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Water Resource Management

Aquatic Ecological Assessment Update for the Tuakau Structure Plan Area

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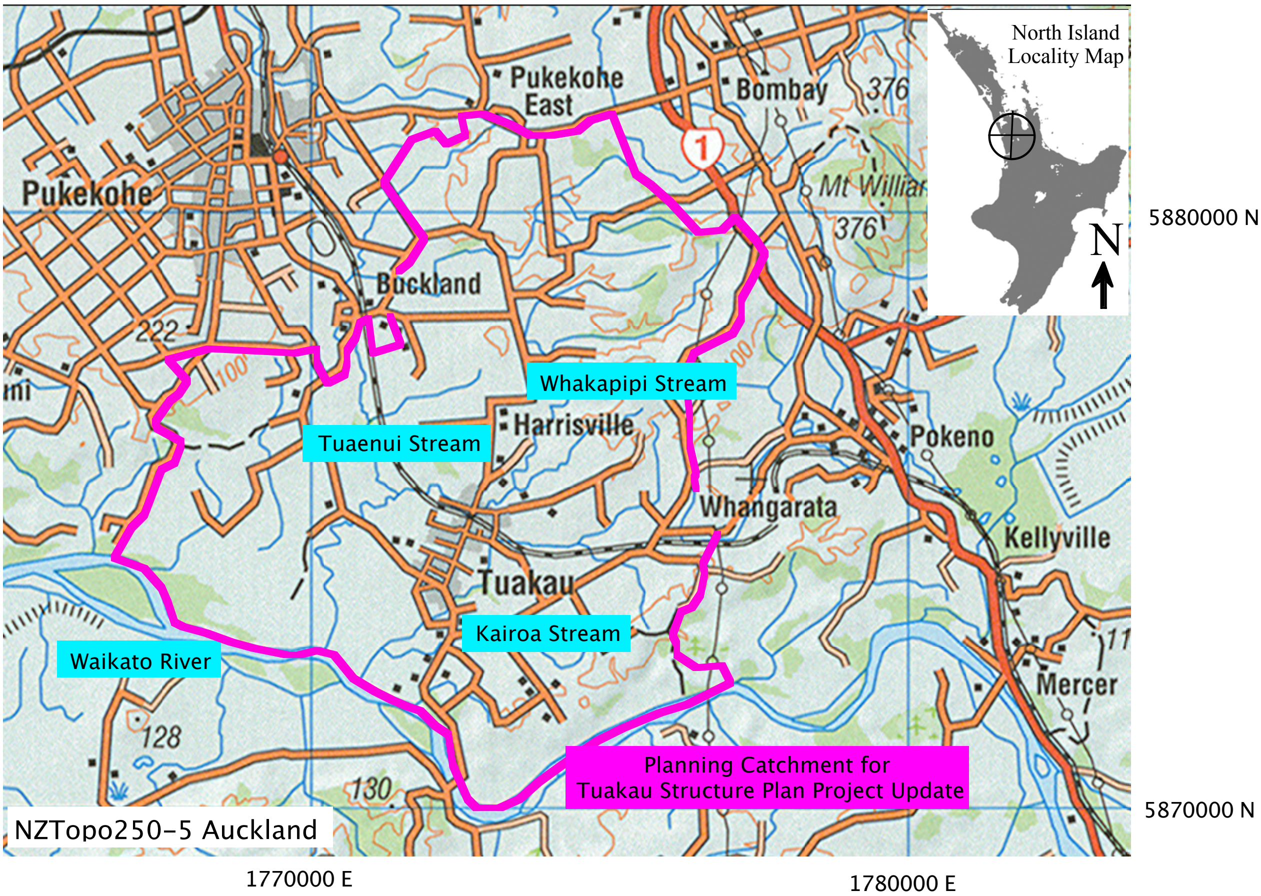
1.0 Introduction and Background

The current Tuakau Structure Plan project has arisen from the need to provide additional urban-zoned land for a growing town population. The 2012 Auckland Plan proposes a doubling of the Pukekohe population over the next 30 years and since Tuakau is only approximately 6 kilometres from Pukekohe, the Waikato District Council considers there is likely to be some spillover of growth to the settlement of Tuakau.

Coffey and Boud (2008) provided a previous contribution to the Tuakau Structure Plan in relation to aquatic ecology, but that assessment related to a small part of the Kairoa Stream catchment only.

The Waikato District Council has now defined a broader footprint to be considered as the planning catchment for the Tuakau Structure Plan Project Update (see Figure 1). The planning catchment now also includes the catchment of the Tuaenui and Whakapipi Streams (See Figure 1).

Figure 1: The footprint of the Waikato District Council planning catchment for the Tuakau Structure Plan update.



On this basis, two of the original hard-bottomed channel reaches surveyed in the Kairoa Stream were resurveyed to compare with survey data for October 2007 (Coffey and Boud, 2008), and an additional two hard-bottomed channel reaches were described in both of the Whakapipi and Tuaenui Streams.

2.0 Methodology and Approach

2.1 General

The survey was conducted on the 20 – 21st of March 2014 using the same methodologies as Coffey and Boud (2008), which were consistent with the protocols for stream surveys in the Waikato Region as specified by Collier and Kelly (2005) and Colliers et. al. (2007).

Figure 2: Sampling Reaches in the Kairoa, Whakapipi and Tuaenui Streams that are described in this report (see Figures 3 to 8 for individual sampling reaches).

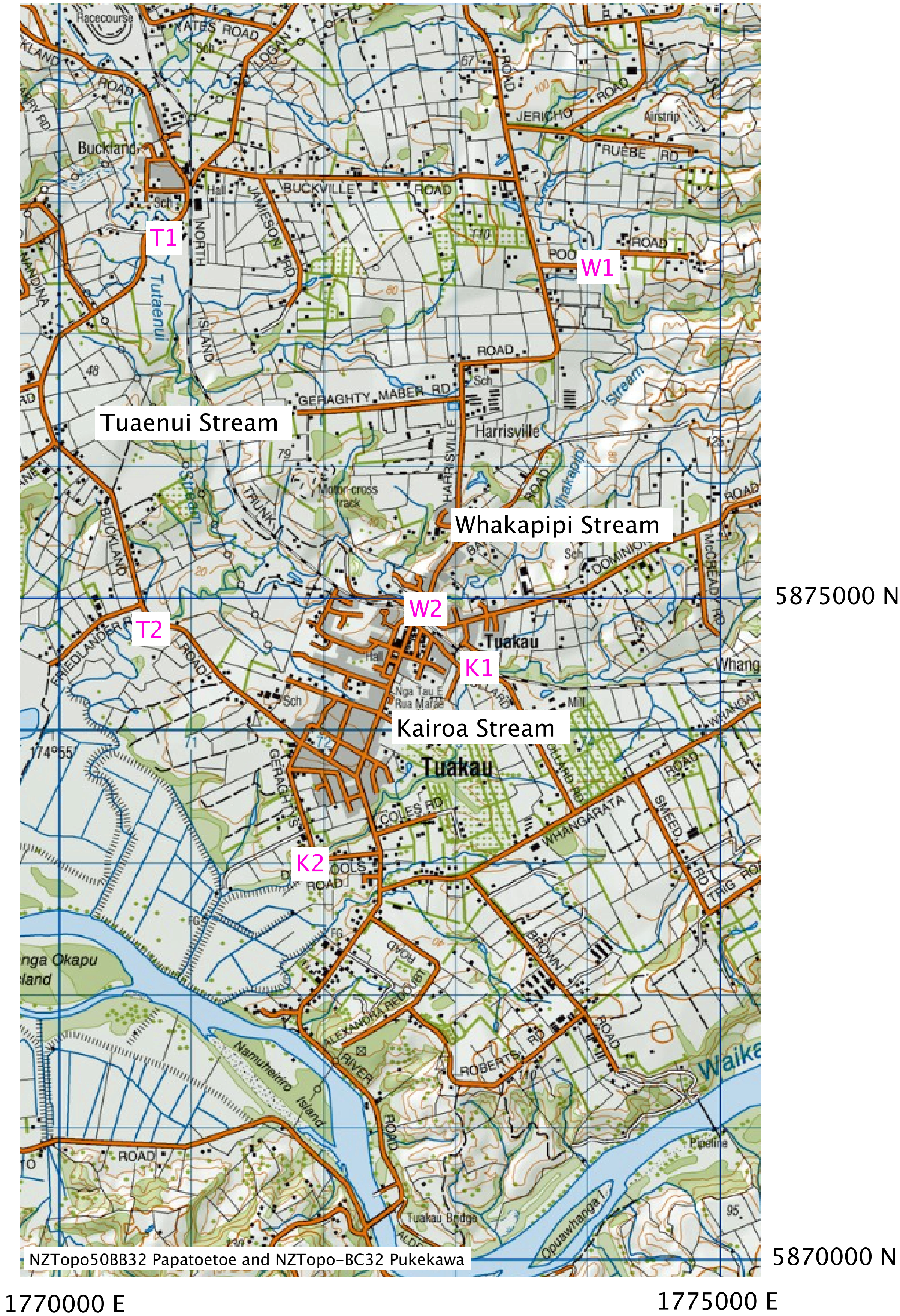


Figure 3: Aerial photograph of Sampling Reach K1 in the Kairoa Stream.

Figure 4: Aerial photograph of Sampling Reach K2 in the Kairoa Stream.

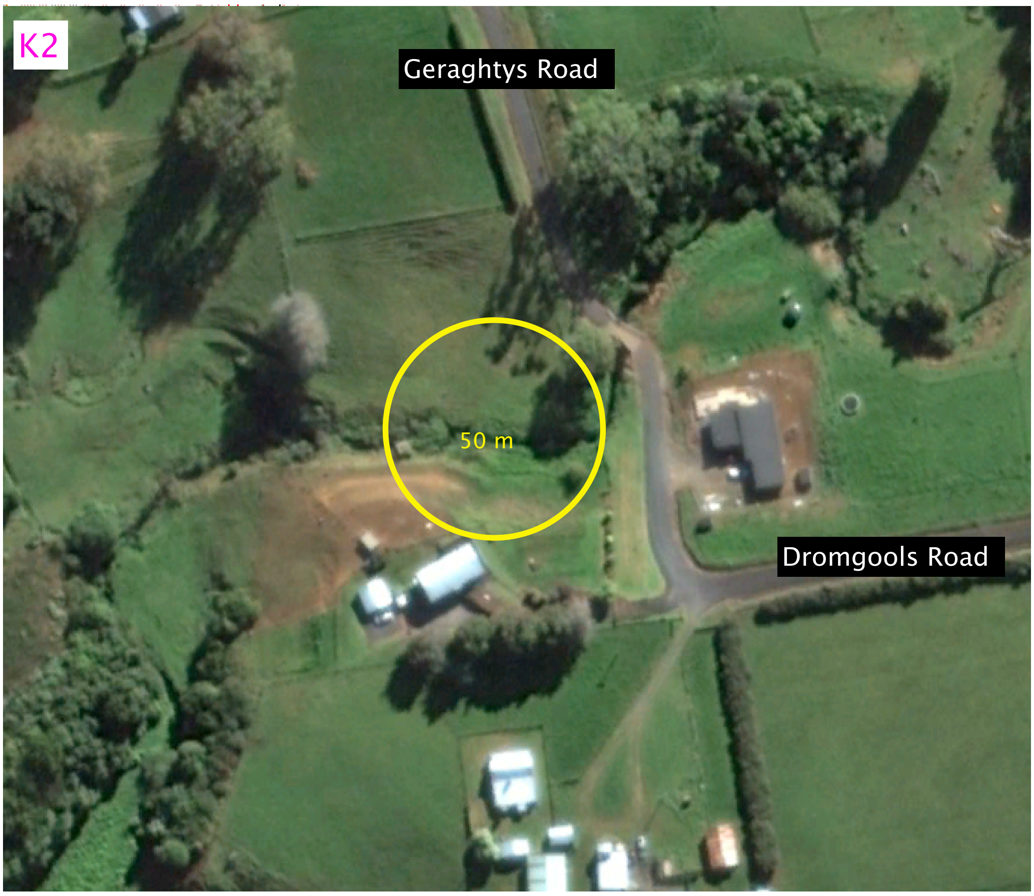


Figure 5: Aerial photograph of Sampling Reach W1 in the Whakapipi Stream.

Figure 6: Aerial photograph of Sampling Reach W2 in the Whakapipi Stream.

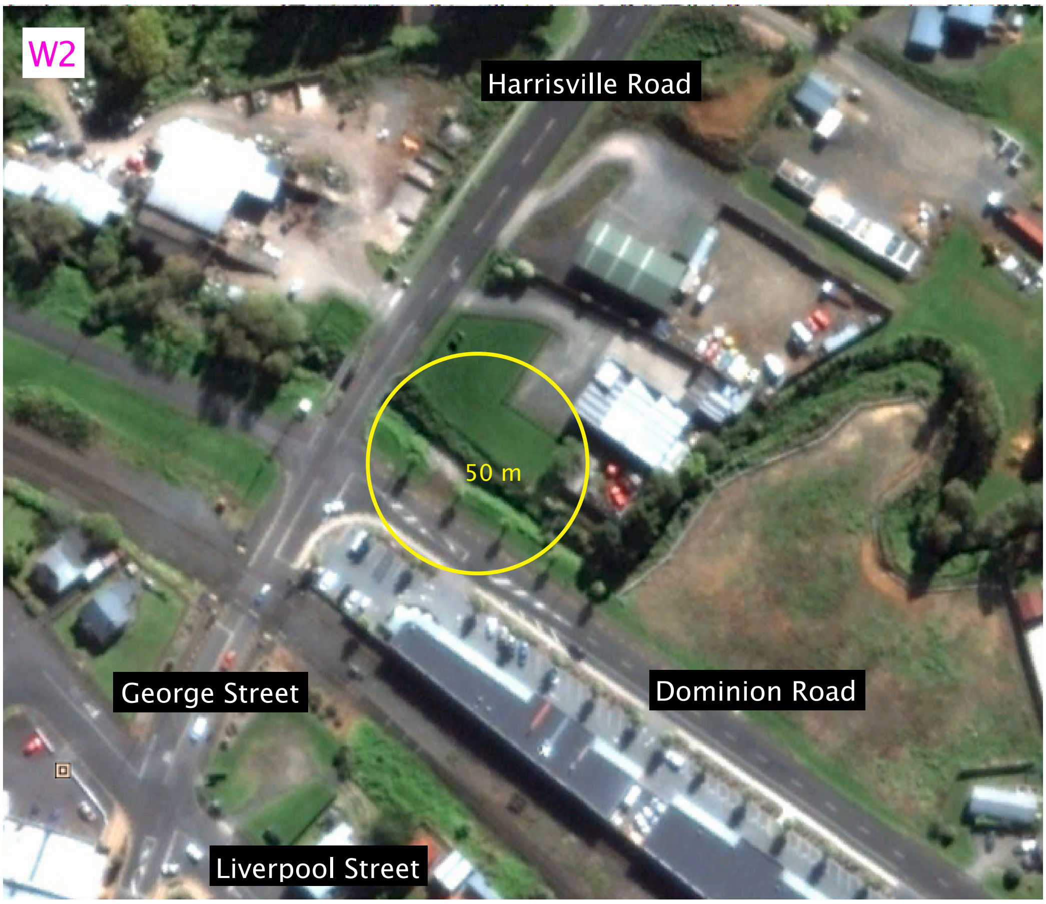
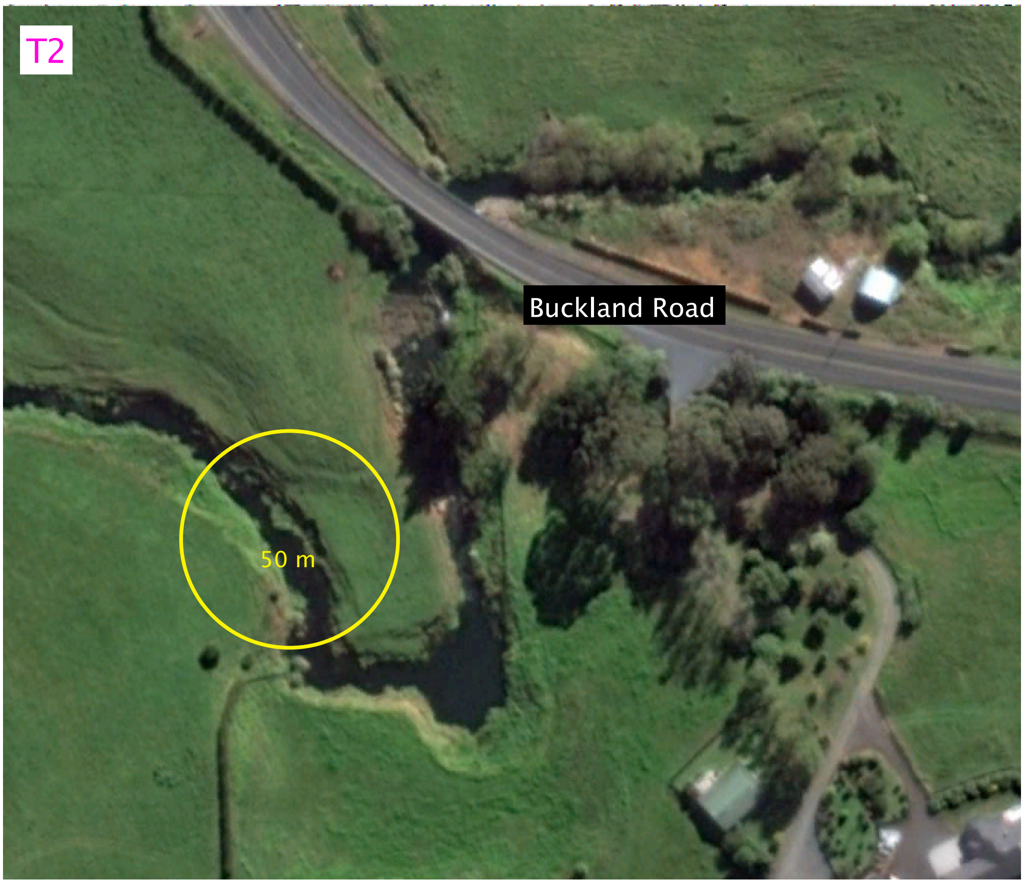


Figure 7: Aerial photograph of Sampling Reach T1 in the Tuaenui Stream

Figure 8: Aerial photograph of Sampling Reach T2 in the Tuaenui Stream



2.2 Habitat Assessment

Field assessment cover forms and relevant habitat forms (Collier and Kelly, 2005) were completed for 50 m long stream sections at each of the six sampling reaches shown in Figures 3 to 8.

Methodology for assessing habitat condition in hard-bottomed streams was consistent with Collier and Kelly (2005).

2.3 Periphyton

Methodology for describing periphyton communities was consistent with Collier et al. (2007).

Periphyton cover was described across five transects within each sampling reach, working from downstream to upstream sites as specified by Collier and Kelly (2005).

Fresh samples of Aufwuchs / periphyton were returned to the laboratory in labelled plastic bags for dissection and identification of component taxa.

2.4 Macrophytes

Methodology for describing macrophyte communities was consistent with Collier et al. (2007). Macrophyte cover was described across five transects within each sampling reach, working from downstream to upstream sites as specified by Collier and Kelly (2005).

Macrophyte taxa were identified and recorded in the field.

2.5 Macroinvertebrates

Methodology for collecting and describing macroinvertebrates communities was consistent with Collier and Kelly (2005).

A long-handled D-net and sieve fitted with 0.5 mm mesh was used to collect five replicate macroinvertebrates samples from an area of approximately three square metres at each sampling site that contained surface water and the proportion of habitat types sampled was recorded on field assessment cover forms for that site.

Five composite macroinvertebrate samples from each sampling reach were drained through a 0.5 mm sieve, transferred to a labelled container and preserved in ethanol for transport to the laboratory.

Ministry for the Environment Protocol P2 with additions or variations as specified by Collier and Kelly (2005) were used to obtain a 200 individual fixed count with scan for rare taxa for each macroinvertebrate sample in the laboratory.

2.6 Fish

A combination of electric fishing and set netting was used to describe fish communities within each sampling reach.

Within each of the six channel reaches surveyed, a 20 m section of flowing stream habitat, less than 1 m deep, was isolated up and downstream by set nets with a mesh size of 2 millimetres. That section of stream was then systematically “fished” (electrocuted) using a portable, battery powered Electric Fishing Machine (Kainga Model EFM300) designed and manufactured by NIWA Instruments Systems.

One baited Fyke net (using ox heart) and one baited G-minnow trap (using perforated jars of marmite) was set overnight within each of the six sampling reaches (see Figures 2 to 8). Catches were counted and measured before being returned to the section of stream, from which they had been removed.

Fish that were included in macroinvertebrate samples were also recorded for each of the six sampling reaches

2.7 Water Quality

Water temperature, dissolved oxygen, pH and conductivity were measured with a calibrated Hach HQ40d meter with twin probe connectors and standard IntelliCAL probes at the upstream end of each sampling reach at the time of sampling instream community structure.

3.0 Results and Discussion

3.1 General

The survey was timed to coincide with dry weather flows.

The technical distinction between hard and soft-bottomed sites in the three streams was generally confounded by the spread of emergent vegetation into and across otherwise hard-bottomed stream channels during dry weather summer conditions.

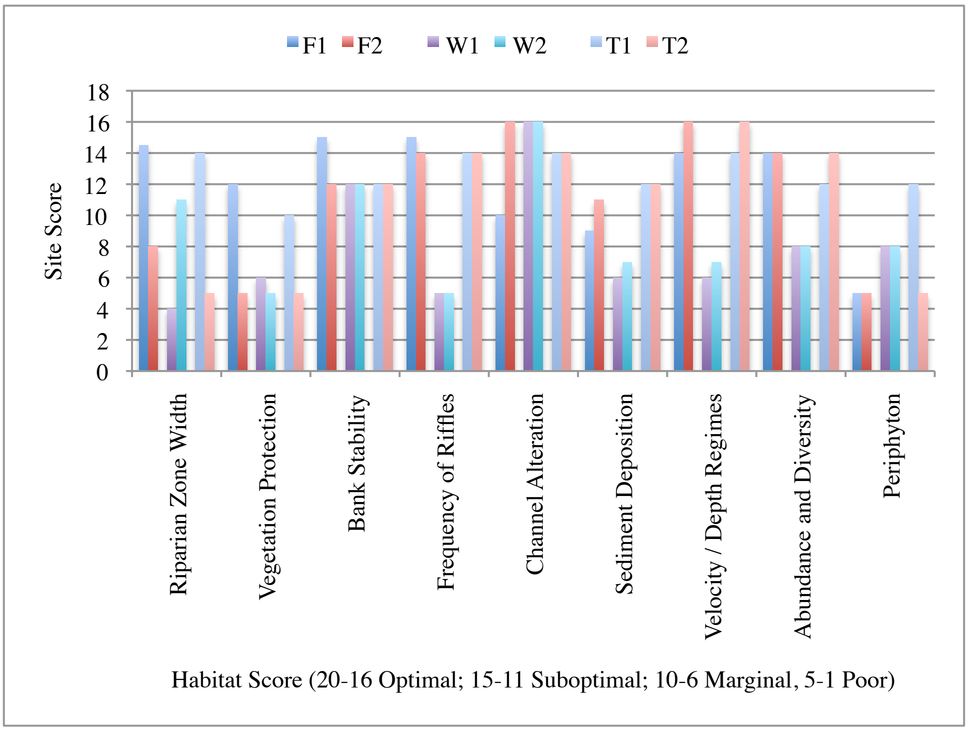
On this basis, transects for describing periphyton were not evenly spaced within each sampling reach but were selected to coincide with the occurrence of open hard substrate within a given sampling reach. Macrophytes were also described at these same transect sites as they generally occurred along the stream bank at transects selected for the description of periphyton.

3.2 Habitat Assessment

Pre-formatted field assessment cover forms (after Collier and Kelly, 2005) for each of the six sampling sites are reproduced in Appendix A. These include water quality records.

Pre-formatted habitat assessment sheets (for hard-bottomed sites after Collier and Kelly, 2005) for each of the six sampling sites are reproduced in Appendix B and summarised in Figures 9 and 10.

Figure 9: Component Habitat Assessment Scores within Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20 - 21 March 2014.

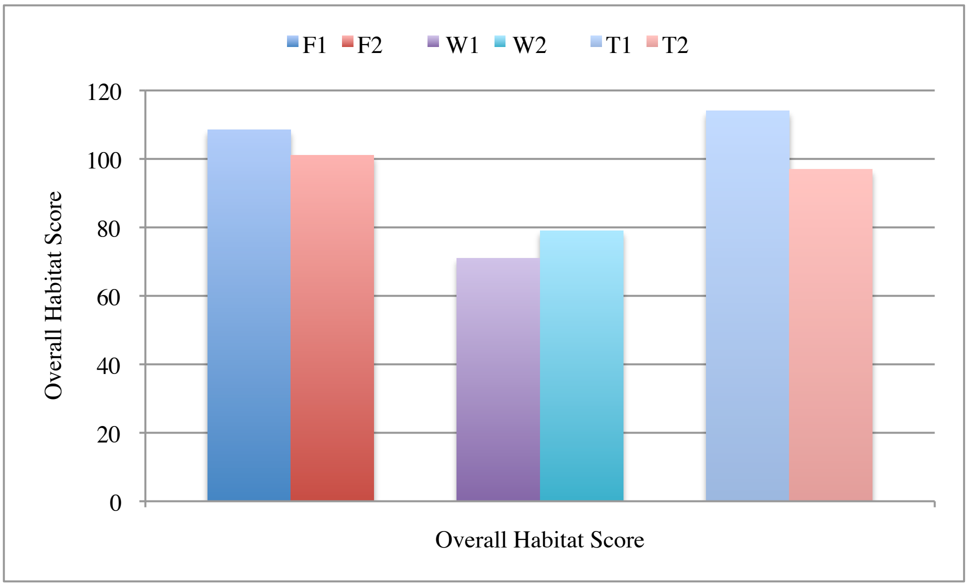


The setting of the Kairoa, Whakapipi and Tuaenui Streams in an agricultural / horticultural / urban setting contributed to generally poor to suboptimal habitat assessment scores (see Figures 9 and 10) with the poorest overall habitat quality being recorded for the Whakapipi Stream.

3.3 Periphyton

Raw data sheets for instream periphyton lifeform and cover are attached as Appendix C and summarised in Figures 11, 12 and 13.

Figure 10: Overall Habitat Assessment Scores within Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20-21 March 2014.

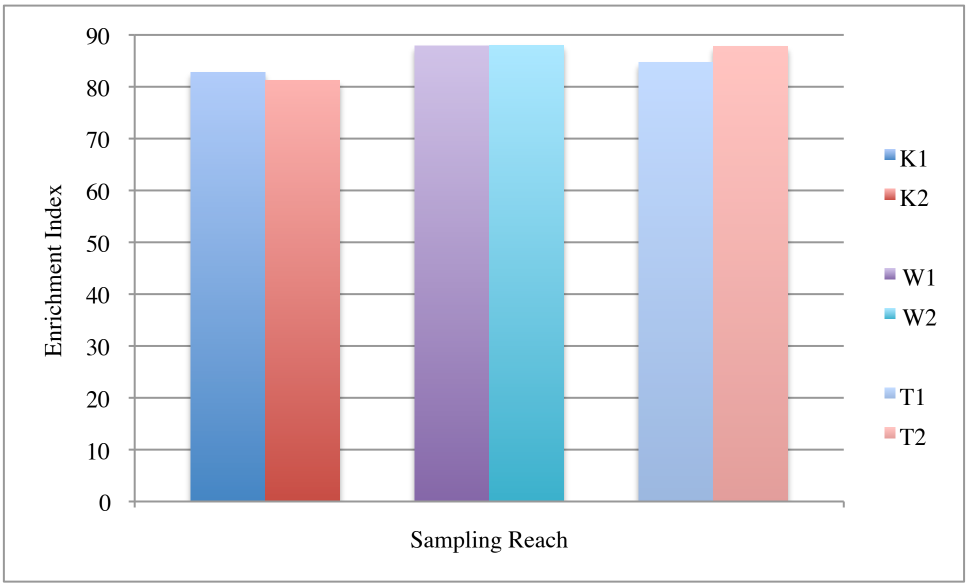


The nutrient enrichment index adopted by Collier and Kelly (2007) ranges from 0 to a maximum of 90 with higher scores indicating higher levels of eutrophication.

Figure 11 illustrates that all six sampling reaches are significantly eutrophic with plant nutrients readily available from stream water.

The periphyton proliferation index was lowest within Sampling Reach T1 due to the stream channel being significantly shaded by exotic trees in the riparian zone. (see Figure 12).

Figure 11: Enrichment Index for Periphyton within Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20-21 March 2014.



Mat forming periphyton was dominated by filamentous periphyton at all hard-bottomed sites at the time of this survey (see Figure 13).

Long filamentous taxa that were present at open (un-shaded) stream sites were generally dominated by the branched green filamentous algae *Cladophora glomerata*, a chain-forming diatom *Tabellaria* and an un-branched green filamentous alga *Spirogyra*.

Figure 12: Proliferation Index for Periphyton within Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20-21 March 2014.

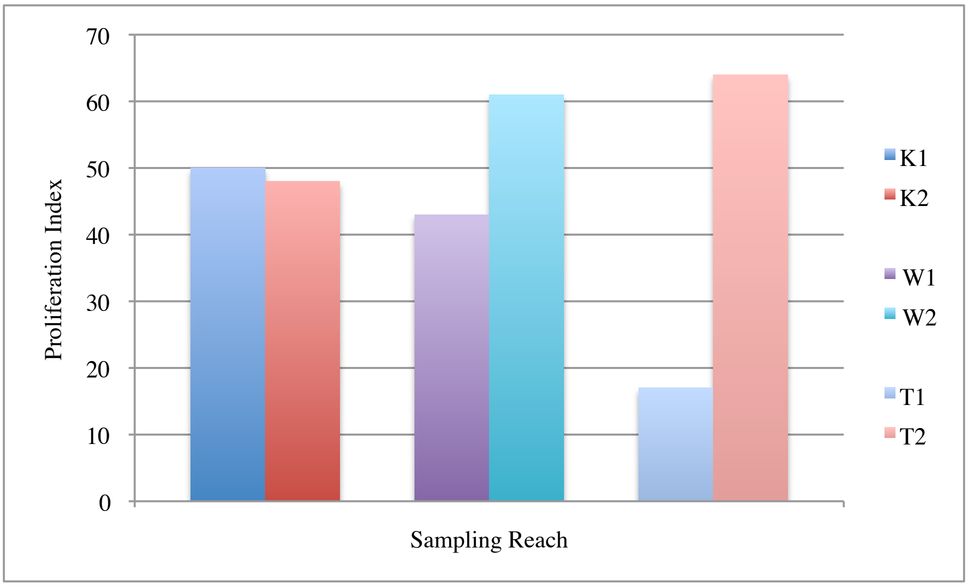
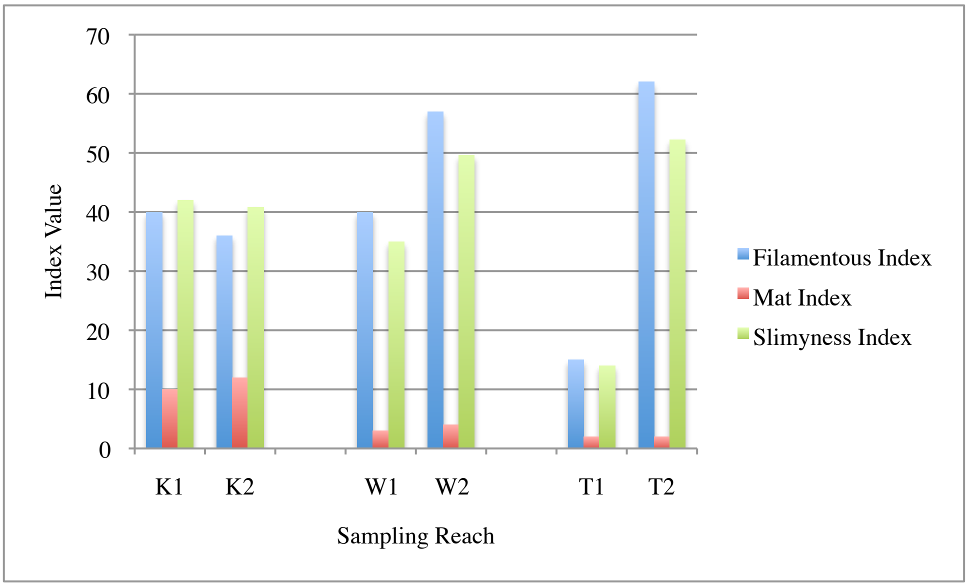


Figure 13: Filamentous, Mat and Slimyness Indices for Periphyton within Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20-21 March 2014.



Mat-forming periphyton was generally dominated by a species of the yellow-green alga *Vaucheria*. Other alga / cyanobacteria that were commonly components of periphyton communities with included *Oscillatoria*, *Phormidium*, *Ulothrix*, *Oedogonium*, *Klebsmordium*, assorted diatoms and the red alga *Compsmopogon* and *Batrachospermum*.

Bryophyte taxa in the study area included *Drepanocladus adnucus*, *Fissidens rigidulus* and a species of *Lophocolea*. The colonial cyanobacterium *Nostoc* was a common associate of *Drepanocladus* within Sampling Reach K2.

3.4 Macrophytes

Raw data sheets for instream macrophytes cover are attached as Appendix D). The free-floating taxa *Azolla rubra* and *Lemna minor* were also present in the study area.

The taxa codes used in Appendix D are listed in Table 1 (Collier and Kelly, 2007).

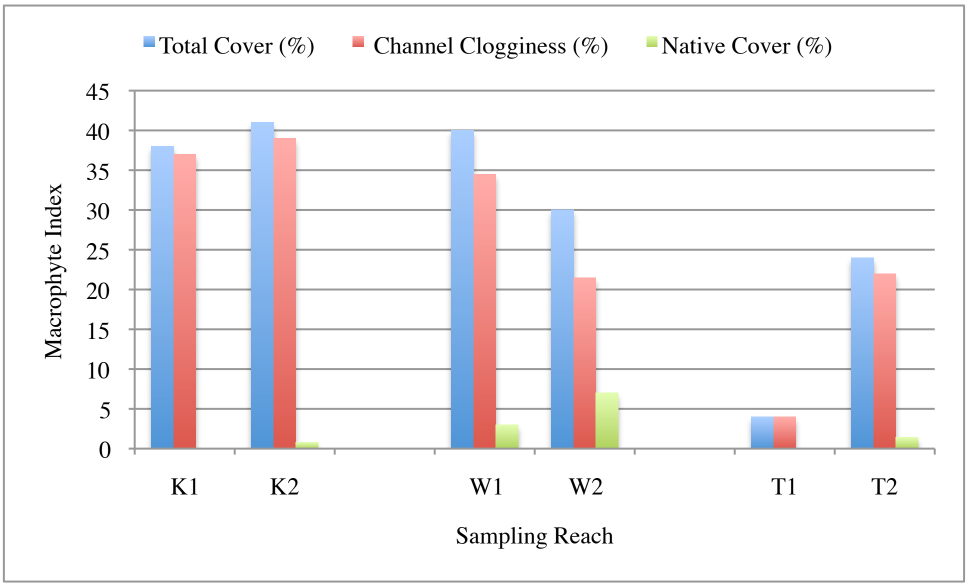
Table 1: Taxa codes used in Stream Survey Sheet 4 (Collier and Kelly, 2007).

Submerged		Emergent	
Mp*	*Myriophyllum propinquum*	Ps*	*Persicaria decipiens*
Mt*	*Myriophyllum triphyllum*	An	*Apium nodiflorum*
Nh*	*Nitella hookeri / cristata*	Gm	*Glyceria maxima*
Po*	*Potamogeton ochreatus*	Gr	*Other grasses*
Cd	*Ceratophyllum demersum*	Lp	*Ludwigia palustris*
Ec	*Elodea canadensis*	Mg	*Mimulus guttatus*
Ed	*Egeria densa*	Ma	*Myriophyllum aquaticum*
Lm	*Lagarosiphon major*	Na	*Nasturtium officinale / microphyllum*
Pk	*Potamogeton crispus*	Ph	*Persicaria hydropiper*
Rt	*Ranunculus trichophyllus*	Ve	*Veronica anagallis - aquatica / Americana*
St	*Callitriche stagnalis*	Ml	*Myosotis laxa*
		Le	*Lycopus europaeus*

* native taxa

Figure 14 illustrates summary macrophyte cover indices for each of the sampling reaches.

Figure 14: Filamentous, Mat and Slimyness Indices for Periphyton within Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20-21 March 2014.



As was the case for periphyton, macrophyte cover was lowest within the shaded channel reach T1.

Emergent macrophyte cover was generally dominated by reed sweet grass (*Glyceria maxima*). However, twin cress (*Apium nodiflorum*) and water pepper (*Persicaria hydropiper*) were locally common in unshaded stream reaches.

Submerged macrophyte cover in open (unshaded) reaches was generally dominated by the introduced oxygen weeds *Egeria densa* and *Elodea canadensis* with curly-leaved pondweed *Potamogeton crispus* and the native charophyte *Nitella hookeri* as sub-dominant associates.

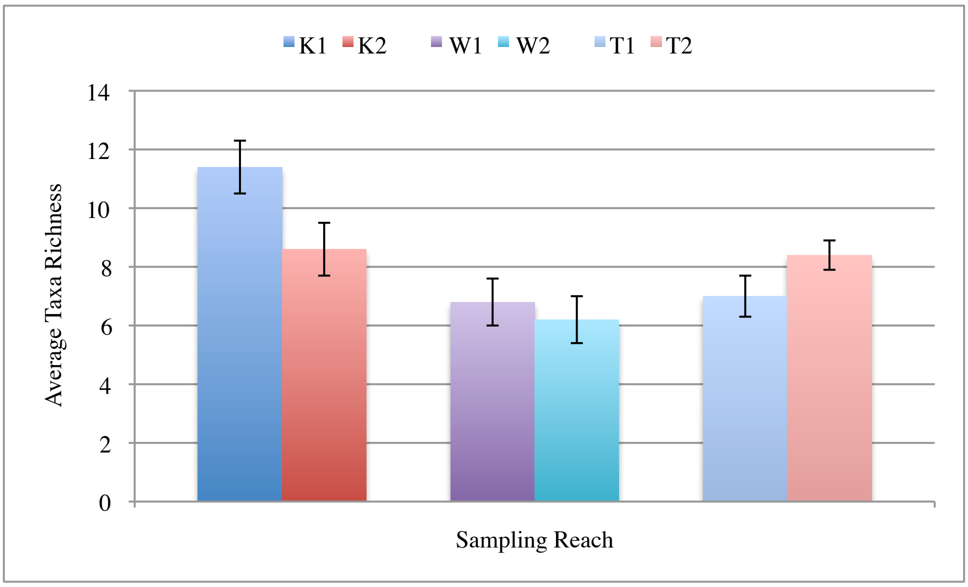
3.5 Macroinvertebrates

Raw laboratory counts and calculations for metrics of macroinvertebrate community structure are provided in Appendix E for Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20-21 March 2014, and these data area summarised in Figures 15 to 20.

Error bars in Figures 15 to 29 are ± stdev where n = 5.

Taxa Richness for invertebrates (see Appendix E and Figure 15) reflects the “health” of instream communities and generally increases with increasing water quality, habitat diversity and / or habitat suitability. Taxa richness was relatively low within all sampling reaches at the time of this survey.

Figure 15: Average Taxa Richness for Aquatic Macroinvertebrates within Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20-21 March 2014.



Probability values for a “two tailed” heteroscedastic T-Test for mean estimates of taxa richness were greater than 5% between Sampling Reaches in the Whakapipi Stream (W1 and W2) indicating there were no significant differences in the mean values for this metric within these two sampling reaches. However, mean values for taxa richness within the two sampling reaches in the Kairoa and Tuaenui Streams were significantly different (PC <5%).

The calculated Macroinvertebrate Community Index (MCI see Appendix E and Figure 16) and Quantitative Macroinvertebrate Community Index (QMCI see Appendix E and Figure 17) rely on prior allocation of scores (tolerance values range from 0 to 10) to freshwater macroinvertebrates based upon their pollution tolerances.

Figure 16: Average MCI for Aquatic Macroinvertebrates within Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20-21 March 2014.

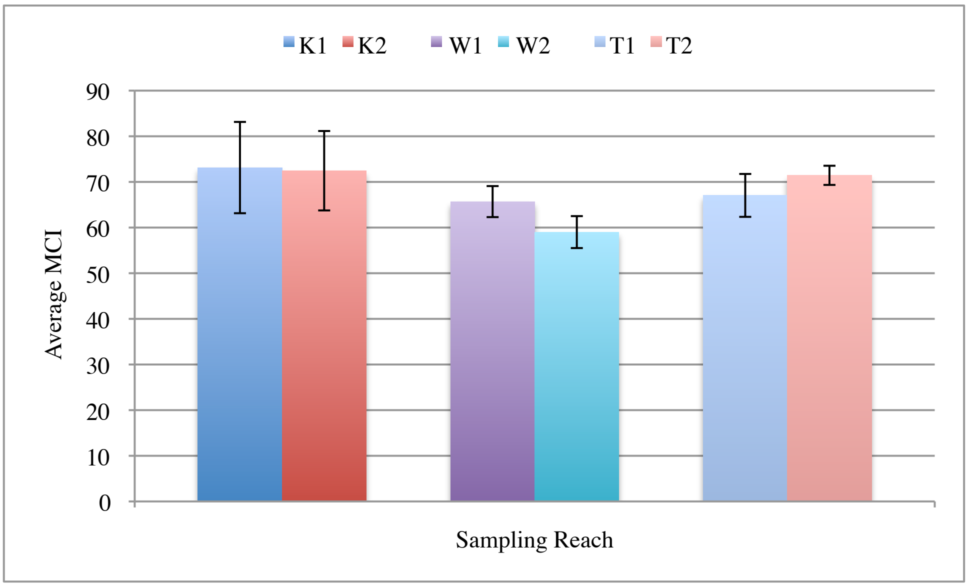
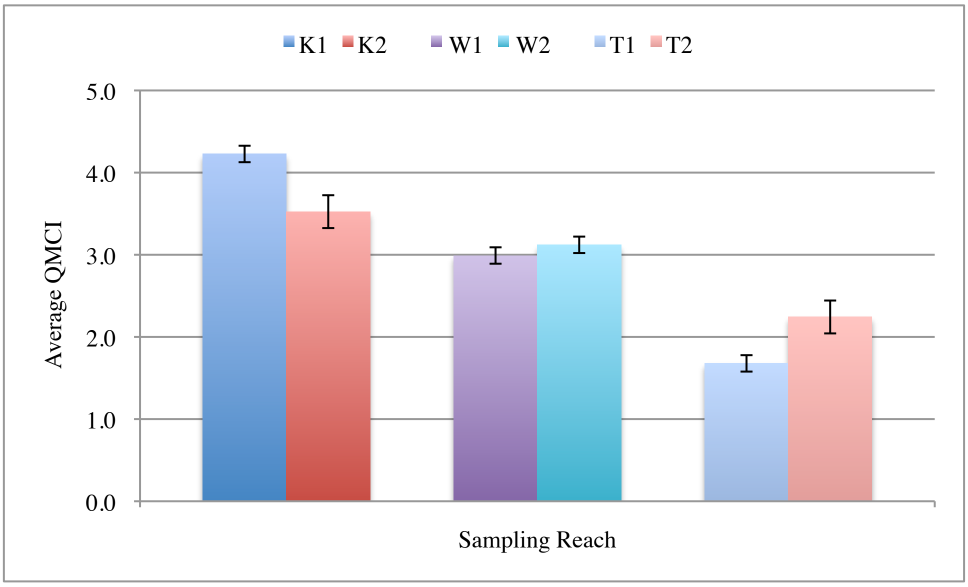


Figure 17: Average QMCI for Aquatic Macroinvertebrates within Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20-21 March 2014.



The MCI and QMCI have been developed as a means of detecting organic pollution in communities inhabiting rock or gravel riffles and taxa that are characteristic of pristine conditions score more highly than taxa that may be found in "polluted" conditions.

Whilst they have been modified to also include non-arthropod species and have been used to assess other forms of contamination, judgement is required when using these indices for specific contaminants / disturbance in other habitat types.

Different tolerance scores have now been assigned for taxa in hard-bottomed and soft-bottomed streams (Stark and Maxted, 2007) but in this instance, all six sampling reaches surveyed were scored as hard-bottomed sites.

Macroinvertebrate Community Index values that are greater than 120 indicate very good instream habitat for aquatic macroinvertebrates. Poor instream habitat for aquatic macroinvertebrates is associated with MCI values of less than eighty. "Good" and "Fair" instream habitat for aquatic macroinvertebrates is associated with MCI values of 100 to 120 and 80 to 100 respectively (Stark 1985, 1993).

Quantitative Macroinvertebrate Community Index values greater than six indicate very good instream habitat for aquatic macroinvertebrates. Poor instream habitat for aquatic macroinvertebrates is associated with QMCI values of less than four. "Good" and "Fair" instream habitat for aquatic macroinvertebrates is associated with QMCI values of four to five and five to six respectively (Stark 1998).

With the exception of Sampling Reach K1 (that would be rates as fair habitat on the basis of its QMCI rating), all other sampling reaches provided poor instream habitat for macroinvertebrates (see Figures 16 and 17).

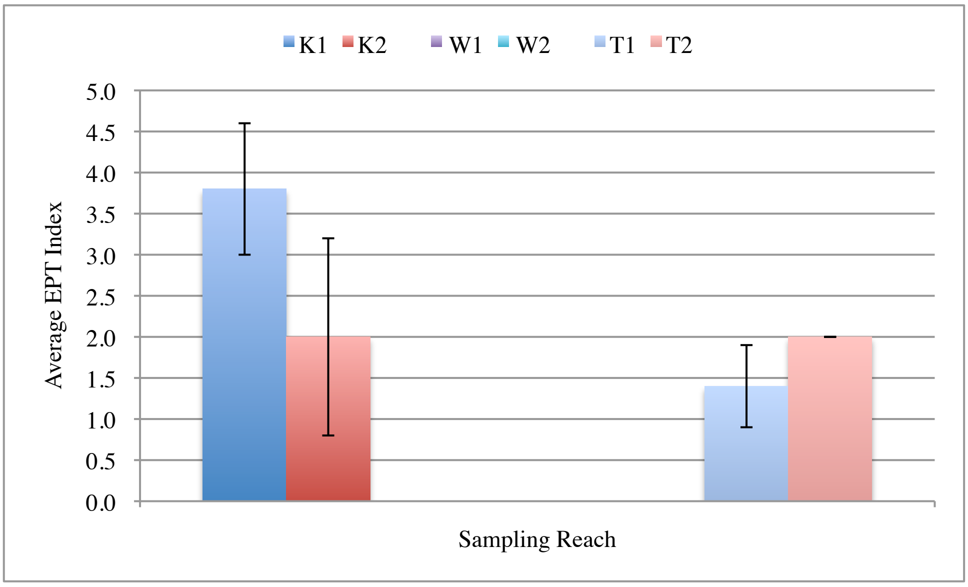
There was a significant reduction in MCI between sampling reaches W1 and W2 but not between K1 and K2 or T1 and T2. However, in terms of QMCI, there was no significant difference between Sampling Reaches W1 and W2 but there was a significant reduction of habitat quality moving downstream from K1 to K2 and a significant improvement in habitat quality moving downstream from T1 to T2 (see Figures 16 and 17).

The Ephemeroptera, Plecoptera, Trichoptera (EPT) Index is the total number of distinct taxa within the orders Ephemeroptera, Plecoptera, and Trichoptera and generally increases with increasing water quality. This value summarises Taxa Richness within the insect orders that are generally considered pollution sensitive.

The EPT Index (see Figure 18) was relatively low at both sampling reaches within the Kairoa and Tuaenui Streams and no EPT Taxa were recorded at the two sampling reaches within the Whakapipi Stream (see Figure 18).

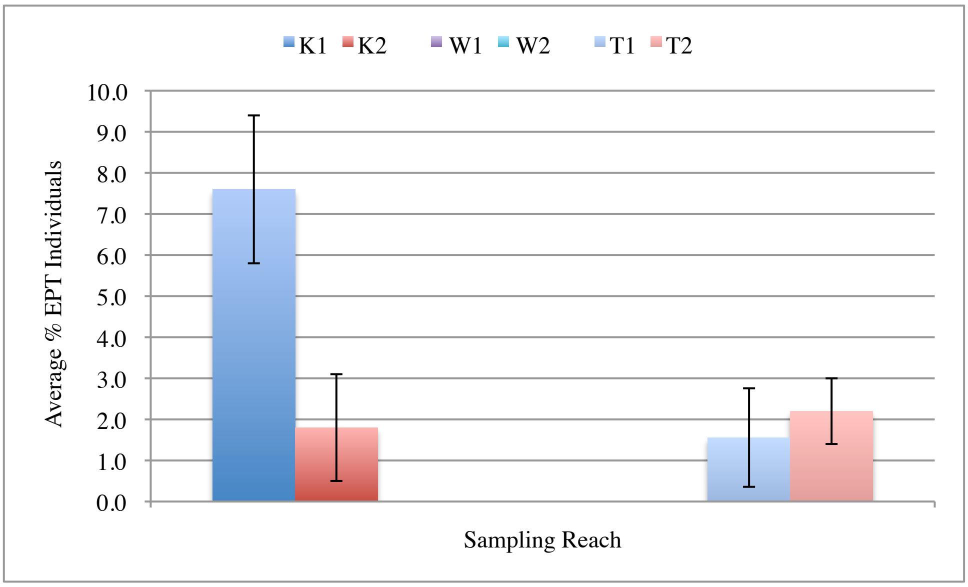
On the basis of the EPT Index, there was a significant reduction of habitat quality moving downstream from K1 to K2 and a significant improvement in habitat quality moving downstream from T1 to T2 (see Figure 18).

Figure 18: Average EPT Index for Aquatic Macroinvertebrates within Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20-21 March 2014.



The percentage density of Ephemeroptera, Plecoptera and Trichoptera (% EPT Individuals – see Figure 19) is a commonly used metric based on the percentage of the total number of pollution sensitive invertebrates in a sample that are within these insect orders. This index should be highest in unimpaired, pristine sites little affected by eutrophication or nutrient enrichment.

Figure 19: Average % EPT Individuals for Aquatic Macroinvertebrates within Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20-21 March 2014.



"Very Good" instream habitat for aquatic macroinvertebrates is associated with greater than 60% EPT Taxa: "Poor" instream habitat is associated with less than 10% EPT Taxa and "Moderate" instream habitat is associated with 10 to 60% EPT Taxa (Milne and Perrie, 2006).

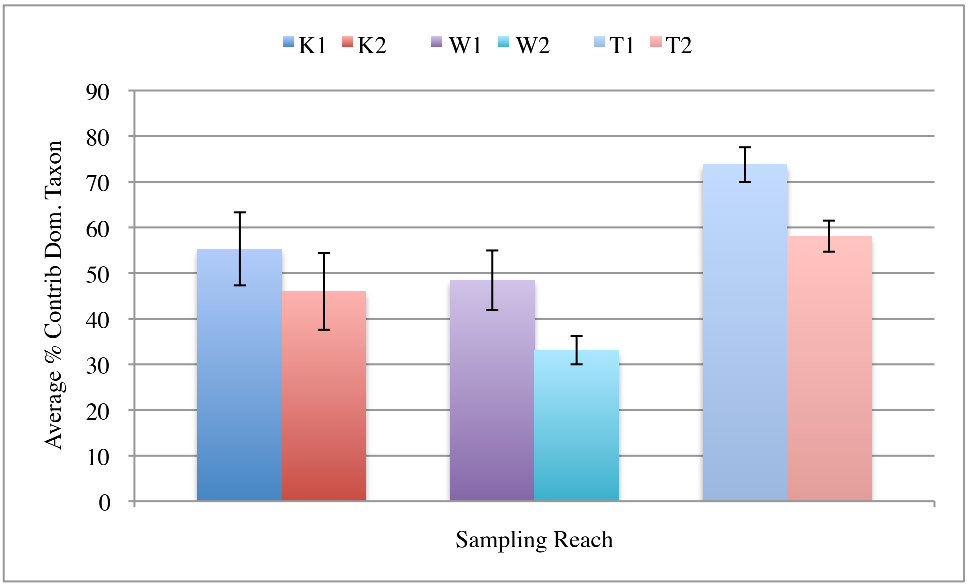
In this instance, no EPT individuals were recorded at the two sampling reaches within the Whakapipi Stream and less than 10% of the macroinvertebrate samples comprised EPT individuals within the two sampling reaches in the Kairoa and Tuaenui Streams.

There was a significant reduction in average % EPT individuals moving downstream from K1 to K2 in the Kairoa Stream.

The percent contribution of the numerically dominant taxon to the total number of organisms is an indication of community balance at the lowest positive taxonomic level. A community dominated by relatively few species would normally indicate environmental stress.

In this instance (see Figure 20), the average percent contribution of the numerically dominant taxon to the total number of organisms within the two Kairoa Stream reaches was not significantly different but it was significantly lower at the downstream sampling reaches of the Whakapipi and Tuaenui Streams relative to upstream reaches.

Figure 20: Average % Contribution (Contrib.) for Dominant (Dom.) Taxon within Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20-21 March 2014.



Overall therefore, instream habitat quality was low within all three streams at the time of this survey.

This was also the case with the Kairoa Stream in 2007 (Coffey and Boud, 2008).

3.6 Fish

Fishing returns are tabulated in Appendix F.

Catch rates for electric fishing are summarised in Figure 21, catch rates for G-minnow traps are summarised in Figure 22, catch rates in Fyke nets are summarised in Figure 2 and miscellaneous fish catches in macroinvertebrate samples are summarised in Figure 24.

A total of six bony fish were caught in the study area between the 20th and 21st of March 2014. They were: *Anguilla dieffenbachii* (long-finned eel), *Anguilla australis* (short-finned eel), *Galaxias maculatus* (inanga), *Gambusia affinis* (mosquito fish), *Gobiomorphus cotidianus* (common bully) and *Carassius auratus* (goldfish).

Koura (*Paranephrops planifrons*) and shrimp (*Paratya curvirostris*) were included as by-catch in Fyke nets and G-minnow traps.

Figure 21: Return from electric fishing machine within Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20-21 March 2014.

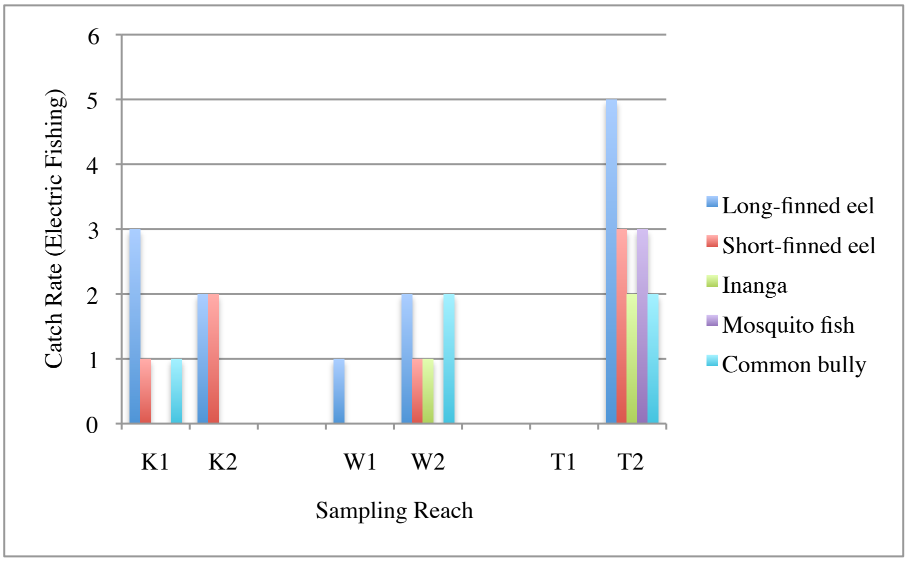


Figure 22: Return from G-minnow Traps within Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20-21 March 2014.

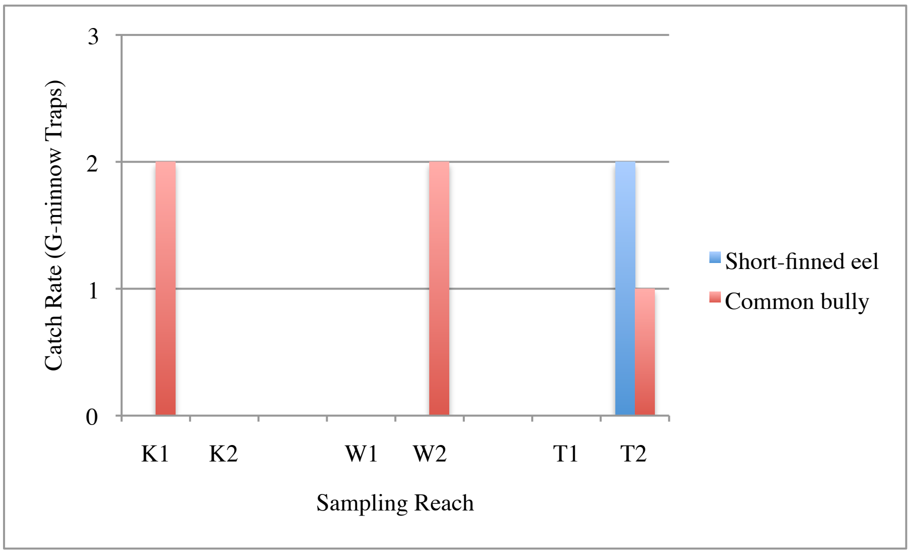


Figure 23: Return from Fyke Nets within Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20-21 March 2014.

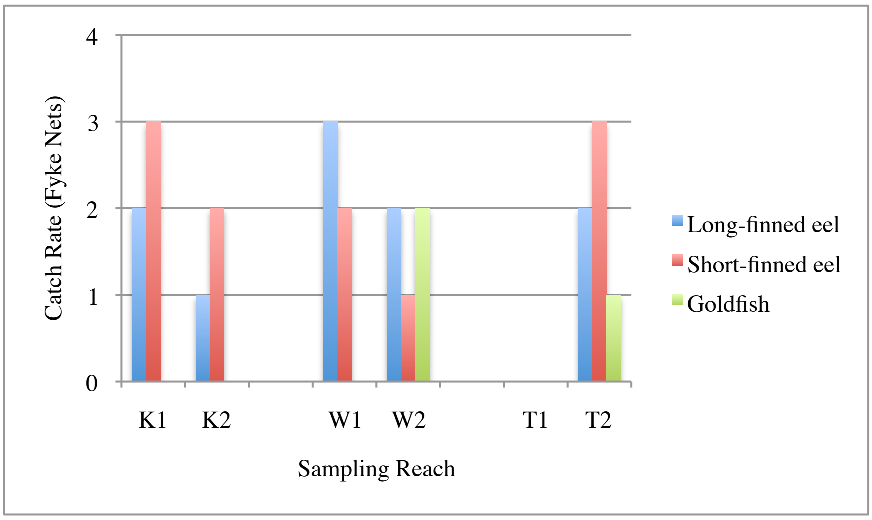
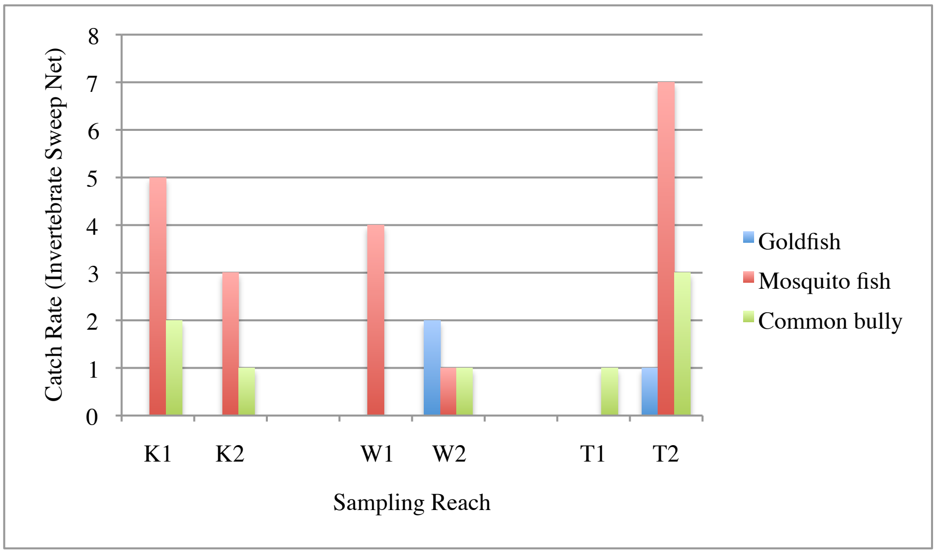


Figure 24: Miscellaneous Fishing Return from Invertebrate Samples within Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20-21 March 2014.



Short and long-finned eels were caught by electric fishing and in Fyke nets and one short-finned eel was caught in a G-minnow trap within sampling reach T2 (see Figures 21 and 23).

The only fish caught within sampling reach T1 was a common bully that was included in a sweep net sample for macroinvertebrates (see Figure 24).

Gold fish were "gill netted" in Fyke nets within Sampling Reaches W2 and T2 (see Figure 23).

The only bony fish caught by Coffey and Boud (2008) in the Kairoa Stream was the short-finned eel.

Mosquito fish are regarded as a pest in the Waikato Region.

3.7 Water Quality

Physico-chemical water quality data abstracted from Appendix A is presented in Table 2.

Daytime pH of stream water varied in the range of 7.2 to 8.2, water temperature varied in the range of 16 to 18 ^{o}C, conductivity varied in the range of 150 to 210 µS/cm and the saturation of dissolved oxygen in stream water varied in the range of 72 to 95 percent.

Table 2: Physico-chemical water quality data within Sampling Reaches K1, K2, W1, W2, T1 and T2 on 20-21 March 2014.

	Sampling Reach					
	F1	F2	W1	W2	T1	T2
Time (hrs)	1500	1400	1300	1200	1100	1000
pH	8.0	8.2	8.2	7.9	7.2	8.2
Water temperature (^{o}C)	18.0	17.5	16.0	17.0	17.0	18.0
Conductivity (µS/cm)	170	160	210	210	150	190
Dissolved oxygen (% satn.)	85	90	72	80	85	95

4.0 Findings and Conclusions

This survey was conducted later in the summer season (March relative to October) relative to the previous survey conducted by Coffey and Boud (2008).

However, there was generally good agreement between the two surveys for the repeat descriptions of Sampling Reaches F1 (Site A of Coffey and Boud, 2008) and F2 (Site H of Coffey and Boud, 2008) in the Kairoa Stream and the database has now been extended to include sites in the Whakapipi and Tuaenui Streams.

As was to be expected, the findings of this survey that was conducted in late summer, reported weedier conditions and lower metrics of macroinvertebrate community structure within the Kairoa Stream and the study area in general relative to October 2007 (Coffey and Boud, 2008).

This survey supports the findings and executive summary of Coffey and Boud 2008) for the now extended footprint of the Tuakau Structure Plan Area.

References

ANZECC and ARMICANZ, 2000. Australia and New Zealand guidelines for fresh and marine water quality, Volume 1, The guidelines.
Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

Biggs, B. J. F. and Kilroy, C., 2000: Stream Periphyton Monitoring Manual.
Published by NIWA for Ministry for the Environment. ISBN 0-478-09099-4.

Biggs, B. J. F., Kilroy, C., Mulcock, C. M. and Scarsbrook, M. R. 2002: New Zealand Stream Health Monitoring and Assessment Kit. Stream Monitoring Manual. Version 2.
NIWA Technical Report 111. 190 p. ISSN 1174-2631, ISBN 0-478-23251-9.

Boothroyd, I. and Stark, J., 2000: Use of invertebrates in monitoring.
In: (Collier, K.J. and Winterbourn, M.J. eds.) New Zealand stream invertebrates: ecology and implications for management. New Zealand limnological Society, Christchurch. Pp. 344-373.

Coffey, B and Boud, E., 2008: Tuakau Structure Plan
Aquatic Ecological Assessment.
Brian T. Coffey and Associates Limited AEE, Tuakau SP H/G February 2008. A report prepared for Harrison Grierson Consultants Limited.

Collier, K. and Kelly, J., 2005: Regional Guidelines for Ecological Assessments of Freshwater Environments. Macroinvertebrate Sampling in Wadeable Streams.
Environment Waikato Technical Report TR2005/02. ISSN: 1172-4005, 24 January 2005, Document #: 943216.

Collier, K., Kelly, J. and Champion, P., 2007: Regional Guidelines for Ecological Assessments of Freshwater Environments. Aquatic Plant Cover in Wadeable Streams.
Environment Waikato Technical Report 2006/47. ISSN: 1172-4005, 24 October 2007, Document #: 1106963.

Davies-Colley, R. J., 1988: Measuring Water Quality with a Black Disk
Limnology and Oceanography, Vol. 33, No. 4, July 1988, pp 616 – 623.

Edgar, N., Meredith, A., Empson, P. and Moore, B., 1994: Regional Ecological Monitoring of Streams in the Waikato (R.E.M.S.).
Environment Waikato, Environmental Quality Section, June 1994.

Milne, J. and Perrie, A., 2006: Freshwater quality monitoring technical report
Greater Wellington Regional Council, December 2005 Revised February 2006.

Ministry for the Environment, 1994: Water Quality Guidelines No.2: Colour and Clarity.
Ministry for the Environment, Wellington.

Ministry for the Environment. 2000: New Zealand periphyton guideline: detecting, monitoring and managing enrichment of streams.
Ministry for the Environment, Wellington.

Ministry for the Environment. 2001: Managing waterways of farms: a guide to sustainable water and riparian management in rural New Zealand.
Ministry for the Environment, Wellington.

Ministry for the Environment; Ministry of Health. 2003: Microbiological Water Quality Guidelines for Marine and Freshwater Recreation Areas.
Ministry for the Environment, Wellington.

Stark, J. D., 1985: A macroinvertebrate community index of water quality for stony streams.
Water and Soil Miscellaneous Publication No. 83, 379 pp. Ministry of Works and Development, Wellington.

Stark, J. D., 1993: Performance of the Macroinvertebrate Community Index; effects of sampling method, sample replication, water depth, current velocity, and abstraction on index values.
New Zealand Journal of Marine and Freshwater Research: 27: 463-475.

Stark, J. D., 1998: SQMCI: a biotic index for freshwater macroinvertebrate coded-abundance data.
New Zealand Journal of Marine and Freshwater Research: 32: 55-66.

Stark, J.D., Boothroyd, I.K.G., Harding, J.S., Maxted, J.R. and Scarsbrook. M.R. 2001: Protocols for sampling macroinvertebrates in wadeable streams.
NZ Macroinvertebrate Working Group Report No. 1. Ministry for the Environment, Wellington.
Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57p.

Stark, J. D., and Maxted J. R., 2007: A user guide for the Macroinvertebrate Community Index.
A report prepared for the Ministry for the Environment. Cawthron Report No.1166. 58 p.

Winterbourn, M. J., 1981: The use of aquatic invertebrates in studies of streams, water quality. In: A review of some biological methods for the assessment of water quality with special reference to New Zealand Part 2.
Water And Soil Technical Publication 22: 5-16.

Environment Waikato Field Assessment Cover Form (Collier and Kelly, 2005)
Wadeable Hard-Bottomed and Soft-Bottomed Streams

Locality: Tuakau	Date: 20 March 2014	Stream / River Name: Kasiroa
Survey Objectives: Extend baseline description of stream condition within Tuakau Structure Plan Area.		
Client: Waikato District Council		Assessor: BTC
Site Code: K1	Date: 20 - 21 March 2014	Photograph codes: K1 series
GPS COORDINATES:	Centre of reach	1772750 E. 5874910 N.
Length of Reach (m): 50 m		

CHANNEL AND RIPARIAN FEATURES

Canopy Cover:	Dom. Riparian Veg.
Open	~~Crops etc~~
~~Partly shaded~~	~~Pasture~~
~~Significantly shaded~~	Exotic trees
Fencing	~~Retired~~
None or ineffective	Native shrub
~~One side or partial~~	~~Native trees~~
~~Complete both sides~~	

INSTREAM HYDRAULIC CONDITIONS

		m
Ave. Stream width (active channel)	2.5	
Max. Stream width (active channel)	3.0	
Ave. Stream width (water)	2.5	
Max. Stream width (water)	3.0	
Ave. Stream depth	0.2	
Max Stream depth	0.3	
		m/s
Ave. Surface velocity	0.25	

WATER QUALITY Time (NZST): 1500 hrs pH: 8.0
Temperature: 18 ºC Conductivity: 170 μS/cm Dissolved Oxygen: 85 % mg/L
Turbldity: ~~Clear~~ Slightly turbid ~~Highly turbid Stained Other~~

STREAM-BOTTOM SUBSTRATA
Compaction (inorganic substrata):
~~assorted sizes tightly packed &/or overlapping~~
moderately packed with some overlap
~~mostly a loose assortment with little overlap~~
~~no packing / loose assortment easily moved~~
Embeddedness*:
(% gravel-boulder particles covered by fine sediment)
~~<5%~~ 5-25% ~~26-50% 51-75% >75%~~
ORGANIC MATERIAL (% cover*)
Large wood (>10 cm diameter)
<5% ~~5-25% 26-50% 51-75% >75%~~
Coarse Detritus (small wood, sticks, leaves etc)
<5% ~~5-25% 26-50% 51-75% >75%~~
Fine (<1 mm) Organic Deposits (edges & backwaters)
~~<5%~~ 5-25% ~~26-50% 51-75% >75%~~

% surficial inorganic substratum size composition (should sum to 100%)

Percentage	Substratum type Dimension mm (middle axis [mm])
	bedrock
10	boulder (>256)
60	cobble (>64 - 256)
20	gravel (>2 - 64)
5	sand (>0.06 - 2)
5	silt (004 - 0.06)
	clay (<0.004

HABITAT TYPES SAMPLED (for macroinvertebrates)
(% of effort; each column should sum to 100%)

	%		%
Stones:	80		
Wood:		Riffles:	80
Macrophytes:	10	Runs:	20
Edges:	10		

see Stream Survey Sheet 3 for periphyton

see Stream Survey Sheet 4 for macrophytes

see Stream Survey Sheet 5 for invertebrates

COMMENTS

Environment Waikato Field Assessment Cover Form (Collier and Kelly, 2005)
Wadeable Hard-Bottomed and Soft-Bottomed Streams

Locality: Tuakau	Date: 20 - 21 March 2014	Stream / River Name: Kairoa
Survey Objectives: Extend baseline description of stream condition within Tuakau Structure Plan Area.		
Client: Waikato District Council		Assessor: BTC
Site Code: K2	Sample Code: K2 series	Photograph codes:
GPS COORDINATES:	Centre of reach	1771900 E. 5873000 N.
Length of Reach (m): 50		

CHANNEL AND RIPARIAN FEATURES

Canopy Cover:	Dom. Riparian Veg.
Open	~~Crops etc~~
~~Partly shaded~~	Pasture
~~Significantly shaded~~	~~Exotic trees~~
Fencing	~~Retired~~
~~None or ineffective~~	~~Native shrub~~
One side or partial	~~Native trees~~
~~Complete both sides~~	

INSTREAM HYDRAULIC CONDITIONS

	m
Ave. Stream width (active channel)	4.0
Max. Stream width (active channel)	6.0
Ave. Stream width (water)	3.5
Max. Stream width (water)	3.8
Ave. Stream depth	0.2
Max Stream depth	1.0
	m/s
Ave. Surface velocity	0.35

WATER QUALITY Time (NZST): 1400 hrsa pH: 8.2
Temperature: 17.5 ºC Conductivity: 160 μS/cm Dissolved Oxygen: 90 % mg/L
Turbldity: ~~Clear~~ Slightly turbid ~~Highly turbid Stained Other~~

STREAM-BOTTOM SUBSTRATA
Compaction (inorganic substrata):
~~assorted sizes tightly packed &/or overlapping~~
moderately packed with some overlap
~~mostly a loose assortment with little overlap~~
~~no packing / loose assortment easily moved~~
Embeddedness*:
(% gravel-boulder particles covered by fine sediment)
<5% ~~5-25% 26-50% 51-75% >75%~~
ORGANIC MATERIAL (% cover*)
Large wood (>10 cm diameter)
<5% ~~5-25% 26-50% 51-75% >75%~~
Coarse Detritus (small wood, sticks, leaves etc)
<5% ~~5-25% 26-50% 51-75% >75%~~
Fine (<1 mm) Organic Deposits (edges & backwaters)
~~<5%~~ 5-25% ~~26-50% 51-75% >75%~~

% surficial inorganic substratum size composition (should sum to 100%)

Percentage	Substratum type Dimension mm (middle axis [mm])
10	bedrock
40	boulder (>256)
10	cobble (>64 - 256)
10	gravel (>2 - 64)
20	sand (>0.06 - 2)
10	silt (004 - 0.06)
	clay (<0.004

HABITAT TYPES SAMPLED (for macroinvertebrates)
(% of effort; each column should sum to 100%)

	%		%
Stones:	80		
Wood:	5	Riffles:	80
Macrophytes:	10	Runs:	20
Edges:	5		

see Stream Survey Sheet 3 for periphyton

see Stream Survey Sheet 4 for macrophytes

see Stream Survey Sheet 5 for invertebrates

COMMENTS

Environment Waikato Field Assessment Cover Form (Collier and Kelly, 2005)
Wadeable Hard-Bottomed and Soft-Bottomed Streams

Locality: Tuakau	Date: 20 - 21 March 2014	Stream / River Name: Whakapipi
Survey Objectives: Extend baseline description of stream condition within Tuakau Structure Plan Area.		
Client: Waikato District Council		Assessor: BTC
Site Code: W1	Sample Code: W1 series	Photograph codes: W1 series
GPS COORDINATES:	Centre of reach	1774095 E. 5877496 N.
Length of Reach (m): 50		

CHANNEL AND RIPARIAN FEATURES

Canopy Cover:	Dom. Riparian Veg.
Open	~~Crops etc~~
~~Partly shaded~~	Pasture
~~Significantly shaded~~	Exotic trees
Fencing	~~Retired~~
None or ineffective	~~Native shrub~~
One side or partial	~~Native trees~~
Complete both sides	

INSTREAM HYDRAULIC CONDITIONS

	m
Ave. Stream width (active channel)	2.0
Max. Stream width (active channel)	3.0
Ave. Stream width (water)	1.5
Max. Stream width (water)	2.5
Ave. Stream depth	0.5
Max Stream depth	1.0
	m/s
Ave. Surface velocity	0.05

WATER QUALITY

Time (NZST): 1300 hrs pH: 8.2

Temperature: 16 ºC Conductivity: 210 μS/cm Dissolved Oxygen: 72 % mg/L

Turbldity: ~~Clear~~ Slightly turbid ~~Highly turbid Stained Other~~

STREAM-BOTTOM SUBSTRATA

Compaction (inorganic substrata):
~~assorted sizes tightly packed &/or overlapping~~
~~moderately packed with some overlap~~
mostly a loose assortment with little overlap
~~no packing / loose assortment easily moved~~

Embeddedness*:
(% gravel-boulder particles covered by fine sediment)
~~<5% 5-25%~~ 26-50% ~~51-75% >75%~~

ORGANIC MATERIAL (% cover*)
Large wood (>10 cm diameter)
<5% ~~5-25% 26-50% 51-75% >75%~~
Coarse Detritus (small wood, sticks, leaves etc)
<5% ~~5-25% 26-50% 51-75% >75%~~
Fine (<1 mm) Organic Deposits (edges & backwaters)
~~<5% 5-25% 26-50%~~ 51-75% ~~>75%~~

% surficial inorganic substratum size composition (should sum to 100%)

Percentage	Substratum type Dimension mm (middle axis [mm])
	bedrock
	boulder (>256)
	cobble (>64 - 256)
20	gravel (>2 - 64)
	sand (>0.06 - 2)
80	silt (004 - 0.06)
	clay (<0.004

HABITAT TYPES SAMPLED (for macroinvertebrates)
(% of effort; each column should sum to 100%)

	%		%
Stones:	20		
Wood:		Riffles:	
Macrophytes:	70	Runs:	100
Edges:	10		

see Stream Survey Sheet 3 for periphyton

see Stream Survey Sheet 4 for macrophytes

see Stream Survey Sheet 5 for invertebrates

COMMENTS

No riffles were present within this reach of stream.

Transects for periphyton were not evenly spaced as much of this reach was soft-bottomed.

Transects were located in brakes in macrophyte cover were stones / gravel were present.

Environment Waikato Field Assessment Cover Form (Collier and Kelly, 2005)
Wadeable Hard-Bottomed and Soft-Bottomed Streams

Locality: Tuakau	Date: 20 - 21 March 2014	Stream / River Name: Whakapipi
Survey Objectives: Extend baseline description of stream condition within Tuakau Structure Plan Area.		
Client: Waikato District Council		Assessor: BTC
Site Code: W2	Sample Code: W2 series	Photograph codes: W2 series
GPS COORDINATES:	Centre of reach	1772760E. 5874915 N.
Length of Reach (m): 50		

CHANNEL AND RIPARIAN FEATURES

Canopy Cover:	Dom. Riparian Veg.
Open	~~Crops etc~~
~~Partly shaded~~	Pasture
~~Significantly shaded~~	~~Exotic trees~~
Fencing	~~Retired~~
None or ineffective	~~Native shrub~~
~~One side or partial~~	~~Native trees~~
~~Complete both sides~~	

INSTREAM HYDRAULIC CONDITIONS

	m
Ave. Stream width (active channel)	3.0
Max. Stream width (active channel)	4.0
Ave. Stream width (water)	2.0
Max. Stream width (water)	2.5
Ave. Stream depth	0.3
Max Stream depth	0.7
	m/s
Ave. Surface velocity	0.5

WATER QUALITY
Time (NZST): 1200 hrs
pH: 7.9
Temperature: 17 ºC
Conductivity: 210 μS/cm
Dissolved Oxygen: 80 % mg/L
Turbldity: ~~Clear~~ Slightly turbid ~~Highly turbid~~ ~~Stained~~ ~~Other~~

STREAM-BOTTOM SUBSTRATA
Compaction (inorganic substrata):
~~assorted sizes tightly packed &/or overlapping~~
moderately packed with some overlap
~~mostly a loose assortment with little overlap~~
~~no packing / loose assortment easily moved~~
Embeddedness*:
(% gravel-boulder particles covered by fine sediment)
~~<5%~~ ~~5-25%~~ 26-50% ~~51-75%~~ ~~>75%~~
ORGANIC MATERIAL (% cover*)
Large wood (>10 cm diameter)
<5% ~~5-25%~~ ~~26-50%~~ ~~51-75%~~ ~~>75%~~
Coarse Detritus (small wood, sticks, leaves etc)
<5% ~~5-25%~~ ~~26-50%~~ ~~51-75%~~ ~~>75%~~
Fine (<1 mm) Organic Deposits (edges & backwaters)
~~<5%~~ ~~5-25%~~ 26-50% ~~51-75%~~ ~~>75%~~

% surficial inorganic substratum size composition (should sum to 100%)

Percentage	Substratum type Dimension mm (middle axis [mm])
	bedrock
	boulder (>256)
	cobble (>64 - 256)
20	gravel (>2 - 64)
	sand (>0.06 - 2)
80	silt (004 - 0.06)
	clay (<0.004

HABITAT TYPES SAMPLED (for macroinvertebrates)
(% of effort; each column should sum to 100%)

	%		%
Stones:	20		
Wood:		Riffles:	
Macrophytes:	60	Runs:	100
Edges:	20		

see Stream Survey Sheet 3 for periphyton

see Stream Survey Sheet 4 for macrophytes

see Stream Survey Sheet 5 for invertebrates

COMMENTS

Environment Waikato Field Assessment Cover Form (Collier and Kelly, 2005)
Wadeable Hard-Bottomed and Soft-Bottomed Streams

Locality: Tuakau	Date: 20 - 21 March 2014	Stream / River Name: Tuaenui
Survey Objectives: Extend baseline description of stream condition within Tuakau Structure Plan Area.		
Client: Waikato District Council		Assessor: BTC
Site Code: T1	Sample Code: T1 series	Photograph codes: T1 series
GPS COORDINATES:	Centre of reach	1770813 E. 5877755 N.
Length of Reach (m): 50		

CHANNEL AND RIPARIAN FEATURES

Canopy Cover:	Dom. Riparian Veg.
~~Open~~	~~Crops etc~~
~~Partly shaded~~	Pasture
Significantly shaded	Exotic trees
Fencing	~~Retired~~
~~None or ineffective~~	~~Native shrub~~
One side or partial	~~Native trees~~
~~Complete both sides~~	

INSTREAM HYDRAULIC CONDITIONS

	m
Ave. Stream width (active channel)	2.5
Max. Stream width (active channel)	3.5
Ave. Stream width (water)	2.0
Max. Stream width (water)	3.0
Ave. Stream depth	0.3
Max Stream depth	1.0
	m/s
Ave. Surface velocity	0.4

WATER QUALITY Time (NZST): 1100 hrs pH: 7.2
Temperature: 17 ℃ Conductivity: 150 μS/cm Dissolved Oxygen: 85 % mg/L
Turbldity: ~~Clear~~ Slightly turbid ~~Highly turbid Stained Other~~

STREAM-BOTTOM SUBSTRATA
Compaction (inorganic substrata):
~~assorted sizes tightly packed &/or overlapping~~
moderately packed with some overlap
~~mostly a loose assortment with little overlap~~
~~no packing / loose assortment easily moved~~
Embeddedness*:
(% gravel-boulder particles covered by fine sediment)
<5% ~~5-25% 26-50% 51-75% >75%~~
ORGANIC MATERIAL (% cover*)
Large wood (>10 cm diameter)
~~<5%~~ 5-25% ~~26-50% 51-75% >75%~~
Coarse Detritus (small wood, sticks, leaves etc)
~~<5%~~ 5-25% ~~26-50% 51-75% >75%~~
Fine (<1 mm) Organic Deposits (edges & backwaters)
<5% ~~5-25% 26-50% 51-75% >75%~~

% surficial inorganic substratum size composition (should sum to 100%)

Percentage	Substratum type Dimension mm (middle axis [mm])
10	bedrock
	boulder (>256)
20	cobble (>64 - 256)
50	gravel (>2 - 64)
	sand (>0.06 - 2)
20	silt (004 - 0.06)
	clay (<0.004

HABITAT TYPES SAMPLED (for macroinvertebrates)
(% of effort; each column should sum to 100%)

	%		%
Stones:	30		
Wood:	30	Riffles:	70
Macrophytes:		Runs:	30
Edges:	40		

see Stream Survey Sheet 3 for periphyton

see Stream Survey Sheet 4 for macrophytes

see Stream Survey Sheet 5 for invertebrates

COMMENTS

Difficult access

Environment Waikato Field Assessment Cover Form (Collier and Kelly, 2005)
Wadeable Hard-Bottomed and Soft-Bottomed Streams

Locality: Tuakau	Date: 20 - 21 March 2014	Stream / River Name: Tuaenui
Survey Objectives: Extend baseline description of stream condition within Tuakau Structure Plan Area.		
Client: Waikato District Council		Assessor: BTC
Site Code: T2	Sample Code: T2 series	Photograph codes: T2 series
GPS COORDINATES:	Centre of reach	1770700 E. 5874744 N.
Length of Reach (m): 50		

CHANNEL AND RIPARIAN FEATURES

Canopy Cover:	Dom. Riparian Veg.
Open	~~Crops etc~~
~~Partly shaded~~	Pasture
~~Significantly shaded~~	Exotic trees
Fencing	~~Retired~~
None or ineffective	~~Native shrub~~
~~One side or partial~~	~~Native trees~~
~~Complete both sides~~	

INSTREAM HYDRAULIC CONDITIONS

	m
Ave. Stream width (active channel)	8.0
Max. Stream width (active channel)	10.0
Ave. Stream width (water)	7.0
Max. Stream width (water)	10.0
Ave. Stream depth	0.3
Max Stream depth	1.0
	m/s
Ave. Surface velocity	0.6

WATER QUALITY

WATER QUALITY	Time (NZST): 1000 hrs	pH: 8.2
Temperature: 18 ºC	Conductivity: 190 µS/cm	Dissolved Oxygen: 95 % mg/L

Turbldity: ~~Clear~~ Slightly turbid ~~Highly turbid~~ ~~Stained~~ ~~Other~~

STREAM-BOTTOM SUBSTRATA

Compaction (inorganic substrata):
~~assorted sizes tightly packed &/or overlapping~~
moderately packed with some overlap
~~mostly a loose assortment with little overlap~~
~~no packing / loose assortment easily moved~~

Embeddedness*:
(% gravel-boulder particles covered by fine sediment)
<5% ~~5-25%~~ ~~26-50%~~ ~~51-75%~~ ~~>75%~~

ORGANIC MATERIAL (% cover*)
Large wood (>10 cm diameter)
<5% ~~5-25%~~ ~~26-50%~~ ~~51-75%~~ ~~>75%~~
Coarse Detritus (small wood, sticks, leaves etc)
<5% ~~5-25%~~ ~~26-50%~~ ~~51-75%~~ ~~>75%~~
Fine (<1 mm) Organic Deposits (edges & backwaters)
~~<5%~~ 5-25% ~~26-50%~~ ~~51-75%~~ ~~>75%~~

% surficial inorganic substratum size composition (should sum to 100%)

Percentage	Substratum type Dimension mm (middle axis [mm])
50	bedrock
	boulder (>256)
10	cobble (>64 - 256)
10	gravel (>2 - 64)
	sand (>0.06 - 2)
30	silt (004 - 0.06)
	clay (<0.004

HABITAT TYPES SAMPLED (for macroinvertebrates)
(% of effort; each column should sum to 100%)

	%		%
Stones:	70		
Wood:	10	Riffles:	80
Macrophytes:	10	Runs:	20
Edges:	10		

see Stream Survey Sheet 3 for periphyton

see Stream Survey Sheet 4 for macrophytes

see Stream Survey Sheet 5 for invertebrates

COMMENTS

Concrete weir upstream of sampling reach

Wadeable Hard-Bottomed Streams (Environment Waikato, 2005)
Qualitative Habitat Assessment Field Data Sheet

Client: Waikato District Council	Date: 20 - 21 May 2014	Assessed by: BTC

Habitat Parameter	Category									
	Optimal	Suboptimal	Marginal	Poor						
1. Riparian Vegetative Zone Width	Bankside vegetation buffer is > 10 m.	Bankside vegetation buffer is < 10m	Pathways present + / or stock access to stream	Breaks frequent	SAMPLING SITE					
	Continuous and dense	Mostly continuous	Mostly healed over	Human activity clear	K1	K2	W1	W2	T1	T2
Left bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	13	8	4	12	14	5
Right bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	16	8	4	10	14	5
Mean LB & RB					14.5	8	4	11	14	5
2. Vegetative Protection	Bank surfaces and immediate riparian zones covered by native vegetation	Bank surfaces covered mainly by native vegetation	Bank surfaces covered by a mixture of grasses / shrubs, blackberry, willow and exotic trees	Bank surfaces covered by grasses and shrubs						
	Trees, understorey shrubs, or non-woody plants present	Disruption evident	Vegetation disruption obvious	DisruptIon of streambank vegetation very high						
	Vegetative disruption minimal	Banks may be covered by exotic forestry	Bare soil / closely cropped veg common	Grass heavily grazed	SAMPLING SITE					
				Significant stock damage to bank	K1	K2	W1	W2	T1	T2
Left bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	10	5	6	5	10	5
Right bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	14	5	6	5	10	5
Mean LB & RB					12	5	6	5	10	5
3. Bank Stability	Banks stable	Moderately stable	Moderately unstable	Unstable						
	Erosion / bank failure absent or minimal	Infrequent small areas of erosion mostly healed over	30-60% of bank in reach has areas of erosion	Many eroded areas	SAMPLING SITE					
	<5% of bank affected	5-30% of bank eroded	High erosion potential during floods	60 - 100% of bank has erosional scars	K1	K2	W1	W2	T1	T2
Left bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	16	12	12	12	12	12
Right bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	14	12	12	12	12	12
Mean LB & RB					15	12	12	12	12	12

Continued: Qualitative Habitat Assessment for Wadeable Hard-Bottomed Streams

Habitat Parameter	Category									
	Optimal	Suboptimal	Marginal	Poor						
4. Frequency of Riffles	Riffles relatively frequent	Occurrence of riffles infrequent	Occassional riffle or run	Generally flat water, shallow riffles						
	Distance between riffles divided by width of stream = 5 – 7	Distance between riffles divided by width of stream = 7 - 15	Bottom contours provide some habitat	Poor habitat	SAMPLING SITE					
	Variety of habitat is key		Distance between riffles divided by width of stream = 15 - 25	Distance between riffles divided by width of stream > 25	K1	K2	W1	W2	T1	T2
Site Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	15	14	5	5	14	14
5. Channel Alteration	Changes to channel / dredging absent or minimal	Some changes to channel / dredging	Channel changes / dredging extensive	Banks shored with gabion or cement						
	Stream with normal pattern	Evidence of past channel / dredging	Embankments or shoring structures present on both banks	>80% of the stream reach channelised and disrupted	SAMPLING SITE					
		Recent channel / dredging not present	40 to 80% of reach channelised and disrupted	Instream habitat altered or absent	K1	K2	W1	W2	T1	T2
Site Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	10	16	16	16	14	14
6. Sediment Deposition	Little / no islands or point bars present	New increase in bar formation. mostly from gravel. sand or fine sediment	Some deposition of new gravel. sand or fine sediment on old and new bars	Heavy deposits of fine material						
(out of channel and in channel)	<20% of the bottom affected by sediment deposition	20-50% of the bottom affected	50-80% of the bottom affected	Increased bar development						
		Slight deposition in pools	Sediment deposits at obstructions, constrictions and bends	>80% of the bottom changing frequently	SAMPLING SITE					
				Pools almost absent due to sediment deposition	K1	K2	W1	W2	T1	T2
Site Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	9	11	6	7	12	12
7. Velocity / Depth regimes	4 velocity / depth regimes present	3 of 4 velocity / depth present	2 of 4 velocity / depth present	Dominated by 1 velocity / depth regime	SAMPLING SITE					
	Slow / deep. Slow / shallow Fast / shallow Fast / deep	If fast / shallow is missing then score lower	If fast / shallow or slow shallow is missing then score lower	Usually slow / deep.	K1	K2	W1	W2	T1	T2
Site Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	14	16	6	7	14	16

Continued: Qualitative Habitat Assessment for Wadeable Hard-Bottomed Streams

Habitat Parameter	Category									
	Optimal	Suboptimal	Marginal	Poor						
8. Abundance and Diversity of Habitat	>50% substrate favourable for invertebrate colonisation and wide variety of woody debris, riffles, root mats	30-50% substrate favourable for invertebrate colonisatlon	10-30% substrate favourable for invertebrate colonisatlon	<10% substrate favourable for invertebrate colonisatlon						
	Snags / submerged logs / undercut banks / cobbles provide abundant fish cover	Snags / submerged logs / undercut banks / cobbles	Fish cover patchy	Fish cover rare or absent						
	Must not be new or transient	Fish cover common	60-90% substrate easily moved by foot	Substrate unstable or lacking	SAMPLING SITE					
		Moderate variety of habitat. Can consist of some new material	Woody debris rare or may be smothered by sediment	Stable habitats lacking or limited to macrophytes	K1	K2	W1	W2	T1	T2
Site Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	14	14	8	8	12	14
9. Periphyton	Periphyton not visible on hand held stones	Periphyton not visible on stones	Periphyton visible	Periphyton obvious and prolific						
	Stable substrate	Stable substrate	<20% cover of available substrate	>20% cover of available substrate	SAMPLING SITE					
	Surfaces rough to touch	Periphyton obvious to touch			K1	K2	W1	W2	T1	T2
Site Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	5	5	8	8	12	5

		SAMPLING SITE					
		K1	K2	W1	W2	T1	T2
Total Score	N.B.: Use only means of LB and RB values.	109	101	71	79	114	97

Appendix C: Stream Survey Sheet 3: Periphyton Cover and Scores.

Job Code: Tuakau Structure Plan		Date: 20 - 21 March 2014						Assessed by: BTC		
Sampling Reach: K1										
Thickness category	Colour category	EIS*	Transect Cover 1	2	3	4	5	Mean Cover	EIS x Mean Cover
Thin mat / film (<0.5 mm thick)	All colours	9	0	0	0	0	0	0	0
Medium mat (0.5-3 mm thick)	Green	5	0	0	0	0	0	0	0
	Light brown	7	0	0	0	0	0	0	0
	Black/dark brown	9	0	0	0	0	0	0	0
Thick mat (>3 mm thick)	Green / light brown	4	20	10	10	10	0	10	40
	Black / dark brown	7	0	0	0	0	0	0	0
Short filaments (≤2 mm long)	Green	5	0	0	0	0	0	0	0
	Brown / reddish	5	0	0	0	0	0	0	0
Long filaments (>2 cm long)	Green	1	20	50	60	40	20	38	38
	Brown / reddish	4	0	0	0	10	0	2	8
Totals								50	86

* Enrichment Indicator Score

		1	2	3	4	5	Average % Cover
Submerged bryophyres	Not Applicable	20	10	10	10	0	10
Iron Bacteria	Not Applicable	0	0	5	0	0	1

K1 Periphyton Enrichment Index	82.8
K1 Periphyton Filamentous Index	40.0
K1 Periphyton Mat Index	10.0
K1 Periphyton Proliferation Index	50.0
K1 Periphyton Slimyness Index	42.0

Note: macrophytes dominate cover along wetted margin of stream

Job Code: Tuakau Structure Plan		Date: 20 - 21 March 2014						Assessed by: BTC		
Sampling Reach: K2										
Thickness category	Colour category	EIS*	Transect Cover 1	2	3	4	5	Mean Cover	EIS x Mean Cover
Thin mat / film (<0.5 mm thick)	All colours	9	0	0	0	0	0	0	0
Medium mat (0.5-3 mm thick)	Green	5	0	0	0	0	0	0	0
	Light brown	7	0	0	0	0	0	0	0
	Black/dark brown	9	0	0	0	0	0	0	0
Thick mat (>3 mm thick)	Green / light brown	4	20	10	10	20	0	12	48
	Black / dark brown	7	0	0	0	0	0	0	0
Short filaments (≤2 mm long)	Green	5	0	0	0	0	0	0	0
	Brown / reddish	5	0	0	0	0	0	0	0
Long filaments (>2 cm long)	Green	1	20	30	30	40	50	34	34
	Brown / reddish	4	0	10	0	0	0	2	8
Totals								48	90

* Enrichment Indicator Score

		1	2	3	4	5	Average % Cover
Submerged bryophyres	Not Applicable	20	10	10	20	0	12
Iron Bacteria	Not Applicable	0	0	0	0	5	1

K2 Periphyton Enrichment Index	81.3
K2 Periphyton Filamentous Index	36.0
K2 Periphyton Mat Index	12.0
K2 Periphyton Proliferation Index	48.0
K2 Periphyton Slimyness Index	40.8

Note: macrophytes dominate cover along wetted margin of stream

Appendix C: Stream Survey Sheet 3: Periphyton Cover and Scores.

Job Code: Tuakau Structure Plan		Date: 20 - 21 March 2014					Assessed by: BTC		
Sampling Reach: W1									
Thickness category	Colour category	EIS*	Transect Cover 1	2	3	4	5	Mean Cover	EIS x Mean Cover
Thin mat / film (<0.5 mm thick)	All colours	9	0	0	0	0	0	0	0
Medium mat (0.5-3 mm thick)	Green	5	0	0	0	0	0	0	0
	Light brown	7	0	0	0	0	0	0	0
	Black/dark brown	9	0	0	0	0	0	0	0
Thick mat (>3 mm thick)	Green / light brown	4	0	5	10	0	0	3	12
	Black / dark brown	7	0	0	0	0	0	0	0
Short filaments (≤2 mm long)	Green	5	0	0	0	0	0	0	0
	Brown / reddish	5	0	0	0	0	0	0	0
Long filaments (>2 cm long)	Green	1	50	40	20	60	30	40	40
	Brown / reddish	4	0	0	0	0	0	0	0
Totals								43	52

* Enrichment Indicator Score

							Average % Cover
Submerged bryophyres	Not Applicable	0	5	10	0	0	3
Iron Bacteria	Not Applicable	0	0	0	0	0	0

W1 Periphyton Enrichment Index	87.9
W1 Periphyton Filamentous Index	40.0
W1 Periphyton Mat Index	3.0
W1 Periphyton Proliferation Index	43.0
W1 Periphyton Slimyness Index	35.0

Note: macrophytes dominate cover along wetted margin of stream

Job Code: Tuakau Structure Plan		Date: 20 - 21 March 2014					Assessed by: BTC		
Sampling Reach: W2									
Thickness category	Colour category	EIS*	Transect Cover 1	2	3	4	5	Mean Cover	EIS x Mean Cover
Thin mat / film (<0.5 mm thick)	All colours	9	0	0	0	0	0	0	0
Medium mat (0.5-3 mm thick)	Green	5	0	0	0	0	0	0	0
	Light brown	7	0	0	0	0	0	0	0
	Black/dark brown	9	0	0	0	0	0	0	0
Thick mat (>3 mm thick)	Green / light brown	4	0	10	0	0	10	4	16
	Black / dark brown	7	0	0	0	0	0	0	0
Short filaments (≤2 mm long)	Green	5	0	0	0	0	0	0	0
	Brown / reddish	5	0	0	0	0	0	0	0
Long filaments (>2 cm long)	Green	1	60	40	70	65	50	57	57
	Brown / reddish	4	0	0	0	0	0	0	0
Totals								61	73

* Enrichment Indicator Score

							Average % Cover
Submerged bryophyres	Not Applicable	0	0	0	0	0	0
Iron Bacteria	Not Applicable	0	5	0	0	5	2

W2 Periphyton Enrichment Index	88.0
W2 Periphyton Filamentous Index	57.0
W2 Periphyton Mat Index	4.0
W2 Periphyton Proliferation Index	61.0
W2 Periphyton Slimyness Index	49.6

Note: macrophytes dominate cover along wetted margin of stream

Job Code: Tuakau Structure Plan		Date: 20 - 21 March 2014						Assessed by: BTC	
Sampling Reach: T1									
Thickness category	Colour category	EIS*	Transect Cover 1	2	3	4	5	Mean Cover	EIS x Mean Cover
Thin mat / film (<0.5 mm thick)	All colours	9	0	0	0	0	0	0	0
Medium mat (0.5-3 mm thick)	Green	5	0	0	0	0	0	0	0
	Light brown	7	0	0	0	0	0	0	0
	Black/dark brown	9	0	0	0	0	0	0	0
Thick mat (>3 mm thick)	Green / light brown	4	0	5	0	5	0	2	8
	Black / dark brown	7	0	0	0	0	0	0	0
Short filaments (≤2 mm long)	Green	5	0	0	0	0	0	0	0
	Brown / reddish	5	0	0	0	0	0	0	0
Long filaments (>2 cm long)	Green	1	10	20	10	10	20	14	14
	Brown / reddish	4	5	0	0	0	0	1	4
Totals								17	26

* Enrichment Indicator Score

		1	2	3	4	5	Average % Cover
Submerged bryophyres	Not Applicable	0	5	0	5	0	2
Iron Bacteria	Not Applicable	0	0	0	0	0	0

T1 Periphyton Enrichment Index	84.7
T1 Periphyton Filamentous Index	15.0
T1 Periphyton Mat Index	2.0
T1 Periphyton Proliferation Index	17.0
T1 Periphyton Slimyness Index	14.0

Note: this reach of stream was significantly shaded

Job Code: Tuakau Structure Plan		Date: 20 - 21 March 2014						Assessed by: BTC	
Sampling Reach: T2									
Thickness category	Colour category	EIS*	Transect Cover 1	2	3	4	5	Mean Cover	EIS x Mean Cover
Thin mat / film (<0.5 mm thick)	All colours	9	0	0	0	0	0	0	0
Medium mat (0.5-3 mm thick)	Green	5	0	0	0	0	0	0	0
	Light brown	7	0	0	0	0	0	0	0
	Black/dark brown	9	5	0	0	0	0	1	9
Thick mat (>3 mm thick)	Green / light brown	4	0	0	5	5	0	2	8
	Black / dark brown	7	0	0	0	0	0	0	0
Short filaments (≤2 mm long)	Green	5	0	0	0	0	0	0	0
	Brown / reddish	5	0	0	0	0	0	0	0
Long filaments (>2 cm long)	Green	1	50	70	60	50	80	62	62
	Brown / reddish	4	0	0	0	0	0	0	0
Totals								65	79

* Enrichment Indicator Score

		1	2	3	4	5	Average % Cover
Submerged bryophyres	Not Applicable	0	0	5	5	0	2
Iron Bacteria	Not Applicable	0	0	5	0	0	1

T2 Periphyton Enrichment Index	87.8
T2 Periphyton Filamentous Index	62.0
T2 Periphyton Mat Index	2.0
T2 Periphyton Proliferation Index	64.0
T2 Periphyton Slimyness Index	52.2

Appenix D: Stream Survey Sheet 4: Macrophyte Cover and Scores.

Job Code: Tuakau Structure Plan	Date: 20 - 21 March 2014	Assessed by: BTC

Sampling Reach K1

Transect	Wetted Width (m)	Channel Width (m)	Overall % Cover	Vegetation Cover (% Wetted Area of Channel)						
				Submerged Plants					Emergent Plants	
				Total Cover	Surface reaching sub-total	Surface reaching Taxa	Sub-Surface sub-total	Sub-Surface Taxa	Total Cover	Taxa
1	1.5	2.0	40	5			5	Pk(5%)	35	An(25%) Ph(5%) Gr(5%)
2	2.0	2.5	30						30	An(25%) Ph(5%)
3	2.3	2.5	40	5			5	Ec(5%)	35	An(20%) Ph(10%) Na(5%)
4	2.0	2.3	30						30	Ph(25%) Gr(5%)
5	0.6	2.0	50						50	Gm(20%) An(20%) Na(10%)
Totals			190	10	0		10		180	

K1 Macrophyte Total Cover (%) 38

K1 Macrophyte Channel Clogginess (%) 37

K1 Macrophyte Native Cover (%) 0

Job Code: Tuakau Structure Plan	Date: 20 - 21 March 2014	Assessed by: BTC

Sampling Reach K2

Transect	Wetted Width (m)	Channel Width (m)	Overall % Cover	Vegetation Cover (% Wetted Area of Channel)						
				Submerged Plants					Emergent Plants	
				Total Cover	Surface reaching sub-total	Surface reaching Taxa	Sub-Surface sub-total	Sub-Surface Taxa	Total Cover	Taxa
1	3.5	5.0	50	0					50	Gm(50%)
2	4.4	4.5	40	10			10	Ed(5%) Ec(3%) Nh(2%)	30	Gm(20%) Na(10%)
3	3.1	4.2	50	0					50	Ph(25%) Gm(20%) Gr(5%)
4	3.6	5.1	25	5			5	Ed(5%)	20	Gm(20%)
5	3.0	4.4	40	5			5	Ed(3%) Nh(2%)	35	Gm(20%) An(10%) Ph(5%)
Totals			205	20	0		20		185	

K2 Macrophyte Total Cover (%) 41

K2 Macrophyte Channel Clogginess (%) 39

K2 Macrophyte Native Cover (%) 0.8

Appenix D: Stream Survey Sheet 4: Macrophyte Cover and Scores.

Job Code: Tuakau Structure Plan	Date: 20 - 21 March 2014	Assessed by: BTC

Sampling Reach W1

Transect	Wetted Width (m)	Channel Width (m)	Overall % Cover	Vegetation Cover (% Wetted Area of Channel)						
				Submerged Plants					Emergent Plants	
				Total Cover	Surface reaching		Sub-Surface		Total Cover	
					sub-total	Taxa	sub-total	Taxa		Taxa
1	1.6	2.1	40	10			10	Nh(5%) Ed(5%)	30	Ph(20%) Gm(10%)
2	1.2	1.9	30	0					30	Gm(15%) An(10%) Lp(5%)
3	1.7	4.9	40	5			5	Nh(5%)	35	Gm(25%) An(10%)
4	1.5	2.2	30	0					30	An(10%) Na(10%) Gr(10%)
5	1.1	1.5	60	40			40	Ed(30%) Nh(5%) Pk (5%)	20	Gm(20%)
Totals			200	55	0		55		145	

W1 Macrophyte Total Cover (%) 40
W1 Macrophyte Channel Clogginess (%) 34.5
W1 Macrophyte Native Cover (%) 3

Job Code: Tuakau Structure Plan	Date: 20 - 21 March 2014	Assessed by: BTC

Sampling Reach W2

Transect	Wetted Width (m)	Channel Width (m)	Overall % Cover	Vegetation Cover (% Wetted Area of Channel)						
				Submerged Plants					Emergent Plants	
				Total Cover	Surface reaching		Sub-Surface		Total Cover	
					sub-total	Taxa	sub-total	Taxa		Taxa
1	2.8	3.2	30	20			20	Nh(20%)	10	Gm(10%)
2	3.0	3.5	40	25			25	Ec(20%) Nh(5%)	15	Gm(10%) Le(5%)
3	1.9	2.5	20	15			15	Ec(15%)	5	Gr(5%)
4	2.2	2.8	30	10			10	Nh(10%)	20	Ph(10%) Gm(5%) Na(5%)
5	1.5	3	30	15			15	Ec(15%)	15	Ph(10%) Gr(5%)
Totals			150	85	0		85		65	

W2 Macrophyte Total Cover (%) 30
W2 Macrophyte Channel Clogginess (%) 21.5
W2 Macrophyte Native Cover (%) 7

Appenix D: Stream Survey Sheet 4: Macrophyte Cover and Scores.

Job Code: Tuakau Structure Plan	Date: 20 - 21 March 2014	Assessed by: BTC

Sampling Reach T1

Transect	Wetted Width (m)	Channel Width (m)	Overall % Cover	Vegetation Cover (% Wetted Area of Channel)						
				Submerged Plants					Emergent Plants	
				Total Cover	Surface reaching		Sub-Surface		Total Cover	
					sub-total	Taxa	sub-total	Taxa		Taxa
1	2.0	2.5	5	0					5	Gr(5%)
2	1.8	2.3	0	0						
3	1.7	2.4	10	0					10	Ph(5%) Gr(5%)
4	2.1	2.5	0	0						
5	1.7	2	5	0					5	Gr(5%)
Totals			20	0	0		0		20	

T1 Macrophyte Total Cover (%)	4
T1 Macrophyte Channel Clogginess (%)	4
T1 Macrophyte Native Cover (%)	0

Job Code: Tuakau Structure Plan	Date: 20 - 21 March 2014	Assessed by: BTC

Sampling Reach T2

Transect	Wetted Width (m)	Channel Width (m)	Overall % Cover	Vegetation Cover (% Wetted Area of Channel)						
				Submerged Plants					Emergent Plants	
				Total Cover	Surface reaching		Sub-Surface		Total Cover	
					sub-total	Taxa	sub-total	Taxa		Taxa
1	6.5	7.5	40	5			5	Nh(5%)	35	An(20%) Gm(15%)
2	7.0	8.1	20	10			10	Ec(10%)	10	Ph(5%) Gr(5%)
3	6.8	7.8	20	5			5	Ec(3%) Nh(2%)	15	Gm(15%)
4	6.2	7.5	30	0					30	Ph(20%) Gm(5%) Gr(%5)
5	7.1	8.0	10	0					10	Gm(10%)
Totals			120	20	0		20		100	

T2 Macrophyte Total Cover (%)	24
T2 Macrophyte Channel Clogginess (%)	22
T2 Macrophyte Native Cover (%)	1.4

Appendix E: Stream Survey Sheet 5: Laboratory Analysis of Macroinvertebrate Samples.

Client: Waikato District Council	Date: 20 March 2014	Lab. Sorting and I.D. by: BTC

	HB*	K1					K2					W1					W2					T1					T2				
TAXA	*MCI*	#1	#2	#3	#4	#5	#1	#2	#3	#4	#5	#1	#2	#3	#4	#5	#1	#2	#3	#4	#5	#1	#2	#3	#4	#5	#1	#2	#3	#4	#5
ANNELIDA (laboratory counts)																															
Oligochaeta	*1*	2	3	5	7	11	14	13	26	9	22	23	18	27	15	18	19	15	22	18	14	12	13	9	11	12	6	8	5	11	4
Hirudinea																															
Glossiphonia sp.	*3*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
MOLLUSCA (laboratory counts)																															
Gyraulus kakuica	*3*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0
Latia sp.	*3*	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0
Physa sp.	*3*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	2
Potamopyrgus antipodarum	*4*	25	39	33	57	31	10	15	29	11	12	15	11	9	15	8	32	28	23	31	27	5	7	3	8	4	54	54	54	48	58
CRUSTACEA (laboratory counts)																															
Amphipoda	*5*	127	109	101	90	126	107	88	67	108	90	46	33	47	43	30	45	54	46	47	60	20	16	18	24	13	10	21	19	8	17
Ostacoda	*3*	0	0	0	0	0	0	0	0	0	0	80	112	89	98	106	60	64	75	62	70	0	0	0	0	0	0	0	0	0	0
Paranephrops planifrons	*5*	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paratya curvirostris	*5*	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INSECT LARVAE (counts)																															
EPHEMEROPTERA (mayflies)																															
Mauiulus luma	*5*	6	2	7	5	5	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tepakia	*8*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zephlebia sp.	*7*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRICHOPTERA (caddisflies)																															
Aoteapsyche colonica	*4*	5	8	5	4	2	2	2	0	2	0	0	0	0	0	0	0	0	0	0	0	2	1	0	2	2	3	2	1	2	3
Costachorema sp.	*7*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hudsonema amabilis	*6*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrobiosella mixta	*9*	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrobiosis sp.	*5*	5	7	6	2	3	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triplectides obseleta	*5*	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	3	2	1	2	3
**Oxyethira albiceps*	*2*	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Paroxythira sp.*	*2*	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HEMIPTERA (water bugs)																															
Anisops wakefieldi	*5*	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Microvelia macgrtegori	*5*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Sigara sp.	*5*	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COLEOPTERA (beetles)																															
Elmidae	*6*	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhantus pulvcerosus	*5*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0
DIPTERA (two winged flies)																															
Aphrophiula neozelandica	*5*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0
Austrosiumulium austrolense	*3*	5	4	12	14	8	25	37	44	32	31	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	2	0
Chironomidae																															
Chironomus sp.	*1*	12	19	24	13	8	35	41	29	33	39	32	23	28	23	37	42	36	31	40	29	127	116	132	122	77	120	109	117	125	110
Orthocladinae	*2*	5	0	5	0	3	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Tanypodinae	*5*	0	2	0	0	0			0	0	0	0	0			0	0	0	0	0			0	0	0	0	0			0	0	0	0	0			0	0	0	0	0		
Culex pervigilans	*3*	0	0	0	0	0			0	3	0	0	2			0	0	0	0	0			0	0	0	0	0			0	0	2	0	0			0	0	2	0	2		
Limonia nigrescens	*6*	0	0	0	0	0			0	0	0	0	0			0	0	0	0	0			0	0	0	0	0			0	0	1	0	0			0	0	0	0	1		
Muscidae	*3*	0	0	0	0	0			0	0	2	0	0			0	0	0	0	0			0	0	0	0	0			0	0	0	0	0			0	0	0	0	0		
Nannochorista sp.	*7*	0	0	0	0	0			1	0	0	0	0			0	0	0	0	0			0	0	0	0	0			0	0	0	0	0			0	0	0	0	0		
Sciomyzidae	*3*	0	0	0	0	0			0	0	0	1	0			0	0	0	0	0			0	0	0	0	0			0	0	0	0	0			1	0	0	0	0		
Zealanoptipula sp.	*6*	0	0	0	0	0			0	0	0	0	0			0	0	0	0	0			0	0	0	0	0			0	0	0	0	0			0	0	0	0	0		
ODONTATA (dragonflies and damselflies)																																											
Antipodochlora braueri	*6*	0	0	0	0	0			0	0	0	0	0			0	1	0	0	1			0	0	0	0	0			0	0	0	0	0			0	0	0	0	0		
Austrolestes colensonis	*6*	0	0	0	0	0			0	0	0	0	0			0	0	0	0	0			0	0	0	0	0			0	0	0	0	0			0	0	0	1	0		
Xanthocnemis zealandica	*5*	2	5	0	4	0			0	0	0	0	2			2	0	0	2	0			0	2	2	0	0			0	0	0	0	0			0	0	0	0	0		
LEPIDOPTERA (moths)																																											
Hygraula nitens	*4*	0	1	0	0	0			0	0	0	0	0			0	0	1	0	0			0	0	0	0	0			0	0	0	0	0			0	0	0	0	0		

SUMMARY STATS: MACROINVERTEBRATES

	K1							K2							W1							W2							T1							T2						
	#1	#2	#3	#4	#5	ave.	S.D.	#1	#2	#3	#4	#5	ave.	S.D.	#1	#2	#3	#4	#5	ave.	S.D.	#1	#2	#3	#4	#5	ave.	S.D.	#1	#2	#3	#4	#5	ave.	S.D.	#1	#2	#3	#4	#5	ave.	S.D.
Taxa Richness	12	12	11	12	10	11	0.9	10	8	8	9	8	8.6	0.9	7	7	6	8	6	6.8	0.8	6	7	7	6	5	6.2	0.8	7	8	7	6	7	7	0.7	8	8	8	9	9	8.4	0.5
# inverts	200	200	200	200	200	200	0	200	200	200	200	200	200	0	200	200	201	200	200	200	0.4	200	200	200	200	200	200	0	169	159	166	170	111	155	25	200	200	200	200	200	200	0
MCI	70	82	73	83	58	73	10	82	68	75	78	60	72	8.7	69	66	60	68	67	66	3.4	57	63	63	57	56	59	3.5	66	60	71	67	71	67	4.7	70	75	70	71	71	71	2.1
QMCI	4.4	4.3	4.0	4.2	4.3	4.2	0.1	3.7	3.4	3.3	3.8	3.4	3.5	0.2	3.0	3.0	3.0	3.2	2.8	3.0	0.1	3.0	3.2	3.1	3.0	3.3	3.1	0.1	1.6	1.6	1.6	1.8	1.7	1.7	0.1	2.2	2.4	2.3	2.0	2.4	2.2	0.2
EPT Index*	4	3	4	5	3	3.8	0.8	3	2	2	3	0	2	1.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	1	2	1.4	0.5	2	2	2	2	2	2	0
%EPT*	9	9	10	7	5	7.6	1.8	3	2	2	3	0	1.8	1.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	1	4	1.6	1.2	3	2	1	2	3	2.2	0.8
% contrib. dom. taxon	64	55	51	45	63	55	8	54	44	34	54	45	46	8.4	40	56	44	49	53	48	6.5	30	32	38	31	35	33	3.1	75	73	80	72	69	74	3.8	60	55	59	63	55	58	3.4

* excluding *Oxythira* and *Paroxythira*

Appendix F: Fishing Data (lengths in centimetres).

Client: Waikato District Council	Date: 20-21 March 2014	Collection measurement ID: BTC

Electric Fishing

	K1	K2		W1	W2		T1	T2
Anguilla dieffenbachii (long-finned eel)	33, 39, 43	30, 45		28	35, 41			23, 34, 37, 45, 50
Anguilla australis (short-finned eel)	45	33, 41		0	41		0	23, 45, 46
Galaxias maculatus (inanga)	0	0		0	7		0	6, 8
Gambusia affinis (mosquito fish)	0	0		0	0		0	2, 2, 3
Gobiomorphus cotidianus (common bully)	7	0		0	5, 7		0	7, 8

G-Minnows Traps

	K1	K2		W1	W2		T1	T2
Anguilla australis (short-finned eel)	0	0		0	0		0	33, 43
Gobiomorphus cotidianus (common bully)	6, 8	0		0	7, 7		0	6

Fyke Nets

	K1	K2		W1	W2		T1	T2
Anguilla dieffenbachii (long-finned eel)	34, 44	53		29, 43, 45	34, 45		0	34, 56
Anguilla australis (short-finned eel)	19, 39, 44	29 ,32		43, 45	32		0	34, 47, 51
Carassius auratus goldfish	0	0		0	4, 4		0	5

Invertebrate Sweep Net

	K1	K2		W1	W2		T1	T2
Carassius auratus goldfish	0	0		0	2, 4		0	4
Gambusia affinis (mosquito fish)	1, 2, 2, 3, 3	3, 3, 3		2, 3, 3, 4	4		0	3, 3, 3, 4, 4, 4, 4
Gobiomorphus cotidianus (common bully)	7, 7	5		0	7		5	6, 6, 7