicates that during wet weather, a greater proportion of P is bound to sediment. As suspended sediment load increases during wet weather, it is likely that the sediment run-off from the catchment is the cause of the elevated TP in wet weather conditions.

5.2.4 Sediment

Turbidity readings in the lower catchment were highly elevated in wet weather conditions, particularly at sites T1, 2, 4 and 6. Turbidity is a measure of water clarity, and an indicator of suspended sediments within the stream. The elevated results are likely the result of erosion within the catchment, exposing lose sediments that are carried into the stream by stormwater run-off. These high suspended sediment loads during wet weather were noticeably observable across all lower catchment sites, at the time of sampling, as shown in the photos of Appendix A. A sample of these photos, showing the difference in water clarity during dry and wet weather, is shown in figure 23 below.

Figure 23: Photographs of Site T6 during dry (left) and wet (right) weather, showing the decreased water clarity during wet weather as a result of increased sediment load, that was a common occurence across all lower catchment sites (see Appendix A).

Sources of high sediment loads may include stream bank erosion, as a result of stock access to the stream and a lack of riparian width and suitable bank vegetation resulting in unstable banks. While there was visible evidence of stock accessing streams, and unstable banks at the time of sampling, the RHA condition scores indicated that on average, the bank erosion was in the lower range of "optimal", while riparian width and bank vegetation were on average "marginal" across the lower catchment. As such this indicates that while there is room for improvement in the stability of the stream banks, particularly in the width of the riparian zone and the quality of vegetation on the stream banks, there may be other critical sources of sediment from within the catchment. Erosion also occurs in the wider catchment, particularly in steeper sloped areas with minimal vegetation. During high rainfall events, these areas are likely to be hot-spot sources for sediment generation and transport (HBRC, 2017). Without appropriate riparian buffer zones, consisting of a diverse assortment of mature, native vegetation, this sediment is carried as run-off into the streams.

Implications of high suspended sediment loads include the smothering of filter feeding organisms, and the degradation of visual clarity inhibiting visual feeders. Sediment in the water column also blocks the penetration of sunlight, restricting photosynthesis of aquatic plants. Sediments are also often bound to nutrients, such as phosphate, further exacerbating nutrient enrichment concerns.

Strategies to reduce suspended sediment loads in wet weather include minimising stream bank erosion through the exclusion of stock access, and the diverse planting of vegetation particularly species with large, stabilising root systems. Vegetation along the riparian zone can also trap sediment, preventing it from reaching the stream. Further steps can also be taken to prevent erosion in the wider catchment, through erosion control planting, particularly in areas of steep geomorphology.

5.2.5 Escherichia coli (E. coli)

E. coli is a bacterium commonly found in the lower intestine of warm-blooded animals. It is an important indicator of the presence of faecal contaminants which may include pathogens in the water. *E. coli* is used to assess the health risk to water users that come into direct contact with water. *E. coli* in the lower catchment sites were consistently above guidelines. *E. coli* levels were significantly elevated during wet weather flows. Values of particular interest however, occurred at T3 and T6 during dry weather. These values are particularly high, indicating that stock may have access to the stream. Both T2 and T5 were situated in areas used for grazing and had “poor” RHA scores for riparian width, indicating that stock could access the stream banks, or indeed the stream bed itself. Another potential source of the high *E. coli* is septic tanks. Further assessment (e.g., faecal source tracking) is needed to narrow down the sources.

5.2.6 Benthic Sediments

Metals in the benthic (stream bed) sediments of the lower catchment were all at concentrations below national guidelines. There was no detectable presence of OCP’s, PAH’s, TPH’s or nitrogen. There was a pattern across the metals, TP and total organic carbon (TOC), in that sites T2 and T5 had higher concentrations than the rest of the lower catchment sites. An assessment of the land uses of the sub catchments that contribute to each of these streams would be required to provide insight as to the cause of this pattern. It is likely that these sub-catchments have a higher proportion of urban and/or industrial land uses. High TOC and TP in sediments can indicate the expression of eutrophication (HBRC, 2020).

5.2.7 Ecology

While some pollution sensitive freshwater species were found across the sites, there were also many pollution tolerant species, with an overall poor to average TICI. This combined with the low scores for RHA’s indicates that the tributaries are poor quality habitats for freshwater organisms.

This conclusion of poor habitat quality is supported by the results of the RHA's to say that there is "sub optimal" to "marginal" habitat diversity and abundance for both fish and invertebrates, with invertebrate habitat abundance in the lower catchment sites on average being of "poor" habitat quality. The likely occurrence of diurnal oxygen fluctuations, as a result of unshaded nutrient rich streams, also supports the conclusions of poor habitat quality.

5.2.8 Summary

Overall, the results of this project have provided baseline indications as to the health of the tributaries, and highlighted areas for further monitoring and potential remediation strategy focus, such as riparian zones. It has also shown that the concern areas of the Rural Ahuriri Tributaries, such as nutrients, sediment, and *E. coli* are the same concerns facing the Ahuriri Estuary itself, as identified in State of the Environment (SOE) monitoring for 2013-2018 (HBRC, 2017; 2020). As a result, it is reasonable to perceive that remediation of the Rural Ahuriri Tributaries will have a follow-on positive impact on the water quality, biodiversity, climate resilience and recreational value of Te Whanganui-a-Orotū.

6.0 Recommendations: *What happens next?*

This project provided a snapshot of the environmental state of the Ahuriri rural tributaries. PDP have the following recommendations, that would further support targeted mitigation of the key stressors identified for the rural tributaries.

6.1 Key Mitigation Measures

As summarised in Table 1, the key stressors may be mitigated by land management actions, including increased riparian buffer zones. Riparian buffer zones assist in stabilising banks to prevent erosion and provide for the entrapment of sediment and nutrients in the filtering of run off and subsurface flows. They also provide shade for the adjacent waterway which can reduce the extent of excess aquatic plant growth and algae in the streams. This can prevent the dissolved oxygen fluctuation between the extreme low dissolved oxygen levels during the morning when plants are respiring, and high dissolved oxygen during the day when plants are photosynthesising. Riparian zones also prevent stock access to streams, reducing the direct sources of *E. coli*, and preventing the trampling of stream banks that exacerbates erosion. The shade, increased habitat (encroaching vegetation and root mats), and production of woody debris can provide increased habitat suitable for fish and invertebrate colonisation. Riparian planting close to the stream can also assist in promoting changes in stream flow past root mats and overhanging/encroaching vegetation, as well as over branches, which can act to provide additional habitat.

Stock exclusion is important for reducing the direct sources of *E. coli* and associated pathogens to the tributaries and preventing the trampling of the stream banks, that can lead to erosion and slumping. Removing stock access to waterways also allows for vegetation to establish in these areas.

Further information on the four key mitigation measures is outlined below.

Riparian Buffer Zones

Increase the riparian buffer zone planting along waterways, with planted buffer zones of at least 10m of width on either side of the stream (Parkyn *et al*., 2000), consisting of a variety of native vegetation, right to the water's edge. It is important to use the correct type of buffer zone (filter strip, planted buffer, or multi-function buffer) of appropriate widths, with stock exclusion and weed management processes in place. This will increase efficiency, support sustainable vegetation growth and allow the buffer zones to meet the intended aquatic functions.

Stock Exclusion

Exclude stock from waterways as much as possible using riparian zones and/or fencing.

Wider Catchment Planting

Increase the proportion of the wider catchment area that is planted, (i.e. not just the buffer zones adjacent to waterways) with a particular focus on steeply sloped areas. This will help prevent erosion of these steep slopes, as well as intercept rainfall and reduce run off in heavy rainfall.

Targeted Nutrient Application

Apply nutrients with a targeted approach, to reduce the amount of nutrients that are lost to run off.

Further Investigation

To help refine mitigation options that may have the greatest effect, and to ensure the most cost-effective approach, PDP recommends the following:

Sediment

- Identify critical source areas for erosion control planting using modelled outputs for the Ahuriri Catchment (e.g., SedNet).
- Undertake an assessment of riparian margins, and critical sediment source areas, to identify where plantings and/or filter strips may be most effective.

E. coli

- Undertake an assessment of where stock exclusion would be beneficial and align with key riparian planting areas where possible.

Nutrients

- Assess opportunities for targeted nutrient application on a case-by-case basis when implementing the Freshwater Farm Plan initiative.
- Investigate how key nutrient parameters move through the landscape, to ensure the use of the correct riparian buffer zones to filter nutrients from surface and subsurface flows.

Effective riparian planting and stock exclusion is likely to have a positive impact on many of the issues identified in this report. Further investigation and environmental monitoring will also be required to provide a broader knowledge of baseline conditions, to identify critical source areas within the catchment, and to assess the effectiveness of the mitigation and remediation strategies.

Existing Data Sources

PDP recommends that ATCGT make use of the existing, publicly available monitoring information that is collected by Hawke's Bay Regional Council (HBRC) and other groups in the Ahuriri Catchment:

Hawkes Bay Regional Council (HBRC) – State of the Environment (SoE) Monitoring at 'Wharerangi Stream U/S Ahuriri Estuary'
See Data

HBRC conduct monthly State of the Environment monitoring along the Wharerangi Stream approximately 650m downstream from site B1 (site known as 'Wharerangi Stream U/S Ahuriri Estuary'). The historical data (extending back to 2015) for *E. coli*, nitrogen and phosphorus provide a significant baseline or "starting point". With monthly monitoring, the SoE results for this site will provide suitable, accessible data for use in education, and driving community involvement and funding.

There are also data sets available for estuary health, at four monitoring sites within the Ahuriri Estuary. For interest, there is also data available for an urban tributary to the Ahuriri Catchment, called 'Taipo Stream at Church Road'. A full SoE report is available every 3 years.

Wilderlab eDNA – Collated data from eDNA assessments across the catchment See map

Wilderlab is an environmental DNA (eDNA) testing lab, that tests DNA found in stream water to detect organisms that are living within, or close to, the waterway. Much of the data processed by Wilderlab is publicly available on their website, including data for the Ahuriri Catchment. Of particular interest, is the data for 'Wharerangi Stream U/S Ahuriri Estuary' and 'Wharerangi at 597 Puketitiri Rd', that were taken at approximately the same site as the HBRC SoE monitoring discussed above. These samples were taken on the 11th of April 2023, and the 20th of March 2022 respectively, both indicate poor stream condition. This collation of data provides a good starting point identifying species that are currently present, to then assess for the potential introduction of new native species to the area that may be a result of mitigation and remediation efforts, in particular the removal of fish passage barriers. Note that this data cannot be used to assess changes in population sizes.

To access the data of interest, open the link above (or visit the Wilderlab website and click on the explore tab), and scroll in on the map to the area of interest. Select a sample icon (note that the gold icons 'gold standard', are of better-quality data) and click on "Explore batch". From this page it is possible to view a range of interactive information about the species detected in the sample, as well as an overall "stream condition" score.

7.0 References

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