ATTACHMENTS MINUTES

Waiāri Kaitiaki Advisory Group Meeting

Wednesday, 9 June 2021

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Pātaka Kai Project
Dean Flavell & Elva Conroy
(Ngāti Tuheke)
9 June 2021

Our Vision

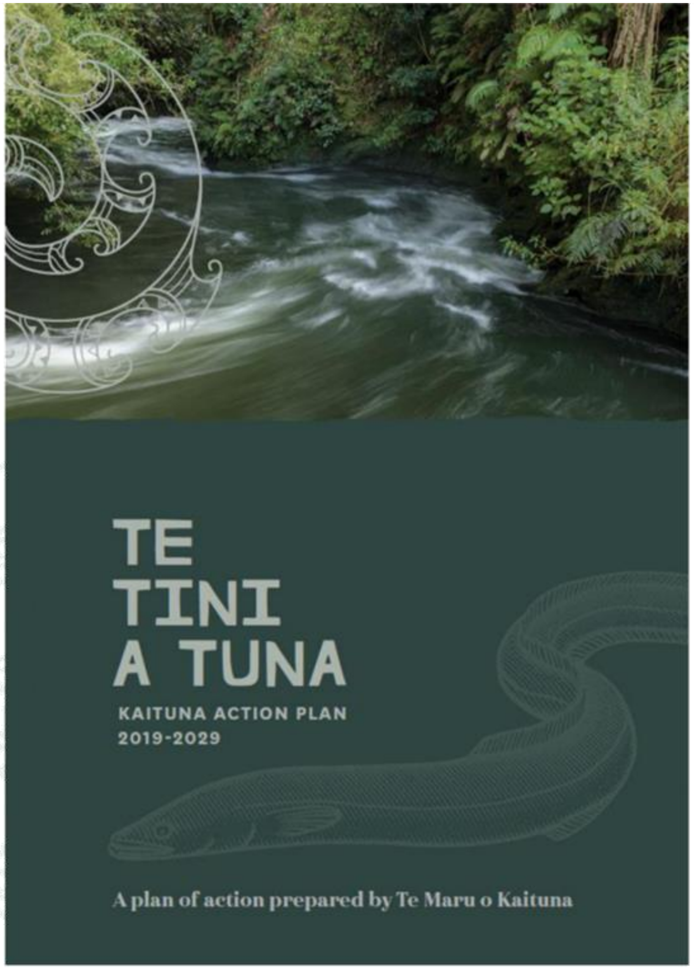
E ora ana te mauri o te Kaituna
e tiakina ana hoki mō ngā whakatupuranga ō nāianei
ō muri nei hoki.

The Kaituna River is in a healthy state and protected
for current and future generations.

Objective 1
The traditional and contemporary relationships that iwi and hapū have with the Kaituna River are provided for, recognised and protected.

Objective 2
Iwi-led projects which restore, protect and/or enhance the Kaituna River, are actively encouraged, promoted and supported by Te Maru o Kaituna through its Action Plan.

Te Maru o Kaituna River Authority is a co-governance partnership set up by



A 10 Year Plan of Action

PRIORITY ACTION 1: Take collective responsibility for improving the health and well-being of the Kaituna River and its tributaries

- Project 1. Lowland drains and drainage canal improvement project
- Project 2. Freshwater quality and quantity limits project
- Project 3. Consented takes and discharges project
- Project 4. Focus catchments project
- Project 5. Farm environment plans project

PRIORITY ACTION 2: Create a network of healthy and diverse Kaituna habitats and ecosystems

- Project 6. Post Kaituna River re-diversion enhancement project
- Project 7. Wetland re-creation project
- Project 8. Kaituna habitats network project
- Project 9. Pātaka kai project

PRIORITY ACTION 3: Connect our communities and visitors to our river and to our projects

- Project 10. Kaituna community connection project
- Project 11. Kaituna River access project
- Project 12. Kaituna cycleway/walkway project
- Project 13. Kaituna cultural and historical heritage project
- Project 14. Upper catchment 'gateway' project
- Project 15. Coastal park network project

ENABLING ACTION 1: Collect good information about the health of the Kaituna River and its tributaries

- Project 16. State of the Awa integrated monitoring and reporting project
- Project 17. Kaituna catchment network mapping project

ENABLING ACTION 2: Establish a Kaituna River restoration and enhancement fund

- Project 18. River restoration and enhancement fund project

Te Maru o Kaituna River Authority is a co-governance partnership set up by

kaituna.org.nz

Purpose of the Pātaka kai project

To increase and enhance habitats for kai awa, in particular tuna (eels), inanga (whitebait), kōura (crayfish), kākahi (freshwater mussels) and watercress.

To enable hapū and Iwi to demonstrate, in a practical way, kaitiakitanga of ngā awa me ngā taonga of the Kaituna River.

Te Maru o Kaituna River Authority is a co-governance partnership set up by the Tapuika Claims Settlement Act 2014, made up of iwi and council representatives

kaituna.org.nz

Our approach (2021ish – 2023)

1. Where did our kaiawa used to be?	2. Where are our kaiawa now?	3. Where do we prioritise restoration efforts?
Research	*Co-developed kaiawa monitoring plan*	*Restoration Plan(s)*
	Kaiawa Monitoring	

Connect whanau, hapu and Iwi to this project and their respective awa

Te Maru o Kaituna River Authority is a co-governance partnership set up by the Tapuika Claims Settlement Act 2014, made up of iwi and council representatives

NEW ROLES:

- Project coordinator
- Communications and administrative support
- Researcher(s).
- Kaimahi to undertake physical monitoring.
- GIS support and data management.
- Plan and report writer(s).

STATUS: APPLYING FOR FUNDING

- Te Wai Māori Fund – submitted
- WBOPDC Community Matching Fund - submitted
- BOPRC – EEF (pending)
- BayTrust / TECT – Combined meeting to discuss options

4SIGHT
CONSULTING

LAND. PEOPLE. WATER.

Tauranga City

WAIARI WATER TREATMENT PLANT: WAIARI STREAM MONITORING REPORT 2021

For Tauranga City Council
3Waters

May 2021

REPORT INFORMATION AND QUALITY CONTROL

Prepared for:	3Waters Tauranga City Council	

Author:	Keren Bennett Principal Ecology Consultant	
Reviewer:	Katrina Browne Senior Environmental Consultant	
Approved for Release:	Keren Bennett Ecology Manager	

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1 INTRODUCTION

Tauranga City Council (TCC) holds resource consent (No. 65637) to take water for municipal supply from the Waiari Stream, near Te Puke.

Conditions 7.1 and 7.2 of the water take consent require biological monitoring to be undertaken over the life of the consent, namely:

- *Three consecutive years prior to construction of the water supply scheme commencing;*
- *Three consecutive years after abstraction reaches a rate greater than 30,000 cubic metres per day;*
- *Once every five years thereafter and between the two survey periods specified above if there is more than 5 years between them for the duration of this consent.*

Specifically, quantitative monitoring of macroinvertebrate communities, fish surveys, macrophyte monitoring and basic water quality monitoring are required.

Conditions 7.1 and 7.2 are further summarised as follows:

Surveys are to be carried out in February of each year of survey, at four locations along the Waiari Stream;

- *above and below the water intake site and;*
- *above and below the Te Puke wastewater treatment plant discharge point.*

Macroinvertebrate samples are to be collected using quantitative protocols, with macrophytes sampled at all four sites and hard-bottomed samples collected from two sites around the proposed intake site.

Fish surveys are to be undertaken using single-pass electric-fishing and baited G-minnow traps at all sites.

Water quality (temperature, pH, turbidity and dissolved oxygen) are to be recorded at each site.

Based on the original timeframes anticipated for commissioning of the water intake plant, monitoring was initially carried out for three seasons between 2010 - 2012 (Bioresearches, 2010; 2011; 2012); however, commissioning of the water intake project was then put on hold because of reduced demand (Bioresearches, 2012). The project was subsequently rescheduled and, as an additional five years had passed since the 2012 baseline survey, a repeat of the biological monitoring survey was undertaken in 2017 (4Sight, 2017).

Construction of the water intake infrastructure and associated instream works commenced in 2018 and is ongoing. 4Sight was commissioned to undertake an additional biological survey in 2019 and annually thereafter, prior to the water take commencing. Construction works were underway at the time of the 2019 survey and were ongoing during most recent 2021 survey. These 2019, 2020 and 2021 surveys are additional to the consented requirements and are intended to provide a broader picture of the Waiari Stream biological features prior to the water take commencing.

This report presents the results from the survey of four sites in the Waiari Stream undertaken over 23 and 24 February 2021.

2 SURVEY METHODS

2.1 Site locations

Four stream sites were sampled, with the locations at three sites based on those assessed in the 2010 – 2017 surveys (Table 1 & Figure 1). For the 2019 and 2020 surveys infrastructure construction works were underway in the vicinity of the intake location and the original Site 2 was not accessible at the time of survey. As such, Site 2 was relocated (Site 2a) to an accessible location approximately 650 metres downstream of the original site. Limitations to safe access and available habitats for survey at Site 2a prompted a review of the downstream 'Site 2' location prior to the 2021 survey. Given the now accessible stream banks below the intake, Site 2 was relocated back upstream (Site 2b), closer to the original Site 2 location.

The eastern (true right) bank opposite and downstream of the intake site has been recontoured and reinforced with rock revetement as part of the instream works in this area. The rocks extend into the stream and provide potential habitat for macroinvertebrate communities and cover for fish. Woody debris, accessible from the western stream bank was present within a swiftly flowing riffle a short distance downstream of the previous extent of instream works.

Access to Sites 1 and 2b was obtained via the construction accessway and temporary bridge crossing from 244 Te Matai Road, Te Puke. The accessway via 315 No. 1 Road was undergoing upgrade works at the time of survey.

Sites 1 and 2b were located upstream and downstream, respectively, of the proposed water intake site (WTP). Sites 3 and 4 were located upstream and downstream, respectively, of the Te Puke wastewater treatment plant (WWTP) outfall, in the lower reaches of the stream (Figure 1). Sites were marked by GPS and photographed, so that they could be relocated for future surveys (see Table 1).

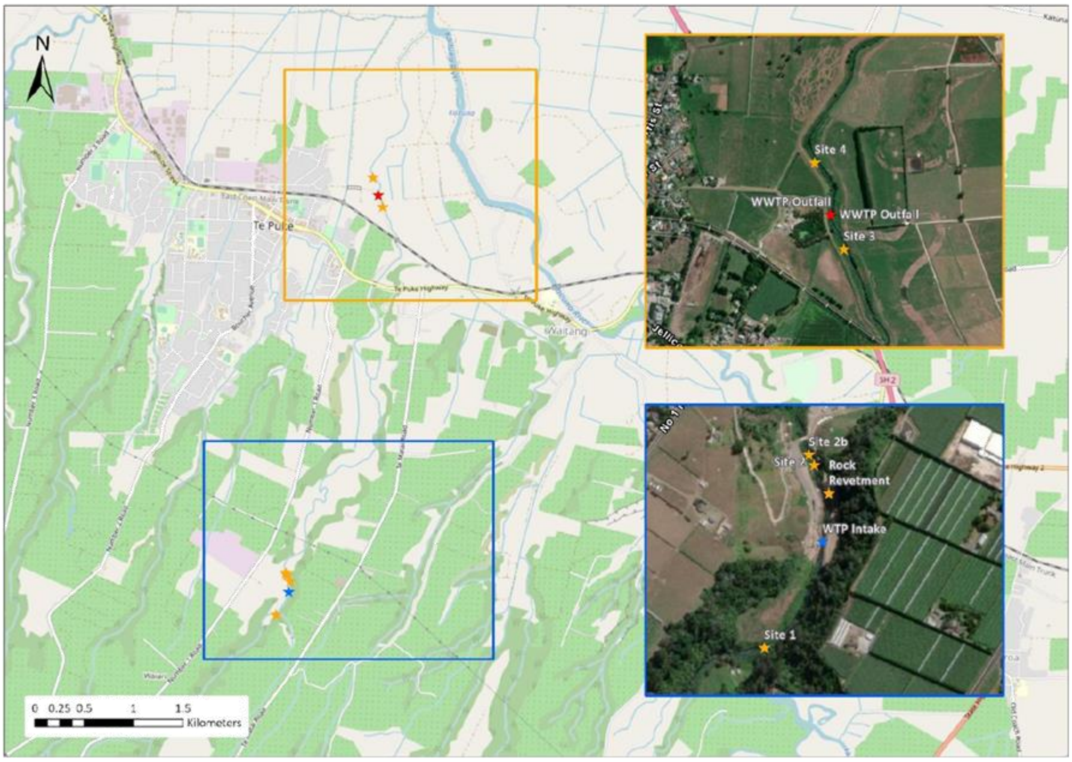

Figure 1: Overview of biological monitoring site locations

Table 1: Site locations and GPS positions

Site	Site Description	NZGD (1949)		NZTM (NZGD, 2000)	
		Longitude	Latitude	Easting	Northing
1	Upstream of water intake site	176 19 43.38523 E	37 49 20.58761 S	1893023	5808866
2b	Downstream of water intake site (relocated from original Site 2).	176 19 47.29714 E	37 49 08.47654 S	1893132	5809236
3	Upstream of wastewater treatment plant outfall	176 20 21.29839 E	37 47 05.72566 S	1894099	5812991
4	Downstream of wastewater treatment plant outfall	176 20 17.69774 E	37 46 57.46000 S	1894020	5813249

2.2 Stream flows

Rainfall data was obtained for the six weeks prior to survey, via the Bay of Plenty Regional Council (BOPRC) telemetry data website. Rainfall monitoring is not undertaken within the Waiari Stream catchment so two sites; the 'Paraiti (Mangorewa) at Upper Rangiuru Rd' and 'Waimapu at Glue Pot Rd', were chosen to indicate likely rainfall in the surrounding catchment that may influence flows in the Waiari Stream in the proximity of the water intake point.

Flow data on the Waiari Stream is collected by NIWA at five-minute intervals via an automated flow meter located at the old Western Bay of Plenty District Council intake, located above the intake site on the Waiari Stream. Flow data for the Waiari Stream for the seven-week period prior to survey was obtained, to demonstrate the range of flows experienced in the lead-up to the survey. The flow data for this period following 6th January 2021 is provisional, as it was obtained from NIWA prior to their scheduled quarterly Quality Assessment processing (E. Bowman, NIWA; pers. comms.).

2.3 Biological monitoring

2.3.1 Macroinvertebrate monitoring

Macroinvertebrate samples were collected from each of the four sites. The resource consent condition specifies that:

> *Invertebrate samples shall be collected using Protocols C3: Hard-bottomed Quantitative and C4: Soft-bottomed Quantitative of the Ministry for the Environment's "Protocols for Sampling Macroinvertebrates in Wadeable Streams". Hard substrates will be sampled above and below the intake and macrophytes will be sampled at four locations.*

Consistent with the previous monitoring, there was insufficient aquatic plant growth at the upstream sites (Sites 1 and 2b) for macrophytes to be sampled (Bioresearches, 2010, 2011, 2012 and 4Sight 2017, 2019, 2020). Additionally, areas of cobble and boulder habitat were generally absent, or restricted to the deeper, or faster flowing sections of the stream, with soft sandy substrates dominating the wadeable areas. For practical and safety reasons this precluded the use of either Protocol C3 or C4 (Stark *et al*. 2001), specified in the conditions of consent. Within the shallower, and safely accessible sections of stream, woody debris constituted the largest form of stable habitat and is the recommended alternative sampling habitat in the Ministry for the Environment protocols (Stark et al. 2001) when macrophytes are absent from soft-bottomed stream habitats. Therefore, macroinvertebrate samples were collected from the woody debris at the two sites. Four replicate macroinvertebrate samples were collected at Site 1. Two samples could be obtained from woody debris at Site 2b and, in addition, four replicate samples were collected for comparison from the rock revetment at Site 2b.

At each site, the samples were collected by placing a D-net (aperture 400 mm, mesh 0.5 mm) downstream of a section of wood and gently scrubbing the wood with a soft nylon brush to dislodge any invertebrates, allowing the water current to carry individuals into the net. Macroinvertebrates from a total estimated surface area of 1 m^2 were collected for each sample before being transferred into a plastic storage container and preserved using 70% - 80% isopropyl alcohol.

At downstream sites (Sites 3 and 4), above and below the WWTP outlet, macrophytes were sampled using methodology from macroinvertebrate sampling Protocol C4: Soft-bottomed Quantitative (Stark et al. 2001). Four replicate samples were collected at each site, constituting the submerged tips of macrophytes (sampled macrophytes consisted entirely of the oxygen weed, *Elodea canadensis*). For each replicate sample, approximately 1.0 – 1.5 L of weed was collected in front of the D-net. The weed was transferred to a lidded bucket containing approximately 1.0 L of stream water. The bucket was shaken vigorously twenty times to dislodge individuals and the water contents poured through a 0.5 mm sieve. This shaking process was carried out a further two times for each sample before the contents of the sieve were transferred to a plastic storage container and preserved with isopropyl alcohol. Macrophytes were retained, transferred to a plastic bag, chilled and returned to the laboratory to be dried at 70°C for 24 hours before weighing.

Preserved macroinvertebrate samples were returned to the laboratory and sorted. Macroinvertebrates were identified to the lowest practicable taxonomic level by an experienced taxonomist (B. Stansfield, EIA Limited) and counted utilising sample processing Protocol P3 (Stark et al. 2001). Biotic indices were calculated to assess the ecological condition of the community including taxa richness, %EPT, which is the proportional abundance of three generally pollution-sensitive orders of insect recorded from each sample (Ephemeroptera or mayflies; Plecoptera or stoneflies; Trichoptera or caddisflies), the Macroinvertebrate Community Index (MCI) calculated from each site and, as quantitative protocols were used on site, the Quantitative MCI (QMCI). The MCI and QMCI are based on the average pollution sensitivity scores for individual taxa recorded (Stark, 1998). The soft-bottomed MCI (MCI-sb) was calculated (Stark and Maxted, 2007a). Scores of >120 and >6.0 (for MCI/MCI-sb and QMCI/QMCI-sb, respectively) are indicative of clean water or 'excellent' habitat quality, 100 – 120 and 5.0 – 6.0 are indicative of 'good' quality or mild organic pollution, 80 – 100 or 4.0 – 5.0 are indicative of 'fair' quality or probable moderate pollution, and scores <80 and <4.0 are indicative of 'poor' quality or probable sewer pollution (Stark, 1998; Table 2). Raw macroinvertebrate results are presented in Appendix A.

Table 2: Summary of MCI and QMCI values

Quality	Descriptors	MCI or MCI-sb	QMCI or QMCI-sb
Excellent	Clean water	> 120	> 6
Good	Doubtful quality/possible mild pollution	100 - 120	5 – 6
Fair	Probable moderate pollution	80- 100	4 – 5
Poor	Probable severe pollution	< 80	< 4

2.3.2 Macroinvertebrate data analysis

Statistical analysis and trend analysis of all seven years of data was undertaken to inform comparison between sites.

All data were first checked, grouped by ecological index and sampling area, whether they were normally distributed using visual observation in a Q–Q plot and statistically using a Shapiro-Wilk Normality Test. Data within each group were generally normally distributed and there were about 28 data points per group so parametric methods were used (e.g., ANOVA).

Data from each site within each group were analysed for trends using Kendall's nonparametric test for a monotonic trend from 2010 to 2021.

2.3.3 Macrophyte monitoring

Macrophyte species composition was recorded from visual assessments of macrophyte cover at each site. Five replicate cross stream transects, at 10 m intervals, were used to identify macrophyte species present at each site and visually estimate the percentage of cover for each identified macrophyte species.

Water depth and/or swift stream flows prevented in-stream transects from being safely undertaken.

2.3.4 Fish surveys

To sample fish communities two unbaited fyke nets and five marmite baited Gee minnow traps were deployed at each site. Water depth, soft sediments and swift stream flow conditions prevented the possibility of effective electric fishing at all sites.

All fish captured were identified, counted and their size estimated before being returned to their habitats. A Quantile Index of Biotic Integrity (QIBI) was calculated for each site based on fish species present, altitude and distance inland (Joy and Henderson, 2007; Surin 2016).

2.3.5 Water Quality Monitoring

Water temperature, dissolved oxygen levels, conductivity, pH and turbidity were measured at each site on two occasions using a pre-calibrated hand-held water quality meter (model YSI ProPlus). Measurements were made at each site at the commencement of field surveys on 23 and 24 February.

3 RESULTS

3.1 Stream flows and rainfall

Small rainfall events occurred on occasion throughout January (Figure 2; Figure 3). A large rain event occurred a week before the surveys, with 120mm and 40mm of rain recorded on 15 February at the Mangorewa and Waimapu gauging sites, respectively. (Figure 2; Figure 3).

Flows in the Waiari Stream were relatively stable over the period leading up to the 2021 field surveys, with an average flow rate of 3.348 m^3/s (±0.003 m^3/s SEM)[1] at the NIWA recording station (above Site 1; Figure 4). The rain event the week prior to the field surveys caused flow levels to increase, to a maximum flow rate of 6.44 m^3/s on 16 February. Data indicates that stream flows had returned to approximately 3.15 m^3/s to 3.16 m^3/s by the time of surveys commencing on 23 February.

Flow data after 6 January was provisional at the time of writing, so has not been subject to NIWA's quality assurance processes. This likely explains the unusual flow 'drops' evident in the data around 19 February (Figure 4).

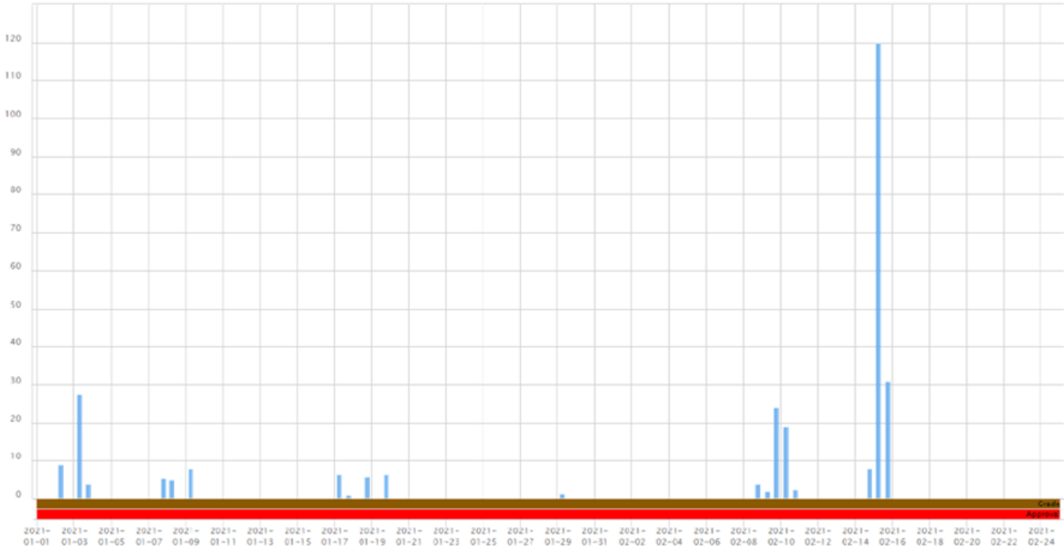

Figure 2: Daily rainfall from the 'Paraiti (Mangorewa) at Upper Rangiuru Rd' rainfall monitoring site for the seven week period prior to the 2021 field surveys. Data coutesy of BOPRC.

[1] Equivalent to 3,348 L/s (±3 L/s SEM)

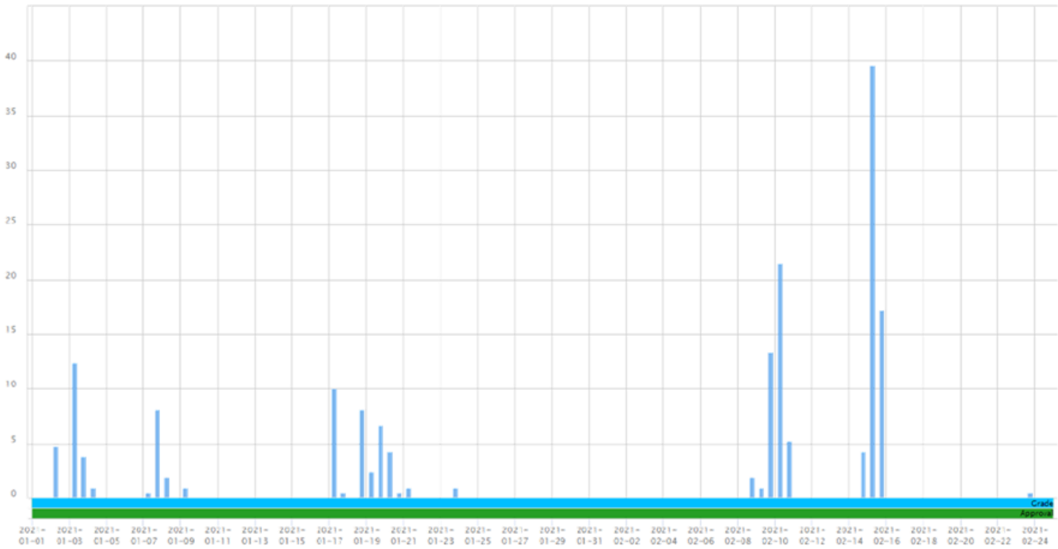

Figure 3: Daily rainfall from the 'Waimapu at Glue Pot Rd' rainfall monitoring site for the seven week period prior to the 2021 field surveys. Data coutesy of BOPRC.

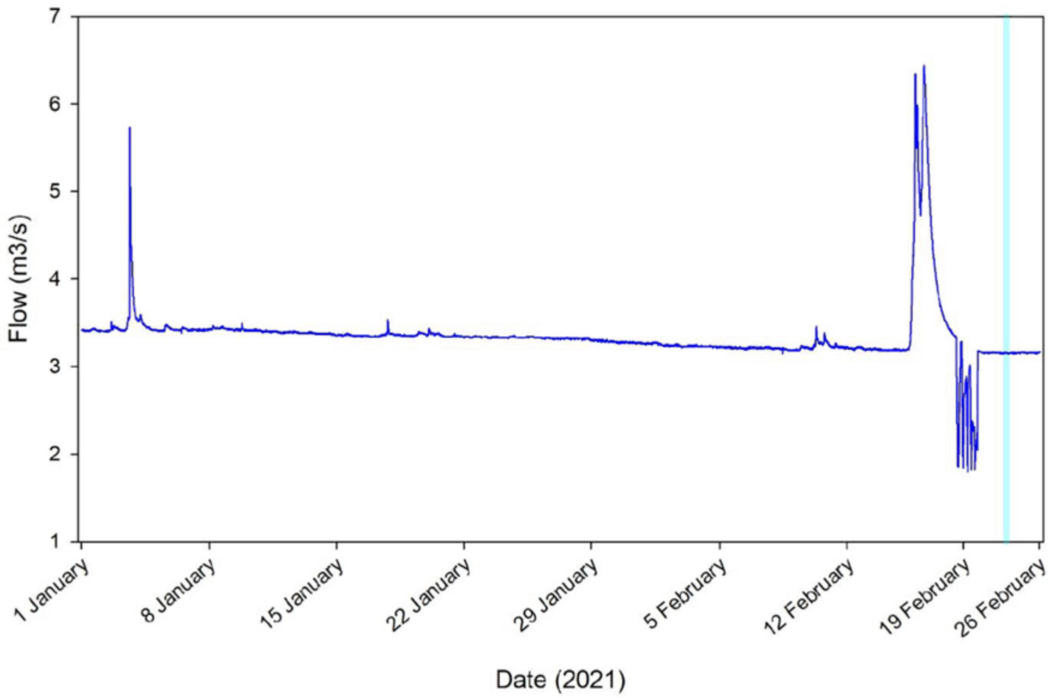

Figure 4: Waiari Stream flow data for the seven-week period leading up to the 2021 field surveys (teal bar). Provisional data provided by NIWA.

3.2 Instream habitats

3.2.1 Upper Waiari Stream – Sites 1 and 2

Sites 1 (Figure 5) and 2b (Figure 6), were located upstream and downstream from the proposed WTP intake, respectively. The WTP intake is located approximately 6 km upstream of the confluence of the Waiari Stream and the Kaituna River. The Waiari Stream in this area gently winds through the narrow, but relatively flat floor of a steep-sided, incised valley. There was little change in vegetation cover from the previous year's survey, with the fenced stream banks dominated by exotic weeds such as mugwort (*Atemisia* sp.), kikuyu (*Cenchrus clandestinus*), bindweed (*Calystegia* sp.) and montbretia (*Crocosmia* sp.). The valley slopes typically consisted of mixed native and exotic bush, the streamside margins of which were largely smothered by exotic vines. Near Site 2b, where bank recontouring has occurred to enable instream works for construction of the WTP, replanting of native species has occurred; these plants are young and weed species are encroaching into the plantings in places.

Figure 5: Site 1; stream features with woody debris evident

Figure 6: Site 2b; lower fast flowing woody riffle area (left) and view upstream towards weir and intake location (right), with rock revetement on left hand (true right) bank

Figure 7: Site 2b; Rock sprawl into stream and view across to soft sediments on far bank edge.

Site 1, upstream of the WTP intake, was located on a relatively straight section of moderately fast flowing stream. Consistent with previous surveys, deposited woody debris was scattered through the reach alongside occasional large boulders and cobbles. The stream banks through this reach are very steep, with banks comprised of soft, highly erodible sand and ash dominated soils. Slumping of the banks was common in places. On this survey occasion, woody debris and some boulders could be safely accessed by wading.

At the time of this survey, the instream construction works footprint had been reduced from previous years, with works occurring in a localised area near the WTP intake pipe location. As a result of extended instream works in previous years (2019 – 2020) Site 2 had been temporary relocated downstream approximately 650 m downstream to one of the few safely accessible locations (Site 2a). During the 2021 site surveys, given the now accessible stream banks below the intake, Site 2 was relocated back upstream (Site 2b), closer to the original Site 2 location. A fast-flowing riffle comprising woody debris and cobbles was present at the downstream extent of the site. Woody debris at the margins of this area were sampled for macroinvertebrate communities; however, swift stream flow limited safe access and movement. On the eastern bank opposite the WTP construction area, bank reinforcement with rock revetement had been installed (Figure 7). These large rocks also provided a stable substrate for macroinvertebrate colonisation and stands of watercress (*Nasturtium officianale*) had established along the stream edge. Sampling of communities on both rock and woody substrates was completed for comparison on this occasion.

Overall, stream width was relatively uniform throughout Site 1, ranging between approximately 16 m - 18 m. The stream width through Site 2b ranged between approximately 12 m - 14 m. Recontouring through the Site 2b reach had created gently sloping stream banks. Beyond the sprawl of the rock revetement, sand and fine pumice gravel were the dominant substrates with occasional small pieces of wood debris evident in slow flowing margins. Previous surveys (Bioresearches, 2010, 2011, 2012; 4Sight, 2017, 2019, 2020) have demonstrated the volatility of substrate movement in this area, with woody debris introduced and/or buried by motile sandy substrates, dependent on flow events. It is probable that woody debris will be introduced naturally back through the stream reach below the intake, over time.

Due to the steep bank edges and swift flows, rooted aquatic vegetation was rare at these sites; however, as noted above, watercress and starwort (*Callitriche stagnalis*) had established at the lower gradient stream margin among the rock revetment at Site 2b. Moss and a moderate cover of filamentous green algae were eident on the stable rock and large woody debris surfaces at Site 1 but was not yet evident on the rock revetement.

3.2.2 Lower Waiari Stream – Site 3 and 4

Site 3 (Figure 8) and Site 4 (Figure 9), located upstream and downstream of the WWTP outfall, respectively, are approximately 2 km upstream of the Waiari Stream confluence with the Kaituna River. This section of the stream flows through low-lying flood plains, dominated by pastural land use and is flanked on both sides by grazed stop-banks used for flood control. Consistent with previous surveys, riparian vegetation was predominantly a mix of pastural grasses and common pasture weeds, with the occasional willows present, typically on the true right (eastern bank).

Figure 8: Site 3; soft sand dominated substrates, with *Elodea* weed beds evident at the margins.

Figure 9: Site 4; Overview of weed beds and sand dominated substrates.

Estimated stream width was relatively uniform within sites, averaging approximately 13 m - 16 m at both sites. The stream bed through each reach was characterised by soft sandy substrates, with finer silty sediments trapped within the macrophyte beds growing along the margins. No large-scale change in habitat from the features observed during the previous (2020) survey was noted. The exotic oxygen weed *Elodea canadensis* were present as dense beds at the margin of each bank at both sites. Previous surveys (Bioresearches, 2010, 2011, 2012; 4Sight, 2017, 2019, 2020) have demonstrated that the extent of these beds is somewhat volatile and affected by flow events and periods of stable flow. Stream banks were moderately steep and showed signs of recent and past erosion events.

3.3 Macroinvertebrate communities

The 2021 macroinvertebrate data is presented in its entirety in Appendix A and is summarised in Table 3, Figure 10 and Figure 11.

3.3.1 Upper Waiari Stream – Sites 1 and 2

The macroinvertebrate community at the WTP sites had moderately high diversity with a mean taxa richness of 21 (±1.0 SEM[2]) at Site 1 and 19 (±1.0 SEM) at Site 2b (Figure 10a). Taxa richness on the rock substrates at Site 2b was lower, with an average of 14.5 taxa per sample (±1.2 SEM).

The macroinvertebrate communities at Sites 1 and 2b were typically dominated by true flies (Diptera), in particular non-biting Chironomid midge larvae from the Tanytarsini group. These taxa feed on fine organic matter, including algae. Algae growth was well established on stable wood substrates at these sites. Molluscs, particularly the common native *Potamopyrgus* and exotic Lymnaean snails, were more common on the rock revetement at Site 2b than on the wood substrates in the upper stream. True flies comprised 79% to 87% of the total abundance of each sample at Site 1, 85% to 92% of the total abundance on wood, and 81% to 89% of the total abundance on the rocks at Site 2b (Figure 11).

Taxa from the generally sensitive EPT (Ephemeroptera, Plecoptera, Trichoptera, or mayflies, stoneflies and caddisflies) group of insects comprised, on average, 10 (± 1.0 SEM) of the 21 taxa recorded from samples at Site 1, and 9 (± 0.0 SEM) of the 19 taxa recorded from samples of wood at Site 2a (Figure 10b). On the rock revetement at Site 2b an average of 5.5 (± 0.9 SEM) of the 14.5 taxa were EPT taxa (37%). EPT comprised about 47% of the taxa diversity at both sites. However, as a proportion of the community, EPT comprised between 10% and 19% of the total community abundance at Site 1, from 8% to 15% of the community abundance on wood at Site 2b (based on two samples) and 4% to 8% on rock substrates at that site (Figure 10c). This indicated that while the number of EPT taxa was relatively diverse at these sites, they were typically present in low numbers within the community.

The MCI-sb scores for Site 1 ranged from 104 to 110 (mean 106.5 ± 1.4 SEM), predominantly indicating 'good' habitat quality on this survey occasion (Figure 10d; Stark and Maxted, 2007a). MCI scores from wood substrates at Site 2b were similar, between 104 to 117 (mean 110.3 ± 6.2 SEM), based on two samples, indicating 'good' instream habitat quality. By comparison MCI scores for samples from the rock revetement ranged between 68 and 90 (mean 80.5 ± 4.7 SEM), indicative of 'poor' to 'fair' instream conditions.

The QMCI score, which considers the abundance of each scoring taxon, ranged from 4.7 to 4.9 (mean 4.8 ± 0.03 SEM) at Site 1, indicative of 'fair' habitat quality. On wood substrates at Site 2b the QMCI scores ranged between 4.7 and 4.8 (mean 4.7 ± 0.7 SEM), also indicative of 'fair' habitat quality (Figure 10e). QMCI scores for samples from rock substrates at Site 2b ranged from 3.0 to 3.2 (mean 3.1 ± 0.4 SEM). The disparity between habitat quality reflected by MCI and QMCI scores reflected the numerical dominance of lower scoring, or more tolerant taxa within the community.

Macroinvertebrate densities (Figure 10f) were variable on wood substrates at both sites but, on average, were higher at Site 2b (mean 760 individuals/m² ± 137.5 SEM) than at Site 1 (mean 639 individuals/m² ± 80.1 SEM). On the rock substrates at Site 2b coverage was lower than on the woody substrates, with a mean of 423 individuals/m² ± 71.8 SEM.

[2] SEM = standard error of the mean

Table 3: Summary of macroinvertebrate indices collected from the Waiari Stream, February 2021.

Site	Sample	No. of taxa	No. EPT taxa	%EPT+	MCI-sb*	QMCI-sb*
1	A	23	10	19.0	104.4	4.8
	B	23	10	10.6	109.7	4.7
	C	20	11	12.0	103.7	4.7
	D	19	9	16.3	108.2	4.9
Mean		*21.3*	*10*	*14.5*	*106.5*	*4.8*
SEM		*1.0*	*0.4*	*1.9*	*1.4*	*0.03*
2b (wood)	A	20	9	14.7	104.1	4.8
	B	18	9	8.0	116.6	4.66
Mean		*19*	*9*	*11.4*	*110.3*	*4.7*
SEM		*1.0*	*0.0*	*3.3*	*6.2*	*0.07*
2b (rocks)	A	14	5	6.7	82.9	3.1
	B	13	5	6.1	81.5	3.2
	C	18	8	7.6	90.0	3.2
	D	13	4	3.7	67.7	3.0
Mean		*14.5*	*5.5*	*6.0*	*80.5*	*3.1*
SEM		*1.2*	*0.9*	*0.8*	*4.7*	*0.04*
3	A	12	3	2.6	78.3	2.4
	B	13	5	5.2	93.5	2.1
	C	13	2	6.4	72.9	2.4
	D	14	4	4.0	85.6	2.5
Mean		*13.0*	*3.5*	*4.5*	*82.6*	*2.3*
SEM		*0.4*	*0.6*	*0.8*	*4.5*	*0.08*
4	A	10	1	0.8	68.2	2.6
	B	15	4	2.0	82.4	1.8
	C	14	2	0.9	69.7	2.0
	D	14	1	0.2	68.4	2.3
Mean		*13.0*	*2.0*	*1.0*	*72.2*	*2.2*
SEM		*1.1*	*0.7*	*0.4*	*3.4*	*0.2*

\+ %EPT (individuals) = the proportion of the community abundance made up of EPT

* Hard bottomed stream versions (MCI and QMCI) were calculated for samples taken from the rock revetment at Site 2b.

SEM = standard error of the mean

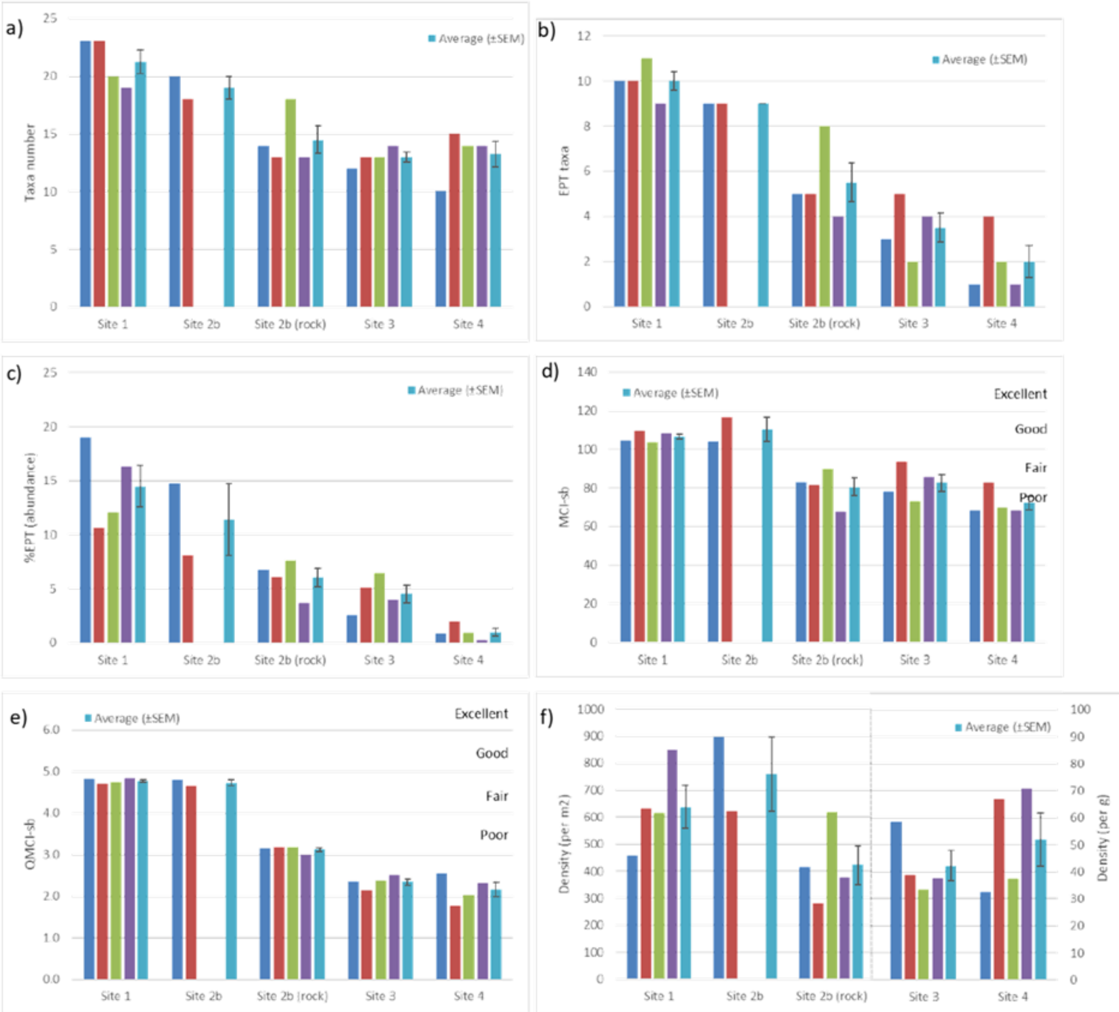

Figure 10: Macroinvertebrate indices including a) total number of taxa, b) total number of EPT taxa, c) % abundance of EPT (individuals), d) MCI-sb* score, e) QMCI-sb* score and f) macroinvertebrate density. Average site scores (±SEM) are illustrated in teal.

* MCI and QMCI (hard bottomed) scores were calculated for samples collected from Site 2b rocks.

3.3.2 Lower Waiari Stream – Site 3 and 4

Sampling of macroinvertebrate communities utilising the weed beds within the lower Waiari Stream recorded a similar diversity of taxa at both sites, with a mean taxon richness of 13.0 (± 0.4 SEM) at Site 3, upstream of the WWTP discharge, and 13.3 (± 1.1 SEM) at the most downstream Site 4 (Table 3, Figure 10a).

Similar to the 2020 survey, the macroinvertebrate communities at both lower Waiari Stream sites were dominated by molluscs, predominantly the native common freshwater snail *Potamopyrgus*, and the introduced snail *Physella* (Figure 11). At Site 3, molluscs comprised 74% to 85% of the total sample abundance and at Site 4 comprised 72% to 83% of the total sample abundance. True flies (Diptera) were also relatively common at both sites and crustaceans (typically the freshwater amphipod *Paracalliope*) were common at Site 4, downstream of the WWTP.

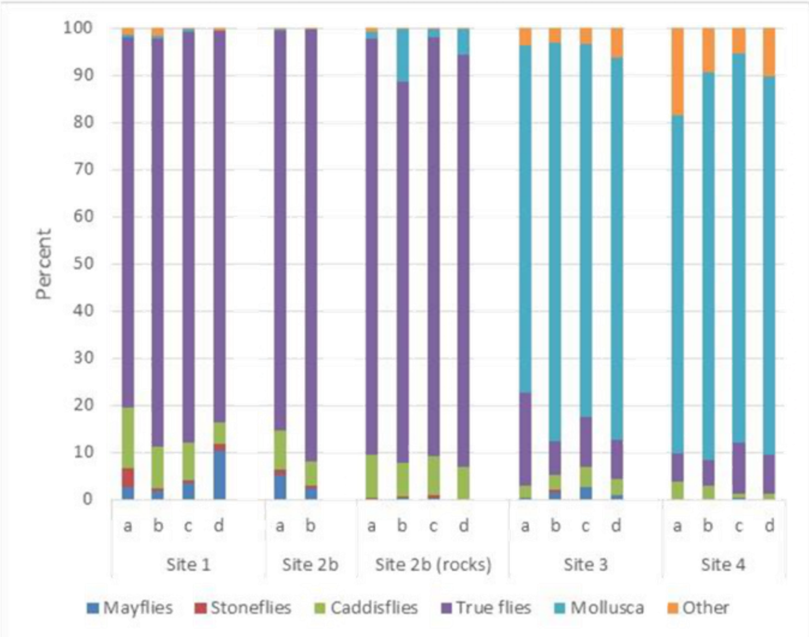

Figure 11: Percentage composition of major taxonomic groups at each site.

EPT taxa were recorded in low diversity from both sites and comprised on average 3.5 (± 0.6 SEM) of the 13.0 taxa recorded from Site 3, and 2.0 (± 0.7 SEM) of the 13.3 taxa recorded from Site 4 (Figure 8b). This equated to an average of 27% (± 4.8 SEM) and 15% (± 4.3 SEM) of the taxa richness at each site, respectively. Overall EPT taxa made up only 4.5% (± 0.8) of the total community abundance at Site 3 and 1.0% (± 0.4) of the total community abundance at Site 4 (Figure 10c).

MCI-sb scores ranged from 73 - 94 (mean 82.6 ± 4.5 SEM) at Site 3, upstream of the WWTP discharge, and from 68 – 82 (mean 72.2 ± 3.4 SEM) at Site 4, below the discharge (Figure 10d). Scores at Site 3 indicated 'poor' to 'fair' instream habitat quality and at Site 4 typically indicated 'poor' instream habitat quality.

QMCI-sb scores at Site 3 ranged between 2.1 to 2.5 (mean 2.3 ± 0.08 SEM) and between 1.7 to 2.6 (mean 2.2 ± 0.17 SEM) at Site 4, indicating 'poor' instream conditions at both sites (Figure 8e). Scores reflected the numerical dominance of low scoring, high tolerance snails and other taxa. Few higher scoring taxa were present at these sites, and only in low abundance.

Macroinvertebrate densities when expressed per gram of aquatic vegetation sampled showed a marginally greater density at Site 4 (mean 51.9 per g ± 9.9 SEM) than Site 3 (mean 42.2 per g ± 5.6 SEM; Figure 10f).

3.3.3 Comparisons with previous years

Comparing the 2021 macroinvertebrate community results with data collected from the previous six surveys, undertaken between 2010 – 2020 (Bioresearches 2010, 2011, 2012; 4Sight 2017, 2019, 2020), reiterates the findings of previous years that there is a high degree of natural variability in community composition and most indices (Figure 12). Inter-annual variability is a natural feature of stream macroinvertebrate monitoring due to the natural spatial and temporal variability of instream environments.

Results continue to indicate that macroinvertebrate community indices remain consistently higher at upper Waiari Stream sites in comparison to lower Waiari Stream sites, with greater taxa diversity, number of EPT taxa, and higher MCI an QMCI scores typically identified from Sites 1 and 2 in the upper stream catchment (Figure 12a, b, d and e). These macroinvertebrate indices in 2021 were found to be very similar to those recorded in 2020, and within the range recorded across previous surveys.

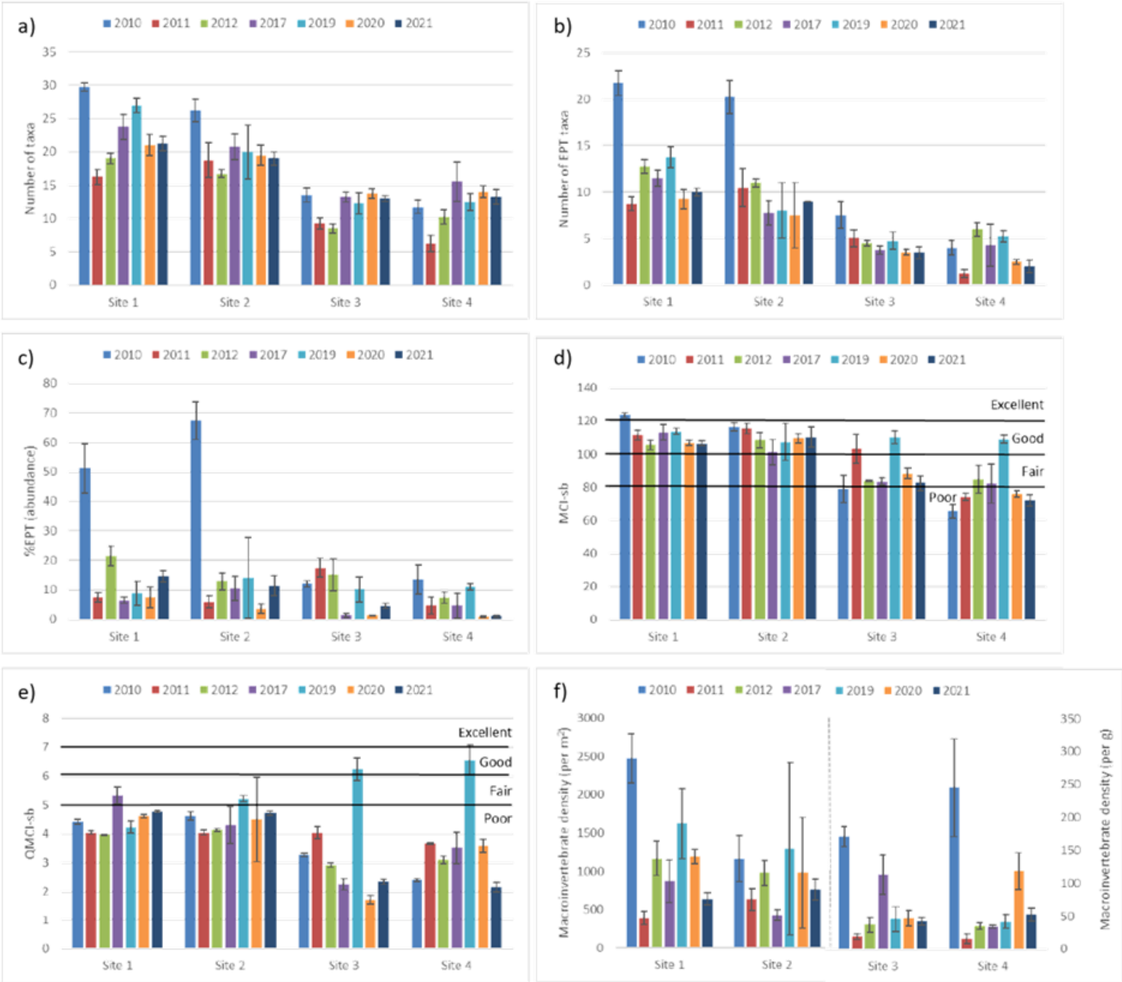

Figure 12: Average (+SEM) macroinvertebrate indices including a) taxa richness, b) EPT taxa richness, c) % abundance of EPT (individuals), d) MCI score, e) QMCI score and f) macroinvertebrate density for each site for all surveys; 2010 – 2021.

3.3.4 Statistical and trend analyses

With the 2021 data survey, baseline data (obtained prior to the water take commencing) has been collected over seven surveys, in the years between 2010 and 2021. Given the variability in some calculated metrics observed across the survey period, data analysis in the form of statistical comparisons and trend analyses across and between sites was undertaken.

Larned and Snelder (2012) and Stark and Maxted (2007b) recommend that trend analysis be conducted only on sites with at least 10 years of data. Nonetheless, data analysis was undertaken on the basis that we consider this to be an assessment of the baseline conditions of the stream, in the absence of the water take, and preliminary investigation into the potential to detect trends with the data already collected.

Means of each index were plotted for each site by year and fitted with a LOESS fit (Figure 13). These plots illustrate the variability in indices that occurred across years and between the upper and lower stream sites.

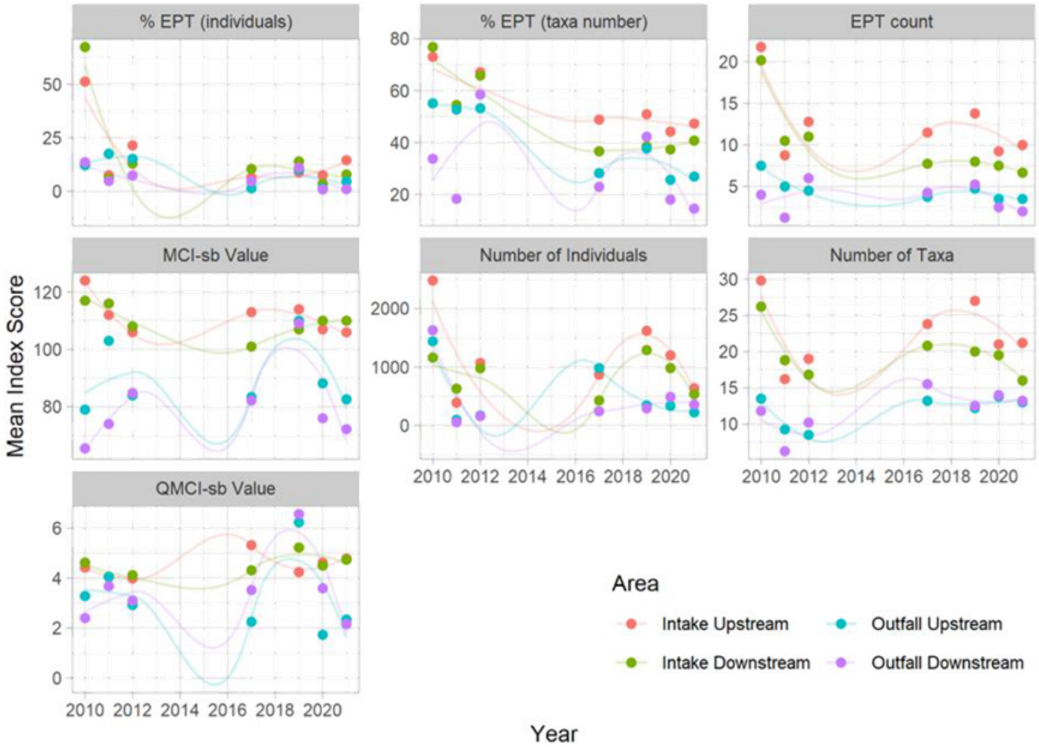

Figure 13: Loess fit of means results by site (area). For sites above and below the WTP intake (Site 1 and 2; Intake upstream and Intake downstream, respectively) and above and below the WWTP outfall (Sites 3 and 4; Outfall upstream and Outfall downstream, respectively).

Results of statistical comparisons (ANOVA) are visually presented as box plots in Figure 14. In that figure the statistical significance of the differences in means within each index is shown (Tukey's Honest Significant Difference test). Different letters indicate a statistically significant difference (e.g., 'a' and 'b' are significantly different but 'a' and 'ab' are not).

Key outcomes are summarised below:

- The mean index values for the upper Waiari Stream sites (Site 1 and 2; upstream and downstream of the intake site) were typically statistically higher than those of the lower stream sites (Sites 3 and 4; upstream and downstream of the WWTP outfall).
- Other than for the total number of taxa, there was no statistical difference between index values upstream (Site 1) and downstream (Site 2) of the WTP intake.
- Similarly, there was no statistical difference between index values upstream (Site 3) and downstream (Site 4) of the WWTP outfall, with the exception of MCI-sb. Mean MCI-sb scores downstream of the WWTP outfall (Site 4) were statistically lower than those recorded upstream of the outfall.

Results of the trend analysis are summarised in Table 4. Key outcomes are described below:

- Site 1 (Intake Upstream), Site 2 (Intake Downstream) and Site 3 (Outfall Upstream) each have declining trends in the proportion of EPT taxa (%EPT taxa), and Sites 1 and 3 also show a declining trend in the proportion of the community abundance made up by EPT (%EPT individuals).
- MCI-sb scores show a declining trend in the upper Waiari Stream Sites 1 and 2 (Intake Upstream and Intake Downstream).

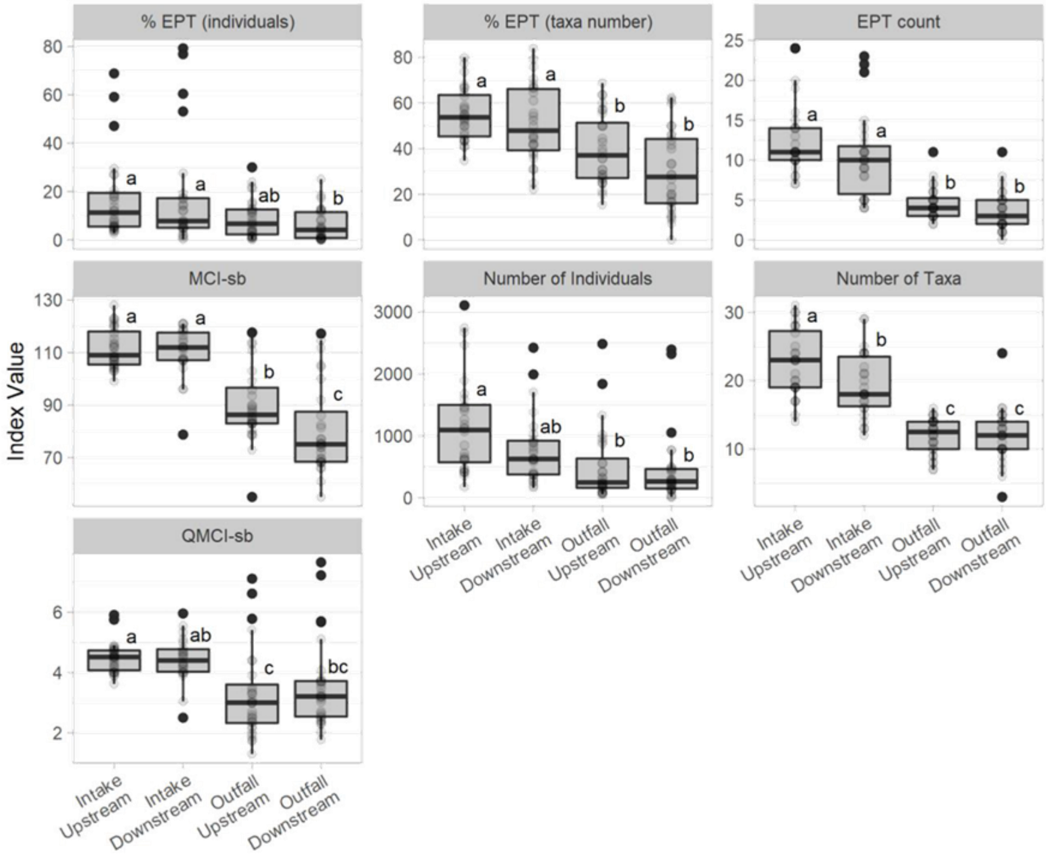

Figure 14: Summary of macroinvertebrate index results for all years for each macroinvertebrate index. Values more than 1.5 times the interquartile range (grey box) are presented as solid black circles. Individual results are presented as transparent circles. The statistical significance of the difference in means is indicated by the letter above each boxplot (sites with the same letter are not statistically different).

Table 4: Summary of results from Kendall's nonparametric test for a monotonic trend from 2010 to 2021. Statistically significant results for negative and positive trends are indicated by -ve and +ve.

Site	No. Taxa	% EPT (Individuals)	% EPT (taxa number)	MCI-sb	QMCI-sb	No. Individuals
Site 1; Intake Upstream		-ve	-ve	-ve	+ve	
Site 2: Intake Downstream			-ve	-ve		
Site 3; Outfall Upstream		-ve	-ve		-ve	
Site 4: Outfall Downstream	+ve	-ve				

- QMCI-sb scores at Site 1 (Intake Upstream) had a small, positive trend, indicating an overall increase in the proportion of higher scoring (more sensitive) taxa within samples.
- Index scores for Site 4 (Outfall Downstream) showed little to no trend over time. The number of taxa was slightly positive and % EPT (individuals) was slightly negative. There was no significant trend for any other index at this site.

3.4 Fish communities

A total of five[3] native and one exotic fish species were recorded during the 2021 survey (Table 5). Inanga (*Galaxias maculatus*) were recorded or observed from all sites, with the exception of Site 1 above the WTP intake location. Consistent with previous surveys, large numbers of inanga were observed schooling along the edges of the macrophyte beds at Sites 3 and 4 near the WWTP in the lower Waiari Stream. On this occasion schools of inanga were also observed in the upper stream near the new rock revetment on the true right bank at Site 2b. Beds of watercress had established in the shallows in this area and may provide a new source of cover for these fish in this area.

Longfin eel (*Anguilla dieffenbachii*) were recorded at all sites but Site 3, upstream of the WWTP. Redfin bully (*Goboiomorphus huttoni*) were recorded at all sites, but were most abundant at Site 2b, downstream of the WTP intake site. The instalment of the rock revetement through this area is likely to be beneficial for redfin bully breeding, as these species attach their eggs to rocks. Other 'unidentified' bullies were recorded at Sites 2b, 3 and 4. These fish were all very small and were also likely to be redfin bully and/or common bully juveniles.

Banded kokopu (*Galaxias fasciatus*) were recorded in the upper Waiari Stream at Sites 1 and 2b. This species, one of the migratory whitebait species, has not otherwise been recorded during previous surveys and, based on Freshwater Fish Database records has not previously been recorded from the Waiari Stream, so comprises a new record in this catchment (Table 6).

One adult brown trout (*Salmo trutta*) and a small group of three mullet were also observed at Site 4, in the lower Waiari Stream.

The Fish QIBI calculated for all sites was indicative of 'excellent' habitat quality or connectivity for fish migrations at all sites (Joy and Henderson, 2007).

Table 5: Fish and large macroinvertebrate species captured during fish sampling, February 2021.

Genus	Species	Common Name	WTP Intake		WWTP Outfall	
			Site 1	Site 2b	Site 3	Site 4
Anguilla	*dieffenbachii*	Longfin eel	1	4		1
Galaxias	*fasciatus*	Banded kokopu	1	3		
	maculatus	Inanga		48+*	*	6+*
Gobiomorphus	sp.	juvenile bully		4	7	1
	huttoni	Redfin bully	4	17	1	5
Salmo	*trutta*	Brown trout				1
Mugil	*cephalus*	Mullet				3
Paranephrops	*planifrons*	Koura, freshwater crayfish			1	
Total number of fish			6	76+	9+	17+

* plus, schools observed

[3] Excluding the juvenile bullies where species could not be confirmed

A search of the New Zealand Freshwater Fish Database (NZFFD) determined no new records have been added since the previous (2020) survey was undertaken. Table 6 summarises the NZFFD records and records from previous surveys that are yet to be added.

Ten species of native fish have previously been recorded from the Waiari Stream catchment. Longfin eel, inanga, redfin bully and common bully were the most commonly recorded fish species.

The only exotic fish species observed on this occasion was a large brown trout observed below the WWTP outfall. Trout, both brown and rainbow have been observed in the upper Waiari Stream on occasion (Bioresearches 2012, 4Sight 2020). A resident spoken to during the most recent survey indicated that he occasionally catches brown trout in the stream near the WWTP.

Table 6: Summary of New Zealand Freshwater Fish Database records and previous survey records for the Waiari Stream between 1980 – 2020.

Genus	Species	Common name	Number of Records
Anguilla	sp.	Unidentified eel	12
	australis	Shortfin eel	11
	dieffenbachii	Longfin eel	23
Gobiomorphus	sp.	Unidentified bully	8
	cotidianus	Common bully	17
	huttoni	Redfin bully	22
	gobioides	Giant bully	4
Galaxias	sp.	Unidentified galaxiid	1
	maculatus	Inanga	23
	argenteus	Giant kokopu	5
Retropinna	*retropinna*	Common smelt	9
Geotria	*australis*	Lamprey	1
Gambusia	*affinis*	Gambusia / mosquito fish	9
Onchorhynchus	*mykiss*	Rainbow trout	5
Salmo	*trutta*	Brown trout	1
Mugil	*cephalus*	Mullet	1

3.5 Macrophyte communities

Visual clarity was excellent at the time of the survey and allowed for visual estimation of the macrophyte community at all sites (Figure 15).

Macrophytes were relatively scarce at Site 1 above the WTP intake location, largely due to the steep, and generally unstable nature of the immediate stream banks and mobile sand substrates. Small amounts of watercress (*Nasturtium officinale*) and starwort (*Callitriche stagnalis*) were present in places as well as a filamentous green algae and moss complex that was visually apparent attached to the stable, embedded woody debris and large boulders.

There was an increase in the abundance of watercress at Site 2b in comparison to previous years surveys (Figure 16), as dense stands had established in shallow margins in association with the recontoured banks and rock revetment on the eastern (true right) bank (Figure 6).

At the lower Waiari Stream sites (Sites 3 and 4) surrounding the WWTP, and consistent with previous years surveys, the exotic oxygen weed *Elodea canadensis* was the dominant macrophyte, consisting of dense weed beds concentrated at the stream margins. Estimated coverage of *Elodea* averaged 48% and 42% of the stream bed at Sites 3 and 4, respectively (Figure 15). The extent of the *Elodea* beds during the 2021 survey was within the range previously recorded through these areas (Figure 16).

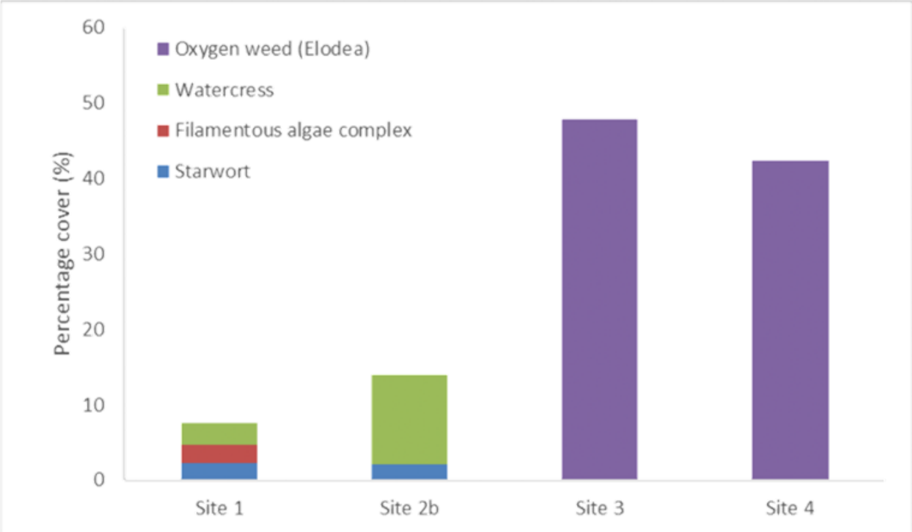

Figure 15: Macrophyte community composition and percent stream cover based on visual assessments.

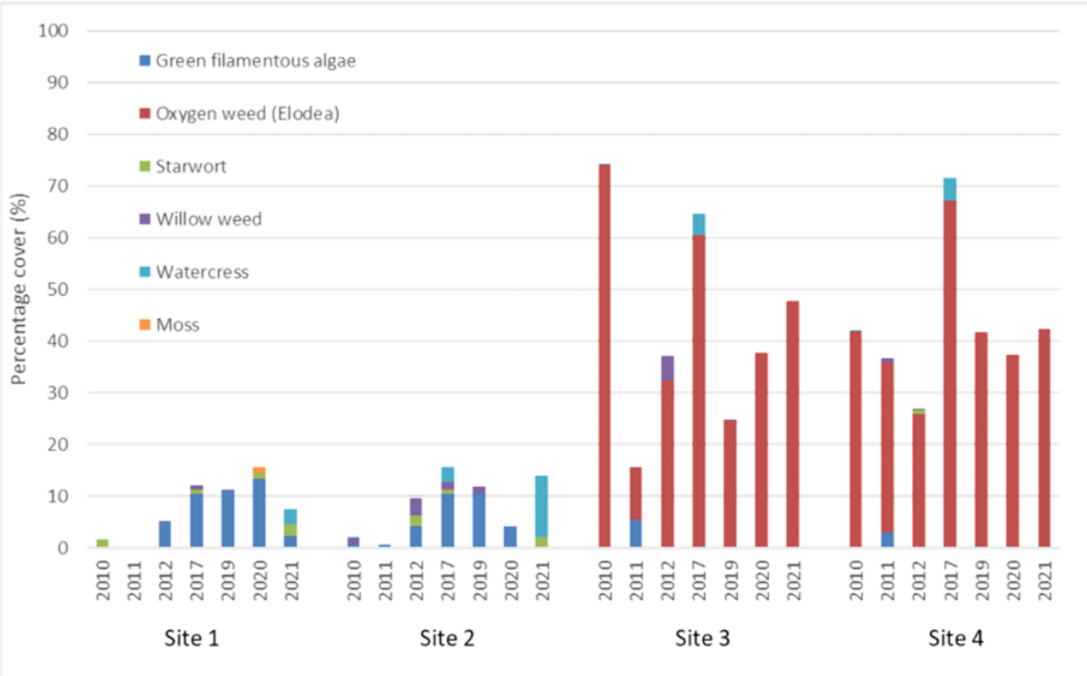

Figure 16: Comparison of macrophyte community composition and percent stream cover, 2010 - 2021.

3.6 Water quality

Basic water quality measurements were collected from each site on 23 February and again on the 24 February. Timing of site visits meant that measurements were made from the upper Waiari Stream (Sites 1 and 2b) in the morning of each day (between 7.30am and 10am) and early afternoon in the lower stream (Sites 3 and 4; 11.30am – 2.30pm). Results indicated high basic water quality at all sites (Table 7). Water quality sampling conditions on both days were undertaken during warm, sunny conditions.

Water quality monitoring was undertaken at similar times on both survey days at Sites 1 and 2b surrounding the WTP intake location. Results determined that the water temperatures were seasonally cool (13.4°C – 13.5°C), well oxygenated (106% - 110%; 11.0 mg/L – 11.5 mg/L), with relatively low conductivity (around 57 - 64 µs/cm) and pH between 7.2 and 7.4. Turbidity was similarly low at both sites, ranging between 3.5 and 4.1 FNU.

In the lower Waiari Stream, at Sites 3 and 4 surrounding the WWTP, spot sampling of water quality occurred early afternoon on 23 February and around midday on 24 February. Water temperature varied by around 1°C between sampling events at each site, being warmer during the mid-afternoon than at around midday (15.6°C vs 14.5°C at Site 3 and 15.1°C vs 14.3°C at Site 4). Dissolved oxygen levels were at supersaturated levels at both sites on both survey occasions, ranging between 108% - 118% and 11.2 mg/L – 11.9 mg/L. Spot sampling was undertaken in the afternoon; however, early morning sampling at these sites in previous years has illustrated that dissolved oxygen levels can reduced at some times of day. Diurnal variation in oxygen levels is a natural feature of streams and can be exacerbated where dense weed beds are present. Conductivity at both lower Waiari Stream Sites 3 and 4 was relatively low (60 µs/cm – 78 µs/cm) but, consistent with previous surveys, was marginally elevated in comparison to the upper stream Sites 1 and 2b. Recorded pH levels were consistent between sites (pH 7.7 to 7.8) and were marginally higher than those recorded in the upper Waiari Stream (pH 7.2 – 7.4).

Table 7: Water quality parameters recorded on 23 and 24 of February 2021.

Parameter	WTP Intake				WWTP Outfall			
	Site 1		Site 2b		Site 3		Site 4	
Date (2021)	23 Feb	24 Feb	23 Feb	24 Feb	23 Feb	24 Feb	23 Feb	24 Feb
Time (NZDST)	08.00	09.50	07.30	08.30	14.30	12.20	13.00	11.35
Temperature (°C)	13.4	13.5	13.4	13.5	15.6	14.5	15.1	14.3
Dissolved oxygen (%)	109	110	107	106	118	114	118	108
Dissolved oxygen (mg/L)	11.4	11.5	11.1	11.0	11.8	11.6	11.9	11.2
Conductivity (µS/cm)	63.7	57.5	57.8	58.4	61.4	60.2	77.7	62.2
pH	7.2	7.4	7.3	7.4	7.8	7.8	7.8	7.7
Turbidity (FNU)	3.8	3.5	3.8	4.1	4.0	4.5	4.0	4.0

4 DISCUSSION

This report provides outcomes of the February 2021 ecological survey of the Waiari Stream, consistent with requirements of conditions 7.1 and 7.2 of resource consent 65637 for the Waiari Water Treatment Plant (WTP) water take. The outcomes of this survey form part of the baseline ecological assessments of the stream, prior to the WTP being completed and the water take commencing. In accordance with consent conditions, the survey focuses on the habitats surrounding the proposed WTP intake and the downstream Te Puke Wastewater Treatment Plant outfall (WWTP). Three years of baseline monitoring was initially carried out between 2010 – 2012 then, due to the project being temporarily halted, surveys were repeated in 2017 after five years, to augment those earlier studies, in the lead-up to commissioning of the WTP. This survey, and the surveys undertaken in 2019 and 2020 are additional to the consent requirements and are intended to provide a broader picture of the Waiari Stream ecology prior to the water take commencing. The 2021 survey comprises the seventh baseline survey of the stream.

Works associated with the construction of the Water Treatment Plant, intake and associated infrastructure commenced in 2018 and are ongoing. Large scale instream and marginal works were underway during the 2019 and 2020 surveys. During the 2021 survey the stream reach surrounding the WTP intake had been recontoured and stabilised and instream works were limited to the area immediately surrounding the future intake location. With instream works being reduced to a localised area, allowing safe access to the stream below the intake point, Site 2 was relocated from its temporary downstream location (Site 2a, 650m downstream) closer to the original Site 2 location (Site 2b).

The stream below the WTP intake has been modified because of works, with recontouring of the banks occurring for a distance below the intake and associated weir structure. Rock revetment has been installed on the eastern (true right) bank and comprises a new stable surface for colonisation for macroinvertebrates and additional cover for fish species. Wood debris is currently absent, other than within a fast-flowing riffle downstream of the works reach; however, there was some sign that wood is being deposited in slower flowing margins on the western bank below the intake site. Due to swift flows, only two macroinvertebrate samples from wood could be collected at Site 2b, so, for comparison purposes, macroinvertebrate samples were also collected from the rock revetment. It is anticipated that at the completion of the onsite construction works and further deposition of wood debris below the outfall, there will be opportunity to reinstate the full extent of macroinvertebrate sampling at Site 2b.

While the consent conditions prescribe specific methodologies for the ecological assessment, some modifications were necessary due to instream conditions and safety concerns making the prescribed methods impractical. Where necessary modifications were made, they followed best practice methodologies (i.e. Stark et al. 2001) and were consistent with the modifications previously made for earlier baseline surveys (Bioresearches 2010, 2011, 2012; 4Sight 2017, 2019, 2020).

Within the uppermost Site 1 and at the relocated Site 2b, and in the lower (Sites 3 and 4) reaches surveyed, stream widths and depths were typically uniform. Substrates at all sites were dominated by coarse sands and pumice gravels, with larger substrates, such as cobbles and boulders found predominantly in the deeper or faster flowing areas near the central stream channel in the upper stream Site 1 only. In the lower stream (Sites 3 and 4) sand deposits formed the dominant bed type.

Large woody debris and log snags were scattered throughout the stream at the upper stream site (Site 1) and in the fast riffle at Site 2b. Wood, and the new rock revetment at Site 2b represented the most stable habitat for colonisation by macroinvertebrate communities in the upper Waiari Stream. Sand dominated the substrate in the lower stream, with a higher proportion of fine, silt material present amongst macrophyte beds closest to the banks in this area. Consistent with previous baseline surveys, swift stream flows coupled with cool, clear, low conductivity, well oxygenated water that was pH normal at all sites suggests excellent basic water quality throughout the Waiari Stream.

Macrophyte growth was largely absent at Site 1, and the green filamentous algae and moss complex visible on much of the large, stable deposits of woody debris within the channel in 2020 was less evident in 2021. Watercress beds had developed at the margins of the stream at Site 2b, including in conjunction with the shallow margins of the rock revetment. At the lower sites near the WWTP (Sites 3 and 4), and consistent with all previous surveys, the exotic oxygen weed *Elodea* dominated the macrophyte community, forming thick growths in beds at the channel edge. With a lack of any hard substrates this weed provides the most significant stable substrate for macroinvertebrate communities, whilst also providing additional resources such as shelter for small fish species. Overall, surveys suggest that the macrophyte communities described in this report, while variable in extent between survey years, are characteristic of the upper and lower reaches of the Waiari Stream (Figure 16).

A moderate amount of within-site variability was recorded in macroinvertebrate communities during the survey, consistent with previous years surveys. Nevertheless, there were some clear distinctions between the macroinvertebrate communities from survey sites around the proposed WTP intake site (Sites 1 and 2b) and the WWTP outfall (Sites 3 and 4) (Figure 10). Overall a greater diversity of taxa was recorded in the upper stream (Sites 1 and 2b), as well as a greater number of taxa from the typically more sensitive EPT group of taxa (comprising mayflies, stoneflies and caddisflies). The proportion of community abundance made up by EPT (%EPT abundance) was higher in the upper stream and was lower at Site 4 in comparison to Site 3, above the WWTP outfall.

Macroinvertebrate Community Index (MCI-sb) scores indicated 'good' instream conditions in the upper stream sites on this survey occasion. Samples from Site 3 and Site 4 in the lower stream ranged between indicators of 'poor' and 'fair' instream conditions, but had an average of 'fair' conditions at both sites. QMCI scores in the upper stream fell within the 'fair' range, and the 'poor' habitat quality category in the lower stream, indicating the numerical dominance of lower scoring taxa, those more tolerant of degraded instream conditions.

At Site 2b there was a clear difference between indices calculated from samples collected from wood substrates and those collected from large rocks that formed the revetment. All indices were lower on the rock substrates than on the wood. This may partially reflect the 'newness' of this rock as a substrate for invertebrates and the limited complexity of the quarried rock; the embedded logs comprise a complex of habitat types (added to by moss coverage) and food sources, and increased complexity may develop over time on the rock substrates.

As the 2021 survey comprised the seventh baseline survey of the Waiari Stream and following community interest in the apparent variability in some calculated macroinvertebrate metrics over time, data analysis in the form of statistical comparisons and trend analyses across and between sites was undertaken. It is noted that Larned and Snelder (2012) and Stark and Maxted (2007b) recommend that trend analysis be conducted only on sites with at least 10 years of data. Nonetheless, data analysis was undertaken on the basis that we consider this to be an assessment of the baseline conditions of the stream, in the absence of the water take, and the work comprises a preliminary investigation into the potential to detect trends with the data already collected.

Statistical analysis confirmed the observations that the mean index values for the upper Waiari Stream sites (Site 1 and 2) were typically statistically higher than those of the lower stream sites (Sites 3 and 4). However, there was no statistical difference between index values upstream (Site 1) and downstream (Site 2) of the WTP intake, other than for the total number of taxa, where numbers were statistically lower at Site 2. Similarly, there was no statistical difference between index values upstream (Site 3) and downstream (Site 4) of the WWTP outfall, with the exception of MCI-sb. Mean MCI-sb scores downstream of the WWTP outfall (Site 4) were statistically lower than those recorded upstream of the outfall.

The trend analyses picked up some trends for the seven years of data available (Table 4). Site 1 and Site 2 in the upper stream and Site 3 above the WWTP each have declining trends in the proportion of EPT taxa (%EPT taxa), and Sites 1 and 3 also show a declining trend in the proportion of the community abundance made up by EPT (%EPT abundance). MCI-sb scores show a declining trend in the upper Waiari Stream Sites 1 and 2. QMCI-sb scores at Site 1 had a small, positive trend, indicating an overall increase in the proportion of higher scoring (more sensitive) taxa within samples. Site 3 had a small negative trend in QMCI-sb scores. Index scores for Site 4 (Outfall Downstream) showed little to no trend over time. The number of taxa was slightly positive and % EPT (abundance) was slightly negative.

Given these trends are occurring in the absence of the water take, these results indicate that there are other factors within the catchment that are impacting the biological health of the Waiari Stream.

Five native fish species were recorded from the Waiari Stream during the survey including two species, inanga and longfin eel, classified as 'at risk – declining' in the most recent threat classification lists (Dunn et al. 2018). Banded kokopu, a migratory whitebait species was recorded from the upper Waiari Stream sites and comprised a new record for the Waiari Stream, based on the New Zealand Freshwater Fish Database records. The Fish QIBI for all sites indicated 'excellent' habitat quality and/or connectivity for fish migration (Joy and Henderson, 2007; Suren, 2016).

Overall, consistent with previous surveys, the 2021 survey determined that the Waiari Stream provides habitat for a relatively diverse range of macroinvertebrate taxa and native fish species. Variation in aquatic biota recorded between the upper and lower stream sites are most likely due to a difference in sampling methodology, as well as habitat changes as the stream moves from a higher gradient, mid catchment reach to the lower gradient reach within a low-lying floodplain, rather than due to significant changes in water quality. Spot sampling of basic water quality measurements on the days of survey indicate that the stream maintains cool, clear, well oxygenated water with pH within the normal range.

Results from this 2021 survey are generally consistent with those recorded in the six earlier baseline stream surveys undertaken between 2010 and 2020. Analysis of the full data set collected from seven years of baseline surveys indicated there were declining trends in some macroinvertebrate indices across all sites; however, Site 4, downstream of the WWTP outfall generally maintained little evidence of change over time. As the WTP intake has not yet commenced, and the surveys comprise baseline data, these results indicate there may be other factors, such as land use and/or land management practices that are may be impacting the longer-term biological health of the Waiari Stream. As the preference is to have ten years data to ensure robust trends analysis (Larned and Snelder 2012, Stark and Maxted 2007b), further baseline surveys will assist to strengthen understanding of the condition of the stream and will strengthen future comparisons with post-commissioning biological data.

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Appendix A:

Raw macroinvertebrate data - 2021

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Taxonomic group	Taxa	MCI score	MCI-sb score	Site 1				Site 2b - rocks				Site 2b - wood		Site 3				Site 4			
				Wai 1A	Wai 1B	Wai 1C	Wai 1D	Wai 2A	Wai 2B	Wai 2C	Wai 2D	Wai 2E	Wai 2F	Wai 3A	Wai 3B	Wai 3C	Wai 3D	Wai 4A	Wai 4B	Wai 4C	Wai 4D
Mayfly	Austroclima	9	6.5	7	9	19	82					46	14	1	1		1				
	Austronella	7	4.7	3											2	6	1				
	Deleatidium	8	5.6							1											
	Nesameletus	9	8.6	1	2	1	5		1												
	Rallidens	9	3.9			1				1		1									
	Zephlebia	7	8.8	1								1							1	1	
Stonefly	Megaleptoperla	9	7.3										1								
	Zelandobius	5	7.4	18	4	4	13	1	1	3		10	3		1						
Caddisfly	Aoteapsyche	4	6.0	1	3	2	5					13	7								
	Beraeoptera	8	7.0										1								
	Edpercivalia	9	6.3		1		1														
	Hudsonema	6	6.5					2							1		2		1		
	Hydrobiosis	5	6.7			1	3			1		2	2								
	Neurochorema	6	6.0	8	12	5	20			7	1	13	6								
	Oxyethira	2	1.2	1	4	1	1	11	5	10	12			1		1	1	7	4	1	4
	Paroxyethira	2	3.7	1																	
	Psilochorema	8	7.8		1	2															
	Pycnocentria	7	6.8	7	19	37	8	9	6	11	3	42	11	4	5	9	5		4		
	Pycnocentrodes	5	3.8	13	2	1	1	6	2	7	3	4	5	1					4	1	
	Triplectides	5	5.7	28	14	1		10	7	16	7							2			1
Bug	Diaprepocoris	5	4.7	1																	
Beetle	Elmidae	6	7.2	5	4	1	3					2	1								
	Hydrophilidae	5	8.0					1													
True Fly	Aphrophila	5	5.6	5	3	2	10			1		7	5								
	Austrosimulium	3	3.9		6	3	6			1		4	1			9	3		2	1	2
	Chironomus	1	3.4	1							1			1						1	1
	Corynoneura	2	1.7					4	10		9										
	Empididae	3	5.4	1	4		3					2	4								
	Harrisius	6	4.7										3								
	Maoridiamesa	3	4.9				2					1	2								
	Muscidae	3	1.6	2	1	1	3					1									
	Orthocladiinae	2	3.2	2		2		9	5	18	19		3	19	1	2	8	5	11	6	18
	Polypedilum	3	8	5	4			7	2	4	4	1	1	2	2	1	2	1	2	2	1
	Stratiomyidae	5	4.2				1														
	Tanypodinae	5	6.5							2											

Taxonomic group	Taxa	MCI score	MCI-sb score	Site 1				Site 2b - rocks				Site 2b - wood		Site 3				Site 4			
				Wai 1A	Wai 1B	Wai 1C	Wai 1D	Wai 2A	Wai 2B	Wai 2C	Wai 2D	Wai 2E	Wai 2F	Wai 3A	Wai 3B	Wai 3C	Wai 3D	Wai 4A	Wai 4B	Wai 4C	Wai 4D
	Tanytarsini	3	4.5	344	528	528	680	348	208	524	296	744	552	24	11	13	6	9	13	14	17
Collembola	Collembola	6	5.3		1																
Crustacea	Ostracoda	3	1.9															4	1		11
	Paracalliope	5	5											9	5	7	13	41	46	11	35
	Paratya	5	3.6					1							1				1		1
	Talitridae	5	5		1												1				
Mites	Mites	5	5.2	1	1	1															
Spiders	Dolomedes	5	6.2		3		1	1													
Mollusc	Ferrissia	3	2.4											9	1	9	1	7	5	9	6
	Gyraulus	3	1.7													1					
	Lymnaeidae	3	1.2					6	11	8	13	1								1	
	Physella	3	0.1											42	45	38	13	22	196	56	40
	Potamopyrgus	4	2.1	2	5	3			20	3	7	1		122	118	137	170	146	212	119	320
	Sphaeriidae	3	2.9																		3
Worms	Oligochaetes	1	3.8							2	1	1				1					
Leeches	Leeches	3	1.2																	1	
Hydroids	Hydroids	3	1.6						1												
Number of Taxa				23	23	20	19	14	13	18	13	20	18	12	13	13	14	10	15	14	14
EPT Value				10	10	11	9	5	5	8	4	9	9	3	5	2	4	1	4	2	1
Number of Individuals				458	632	616	848	416	279	620	376	897	622	235	194	234	227	244	503	224	460
% EPT Individuals				19.0	10.6	12.0	16.3	6.7	6.1	7.6	3.7	14.7	8.0	2.6	5.2	6.4	4.0	0.8	2.0	0.9	0.2
% EPT Taxa				43.5	43.5	55.0	47.4	35.7	38.5	44.4	30.8	45.0	50.0	25.0	38.5	15.4	28.6	10.0	26.7	14.3	7.1
MCI-sb Value				104.4	109.7	103.7	108.2	82.9*	81.5*	90.0*	67.7*	104.1	116.6	78.3	93.5	72.9	85.6	68.2	82.4	69.7	68.4
QMCI-sb Value				4.83	4.71	4.74	4.85	3.14*	3.18*	3.17*	2.99*	4.80	4.66	2.36	2.14	2.36	2.51	2.55	1.77	2.03	2.31

MCI or QMCI (hard bottomed stream version)

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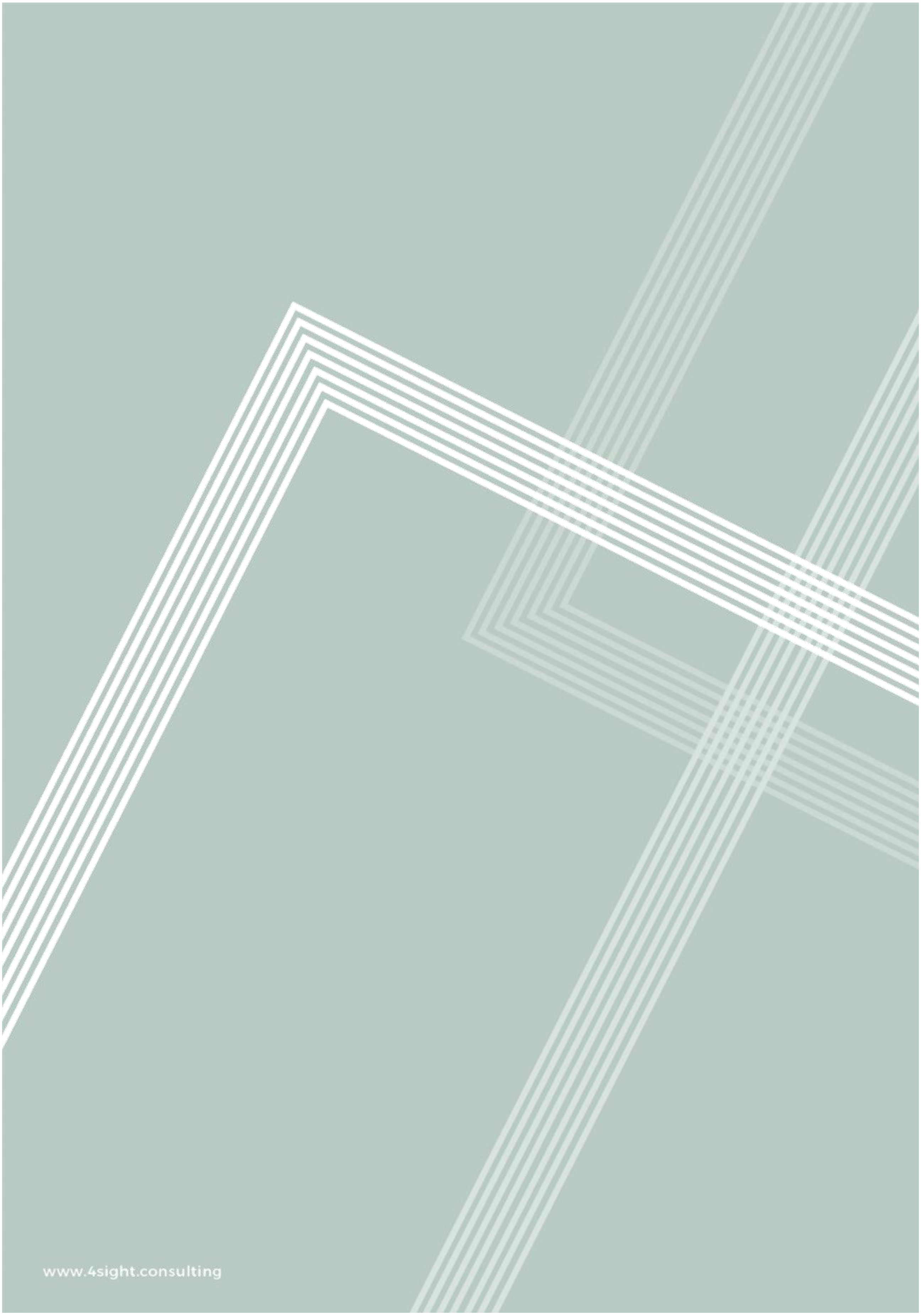
Appendix B:

Aquatic plant transects – raw data -2021

Coverage of aquatic plants (m) from transects at each Waiari Stream site (visually assessed). P = present nearby, but not within transect.

Site	Transect	Stream width (m)	Green filamentous algae/ moss complex	Oxygen weed (*Elodea canadensis*)	Starwort (*Callitriche stagnalis*)	Watercress (*Nasturtium officinale*)
1	1	17			0.2	0.5
	2	18				
	3	16			0.3	
	4	17	0.4		0.7	
	5	16			0.3	
Average		*16.8*				
2	1	14			0.3	2.0
	2	13			0.2	2.0
	3	14			0.4	2.0
	4	15				1.0
	5	15				1.3
Average		*14.2*				
3	1	13		6.5		
	2	13		6.5		
	3	14		6.0		
	4	14		7.0		
	5	14		6.0		
Average		*13.6*				
4	1	15		7.0		
	2	15		6.0		
	3	16		7.0		
	4	16		6.0		
	5	16		7.0		
Average		*15.6*				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WAIARI STREAM MONITORING 2021
Keren Bennett
Principal Ecology Consultant
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Overview

- Biological monitoring of the Waiari Stream is required as a condition of resource consent
- Monitoring of macroinvertebrate communities, fish, macrophytes (aquatic plants) and basic water quality
- Four survey sites:
  - Upstream and downstream of the WTP intake
  - Upstream and downstream of the Te Puke WWTP discharge
- Monitoring began in 2010, with repeat baseline surveys in 2011, 2012, 2017, 2019, 2020 and 2021
- Construction of the WTP intake and infrastructure began in 2018

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Waiari Stream habitats

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Waiari Stream habitats

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Fish communities

- Good diversity of native fish within the stream
- Fish IBI indicates 'excellent' diversity at all sites
- Longfin eel, inanga and redfin bully are the most common recorded species
- Banded kokopu recorded near the WTP in 2021 – not previously recorded from the Waiari
- Rock revetement near the WTP intake provides new habitat for fish such as bullies and eels

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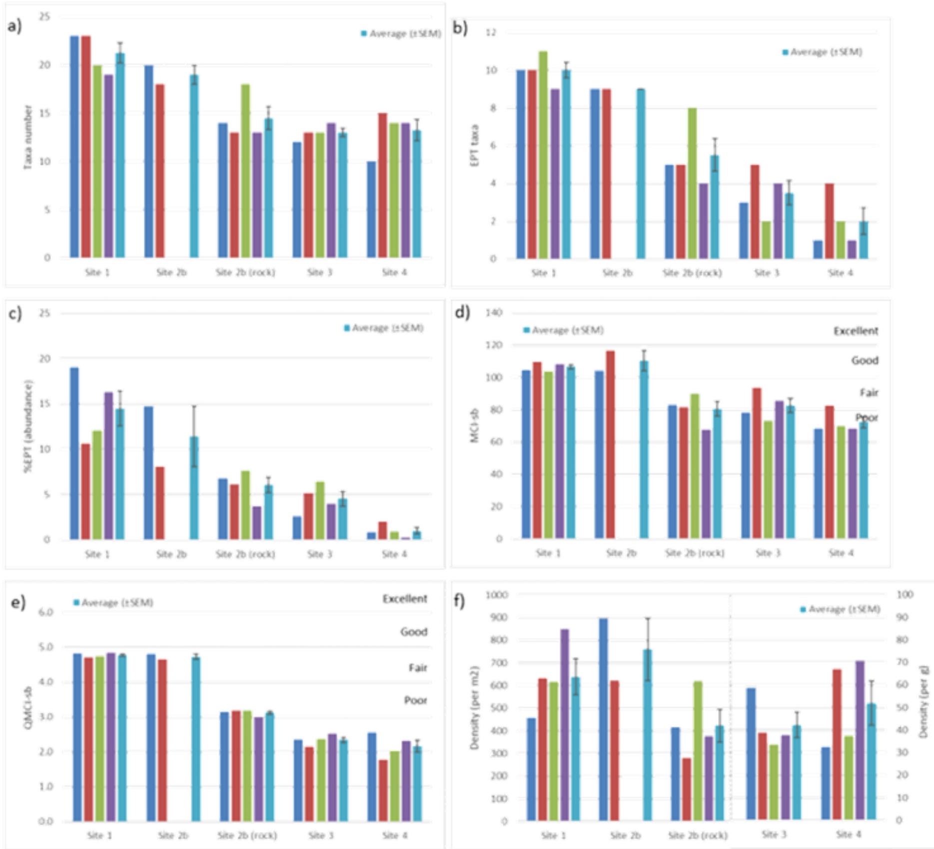
Macroinvertebrate communities - 2021

- Samples are taken from wood near the WTP and aquatic plants near the WWTP
- Comparative samples also taken from the rock revetement in 2021
- A range of indices are calculated that each tell part of the community story
- There are differences between results from the upper stream and lower stream



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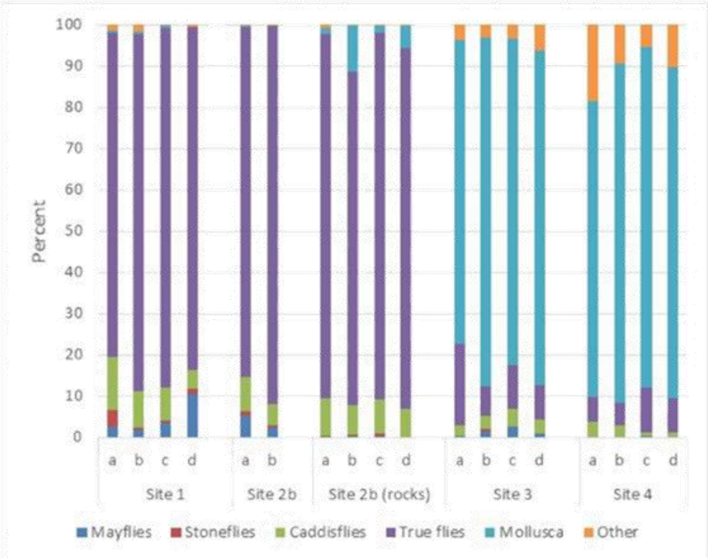
Community composition



- Communities on oxygen weed in the lower stream are dominated by snails
- Communities on wood (or rocks) in the upper stream are dominated by non-biting midge larvae (Chironomids)

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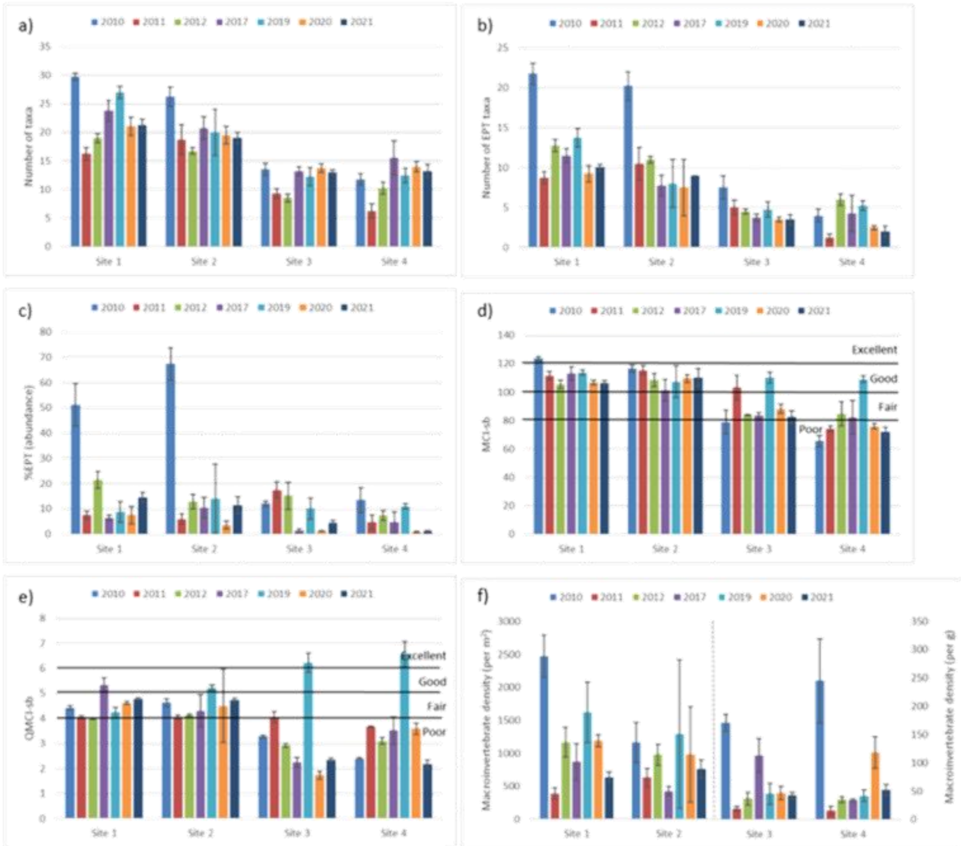
Macroinvertebrate communities – baseline results

- Seven years of baseline sampling results now available
- Observable differences in community indices in the upper vs lower Waiari
- Variation in results between years
- Communities are influenced by:
  - High flow / storm events
  - Low flow / drought conditions
  - Regularity of events and time since last event
  - Sediment (substrate) types



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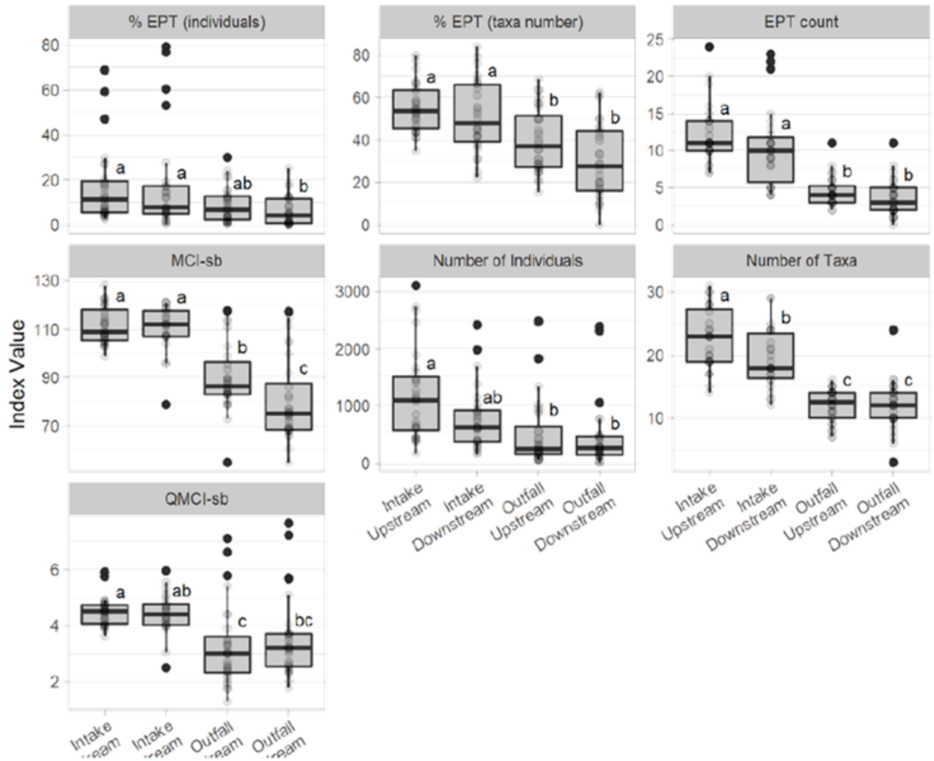
Statistical comparisons and trend analysis

- Mean index values in the upper Waiari were typically statistically higher than those of the lower Waiari
- Index values upstream and downstream of the WTP intake were statistically similar, except for the total number of taxa
- Index values upstream and downstream of the WWTP outfall were statistically similar, except for MCI-sb



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Statistical comparisons and trend analysis

- Preliminary trends analysis carried out on seven years of data
- Less than the recommended 10 years of data
- Small, but statistically significant trends observed in some indices
- Baseline data – water take is yet to commence

Site	No. Taxa	% EPT (Individuals)	% EPT (taxa number)	MCI-sb	QMCI-sb	No. Individuals
Site 1; Intake Upstream		-ve	-ve	-ve	+ve	
Site 2: Intake Downstream			-ve	-ve		
Site 3; Outfall Upstream		-ve	-ve		-ve	
Site 4: Outfall Downstream	+ve	-ve				

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TANGATA WHENUA REMUNERATION POLICY 2021

Tauranga City

Policy type	City		
Authorised by	Council		
First adopted	22 February 2021	**Minute reference**	CO1/21/4
Review date	This policy will be reviewed at least every three years or earlier as required. Remuneration will be reviewed upon each update of the Cabinet fees framework.		

1. PURPOSE

1.1 To outline the remuneration payable and any other allowances made available to tangata whenua for the provision of expert advice to council decision-making processes.

1.2 To outline the role of Te Rangapū Mana Whenua o Tauranga Moana in aiding council decision-making.

2. SCOPE

2.1 This policy applies to the remuneration of tangata whenua appointed to Te Rangapū Mana Whenua o Tauranga Moana, Council committees and advisory groups.

2.2 This policy also applies to tangata whenua appointed to provide advice to a council project.

2.3 The policy does not apply to any payments for cultural impact assessments or earthworks monitoring.

4. PRINCIPLES

4.1 Compensating tangata whenua for their involvement in Council decision-making processes and projects reflects the partnership between Council and Tauranga Moana iwi and hapū.

4.2 The achievement of community outcomes requires the active involvement of tangata whenua in decision-making process and projects.

4.3 Council recognises that tangata whenua may have limited capacity and financial resources and that this may restrict their ability to actively participate in Council processes.

5. POLICY STATEMENT

5.1 Levels of Remuneration

5.1.1 Remuneration for tangata whenua appointed to Council standing committees of the whole will be confirmed at the commencement of each electoral term (subject to Council agreeing to tangata whenua representatives on standing committees of the whole).

5.1.2 A meeting fee set at $270 will be paid to tangata whenua representatives appointed to all other governance committees, advisory groups, or fora with joint tangata whenua and elected member membership.

5.1.3 The Chief Executive may negotiate additional compensation (within approved Council budgets) where a tangata whenua representative is appointed as the Chairperson of a governance committee, advisory group or forum.

5.1.4 Tangata whenua representatives appointed to provide input and advice to a council project will be paid an hourly rate of $150 via an agreed contract with specified responsibilities and deliverables

5.1.5 A tangata whenua representative may be appointed to advise a council project where a tangata whenua representative will provide particular skills, expertise and knowledge that is not available in-house. Not all council projects will require the advice of a tangata whenua representative.

5.1.6 Mileage and travel allowances will not be provided.

5.1.7 No remuneration will be paid where a tangata whenua representative is participating in their role as an employee or representative of an organisation and where that person is receiving financial remuneration from that organisation or where that organisation is being remunerated by council for their participation.

5.2 Te Rangapū Mana Whenua o Tauranga Moana

5.2.1 Te Rangapū Mana Whenua o Tauranga Moana (Te Rangapū) provides an opportunity for council staff to work with tangata whenua to ensure Council work programmes are responsive to the interests of tangata whenua.

5.2.2 Te Rangapū and Council will agree an annual contract and budget to enable Te Rangapū to progress identified priorities that support Council to deliver outcomes for Māori.

5.2.3 The budget will also be sufficient to support payment of meeting fees, fund administration expenses, and enable members of Te Rangapū to attend local training sessions related to the activities of Te Rangapū.

5.2.4 The budget allocated to Te Rangapū must be spent for the purposes identified in the contract. Any unspent funds will not be carried forward.

5.2.5 Council will pay a meeting of fee of $270 per individual mandated member (except the Chairperson) (one per iwi or hapū) per meeting.

5.2.6 The Chairperson will be paid a meeting fee of $365 in recognition of the extra duties undertaken by the Chairperson. Additional remuneration may be paid to the Chairperson so long as it remains within the overall budget allocated to Te Rangapū.

6. RELEVANT DELEGATIONS

6.1 The implementation of this policy is delegated to the Chief Executive and their sub-delegates.

7. REFERENCES AND RELEVANT LEGISLATION

7.1 Local Government Act 2002
Cabinet Fees Framework

8. ASSOCIATED POLICIES/PROCEDURES

Tauranga City Council Code of Conduct

Engaging and Paying for Cultural Monitoring of Earthworks Procedure

Cultural Impact / Māori Values Assessment Procedure

Tauranga City Council and Kaumatua/ Tangata Whenua Involvement in Significant Activities and Events

Iwi and hapū protocol agreements