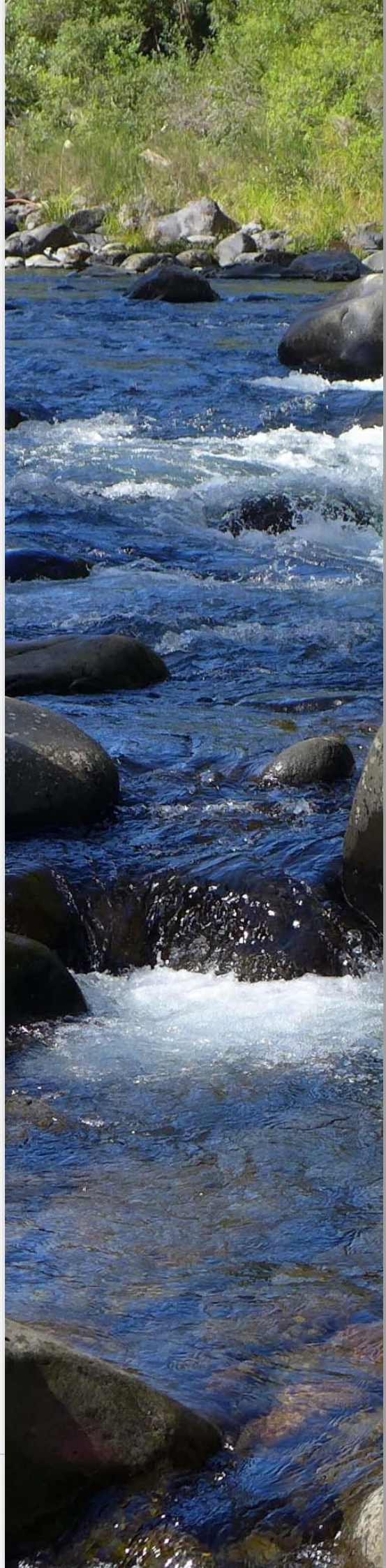
Hikurangi Catchment
Freshwater Monitoring Programme
2017 – Baseline Survey

AB Ecology Ltd
Ecological Consultancy

Hikurangi Catchment Freshwater Monitoring Programme - 2017 Baseline Survey



Prepared for:

Living Water

Prepared by:

Amy Bazeley - AB Ecology Ltd **- April 2017**

Fieldwork undertaken by:

Amy Bazeley, Department of Conservation,

Nga Kaitiaki O Nga Wai Maori and Nga Tirairaka o Ngati Hine

Feb – March 2017

AB Ecology Ltd
Ecological Consultancy

PO Box 402041, Tutukaka, 0153
Ph: 09 434 4951
Mob: 021 1691 557
Email: amyb@abecology.co.nz
Website: www.abecology.co.nz

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1.0 INTRODUCTION

The Living Water Programme is a 10-year partnership between Fonterra and the Department of Conservation (DOC), with the main aim of improving waterways, natural habitats, biodiversity and ecosystems in five selected, priority catchments around the country. The vision of the Livnign Water programme is “A sustainable dairy industry is part of healthy functioning ecosystems that together enrich the lives of all New Zealanders”.

The Kaipara Harbour catchment has been identified as one of these priority catchments with current activity focussed at the source within the Hikurangi catchment. The low-lying Hikurangi floodplain is a dominant feature of this area and is often subject to flooding.

As part of this partnership, the programme aims to create a monitoring programme for water quality and freshwater ecological values that will be effective in detecting short and long-term effects of restoration initiatives and other environmental changes in the catchment. This report provides the results of a baseline survey of sixteen sites in strategic locations throughout the catchment that will help to document some of these existing values and issues.

AB Ecology Ltd has been commissioned to carry out this study. The field survey was carried out during the period 23 February to 2 March 2017. Personnel involved in this survey were Amy Bazeley (AB Ecology Ltd), Ben Herbert and Amy Macdonald (DOC, Whangarei) and Allan Halliday from Nga Kaitiaki O Nga Wai Maori and Delaraine Armstrong from Nga Tirairaka o Ngati Hine.

The survey locations and measurement parameters have been previously prescribed by the report entitled Hikurangi Catchment Monitoring Programme, produced by Kessels Ecology in 2014. This report provides some additional detail on background and methodology and should be read in conjunction with this AB Ecology Ltd report.

2.0 SITE LOCATIONS

The area covered by this monitoring programme focuses on pump station tributaries feeding into the Wairua River on the Hikurangi floodplain, and in its upstream catchments. Two reference sites are also provided. Table 1 and Figure 1 below provide the list of sample sites, their locations and work to be undertaken at each site. These sites and the monitoring programme design has been outlined in Kessels Ecology 2014.

Figure 1: Stream monitoring sites within the Hikurangi Catchment (Kessels Ecology 2014).

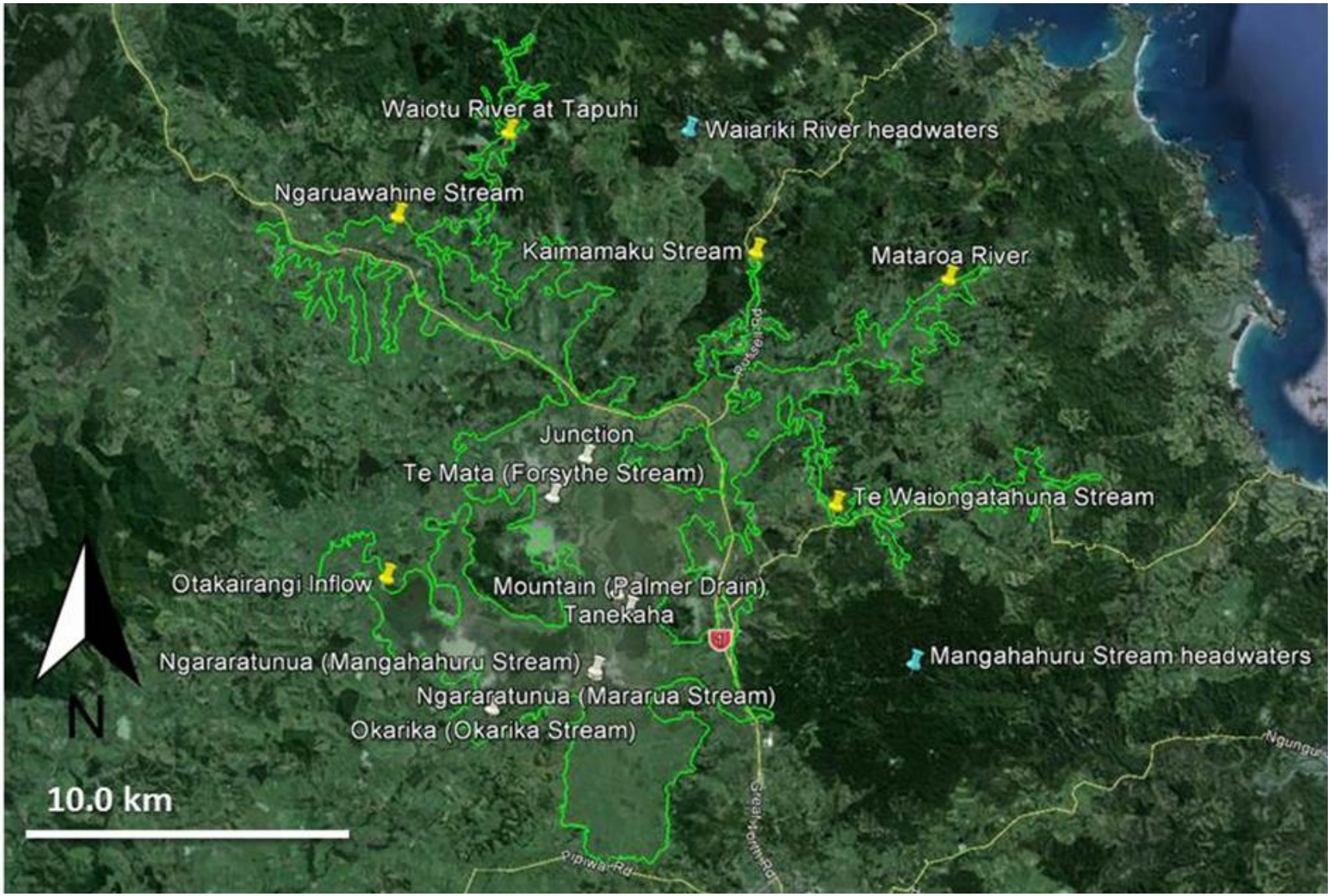


Table 1: Stream monitoring sites within the Hikurangi Catchment. Locations and work to be completed per site (Kessels Ecology 2014).

Site	NZTM Northing	NZTM Easting	Survey methods	Site notes
Sites within HC floodplain- pump station tributaries (white pins on Figure 1)				
Mararua Stream (Ngararatunua Pocket)*	6057639.041	1712122.203	Fish, spot water quality measurements, sediment cover, habitat, aquatic plants, macroinvertebrates, search for kākahi	Flows into Wairua River in southeastern side of HC. Catchment contains high protection priority area
Mangahahuru Stream (Ngararatunua Pocket)*	6057772.17	1712130.31		
Forsythe Stream (Te Mata Pocket)*	6063222.122	1710840.036		
Luptons Point Drain (Otonga Pocket)	6060386.138	1713407.173		Flows into Wairua River in eastern side of HC
Palmer Drain (Mountain Pocket)	6059654.561	1713204.07		
Okarika Stream (Okarika Pocket)	6056594.928	1708877.457		
Unnamed Drain (Tanekaha Pocket)	6060175.088	1712843.178		
Unnamed tributary (Junction Pocket)	6064432.629	1711888.016		Tributary of Waiotu River
Other sites in upper HC floodplain (yellow pins on Figure 1)				
Kaimamaku Stream	6071395	1717069	Fish, spot water quality measurements, sediment cover, habitat, aquatic plants, macroinvertebrates, search for kākahi	Fish last surveyed in 1999.
Mataroa River*	6069908	1723370		Fish last surveyed in 1999.
Waiotu River at Tapuhi	6074637	1709568		Fish last surveyed in 1999.
Otakairangi Stream- Wetland Inflow*	6060740	1705579		Fish last surveyed in 1999.
Te Waiongatahuna Stream (trib of Kirikiritoki Stream)	6062867	1719735	Spot water quality measurements, sediment cover, habitat, aquatic plants, macroinvertebrates, search for kākahi	Fish surveyed by Williams et al. (2013)
Ngaruawahine Stream*	6072258	1705796		Fish surveyed by Williams et al. (2013)
Sites in HC catchment- reference sites with native forest catchment (blue pins on Fig 1)				
Waiariki River headwater	6057877	1722134	Fish, spot water quality measurements, sediment cover, habitat, aquatic plants, macroinvertebrates, search for kākahi	Potential reference site- native forest upstream
Mangahahuru Stream headwater	6074588	1715226		Potential reference site- native forest upstream

3.0 ASSESSMENT METHODOLOGY

The stream monitoring work involved the following assessments. The standard methodology is provided for each assessment type, plus any deviations from the methodology due to *in situ* conditions. All field sheets are included in Appendix 1 of this report for reference.

3.1 PHYSICAL HABITAT ASSESSMENT

Protocol 1 – Site Characterisation field sheets, as described in the national protocols developed by Harding et al. (2009), were used to assess the physical habitat at each site. This protocol is designed to provide a quick characterisation of a site in a qualitative form. It looks at channel and bank physical form, flow conditions, instream substrate and macrophytes and riparian and catchment parameters.

3.2 AQUATIC PLANTS

Periphyton and macrophytes were assessed following the Waikato Regional Council guidelines (Collier et. al., 2006). These guidelines provide a rapid visual assessment of the aquatic plant cover at each site.

Macrophytes

Five transects were laid out at 10 metre intervals along the length of each site survey reach (50m). At each transect, the percentage cover of submerged, surface-reaching and emergent macrophytes was assessed and recorded. The measurement was made facing upstream and estimating aquatic vegetation cover from a plan view (i.e. looking down) occupying a 1m belt upstream of the transect and across the entire wetted width of the stream. In the results section of this report a link is provided to the individual field sheets for each site with the recorded baseline data.

Additional information that was sometimes recorded at the sites included a measure of instream shade, where there was a lot of emergent species provided shade to the water body. This was not recorded at every site as it was not always a feature. The measure was recorded under the adapted column “Riparian shade” in the field sheet. Note that this was not actual bank side vegetation but instream vegetation emerging and creating cover over the wetted channel.

Periphyton

In the hard-bottomed streams, five transects were laid out at 10 metre intervals along the length of each site survey reach (50m). Working from the downstream end of the sample reach, the periphyton cover was assessed on the substrate, at five points (10%, 30%, 50%, 70% and 90%) across the wetted width of the transects.

The periphyton was assessed on whatever substrate occurred at the sampling point. The average percentage cover of the upper surface of the substrate was recorded for periphyton colour and type. The following criteria were used:

- Thin mat or film (less than 0.5 mm thick) - Any colour.
- Medium mat (0.5 to 3 mm thick) - Green, light brown or black/dark brown.
- Thick mat (more than 3 mm thick) - Green, light brown or black/dark brown.
- Short filaments (less than about 2 cm long) - Green, brown/reddish.
- Long filaments (more than about 2 cm long) - Green, brown/reddish.

In the soft-bottomed streams, the abundance of instream macroinvertebrates meant that any sampling of the sediment substrate for periphyton was impractical. In these instances, a qualitative observation on the type and cover of periphyton present was made for the whole stream survey reach. If more detail than this is sought, this could be improved on in subsequent rounds of monitoring by making an assessment of periphyton cover on the macrophyte stems at five locations across each transect in an area of around 10 cm diameter.

In the results section of this report a link is provided to the individual field sheets for each site with the recorded baseline data.

3.3 SEDIMENT COVER

Sediment cover was assessed at each site using 'Method 2 – Instream visual assessments of % sediment cover' (Clapcott et al., 2011). This is a visual estimate of the proportion of the habitat covered by deposited sediment (<2mm) at each site. Its application is for hard-bottomed streams only, so this methodology should strictly only be used at Sites 9, 11, 13, 15 and 16. However, it was also used at Sites 2, 8 and 14 where there were some gravel beds accumulated amongst the soft sediments.

The survey was undertaken using an underwater viewer (bathyscope). Five transects were laid out at 10 metre intervals along the length of each site survey reach (50m). Working from the downstream end of the sample reach, the stream bed is viewed at 4 randomly determined locations across each transect. An estimate of the sediment cover in the viewing circle at each location was recorded.

In the results section of this report a link is provided to the individual field sheets for each site with the recorded baseline data.

3.4 WATER QUALITY SAMPLING

All sample and field measurement collection methods follow those documented in the council's Field Monitoring Procedure Manual. Water samples were collected by Department of Conservation staff and analysed by Whangarei District Council (WDC) and Hills Laboratories. Twelve water quality indicators were measured to assess water quality. These were total nitrogen, ammoniacal nitrogen, total phosphorus, bacteria, water clarity, suspended sediments, turbidity, dissolved oxygen, pH, water temperature and conductivity. Observations such as preceding weather conditions and any random events such as livestock or large numbers of waterfowl in stream are also recorded at the time of sampling.

Six stream sites in the Hikurangi Swamp Scheme are sampled monthly on the third Wednesday of the month. The sites are as follows:

- 1. Te Mata pump station
- 2. Otonga pump station
- 3. Mountain pump station
- 4. Maungahahuru pump station
- 5. Ngararatunua pump station
- 6. Okarika pump station

The measurements of dissolved oxygen, pH, water temperature and conductivity are measured using a YSI Professional Plus Instrument (Pro Plus) using sensors for the above measurements. Water clarity measurement is a black disc observation. All total nitrogen, ammoniacal nitrogen, total phosphorus and bacterial measurements are collected in sampling jars at site and assessed by the WDC and Hill Laboratories. All samples are taken from the same GPS location at each site.

A summary of the results of water clarity, dissolved oxygen, pH, water temperature, specific conductance (SPC) and conductivity are included in this report. The Department of Conservation have the results of total nitrogen, ammoniacal nitrogen, total phosphorus, bacteria on file if required.

The results are compared to the Australian and New Zealand Environmental and Conservation Council (ANZECC) assessment values for the protection of aquatic ecosystems in New Zealand (ANZECC 2000). The assessment values for lowland rivers are shown in Table 2.

Table 2. Assessment values for NZ lowland rivers (ANZECC 2000)

Parameter	Assessment values for lowland rivers
Dissolved oxygen (% saturation)	98-105
Water clarity (m)	> 0.6
Turbidity (NTU)	< 5.6
Dissolved reactive phosphorus (mg/L)	< 0.033
Nitrate, nitrite nitrogen (mg/L)	< 0.444
Ammoniacal nitrogen (mg/L)	< 0.021
Total nitrogen (mg/L)	< 0.614
pH	7.2 - 7.8

3.5 FISH

An updated freshwater fish survey was undertaken by Mike McGlynn at each of the survey sites. The survey method consisted of setting fyke nets and traps. In total, 2 fyke nets, 8 Gee minnow traps and 2 Kilwell bait traps were set overnight at every site. Nets and traps were set unbaited.

All sixteen sites were suitable for trapping so the same methodology was considered to be the most practical for future ease of monitoring.

The field survey was carried out during the period 5-14 December 2016. Personnel involved in this survey were Keith Hawkins, Ben Herbert, Fiona Watson, Heidi Weston [DOC, Whangarei] and Mike McGlynn [F/W Fish Contractor]. Amy Macdonald provided invaluable logistical support.

A summary of results is provided for each site in the results section of this report. The full data sets have also been sent to the NIWA Freshwater fish database.

3.6 AQUATIC MACROINVERTEBRATE SAMPLING

Sample collection used the sampling protocols developed by the New Zealand Macroinvertebrate Working Group (Stark *et al.,* 2001). This methodology outlines separate protocols for semi-quantitative sampling of hard-bottomed and soft-bottomed streams therefore acknowledging the inherent differences in morphology and community composition found therein. The sites sampled were hard and soft-bottomed as follows:

Table 3: Stream substrate type at each site.

Stream substrate type	Site number
Soft-bottomed	Site 1, 2, 3, 4, 5, 6, 7, 8, 10, 12,14
Hard-bottomed	Site 9, 11, 13,15, 16

Note that Sites 2, 8 and 14 were mainly soft-bottomed but also had some areas where gravel beds had accumulated amongst the soft sediments.

Protocol C1 (Hard-bottomed Semi-quantitative) and C2 (Soft-bottomed Semi-quantitative) were followed. Sample collection used a 500-micron mesh net for both protocols.

The habitats sampled in the soft-bottomed streams included bank edge, woody debris (where available) and macrophytes over a $3m^2$ area comprised of ten replicate unit efforts of 0.3 m^2. The sample collected was preserved in 80% ethanol until it was processed.

The samples for the hard-bottomed streams were collected from a fixed area of approximately 1 m^2 composed of ten replicate unit efforts of 0.1 m^2. The sampling technique involved kicking/disturbing the substrate in the sub-sample area whilst holding the capture net flush with the streambed immediately downstream. Invertebrate fauna were dislodged from the substrate in this manner and swept into the net by the stream current. The net was emptied into the collecting jar between replicate units to avoid clogging or loss of macroinvertebrates.

All sample processing was carried out by Cawthron Institute. It followed the procedure as outlined in Protocol P1 of the NZ Macroinvertebrate Working Group report. All organisms and their relative numbers were recorded as they were observed in the sorting tray. Each taxon was assigned one of five coded abundance scores these being: - R = Rare (1-4 individuals); C = Common (5-19 individuals); A = Abundant (20-99 individuals); VA = Very Abundant (100-499 individuals); VVA = Extra Abundant (500+ individuals) per sample.

The data was analysed for total number of invertebrate taxa, the soft and hard-bottomed relevant Macroinvertebrate Community Index (MCI) values and the Semi-Quantitative MCI (SQMCI) values.

Table 4 provides a summary of the quality class thresholds that are applied (taken from Stark 1998 and Stark & Maxted 2007), in the interpretation of the MCI and SQMCI results.

Table 4: Quality class thresholds for the interpretation of MCI and SQMCI results.

Quality class	Interpretation	MCI score (HB & SB)	SQMCI (HB & SB)
Excellent	Clean water	>119	>5.99
Good	Doubtful quality or possible mild pollution	100-119	5-5.99
Fair	Probable moderate pollution	80-99	4-4.99
Poor	Probable severe pollution	<80	<4

The following comments relating to the macroinvertebrate samples were provided by the sample processor at Cawthron - Karen Shearer. They have been summarised here and are useful observations in that they illustrate ongoing concerns for native fauna viability in the presence of the pest fish *Gambusia affinis* (mosquito fish).

- Where mosquito fish were abundant (i.e. > 20 found in a sample), invertebrate diversity (particularly Trichoptera) was generally lower, and so was the average size (length in mm) of the invertebrates. One sample (Palmer Drain) had greater than 75 mosquito fish in it, and in that sample no invertebrates longer than 4 mm were found.
- Vice versa, in the absence of mosquito fish, the invertebrate diversity (particularly Trichoptera) and average size was greater.
- In the Mataroa sample (where mosquitofish and bullies were found), the larger bullies all had slits in their guts. A possible explanation for this may be attacks by mosquito fish before preservation.

4.0 RESULTS

Site name	Site No.	NZTM Northing	NZTM Easting	Survey date
Mararua Stream (Ngararatunua pocket)	1	6057639.041	1712122.203	23/02/2017

Site location:

Site photo:

Physical habitat:

The Mararua Stream flows through the south-eastern part of the swamp. It is fed by an intense network of drains in this area. Site 1 is just upstream of the confluence of this drain with the Mangahahuru Stream, which then flows into the Wairua River.

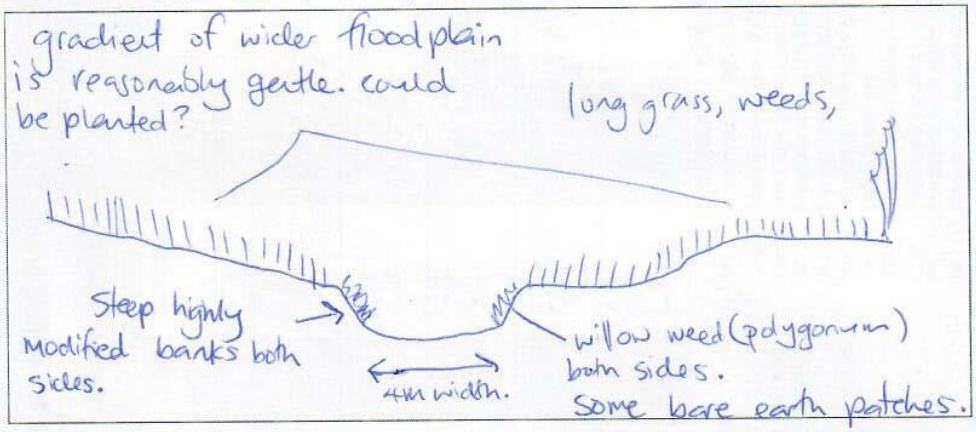
Site 1 is a cut drain that is straight with no meander pattern. The channel is approximately 4 metres wide and is one long run. Flows were low at the time of survey. The banks are steep, stable and straight and 3 to 4 metres tall. They are covered in rank grass with the occasional shrub. The bank vegetation does not offer any effective shade to the waterway.

The surrounding land use is dairy grazing land.

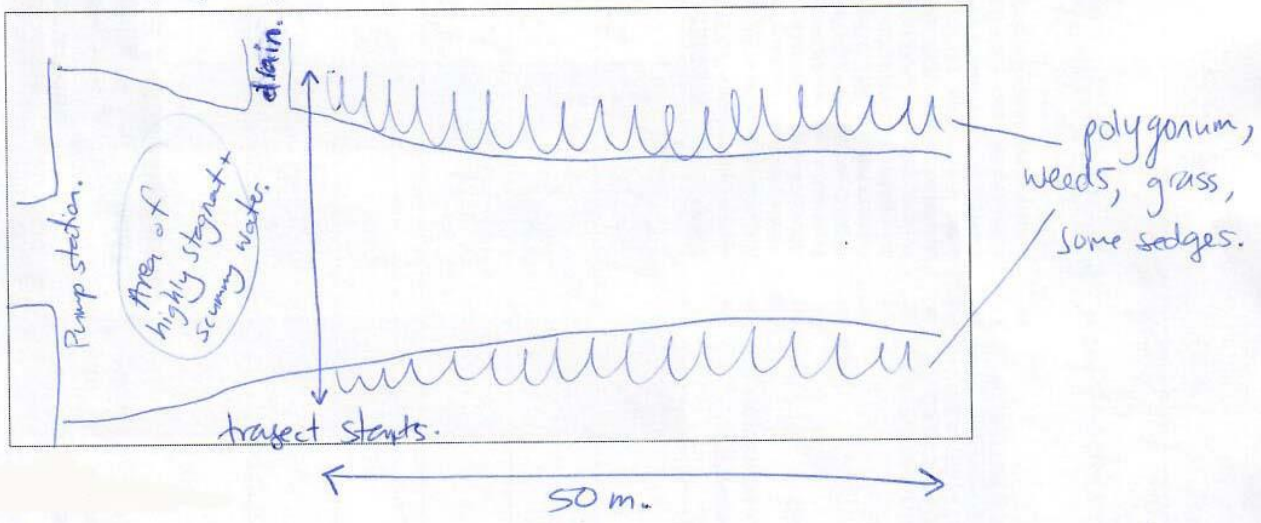
Aquatic plants are limited to the edges of the channel and include small pockets of red pondweed and alligator weed. There are also some pockets of emergent willow weed at the edges of the channel. The water had low clarity with a high sediment load at the time of survey. Long green filamentous algae is common on the stems of emergent vegetation along the edge of the stream.

The stream is soft-bottomed and dominated by bare clay. There is a layer of lose sediment on the substrate and on most instream features. There was no instream woody debris, moss or leaves.

Cross section diagram of site (*include shape of floodplain, riparian vegetation, and channel shape*)



Plan diagram of site (*include significant land marks, access points, N direction, direction of stream flow, location of roads, rough scale*)



Field water quality measurements (2016-2017):

Date	Time	DO (mg/l)	DO %	pH	Temp ('C)	Cond.	SPC	Clarity
21/09/201	12.40 pm	5.3	52.6	6.3	15	94.6	73.8	n/a
19/10/2016	11:35 AM	8.71	86.4	6.77	15	169.5	209.3	0.35 m
16/11/2016	11:49 AM	8.85	93.5	6.88	18.2	192.9	221.8	2 of 10
21/12/2016	10:27 AM	6.27	64.7	6.74	16.8	237.2	281	1 of 10
18/01/2017	11:17 AM	7.96	82.7	6.93	17	292.4	344.1	1 of 10
15/02/2017	8:08 AM	2.49	27.9	6.94	20.8	344.5	316.5	1 of 10
15/03/2017	11.53 a.m	2.2	23.6	6.26	18.9	261.7	297.1	2 of 10

Freshwater fish survey:

Fish recorded at the site during the freshwater fish baseline survey are shown below.

Common name	Species name	Number recorded
Threatened /At risk indigenous species		
Longfin eel	*Anguilla dieffenbachii*	2
Unidentified eel	*Anguilla sp.*	3
Non-threatened indigenous species		
Crans bully	*Gobiomorphus basalis*	18
Shortfin eel	*Anguilla australis*	13
Introduced fish		
Catfish	*Ameiurus nebulosus*	3
Mosquito fish	*Gambusia affinis*	Abundant

The fish survey results are also stored on the NIWA Freshwater fish database. They are recorded on NIWA card no. 110298.

For the limited physical habitat available and the wider limitations of the catchment, there is a reasonable diversity of native fish present here. Notwithstanding this, mosquito fish are the dominant species.

Macroinvertebrate survey:

The macroinvertebrate survey at this site used the soft-bottomed sampling protocol.

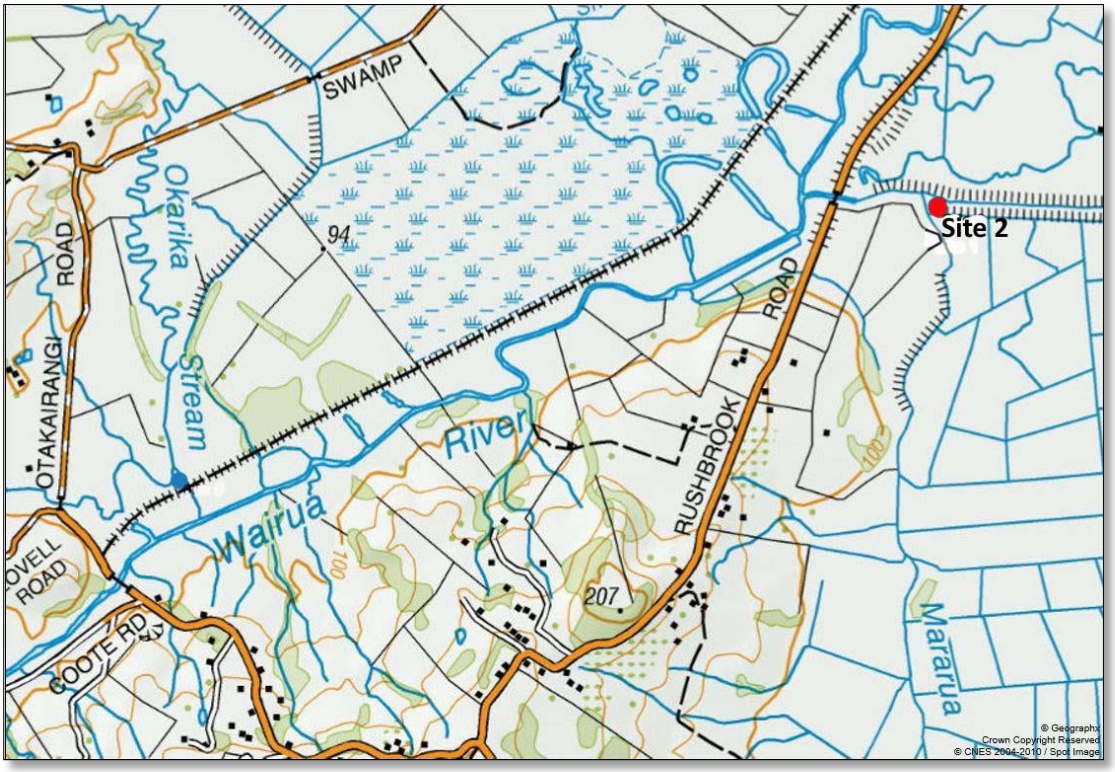
Macroinvertebrate survey results			**Site 1**
24/02/2017		**MCI-sb invert taxon score**	**Mararua Stream**
Order	**Genus**		
Odonata (dragonflies/damselflies)	*Xanthocnemis*	1.2	VA
Hemiptera (water bugs)	*Sigara*	2.4	C
Diptera (flies)	Empididae	5.4	R
	Orthocladiinae	3.2	R
	Tanytarsus	Not available	VA
Trichoptera (caddis flies)	*Oxyethira*	1.2	R
Crustacea (crustaceans)	Cladocera	0.7	R
	Copepoda	2.4	A
	Ostracoda	1.9	C
Mollusca (snails, limpets, bivalves)	*Physa*	0.1	C
	Potamopyrgus	2.1	C
Leeches	Hirudinea	1.2	R
Roundworms	Nematoda	3.1	R
Worms	Oligochaeta	3.8	VA
Flatworms	Platyhelminthes	0.9	VA
Springtails	Collembola	5.3	R
Coelenterata	*Hydra*	1.6	A
	Total number of invertebrate taxa		**17**
	MCI		**46**
	SQMCI		**1.55**

The number of taxa is at a moderate level at 17 different taxa, albeit dominated by pollution tolerant taxa such as midge larvae, worms and flatworms. There are no pollution sensitive species in the sample, e.g. mayfly, stonefly or caddisfly. The MCI and SQMCI scores for the sample are 46 and 1.55 respectively. This indicates poor water quality - probable severe pollution.

Fish in macroinvertebrate sample	**Site 1 – Mararua Stream**
Gambusia	**present (~25)**

Site name	Site No.	NZTM Northing	NZTM Easting	Survey date
Mangahahuru Stream (Ngararatunua pocket)	2	6057772.17	1712130.31	28/02/2017

Site location:



Site photo:

Physical habitat:

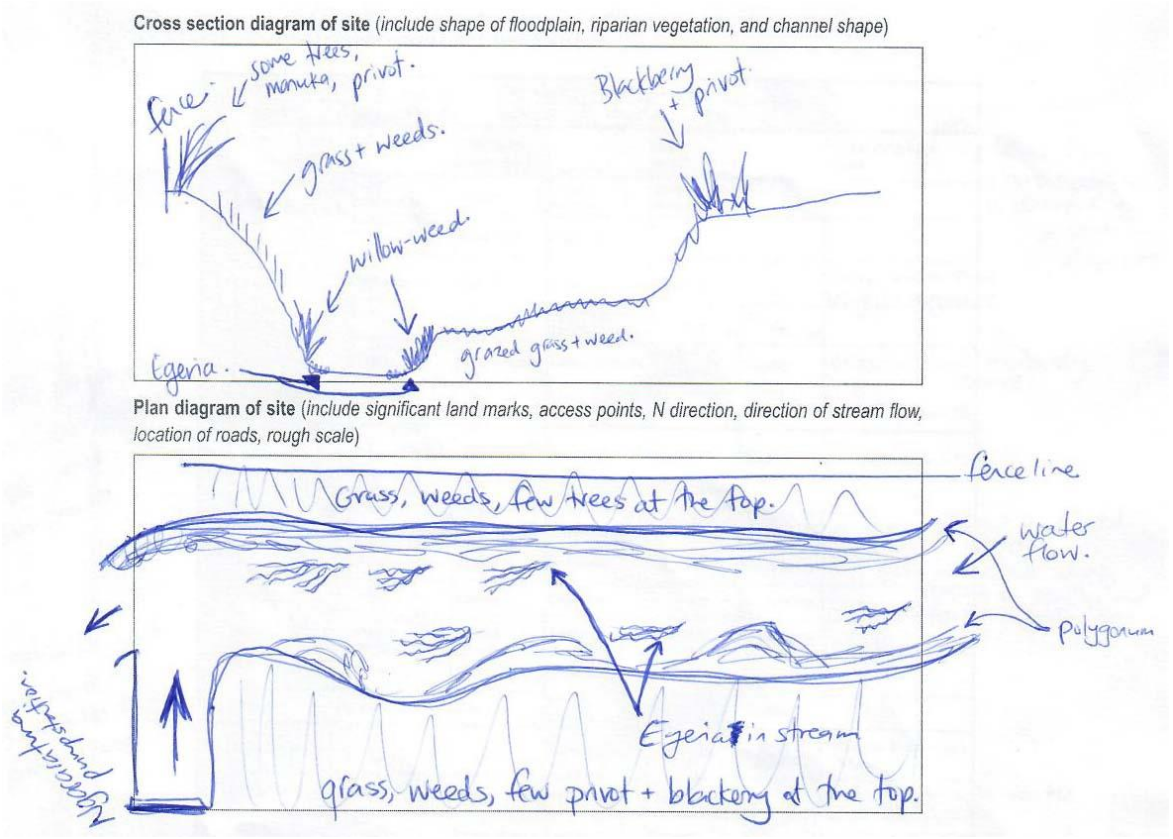
The Mangahahuru Stream flows into the swamp from the east between Hikurangi and Apotu. Its headwaters, and most of its catchment are in the clay hills of Glenbervie forest to the east. Site 2 is just upstream of the confluence of this stream with the Mararua Stream, which then flows into the Wairua River approximately 0.5 kilometres downstream.

Site 2 has been channelised but is still weakly sinuous. The channel is approximately 4 metres wide and is one long run. Flows levels were low at the time of survey. The flow rate was moderately slow but at least noticeable, which is different to the sluggish flows observed at many of the other pump station sites. The banks are steep, stable and straight and the upper bank height is 4 metres tall. There is a lower terrace on the true left bank which is around 1 metre tall. The riparian vegetation is mainly rank grass, bare earth, or weeds and sedges. There is the occasional tree and shrub including tree privet, grey willow and manuka. Blackberry was also recorded. The bank vegetation does not offer any effective shade to the waterway.

The surrounding land use is dairy grazing land. There is evidence of stock having access to the stream here with pugging present on the lower terrace of the true left bank.

Aquatic plants were common at this site. The main species is *Egeria densa* that grows in large beds throughout the channel. It was the only submerged species recorded and in most of the survey area it dominated the total macrophyte cover. There is a thin strip of water pepper at the edges of the stream channel. Alligator weed was also recorded. The water had good clarity at the time of survey. Long filamentous green algae was growing on the *Egeria* and some areas of the gravel beds. No other periphyton was recorded.

The stream is soft-bottomed and dominated by clay and mud. However, there are areas of accumulated sand and fine gravel, which were visible in open areas between the beds of *Egeria*. Where this coarser substrate occurred, a thin layer of loose sediment was common across the substrate base. There were no instream woody debris, moss or leaves recorded.



Field water quality measurements (2016-2017):

Date	Time	DO (mg/l)	DO %	pH	Temp ('C)	Cond.	SPC	Clarity
21/09/201	12.15 pm	5.85	58	6.5	14.2	58.7	73.8	n/a
19/10/2016	11:16 am	12.96	127.19	7.2	14.6	92.6	115.4	1.5 m
16/11/2016	11:33 am	12.54	130.8	7.43	17.4	98.4	115.3	8 of 10
21/12/2016	10:15 am	8.85	95.5	7.08	19	107.5	121.4	6 of 10
18/01/2017	11:04 am	8.51	93.2	7.43	19.5	123.8	137.6	8 of 10
15/02/2017	7:54 am	2.71	30.2	7.03	20.6	166.5	125.4	6 of 10
15/03/2017	11.41 am	5.8	61.3	6.5	18	122.5	141	3 of 10

Freshwater fish survey:

Fish recorded at the site during the freshwater fish baseline survey are shown below.

Common name	Species name	Number recorded
Threatened /At risk indigenous species		
Longfin eel	*Anguilla dieffenbachii*	1
Unidentified eel	*Anguilla sp.*	2
Non-threatened indigenous species		
Crans bully	*Gobiomorphus basalis*	14
Shortfin eel	*Anguilla australis*	11
Introduced fish		
Catfish	*Ameiurus nebulosus*	24
Goldfish	*Carassius auratus*	1
Mosquito fish	*Gambusia affinis*	Abundant

4 freshwater crabs were also recorded during the fish survey.

The fish survey results are also stored on the NIWA Freshwater fish database. They are recorded on NIWA card no. 110299.

For the limited physical habitat available and the wider limitations of the catchment, there is a reasonable diversity of native fish present here. Notwithstanding this, mosquito fish and catfish, both known pest fish, are the dominant species present.

Macroinvertebrate survey:

The macroinvertebrate survey at this site used the soft-bottomed sampling protocol.

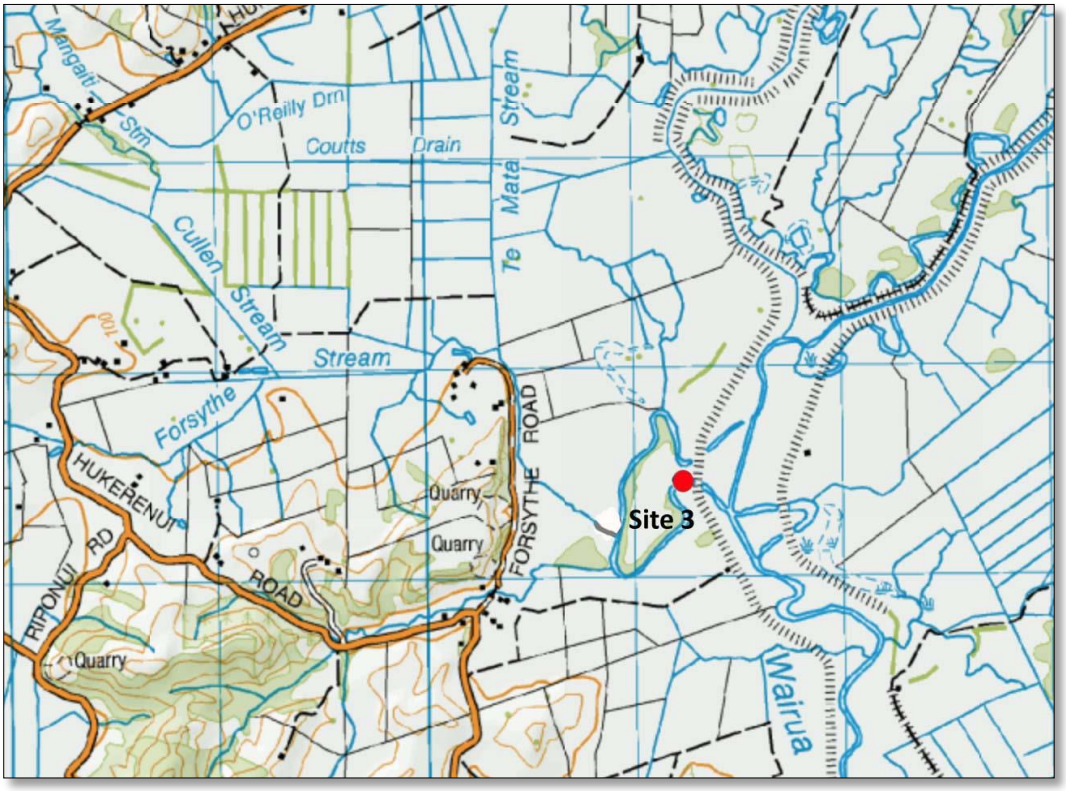
Macroinvertebrate survey results			**Site 2**
24/02/2017		**MCI-sb invert taxon score**	**Mangahahuru Stream**
Order	**Genus**		
Ephemeroptera (mayflies)	*Zephlebia*	8.8	R
Odonata (dragonflies/damselflies)	*Xanthocnemis*	1.2	C
Lepidoptera (moths)	*Hygraula*	1.3	R
Diptera (flies)	Orthocladiinae	3.2	C
	Tanytarsus	not available	C
Trichoptera (caddis flies)	*Oxyethira*	1.2	A
Crustacea (crustaceans)	*Amarinus*	not available	R
	Amphipoda	5.5	VA
	Ostracoda	1.9	R
Mollusca (snails, limpets, bivalves)	*Gundlachia*	2.4	C
	Physa	0.1	A
	Potamopyrgus	2.1	VVA
Oligochaeta (worms)		3.8	A
Platyhelminthes (flatworms)		0.9	R
	Hydra	1.6	R
Total number of invertebrate taxa			**15**
MCI			**52**
SQMCI			**2.55**

The number of taxa is at a moderate level with 15 different taxa recorded. Freshwater snails (*Potamopyrgus*) are super abundant, followed by Amphipoda, worms, *Physa* and the purse caddis (Oxyethira). All these taxa will find abundant habitat in the marcophyte beds here. The MCI and SQMCI scores for the sample are 52 and 2.55 respectively. This indicates poor water quality - probable severe pollution.

Fish in macroinvertebrate sample	**Mangahahuru Stream**
Gambusia	**present (~10)**

Site name	Site No.	NZTM Northing	NZTM Easting	Survey date
Forsythe Stream (Te mata pocket)	3	6063222.122	1710840.036	23/02/2017

Site location:



Site photo:

Physical habitat:

This is a pump station tributary site. Forsythe Stream flows into the north-eastern end of the swamp from the farmed hills around Riponui. A number of drains from dairy land in the north-eastern corner of the swamp also flow into Forsythe stream upstream of the survey site. The survey site is immediately upstream of the pump station. Forsythe Stream confluences with the Wairua river 50 metres downstream of the site.

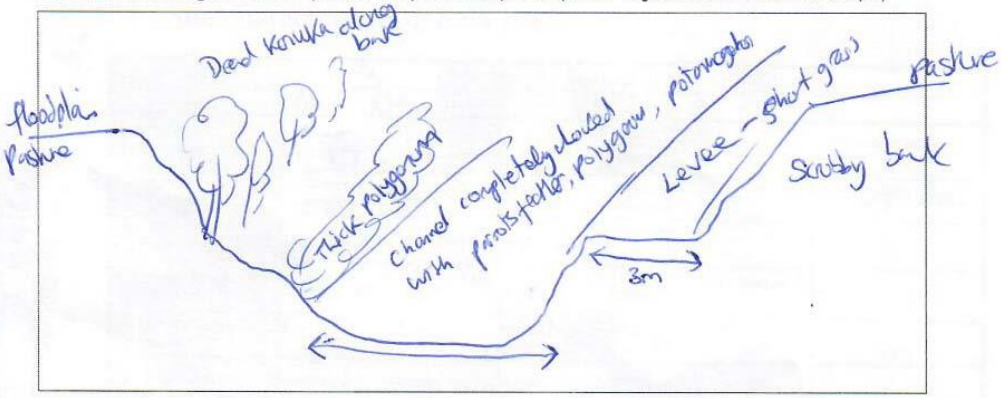
Site 3 has been cut into a uniform channel with a single long bend in it. The channel is approximately 6 metres wide and is one long run. Flows levels were low at the time of survey. The flow rate was also very slow and sluggish. The banks are steep, stable and straight and the upper bank height is 4 metres tall. There is a lower terrace about 3 metres wide on the true left bank which is around 1.25 metre tall and covered in short grass. The riparian vegetation is mainly rank grass, bare earth, or weeds. There is a line of dead kanuka along the true right bank. The bank vegetation does not offer any effective overhead shade to the waterway.

The surrounding land use is dairy grazing land. There is evidence of stock having access to the stream here with pugging present on the lower terrace of the true left bank.

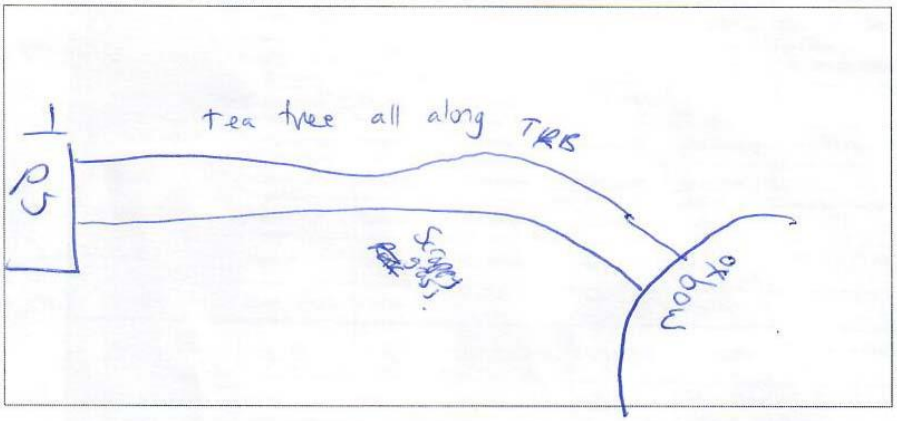
Aquatic plants were common at this site. The submerged species, *Egeria densa* is present and ranges from 10 to 30% of the cover. The most dominant instream macrophytes are emergent plants with abundant parrots feather and *Persicaria* species and also some duckweed, alligator weed and small patches of water buttercup. The water clarity was poor and there were patches of long and short filamentous green algae growing on the stems of the parrots feather and alligator weed. Surface scums and oily sheens were common.

The stream is soft-bottomed and dominated by clay and mud. There was a thick layer (30+ cm) of anaerobic sediment settled over the clay base. There was no instream woody debris, moss or fallen leaves.

Cross section diagram of site (*include shape of floodplain, riparian vegetation, and channel shape*)



Plan diagram of site (*include significant land marks, access points, N direction, direction of stream flow, location of roads, rough scale*)



Field water quality measurements (2016-2017):

Date:	Time	DO (mg/l)	DO %	pH	Temp ('C)	Cond.	SPC	Clarity
21/09/16	11:08 am	5.5	54.1	6.3	14.3	87.4	109.9	n/a
19/10/16	9:14 am	5.8	68.2	6.41	15.9	116.8	141.5	1.0 m
16/11/16	9:44 am	6.82	71.9	6.62	17.9	117	135.2	2 of 10
21/12/16	8:47 am	7.54	86	7.09	21.8	143.5	152.8	3 of 10
18/01/17	9:48 am	4.98	57	7.26	22	142.8	151.5	6 of 10
15/02/17	8:43am	4.65	53.6	7.32	22.6	185.5	176.9	3 OF 10
15/03/17	9:46 am	1.14	12.6	6.49	19.9	155.4	172.3	3 OF 10

Freshwater fish survey:

Fish recorded at the site during the freshwater fish baseline survey are shown below.

Common name	Species name	Number recorded
Threatened /At risk indigenous species		
Unidentified eel	*Anguilla sp.*	11
Non-threatened indigenous species		
Crans bully	*Gobiomorphus basalis*	23
Shortfin eel	*Anguilla australis*	38
Introduced fish		
Catfish	*Ameiurus nebulosus*	15
Goldfish	*Carassius auratus*	11
Mosquito fish	*Gambusia affinis*	Abundant

The fish survey results are also stored on the NIWA Freshwater fish database. They are recorded on NIWA card no. 110300

For the limited physical habitat available and the highly anaerobic water quality at this site, there is a good population of eels and Crans bully present. Pest fish such as catfish, goldfish and Gambusia are present also, with the latter in noticeably high numbers.

Macroinvertebrate survey:

The macroinvertebrate survey at this site used the soft-bottomed sampling protocol.

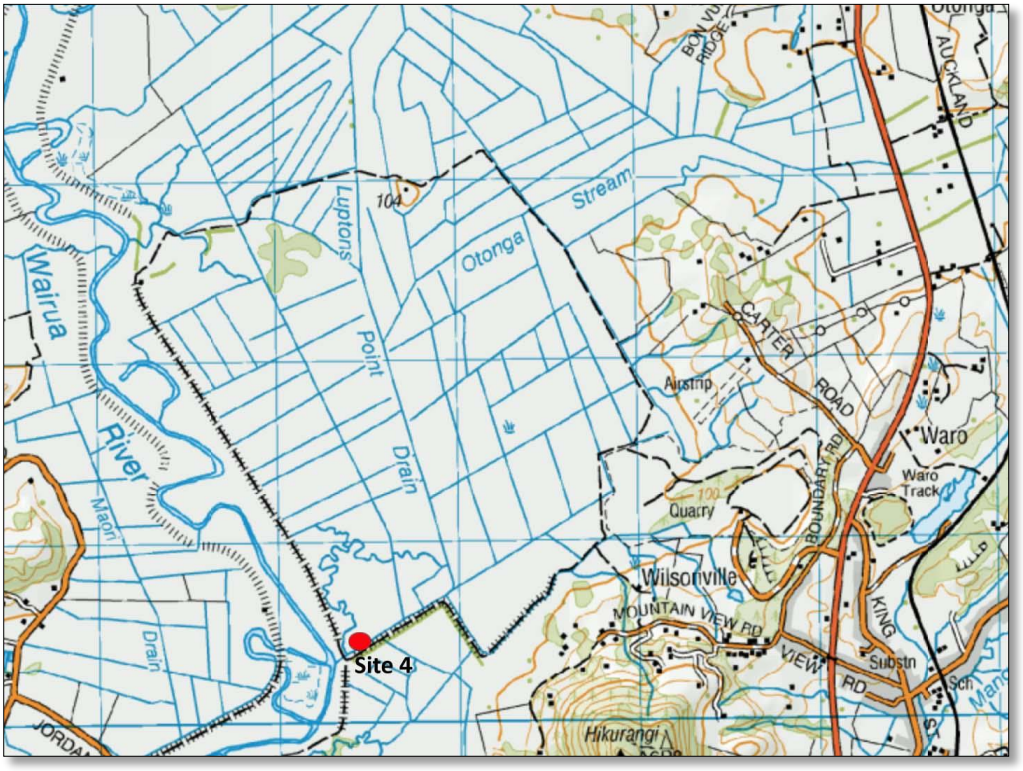
Macroinvertebrate survey results			**Site 3**
23/02/2017		**MCI-sb invert taxon score**	**Forsythe Stream**
Order	**Genus**		
Ephemeroptera (mayflies)	*Zephlebia*	8.8	R
Odonata (dragonflies/damselflies)	*Hemicordulia*	0.4	R
	Xanthocnemis	1.2	A
Diptera (flies)	Orthocladiinae	3.2	C
	Tanytarsus	not available	VA
Trichoptera (caddis flies)	*Oxyethira*	1.2	C
Crustacea (crustaceans)	Cladocera	0.7	VA
	Copepoda	2.4	C
Mollusca (snails, limpets, bivalves)	*Physa*	0.1	A
	Potamopyrgus	2.1	C
Acarina (mites)	*Dolomedes*	6.2	R
Oligochaeta (worms)		3.8	C
Platyhelminthes (flatworms)		0.9	A
Coelenterata	*Hydra*	1.6	A
	Total number of invertebrate taxa		**14**
	MCI		**50**
	SQMCI		**0.73**

Fish in macroinvertebrate sample	**Site 3 – Forsythe Stream**
Gambusia	**present (~25)**

The number of taxa is at a moderate level at 14 different taxa. There is only one recording of a sensitive taxa, i.e mayfly, the rest of the sample is dominated by pollution tolerant species. The MCI and SQMCI scores for the sample further confirm this with a low score of 50 and 0.73 respectively. This indicates poor water quality - probable severe pollution.

Site name	Site No.	NZTM Northing	NZTM Easting	Survey date
Luptons point drain (Otonga pocket)	4	6060386.138	1713407.173	24/02/2017

Site location:



Site photo:

Physical habitat:

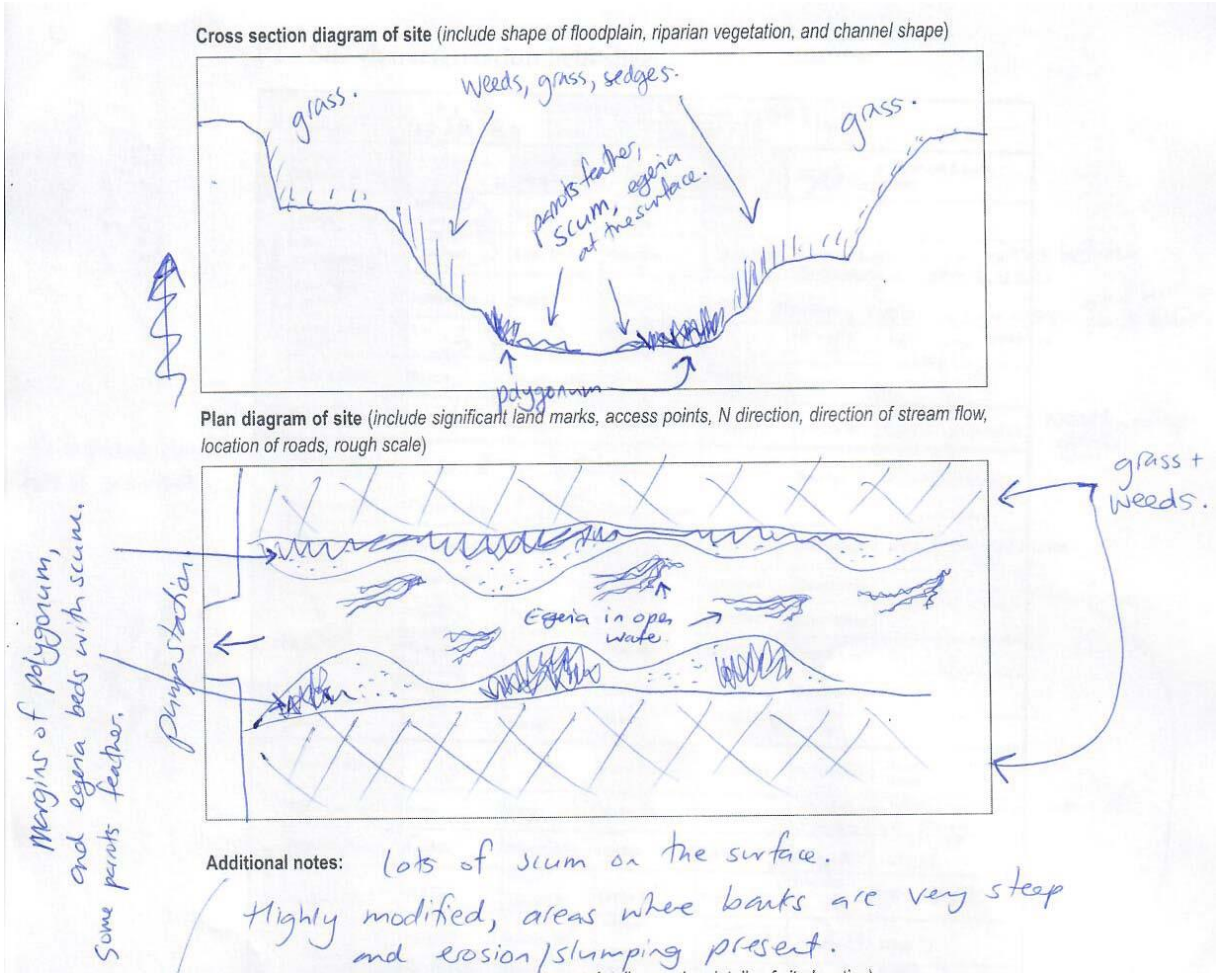
This is a pump station tributary site. Luptons point drain receives water from central eastern part of the swamp and Otonga Stream. The majority of the catchment is dairy land. Site 4 is immediately upstream of the pump station. The drain confluences with the Wairua river 50 metres downstream of the pump station and site.

Site 4 is a straight, cut drain. The channel is approximately 5 metres wide and is one long run. Flows levels were low at the time of survey. The flow rate was slow but visible, especially in areas between submerged plant beds. The banks are steep, stable and straight and the upper bank height is up to 10 metres tall. The true left bank is the stop bank. There is a lower bank at around 3 metres tall on both sides. The banks are covered in short grass and bare earth with some weeds. There is no other riparian vegetation to provide shade or organic input.

The surrounding land use is dairy grazing land. There is evidence of stock having access to the stream here with pugging present on the lower terrace of the true left bank and small pockets of associated bank slumping.

Aquatic plants were abundant at this site with almost complete cover from bank to bank with the submerged species, *Egeria densa.* Other species present include alligator weed, parrots feather, water pepper and a small amount of water plantain. Water pepper was common as a band of vegetation along the edge of the channel. The water clarity was good and there were some significant areas (up to 80% of the reach) of long filamentous green algae growing on the stems of the instream vegetation. Surface scums were common.

The stream is soft-bottomed and dominated by hard-packed clay. There were some areas of sand and silt and a a 20cm layer of sediment settled over the clay base. There was no instream woody debris, moss or fallen leaves.



Field survey water quality (September 2016-March 2017):

Date:	Time	DO (mg/l)	DO %	pH	Temp ('C)	Cond.	SPC	Clarity
21/09/16	11.49 am	5.17	50.7	6.7	14.8	116.9	145.3	n/a
19/10/16	10:22 am	9.07	92.4	7.21	15.9	342.5	416	0.35 m
16/11/16	10:37 am	8.42	90	7.47	18.6	468.3	533.6	3 of 10
21/12/16	9:39 am	7.49	82.3	7.45	19.9	869	964	7 of 10
18/01/17	10:26 am	8.13	89.9	7.46	20.1	1042.07	1149	7 of 10
15/02/17	7:09 am	1.32	14.9	7.43	21.2	1090.1	1011	8 of 10
15/03/17	10:36 am	2.73	29.8	6.21	19.6	303.7	338.5	2 of 10

Freshwater fish survey:

Fish recorded at the site during the freshwater fish baseline survey are shown below.

Common name	Species name	Number recorded
Crans bully	*Gobiomorphus basalis*	41
Shortfin eel	*Anguilla australis*	3
Introduced fish		
Mosquito fish	*Gambusia affinis*	Abundant

N.B. One fyke net was set directly below the pump station. This was where all the Crans bullies and 2 eels were caught.

The fish survey results are also stored on the NIWA Freshwater fish database. They are recorded on NIWA card no. 110301.

Macroinvertebrate survey:

The macroinvertebrate survey at this site used the soft-bottomed sampling protocol.

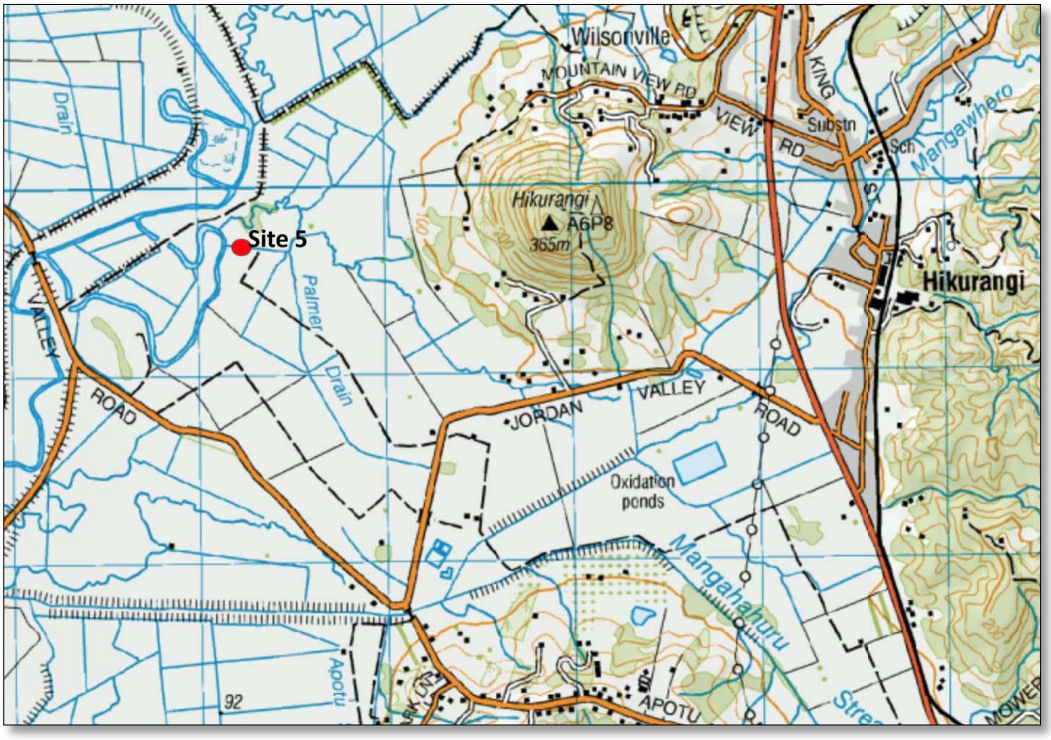
Macroinvertebrate survey results			Site 4
24/02/2017		**MCI-sb invert taxon score**	**Luptons point drain**
Order	**Genus**		
Odonata (dragonflies/damselflies)	*Xanthocnemis*	1.2	A
Lepidoptera (moths)	*Hygraula*	1.3	A
Diptera (flies)	*Tanytarsus*	not available	C
Trichoptera (caddis flies)	*Oxyethira*	1.2	A
	Paroxyethira	3.7	R
Crustacea (crustaceans)	Amphipoda	5.5	R
	Cladocera	0.7	R
Mollusca (snails, limpets, bivalves)	*Physa*	0.1	A
	Potamopyrgus	2.1	C
Acarina (mites)		5.2	R
Platyhelminthes (flatworms)		0.9	R
Coelenterata	*Hydra*	1.6	R
Total number of invertebrate taxa			**12**
MCI			**43**
SQMCI			**1.08**

The number of taxa is at a moderate -low with 12 different taxa recorded. The sample is dominated by damselfly and moth larvae, purse caddisfly and snails (*Physa*). Most taxa present are pollution tolerant. There are no pollution sensitive species in the sample, e.g. mayfly, stonefly or caddisfly. The MCI and SQMCI scores for the sample are low at 43 and 1.08 respectively. This indicates poor water quality - probable severe pollution.

Fish in macroinvertebrate sample	Site 4 – Luptons point drain
Gambusia	**present (~10)**

Site name	Site No.	NZTM Northing	NZTM Easting	Survey date
Palmer Drain (Mountain pocket)	5	6059654.561	1713204.07	27/02/2017

Site location:



Site photo:

Physical habitat:

This is a pump station tributary site. Palmer drain receives water from central eastern part of the swamp, generally from around the mountain (Hikurangi). The majority of the catchment is dairy land. Site 5 is directly upstream of an oxbow of the Wairua river and feeds directly into it. This then empties into the Wairua via the pump station directly west of the site.

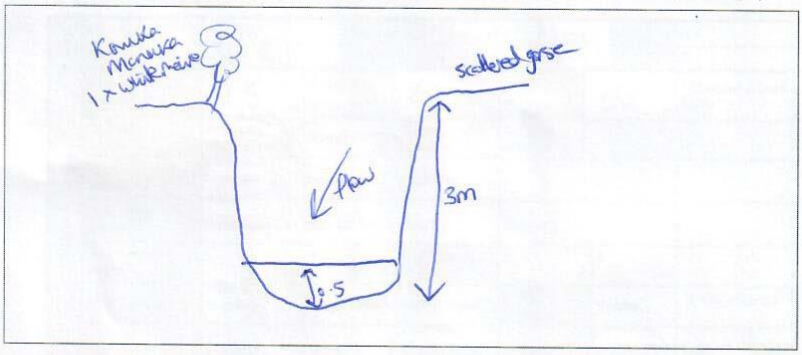
Site 5 is a deep, straight, cut drain. The channel is approximately 1.5 metres wide and is one long run. Flow levels were low at the time of survey. The flow rate was negligible. The banks are very steep but generally stable. There is some evidence of historic slumping, but vegetation has grown over this. The banks are approximately 3 metres tall. Bank cover comprises bare soil on the steep sides, with grass and shrubs on the top. Kanuka, totara, manuka, Chinese privet and a white maire were recorded on the true right bank. Scattered gorse was on the true left bank. This vegetation will provide some shade and organic input to the stream. The steepness and depth of the drain also provides some shade, i.e. via the banks.

The surrounding land use is dairy grazing land. There is no evidence of stock damage. The drain is fenced but also too steep for stock access.

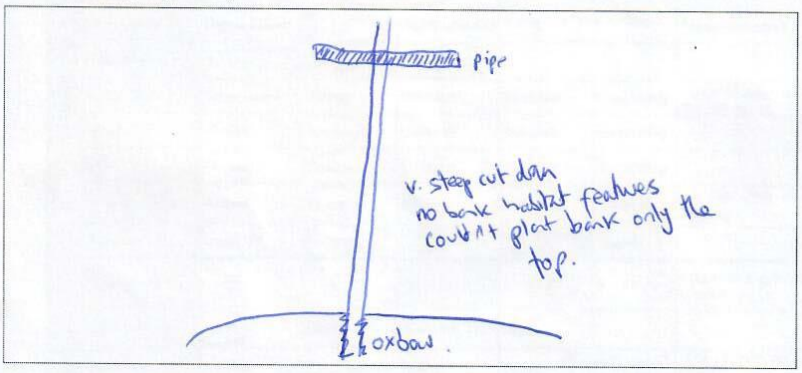
Aquatic plants were present at this site but not abundant (2 to 15% total cover). The emergent plant, water pepper had recently been sprayed along the lower edges of the banks. Other species present were also emergent and included duckweed, alligator weed and the sedge species *Cyperus brevifolius*. The water clarity was moderate but there was a layer (approx. 10cm thick) of loose sediments over the substrate which meant clarity was quickly lost on disturbance. Long, green filamentous algae was common growing on the stems of the instream vegetation. Surface scums were common.

The stream is soft-bottomed and dominated by hard-packed clay. There was very little instream woody debris or leaves in the substrate and no moss.

Cross section diagram of site (*include shape of floodplain, riparian vegetation, and channel shape*)



Plan diagram of site (*include significant land marks, access points, N direction, direction of stream flow, location of roads, rough scale*)



Field survey water quality (September 2016-March 2017):

Date:	Time	DO (mg/l)	DO %	pH	Temp	Cond.	SPC	Clarity
21/09/16	1:10 pm	6.18	60.9	5.9	15.9	114.2	138.2	n/a
19/10/16	10.46 am	4.35	42.4	6.16	14.2	131.2	164	1.0 m
16/11/16	10:59 am	3.71	38.8	6.52	17.6	178.2	207.7	8 of 10
21/12/16	9:55 am	7.78	85	6.78	19.6	340.4	379.5	5 of 10
18/01/17	10:42 am	10.06	112.3	7.39	20.7	383.7	417.9	4 of 10
15/02/17	7:33 am	1.32	14.6	6.92	20	494.8	448	3 of 10
15/03/17	11:00 am	1.86	19.6	5.88	18.2	226.8	260.8	3 of 10

Freshwater fish survey:

Fish recorded at the site during the freshwater fish baseline survey are shown below.

Common name	Species name	Number recorded
Threatened /At risk indigenous species		
Longfin eel	*Anguilla dieffenbachii*	1
Unidentified eel	*Anguilla sp.*	4
Non-threatened indigenous species		
Shortfin eel	*Anguilla australis*	47
Introduced fish		
Mosquito fish	*Gambusia affinis*	Abundant

The fish survey results are also stored on the NIWA Freshwater fish database. They are recorded on NIWA card no. 110302.

Fish diversity at this site is low and limited to eels and mosquito fish. Short fin eel are abundant.

Macroinvertebrate survey:

The macroinvertebrate survey at this site used the soft-bottomed sampling protocol.

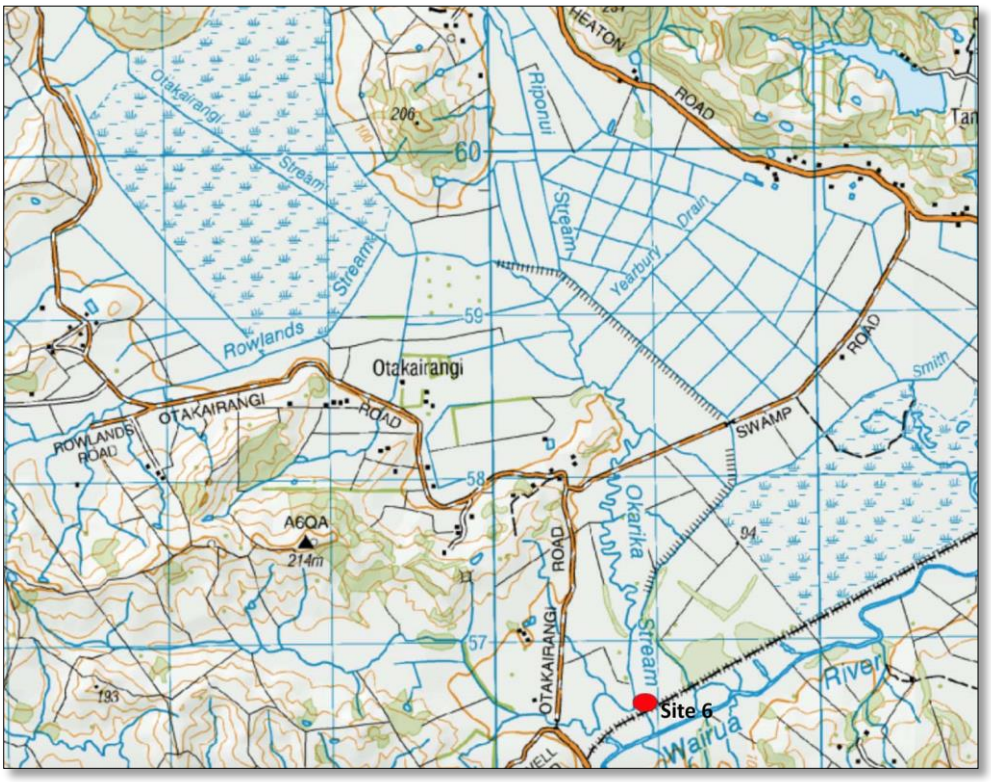
Macroinvertebrate survey results			**Site 5**
27/02/2017		**MCI-sb invert taxon score**	**Palmer Drain**
Order	**Genus**		
Odonata (dragonflies/damselflies)	Zygoptera	0.4	C
Diptera (flies)	Orthocladiinae	3.2	R
	Tanytarsus	not available	R
Trichoptera (caddis flies)	Leptoceridae	6.5	R
Crustacea (crustaceans)	Cladocera	0.7	R
	Copepoda	2.4	A
	Ostracoda	1.9	R
Mollusca (snails, limpets, bivalves)	*Physa*	0.1	R
	Potamopyrgus	2.1	R
Hirudinea (leeches)		1.2	A
Nematoda (roundworms)		3.1	A
Oligochaeta (worms)		3.8	VA
Platyhelminthes (flatworms)		0.9	C
Total number of invertebrate taxa			**13**
MCI			**44**
SQMCI			**3.02**

The number of taxa is moderately low with 13 different taxa recorded. Roundworms, leeches and Copepods dominate. There is only one pollution sensitive taxa in the sample, i.e. the caddisfly Leptoceridae. The MCI and SQMCI scores for the sample are 44 and 3.02. This indicates poor water quality - probable severe pollution.

Fish in macroinvertebrate sample	**Site 5 – Palmer drain**
Gambusia	**present (~75)**

Site name	Site No.	NZTM Northing	NZTM Easting	Survey date
Okarika Stream (Okarika pocket)	6	6056594.928	1708877.457	24/02/2017

Site location:



Site photo:

Physical habitat:

This is a pump station tributary site. Okarika Stream drains the central western part of the swamp from the area around Riponui and Otakairangi. The majority of the catchment is dairy land but this drain also receives flow from the Otakairangi swamp. Site 6 is just upstream of the confluence of this major tributary and the Wairua River. The site is immediately upstream of the pump station.

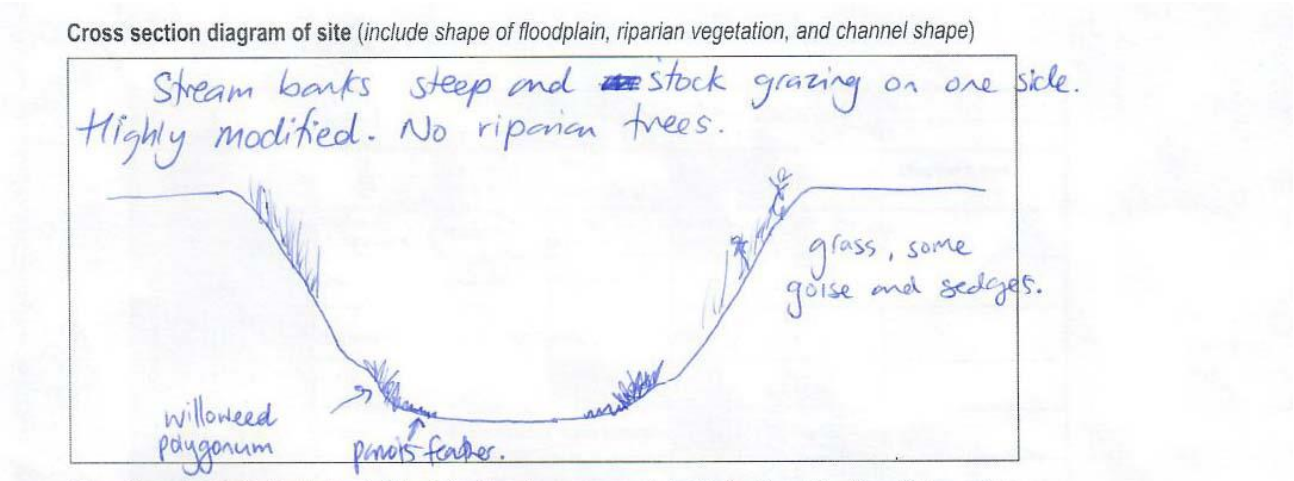
Site 6 is a widened, slightly curving, cut drain. The channel is approximately 6 metres wide and is one long run. Flow levels were low at the time of survey. The flow rate was also very slow. The banks are mostly stable and up to 6 metres tall. There is a narrow, low shelf at the base of each bank at about 0.5 metres height. This is mainly covered in water pepper. The remaining bank cover is earth, rank grass and the occasional gorse bush. This vegetation provides no riparian shade or organic input to the stream.

The surrounding land use is dairy grazing land. There is some evidence of stock grazing on the true right bank.

Aquatic plants were common at this site (between 50 and 90%). There was a band of up to a metre wide down both banks of water pepper. In the water column, there were large beds of *Egeria densa* and some *Lagarosiphon major*. Parrots feather, duckweed and Azolla were also common. The water clarity was poor and there was abundant sediment in the water column and over the substrate. Long, green filamentous algae was common growing on the stems of the instream vegetation. Surface scums were also common.

The stream is soft-bottomed and dominated by hard-packed clay. There was no instream woody debris, leaves or moss in the substrate.

Cross section diagram of site (*include shape of floodplain, riparian vegetation, and channel shape*)



Plan diagram of site (*include significant land marks, access points, N direction, direction of stream flow, location of roads, rough scale*)

Field survey water quality (September 2016-March 2017):

Date	Time	DO (mg/l)	DO %	pH	Temp ('C)	Cond.	SPC	Clarity
21/09/16	1:40 pm	4.5	44.5	6	15	79.2	97.8	n/a
19/10/16	12.11 p.m	6.27	62.7	6.32	15.4	111.8	132. 9	0.5 m
16/11/16	12:28 am	8.37	90.3	6.49	19	111.1	125.4	4 of 10
21/12/16	10:53 am	3.78	42.4	6.65	21	125	135.3	3 of 10
18/01/17	11:38 am	2.91	32.1	7.13	20.2	165.5	171.2	7 OF 10
15/02/17	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
15/03/17	12:29 a.m	1.98	21.6	5.99	19.5	177	197.6	2 of 10

Freshwater fish survey:

Fish recorded at the site during the freshwater fish baseline survey are shown below.

Common name	Species name	Number recorded
Non-threatened indigenous species		
Shortfin eel	*Anguilla australis*	4
Introduced fish		
Catfish	*Ameiurus nebulosus*	14
Mosquito fish	*Gambusia affinis*	Abundant

The fish survey results are also stored on the NIWA Freshwater fish database. They are recorded on NIWA card no. 110303.

Five freshwater crabs were also recorded from this site. Fish diversity at this site is low with the only native being short fin eels. Catfish dominate the sample.

Macroinvertebrate survey:

The macroinvertebrate survey at this site used the soft-bottomed sampling protocol.

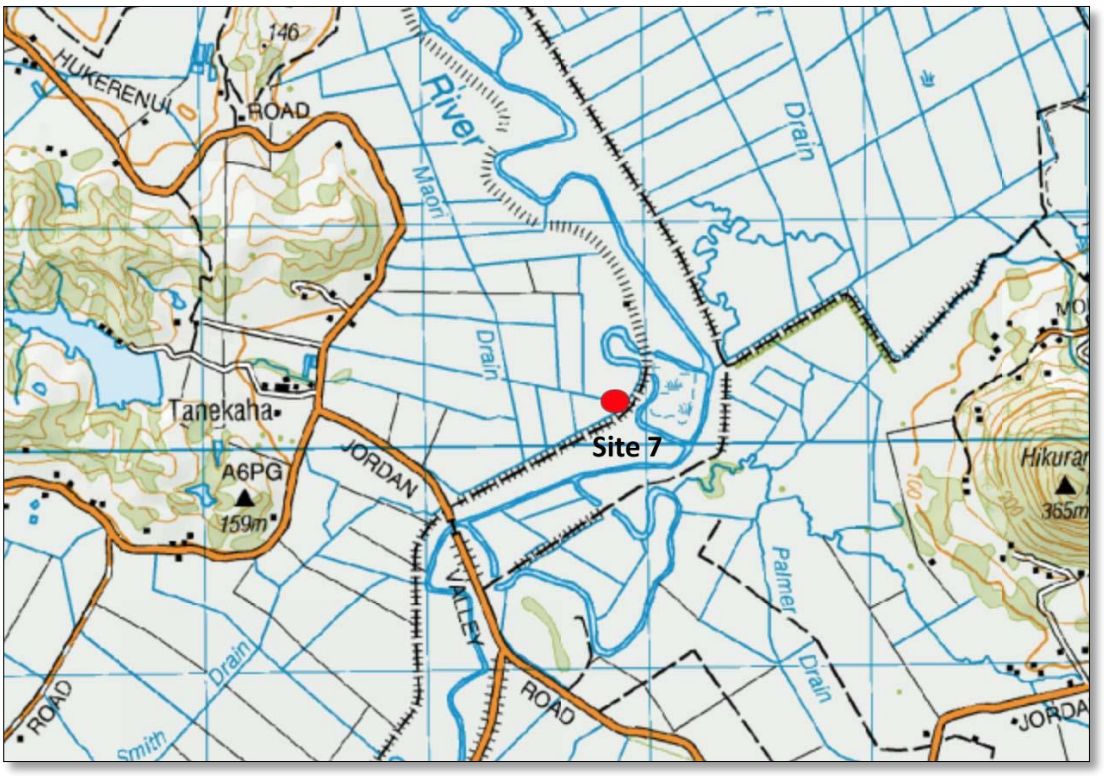
Macroinvertebrate survey results			**Site 6**
24/02/2017		**MCI-sb invert taxon score**	**Okarika Stream**
Order	**Genus**		
Odonata (dragonflies/damselflies)	Zygoptera	0.4	R
Diptera (flies)	Orthocladiinae	3.2	R
	Tanytarsus	not available	C
Trichoptera (caddis flies)	*Oxyethira*	1.2	C
Crustacea (crustaceans)	*Amarinus*	not available	R
	Cladocera	0.7	R
	Ostracoda	1.9	A
Mollusca (snails, limpets, bivalves)	*Physa*	0.1	A
Hirudinea (leeches)		1.2	R
Nematoda (roundworms)		3.1	R
Oligochaeta (worms)		3.8	A
Platyhelminthes (flatworms)		0.9	R
Collembola (springtails)		5.3	C
Coelenterata	*Hydra*	1.6	C
	Total number of invertebrate taxa		**14**
	MCI		**39**
	SQMCI		**1.91**

The number of taxa is at a moderately low level with 14 different taxa. The sample is dominated by worms, freshwater snails (*Physa*) and seed shrimp (Ostracoda). All taxa present are pollution tolerant. There are no pollution sensitive taxa in the sample. The MCI and SQMCI scores for the sample are 39 and 1.91 respectively. This indicates poor water quality - probable severe pollution.

Fish in macroinvertebrate sample	**Site 6 – Okarika Stream**
Gambusia	**present (~10)**

Site name	Site No.	NZTM Northing	NZTM Easting	Survey date
Unnamed drain (Tanekaha pocket)	7	6060175.088	1712843.178	27/02/2017

Site location:



Site photo:

Physical habitat:

This is a pump station tributary site. This unnamed drain receives water from Maori Drain and dairy land in the central part of the swamp. It also has some higher ground in bush, forestry and farmland in its catchment in the hills around Tanekaha. Site 7 is at the eastern end of the unnamed drain. It then travels a short distance to the north east before entering an oxbow where it is pumped into the Wairua River.

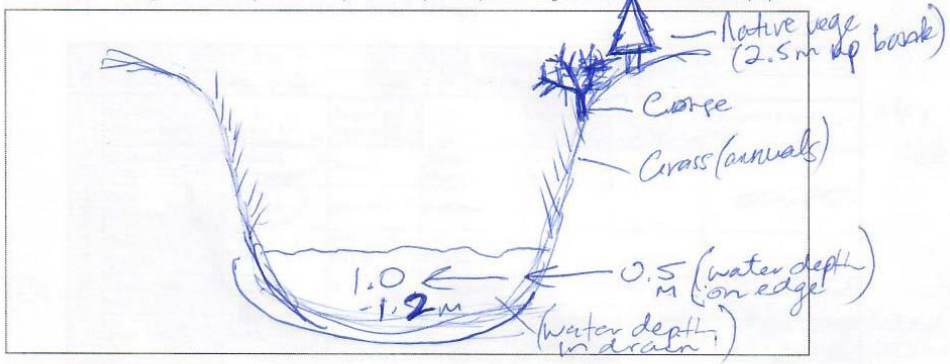
Site 7 is a deep, straight, cut drain. The channel varies from between approximately 1.5 to 2 metres wide and is one long run. Flow levels were low at the time of survey. The flow rate was negligible. The banks are very steep but generally stable. They are approximately 3.5 metres tall. Bank cover comprises bare soil on the steep sides, with rank grass. There are shrubs on the top of the true left bank. These include manuka, gorse and cabbage trees. This vegetation, although on the northern side of the drain, provides no overhead shade to the drain and is set back too far to provide organic input. The steepness and depth of the drain may provide some shade during spring and autumn, i.e. via the banks.

The surrounding land use is dairy grazing land. There is no evidence of stock damage. The drain is too steep for stock access.

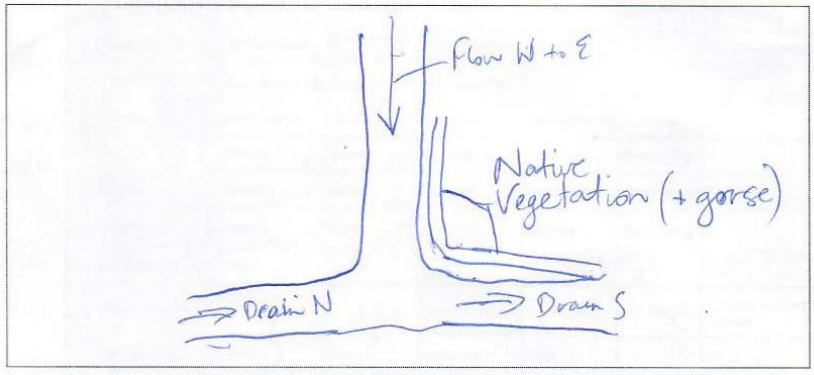
Aquatic plants provide almost continuous cover in the channel and are around 60 to 100% cover. There are thick beds of the submerged species *Egeria densa* throughout the site. Emergent and floating species include abundant parrots feather and duckweed. The sedge species *Cyperus eragrostis* is present at the banks edges. The water clarity was low and there is a layer (approx. 15 to 20cm thick) of loose, anaerobic sediments over the substrate. Long, green filamentous algae was common growing on the stems of the instream vegetation. There were light brown and green mats of algae floating in the water column and on the surface of the water. Surface scums were common.

The stream is soft-bottomed and dominated by hard-packed clay. There was very little instream woody debris or leaves in the substrate and no moss.

Cross section diagram of site (*include shape of floodplain, riparian vegetation, and channel shape*)



Plan diagram of site (*include significant land marks, access points, N direction, direction of stream flow, location of roads, rough scale*)



Freshwater fish survey:

Fish recorded at the site during the freshwater fish baseline survey are shown below.

Common name	Species name	Number recorded
Threatened /At risk indigenous species		
Longfin eel	*Anguilla dieffenbachii*	3
Unidentified eel	*Anguilla sp.*	10
Non-threatened indigenous species		
Shortfin eel	*Anguilla australis*	27
Introduced fish		
Goldfish	*Carassius auratus*	1
Mosquito fish	*Gambusia affinis*	Abundant

The fish survey results are also stored on the NIWA Freshwater fish database. They are recorded on NIWA card no. 110304. Eels are common at this site.

Macroinvertebrate survey:

The macroinvertebrate survey at this site used the soft-bottomed sampling protocol.

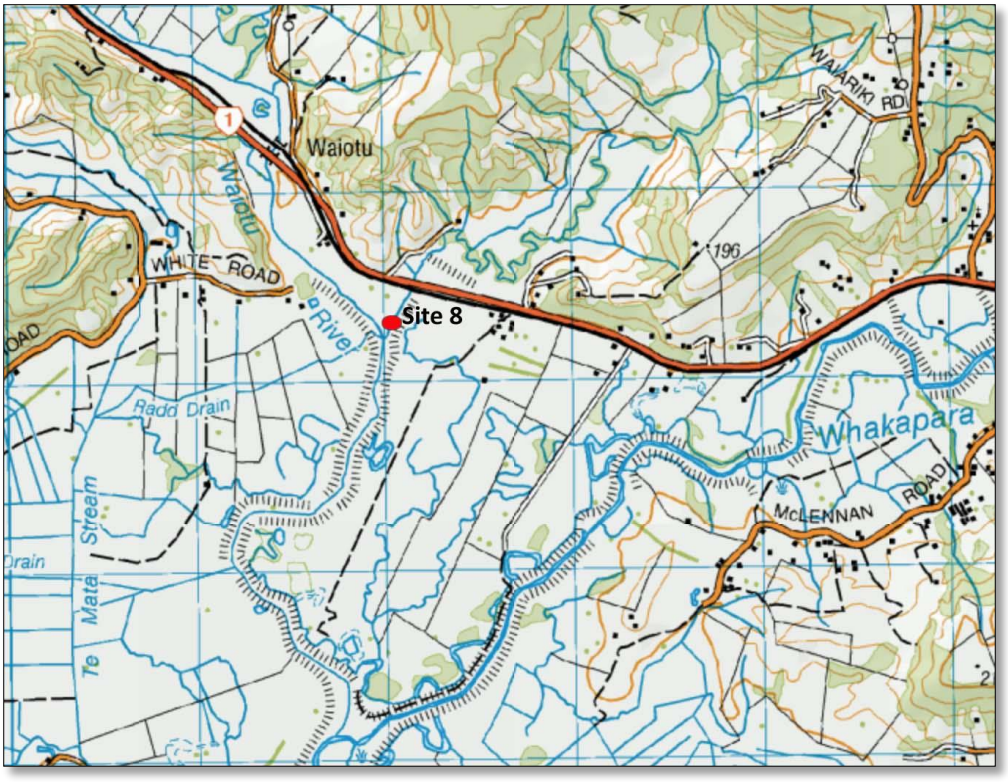
Macroinvertebrate survey results 27/02/2017			**Site 7**
Order	**Genus**	**MCI-sb invertebrate taxon score**	**Tanekaha Pocket**
Hirudinea (leeches)		1.2	C
Nematoda (round worms)		3.1	R
Oligochaeta (worms)		3.8	VA
Platyhelminthes (flatworms)		0.9	R
Collembola (springtails)		5.3	R
Total number of invertebrate taxa			**5**
MCI			**64**
SQMCI			**1.18**

The number of taxa is low at this site with 5 different taxa recorded. Worms dominate the sample. There are no pollution sensitive species in the sample, e.g. mayfly, stonefly or caddisfly. The MCI and SQMCI scores for the sample are 64 and 1.18 respectively. This indicates poor water quality - probable severe pollution.

Fish in macroinvertebrate sample	**Site 7 – Unnamed drain**
Gambusia	**present (~25)**

Site name	Site No.	NZTM Northing	NZTM Easting	Survey date
Waikariki Stream	8	6064432.629	1711888.016	27/02/2017

Site location:



Site photo:

Physical habitat:

The Waikariki Stream flows into the swamp from the north at Waiotu. Its catchment extends up to Puhipuhi and drains undulating farmland and some forestry. Site 8 is just upstream of the confluence of this stream with the Waiotu River.

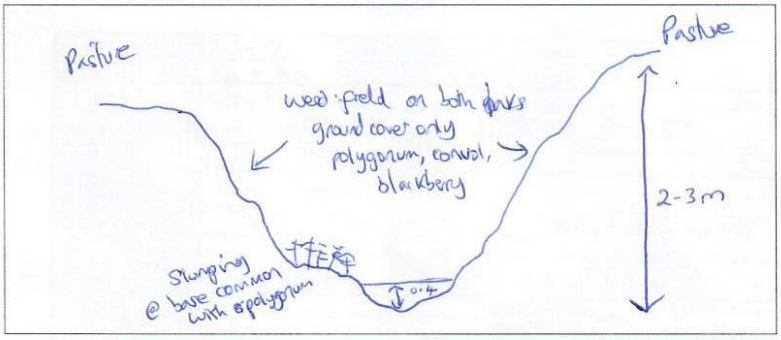
Site 8 has a natural channel. It is deep set and weakly sinuous. The channel width ranges from 0.3 to 1 metre wide and is a combination of runs and pools. Flows levels were low at the time of survey. The flow rate was moderately fast. The banks are steep and unstable with lots of slumped material collected at the base of the banks forming a lower bank of around 0.5 metres tall. The upper bank height is 2-3 metres tall. The riparian vegetation is mainly rank grass, bare earth or weeds including blackberry, bindweed and willow weed. The bank vegetation does not offer any effective shade to the waterway except for a thin strip at the bank edge where water pepper dominates.

The surrounding land use is dairy grazing land. There is evidence of stock having access to the stream here with pugging present on the lower terrace of the true left bank.

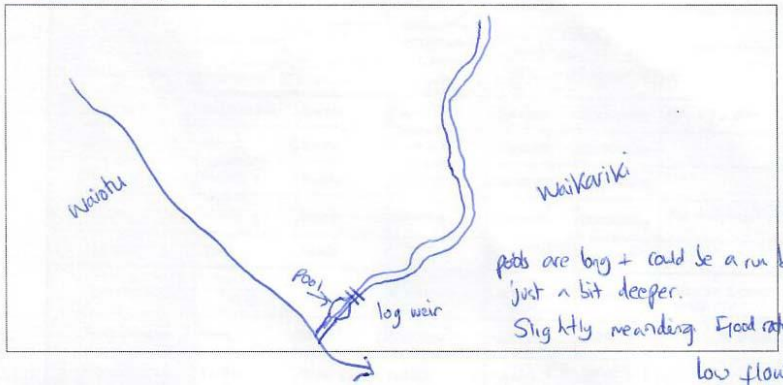
Aquatic plants were common across at least half the channel throughout the site. The main species was *Egeria densa* that grows in dense, submerged beds. There was also a continuous strip (between 0.5 and 1 metre wide) of water pepper and willow weed along the edges of the stream channel. Long filamentous green algae was growing on the *Egeria* and some areas of the gravel beds. Periphyton was recorded on some of the gravel substrate accumulated in the channel. In the samples collected there was a thin film (0.5mm thick) of periphyton over the surface of the substrates..

The stream is soft-bottomed and dominated by clay and mud but with beds of sand and gravel . Where this coarser substrate occurred, a thin layer of loose sediment was common across the substrate base ranging from 5 to 30% cover. There was the occasional instream woody debris, but no leaves or moss. The occasional freshwater mussel was recorded at this site with the bathyscope and three Crans bullies were also recorded.

Cross section diagram of site (*include shape of floodplain, riparian vegetation, and channel shape*)



Plan diagram of site (*include significant land marks, access points, N direction, direction of stream flow, location of roads, rough scale*)



Freshwater fish survey:

Fish recorded at the site during the freshwater fish baseline survey are shown below.

Common name	Species name	Number recorded
Crans bully	*Gobiomorphus basalis*	23
Shortfin eel	*Anguilla australis*	2

Results were sent to the Freshwater fish database. They are recorded on NIWA card no. 110305

Shortfin eel and a healthy population of Crans bully were recorded here. Site habitat is good for fish. Two koura (*Paranephrops planifrons)* were also recorded in the fish survey nets.

Macroinvertebrate survey:

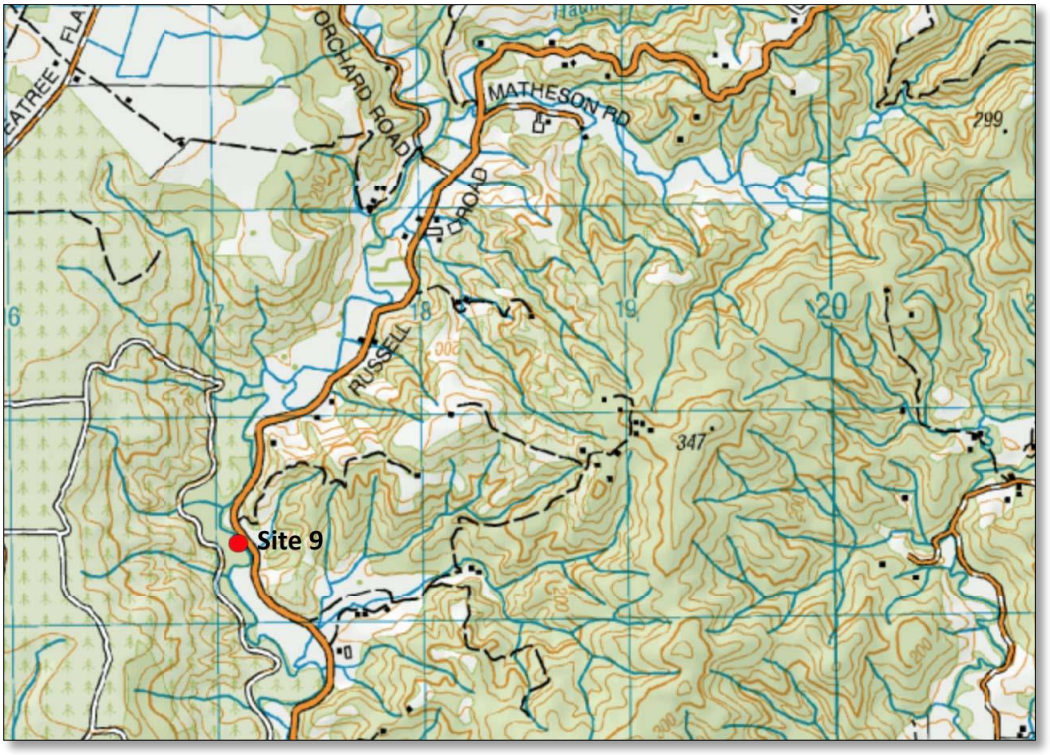
The macroinvertebrate survey at this site used the soft-bottomed sampling protocol.

Macroinvertebrate survey results			**Site 8**
27/02/2017		**MCI-sb invertebrate taxon score**	**Waikariki Stream**
Order	**Genus**		
Ephemeroptera (mayflies)	*Mauiulus*	4.1	R
	Zephlebia	8.8	A
Coleoptera (beetles)	Elmidae	7.2	C
Diptera (flies)	*Austrosimulium*	3.9	A
	Orthocladiinae	3.2	C
	Polypedilum	8	C
	Tanytarsus	not available	R
Trichoptera (caddis flies)	*Hudsonema*	6.5	R
	Hydrobiosis	6.7	R
	Oxyethira	1.2	C
	Paroxyethira	3.7	R
	Pycnocentria	6.8	VA
	Pycnocentrodes	3.8	C
	Triplectides	5.7	A
Crustacea (crustaceans)	Amphipoda	5.5	VA
Mollusca (snails, limpets, bivalves)	*Potamopyrgus*	2.1	VVA
Oligochaeta (worms)		3.8	C
	Total number of invertebrate taxa		**17**
	MCI		**101**
	SQMCI		**3.53**

The number of taxa is at a moderate level with 17 different taxa. There are a range of pollution sensitive and tolerant species present. The sample is dominated by the freshwater snail *Potamopyrgus,* but there is also a range of mayfly, caddisfly and true fly larvae present. The MCI and SQMCI scores for the sample are 101 and 3.53 respectively. The MCI score indicates good water quality - possible mild pollution or environmental perturbation. The SQMCI indicates poor water quality. No fish were recorded in the sample.

Site name	Site No.	NZTM Northing	NZTM Easting	Survey date
Kaimamaku Stream	9	6071395	1717069	1/3/2017

Site location:



Site photo:

Physical habitat:

The Kaimamaku Stream is an upper floodplain site, which is one of the main tributaries to the Whakapara River. It flows through the farmed valley that Russell Road winds through, and its catchment is largely higher, steep ground that is in forestry or native bush.

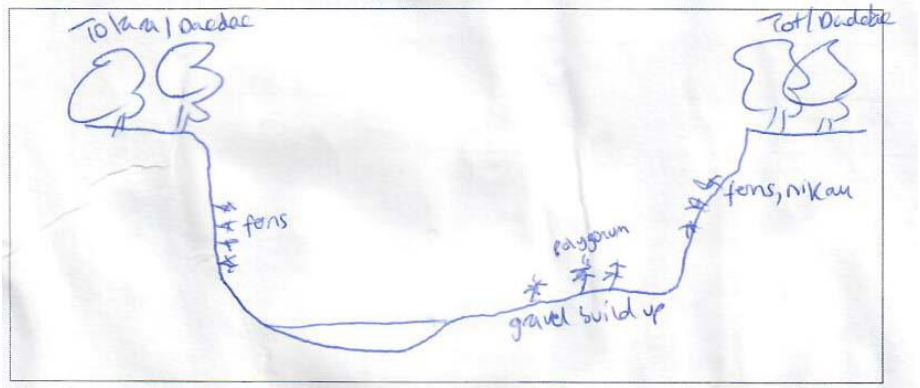
Site 9 has a natural channel with a natural meander pattern. It is deep set down from the floodplain with steep banks. The channel width ranges from 4 to 7 metres wide and is a combination of runs, riffles and pools. Flow levels were low at the time of survey. The flow rate was moderately fast. The banks are steep but mostly stable and covered in ferns. They are around 3.5 metres tall up to the floodplain. There are gravel terraces that form lower banks at about 0.5 metres. The riparian vegetation is totara and kahikatea forest. The bank vegetation provides good shade to the river.

The surrounding land use is beef grazing land. There is no evidence of stock having access to the stream.

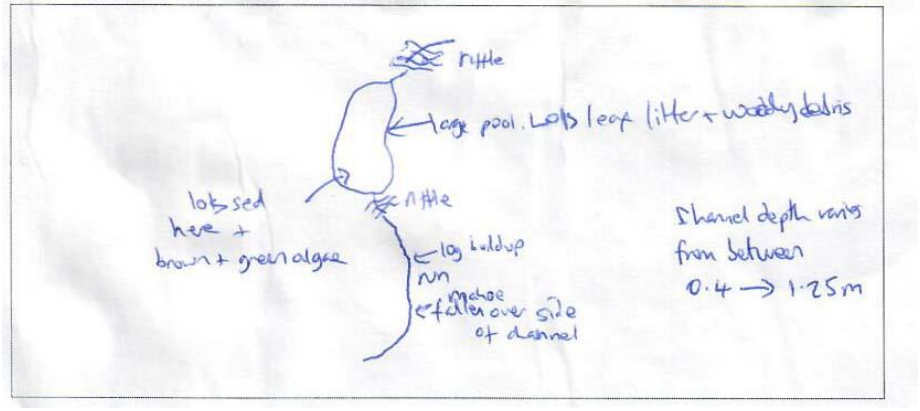
Aquatic plants were present at the site but not common (between 2 and 20% cover across the channel. The main species present is *Nitella* sp., which creates submerged beds in the channel. The occasional pocket of emergent *Isolepis prolifera,* willow weed and starwort was also recorded. Periphyton was recorded on some of the gravel and cobble substrate. It was recorded as either a thin (<0.5mm) or medium (0.5-3mm) mat of brown and green algae covering around a third of the substrate surface where sampled.

The stream is hard-bottomed and dominated by gravel with silt, sand and cobble. There were several large and small pieces of woody debris instream and also some leaf litter and areas of moss on the substrate. Sediment cover was light with only slight sediment cover over the instream substrate (between 1 and 20%) for most of the site. There were a couple of places in the survey area (mainly in a large pool) where sediment cover was greater (60 to 70%). Several Crans bullies were recorded at this site with the bathyscope.

Cross section diagram of site (*include shape of floodplain, riparian vegetation, and channel shape*)



Plan diagram of site (*include significant land marks, access points, N direction, direction of stream flow, location of roads, rough scale*)



Freshwater fish survey:

Fish recorded at the site during the freshwater fish baseline survey are shown below.

Common name	Species name	Number recorded
Crans bully	*Gobiomorphus basalis*	37
Shortfin eel	*Anguilla australis*	0
Introduced fish		
Rainbow trout	*Oncorhynchus mykiss*	1

Fish survey results are recorded on the NIWA Freshwater fish database. They are recorded on NIWA card no. 110306.

There is a healthy population of Crans bully recorded here and they were conspicuous during the sediment cover sampling using the bathyscope. No eels were recorded here. There is good habitat at this site.

Macroinvertebrate survey:

The macroinvertebrate survey at this site used the hard-bottomed sampling protocol.

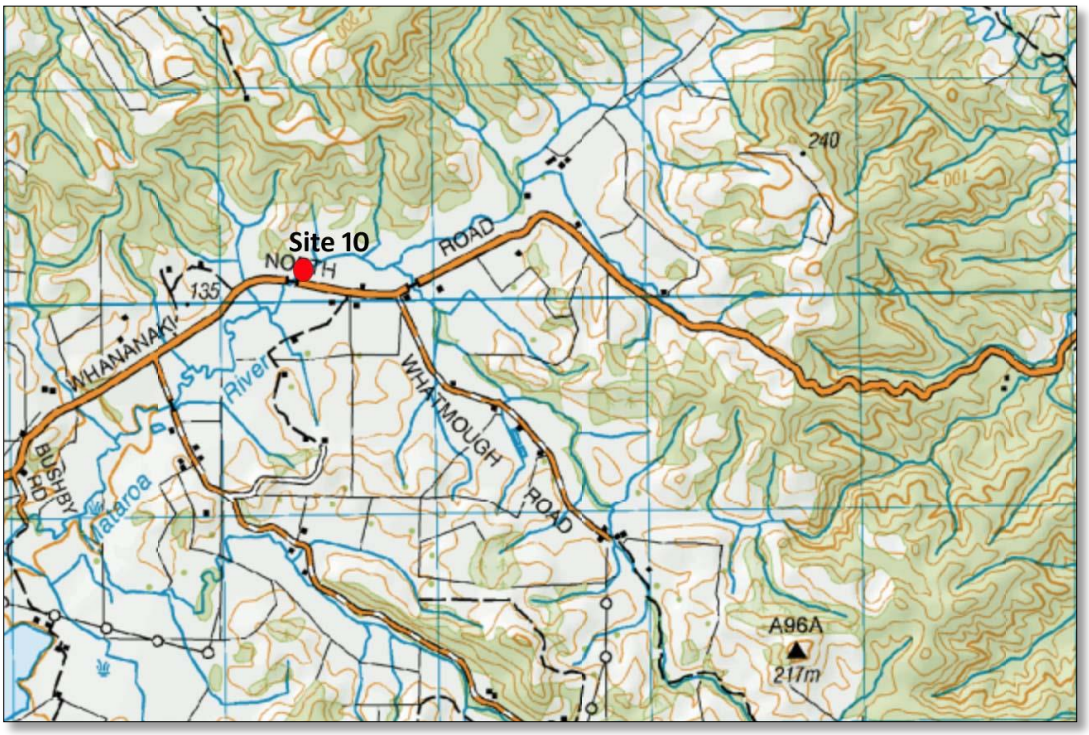
Macroinvertebrate sample results			**Site 9**
1/03/2017		**MCI-hb invertebrate taxon score**	**Kaimamaku Stream**
Order	**Genus**		
Ephemeroptera (mayflies)	*Ameletopsis*	10	R
	Coloburiscus	9	A
	Deleatidium	8	A
	Mauiulus	5	A
	Zephlebia	7	A
Megaloptera (dobsonflies)	*Archichauliodes*	7	A
Odonata (dragonflies/damselflies)	Anisoptera	5	R
	Zygoptera	5	R
Coleoptera (beetles)	Elmidae	6	VA
	Hydraenidae	8	C
Diptera (flies)	*Aphrophila*	5	R
	Austrosimulium	3	C
	Orthocladiinae	2	R
	Tanypodinae	5	R
	Tanytarsus	3	C
Trichoptera (caddis flies)	*Hydropsyche (Aoteapsyche)*	4	A
	Hudsonema	6	C
	Hydrobiosis	5	R
	Neurochorema	6	R
	Oxyethira	2	A
	Paroxyethira	2	C
	Pycnocentria	7	A
	Pycnocentrodes	5	A
	Triplectides	5	C
Mollusca (snails, limpets, bivalves)	*Physa*	3	R
	Potamopyrgus	4	A
Acarina (mites)		5	R
Nematoda (roundworms)		3	R
Platyhelminthes (flatworms)		3	C
Collembola (springtails)		6	R
Total number of invertebrate taxa			**30**
MCI			**103**
SQMCI			**5.68**

The number of taxa is high with 30 different taxa recorded. There is a good range of sensitive and tolerant taxa indicating a healthy community. The MCI and SQMCI scores for the sample are 103 and 5.68 respectively. This indicates good water quality with only possible mild pollution.

Fish in macroinvertebrate sample	**Site 9 – Kaimamaku stream**
Gobiomorphus	**Present (1)**

Site name	Site No.	NZTM Northing	NZTM Easting	Survey date
Mataroa River	10	6069908	1723370	1/03/2017

Site location:



Site photo:

Physical habitat:

This site is in the upper Hikurangi catchment floodplain. The Mataroa River feeds into Kaiikanui River and then into Whakapara River once down on the floodplain. The Mataroa River lies in a farmed valley, but its catchment is mainly steep hills covered in native bush. Site 10 is directly upstream of where it crosses under the Whananaki North road bridge.

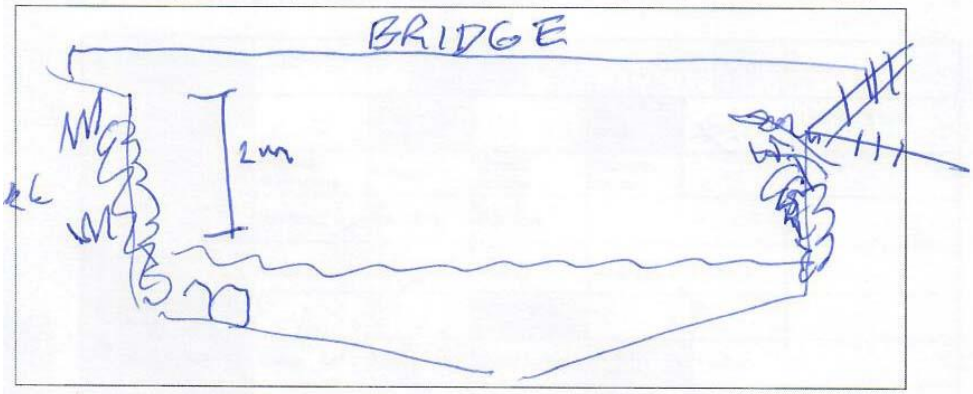
Site 10 is a deep, straight, cut drain. The channel is approximately 2.5 metres wide and is one long run. Flow levels were low at the time of survey. The flow rate was very slow. The banks are very steep but generally stable. The banks are approximately 2 metres tall. Bank cover comprises grass with weeds such as tradescantia, watsonia, Japanese honeysuckle, water pepper and blackberry. This vegetation will provide a little overhanging shade to the stream but no useful organic input. The steepness and depth of the drain also provides some shade, i.e. via the banks.

The immediate surrounding land use is dairy grazing land. Beyond this is bush clad hills. There is no evidence of stock damage. The drain is too steep for stock access and is fenced.

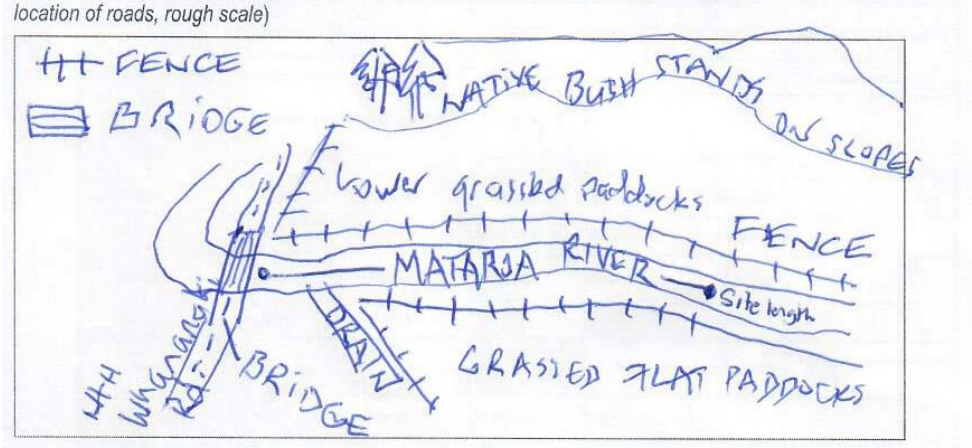
Aquatic plants were common in the channel and much of the survey area had almost complete channel cover from *Nitella* sp. and red pondweed. Water pepper dominated in the survey area at its upstream end. The water clarity was moderate but there was a layer (approx. 10cm thick) of loose sediments over the substrate which meant clarity was quickly lost on disturbance. Long, green filamentous algae was common growing on the stems of the instream vegetation.

The stream is soft-bottomed and dominated by hard-packed clay. There were some areas where gravel and sand had accumulated. There was no instream woody debris, leaves or moss in or on the substrate.

Cross section diagram of site (*include shape of floodplain, riparian vegetation, and channel shape*)



Plan diagram of site (*include significant land marks, access points, N direction, direction of stream flow, location of roads, rough scale*)



Freshwater fish survey:

Fish recorded at the site during the freshwater fish baseline survey are shown below.

Common name	Species name	Number recorded
Non-threatened indigenous species		
Crans bully	*Gobiomorphus basalis*	39
Shortfin eel	*Anguilla australis*	2
Introduced fish		
Mosquito fish	*Gambusia affinis*	Recorded in side drain only

Results were sent to the Freshwater fish database. They are recorded on NIWA card no. 110307.

Over sixty freshwater crabs were recorded in the traps from this site also.

Macroinvertebrate survey:

The macroinvertebrate survey at this site used the soft-bottomed sampling protocol.

Macroinvertebrate survey results			**Site 10**
1/03/2017		**MCI-sb invertebrate taxon score**	**Mataroa River**
Order	**Genus**		
Ephemeroptera (mayflies)	*Mauiulus*	4.1	R
	Zephlebia	8.8	A
Odonata (dragonflies/damselflies)	*Austrolestes*	0.7	R
	Xanthocnemis	1.2	R
	Zygoptera	0.4	A
Hemiptera (water bugs)	*Sigara*	2.4	C
Coleoptera (beetles)	Elmidae	7.2	R
Diptera (flies)	*Austrosimulium*	3.9	C
	Orthocladiinae	3.2	VA
	Polypedilum	8	C
	Tanypodinae	6.5	R
	Tanytarsus	not available	R
Trichoptera (caddis flies)	*Oxyethira*	1.2	VA
	Paroxyethira	3.7	R
	Triplectides	5.7	A
Crustacea (crustaceans)	*Amarinus*	not available	R
	Copepoda	2.4	R
Mollusca (snails, limpets, bivalves)	*Gundlachia*	2.4	C
	Physa	0.1	C
	Potamopyrgus	2.1	VVA
Acarina (mites)		5.2	R
Oligochaeta (worms)		3.8	R

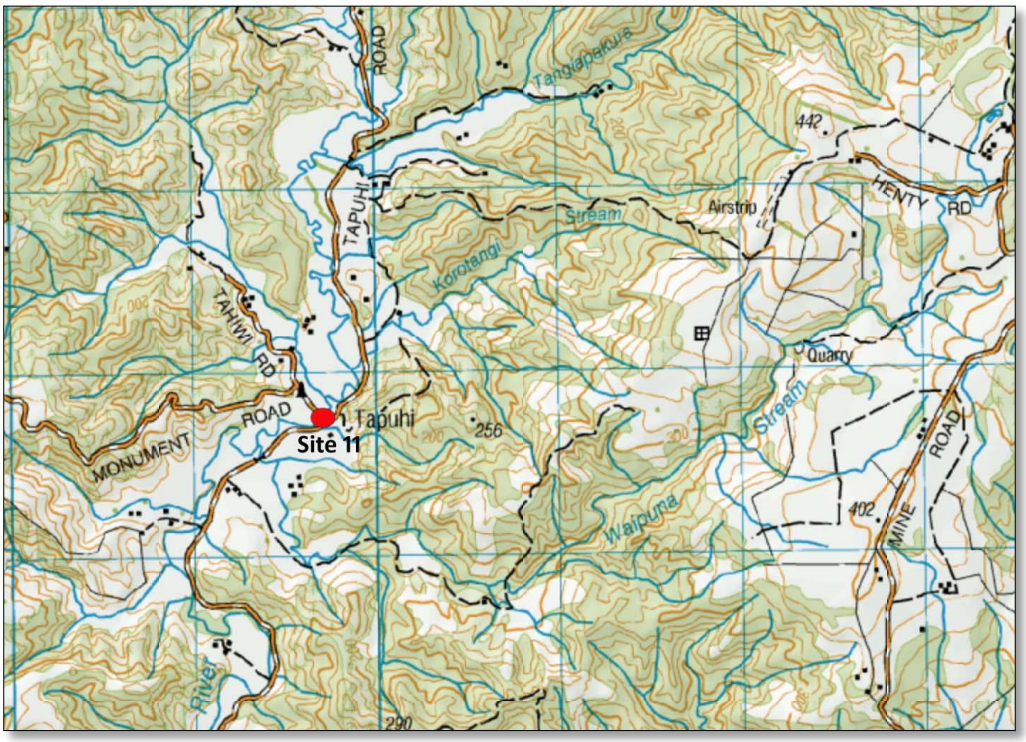
Collembola (springtails)		5.3	C
	Total number of invertebrate taxa		**23**
	MCI		**75**
	SQMCI		**2.41**

The number of taxa is at a moderate high level with 23 different taxa recorded. The sample is dominated by pollution tolerant taxa including freshwater snails, purse caddisfly (*Oxyethira*) and midge larvae (Orthocladiinae). The MCI and SQMCI scores for the sample are 75 and 2.41 respectively. This indicates poor water quality - probable severe pollution.

Fish in macroinvertebrate sample	**Site 10 – Mataroa River**
Gambusia	present (2)
Gobiomorphus	present (4)

Site name	Site No.	NZTM Northing	NZTM Easting	Survey date
Waiotu River at Tapuhi	11	6074637	1709568	23/02/2017

Site location:



Site photo:

Physical habitat:

This site is in the upper Hikurangi catchment floodplain. The Waiotu River has a large catchment that originates to the north in Russell Forest. At the sampling point at Tapuhi, the river has travelled through native bush, some open farmland and also plantation forestry. Site 11 is taken from both upstream and downstream of the road bridge at Tapuhi.

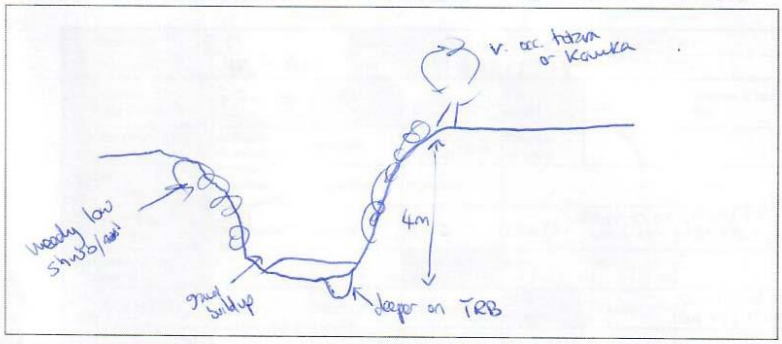
Site 11 is along a straight section of the river. It is a natural channel. The channel is approximately 3.5 to 6 metres wide and is one long run with a short riffle where it passes under the road bridge. Flow levels were low at the time of survey. The flow rate was moderate. The banks are very steep but generally stable. They are approximately 3 to 4 metres tall. Bank cover comprises grass with weeds such as tradescantia, watsonia, bindweed and blackberry. There is the occasional totara, walnut and kanuka on the banks. Overhanging grasses and the road bridge provide the only effective shade in the sampled stream reach.

The immediate surrounding land use is beef grazing land. Beyond this are bush clad hills. Stock have some, restricted access to the river 50 metres upstream of the site, at a fenced off drinking point. There is no evidence of stock access or damage to the river banks or bed in the surveyed reach.

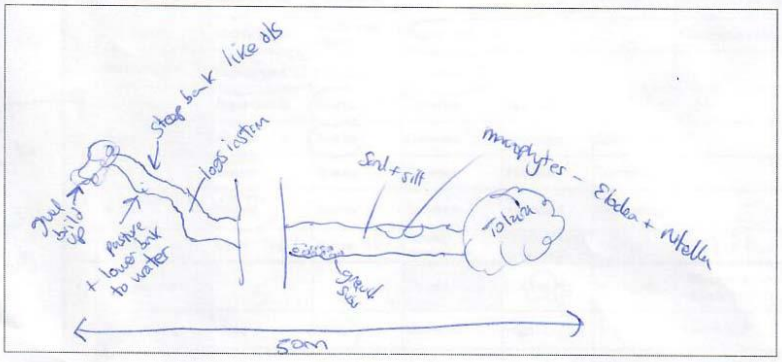
Aquatic plants were uncommon and mostly only comprised 10% cover across the channel. The main species present were small beds of *Nitella* sp. or Canadian pondweed (*Elodea canadensis*). Swamp willow weed was present in small stands at the edges of the river. Periphyton was recorded on some of the gravel and cobble substrate. It was recorded as either a thin mat (<0.5mm) of brown algae covering around a fifth of the substrate surface where sampled, or short and long green and brown filamentous algae covering up to 70% of the substrate surface.

The stream is hard-bottomed and dominated by gravel with silt, sand and cobble. There were some large and small pieces of woody debris instream. There was no leaf litter or areas of moss. Sediment cover was light along the true right bank (around 10 to 20%), but with heavier build ups along the left bank.

Cross section diagram of site *(include shape of floodplain, riparian vegetation, and channel shape)*



Plan diagram of site *(include significant land marks, access points, N direction, direction of stream flow, location of roads, rough scale)*



Broken shells of freshwater mussels were recorded in places and an eel (unidentified) and koura were observed using the bathyscope.

Freshwater fish survey:

Fish recorded at the site during the freshwater fish baseline survey are shown below.

Common name	Species name	Number recorded
Threatened /At risk indigenous species		
Longfin eel	*Anguilla dieffenbachii*	1
Non-threatened indigenous species		
Crans bully	*Gobiomorphus basalis*	78
Shortfin eel	*Anguilla australis*	1
Introduced fish		
Rainbow trout	*Oncorhynchus mykiss*	2

Results were sent to the Freshwater fish database. They are recorded on NIWA card no. 110308.

A large population of Crans bully are present at this site. There is some good habitat here for this species.

Macroinvertebrate survey:

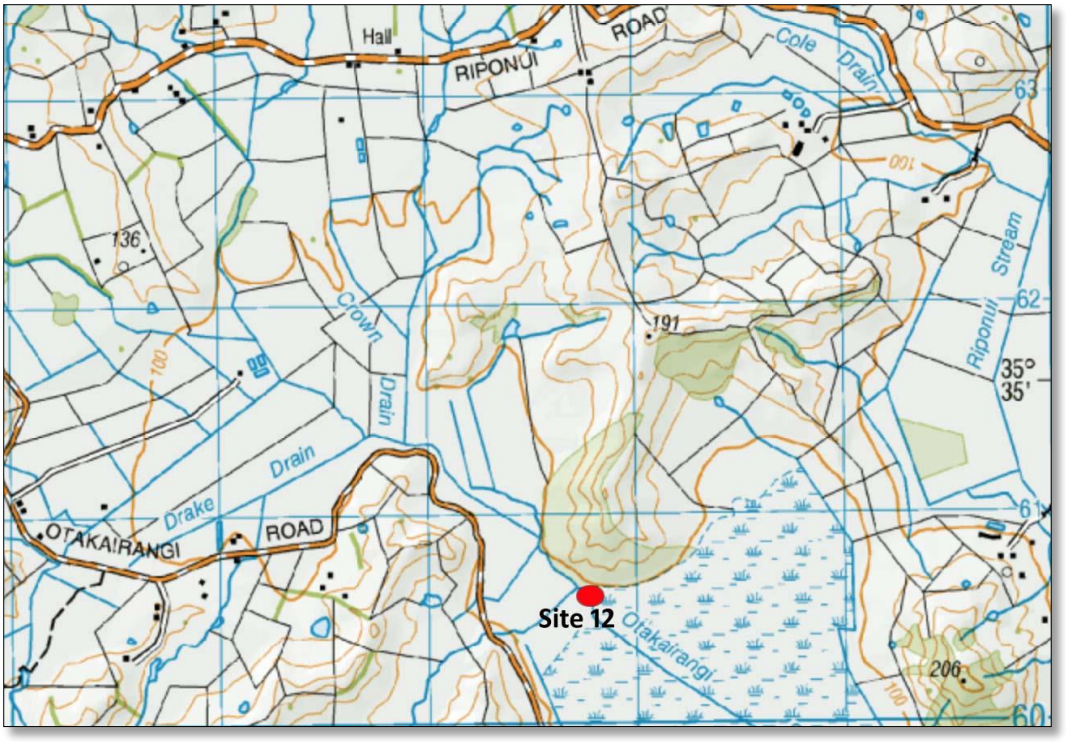
The macroinvertebrate survey at this site used the hard-bottomed sampling protocol.

Macroinvertebrate survey results			**Site 11**
23/02/2017		**MCI-hb invertebrate taxon score**	**Waiotu River**
Order	**Genus**		
Ephemeroptera (mayflies)	*Deleatidium*	8	C
	Zephlebia	7	A
Megaloptera (dobsonflies)	*Archichauliodes*	7	A
Odonata (dragonflies/damselflies)	Anisoptera	5	R
	Antipodochlora	6	R
	Xanthocnemis	5	A
	Zygoptera	5	A
Hemiptera (water bugs)	*Sigara*	5	R
Coleoptera (beetles)	Elmidae	6	A
	Hydraenidae	8	R
Diptera (flies)	*Austrosimulium*	3	C
	Eriopterini	9	R
	Orthocladiinae	2	C
	Tanypodinae	5	C
	Tanytarsus	3	C
Trichoptera (caddis flies)	*Hydropsyche (Aoteapsyche)*	4	C
	Hydrobiosis	5	R
	Neurochorema	6	R
	Olinga	9	R
	Oxyethira	2	C
	Paroxyethira	2	R
	Polyplectropus	8	R
	Pycnocentria	7	A
	Pycnocentrodes	5	R
	Triplectides	5	VA
Crustacea (crustaceans)	Ostracoda	3	C
Mollusca (snails, limpets, bivalves)	*Physa*	3	C
	Potamopyrgus	4	VVA
	Sphaeriidae	3	R
Collembola (springtails)		6	R
Total number of invertebrate taxa			**30**
MCI			**104**
SQMCI			**4.48**

The number of taxa is high with 30 different taxa. The MCI and SQMCI scores also reflect this with scores of 104 and 4.48 respectively and indicate between good and fair water quality.

Site name	Site No.	NZTM Northing	NZTM Easting	Survey date
Otakairangi Stream – Wetland inflow	12	6060740	1705579	24/02/2017

Site location:



Site photo:

Physical habitat:

This site is in the upper Hikurangi catchement floodplain on Otakairangi Stream. The stream has a catchment in the low hills around the north western end of the floodplain and then flows through a network of drains in dairy land.

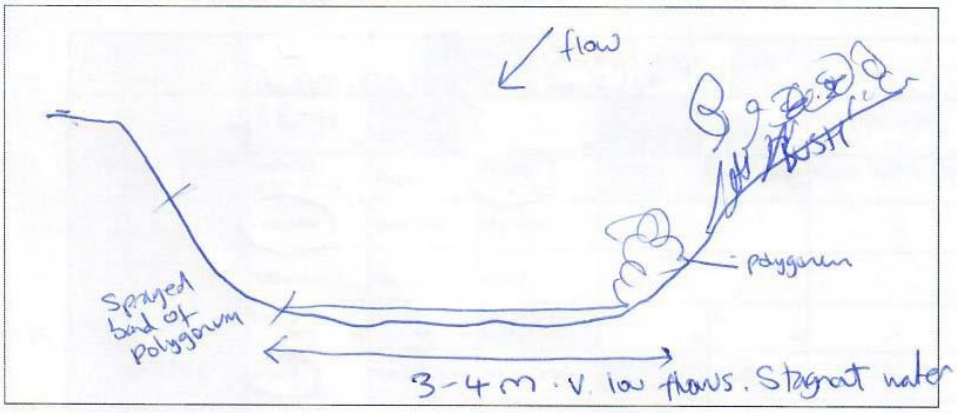
Site 12 is a wide, uniform channel with a single long bend in it. The channel varies from 3 to 6 metres wide and is one long run. Flows levels were very low at the time of survey and the flow rate was negligible. The banks are wide and have a moderate slope. They are approximately 3 metres tall. The riparian vegetation is mainly rank grass or herbaceous weeds. There is native bush at 10 to 15 metres from the channel on the true left bank. The bank vegetation does not offer any effective overhead shade to the waterway.

The surrounding land use is dairy grazing land. There is no evidence of stock having access to the stream.

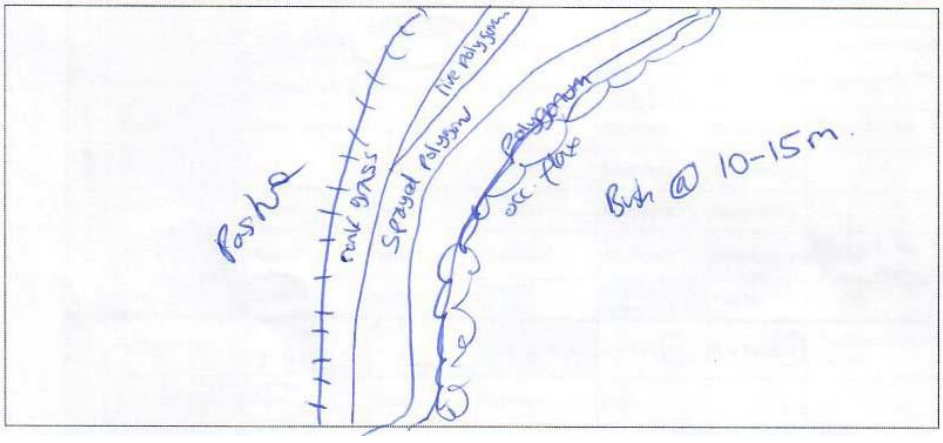
Aquatic plants were a dominant feature of this site with thick beds of *Egeria densa* covering most of the channel. Water pepper was also common at the stream edges. Duckweed was recorded at low levels. The aquatic vegetation had been recently sprayed. This dead and decaying biomass, coupled with the low water levels at the time of survey, had led to very poor water quality with extreme levels of anaerobic sediment, low water clarity, high anaerobic odour, surface scums and oily sheens. Long and short filamentous green algae was growing abundantly throughout the site on the plant stems. Thin mats of algae were also recorded growing over dead plant matter.

The stream is soft-bottomed and dominated by clay and mud. There was a thick layer (30+ cm) of anaerobic sediment settled over the clay base. There was no instream woody debris, moss or fallen leaves recorded.

Cross section diagram of site (*include shape of floodplain, riparian vegetation, and channel shape*)



Plan diagram of site (*include significant land marks, access points, N direction, direction of stream flow, location of roads, rough scale*)



Freshwater fish survey:

Fish recorded at the site during the freshwater fish baseline survey are shown below.

Common name	Species name	Number recorded
Non-threatened indigenous species		
Shortfin eel	*Anguilla australis*	3
Introduced fish		
Catfish	*Ameiurus nebulosus*	1
Goldfish	*Carassius auratus*	2
Mosquito fish	*Gambusia affinis*	Abundant

Results were sent to the Freshwater fish database. They are recorded on NIWA card no. 110309

Two freshwater crabs were also recorded at the traps at this site. The habitat conditions and water quality are very poor at this site under summer time low flows. The limited fish fauna recorded here may be a reflection of this.

Macroinvertebrate survey:

The macroinvertebrate survey at this site used the soft-bottomed sampling protocol.

Macroinvertebrate survey results			**Site 12**
24/02/2017		**MCI-sb invertebrate taxon score**	**Otakairangi Stream**
Odonata (dragonflies/damselflies)	*Hemicordulia*	0.4	R
Diptera (flies)	*Tanytarsus*	not available	R
Trichoptera (caddisflies)	*Oxyethira*	1.2	R
Mollusca (snails, limpets, bivalves)	*Physa*	0.1	R
Hirudinea (leeches)		1.2	A
Nematoda (roundworms)		3.1	R
Oligochaeta (worms)		3.8	VVA
Platyhelminthes (flatworms)		0.9	R
Total number of invertebrate taxa			**8**
MCI			**31**
SQMCI			**3.67**

The number of taxa is at a low level with 8 different taxa recorded. All species present are pollution tolerant and the sample is dominated by a super abundance of worms. The MCI and SQMCI scores for the sample are 31 and 3.67. This indicates poor water quality – probable severe pollution.

Fish in macroinvertebrate sample	**Site 12 – Otakairangi Stream**
Gambusia	**present (~25)**

Site name	Site No.	NZTM Northing	NZTM Easting	Survey date
Te Waiongatahuna Stream	13	6062867	1719735	1/03/2017

Site location:

Site photo:

Physical habitat:

This site is in the upper Hikurangi Catchment. Te Waiongatahuna Stream is fed by Kirikiritoki Stream which drains the hilly bush and farmland around Marua. Te Waiongatahuna Stream is a tributary to Whakapara River.

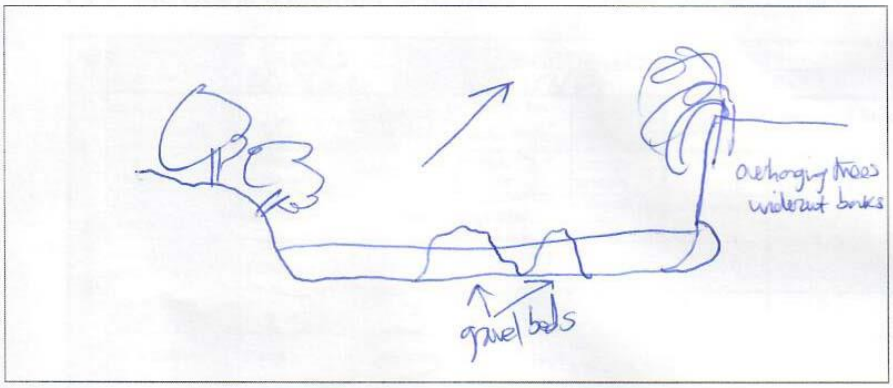
Site 13 is a long, straight section of the stream. It is a natural channel. The channel is approximately 10 metres wide. It is one long run with some large pool areas and short riffles. Flow levels were low at the time of survey. The flow rate was moderate. The banks have a moderate slope but are generally stable. The banks are approximately 2.5 to 3 metres tall. Bank cover comprises grass with trees such as totara and kanuka. Overhanging grasses and the bankside trees provide some shade and inorganic input to the stream.

The immediate surrounding land use is beef grazing land. Beyond this are bush clad hills. There is some evidence of stock in the stream with minor damage at the crossing.

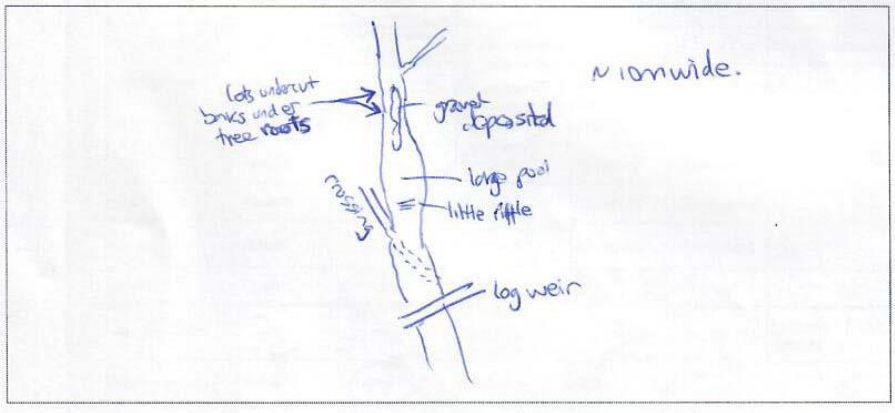
Aquatic plants were present and varied in coverage across the survey area. The main species were beds of *Egeria densa* with pockets of *Nitella* sp. The occasional area of water forget-me not, starwort and *Elatine gratioloides.* Swamp willow weed was present in small stands at the edges of the river. Alligator weed was also recorded. Periphyton was recorded on the sampled gravel and cobble substrate. It was recorded as either a thin mat (0.5 -3mm) of light brown algae with variable coverage over the cobble surface or a thick green mat over the surface. The latter (green algae) was conspicuous at this site.

The stream is hard-bottomed and dominated by gravel with silt, sand and cobble. There were some large and small pieces of woody debris instream along with leaf litter and pockets of moss along the banks. Undercut banks provide habitat too. Sediment cover was common. There was a moderate layer of sediment on many of the instream sample areas observed by the bathyscope.

Cross section diagram of site (*include shape of floodplain, riparian vegetation, and channel shape*)



Plan diagram of site (*include significant land marks, access points, N direction, direction of stream flow, location of roads, rough scale*)



Freshwater fish survey:

Fish recorded at the site during the freshwater fish baseline survey are shown below.

Common name	Species name	Number recorded
Non-threatened indigenous species		
Crans bully	*Gobiomorphus basalis*	83
Shortfin eel	***Anguilla australis***	1

Results were sent to the Freshwater fish database. They are recorded on NIWA card no. 110310.

A large population of Crans bully are present at this site. There is some good habitat here for this species.

Macroinvertebrate survey:

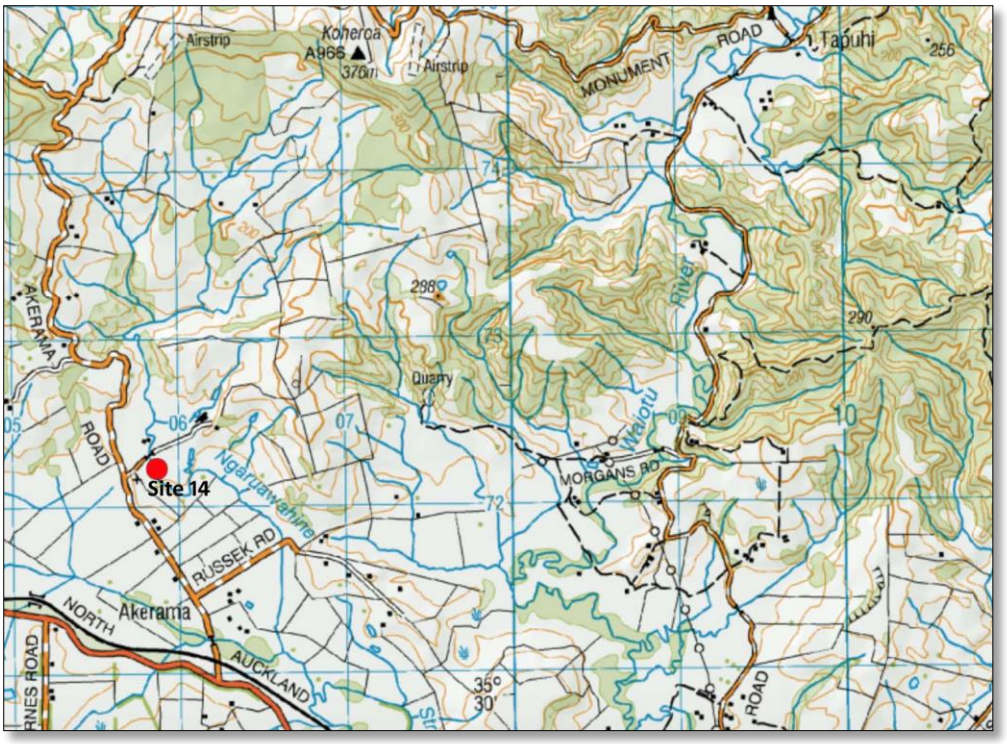
The macroinvertebrate survey at this site used the hard-bottomed sampling protocol.

Macroinvertebrate survey results			**Site 13**
1/03/2017		**MCI-hb invertebrate taxon score**	**Te Waiongatahuna Stream**
Order	**Genus**		
Ephemeroptera (mayflies)	*Austronella*	7	C
	Deleatidium	8	R
	Mauiulus	5	C
	Zephlebia	7	A
Megaloptera (dobsonflies)	*Archichauliodes*	7	A
Odonata (dragonflies/damselflies)	Anisoptera	5	R
	Zygoptera	5	R
Coleoptera (beetles)	Elmidae	6	A
Diptera (flies)	Orthocladiinae	2	A
	Tanypodinae	5	R
	Tanytarsus	3	C
Trichoptera (caddis flies)	*Hydropsyche (Aoteapsyche)*	4	R
	Hudsonema	6	C
	Hydrobiosis	5	R
	Oecetis	6	R
	Oxyethira	2	A
	Paroxyethira	2	C
	Pycnocentria	7	A
	Pycnocentrodes	5	VA
	Triplectides	5	A
Crustacea (crustaceans)	Ostracoda	3	R
Mollusca (snails, limpets, bivalves)	*Gundlachia*	3	C
	Latia	3	C
	Physa	3	R
	Potamopyrgus	4	VA
Acarina (mites)		5	R
Hirudinea (leeches)		3	C
Nemertea (proboscis worms)		3	A
Oligochaeta (worms)		1	C
Platyhelminthes (flatworms)		3	C
Total number of invertebrate taxa			**30**
MCI			**89**
SQMCI			**4.55**

The number of taxa is high with 30 different taxa recorded in this sample. There is a good range of species present but some indicators of organic enrichment, e.g. freshwater snails are very abundant. The MCI and SQMCI scores for the sample also reflect this with scores of 89 and 4.55 respectively. These scores both indicate fair water quality – probable moderate pollution. There were no fish caught in this macroinvertebrate sample.

Site name	Site No.	NZTM Northing	NZTM Easting	Survey date
Ngaruawahine Stream	14	6072258	1705796	23/02/2017

Site location:



Site photo:

Physical habitat:

This site is in the upper Hikurangi Catchment. Ngaruawahine Stream drains the hilly bush and farmland in a catchment to the east of Akerama Road. It is a tributary, ultimately to the Waiotu River and confluences with it at Waiotu.

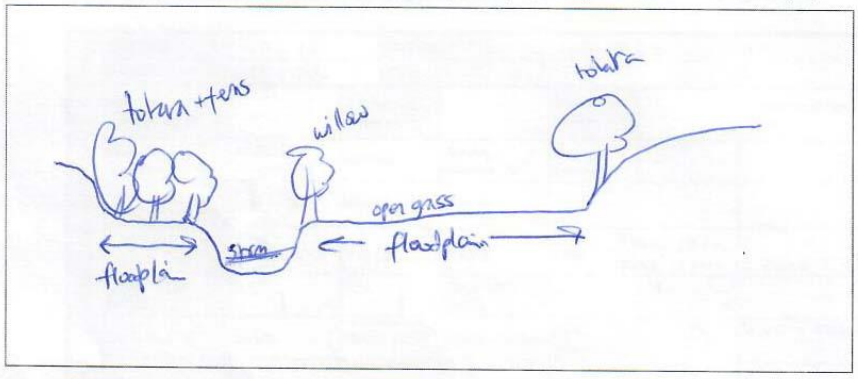
Site 14 is a weakly sinuous section of this stream starting just downstream of the road bridge by the marae. It is a natural channel. The channel width varies from between 1.5 metres and 4 metres wide. It is as series of run, riffles and pools in the surveyed section. Flow levels were low at the time of survey. The flow rate was moderate. The banks have a moderate slope but are generally stable. The lower banks are approximately 1 metre tall to the floodplain and the upper bank 2.5 to 3 metres tall. Bank cover comprises grass with trees such as willow, Chinese privet, totara and kanuka. Overhanging grasses and the bankside trees provide some good shade and inorganic input to the stream. Tradescantia, scotch thistle and blackberry are all present in the ground and shrub layer.

The immediate surrounding land use is beef grazing land. There is some evidence of stock in the stream.

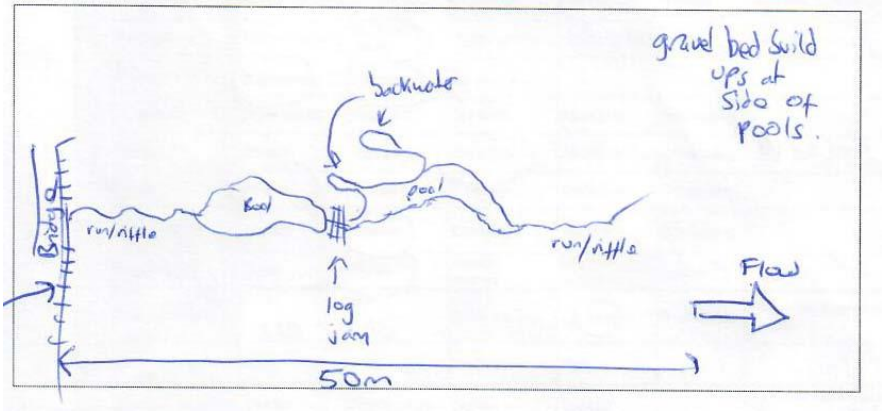
Aquatic plants were present but not common. There were some beds of *Nitella* sp. and the occasional pocket of water pepper. Periphyton was recorded on the sampled gravel and cobble substrate. It was recorded mainly as a thin mat (<0.5 mm) of light brown algae over a quarter to half of the cobble surface or there was the occasional area where long green and brown algae were recorded.

The stream is generally soft-bottomed but there were also accumulated gravel beds and some cobble. There were some large and small pieces of woody debris instream along with some leaf litter. No moss was recorded. Undercut banks provide habitat too. Sediment cover was common. There was a light layer of sediment on many of the instream pool areas but the riffles and faster runs has low sediment cover.

Cross section diagram of site (*include shape of floodplain, riparian vegetation, and channel shape*)



Plan diagram of site (*include significant land marks, access points, N direction, direction of stream flow, location of roads, rough scale*)



Freshwater fish survey:

Fish recorded at the site during the freshwater fish baseline survey are shown below.

Common name	Species name	Number recorded
Non-threatened indigenous species		
Crans bully	*Gobiomorphus basalis*	26
Shortfin eel	*Anguilla australis*	3

Results were sent to the Freshwater fish database. They are recorded on NIWA card no. 110311.

Only native species were recorded at this site. There is some good habitat here. Freshwater mussels were also recorded in the fish survey process. They are historically known to be in this stream.

Macroinvertebrate survey:

The macroinvertebrate survey at this site used the soft-bottomed sampling protocol.

Macroinvertebrate survey results			**Site 14**
23/02/2017		**MCI-sb invertebrate taxon score**	**Ngaruawahine Stream**
Order	**Genus**		
Ephemeroptera (mayflies)	*Deleatidium*	5.6	A
	Mauiulus	4.1	R
	Zephlebia	8.8	VA
Megaloptera (dobsonflies)	*Archichauliodes*	7.3	R
Odonata (dragonflies/damselflies)	Anisoptera	6	R
	Hemicordulia	0.4	R
	Zygoptera	0.4	R
Coleoptera (beetles)	Elmidae	7.2	A
	Hydraenidae	6.7	R
	Hydrophilidae	8	R
Diptera (flies)	*Austrosimulium*	3.9	A
	Corynoneura	1.7	C
	Muscidae	1.6	R
	Orthocladiinae	3.2	C
	Paradixa	8.5	C
	Polypedilum	8	C
	Tanypodinae	6.5	C
	Tanytarsus	not available	A
Trichoptera (caddis flies)	*Hudsonema*	6.5	C
	Hydrobiosis	6.7	R
	Oxyethira	1.2	A
	Plectrocnemia	6.6	R
	Triplectides	5.7	A
	Zelandoptila	7	R

Crustacea (crustaceans)	Cladocera	0.7	A
	Copepoda	2.4	C
	Ostracoda	1.9	A
Mollusca (snails, limpets, bivalves)	*Physa*	0.1	A
	Potamopyrgus	2.1	VA
Acarina (mites)		5.2	R
Hirudinea (leeches)		1.2	R
Nematoda (roundworms)		3.1	R
Oligochaeta (worms)		3.8	A
Platyhelminthes (flatworms)		0.9	R
Collembola (springtails)		5.3	R
Coelenterata	*Hydra*	1.6	C
Total number of invertebrate taxa			**36**
MCI			**86**
SQMCI			**4.29**

The number of taxa is high with 36 different taxa. There is a broad range of pollution tolerant and sensitive taxa in the sample. The MCI and SQMCI scores for the sample are 86 and 4.29 respectively. These scores both indicate fair water quality – probable moderate pollution.

Site name	Site No.	NZTM Northing	NZTM Easting	Survey date
Waiariki River headwater	15	6057877	1722134	27/02/2017

Site location:

Site photo:

Physical habitat:

This site is a headwater reference site for the Waiariki River. This tributary stream is named Pukekaikiore Stream and has a steep catchment in a mix of forestry vegetation and native bush.

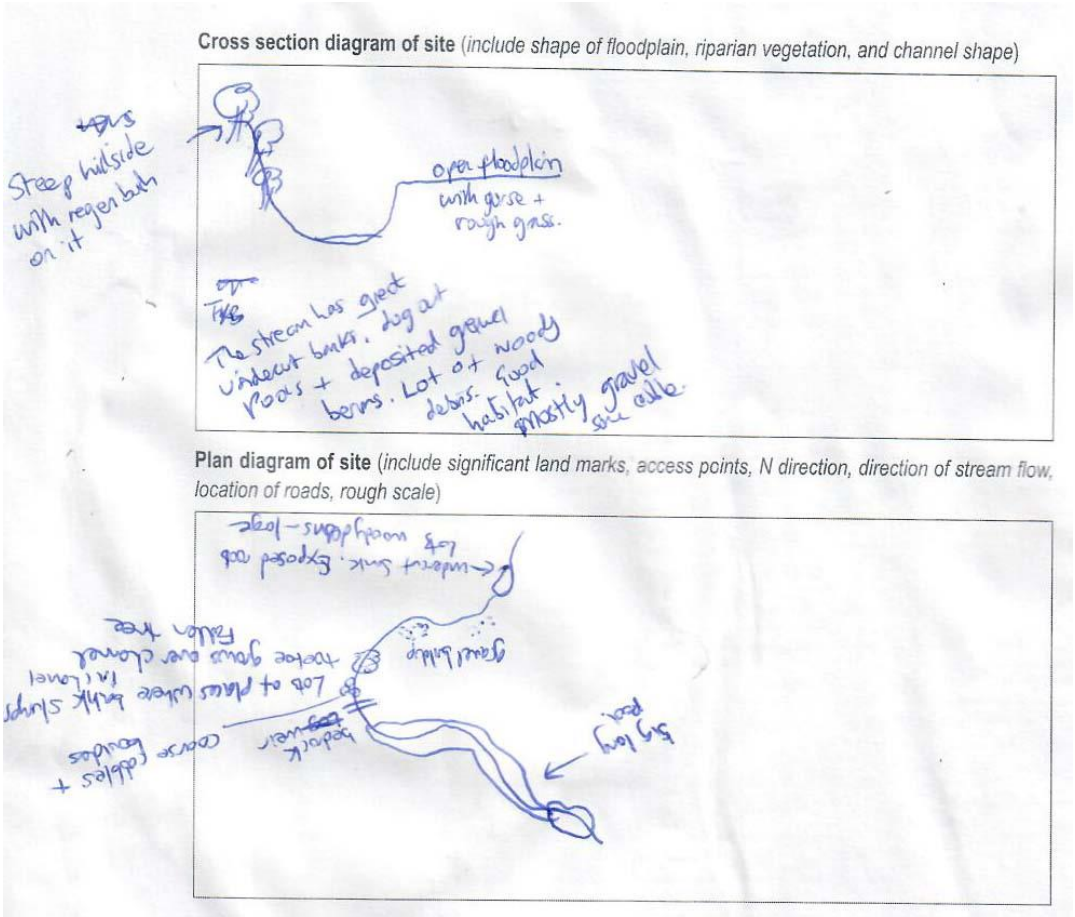
Site 15 is a meandering section of the stream. It has a wetted channel width of between 3 to 4 metres wide. The surveyed section encompasses a series of runs, riffles and pools. Flow levels were low at the time of survey. The flow rate was moderate. The banks are 2.5 metres tall and unstable. There were multiple areas of slumping and undercutting in the surveyed section. Bank cover comprises rank grass with sprayed gorse on the true left bank and regenerating native forest on the true right bank. Regenerating native bankside trees provide a little overhead shade, but most effective shade comes from overhanging grasses and ferns.

The immediate surrounding land use is beef grazing land and some forestry. There is no obvious evidence of stock in the stream but the stream is unfenced at the survey site.

There were no aquatic plants recorded in the survey area. Periphyton was recorded on the sampled gravel and cobble substrate. It was recorded mainly as a thin mat (<0.5 mm) of light brown algae over around a fifth of the cobble surface.

The stream is hard-bottomed comprising silt, sand, gravel and cobble. There were some large and small pieces of woody debris instream along with some leaf litter and moss. Undercut banks provide habitat too. Sediment cover was common. There was a light to moderate layer of sediment on the substrate in many of the instream pool areas but the riffles and faster runs had low sediment cover.

During the physical habitat survey a rat, bell frog, koura and shrimp were recorded. No freshwater mussels were recorded.



Freshwater fish survey:

Fish recorded at the site during the freshwater fish baseline survey are shown below.

Common name	Species name	Number recorded
Non-threatened indigenous species		
Crans bully	*Gobiomorphus basalis*	2

Results were sent to the Freshwater fish database. They are recorded on NIWA card no. 110313.

Only Crans bully were recorded here and these were in low numbers in the sample. 27 Koura were also recorded.

Macroinvertebrate survey:

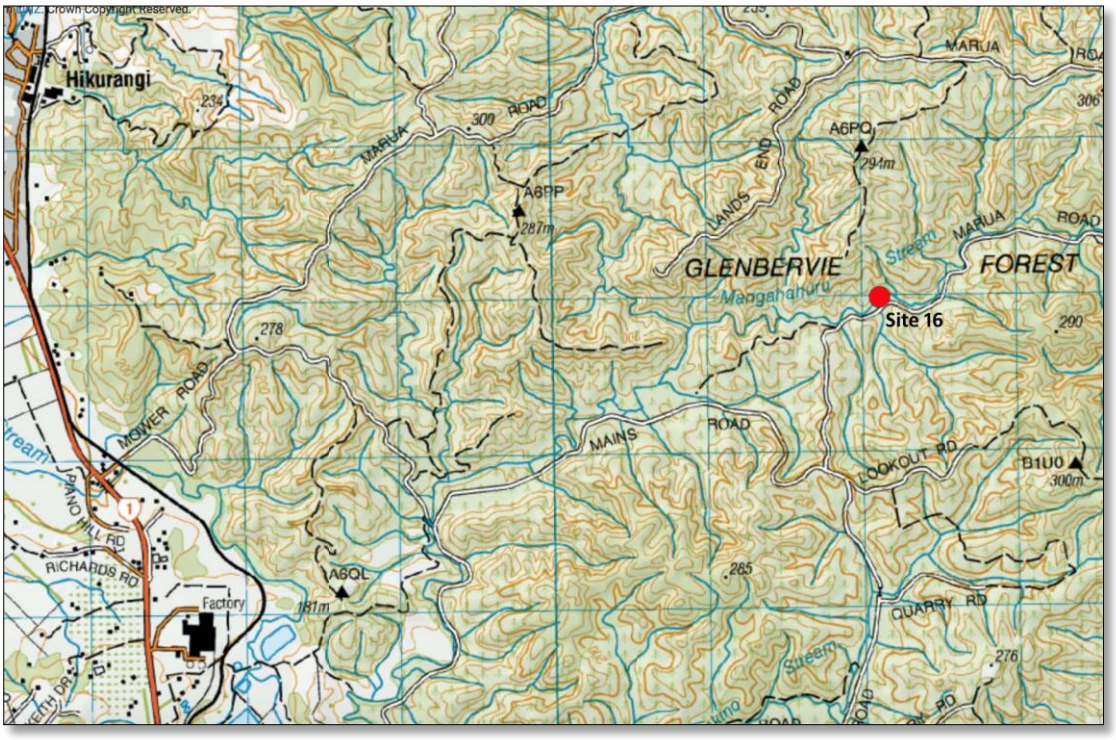
The macroinvertebrate survey at this site used the hard-bottomed sampling protocol.

Macroinvertebrate survey results			**Site 15**
2/03/2017		**MCI-hb invertebrate taxon score**	**Mangahahuru Stream headwater**
Order	**Genus**		
Ephemeroptera (mayflies)	*Coloburiscus*	9	A
	Deleatidium	8	R
	Mauiulus	5	R
	Nesameletus	9	R
	Oniscigaster	10	R
	Zephlebia	7	A
Megaloptera (dobsonflies)	*Archichauliodes*	7	R
Odonata (dragonflies/damselflies)	*Antipodochlora*	6	C
Coleoptera (beetle larvae)	Hydrophilidae	5	R
Diptera (flies)	Orthocladiinae	2	C
	Polypedilum	3	A
	Psychodidae	1	R
	Tanytarsus	3	C
Trichoptera (caddis flies)	*Hydropsyche (Aoteapsyche)*	4	R
	Hudsonema	6	C
	Neurochorema	6	R
	Oeconesidae	9	R
	Olinga	9	C
	Triplectides	5	A
Mollusca (snails, limpets, bivalves)	*Gundlachia*	3	R
	Potamopyrgus	4	A
Oligochaeta (worms)		1	R
Total number of invertebrate taxa			**23**
MCI			**109**
SQMCI			**5.51**

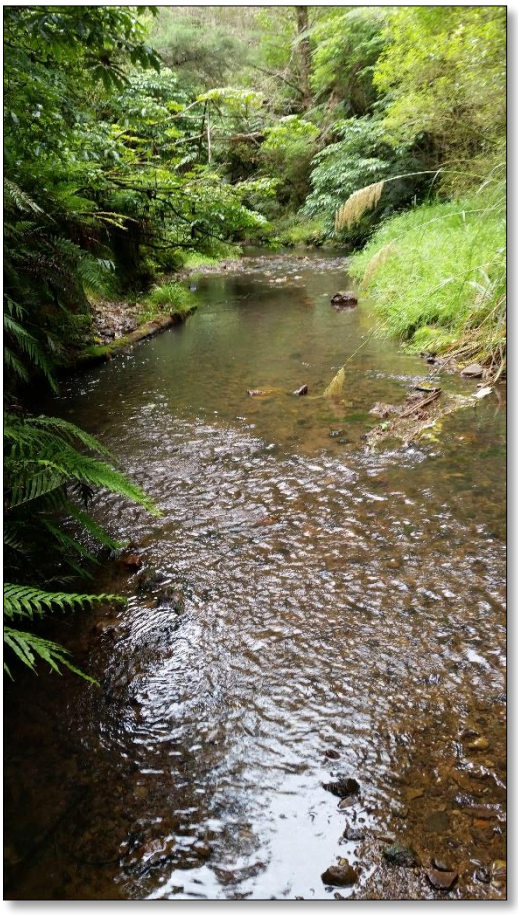
The number of taxa is at a moderate high level with 23 different taxa. This is a diverse macroinvertebrate community with some highly sensitive fauna present. The MCI and SQMCI scores for the sample reflects this with scores of 109 and 5.51 respectively. These scores both indicate good water quality – possible mild pollution. There were no freshwater fish in the macroinvertebrate sample.

Site name	Site No.	NZTM Northing	NZTM Easting	Survey date
Mangahahuru Stream headwater	16	6074588	1715226	02/03/2017

Site location:



Site photo:



Physical habitat:

This site is a headwater reference site for the Mangahahuru River. It is taken in the centre of the Glenbervie forest. The stream here has a steep catchment that is entirely in exotic forestry.

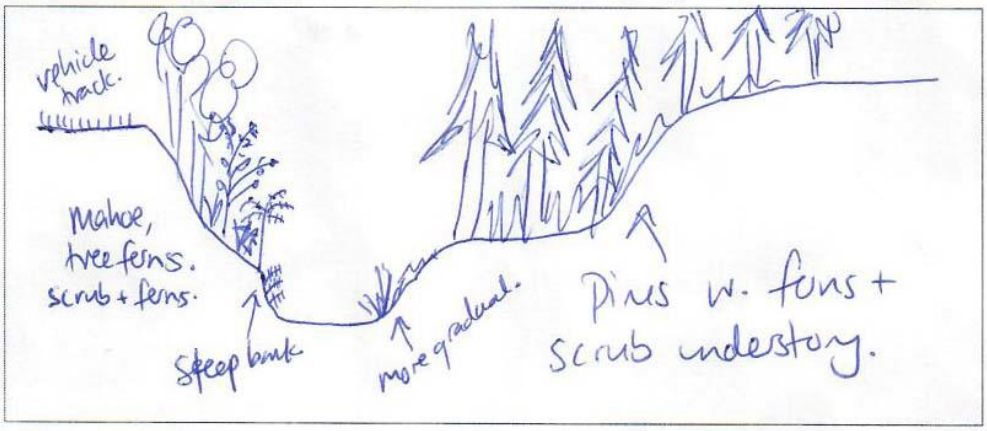
Site 16 is on a weakly meandering section of the stream. It has a wetted channel width of between 4 to 5 metres wide. The surveyed section encompasses a run, riffle and pools. Flow levels were low at the time of survey. The flow rate was moderate. The banks are 1 to 2.5 metres tall and mostly stable. Bank cover comprises rank grass with regenerating mahoe, tree ferns and scrub on the true left bank and pines with a fern and scrub understorey on the true right bank. There is some pampas. Bank side vegetation is good and overhanging trees are providing lots of overhead shade and input of woody debris and leaves.

There is no stock in the stream but the stream in unfenced at the survey site.

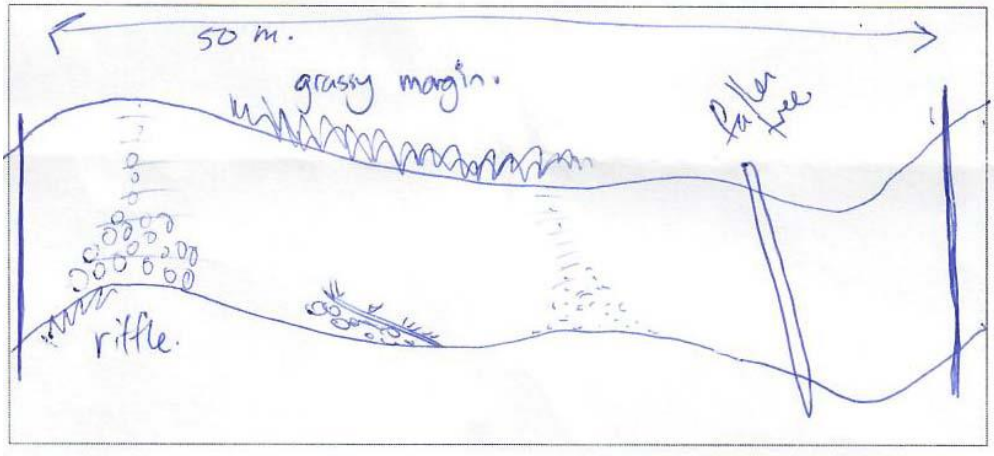
There were no aquatic plants recorded in the survey area. Periphyton was recorded on the sampled gravel and cobble substrate. It was recorded mainly as a thin mat (<0.5 mm) of light brown algae over around half the substrate surface. There is the occasional area of long green filamentous algae and areas of submerged bryophytes.

The stream is hard-bottomed comprising mainly cobble but also silt, sand and gravel. Large and small pieces of woody debris and leaf litter were common instream. Moss was recorded instream also. Undercut banks provide habitat too. Sediment cover was generally light but there were some pockets in Transect 4 and 5 that had more significant cover.

Cross section diagram of site (*include shape of floodplain, riparian vegetation, and channel shape*)



Plan diagram of site (*include significant land marks, access points, N direction, direction of stream flow, location of roads, rough scale*)



Freshwater fish survey:

Fish recorded at the site during the freshwater fish baseline survey are shown below.

Common name	Species name	Number recorded
Non-threatened indigenous species		
Crans bully	*Gobiomorphus basalis*	2

Results were sent to the Freshwater fish database. They are recorded on NIWA card no. 110313.

Only Crans bully were recorded here and low numbers in the sample. 27 Koura were also recorded.

Macroinvertebrate survey:

The macroinvertebrate survey at this site used the soft-bottomed sampling protocol.

Macroinvertebrate survey results			**Site 16**
27/02/2017			**Waiariki headwater**
Order	**Genus**		
Ephemeroptera (mayflies)	*Ameletopsis*	10	R
	Deleatidium	8	A
	Neozephlebia	7	R
	Nesameletus	9	A
	Zephlebia	7	A
Plecoptera (stoneflies)	*Zelandobius*	5	R
Megaloptera (dobsonflies)	*Archichauliodes*	7	A
Odonata (dragonflies/damselflies)	Anisoptera	5	R
	Zygoptera	5	C
Hemiptera (water bugs)	*Anisops*	5	C
Coleoptera (beetles)	Dytiscidae	5	R
	Scirtidae	8	R
Diptera (flies)	*Austrosimulium*	3	C
	Chironomus	1	R
	Culex	3	R
	Empididae	3	R
	Orthocladiinae	2	A
	Paradixa	4	C
	Polypedilum	3	R
	Tanypodinae	5	R
	Tanytarsus	3	A
Trichoptera (caddis flies)	*Hudsonema*	6	R
	Hydrobiosis	5	R
	Oxyethira	2	A
	Polyplectropus	8	R
	Psilochorema	8	R
	Pycnocentria	7	R
	Zelandoptila	8	R

Crustacea (crustaceans)	Amphipoda	5	R
	Cladocera	5	C
Acarina (mites)		5	R
Oligochaeta (worms)		1	A
Total number of invertebrate taxa			**32**
MCI			**105**
SQMCI			**4.89**

The number of taxa is high with 32 different taxa present. This is a diverse macroinvertebrate community with some reasonable sized populations of sensitive fauna. The MCI and SQMCI scores for the sample reflects this with scores of 105 and 4.89 respectively. The MCI score indicates good water quality, the SQMCI score indicates fair water quality. There were no freshwater fish in the macroinvertebrate sample.

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6.0 APPENDIX 1

Field sheets

P1 - Site characterization field sheet

Site	Site code		Site name			GPS	N -		
	Assessor		Date				E -		
Channel & Bank	Wetted channel width	m	Vegetated bank width	m	Site length	m	* Channel & bank notes		
	Channel shape	Artificially channelised	Straight	Weakly sinuous	Strongly sinuous				
	Flow conditions	Low flow	Base flow	High flow					
	Flow types present	Riffle/rapid ☐	Run ☐	Pool ☐	Other ☐				
	Lower bank height	L – m	R – m	Upper bank height	L – m	R – m			
	Bank stability	Stable	Mostly stable	Highly unstable	Bank undercut	Yes/No			
	Bank cover	Soil ☐	Stony ☐	Grass ☐	Tussock ☐	Shrubs ☐	Trees ☐	Artificial ☐	
In-stream	Stream bed substrate	Clay/mud ☐	Silt/sand ☐	Gravel ☐	Cobble ☐	Boulder ☐	Bedrock ☐	Artificial ☐	
	Bed stability	Highly stable	Moderately stable	Highly unstable			* In-stream notes		
	Macrophytes	Submerged ☐	Marginal ☐	Emergent ☐					
	Periphyton	None visible	Sparse	Common	Abundant	Dominating			
	Wood	Absent	Sparse	Common	Abundant	Dominating			
	Moss	Absent	Sparse	Common	Abundant	Dominating			
	Leaves	Absent	Sparse	Common	Abundant	Dominating			
	Shading	Open	Partial	Heavily shaded	Overhanging vegetation	Yes/No			
Riparian & Catchment	Riparian width	L – m	R – m	Stock access	L – Yes/No	R – Yes/No	* Riparian & catchment notes		
	Stock damage	None	Minor	Moderate	High				
	Problem plants	Yes/No	Photo taken – Yes/No		Type(s)				
	Riparian cover	Soil ☐	Rock/ gravel ☐	Grass ☐	Tussock ☐	Wetland plants ☐			
		Ferns ☐	Shrubs ☐	Native trees ☐	Deciduous exotic ☐	Conifers ☐	Other ☐		
	Adjacent land use	Conservation/ reserve ☐	Short grazed ☐	Long ungrazed ☐	Production forest ☐	Dairy cattle ☐	Beef cattle ☐	Sheep ☐	
		Crop ☐	Horticulture ☐	Deer ☐	Horse ☐	Urban ☐	Road ☐	Other ☐	
	Catchment land use	Native forest ☐	Plantation forest ☐	Farming ☐	Urban ☐	Industry ☐	Mining ☐	Other ☐	

P1 - Site characterization field sheet (continued)

Cross section diagram of site (*include shape of floodplain, riparian vegetation, and channel shape*)

Plan diagram of site (*include significant land marks, access points, N direction, direction of stream flow, location of roads, rough scale*)

Additional notes:

Stream:_____ **Located number:**_____ **Sample Number:**_____

Date:_____

Transect	Wetted width (m)	Channel width (m)	Thalweg depth (m)	Vegetation cover (% wetted area)							
				Total cover	Submerged plants					Emergent plants	
					Total submerged	Surface-reaching		Below surface		Total emergent	Species
						Sub-total	Species	Sub-total	Species		
1											
2											
3											
4											
5											

		SUBMERGED SPECIES		EMERGENT SPECIES		EMERGENT SPECIES
	Cd	*Ceratophyllum demersum* - HORNWORT	As	*Agrostis stolonifera* – CREEPING BENT	Me	*Mentha spp.* – WILD MINT
Native	Ec	*Elodea canadensis* - CANADIAN PONDWEED	An	*Apium nodiflorum* - WATER CELERY	Mep	*Mentha pulegium* – PENNYROYAL
Introduced	Ed	*Egeria densa*	Apa	*Alisma plantago-aquatica* – WATER PLANTAIN	Mpc	*Mentha x piperita var. citrata* - BERGAMOT MINT
	St	*Callitriche stagnalis* - STARWORT	Ap	*Alternanthera philoxeroides* – ALLIGATOR WEED	Ml	*Myosotis laxa – WATER FORGET-ME-NOT*
	Lm	*Lagarosiphon major*	Eg	*Erythranthe guttata* - MONKEY MUSK	Ma	*Myriophyllum aquaticum* - PARROTS FEATHER
	Mp	*Myriophyllum propinquum*	Gd	*Glyceria declinata* – FLOATINGSWEET GRASS	Na	*Nasturtium officinale/microphyllum* - WATERCRESS
	Mt	*Myriophyllum triphyllum*	Gm	*Glyceria maxima* - REED SWEET GRASS	Gr	Other grass spp
	Nh	*Nitella hookeri/cristata*	Ip	*Iris pseudacorus* – YELLOW FLAG	Pd	*Paspalum distichum* – MERCER GRASS
	Pc	*Potamogeton cheesemanii* – RED PONDWEED	Ipr	*Isolepis prolifera* – JUMPING RUSH	Ps	*Persicaria decipiens* - SWAMP WILLOW WEED
	Pk	*Potamogeton crispus* - CURLED PONDWEED	Ja	*Juncus articulatus* – JOINTED RUSH	Ph	*Persicaria hydropiper* - WATER PEPPER
	Po	*Potamogeton ochreatus* -BLUNT PONDWEED	Lop	*Lotus pedunculatus* - LOTUS	Rf	*Ranunculus flamula* – LESSER SPEARWORT
	PoS	*Potamogeton subolongus* – MUD PONDWEED	Lp	*Ludwigia palustris* - WATER PURSLANE	Ve	*Veronica anagallis-aquatica/Americana* - WATER SPEEDWELL
	Rt	*Ranunculus tricophyllus* – WATER BUTTERCUP	Lup	*Ludwigia peploides* – PIMROSE WILLOW	Uid	Unidentified Other species
	Uid	Unidentified Other species	Le	*Lycopus europaeus* - GYPSYWORT		

Datasheet for macrophyte rapid assessment

Datasheet for periphyton rapid assessment

Bryophytes and iron bacterial growths are recorded here for convenience (NA = not applicable)

Stream:_____ **Located number:**_____

Sample Number:_____ **Date:**_____

		Transect					
Thickness category	**Colour category**	**A**	**B**	**C**	**D**	**E**	**Mean cover**
Thin mat/film (<0.5 mm thick)	NA						
Medium mat (0.5-3 mm thick)	Green						
	Light brown						
	Black/dark brown						
Thick mat (>3 mm thick)	Green/light brown						
	Black/dark brown						
Short filaments (≤2 mm long)	NA						
Long filaments (>2 cm long)	Green						
	Brown/reddish						
Submerged bryophytes	NA						
Iron bacteria growths	NA						

Method 2 – Instream visual assessment of % sediment cover

% Sediment	Transect 1		Transect 2		Transect 3		Transect 4		Transect 5	
Location 1	**Q1**	Q2	**Q1**	Q2	**Q1**	Q2	**Q1**	Q2	**Q1**	Q2
	Q3	Q4	Q3	Q4	Q3	Q4	Q3	Q4	Q3	Q4
Location 2	**Q1**	Q2	**Q1**	Q2	**Q1**	Q2	**Q1**	Q2	**Q1**	Q2
	Q3	Q4	Q3	Q4	Q3	Q4	Q3	Q4	Q3	Q4
Location 3	**Q1**	Q2	**Q1**	Q2	**Q1**	Q2	**Q1**	Q2	**Q1**	Q2
	Q3	Q4	Q3	Q4	Q3	Q4	Q3	Q4	Q3	Q4
Location 4	**Q1**	Q2	**Q1**	Q2	**Q1**	Q2	**Q1**	Q2	**Q1**	Q2
	Q3	Q4	Q3	Q4	Q3	Q4	Q3	Q4	Q3	Q4