

Rivers State of the Environment monitoring programme

Annual data report 2015/16

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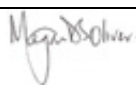

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1. Introduction

This report summarises the key results from the Rivers State of Environment (RSoE) monitoring programme for the period 1 July 2015 to 30 June 2016 inclusive. The RSoE programme incorporates monthly monitoring of water quality, periphyton cover and sediment deposition at 53 river and stream sites across the Wellington Region. Macrophyte cover is also assessed monthly at selected RSoE sites. Annual assessments of invertebrate community composition, periphyton biomass and habitat quality are conducted at a subset of these 53 RSoE sites in summer/autumn.

In addition to the routine monitoring outlined above, this report also briefly summarises the results of two river monitoring trials that were undertaken during 2015/16, these were:

- The collection of monthly periphyton biomass samples at 13 of the existing RSoE sites; and
- An ecologically focused assessment (invertebrate and fish community composition) at a subset of 50 new monitoring sites that have been selected randomly across the region.

Note that the suitability of rivers for contact recreation purposes is reported separately under Greater Wellington Regional Council's (GWRC) recreational water quality monitoring programme; for the 2015/16 results, see Morar & Greenfield (2016). Information on river and stream flows is reported under GWRC's hydrological monitoring programme (see Harkness 2016).

2. Overview of RSoE monitoring programme

River and stream water quality has been routinely monitored in the western part of the Wellington Region since 1987 and in the Wairarapa since 1991. The monitoring programme has continued to evolve since this time with changes made to the location and number of monitoring sites, the range of variables monitored, and the methods of analysis (see Milne and Perrie (2005) and Perrie et al. (2012) for details). However, since September 2003, the RSoE monitoring programme has remained largely unchanged, with only minor changes to the existing suite of monitoring sites and variables.

2.1 Monitoring objectives

The aims of GWRC's Rivers SoE monitoring programme are to:

1. Assist in the detection of spatial and temporal changes in rivers and streams;
2. Contribute to our understanding of freshwater biodiversity in the Wellington Region;
3. Determine the suitability of rivers and streams for designated uses;
4. Provide information to assist in targeted investigations where remediation or mitigation of poor water quality or ecosystem health is desired; and
5. Provide information required to determine the effectiveness of regional plans and policies.

2.2 Monitoring network

Water quality and ecosystem health are currently monitored at up to 53 river and stream sites (Figure 2.1, Appendix 1). These sites were chosen to represent the major land uses and human activities, and also the natural diversity of rivers and streams, in the Wellington Region.

2.2.1 Changes to the monitoring network

No major changes were made to the RSoE monitoring network during 2015/16. However, the Pauatahanui Stream at Elmwood Bridge (RS14) site was moved approximately 0.2 km upstream. This was because safe access was no longer possible at the existing site due to the Transmission Gully roading project. Movement of this site is not expected to have any major influence on the water quality data record but the instream habitat of the new site is significantly different. This change in habitat, from hard-bottomed to soft-bottomed, will likely impact on macroinvertebrate and periphyton monitoring results and this will limit the comparisons that can be undertaken with historical data.

2.3 Monitoring variables

An overview of the physico-chemical, biological and habitat variables that are monitored across the network of 53 RSoE sites is provided in Table 2.1. Further information is outlined in Sections 2.3.1 to 2.3.4 and details of field and analytical methods are provided in Appendix 2. Not all variables are assessed at all sites due to site characteristics (eg, sites with soft-bottomed substrates are not assessed for periphyton as periphyton is unlikely to grow on

this substrate type). In regards to assessments of the macroinvertebrate community and periphyton biomass, the number of sites where samples were collected is reduced when compared to previous years. Macroinvertebrate communities were sampled at 37 sites compared with the typical 53 and periphyton biomass samples were collected from 17 sites compared with 44 previously. These changes reflect a shift in the monitoring needs of GWRC and allowed resources to be put towards the two monitoring trials that were undertaken during 2015/16 (see Sections 2.4 and 7 for further details on these monitoring trials).

Table 2.1: Overview of physico-chemical, biological and habitat variables that are monitored across the RSoE sites (maximum sites assessed = 53)

Physico-chemical variables	No. of RSoE sites
Monthly water quality sampling – core variables*	53
Monthly analysis of dissolved copper and zinc (total copper & zinc)	10 (6)
Monthly analysis of TSS** and SSC**	15
Biological variables/assessments	No. of RSoE sites
Monthly periphyton cover	44
Annual periphyton biomass	17
Monthly periphyton biomass***	13
Monthly macrophyte cover	16
Annual macroinvertebrate	37
Habitat quality variables/assessments	No. of RSoE sites
Monthly fine sediment cover	53
Annual rapid habitat assessment	37

*Core water quality variables include dissolved oxygen, temperature, pH, conductivity, visual clarity, turbidity, faecal indicator bacteria, total organic carbon, and dissolved and total nutrients.

**TSS = Total Suspended Sediment; SSC = Suspended Sediment Concentration.

***Monthly periphyton biomass (chlorophyll a) assessments were undertaken as part of a monitoring trial undertaken during 2015/16 (refer to Sections 2.4 and 7.1).

2.3.1 Water quality variables

River and stream water quality is assessed at monthly intervals by measuring a range of physico-chemical and microbiological variables: dissolved oxygen, temperature, pH, conductivity, visual clarity, turbidity, faecal indicator bacteria, total organic carbon, and dissolved and total nutrients. Water samples from ten RSoE sites located in urban catchments with likely exposure to heavy metal inputs, or which discharge into sensitive downstream receiving environments (eg, harbours and estuaries), are also analysed for concentrations of copper and zinc. The full list of variables monitored, together with details of field and analytical methods, is provided in Appendix 2.

2.3.2 Biological variables

Rivers and streams are also assessed for ecosystem health. This involves semi-quantitative assessments of macroinvertebrate communities and periphyton biomass during stable/low flows in summer/autumn. Assessments of periphyton are only undertaken at sites with hard substrates such as cobbles and large gravel (44 in total, see Appendix 1 for RSoE site substrate types). Periphyton cover is assessed monthly at these sites at the time of water sample collection. As noted in Section 2.2.1, in 2015/16 assessments of macroinvertebrate communities and periphyton biomass were not undertaken at all of the 53 and 44 RSoE sites (respectively) where these have previously occurred.

Macrophyte cover is assessed at RSoE sites that are soft-bottomed and hence more likely to support macrophyte communities. Macrophyte cover is also assessed at hard-bottomed sites known to have, at least at times, high macrophyte cover.

Details of current biological monitoring methods are summarised in Appendix 2.

2.3.3 Habitat variables

Habitat assessments are undertaken annually coinciding with macroinvertebrate sample collection, during 2015/16 this occurred at 37 of the 53 RSoE sites (during summer/early autumn). This assessment provides an indication of the condition of the physical habitat and its ability to support stream biota, and incorporates the following variables: deposited sediment cover, invertebrate habitat abundance and diversity, fish habitat abundance and diversity, hydraulic heterogeneity, bank stability, channel modification, and riparian buffer width, integrity and shade. Fine sediment cover is also assessed monthly at the time of water sample collection at all 53 sites. Details of current habitat assessment methods are summarised in Appendix 2.

2.3.4 Changes to monitoring variables in 2015/16

In 2015/16, the following changes to the variables monitored were made:

- Analysis of total suspended solids (TSS) ceased at all but 15 sites. At these sites, analysis of suspended sediment concentration (SSC) was added to allow for site-specific relationships between TSS and SSC to be explored. Measures of sediment concentration were retained at these 15 sites as they discharge into sensitive downstream environments or are sites with known sediment-related issues.
- Total recoverable copper, total recoverable zinc, dissolved organic carbon, dissolved calcium, dissolved magnesium and hardness tests were added to six of the ten sites where dissolved copper and dissolved zinc are also analysed.
- Analysis of Ash Free Dry Matter (AFDM) ceased being analysed in periphyton samples collected annually and the habitat where periphyton is assessed was changed from riffles to runs. These changes were made to better align the periphyton biomass sampling with methodology with that

necessary for future reporting requirements (See Section 7 and Greenfield (2016) for further details).

- The habitat assessment method was updated to follow the most recently released protocols presented in Clapcott (2015) (cf. the previously used protocols in Clapcott 2013).

2.4 Additional river monitoring trialled during 2015/16

Background on the two river monitoring trials undertaken during 2015/16 is provided below and results are presented in Section 7.

2.4.1 Monthly periphyton biomass sampling

During 2015/16, periphyton biomass (as chlorophyll *a*) was measured monthly at 13 sites as part of a trial to assess monitoring methods for reporting against the National Policy Statement for Freshwater Management (NPS-FM, MfE 2014) periphyton attribute. The main aim of the trial was to assess whether periphyton cover assessments could be used to estimate chlorophyll *a* concentration using conversion factors developed for rivers in the Canterbury Region. The full results of the trial are presented in Greenfield (2016) while measured chlorophyll *a* results between August 2015 and June 2016 are presented in this report (see Section 7).

2.4.2 Ecologically focused assessments at sites selected randomly

While the current RSoE programme provides invaluable information on water quality and some biological measures of ecosystem health (eg, macroinvertebrates) from key rivers across the region, it has been acknowledged that the programme contains some limitations. These include that the existing monitoring site network is not overly representative of rivers and streams in the Wellington Region as the sites are unevenly distributed (across the region) and tend to be located on larger rivers at the bottom of catchments. Furthermore, key measures of ecosystem health, such as assessments of fish communities, are not currently part of the RSoE programme.

Therefore, to help address some of these limitations, in the 2015/16 a new site network of 50 randomly selected sites (ie, using a probabilistic network design approach as described in Collier and Hamer (2012)) located on developed land (indigenous forest cover <90%) was proposed¹. It is planned that the monitoring undertaken at this network of sites would be ecologically focused (cf. water quality). To help assess the resource requirements and develop monitoring and reporting methodology appropriate for this proposed network/programme, seven sites were visited during summer/autumn of 2015/16. Habitat, macroinvertebrate communities and fish communities were assessed at these sites. It's expected that such a network/programme would allow for a more robust assessment of the ecological health of the region's rivers and streams and allow for a better assessment against the ecosystem health objectives in GWRC's Proposed Natural Resource Plan (eg, indigenous

¹Note that the site network is still being developed in the sense that many sites need to be visited and assessed for their suitability (eg, are they permanently flowing), whether they can be accessed safely and, where required, will the landowners allow access.

fish communities are resilient and their structure, composition and diversity are balanced) (GWRC 2015).

The results from the assessments undertaken at these seven sites are presented in this report (see Section 7) and further documentation of this programme as it is developed is expected at a later date.

3. Physico-chemical and microbiological water quality

3.1 Approach to analysis

In this section a water quality index is used as a comparative measure to summarise water quality across the Wellington Region, based on physico-chemical and microbiological data collected monthly from July 2015 to June 2016 inclusive (see Appendix 3 for tabulated data). Concentrations of heavy metals (copper and zinc) recorded at selected urban sites are also summarised (Appendix 4). The summary information is typically based on 12 sampling events for all 53 sites. However, sampling was not always possible in every month at some sites (eg, access issues such as calving, locked gates or safety issues such as high river flows, etc.).

During data processing, any water quality variables reported as less than or greater than detection limits were replaced by values one half of the detection limit or the detection limit, respectively (eg, a value of <2 became 1, a value of >400 became 400). The exception is minimum values reported in the tabulated summaries in Appendices 3 and 4 (ie, if a value was reported as <2 the minimum value presented is <2).

3.1.1 Water quality index

A water quality index (WQI), as described by Perrie (2007) and Perrie et al. (2012), is used to facilitate inter-site comparisons of the state of water quality in the region's rivers and streams. The WQI is derived from the *median* values of the following six variables: visual clarity (black disc), dissolved oxygen (% saturation), dissolved reactive phosphorus, ammoniacal nitrogen, nitrite-nitrate nitrogen and *Escherichia coli* (*E. coli*).

The application of the WQI enables water quality at each site to be classified into one of four categories, as follows:

- Excellent: median values for all 6 variables comply with guideline values
- Good: median values for 5 of the 6 variables comply with guideline values, of which dissolved oxygen is one variable that must comply²
- Fair: median values for 3 or 4 of the 6 variables comply with guideline values, of which dissolved oxygen is one variable that must comply²
- Poor: median values for <3 of the 6 variables comply with guideline values, or the median dissolved oxygen concentration/value does not comply with the guideline value.

The guidelines used in the WQI assessment are listed in Table 3.1. Refer to Perrie (2007) and Perrie et al. (2012) for further discussion on these guidelines.

² If the median dissolved oxygen concentration does not comply with the guideline value, then the WQI grade automatically drops to 'poor'.

Table 3.1: Physico-chemical and microbiological variables and guideline values used in GWRC's WQI

Variable	Guideline value	Reference
Dissolved oxygen (% saturation)	≥80	RMA 1991 Third Schedule
Visual clarity (m)	≥1.6	MfE (1994)
Nitrite-nitrate nitrogen (mg/L)	≤0.444	ANZECC & ARMCANZ (2000)
Ammoniacal nitrogen (mg/L)	≤0.021	ANZECC & ARMCANZ (2000)
Dissolved reactive phosphorus (mg/L)	≤0.010	ANZECC & ARMCANZ (2000)
<i>E. coli</i> (cfu/100mL)	≤100	ANZECC & ARMCANZ (2000)

As outlined in Perrie (2007), the WQI is for comparative purposes rather than an absolute measure of water quality; sites with a grade of 'good', 'fair', or 'poor' are all considered degraded to some degree because the median value of at least one of the six physico-chemical or microbiological variables in the WQI did not comply with a guideline value. In addition, as the WQI is based on median values (ie, 50% compliance), sites awarded the same water quality grade may exhibit varying degrees of compliance (from 51 to 100%) with the guideline value. Therefore, to differentiate between 'better' and 'poorer' sites, the sites within each WQI class are ranked based on the number of times non-compliance with a guideline occurred for each of the six key variables (eg, a site that did not comply with a guideline on 40% of sampling occasions will be ranked lower than a site with the same WQI grade that did not comply with the same guideline on 10% of sampling occasions).

3.1.2 Heavy metals

Heavy metal (copper and zinc) concentrations are compared against ANZECC (2000) chronic toxicity 'trigger values' (95% level of protection). Because water hardness affects the toxicity of some heavy metals, where metal concentrations exceed trigger values, site-specific, hardness-modified trigger values are calculated based on recommendations and calculations in ANZECC (2000). Since the availability of water hardness data varied across the ten sites during 2015/16, the calculation of hardness-modified trigger values and application of the trigger values are undertaken in the following two ways:

- For the six sites where total hardness was analysed in monthly water samples, the hardness-modified trigger value is calculated for each sampling occasion and compared against the metal concentration from that occasion. A breach of the chronic toxicity guidelines is defined as occurring when a site exceeds its hardness-modified trigger value on more than 50% of sampling occasions; and,
- For the four sites where total hardness was not analysed in monthly water samples, the hardness-modified trigger value is calculated based on the median water hardness value generated from monthly monitoring over July 2012 to June 2013. A breach of the chronic toxicity guideline is defined as occurring when the median heavy metal concentration from

monthly sampling over 2015/16 exceeds this site-specific, hardness modified trigger value.

3.2 Results

3.2.1 Water quality index

Application of the WQI resulted in the following overall water quality grades for the 53 RSoE sites monitored in the Wellington Region over the July 2015 to June 2016 reporting period (Figure 3.1: Table 3.2):

- Excellent: 24 sites (45.3%)
- Good: 8 sites (15.1%)
- Fair: 14 sites (26.4%)
- Poor: 7 sites (13.2%)

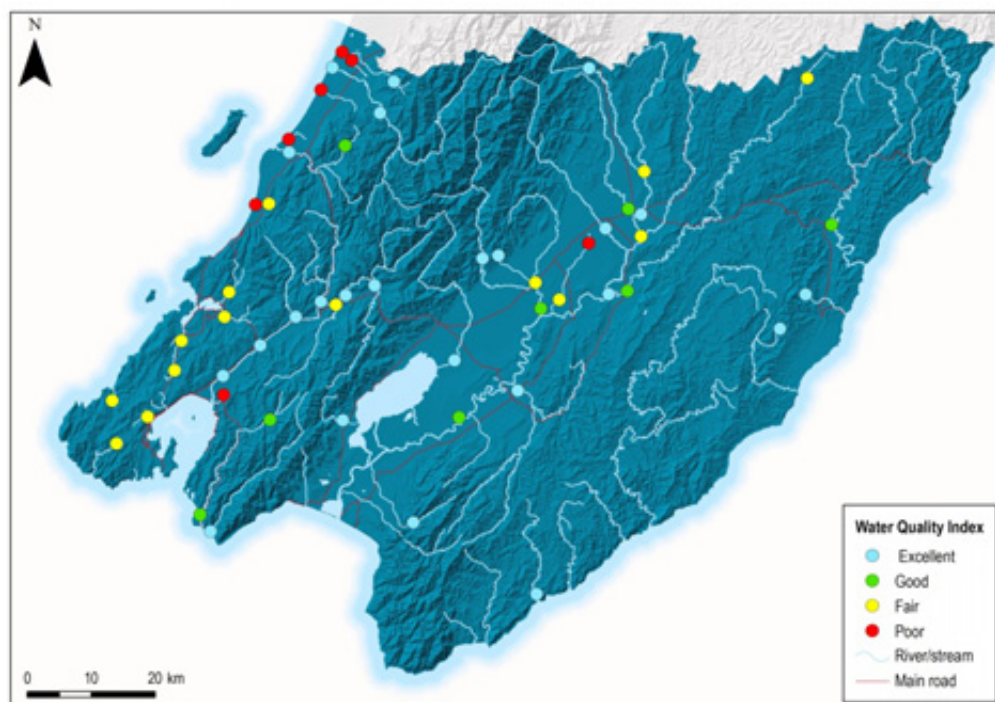


Figure 3.1: Water Quality Index grades for RSoE sites sampled at monthly intervals between July 2015 and June 2016, based on compliance of median dissolved oxygen, visual clarity, nitrite-nitrate nitrogen, ammoniacal nitrogen, dissolved reactive phosphorus and *E. coli* values with guideline values

Table 3.2: Water Quality Index grades for RSoE sites sampled at monthly intervals over July 2015 to June 2016 inclusive, based on compliance of median dissolved oxygen (DO), visual clarity (clarity), *E. coli*, nitrite-nitrate nitrogen (NNN), ammoniacal nitrogen (Amm. N) and dissolved reactive phosphorus (DRP) values with guideline values

Rank	Site no.	Site name	Guideline compliance (median values)					
			DO	Clarity	<i>E. coli</i>	NNN	Amm. N	DRP
Excellent water quality								
1=	RS20	Hutt R at Te Marua Intake Site	✓	✓	✓	✓	✓	✓
	RS52	Tauanui R at Whakatotomo Rd	✓	✓	✓	✓	✓	✓
3=	RS25	Akatarawa R at Hutt Confluence	✓	✓	✓	✓	✓	✓
	RS26	Whakatikei R at Riverstone	✓	✓	✓	✓	✓	✓
5=	RS23	Pakuratahi R d/s Farm Ck	✓	✓	✓	✓	✓	✓
	RS47	Waiohine R at Gorge	✓	✓	✓	✓	✓	✓
7	RS05	Otaki R at Pukehinou	✓	✓	✓	✓	✓	✓
8=	RS31	Ruamahanga R at McLays	✓	✓	✓	✓	✓	✓
	RS56	Waiorongomai R at Forest Park	✓	✓	✓	✓	✓	✓
10	RS43	Motuwaireka St at Headwaters	✓	✓	✓	✓	✓	✓
11	RS10	Waikanae R at Greenaway Rd	✓	✓	✓	✓	✓	✓
12	RS41	Waingawa R at South Rd	✓	✓	✓	✓	✓	✓
13	RS03	Waitohu S at Forest Park	✓	✓	✓	✓	✓	✓
14	RS06	Otaki R at Mouth	✓	✓	✓	✓	✓	✓
15	RS55	Tauherenikau R at Websters	✓	✓	✓	✓	✓	✓
16	RS22	Hutt R at Boulcott	✓	✓	✓	✓	✓	✓
17=	RS21	Hutt R Opp. Manor Park G.C.	✓	✓	✓	✓	✓	✓
	RS30	Orongorongo R at Orongorongo Station	✓	✓	✓	✓	✓	✓
19	RS49	Beef Ck at Headwaters	✓	✓	✓	✓	✓	✓
20	RS51	Huangarua R at Ponatahi Br	✓	✓	✓	✓	✓	✓
21	RS44	Tolara S at Stronvar	✓	✓	✓	✓	✓	✓
22	RS32	Ruamahanga R at Te Ore Ore	✓	✓	✓	✓	✓	✓
23	RS53	Awhea R at Tora Rd	✓	✓	✓	✓	✓	✓
24	RS33	Ruamahanga R at Gladstone Br	✓	✓	✓	✓	✓	✓
Good water quality								
25	RS28	Wainuiomata R at Manuka Track	✓	✓	✓	✓	✓	x
26	RS09	Waikanae R at Mangaone Walkway	✓	✓	✓	✓	✓	x
27	RS29	Wainuiomata R d/s of White Br	✓	✓	✓	✓	✓	x
28	RS48	Waiohine R at Bicknells	✓	✓	✓	✓	✓	x
29	RS40	Waipoua R at Colombo Rd Br	✓	✓	✓	x	✓	✓
30	RS42	Whareama R at Gauge	✓	x	✓	✓	✓	✓
31	RS34	Ruamahanga R at Pukio	✓	✓	✓	✓	✓	x
32	RS37	Taueru R at Gladstone	✓	✓	✓	x	✓	✓
Fair water quality								
33	RS36	Taueru R at Castlehill	✓	x	x	✓	✓	✓
34	RS13	Horokiri S at Snodgrass	✓	✓	x	x	✓	✓
35	RS24	Mangaroa R at Te Marua	✓	✓	x	x	✓	✓
36	RS14	Pauatahanui S at Elmwood Br	✓	✓	x	✓	✓	x
37	RS17	Makara S at Kennels	✓	✓	x	✓	✓	x
38	RS11	Whareroa S at Waterfall Rd	✓	x	x	✓	✓	x
39	RS15	Porirua S at Glenside	✓	✓	x	x	✓	x
40	RS50	Mangatarere S at SH 2	✓	✓	x	x	✓	x
41	RS46	Parkvale S at Weir	✓	✓	x	x	✓	x
42	RS39	Whangaehu R at 250m u/s confl	✓	✓	x	x	✓	x
43	RS38	Kopuaranga R at Stuarts	✓	✓	x	x	✓	x
44	RS19	Kaiwharawhara S at Ngaio Gorge	✓	✓	x	x	✓	x
45	RS16	Porirua S at Wall Park (Milk Depot)	✓	✓	x	x	✓	x
46	RS18	Karori S at Makara Peak	✓	✓	x	x	✓	x
Poor water quality								
47	RS45	Parkvale Trib at Lowes Res	x	✓	✓	x	✓	x
48	RS04	Waitohu S at Norfolk Crescent	✓	x	x	x	✓	x
49	RS12	Whareroa S at QE Park	x	x	✓	✓	x	x
50	RS57	Waiwhetu S at Whites Line East	x	x	x	✓	x	x
51	RS08	Ngarara S at Field Way	x	x	x	✓	x	x
52	RS02	Mangapouri S at Bennetts Rd	✓	x	x	x	x	x
53	RS07	Mangaone S at Sims Road Br	✓	x	x	x	x	x

The water quality variables that most commonly failed to comply with guideline values (based on median values) were dissolved reactive phosphorus (23 sites), followed by *E. coli* (19 sites), nitrite-nitrate nitrogen (16 sites) and clarity (9 sites). Guidelines for ammoniacal nitrogen and dissolved oxygen were not met at five and four sites, respectively.

3.2.2 Heavy metals

Median concentrations of dissolved copper and zinc exceeded the ANZECC (2000) default trigger values at two (Karori Stream at Makara Mountain Bike Park and Kaiwharawhara Stream at Ngaio Gorge) and three (Porirua Stream at Wall Park, Karori Stream at Makara Mountain Bike Park and Waiwhetu Stream at Whites Line East) sites, respectively. Once local water hardness was taken into account and the site-specific, hardness-modified trigger values applied, no site exceeded its modified guideline for copper. However, two sites (Karori Stream at Makara Mountain Bike Park, and Waiwhetu Stream at Whites Line East) still exceeded their modified guidelines for zinc. Summary statistics for heavy metals can be found in Appendix 4.

4. Periphyton and macrophytes

4.1 Approach to analysis

Assessments of periphyton are limited to RSoE sites with hard substrates (Figure 4.1). Monthly observations of percent streambed periphyton cover (filamentous and mat-forming (including cyanobacteria) periphyton) from July 2015 to June 2016 inclusive at 44 sites, and assessments of periphyton biomass (chlorophyll *a*) undertaken once in summer at 17 sites are compared against various MfE (2000) guidelines (Table 4.1). Monthly cover assessments of potentially toxic mat-forming cyanobacteria are compared against the MfE and MoH (2009) guidelines (Table 4.2). Macrophyte cover and macrophyte channel clogginess³, measured monthly at 16 RSoE sites, are also summarised.

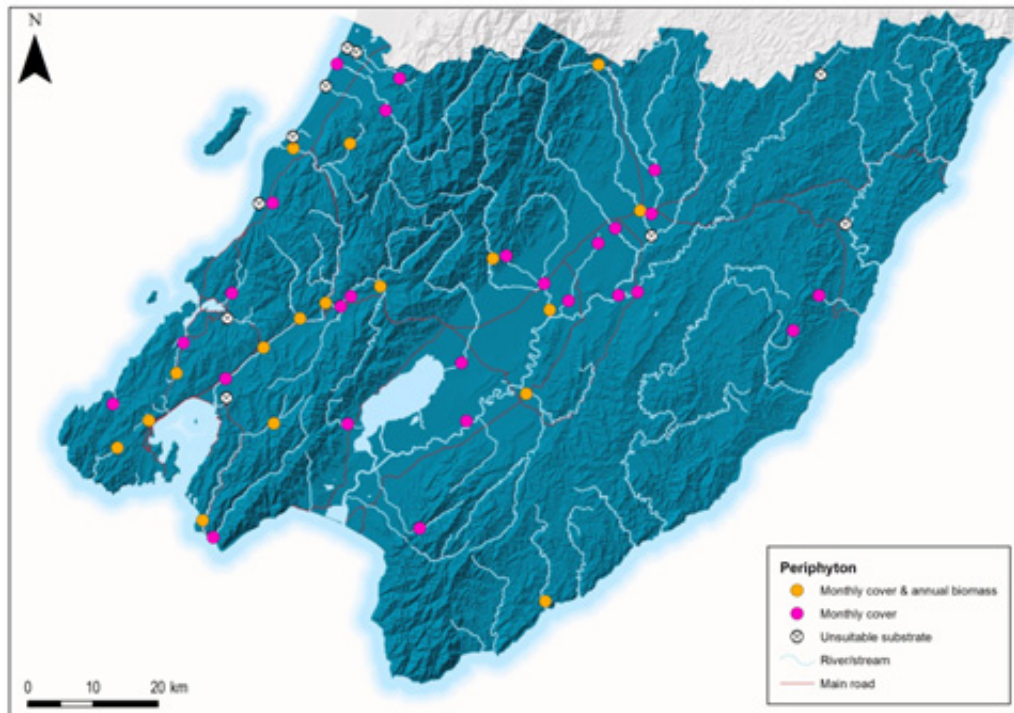


Figure 4.1: Sites with hard-bottomed substrates where monthly observations of periphyton cover and, in some cases, one-off summer/autumn biomass (chlorophyll *a*) samples were collected during 2015/16. RSoE sites with unsuitable substrates for periphyton growth that were not sampled are also indicated

³ Essentially how "clogged" up a stream channel is with macrophytes.

Table 4.1: MfE (2000) guidelines used to assess periphyton streambed cover and biomass

Instream value/variable	Mat periphyton	Filamentous periphyton
<i>Aesthetics/recreation</i>		
Maximum cover of visible streambed	60% >0.3 cm thick	30% >2 cm long
<i>Benthic biodiversity</i>		
Maximum chlorophyll <i>a</i>	50 mg/m ²	50 mg/m ²
<i>Trout habitat and angling</i>		
Maximum cover of visible streambed	N/A	30% >2 cm long

Table 4.2: MfE/MoH (2009) alert framework for benthic cyanobacteria cover in rivers

Alert level	Guideline
Green	≤20% coverage of potentially toxic cyanobacteria attached to substrate
Amber	20–50% coverage of potentially toxic cyanobacteria attached to substrate
Red	>50% coverage of potentially toxic cyanobacteria attached to substrate

¹The red alert level is slightly modified from the MfE and MoH (2009) guidelines; detached mats are not recorded.

4.2 Results

The number of observations of streambed periphyton cover made during the reporting period varied among the 44 RSoE sites due to either site access being restricted or because turbid water or high flows prevented periphyton assessments being carried out on some occasions. Of the 44 RSoE sites with periphyton cover observations, 14 exceeded the MfE (2000) guideline for filamentous periphyton streambed cover on at least one sampling occasion (Table 4.3). The sites that most often exceeded the guideline were Huangarua River at Ponatahi Bridge (seven times), Awhea River at Tora Road (six times) and Mangatarere Stream at State Highway Two (four times). These sites are all located in catchments dominated by pastoral land use.

No sites exceeded the MfE (2000) guideline for mat-forming periphyton cover during the reporting period. However, seven sites exceeded the MfE/MoH (2009) alert 'Amber' guideline for benthic mat-forming cyanobacteria cover. One of these seven sites (Pakuratahi River 50 below Farm Creek) also exceeded the action 'Red' guideline for benthic mat-forming cyanobacteria cover on one occasion.

Eight of the 17 RSoE sites sampled once during the 2015/16 summer exceeded the MfE (2000) chlorophyll *a* guideline for benthic biodiversity (Table 4.4). The highest chlorophyll *a* biomass recorded was in the Huangarua River at Ponatahi Bridge (500.8 mg/m²).

A summary of total streambed macrophyte cover and macrophyte channel cloginess data is presented in Table 4.5. Sites that recorded the highest median cover were Parkvale tributary at Lowes Reserve (76%), Waiwhetu

Stream at Whites Line East (64%) and Taueru River at Gladstone (58%). Parkvale tributary at Lowes Reserve and also Whareroa Stream at Queen Elizabeth Park had the highest median macrophyte channel clogginess (72% and 66%, respectively).

Table 4.3: Summary of monthly observations at RSoE sites, over July 2015 to June 2016 inclusive, of visible streambed periphyton cover in relation to exceedances of the MfE (2000) and MfE & MoH (2009) guidelines. Values in bold indicate a guideline exceedance

Site no.	Site name	n	Streambed cover						
			Filamentous (>2 cm long)		Mats ¹ (>0.3 cm thick)		Cyanobacterial mats ¹ (>0.1 cm thick)		
			Max	n >30%	Max	n >60%	Max	n 20–50%	n >50%
RS03	Waitohu S at Forest Pk	9	0	0	2	0	2	0	0
RS05	Otaki R at Pukehinau	11	8	0	2	0	2	0	0
RS06	Otaki R at Mouth	10	19	0	2	0	2	0	0
RS09	Waikanae R at Mangaone Walkway	12	0	0	0	0	0	0	0
RS10	Waikanae R at Greenaway Rd	11	3	0	10	0	6	0	0
RS11	Whareroa S at Waterfall Rd	11	0	0	0	0	0	0	0
RS13	Horokiri S at Snodgrass	11	33	1	18	0	7	0	0
RS14	Pauatahanui S at Elmwood Br	12	90	1	37	0	0	0	0
RS15	Porirua S at Glenside	10	2	0	0	0	0	0	0
RS16	Porirua S at Wall Park (Milk Depot)	9	52	2	0	0	0	0	0
RS17	Makara S at Kennels	11	42	1	0	0	1	0	0
RS18	Karori S at Makara Peak	11	13	0	3	0	0	0	0
RS19	Kaiwharawhara S at Ngaio Gorge	10	49	1	0	0	0	0	0
RS20	Hutt R at Te Marua Intake Site	10	0	0	6	0	8	0	0
RS21	Hutt R opp. Manor Park G.C.	9	4	0	25	0	28	1	0
RS22	Hutt R at Boulcott	8	10	0	24	0	25	1	0
RS23	Pakuratahi R 50m d/s Farm Ck	12	11	0	44	0	53	3	1
RS24	Mangaroa R at Te Marua	10	75	3	11	0	19	0	0
RS25	Akatarawa R at Hutt confl.	12	1	0	5	0	15	0	0
RS26	Whakatikei R at Riverstone	12	12	0	16	0	9	0	0
RS28	Wainuiomata R at Manuka Track	12	6	0	1	0	1	0	0
RS29	Wainuiomata R d/s of White Br	11	49	3	41	0	33	1	0
RS30	Orongorongo R at Orongorongo Stn	10	19	0	58	0	7	0	0
RS31	Ruamahanga R at McLays	9	1	0	0	0	0	0	0
RS32	Ruamahanga R at Te Ore Ore	8	16	0	0	0	0	0	0
RS33	Ruamahanga R at Gladstone Br	9	43	1	13	0	3	0	0
RS34	Ruamahanga R at Pukio	9	32	1	0	0	0	0	0
RS37	Taueru R at Gladstone	4	30	0	16	0	6	0	0
RS38	Kopuaranga R at Stuarts	9	95	2	31	0	3	0	0
RS40	Waipoua R at Colombo Rd Br	11	42	2	37	0	37	2	0
RS41	Waingawa R at South Rd	9	1	0	30	0	30	1	0
RS43	Motuwaireka S at Headwaters	10	0	0	0	0	0	0	0
RS44	Totara S at Stronvar	9	11	0	0	0	0	0	0
RS45	Parkvale Trib at Lowes Res.	9	0	0	0	0	0	0	0
RS46	Parkvale S at Weir	6	29	0	8	0	3	0	0
RS47	Waiohine R at Gorge	10	0	0	0	0	0	0	0
RS48	Waiohine R at Bicknells	9	6	0	0	0	0	0	0
RS49	Beef Ck at Headwaters	10	0	0	0	0	0	0	0
RS50	Mangatarere S at SH 2	11	78	4	12	0	5	0	0
RS51	Huangarua R at Ponatahi Br	10	93	7	54	0	31	1	0
RS52	Tauanui R at Whakatomotomo Rd	8	11	0	18	0	13	0	0
RS53	Awhea R at Tora Rd	10	100	6	0	0	0	0	0
RS55	Tauherenikau R at Websters	9	3	0	2	0	1	0	0
RS56	Waiorongomai R at Forest Pk	10	1	0	0	0	0	0	0

¹ Mat-forming and cyanobacterial mat-periphyton cover data are not mutually exclusive (eg, cyanobacterial mats >0.3 cm thick would also be counted under mat-forming periphyton).

Table 4.4: Periphyton biomass (chlorophyll a) from one-off sampling during summer 2015/16 at 17 RSoE sites. Exceedance with the MfE (2000) chlorophyll a guideline for benthic biodiversity is highlighted in bold type

Site no.	Site name	Chlorophyll a (mg/m ²)
RS09	Waikanae R at Mangaone Walkway	4.1
RS10	Waikanae R at Greenaway Rd	5.3
RS15	Porirua S at Glenside	13.5
RS18	Karori S at Makara Peak	101.0
RS19	Kaiwharawhara S at Ngaio Gorge	153.2
RS21	Hutt River Opp. Manor Park G.C.	46.0
RS23	Pakuratahi R 50m d/s Farm Ck	54.3
RS25	Akatarawa R at Hutt confl.	44.0
RS26	Whakatikei R at Riverstone	110.6
RS28	Wainuiomata R at Manuka Track	22.7
RS29	Wainuiomata R d/s of White Br	129.5
RS37	Taueru R at Gladstone	381.1
RS40	Waipoua R at Colombo Road Br	91.1
RS47	Waiohine R at Gorge	1.7
RS48	Waiohine R at Bicknells	59.8
RS51	Huangarua R at Ponatahi Br	500.8
RS53	Awhea R at Tora Rd	28.8

Table 4.5: Summary of total streambed macrophyte cover and macrophyte channel clogginess at selected RSoE sites, based on monthly observations between July 2015 and June 2016

Site No.	Site name	Total streambed macrophyte cover (%)				Macrophyte channel clogginess (%)			
		n*	Median	Min.	Max.	n*	Median	Min.	Max.
RS02	Mangapouri S at Bennetts Rd	10	20	0	88	9	16	1	73
RS04	Waitohu S at Norfolk Crescent	10	2	0	54	7	4	0	33
RS07	Mangaone S at Sims Road Br	12	36	10	80	8	36	16	80
RS08	Ngarara S at Field Way	11	4	0	12	7	8	0	12
RS12	Whareroa S at QE Park	11	18	4	100	7	66	10	88
RS14	Pauatahanui S at Elmwood Br	9	0	0	0	9	0	0	0
RS17	Makara S at Kennels	11	7	0	14	11	2	0	12
RS29	Wainuiomata R d/s of White Br	11	10	2	38	9	10	2	21
RS36	Taueru R at Castlehill	11	0	0	0	11	0	0	0
RS37	Taueru R at Gladstone	9	58	30	93	9	36	10	71
RS38	Kopuaranga R at Stuarts	8	18	0	90	7	19	0	64
RS39	Whangaehu R at 250m from Confl	10	31	0	92	9	27	0	76
RS42	Whareama R at Gauge	7	12	0	96	6	13	0	40
RS45	Parkvale Trib at Lowes Reserve	9	76	60	84	9	72	4	82
RS46	Parkvale S at Weir	8	45	4	80	7	39	4	72
RS57	Waiwhetu S at Whites Line East	11	64	0	94	10	32	2	59

*High flows and/or turbid water restricted the number of observations that could be undertaken or on some occasions restricted the observations to only surface reaching cover (eg, the river was too turbid to assess submerged macrophyte cover but surface reaching cover was still visible).

5. Macroinvertebrates

5.1 Approach to analysis

Macroinvertebrate sampling was undertaken at 37 of the 53 RSoE sites during summer 2015/16. The Macroinvertebrate Community Index (MCI), an index of sensitivity to a wide range of environmental variables (Stark & Maxted 2007), is used to summarise macroinvertebrate health. Additional macroinvertebrate indices (QMCI, %EPT taxa, and taxa richness)⁴ are presented in Appendix 5. Refer to Perrie et al. (2012) for further explanation of these indices.

The quality classifications, as recommended by Stark and Maxted (2007), for interpretation of the MCI scores are outlined in Table 5.1. Soft bottomed MCI scores (MCI-sb) have also been calculated for the six RSoE sites that were sampled which have soft substrates (see Appendix 1).

Table 5.1: Interpretation of MCI-type scores (from Stark & Maxted 2007)

Quality class	MCI and MCI-sb
Excellent	≥ 120
Good	100–119
Fair	80–99
Poor	<80

5.2 Results

The MCI scores based on one sample collected from each monitoring site are presented in Table 5.2. The 37 RSoE sites fell into the following MCI quality classes (Figure 5.1):

- Excellent: 9 sites (24.3%)
- Good: 14 sites (37.8%)
- Fair: 9 sites (24.3%)
- Poor: 5 sites (13.5%)

All of the RSoE sites in the ‘excellent’ MCI quality class are located in catchments dominated by indigenous forest cover (eg, sites located in the upper reaches of the Otaki, Waikanae, Hutt and Ruamahanga rivers). Four of the five RSoE sites in the ‘poor’ quality class have soft-sediment substrate and all five sites are located in catchments dominated by either pastoral landcover (three sites) or urban landcover (two sites).

⁴ QMCI = Quantitative MCI and %EPT taxa = the percentage of pollution-sensitive Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) taxa. See Perrie et al. (2012) for index calculation details.

Table 5.2: MCI scores for RSOE sites sampled in summer 2015/16
 (* denotes MCI-sb scores that were used to apply quality classes at soft-bottomed sites while values in brackets are the MCI-hb scores for these sites)

Site no.	Site name	MCI score	MCI quality class
RS02	Mangapouri S at Bennetts Rd	89.2* (88.3)	Fair
RS05	Otaki R at Pukehinau	114.0	Good
RS06	Otaki R at Mouth	108.6	Good
RS07	Mangaone S at Sims Road Br	58.3* (82.9)	Poor
RS09	Waikanae R at Mangaone Walkway	132.8	Excellent
RS10	Waikanae R at Greenaway Rd	129.1	Excellent
RS13	Horokiri S at Snodgrass	109.6	Good
RS14	Pauatahanui S at Elmwood Br	90.9* (94.8)	Fair
RS15	Porirua S at Glenside	100.0	Good
RS16	Porirua S at Wall Park (Milk Depot)	80.7	Fair
RS18	Karori S at Makara Pk.	85.2	Fair
RS19	Kaiwharawhara S at Ngaio Gorge	71.4	Poor
RS20	Hutt R at Te Marua Intake Site	138.2	Excellent
RS21	Hutt R Opp. Manor Park G.C.	121.7	Excellent
RS22	Hutt R at Boulcott	113.0	Good
RS23	Pakuratahi R 50m d/s Farm Creek	113.6	Good
RS24	Mangaroa R at Te Marua	115.2	Good
RS25	Akatarawa R at Hutt confl.	130.0	Excellent
RS26	Whakatikei R at Riverstone	131.4	Excellent
RS28	Wainuiomata R at Manuka Track	130.3	Excellent
RS29	Wainuiomata R d/s of White Bridge	111.2	Good
RS31	Ruamahanga R at McLays	129.5	Excellent
RS32	Ruamahanga R at Te Ore Ore	118.9	Good
RS33	Ruamahanga R at Gladstone Br	106.7	Good
RS34	Ruamahanga R at Pukio	103.3	Good
RS37	Taueru R at Gladstone	84.8	Fair
RS38	Kopuaranga S at Stuarts	94.3	Fair
RS39	Whangaehu R 250m u/s confl.	60.0* (83.8)	Poor
RS40	Waipoua R at Colombo Road Br	98.3	Fair
RS41	Waingawa R at South Rd	101.1	Good
RS42	Whareama R at Gauge	79.2* (80.0)	Poor
RS47	Waiohine R at Gorge	141.1	Excellent
RS48	Waiohine R at Bicknells	106.7	Good
RS50	Mangatarere S at SH 2	101.5	Good
RS51	Huangarua R at Ponatahi Br	95.7	Fair
RS53	Awhea R at Tora Rd	89.2	Fair
RS57	Waiwhetu S at Whites Line East	55.4* (60.0)	Poor

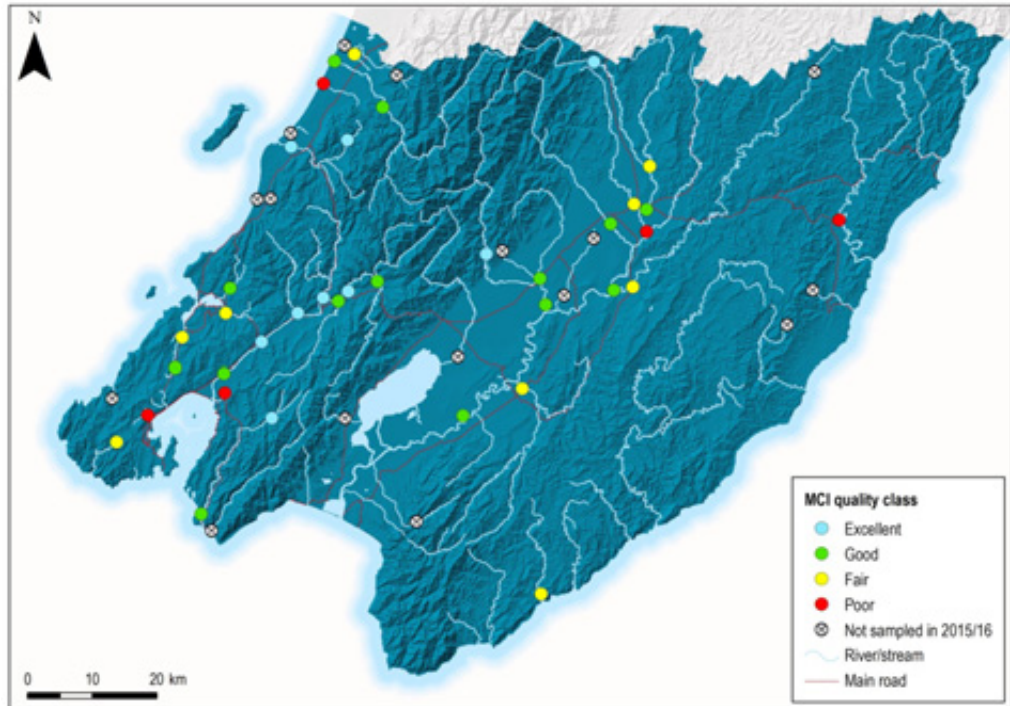


Figure 5.1: MCI quality classes for the 37 RSoE sites, determined from one sampling event over summer 2015/16. Sites that would normally be sampled but were not during 2015/16 are also indicated

6. Habitat quality

6.1 Approach to analysis

Habitat assessments were undertaken at each of the 37 RSoE sites at the time annual biological samples were collected in summer 2015/16. A summary of the overall habitat scores for each site is provided (individual scores for each of the ten components that make up the overall habitat score can be found in Appendix 6); these overall scores provide an indication of the physical stream habitat condition and its ability to support stream biota.

Streambed fine sediment cover was assessed monthly at the time of water sample collection. A tabulated summary of these monthly assessments is presented.

6.2 Results

6.2.1 Habitat assessment

Overall habitat scores ranged from 27 (Awhea River at Tora Road) to 97 (Waikanae River at Mangaone Walkway) with a median score across all 37 sites sampled of 68 (Table 6.1). The RSoE sites that had the highest habitat scores were all located in catchments with indigenous forest as the dominant landcover and had hard-bottomed substrate (eg, Waikanae River at Mangaone Walkway and Wainuiomata River at Manuka Track). In contrast, the RSoE sites that had the lowest habitat scores were all located in catchments dominated by either pastoral or urban landcover and tended to have soft-sediment substrates (eg, Mangaone Stream at Sims Road Bridge, Whangaehu River 250m upstream of the Ruamahanga River Confluence and Waiwhetu Stream at Whites Line East).

6.2.2 Fine sediment cover

The number of observations of fine sediment streambed cover made during the reporting period varied among the 53 sites due to site access being restricted, or turbid water or high flows inhibiting the assessment⁵. Unsurprisingly, most (seven) of the nine sites considered 'soft-bottomed' typically had high proportions of fine sediment cover (Table 6.1). Of the 44 RSoE sites considered hard-bottomed, median fine sediment cover values ranged from 0 (at 15 sites, eg, Otaki River at Pukehinau) to >50% at one site (85% at Makara Stream at Kennels). Sites that had higher median values for fine sediment streambed cover tended to be located on smaller streams, mostly on the Kapiti Coast (eg, Mangapouri Stream at Bennetts Road) or in eastern Wairarapa (eg, Taueru River at Castlehill).

⁵Over the reporting period, turbid and/or humic stained water limited the number of monthly fine sediment assessments carried out at the Mangaone Stream at Sims Road Bridge (zero assessments possible), Ngarara Stream at Field Way (one assessment) and Whareroa Stream at QE Park (one assessment) (Table 6.1).

Table 6.1: Overall habitat quality scores based on a one-off assessment and summary of monthly observations of fine sediment (<2 mm) streambed cover at RSoE sites during 2015/16

Site no.	Site name	Overall habitat score	Fine sediment streambed cover			
			n	Median	Minimum	Maximum
RS02	Mangapouri S at Bennetts Rd	50.0	5	70	60	100
RS03	Waitohu S at Forest Pk	Not assessed	9	0	0	0
RS04	Waitohu S at Norfolk Cres	Not assessed	4	80	60	100
RS05	Otaki R at Pukehinau	85.0	11	0	0	40
RS06	Otaki R at Mouth	66.0	11	0	0	20
RS07	Mangaone S at Sims Rd Br	33.0	0	-	-	-
RS08	Ngarara S at Field Way	Not assessed	1	100	100	100
RS09	Waikanae R at Mangaone Walkway	97.0	12	0	0	30
RS10	Waikanae R at Greenaway Rd	68.0	11	10	0	30
RS11	Whareroa S at Waterfall Rd	Not assessed	11	20	0	40
RS12	Whareroa S at QE Park	Not assessed	1	100	100	100
RS13	Horokiri S at Snodgrass	72.0	11	10	10	50
RS14	Pauatahanui S at Elmwood Br	67.5	12	50	25	85
RS15	Porirua S at Glenside	73.0	10	18	0	40
RS16	Porirua S at Wall Park (Milk Depot)	48.0	9	25	10	70
RS17	Makara S at Kennels	Not assessed	11	85	60	95
RS18	Karori S at Makara Peak	78.0	11	25	20	70
RS19	Kaiwharawhara S at Ngaio Gorge	69.0	10	23	10	40
RS20	Hutt R at Te Marua Intake Site	71.5	11	0	0	10
RS21	Hutt R opp. Manor Park GC	62.0	9	15	5	40
RS22	Hutt R at Boulcott	68.5	9	5	0	30
RS23	Pakuratahi R 50m d/s Farm Ck	78.5	12	5	0	5
RS24	Mangaroa R at Te Marua	72.0	11	0	0	10
RS25	Akatarawa R at Hutt confl	89.0	12	30	5	40
RS26	Whakatikei R at Riverstone	89.0	12	30	15	60
RS28	Wainuiomata R at Manuka Track	95.5	12	0	0	10
RS29	Wainuiomata R d/s of White Br	65.5	12	15	5	40
RS30	Orongorongo R at Orongorongo Stn	Not assessed	10	10	0	20
RS31	Ruamahanga R at McLays	83.0	9	0	0	0
RS32	Ruamahanga R at Te Ore Ore	68.0	8	35	10	50
RS33	Ruamahanga R at Gladstone Br	68.0	9	0	0	10
RS34	Ruamahanga R at Pukio	61.0	9	10	0	20
RS36	Taueru R at Castlehill	Not assessed	11	70	40	90
RS37	Taueru R at Gladstone	52.0	7	10	0	20
RS38	Kopuaranga R at Stuarts	59.0	8	23	0	30
RS39	Whangaehu R 250m u/s confl	34.0	5	40	20	80
RS40	Waipoua R at Colombo Rd Br	72.0	11	0	0	20
RS41	Waingawa R at South Rd	67.0	9	5	0	20
RS42	Whareama R at Gauge	37.0	5	90	30	100
RS43	Motuwaireka S at Headwaters	Not assessed	10	5	0	10
RS44	Totara S at Stronvar	Not assessed	9	20	10	40
RS45	Parkvale Trib at Lowes Res	Not assessed	6	5	0	50
RS46	Parkvale S at Weir	Not assessed	5	20	10	40
RS47	Waiohine R at Gorge	85.0	10	0	0	10
RS48	Waiohine R at Bicknells	72.0	10	0	0	10
RS49	Beef Ck at Headwaters	Not assessed	10	0	0	0
RS50	Mangatarere S at SH 2	45.0	10	10	0	20
RS51	Huangaaru R at Ponatahi Br	63.0	9	10	5	20
RS52	Tauanui R at Whakatomotomo Rd	Not assessed	8	0	0	10
RS53	Awhea R at Tora Rd	27.0	6	35	20	80
RS55	Tauherenikau R at Websters	Not assessed	9	40	0	90
RS56	Waiorongomai R at Forest Pk	Not assessed	10	0	0	20
RS57	Waiwhetu S at Whites Line East	36.5	9	30	15	60

7. Additional river monitoring trials undertaken in 2015/16

See Section 2.4 for background information on the data presented below from the two river monitoring trials that were undertaken in 2015/16.

7.1 Monthly periphyton biomass sampling

7.1.1 Approach to analysis

Thirteen RSoE sites (Figure 7.1) were sampled monthly from August 2015 to June 2016 (max $n = 11$), although due to high flows or, at one site, extensive macrophyte growth, sampling could not occur in every sampling month. Monthly chlorophyll a concentrations are summarised and assessed against the NPS-FM bottom line of 200 mg/m^2 . However, this should be considered an initial assessment as there is insufficient data to properly compare against NPS-FM thresholds which specifies that three years of monthly data (ie, 36 data points) are required to undertake this assessment (MfE 2015).

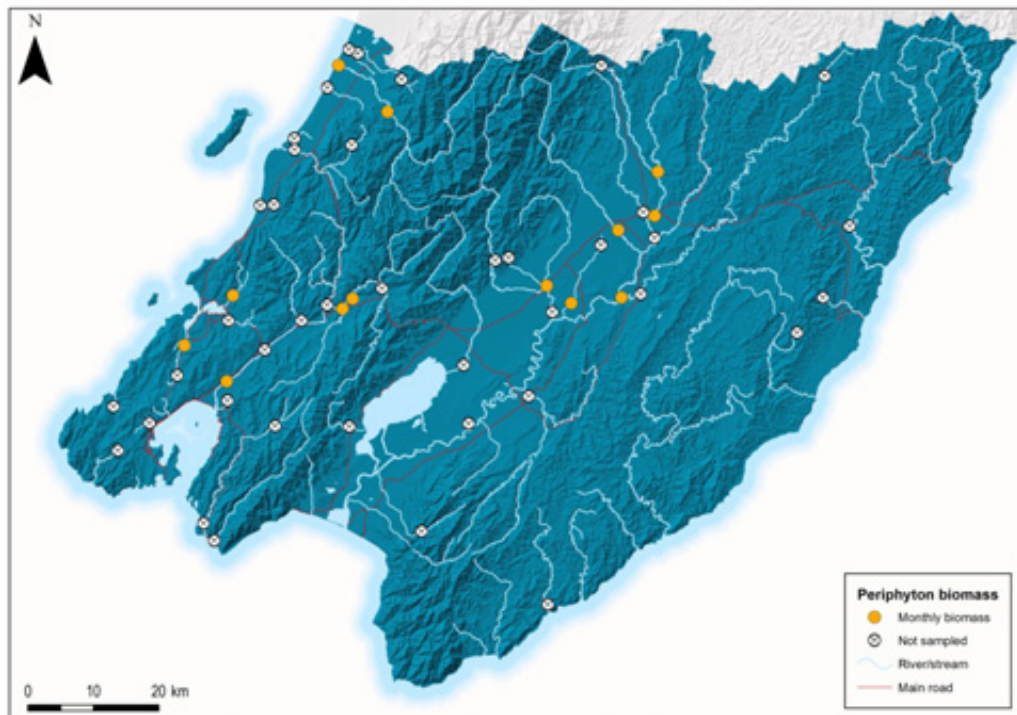


Figure 7.1: The 13 RSoE sites where periphyton biomass (chlorophyll a) was sampled monthly during 2015/16. RSoE sites not sampled are also indicated

Some rivers and streams have higher periphyton biomass than others due to natural factors such as long accrual periods⁶ and nutrient enriched geology (MfE 2015). In MfE (2015), these types of rivers are classed as “productive” and all other rivers are classed as “default” because they are the dominant class across New Zealand. Application of the NPS-FM bottom line threshold differs between these two river classes (productive and default). For a breach to occur in a productive class river, the threshold needs to be exceeded on more than six occasions over a three year period. For a breach to occur in a default class

⁶ Periods of stable flows that allow periphyton to proliferate.

river, the threshold needs to be only exceeded on more than three occasions (MfE 2015). Based on the criteria for determining productive and default river classes in MfE (2015), Greenfield (2016) considered two of the 13 RSoE sites sampled as part of this trial to be within this productive class: Kopuaranga River at Stuarts and Parkvale Stream at Weir. Therefore, the other 11 RSoE sites sampled are within the default class.

7.1.2 Results

Median chlorophyll *a* concentrations ranged from 0.7 mg/m² (Otaki River at Pukehinau) to 191.0 mg/m² (Kopuaranga River at Stuarts) and maximum chlorophyll *a* concentrations ranged from 4.7 mg/m² (Waingawa River at South Rd) to 365.8 mg/m² (Kopuaranga River at Stuarts) (Table 7.1). Two sites, the Mangaroa River at Te Marua and the Kopuaranga River at Stuarts, exceeded 200 mg/m² bottom line threshold on two and four sampling occasions, respectively. These two sites are classed as default and productive, respectively. While this is only an initial assessment based on one year's worth of data, it seems likely that these two sites will not meet the NPS-FM bottom line once three years of data have been collected.

Table 7.1: Summary of periphyton biomass (chlorophyll *a*) from monthly sampling during August 2015 to July 2016. The number of sampling occasions a site exceeded the NPS-FM bottom line of 200 mg/m³ is also provided

Site No.	Site name	<i>n</i>	Chlorophyll <i>a</i> (mg/m ²)		
			Median	Maximum	<i>n</i> >200
RS05	Otaki R at Pukehinau	11	0.7	12.6	0
RS06	Otaki R at Mouth	11	3.0	29.5	0
RS13	Horokiri S at Snodgrass	10	22.1	70.6	0
RS16	Porirua S at Wall Park (Milk Depot)	11	23.8	98.1	0
RS20	Hutt R at Te Marua Intake Site	10	6.1	23.6	0
RS22	Hutt R at Boulcott	10	4.4	172.7	0
RS24	Mangaroa R at Te Marua	10	89.2	327.3	2
RS32	Ruamahanga R at Te Ore Ore	10	5.7	33.3	0
RS33	Ruamahanga R at Gladstone Br	11	2.0	123.5	0
RS38	Kopuaranga R at Stuarts*	8	191	365.8	4
RS41	Waingawa R at South Rd	11	2.8	4.7	0
RS46	Parkvale S at Weir*	4	24.7	77.5	0
RS50	Mangatarere S at SH 2	11	37.0	147.2	0

*These two sites are classed as "productive" based on MfE (2015) criteria. All other sites are classed as "default".

7.2 Ecologically focused assessments at sites selected randomly

7.2.1 Approach to analysis

As part of this trial, one-off assessments of habitat quality, macroinvertebrate communities and fish communities were undertaken at seven sites during summer/autumn of 2015/16 (Figure 7.2). Habitat and macroinvertebrate data have been summarised as per the analyses detailed in Sections 5 and 6, respectively, and fish community data has been summarised and tabulated. Further macroinvertebrate metrics and full habitat scores can be found in Appendix 7.

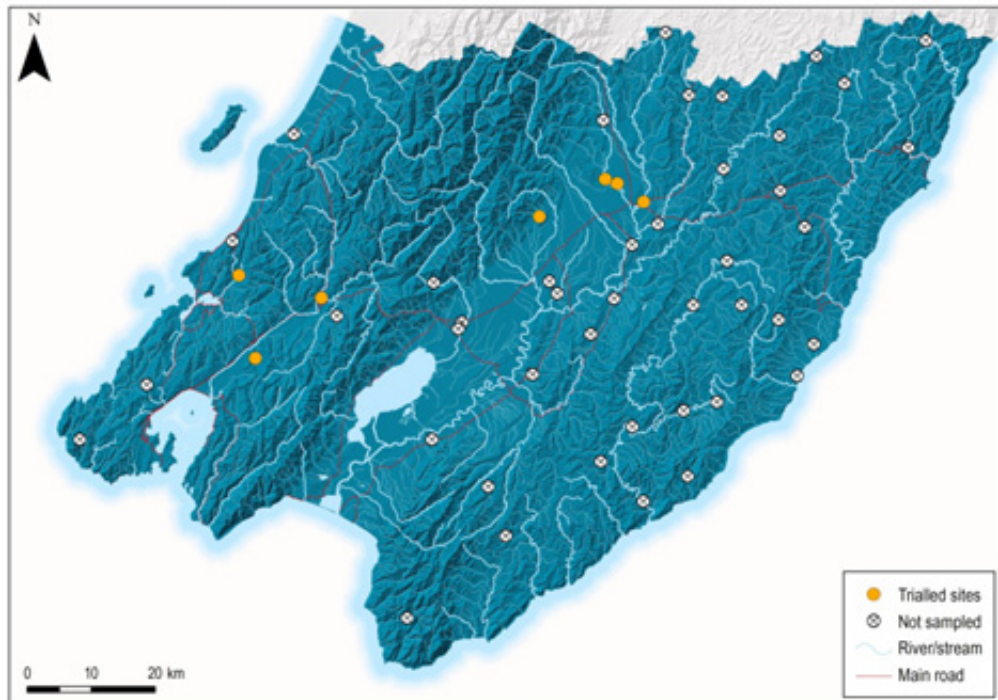


Figure 7.2: The proposed network* of 50 randomly selected sites for the development of an ecologically focused monitoring programme. The seven sites that were trialed in 2015/16 are indicated

*Note that the site network is still being developed in the sense that many sites need to be visited and assessed for their suitability (eg, are they permanently flowing), whether they can be accessed safely and, where required, will the landowners allow access.

7.2.2 Results

The MCI scores and overall habitat scores based on one assessment undertaken from each monitoring site are presented in Table 7.2. MCI scores ranged from 73.7 (Opaki Stream off Paierau Road) to 129.6 (Hutt River upstream of Akatarawa confluence). The lowest habitat score was recorded at Stokes Valley Stream at Delaney Park (26) and the highest at Horokiri Stream at Battlehill Park (81). Ten species of fish, as well as koura (freshwater) crayfish, were recorded across the seven sites surveyed (Table 7.3). Of these ten species, nine are native or endemic and one (brown trout) is introduced. No fish were caught at two of the seven sites surveyed.

Table 7.2: MCI scores, MCI quality classes and overall habitat scores for the seven sites that were trialled as part of the development of an ecologically focused monitoring programme that utilises sites randomly selected across the region

Site no.	Site name	MCI score	MCI quality class	Overall habitat score (#/100)
RAN20	Opaki S off Paierau Rd	73.7	Poor	39.0
RAN25	Hutt R U/S of Akatarawa confl.	129.6	Excellent	69.0
RAN35	Enaki S off Hururua Rd	71.8	Poor	42.0
RAN36	Ruamahanga R U/S of Te Ore Ore	100.8	Good	69.0
RAN54	Horokiri S at Battlehill Park	122.4	Excellent	81.0
RAN68	Waipoua R off Matahiwi Rd	98.3	Fair	78.5
RAN70	Stokes Valley S at Delaney Park	94.5	Fair	26.0

Table 7.3: Fish species (and numbers) and koura (freshwater crayfish) caught at the seven sites that were trialled as part of the development of an ecologically focused monitoring programme that utilises sites randomly selected across the region

Site no.	Site name	Longfin eel	Shortfin eel	Unidentified eel / eelver [#]	Redfin bully	Bluegill bully	Common bully	Upland bully	Cran's Bully	Unidentified bully [#]	Torrentfish	Koaro	Brown trout	Koura	No fish
RAN20	Opaki S off Paierau Rd*														*
RAN25	Hutt R U/S of Akatarawa Conf.**			1	4	3			4	3			4		
RAN35	Enaki S off Hururua Rd*	10	24						15	7					
RAN36	Ruamahanga R U/S of Te Ore Ore**		1	2			1			16	10			1	
RAN36	Ruamahanga R U/S of Te Ore Ore***	7	4				10			30				1	
RAN54	Horokiri S at Battlehill Park*	3			34							5		1	
RAN68	Waipoua R off Matahiwi Rd**	8	12	1				145		4	4			3	
RAN70	Stokes Valley S at Delaney Park*														*

*Site sampled using Joy et al. (2013) backpack electric fishing protocols for wadeable rivers.

**Site sampled using in-house, in-development, backpack electric fishing protocols for larger non-wadeable rivers.

***Site sampled using in-house, in-development, netting/trapping protocols for larger non-wadeable rivers.

[#]Too small to be accurately identified.

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Appendix 1: Monitoring sites

Table A1.1: RSOE monitoring sites

Site no.	Site name	NZTM site coordinates		Substrate (hard or soft bottomed)	REC	Dominant land cover
		Easting	Northing			
RS02	Mangapouri S at Bennetts Rd	1780903	5487645	Soft	WD/L/AI/U**	Urban
RS03	Waitohu S at Forest Pk	1787593	5483689	Hard	CW/H/HS/IF	Indigenous forest
RS04	Waitohu S at Norfolk Cres	1779537	5488304	Soft	CW/L/HS/P	Pasture
RS05	Otaki R at Pukehinou	1785426	5478749	Hard	CW/H/HS/IF	Indigenous forest
RS06	Otaki R at Mouth	1777983	5485886	Hard	CW/H/HS/IF	Indigenous forest
RS07	Mangaone S at Sims Rd Br	1776242	5482408	Soft	WW/L/AL/P	Pasture
RS08	Ngarara S at Field Way	1771180	5474620	Soft	WW/L/AL/U**	Urban
RS09	Waikanae R at Mangaone Walkway	1779974	5473638	Hard	CW/L/HS/IF	Indigenous forest
RS10	Waikanae R at Greenaway Rd	1771223	5472915	Hard	CW/L/HS/IF**	Indigenous forest
RS11	Whareroa S at Waterfall Rd	1768074	5464532	Hard	WW/L/HS/IF**	Indigenous forest
RS12	Whareroa S at QE Park	1765976	5464400	Soft	WW/L/HS/P	Pasture
RS13	Horokiri S at Snodgrass	1761804	5450653	Hard	CW/L/HS/P	Pasture
RS14	Pauatahanui S at Elmwood Br	1761097	5446783	Hard/Soft*	CW/L/HS/P	Pasture
RS15	Porirua S at Glenside	1753289	5438364	Hard	CW/L/HS/U	Urban
RS16	Porirua S at Wall Park (Milk Depot)	1754366	5443031	Hard	WW/L/HS/U	Urban
RS17	Makara S at Kennels	1743530	5433635	Hard	CW/L/HS/P	Pasture
RS18	Karori S at Makara Peak M.P. Park	1744213	5426874	Hard	CW/L/HS/U	Urban
RS19	Kaiwharawhara S at Ngaio Gorge	1749069	5431077	Hard	CW/L/HS/U	Urban
RS20	Hutt R at Te Marua Intake Site	1780071	5450158	Hard	CX/H/HS/IF	Indigenous forest
RS21	Hutt R opp. Manor Park G.C.	1766679	5442285	Hard	CW/H/HS/IF	Indigenous forest
RS22	Hutt R at Boulcott	1760858	5437486	Hard	CW/L/HS/IF	Indigenous forest
RS23	Pakuratahi R 50m d/s Farm Ck	1784607	5451677	Hard	CX/H/HS/IF	Indigenous forest
RS24	Mangaroa R at Te Marua	1778543	5448643	Hard	CW/L/HS/P	Pasture
RS25	Akatarawa R at Hutt confl.	1776183	5449184	Hard	CW/L/HS/IF	Indigenous forest
RS26	Whakatikei R at Riverstone	1772256	5446748	Hard	CW/L/HS/S	Indigenous forest
RS28	Wainuiomata R at Manuka Track	1768242	5430634	Hard	CW/L/HS/IF	Indigenous forest
RS29	Wainuiomata R d/s of White Br	1757316	5415724	Hard	CW/L/HS/IF	Indigenous forest
RS30	Orongorongo R at Orongorongo Stn	1758930	5413095	Hard	CW/H/HS/IF	Indigenous forest
RS31	Ruamahanga R at McLays	1818149	5485809	Hard	CX/H/HS/S	Indigenous forest
RS32	Ruamahanga R at Te Ore Ore	1825574	5463019	Hard	CW/L/SS/P	Pasture
RS33	Ruamahanga R at Gladstone Br	1821208	5450327	Hard	CW/L/SS/P	Pasture
RS34	Ruamahanga R at Pukio	1797832	5431010	Hard	CW/L/SS/P	Pasture
RS36	Taueru R at Castlehill	1852300	5484198	Soft	CW/L/SS/P	Pasture
RS37	Taueru R at Gladstone	1824148	5450815	Hard	CD/L/SS/P	Pasture
RS38	Kopuaranga R at Stuarts	1826761	5469569	Hard	CW/L/SS/P	Pasture
RS39	Whangaehu R 250m u/s confl.	1826267	5459407	Soft	CD/L/SS/P	Pasture
RS40	Waipoua R at Colombo Rd Br	1825018	5462890	Hard	CW/L/HS/P	Pasture
RS41	Waingawa R at South Rd	1820716	5460649	Hard	CX/H/HS/IF	Indigenous forest
RS42	Whareama R at Gauge	1856090	5461229	Soft	WW/L/SS/P	Pasture
RS43	Motuwaireka S at Headwaters	1852018	5450302	Hard	CW/L/HS/S	Indigenous forest
RS44	Totara S at Stronvar	1848025	5444916	Hard	CW/L/HS/EF	Exotic forest
RS45	Parkvale Trib at Lowes Res.	1818094	5458352	Hard	WD/L/AI/P	Pasture
RS46	Parkvale S at Weir	1813515	5449469	Hard	WD/L/AI/P	Pasture
RS47	Waiohine R at Gorge	1801889	5455995	Hard	CX/H/HS/IF	Indigenous forest
RS48	Waiohine R at Bicknells	1810615	5448099	Hard	CW/H/HS/P	Pasture
RS49	Beef Ck at Headwaters	1803963	5456398	Hard	CW/L/HS/S	Indigenous forest
RS50	Mangatarere S at SH 2	1809768	5452160	Hard	CW/L/HS/P	Pasture
RS51	Huangarua R at Ponatahi Br	1807009	5435213	Hard	CD/L/SS/P	Pasture
RS52	Tauanui R at Whakatomotomo Rd	1790648	5414515	Hard	CW/H/HS/IF	Indigenous forest
RS53	Awhea R at Tora Rd	1809951	5403289	Hard	WW/L/SS/P	Pasture
RS55	Tauherenikau R at Websters	1797082	5439942	Hard	CW/H/HS/P**	Pasture
RS56	Waiorongomai R at Forest Pk	1779604	5430559	Hard	CW/H/HS/IF	Indigenous forest
RS57	Waiwhetu S at Whites Line East	1760977	5434510	Soft	WW/L/HS/U	Urban

*This site was shifted 0.2 km upstream partway through the 2015/16 year. This changed the habitat at the site from a hard-bottomed to soft (See section 2.2.1).

**REC landcover class changed to reflect more up-to-date catchment scale landcover information from MfE (2010).

Table A1.2: Monitoring site coordinates for the seven sites that were trialled as part of the development of an ecologically focused monitoring programme that utilises sites randomly selected across the region

Site no.	Site name	NZTM site coordinates	
		Easting	Northing
RAN20	Opaki S off Paierau Rd	1822764	5466937
RAN25	Hutt R U/S of Akatarawa Conf.	1776482	5448968
RAN35	Enaki S off Hururua Rd	1810581	5461740
RAN36	Ruamahanga R U/S of Te Ore Ore	1826904	5464009
RAN54	Horokiri S at Battlehill Park	1763560	5452486
RAN68	Waipoua R off Matahiwi Rd	1820896	5467586
RAN70	Stokes Valley S at Delaney Park	1766146	5439495

Appendix 2: Monitoring variables and methods

A summary of what physico-chemical and biological sampling was undertaken at each RSoE site during 2015/16 is provided in Table A2.1. All sites are sampled monthly for core water quality variables (eg, dissolved oxygen, temperature, pH, conductivity, visual clarity, turbidity, faecal indicator bacteria, total organic carbon, and dissolved and total nutrients) and all sites are assessed monthly for fine sediment cover. Further details on sampling and analytical methods for all physico-chemical, microbiological and biological variables are provided below.

Table A2.1: Summary of what physico-chemical, biological and habitat variables were undertaken at which RSoE sites during 2015/16 (TSS = total suspended solids and SSC = suspended sediment concentration)

Site no.	Site name	Dissolved copper & zinc*	Total copper & zinc	TSS & SSC	Macrophytes	Monthly periphyton cover	Monthly periphyton biomass*	Annual periphyton biomass	Annual macroinvertebrate rate & habitat
RS02	Mangapouri S at Bennetts Rd	y	y		y				y
RS03	Waitohu S at Forest Pk					y			
RS04	Waitohu S at Norfolk Cres				y				
RS05	Otaki R at Pukehinau					y	y		y
RS06	Otaki R at Mouth					y	y		y
RS07	Mangaone S at Sims Rd Br				y				y
RS08	Ngarara S at Field Way	y			y				
RS09	Waikanae R at Mangaone Walkway					y		y	y
RS10	Waikanae R at Greenaway Rd	y		y		y		y	y
RS11	Whareroa S at Waterfall Rd					y			
RS12	Whareroa S at QE Park				y				
RS13	Horokiri S at Snodgrass			y		y	y		y
RS14	Pauatahanui S at Elmwood Br			y	y	y			y
RS15	Porirua S at Glenside	y	y	y		y		y	y
RS16	Porirua S at Wall Park (Milk Depot)	y	y	y		y	y		y
RS17	Makara S at Kennels				y	y			
RS18	Karori S at Makara Peak M.P. Park	y	y			y		y	y
RS19	Kaiwharawhara S at Ngaio Gorge	y	y			y		y	y
RS20	Hutt R at Te Marua Intake Site					y	y		y
RS21	Hutt R opp. Manor Park G.C.	y		y		y		y	y
RS22	Hutt R at Boulcott	y		y		y	y		y
RS23	Pakuratahi R 50m d/s Farm Ck					y		y	y
RS24	Mangaroa R at Te Marua					y	y		y
RS25	Akatarawa R at Hutt confl.					y		y	y
RS26	Whakatikei R at Riverstone					y		y	y
RS28	Wainuiomata R at Manuka Track					y		y	y
RS29	Wainuiomata R d/s of White Br				y	y		y	y
RS30	Orongorongo R at Orongorongo Stn					y			
RS31	Ruamahanga R at McLays					y			y
RS32	Ruamahanga R at Te Ore Ore			y		y	y		y
RS33	Ruamahanga R at Gladstone Br			y		y	y		y
RS34	Ruamahanga R at Pukio			y		y			y
RS36	Taueru R at Castlehill				y				
RS37	Taueru R at Gladstone			y	y	y		y	y
RS38	Kopuaranga R at Stuarts			y	y	y	y		y
RS39	Whangaehu R 250m u/s confl.			y	y				y
RS40	Waipoua R at Colombo Rd Br					y		y	y
RS41	Waingawa R at South Rd					y	y		y
RS42	Whareama R at Gauge			y	y				y
RS43	Motuwaireka S at Headwaters					y			

RS44	Totara S at Stronvar				y			
RS45	Parkvale Trib at Lowes Res.				y	y		
RS46	Parkvale S at Weir				y	y	y	
RS47	Waiohine R at Gorge				y		y	y
RS48	Waiohine R at Bicknells				y		y	y
RS49	Beef Ck at Headwaters				y			
RS50	Mangatarere S at SH 2				y	y		y
RS51	Huangarua R at Ponatahi Br				y		y	y
RS52	Tauanui R at Whakatomotomo Rd				y			
RS53	Awhea R at Tora Rd				y		y	y
RS55	Tauherenikau R at Websters			y	y			
RS56	Waiorongomai R at Forest Pk				y			
RS57	Waiwhetu S at Whites Line East	y	y					

*These samples were collected under the “additional monitoring” outlined in Section 7.

Physico-chemical and microbiological water quality

Core water quality variables measured/analysed at each RSoE site are presented in Table A2.2. As far as practicable, individual RSoE monitoring sites are sampled at the same time of the month (and usually at the same time of the day) throughout the year, and where possible all sites on a river or stream are sampled on the same day. Field meters are calibrated on the morning of the day of sampling. Water samples are collected in mid-stream (where possible), typically in run-type habitat from a representative reach of stream. Samples requiring laboratory analysis are placed in chillibins with ice and couriered overnight to RJ Hill Laboratories in Hamilton. Water samples for heavy metal and dissolved nutrient analysis were all laboratory filtered.

Table A2.2: RSoE field and analytical water quality methods and detection limits

Variable	Method	Detection limit
Water temperature	Field meter – generally YSI ProODO	0.01 °C
Dissolved oxygen	Field meter – generally YSI ProODO	0.01 mg/L
Visual clarity	Black disc (20 mm disc if clarity <0.5 m, 60 mm disc for clarity between 0.5 m and 1.5 m, 200 mm disc for clarity >1.5 m)	0.01 m
pH	Field meter – generally YSI Professional Plus	0.01 units
Conductivity	Field meter – generally YSI Professional Plus	0.1 µS/cm
Turbidity	Analysis using a Hach 2100N, Turbidity meter. APHA 2130 B 22nd Ed. 2012	0.05 NTU
Total suspended solids	Filtration using Whatman 934 AH, Advantec GC-50 or 1-2 equivalent filters (nominal pore size 1.2–1.5µm), gravimetric determination. APHA 2540 D 22nd Ed. 2012	2 mg/L
Suspended sediment concentration	Filtration using Advantec GC-50 or equivalent 125mm diameter filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. Entire sample filtered. No correction for density. Note: g/m ³ units are equivalent to mg/L. ASTM D3977-97 (Modified).	10 mg/L
Total organic carbon	Catalytic oxidation, IR detection, for Total C. Acidification, purging for Total Inorganic C. TOC = TC–TIC. APHA5310 B 22nd Ed. 2012	0.5 mg/L
Ammoniacal nitrogen	Filtered sample. Phenol/hyperchlorite colorimetry. Discrete Analyser. (NH ₄ -N = NH ₄ + -N + NH ₃ -N) APHA 4500-NH ₃ F (modified from manual analysis) 22nd Ed. 2012	0.005 mg/L
Nitrite nitrogen	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO ₂ ⁻ I (Modified) 22nd Ed. 2012	0.001 mg/L
Nitrate nitrogen	Calculation: (Nitrate-N + Nitrite-N) – Nitrite-N	0.001 mg/L
Nitrate + nitrite nitrogen	Total oxidised nitrogen. Automated cadmium reduction, Flow injection analyser. APHA 4500-NO ₃ ⁻ I (Modified) 22nd Ed. 2012	0.001 mg/L
Total Kjeldahl nitrogen	Kjeldahl digestion, phenol/hyperchlorite colorimetry (Discrete Analysis). APHA 4500-N Org C. (modified) 4500-NH ₃ F (modified) 22nd Ed. 2012	0.1 mg/L
Total nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N	0.11 mg/L ¹

Total phosphorus	Total Phosphorus digestion, ascorbic acid colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 22nd Ed. 2012	0.004 mg/L
Dissolved reactive phosphorus	Filtered sample. Molybdenum blue colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 22nd Ed. 2012	0.001 mg/L
Faecal coliforms	APHA 9222D 22 nd Ed. 2012	1 cfu/100mL
<i>E. coli</i>	APHA 9222G 22 nd Ed. 2012	1 cfu/100mL
Total recoverable copper	Nitric/Hydrochloric acid extraction, 85°C, 2.75 hr, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.0005 mg/L
Total recoverable zinc	Nitric/Hydrochloric acid extraction, 85°C, 2.75 hr, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.001 mg/L
Dissolved copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd Ed. 2012	0.0005 mg/L
Dissolved zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd Ed. 2012	0.0010 mg/L
Total hardness	Calculation from Calcium and Magnesium. APHA 2340 B 22 nd ed. 2012.	1.0 mg/L as CaCO ₃

¹ A detection limit of 0.05 mg/L can be achieved if samples are analysed in duplicate.

Periphyton

Formal periphyton assessments are limited to the 44 RSoE sites with hard substrates.

Monthly assessment of visible streambed cover

Periphyton cover is determined by estimating the percentage of mat (>0.3 cm thick), cyanobacterial mat (>0.1 cm thick) and filamentous (>2 cm long) periphyton present on the stream or river bed. Note that cover of mat and cyanobacterial mat-periphyton are not mutually exclusive (ie, cyanobacterial mat cover >0.3 cm thick will also be counted as mat-periphyton). A total of 20 observations are undertaken at each site from two transects of ten observations or, if the stream or river is not wide enough or too deep/swift to wade across more than half of the river's width, four transects of five observations. Each observation is typically made with an underwater viewer and covers an approximate area of a 30 cm diameter circle.

Visible streambed periphyton cover assessments are carried out equally in both run and riffle-type habitats if these are present at a sampling site/reach.

Annual assessment of biomass

Periphyton samples for quantitative biomass assessments (chlorophyll *a*) are collected during late summer/early autumn, typically at the time of macroinvertebrate sample collection. During 2016/17, chlorophyll *a* samples were collected from only 17 of the 44 RSoE sites with hard substrates. Sampling protocols differed in 2015/16 compared with previous years, with samples collected from run habitat and following a modified version of quantitative method 1b (QM-1b), as outlined by Biggs and Kilroy (2000) that involves pooling periphyton samples from 10 rocks into a single composite sample for analysis (See Greenfield (2016) for further details).

Macrophytes

Macrophyte cover is assessed monthly at 16 of the 53 RSoE sites (at the time of water sample collection). These sites were selected because they are either soft-bottomed sites and hence are more likely to support macrophyte communities and/or were known to have, at least at times, moderate to high macrophyte cover.

Macrophyte cover is assessed following the method in Collier et al. (2007) except that information on the native and exotic components of the macrophyte community are not recorded. This method provides a general overview of reach scale rooted macrophyte

cover (Collier et al. 2007) and involves estimating the proportion of emergent, surface reaching and submerged rooted macrophyte cover in 1 m strips at 5 evenly spaced transects along a sampling reach (~50–100 m). The proportion of channel cross sectional area (or volume) occupied by the submerged macrophyte cover in each transect is also estimated to feed into the channel cloginess calculation (following Matheson et al. 2012). Macrophyte indices are calculated as follows:

- Total macrophyte cover = \sum (% emergent cover + % surface reaching cover + % submerged cover)/5
- Macrophyte channel cloginess = \sum (% emergent cover + % surface reaching cover + (% submerged cover * % channel cross sectional area occupied by submerged cover))/5

Note: Collier et al. (2007) state that this method is most suitable for wadeable streams. Undertaking this assessment in non-wadeable streams, as well streams that are turbid or experiencing elevated flows, may result in less reliable estimates of reach scale macrophyte cover.

Macroinvertebrates

A single macroinvertebrate sample is collected at or adjacent to 37 of the 53 RSoE water sampling sites during summer/early autumn. The timing of sampling is determined at random, although macroinvertebrate sampling is, where practicable, avoided within two weeks of any flood event (flood events are defined as flows greater than three times the median river flow).

Samples are collected with the use of a kick-net (0.5 mm mesh size) following Protocol C1 of the national macroinvertebrate sampling protocols (Stark et al. 2001) for the 31 sites with hard substrate (in riffle habitat) and Protocol C2 for the six sites with a soft substrate. All samples are processed in accordance with Protocol P2 (Stark et al. 2001).

Sampling undertaken at the seven sites that were trialled as part of the development of an ecologically focused monitoring programme that utilises sites randomly selected across the region followed the above approach used at RSoE sites. All seven sites were considered to have hard substrate.

Habitat quality

Habitat assessments are undertaken annually at the 37 RSoE sites during summer/early autumn when invertebrates samples are collected following the updated methods outlined in Clapcott (2015; cf. earlier protocols in Clapcott (2013)). This assessment provides an indication of the condition of the physical habitat and its ability to support stream biota, and incorporates the following variables: deposited sediment cover, invertebrate habitat abundance and diversity, fish habitat abundance and diversity, hydraulic heterogeneity, bank erosion, and riparian width and shade. Each category is scored between 1 ('poor') and 10 ('excellent'). Summation of individual scores provides an overall total habitat quality score for each site (lowest and highest possible scores are 10 and 100, respectively).

This methodology was developed with a focus on wadeable hard-bottomed streams (Clapcott 2015) and hence its applicability to other stream/river types has not been explored.

Sampling undertaken at the seven sites that were trialled as part of the development of an ecologically focused monitoring programme that utilises sites randomly selected across the region also followed this approach.

Fine sediment streambed cover

Assessments of fine sediment streambed cover are undertaken monthly and coincide with the collection of water samples at each of the 53 RSoE sites using a modified version of Sediment Assessment Method 1 (Clapcott et al. 2011; bankside visual estimate of % sediment cover). This method involves a relatively quick visual estimate of the proportion fine sediment (<2 mm) cover of the streambed and it is undertaken from the bankside of the river. Visual estimates are typically made in run-type habitat over a representative reach (typically 20–50 m) and information on the length and width or streambed assessed is also recorded. The modification to the method is that, apart from sand, proportions of streambed cover of other substrates (eg, gravels, cobbles, etc.) are not estimated.

Fish

Assessments of fish communities were undertaken at the seven sites that were trialled as part of the ecologically focused monitoring programme applied at sites randomly selected across the region. For the four sites deemed suitable (eg, >90% of the reach <0.6 m deep and average stream/river wetted width <12 m) the backpack electric fishing protocols outlined in Joy et al. (2013) were used. These protocols were applied at sites: RAN20, RAN35, RAN54 and RAN70.

For the three larger river sites (RAN25, RAN36 and RAN68), a 500 metre reach of river was broken into the following mesohabitat types: riffle, shallow run, deep run, pool and backwater. Several representative sites within these habitat types that could be safely fished using a backpack electric fishing machine (eg, riffles and shallow runs) were then assessed. At one site, RAN36, six fine-mesh fyke nets and 12 fine-mesh Gee-minnow traps were also set and left overnight in the deeper run and pool habitat present. It's important to note that the fishing undertaken at these three larger river sites was to help the development of a suitable methodology for assessing fish communities in larger rivers as no national protocols exist. It is likely that this methodology will be refined as the monitoring programme develops.

Appendix 3: Physico-chemical and microbiological data

Table A3.1: Water temperature (°C)

Site no.	Site name	Median	Minimum	5th percentile	95th percentile	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	14.9	9.2	10.5	20.0	21.4	12
RS03	Waitohu S at Forest Pk	11.0	6.3	7.2	16.3	16.7	10
RS04	Waitohu S at Norfolk Cres	13.3	7.8	9.1	19.1	20.2	12
RS05	Otaki R at Pukehinau	10.2	5.6	6.4	18.8	19.5	12
RS06	Otaki R at Mouth	12.9	7.4	8.3	20.9	22.8	12
RS07	Mangaone S at Sims Rd Br	11.9	8.9	9.4	19.3	19.9	12
RS08	Ngarara S at Field Way	15.4	7.0	8.2	21.3	21.7	11
RS09	Waikanae R at Mangaone Walkway	11.7	5.3	6.6	16.3	16.6	12
RS10	Waikanae R at Greenaway Rd	15.3	7.6	8.3	22.4	22.5	11
RS11	Whareroa S at Waterfall Rd	12.8	6.3	7.2	16.4	16.6	11
RS12	Whareroa S at QE Park	13.9	7.8	8.8	18.4	18.7	11
RS13	Horokiri S at Snodgrass	12.6	6.2	7.4	18.1	18.3	11
RS14	Pauatahanui S at Elmwood Br	13.0	5.1	6.7	17.9	18.1	12
RS15	Porirua S at Glenside	14.0	5.9	6.8	17.9	18.0	12
RS16	Porirua S at Wall Park (Milk Depot)	14.5	5.8	6.7	18.7	18.9	12
RS17	Makara S at Kennels	15.8	5.6	6.3	20.2	20.9	12
RS18	Karori S at Makara Peak	13.6	8.4	8.9	18.2	18.5	12
RS19	Kaiwharawhara S at Ngaio Gorge	14.2	7.6	7.9	19.4	20.6	12
RS20	Hutt R at Te Marua Intake Site	11.7	6.2	6.3	18.2	18.5	12
RS21	Hutt R opp. Manor Park G.C.	14.0	8.1	8.2	20.7	22.1	12
RS22	Hutt R at Boulcott	14.3	8.1	8.4	21.4	22.6	12
RS23	Pakuratahi R 50m d/s Farm Ck	12.6	6.8	7.0	17.8	18.9	12
RS24	Mangaroa R at Te Marua	13.2	7.3	7.6	18.1	18.2	12
RS25	Akatarawa R at Hutt confl.	12.3	6.8	7.0	18.8	19.2	12
RS26	Whakatikei R at Riverstone	12.3	7.2	7.3	18.5	18.7	12
RS28	Wainuiomata R at Manuka Track	10.9	6.7	7.4	13.9	14.6	12
RS29	Wainuiomata R d/s of White Br	14.3	9.0	9.2	20.1	21.9	12
RS30	Orongorongo R at Orongorongo Stn	16.0	9.3	9.5	21.2	22.5	12
RS31	Ruamahanga R at McLays	9.3	5.7	6.0	17.0	18.0	11
RS32	Ruamahanga R at Te Ore Ore	13.5	8.0	8.8	20.1	20.5	12
RS33	Ruamahanga R at Gladstone Br	15.0	8.7	9.3	22.3	23.7	12
RS34	Ruamahanga R at Pukio	14.5	8.4	9.1	21.6	22.3	12
RS36	Taueru R at Castlehill	12.5	5.0	5.4	19.3	19.8	12
RS37	Taueru R at Gladstone	12.0	6.0	6.9	18.0	18.2	10
RS38	Kopuaranga R at Stuarts	12.2	7.5	8.7	18.0	19.2	12
RS39	Whangaehu R 250m u/s confl.	13.0	7.2	8.6	19.9	20.2	12
RS40	Waipoua R at Colombo Rd Br	16.0	7.6	7.8	21.3	21.4	12
RS41	Waingawa R at South Rd	15.5	7.1	7.7	21.0	21.2	12
RS42	Whareama R at Gauge	14.5	6.6	7.9	22.6	23.8	11
RS43	Motuwaireka S at Headwaters	11.0	5.6	6.9	17.1	17.3	11
RS44	Totara S at Stronvar	13.3	5.8	6.6	21.3	22.3	9
RS45	Parkvale Trib at Lowes Res.	12.8	10.7	10.7	14.0	14.0	10
RS46	Parkvale S at Weir	13.6	8.8	10.0	17.9	18.4	11
RS47	Waiohine R at Gorge	9.6	6.4	6.6	15.5	15.6	12
RS48	Waiohine R at Bicknells	11.9	8.3	9.2	17.6	17.8	12
RS49	Beef Ck at Headwaters	10.2	6.9	7.3	14.1	14.5	10
RS50	Mangatarere S at SH 2	12.6	8.5	9.3	15.8	16.2	12
RS51	Huangarua R at Ponatahi Br	12.8	6.8	7.7	21.6	22.2	12
RS52	Tauanui R at Whakatomotomo Rd	11.5	6.1	6.6	18.0	18.1	8
RS53	Awhea R at Tora Rd	16.2	7.9	8.0	27.9	29.6	12
RS55	Tauherenikau R at Websters	15.1	6.2	7.0	19.1	19.3	11
RS56	Waiorongomai R at Forest Pk	13.4	7.2	7.7	17.6	17.6	11
RS57	Waiwhetu S at Whites Line East	13.8	9.7	9.9	19.1	20.2	12

*Lower *n* counts for some sites reflects sampling occasions when the field meter had malfunctioned and no measurement could be made or when a site could not be accessed.

Table A3.2: Dissolved oxygen (% saturation)

Site no.	Site name	Median	Minimum	5th percentile	95th percentile	Maximum	n*
RS02	Mangapouri S at Bennetts Rd	80.9	51.6	57.8	92.6	93.3	12
RS03	Waitohu S at Forest Pk	99.8	97.5	97.8	102.0	102.2	10
RS04	Waitohu S at Norfolk Cres	89.8	40.1	57.0	95.8	96.6	12
RS05	Otaki R at Pukehinau	100.8	98.7	98.7	104.8	106.3	12
RS06	Otaki R at Mouth	104.4	97.7	98.0	113.3	114.5	12
RS07	Mangaone S at Sims Rd Br	80.2	54.8	59.9	92.0	94.7	12
RS08	Ngarara S at Field Way	54.8	5.8	14.1	69.0	70.1	11
RS09	Waikanae R at Mangaone Walkway	98.8	97.2	97.3	101.8	103.4	12
RS10	Waikanae R at Greenaway Rd	101.4	99.5	99.6	106.4	109.5	11
RS11	Whareroa S at Waterfall Rd	92.1	81.5	85.2	99.7	102.1	11
RS12	Whareroa S at QE Park	71.4	54.8	56.8	79.5	80.3	11
RS13	Horokiri S at Snodgrass	100.6	92.7	93.2	110.1	114.1	11
RS14	Pauatahanui S at Elmwood Br	96.1	82.1	82.4	100.0	101.4	12
RS15	Porirua S at Glenside	105.1	99.7	100.2	114.2	116.8	11
RS16	Porirua S at Wall Park (Milk Depot)	102.5	91.8	96.3	114.0	114.7	12
RS17	Makara S at Kennels	99.3	83.3	87.4	107.6	110.6	11
RS18	Karori S at Makara Peak	99.3	89.3	92.4	104.8	104.9	11
RS19	Kaiwharawhara S at Ngaio Gorge	101.9	96.4	98.0	111.1	113.8	11
RS20	Hutt R at Te Marua Intake Site	101.1	99.7	100.1	103.5	104.5	12
RS21	Hutt R opp. Manor Park G.C.	103.8	101.1	101.7	114.0	119.7	12
RS22	Hutt R at Boulcott	102.9	99.8	100.1	111.3	113.8	12
RS23	Pakuratahi R 50m d/s Farm Ck	97.1	94.8	94.8	102.2	103.4	12
RS24	Mangaroa R at Te Marua	105.1	98.9	99.0	115.1	119.6	12
RS25	Akatarawa R at Hutt confl.	101.7	101.0	101.1	104.0	104.2	12
RS26	Whakatikei R at Riverstone	103.1	101.3	101.5	106.6	107.0	12
RS28	Wainuiomata R at Manuka Track	98.9	95.7	95.8	102.1	102.8	12
RS29	Wainuiomata R d/s of White Br	101.9	89.6	90.3	117.5	125.0	12
RS30	Orongorongo R at Orongorongo Stn	100.9	97.4	98.3	103.5	103.5	12
RS31	Ruamahanga R at McLays	96.9	95.0	95.3	99.9	100.7	11
RS32	Ruamahanga R at Te Ore Ore	99.6	92.3	95.2	111.2	117.1	12
RS33	Ruamahanga R at Gladstone Br	102.6	94.5	95.3	125.0	136.3	12
RS34	Ruamahanga R at Pukio	100.8	95.5	95.8	109.2	109.3	12
RS36	Taueru R at Castlehill	96.3	80.0	86.2	103.8	105.1	12
RS37	Taueru R at Gladstone	83.2	58.2	60.6	99.3	99.8	10
RS38	Kopuaranga R at Stuarts	94.3	79.3	82.7	98.8	98.8	12
RS39	Whangaehu R 250m u/s confl.	98.1	12.8	33.1	139.3	165.9	12
RS40	Waipoua R at Colombo Rd Br	107.8	96.7	100.1	120.7	120.9	12
RS41	Waingawa R at South Rd	102.7	97.5	97.9	106.2	106.6	12
RS42	Whareama R at Gauge	94.1	57.5	60.0	104.3	106.2	11
RS43	Motuwaireka S at Headwaters	97.7	94.4	94.8	108.3	114.0	11
RS44	Totara S at Stronvar	98.9	26.2	52.6	109.2	112.4	9
RS45	Parkvale Trib at Lowes Res.	76.3	69.8	69.8	82.8	84.2	10
RS46	Parkvale S at Weir	91.4	63.7	65.7	109.7	111.6	11
RS47	Waiohine R at Gorge	101.0	96.9	97.6	102.7	102.8	12
RS48	Waiohine R at Bicknells	101.4	96.6	97.3	107.4	111.1	12
RS49	Beef Ck at Headwaters	100.0	96.3	96.9	102.9	103.2	10
RS50	Mangatarere S at SH 2	97.6	90.6	92.0	119.9	125.2	11
RS51	Huangarua R at Ponatahi Br	99.4	92.0	92.5	111.8	117.6	12
RS52	Tauanui R at Whakatomotomo Rd	100.3	87.7	88.3	104.4	105.4	8
RS53	Awhea R at Tora Rd	103.3	66.6	79.7	184.3	190.5	12
RS55	Tauherenikau R at Websters	101.2	96.2	96.9	104.8	105.3	11
RS56	Waiorongomai R at Forest Pk	101.6	97.4	97.7	104.6	106.0	11
RS57	Waiwhetu S at Whites Line East	78.6	38.0	40.7	135.5	148.5	12

*Lower *n* counts for some sites reflects sampling occasions when the field meter had malfunctioned and no measurement could be made or when a site could not be accessed.

Table A3.3: Dissolved oxygen (mg/L)

Site no.	Site name	Median	Minimum	5th percentile	95th percentile	Maximum	n*
RS02	Mangapouri S at Bennetts Rd	8.3	4.9	5.4	10.2	10.3	12
RS03	Waitohu S at Forest Pk	11.1	9.6	9.7	12.3	12.6	10
RS04	Waitohu S at Norfolk Cres	9.4	3.8	5.8	10.8	10.8	12
RS05	Otaki R at Pukehinau	11.4	9.3	9.6	12.7	13	12
RS06	Otaki R at Mouth	11.0	9.1	9.2	12.7	12.9	12
RS07	Mangaone S at Sims Rd Br	8.8	5.1	5.7	10.4	10.4	12
RS08	Ngarara S at Field Way	5.3	0.6	1.3	7.9	8.2	11
RS09	Waikanae R at Mangaone Walkway	10.7	9.5	9.6	12.4	12.6	12
RS10	Waikanae R at Greenaway Rd	10.2	8.8	8.9	12.1	12.1	11
RS11	Whareroa S at Waterfall Rd	9.7	8.0	8.3	12	12.1	11
RS12	Whareroa S at QE Park	6.7	5.6	5.6	9.2	9.3	11
RS13	Horokiri S at Snodgrass	10.7	8.8	8.8	13.2	13.3	11
RS14	Pauatahanui S at Elmwood Br	10.1	7.8	7.8	12.2	12.6	12
RS15	Porirua S at Glenside	11.1	9.6	9.9	12.4	12.7	11
RS16	Porirua S at Wall Park (Milk Depot)	10.9	8.5	9.3	12.5	12.9	12
RS17	Makara S at Kennels	9.7	7.6	8.0	12.4	12.7	11
RS18	Karori S at Makara Peak	10.1	9.2	9.3	11.6	11.7	11
RS19	Kaiwharawhara S at Ngaio Gorge	10.5	9.7	9.7	12.0	12.2	11
RS20	Hutt R at Te Marua Intake Site	10.9	9.7	9.7	12.4	12.5	12
RS21	Hutt R opp. Manor Park G.C.	10.8	9.9	10.0	12.1	12.2	12
RS22	Hutt R at Boulcott	10.4	9.4	9.5	11.9	12.0	12
RS23	Pakuratahi R 50m d/s Farm Ck	10.3	9.2	9.4	12.0	12.1	12
RS24	Mangaroa R at Te Marua	11.0	10.5	10.5	11.8	12.0	12
RS25	Akatarawa R at Hutt confl.	10.8	9.6	9.7	12.4	12.5	12
RS26	Whakatikei R at Riverstone	10.8	9.9	10.0	12.4	12.4	12
RS28	Wainuiomata R at Manuka Track	11.1	9.7	9.9	12.0	12.4	12
RS29	Wainuiomata R d/s of White Br	10.8	7.9	8.9	11.9	12.2	12
RS30	Orongorongo R at Orongorongo Stn	10.0	8.7	8.9	11.2	11.4	12
RS31	Ruamahanga R at McLays	11.2	9.1	9.2	12.4	12.4	11
RS32	Ruamahanga R at Te Ore Ore	10.8	8.3	8.7	12.0	12.1	12
RS33	Ruamahanga R at Gladstone Br	10.8	9.1	9.4	12.2	12.6	11
RS34	Ruamahanga R at Pukio	10.6	8.9	9.0	11.6	11.7	12
RS36	Taueru R at Castlehill	10.6	8.6	9.1	12.1	12.2	12
RS37	Taueru R at Gladstone	9.5	5.5	5.7	11.3	11.5	10
RS38	Kopuaranga R at Stuarts	10.0	7.3	7.9	11.5	11.8	12
RS39	Whangaehu R 250m u/s confl.	10.6	1.1	3.2	14.0	15.1	12
RS40	Waipoua R at Colombo Rd Br	10.8	9.8	9.9	12.3	12.7	12
RS41	Waingawa R at South Rd	10.5	9.2	9.3	12.0	12.1	12
RS42	Whareama R at Gauge	9.6	5.5	5.7	11.9	12.2	11
RS43	Motuwaireka S at Headwaters	10.5	9.0	9.1	12.8	13.4	11
RS44	Totara S at Stronvar	10.8	2.4	4.6	12.9	13.2	9
RS45	Parkvale Trib at Lowes Res.	8.0	7.2	7.3	9.0	9.0	10
RS46	Parkvale S at Weir	9.6	6.1	6.2	11.9	12.2	11
RS47	Waiohine R at Gorge	11.4	9.8	9.9	12.3	12.5	12
RS48	Waiohine R at Bicknells	10.7	9.6	10.1	11.9	12.1	12
RS49	Beef Ck at Headwaters	11.1	10	10.2	12.3	12.3	10
RS50	Mangatarere S at SH 2	10.7	9.6	9.6	12.1	12.3	11
RS51	Huangarua R at Ponatahi Br	10.5	8.7	9.1	11.8	12.4	12
RS52	Tauanui R at Whakatomotomo Rd	10.7	8.4	8.8	12.5	12.6	8
RS53	Awhea R at Tora Rd	11.6	7.1	7.9	15.2	16.1	12
RS55	Tauherenikau R at Websters	10.2	9.4	9.5	12.3	12.4	11
RS56	Waiorongomai R at Forest Pk	10.2	9.6	9.7	12.2	12.2	11
RS57	Waiwhetu S at Whites Line East	8.4	3.7	4.0	11.9	12.1	12

*Lower n counts for some sites reflects sampling occasions when the field meter had malfunctioned and no measurement could be made or when a site could not be accessed.

Table A3.4: pH – field meter

Site no.	Site name	Median	Minimum	5th percentile	95th percentile	Maximum	n*
RS02	Mangapouri S at Bennetts Rd	6.8	6.6	6.6	7.0	7.0	11
RS03	Waitohu S at Forest Pk	7.4	6.5	6.9	7.6	7.7	10
RS04	Waitohu S at Norfolk Cres	6.8	6.4	6.5	6.9	6.9	12
RS05	Otaki R at Pukehinau	7.3	6.8	6.9	7.7	7.9	12
RS06	Otaki R at Mouth	7.4	6.9	7.0	8.1	8.2	12
RS07	Mangaone S at Sims Rd Br	6.9	6.5	6.5	7.1	7.1	12
RS08	Ngarara S at Field Way	6.9	6.7	6.7	7.0	7.0	11
RS09	Waikanae R at Mangaone Walkway	7.4	6.9	7.0	7.6	7.7	12
RS10	Waikanae R at Greenaway Rd	7.3	7.0	7.0	7.4	7.4	11
RS11	Whareroa S at Waterfall Rd	7.4	7.0	7.2	7.5	7.6	11
RS12	Whareroa S at QE Park	6.8	6.5	6.6	7.2	7.5	11
RS13	Horokiri S at Snodgrass	7.3	7.0	7.1	7.5	7.5	11
RS14	Pauatahanui S at Elmwood Br	7.3	6.8	6.8	7.6	7.7	12
RS15	Porirua S at Glenside	7.5	7.3	7.3	8.0	8.1	12
RS16	Porirua S at Wall Park (Milk Depot)	7.3	7.0	7.1	8.0	8.2	12
RS17	Makara S at Kennels	7.3	7.1	7.1	7.6	7.7	12
RS18	Karori S at Makara Peak	7.1	6.8	6.9	7.4	7.4	12
RS19	Kaiwharawhara S at Ngaio Gorge	7.6	7.4	7.5	8.0	8.2	11
RS20	Hutt R at Te Marua Intake Site	7.1	6.8	6.8	7.4	7.5	12
RS21	Hutt R opp. Manor Park G.C.	7.1	6.9	6.9	7.4	7.5	12
RS22	Hutt R at Boulcott	7.0	6.7	6.8	7.3	7.3	12
RS23	Pakuratahi R 50m d/s Farm Ck	6.7	6.1	6.3	7.0	7.0	12
RS24	Mangaroa R at Te Marua	7.1	6.6	6.7	7.4	7.6	12
RS25	Akatarawa R at Hutt confl.	7.0	6.6	6.8	7.5	7.6	12
RS26	Whakatikei R at Riverstone	7.3	6.8	6.9	7.7	7.7	12
RS28	Wainuiomata R at Manuka Track	7.2	6.7	6.9	7.4	7.4	11
RS29	Wainuiomata R d/s of White Br	7.3	6.9	7.0	8.1	8.3	11
RS30	Orongorongo R at Orongorongo Stn	7.7	7.3	7.4	8.2	8.5	11
RS31	Ruamahanga R at McLays	7.1	6.5	6.6	7.6	7.7	10
RS32	Ruamahanga R at Te Ore Ore	7.7	7.2	7.3	8.0	8.1	11
RS33	Ruamahanga R at Gladstone Br	7.6	7.0	7.0	8.4	8.8	11
RS34	Ruamahanga R at Pukio	7.6	7.0	7.1	8.0	8.2	11
RS36	Taueru R at Castlehill	7.7	6.2	6.5	8.0	8.0	10
RS37	Taueru R at Gladstone	7.7	7.0	7.1	8.0	8.0	10
RS38	Kopuaranga R at Stuarts	7.7	7.2	7.3	8.0	8.0	11
RS39	Whangaehu R 250m u/s confl.	7.5	6.8	6.8	8.1	8.4	11
RS40	Waipoua R at Colombo Rd Br	7.4	6.7	6.9	8.0	8.1	11
RS41	Waingawa R at South Rd	7.3	6.9	7.0	7.8	8.0	11
RS42	Whareama R at Gauge	7.9	7.6	7.7	8.2	8.3	10
RS43	Motuwaireka S at Headwaters	7.9	7.2	7.4	8.0	8.0	10
RS44	Totara S at Stronvar	7.6	7.3	7.3	7.8	7.8	8
RS45	Parkvale Trib at Lowes Res.	6.5	6.3	6.3	6.6	6.6	9
RS46	Parkvale S at Weir	7.1	6.8	6.9	7.8	8.0	10
RS47	Waiohine R at Gorge	7.5	6.3	6.6	7.8	7.8	10
RS48	Waiohine R at Bicknells	7.1	6.1	6.4	7.4	7.5	10
RS49	Beef Ck at Headwaters	7.5	7.1	7.1	7.7	7.8	9
RS50	Mangatarere S at SH 2	7.0	6.6	6.6	7.2	7.2	10
RS51	Huangarua R at Ponatahi Br	7.7	7.5	7.5	8.1	8.1	11
RS52	Tauanui R at Whakatomotomo Rd	7.7	7.6	7.6	7.8	7.8	7
RS53	Awhea R at Tora Rd	8.1	7.5	7.6	8.7	8.7	11
RS55	Tauherenikau R at Websters	7.3	6.7	6.7	7.6	7.6	10
RS56	Waiorongomai R at Forest Pk	7.3	7.1	7.1	7.6	7.6	10
RS57	Waiwhetu S at Whites Line East	6.6	6.3	6.3	7.0	7.0	11

*Lower n counts for some sites reflects sampling occasions when the field meter had malfunctioned and no measurement could be made or when a site could not be accessed.

Table A3.5: Visual clarity (m)

Site no.	Site name	Median	Minimum	Maximum	n*
RS02	Mangapouri S at Bennetts Rd	0.78	<0.20	1.72	11
RS03	Waitohu S at Forest Pk	3.04	0.53	5.19	9
RS04	Waitohu S at Norfolk Cres	0.86	0.22	2.57	11
RS05	Otaki R at Pukehinau	4.91	1.20	10.71	11
RS06	Otaki R at Mouth	4.68	0.80	9.51	11
RS07	Mangaone S at Sims Rd Br	0.74	0.30	1.48	11
RS08	Ngarara S at Field Way	0.61	0.36	1.01	11
RS09	Waikanae R at Mangaone Walkway	4.39	2.53	6.21	12
RS10	Waikanae R at Greenaway Rd	5.15	1.49	9.63	11
RS11	Whareroa S at Waterfall Rd	1.10	0.65	>2.00	11
RS12	Whareroa S at QE Park	0.99	0.63	1.98	11
RS13	Horokiri S at Snodgrass	2.62	1.71	4.14	11
RS14	Pauatahanui S at Elmwood Br	2.07	1.27	3.03	12
RS15	Porirua S at Glenside	3.07	0.46	5.39	12
RS16	Porirua S at Wall Park (Milk Depot)	2.64	0.23	5.42	12
RS17	Makara S at Kennels	1.64	0.32	2.59	12
RS18	Karori S at Makara Peak	3.76	0.94	6.80	12
RS19	Kaiwharawhara S at Ngaio Gorge	5.64	0.66	8.00	11
RS20	Hutt R at Te Marua Intake Site	5.61	1.67	8.70	12
RS21	Hutt R opp. Manor Park G.C.	4.38	1.01	8.25	12
RS22	Hutt R at Boulcott	4.60	0.76	8.04	12
RS23	Pakuratahi R 50m d/s Farm Ck	5.84	1.96	9.98	12
RS24	Mangaroa R at Te Marua	2.26	0.92	3.86	12
RS25	Akatarawa R at Hutt confl.	5.68	3.17	8.45	12
RS26	Whakatikei R at Riverstone	5.47	3.25	7.52	12
RS28	Wainuiomata R at Manuka Track	2.90	2.22	3.53	12
RS29	Wainuiomata R d/s of White Br	2.92	1.02	4.96	12
RS30	Orongorongo R at Orongorongo Stn	3.01	0.24	7.92	12
RS31	Ruamahanga R at McLays	7.51	1.07	10.6	11
RS32	Ruamahanga R at Te Ore Ore	1.96	0.11	8.05	12
RS33	Ruamahanga R at Gladstone Br	2.52	0.24	7.70	12
RS34	Ruamahanga R at Pukio	2.01	0.20	5.98	12
RS36	Taueru R at Castlehill	1.56	0.20	2.97	12
RS37	Taueru R at Gladstone	2.11	0.34	5.30	11
RS38	Kopuaranga R at Stuarts	1.73	0.31	4.52	12
RS39	Whangaehu R 250m u/s confl.	1.68	0.31	2.39	10
RS40	Waipoua R at Colombo Rd Br	4.44	0.51	7.68	12
RS41	Waingawa R at South Rd	4.32	0.20	8.00	12
RS42	Whareama R at Gauge	1.34	0.16	>2.00	10
RS43	Motuwaireka S at Headwaters	2.25	1.00	3.01	10
RS44	Totara S at Stronvar	3.02	2.11	5.14	8
RS45	Parkvale Trib at Lowes Res.	2.47	1.00	3.51	10
RS46	Parkvale S at Weir	1.70	1.02	4.01	11
RS47	Waiohine R at Gorge	5.40	0.14	10.53	12
RS48	Waiohine R at Bicknells	2.03	0.13	7.62	12
RS49	Beef Ck at Headwaters	2.90	1.48	3.74	10
RS50	Mangatarere S at SH 2	2.12	0.45	5.52	12
RS51	Huangarua R at Ponatahi Br	4.22	0.34	7.60	12
RS52	Tauanui R at Whakatomotomo Rd	4.74	2.13	6.33	8
RS53	Awhea R at Tora Rd	2.41	0.08	5.60	10
RS55	Tauherenikau R at Websters	3.64	0.35	10.2	11
RS56	Waiorongomai R at Forest Pk	4.53	0.41	8.26	11
RS57	Waiwhetu S at Whites Line East	0.95	0.24	2.04	12

*Lower n counts for some sites reflects sampling occasions when the field equipment was broken and no measurement could be made or when a site could not be accessed.

Table A3.6: Turbidity (NTU)

Site no.	Site name	Median	Minimum	Maximum	n*
RS02	Mangapouri S at Bennetts Rd	6.8	4.6	107.0	12
RS03	Waitohu S at Forest Pk	1.0	0.4	9.4	10
RS04	Waitohu S at Norfolk Cres	5.2	2.9	51.0	12
RS05	Otaki R at Pukehinau	1.1	0.3	4.9	12
RS06	Otaki R at Mouth	1.2	0.4	6.8	12
RS07	Mangaone S at Sims Rd Br	9.1	4.3	23.0	12
RS08	Ngarara S at Field Way	7.1	4.4	25.0	11
RS09	Waikanae R at Mangaone Walkway	0.6	0.3	1.2	12
RS10	Waikanae R at Greenaway Rd	0.7	0.3	3.4	12
RS11	Whareroa S at Waterfall Rd	4.6	1.6	10.5	11
RS12	Whareroa S at QE Park	5.3	2.0	10.3	11
RS13	Horokiri S at Snodgrass	1.3	0.5	2.8	11
RS14	Pauatahanui S at Elmwood Br	1.9	1.1	5.4	12
RS15	Porirua S at Glenside	1.3	0.7	16.4	12
RS16	Porirua S at Wall Park (Milk Depot)	2.0	1.3	82.0	12
RS17	Makara S at Kennels	3.0	1.9	32.0	12
RS18	Karori S at Makara Peak	1.0	0.5	6.1	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.8	0.3	11.4	12
RS20	Hutt R at Te Marua Intake Site	0.6	0.3	2.3	12
RS21	Hutt R opp. Manor Park G.C.	0.7	0.4	5.3	12
RS22	Hutt R at Boulcott	0.6	0.4	11.1	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.5	0.2	2.0	12
RS24	Mangaroa R at Te Marua	1.3	0.6	5.4	12
RS25	Akatarawa R at Hutt confl.	0.3	0.3	1.7	12
RS26	Whakatikei R at Riverstone	0.5	0.3	1.2	12
RS28	Wainuiomata R at Manuka Track	0.8	0.6	1.6	12
RS29	Wainuiomata R d/s of White Br	1.2	0.7	4.3	12
RS30	Orongorongo R at Orongorongo Stn	1.5	0.6	28.0	12
RS31	Ruamahanga R at McLays	0.4	0.2	5.2	11
RS32	Ruamahanga R at Te Ore Ore	2.2	0.3	73.0	12
RS33	Ruamahanga R at Gladstone Br	1.7	0.3	38.0	12
RS34	Ruamahanga R at Pukio	2.8	0.7	37.0	12
RS36	Taueru R at Castlehill	3.3	1.6	19.5	12
RS37	Taueru R at Gladstone	1.3	0.9	22.0	11
RS38	Kopuaranga R at Stuarts	2.5	0.5	16.0	12
RS39	Whangaehu R 250m u/s confl.	2.3	1.3	13.1	12
RS40	Waipoua R at Colombo Rd Br	0.6	0.3	13.1	12
RS41	Waingawa R at South Rd	1.3	0.4	163.0	12
RS42	Whareama R at Gauge	3.5	1.3	74.0	11
RS43	Motuwaiereka S at Headwaters	0.5	0.2	1.2	11
RS44	Totara S at Stronvar	0.6	0.2	1.8	9
RS45	Parkvale Trib at Lowes Res.	0.5	0.2	0.7	10
RS46	Parkvale S at Weir	1.6	0.5	5.8	11
RS47	Waiohine R at Gorge	0.7	0.2	62.0	12
RS48	Waiohine R at Bicknells	2.4	0.6	88.0	12
RS49	Beef Ck at Headwaters	1.1	0.7	1.5	10
RS50	Mangatarere S at SH 2	1.0	0.4	9.6	12
RS51	Huangarua R at Ponatahi Br	0.4	0.3	21.0	12
RS52	Tauanui R at Whakatomotomo Rd	0.4	0.3	2.4	8
RS53	Awhea R at Tora Rd	1.8	0.4	94.0	12
RS55	Tauherenikau R at Websters	1.1	0.3	220.0	11
RS56	Waiorongomai R at Forest Pk	0.7	0.3	28.0	11
RS57	Waiwhetu S at Whites Line East	6.2	2.3	50.0	12

*Lower n counts for some sites reflect sampling occasions when a site could not be accessed.

Table A3.7: Total suspended solids (mg/L)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS10	Waikanae R at Greenaway Rd	1.0	<2	<2	12
RS13	Horokiri S at Snodgrass	1.0	<2	<2	11
RS14	Pauatahanui S at Elmwood Br	1.0	<2	4.0	12
RS15	Porirua S at Glenside	1.0	<2	14.0	12
RS16	Porirua S at Wall Park (Milk Depot)	1.0	<2	230.0	12
RS21	Hutt R opp. Manor Park G.C.	1.0	<2	3.0	12
RS22	Hutt R at Boulcott	1.0	<2	5.0	12
RS32	Ruamahanga R at Te Ore Ore	2.0	<2	81.0	12
RS33	Ruamahanga R at Gladstone Br	1.0	<2	60.0	12
RS34	Ruamahanga R at Pukio	1.5	<2	49.0	12
RS37	Taueru R at Gladstone	1.0	<2	19.0	11
RS38	Kopuaranga R at Stuarts	2.5	<2	21.0	12
RS39	Whangaehu R 250m u/s confl.	2.0	<2	14.0	12
RS42	Whareama R at Gauge	3.0	<2	84.0	11
RS55	Tauherenikau R at Websters	1.0	<2	700.0	11

*Lower *n* counts for some sites reflect sampling occasions when a site could not be accessed.

Table A3.8: Suspended sediment concentration (mg/L)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS10	Waikanae R at Greenaway Rd	5.5	<10	<11	11
RS13	Horokiri S at Snodgrass	5.0	<10	<11	11
RS14	Pauatahanui S at Elmwood Br	5.3	<10	<11	12
RS15	Porirua S at Glenside	5.0	<10	<11	12
RS16	Porirua S at Wall Park (Milk Depot)	5.0	<10	250.0	12
RS21	Hutt R opp. Manor Park G.C.	5.0	<10	<11	12
RS22	Hutt R at Boulcott	5.0	<10	<11	11
RS32	Ruamahanga R at Te Ore Ore	5.3	<10	96.0	12
RS33	Ruamahanga R at Gladstone Br	5.3	<10	67.0	12
RS34	Ruamahanga R at Pukio	5.5	<10	55.0	12
RS37	Taueru R at Gladstone	5.5	<10	22.0	11
RS38	Kopuaranga R at Stuarts	5.5	<10	23.0	12
RS39	Whangaehu R 250m u/s confl.	5.5	<10	15.0	12
RS42	Whareama R at Gauge	5.5	<10	91.0	11
RS55	Tauherenikau R at Websters	5.5	<10	590.0	11

*Lower *n* counts for some sites reflect sampling occasions when a site could not be accessed.

Table A3.9: Electrical conductivity – field meter ($\mu\text{S}/\text{cm}$)

Site no.	Site name	Median	Minimum	5th percentile	95th percentile	Maximum	n*
RS02	Mangapouri S at Bennetts Rd	213	181	193	234	235	11
RS03	Waitohu S at Forest Pk	89	75	78	97	102	10
RS04	Waitohu S at Norfolk Cres	150	67	93	191	203	12
RS05	Otaki R at Pukehinau	65	48	51	82	84	12
RS06	Otaki R at Mouth	66	50	56	84	85	12
RS07	Mangaone S at Sims Rd Br	209	158	167	295	383	12
RS08	Ngarara S at Field Way	314	207	241	636	928	11
RS09	Waikanae R at Mangaone Walkway	88	84	84	94	95	12
RS10	Waikanae R at Greenaway Rd	106	95	97	117	123	11
RS11	Whareroa S at Waterfall Rd	255	233	234	285	288	11
RS12	Whareroa S at QE Park	293	248	250	300	300	11
RS13	Horokiri S at Snodgrass	201	184	189	213	214	11
RS14	Pauatahanui S at Elmwood Br	182	167	170	209	210	12
RS15	Porirua S at Glenside	268	181	193	276	278	12
RS16	Porirua S at Wall Park (Milk Depot)	260	185	202	276	278	12
RS17	Makara S at Kennels	299	235	251	351	362	12
RS18	Karori S at Makara Peak	231	195	201	243	248	12
RS19	Kaiwharawhara S at Ngaio Gorge	305	236	260	315	315	12
RS20	Hutt R at Te Marua Intake Site	76	66	66	86	86	12
RS21	Hutt R opp. Manor Park G.C.	97	79	82	109	110	12
RS22	Hutt R at Boulcott	97	87	87	112	113	12
RS23	Pakuratahi R 50m d/s Farm Ck	89	77	80	94	95	12
RS24	Mangaroa R at Te Marua	110	97	100	123	127	12
RS25	Akatarawa R at Hutt confl.	87	53	67	96	96	12
RS26	Whakatikei R at Riverstone	118	106	109	127	127	12
RS28	Wainuiomata R at Manuka Track	111	97	98	120	121	11
RS29	Wainuiomata R d/s of White Br	142	124	127	151	151	11
RS30	Orongorongo R at Orongorongo Stn	146	121	124	170	172	11
RS31	Ruamahanga R at McLays	53	36	40	59	60	10
RS32	Ruamahanga R at Te Ore Ore	124	61	66	167	170	11
RS33	Ruamahanga R at Gladstone Br	107	61	67	131	132	11
RS34	Ruamahanga R at Pukio	112	75	76	168	171	11
RS36	Taueru R at Castlehill	235	189	202	322	339	10
RS37	Taueru R at Gladstone	442	290	342	461	461	10
RS38	Kopuaranga R at Stuarts	265	146	180	408	411	11
RS39	Whangaehu R 250m u/s confl.	346	313	319	477	565	11
RS40	Waipoua R at Colombo Rd Br	100	77	78	116	119	11
RS41	Waingawa R at South Rd	57	48	48	67	69	11
RS42	Whareama R at Gauge	622	401	439	698	704	10
RS43	Motuwaireka S at Headwaters	303	200	217	410	420	10
RS44	Totara S at Stronvar	295	224	235	405	434	8
RS45	Parkvale Trib at Lowes Res.	175	151	154	185	187	9
RS46	Parkvale S at Weir	155	139	145	169	170	10
RS47	Waiohine R at Gorge	55	27	37	62	63	10
RS48	Waiohine R at Bicknells	67	32	43	79	81	10
RS49	Beef Ck at Headwaters	99	79	82	123	125	9
RS50	Mangatarere S at SH 2	117	95	97	141	148	10
RS51	Huangarua R at Ponatahi Br	431	277	282	532	556	11
RS52	Tauanui R at Whakatomotomo Rd	147	101	109	182	183	7
RS53	Awhea R at Tora Rd	466	347	380	515	520	11
RS55	Tauherenikau R at Websters	69	51	54	80	82	10
RS56	Waiorongomai R at Forest Pk	122	96	104	148	148	10
RS57	Waiwhetu S at Whites Line East	242	84	131	261	266	11

*Lower n counts for some sites reflects sampling occasions when the field meter had malfunctioned and no measurement could be made or when a site could not be accessed.

Table A3.10: Total organic carbon (mg/L)

Site no.	Site name	Median	Minimum	Maximum	n*
RS02	Mangapouri S at Bennetts Rd	6.8	3.8	27	12
RS03	Waitohu S at Forest Pk	1.9	1.1	8.7	10
RS04	Waitohu S at Norfolk Cres	3.2	1.0	8.9	12
RS05	Otaki R at Pukehinau	1.1	0.6	4.5	12
RS06	Otaki R at Mouth	0.9	0.3	4.1	12
RS07	Mangaone S at Sims Rd Br	3.9	2.6	12.4	12
RS08	Ngarara S at Field Way	16.8	10.6	22	11
RS09	Waikanae R at Mangaone Walkway	1.1	0.3	2.2	12
RS10	Waikanae R at Greenaway Rd	1.1	0.7	2.2	12
RS11	Whareroa S at Waterfall Rd	2.7	2.2	4.5	11
RS12	Whareroa S at QE Park	11.7	7.5	23	11
RS13	Horokiri S at Snodgrass	1.9	1.3	2.2	11
RS14	Pauatahanui S at Elmwood Br	3.1	2.6	5.7	12
RS15	Porirua S at Glenside	2.7	1.6	5.7	12
RS16	Porirua S at Wall Park (Milk Depot)	2.8	2.1	14.5	12
RS17	Makara S at Kennels	4.0	3.4	8.0	12
RS18	Karori S at Makara Peak	1.8	1.3	5.6	12
RS19	Kaiwharawhara S at Ngaio Gorge	2.7	2.0	4.7	12
RS20	Hutt R at Te Marua Intake Site	1.6	0.9	4.0	12
RS21	Hutt R opp. Manor Park G.C.	1.6	0.8	4.2	12
RS22	Hutt R at Boulcott	1.6	1.1	4.1	12
RS23	Pakuratahi R 50m d/s Farm Ck	1.8	1.2	4.5	12
RS24	Mangaroa R at Te Marua	3.8	1.4	8.5	12
RS25	Akatarawa R at Hutt confl.	1.7	0.8	2.6	12
RS26	Whakatikei R at Riverstone	1.4	0.8	2.2	12
RS28	Wainuiomata R at Manuka Track	1.6	1.2	3.7	12
RS29	Wainuiomata R d/s of White Br	1.6	0.7	2.2	12
RS30	Orongorongo R at Orongorongo Stn	1.0	0.3	2.7	12
RS31	Ruamahanga R at McLays	1.0	0.3	3.0	11
RS32	Ruamahanga R at Te Ore Ore	2.0	0.3	3.8	12
RS33	Ruamahanga R at Gladstone Br	1.4	0.6	3.4	12
RS34	Ruamahanga R at Pukio	1.8	0.7	3.6	12
RS36	Taueru R at Castlehill	4.2	1.8	9.9	12
RS37	Taueru R at Gladstone	2.7	0.3	9.4	11
RS38	Kopuaranga R at Stuarts	2.0	0.3	7.7	12
RS39	Whangaehu R 250m u/s confl.	8.1	1.6	13.9	12
RS40	Waipoua R at Colombo Rd Br	1.6	0.9	3.9	12
RS41	Waingawa R at South Rd	1.0	0.3	11.8	12
RS42	Whareama R at Gauge	6.3	2.8	9.0	11
RS43	Motuwaireka S at Headwaters	1.5	0.3	3.3	11
RS44	Totara S at Stronvar	2.8	1.8	4.2	9
RS45	Parkvale Trib at Lowes Res.	3.0	1.4	5.3	10
RS46	Parkvale S at Weir	4.8	3.6	6.7	11
RS47	Waiohine R at Gorge	1.3	0.6	6.1	12
RS48	Waiohine R at Bicknells	1.4	0.3	5.5	12
RS49	Beef Ck at Headwaters	1.3	0.5	3.0	10
RS50	Mangatarere S at SH 2	1.6	0.6	3.8	12
RS51	Huangarua R at Ponatahi Br	1.1	0.3	6.7	12
RS52	Tauanui R at Whakatomotomo Rd	1.6	0.3	2.5	8
RS53	Awhea R at Tora Rd	1.8	0.3	7.8	12
RS55	Tauherenikau R at Websters	1.0	0.3	13.1	11
RS56	Waiorongomai R at Forest Pk	2.0	0.7	13.2	11
RS57	Waiwhetu S at Whites Line East	2.8	1.4	10.0	12

*Lower n counts for some sites reflect sampling occasions when a site could not be accessed.

Table A3.11: Ammoniacal nitrogen (mg/L)

Site no.	Site name	Median	Minimum	Maximum	n*
RS02	Mangapouri S at Bennetts Rd	0.042	0.011	0.109	12
RS03	Waitohu S at Forest Pk	0.003	<0.005	0.008	10
RS04	Waitohu S at Norfolk Cres	0.016	<0.005	0.060	12
RS05	Otaki R at Pukehinau	0.003	<0.005	0.006	12
RS06	Otaki R at Mouth	0.003	<0.005	0.007	12
RS07	Mangaone S at Sims Rd Br	0.099	0.041	0.150	12
RS08	Ngarara S at Field Way	0.023	<0.005	0.052	11
RS09	Waikanae R at Mangaone Walkway	0.003	<0.005	0.007	12
RS10	Waikanae R at Greenaway Rd	0.003	<0.005	0.007	12
RS11	Whareroa S at Waterfall Rd	0.003	<0.005	0.007	11
RS12	Whareroa S at QE Park	0.049	0.016	0.200	11
RS13	Horokiri S at Snodgrass	0.003	<0.005	0.012	11
RS14	Pauatahanui S at Elmwood Br	0.009	<0.005	0.022	12
RS15	Porirua S at Glenside	0.003	<0.005	0.013	12
RS16	Porirua S at Wall Park (Milk Depot)	0.013	<0.005	0.089	12
RS17	Makara S at Kennels	0.010	<0.005	0.037	12
RS18	Karori S at Makara Peak	0.015	<0.005	0.034	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.003	<0.005	0.052	12
RS20	Hutt R at Te Marua Intake Site	0.003	<0.005	0.006	12
RS21	Hutt R opp. Manor Park G.C.	0.003	<0.005	0.009	12
RS22	Hutt R at Boulcott	0.003	<0.005	<0.005	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.003	<0.005	<0.005	12
RS24	Mangaroa R at Te Marua	0.003	<0.005	0.015	12
RS25	Akatarawa R at Hutt confl.	0.003	<0.005	<0.005	12
RS26	Whakatikei R at Riverstone	0.003	<0.005	0.006	12
RS28	Wainuiomata R at Manuka Track	0.003	<0.005	0.005	12
RS29	Wainuiomata R d/s of White Br	0.009	<0.005	0.013	12
RS30	Orongorongo R at Orongorongo Stn	0.003	<0.005	<0.005	12
RS31	Ruamahanga R at McLays	0.003	<0.005	0.006	11
RS32	Ruamahanga R at Te Ore Ore	0.003	<0.005	0.006	12
RS33	Ruamahanga R at Gladstone Br	0.003	<0.005	0.114	12
RS34	Ruamahanga R at Pukio	0.007	<0.005	0.049	12
RS36	Taueru R at Castlehill	0.006	<0.005	0.027	12
RS37	Taueru R at Gladstone	0.003	<0.005	0.051	11
RS38	Kopuaranga R at Stuarts	0.004	<0.005	0.019	12
RS39	Whangaehu R 250m u/s confl.	0.003	<0.005	0.027	12
RS40	Waipoua R at Colombo Rd Br	0.003	<0.005	0.007	12
RS41	Waingawa R at South Rd	0.003	<0.005	0.012	12
RS42	Whareama R at Gauge	0.003	<0.005	0.018	11
RS43	Motuwaireka S at Headwaters	0.003	<0.005	0.005	11
RS44	Totara S at Stronvar	0.003	<0.005	0.026	9
RS45	Parkvale Trib at Lowes Res.	0.003	<0.005	0.006	10
RS46	Parkvale S at Weir	0.011	<0.005	0.090	11
RS47	Waiohine R at Gorge	0.003	<0.005	<0.005	12
RS48	Waiohine R at Bicknells	0.003	<0.005	0.028	12
RS49	Beef Ck at Headwaters	0.003	<0.005	0.005	10
RS50	Mangatarere S at SH 2	0.012	<0.005	0.290	12
RS51	Huangarua R at Ponatahi Br	0.003	<0.005	0.006	12
RS52	Tauanui R at Whakatomotomo Rd	0.003	<0.005	<0.005	8
RS53	Awhea R at Tora Rd	0.003	<0.005	0.020	12
RS55	Tauherenikau R at Websters	0.003	<0.005	0.012	11
RS56	Waiorongomai R at Forest Pk	0.003	<0.005	0.013	11
RS57	Waiwhetu S at Whites Line East	0.068	<0.005	0.300	12

*Lower n counts for some sites reflect sampling occasions when a site could not be accessed.

Table A3.12: Nitrite-nitrate nitrogen (mg/L)

Site no.	Site name	Median	Minimum	Maximum	n*
RS02	Mangapouri S at Bennetts Rd	1.605	0.460	3.00	12
RS03	Waitohu S at Forest Pk	0.024	0.009	0.048	10
RS04	Waitohu S at Norfolk Cres	0.455	0.230	0.910	12
RS05	Otaki R at Pukehinau	0.034	0.009	0.060	12
RS06	Otaki R at Mouth	0.040	0.011	0.123	12
RS07	Mangaone S at Sims Rd Br	1.440	0.880	2.900	12
RS08	Ngarara S at Field Way	0.023	0.002	0.510	11
RS09	Waikanae R at Mangaone Walkway	0.133	0.064	0.190	12
RS10	Waikanae R at Greenaway Rd	0.194	0.068	0.420	12
RS11	Whareroa S at Waterfall Rd	0.310	0.240	0.740	11
RS12	Whareroa S at QE Park	0.091	0.018	0.650	11
RS13	Horokiri S at Snodgrass	0.640	0.070	0.970	11
RS14	Pauatahanui S at Elmwood Br	0.305	<0.001	0.720	12
RS15	Porirua S at Glenside	0.795	0.300	1.550	12
RS16	Porirua S at Wall Park (Milk Depot)	0.770	0.270	1.480	12
RS17	Makara S at Kennels	0.155	<0.001	1.120	12
RS18	Karori S at Makara Peak	1.300	0.960	1.600	12
RS19	Kaiwharawhara S at Ngaio Gorge	1.195	0.940	1.490	12
RS20	Hutt R at Te Marua Intake Site	0.075	0.043	0.126	12
RS21	Hutt R opp. Manor Park G.C.	0.208	0.122	0.350	12
RS22	Hutt R at Boulcott	0.205	0.089	0.330	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.204	0.150	0.350	12
RS24	Mangaroa R at Te Marua	0.485	0.390	0.670	12
RS25	Akatarawa R at Hutt confl.	0.067	0.012	0.177	12
RS26	Whakatikei R at Riverstone	0.118	0.027	0.300	12
RS28	Wainuiomata R at Manuka Track	0.060	0.017	0.091	12
RS29	Wainuiomata R d/s of White Br	0.091	0.002	0.360	12
RS30	Orongorongo R at Orongorongo Stn	0.029	0.005	0.115	12
RS31	Ruamahanga R at McLays	0.021	0.006	0.040	11
RS32	Ruamahanga R at Te Ore Ore	0.315	0.129	0.750	12
RS33	Ruamahanga R at Gladstone Br	0.315	0.150	0.750	12
RS34	Ruamahanga R at Pukio	0.265	0.001	0.830	12
RS36	Taueru R at Castlehill	0.082	0.004	0.710	12
RS37	Taueru R at Gladstone	1.020	0.520	1.770	11
RS38	Kopuaranga R at Stuarts	1.000	0.770	1.380	12
RS39	Whangaehu R 250m u/s confl.	0.550	0.001	2.200	12
RS40	Waipoua R at Colombo Rd Br	0.625	0.210	1.370	12
RS41	Waingawa R at South Rd	0.055	0.006	0.200	12
RS42	Whareama R at Gauge	0.002	<0.001	0.540	11
RS43	Motuwaireka S at Headwaters	0.023	0.005	0.182	11
RS44	Totara S at Stronvar	0.018	<0.001	0.460	9
RS45	Parkvale Trib at Lowes Res.	5.550	3.300	6.400	10
RS46	Parkvale S at Weir	1.600	0.011	3.900	11
RS47	Waiohine R at Gorge	0.035	0.003	0.054	12
RS48	Waiohine R at Bicknells	0.245	0.062	0.650	12
RS49	Beef Ck at Headwaters	0.019	0.001	0.051	10
RS50	Mangatarere S at SH 2	0.975	0.560	1.810	12
RS51	Huangarua R at Ponatahi Br	0.265	<0.001	0.520	12
RS52	Tauanui R at Whakatomotomo Rd	0.008	<0.001	0.020	8
RS53	Awhea R at Tora Rd	0.011	<0.001	0.360	12
RS55	Tauherenikau R at Websters	0.030	0.010	0.109	11
RS56	Waiorongomai R at Forest Pk	0.014	0.003	0.126	11
RS57	Waiwhetu S at Whites Line East	0.265	0.003	0.630	12

*Lower n counts for some sites reflect sampling occasions when a site could not be accessed.

Table A3.13: Total Kjeldahl nitrogen (mg/L)

Site no.	Site name	Median	Minimum	Maximum	n*
RS02	Mangapouri S at Bennetts Rd	0.56	0.31	2.20	12
RS03	Waitohu S at Forest Pk	0.05	<0.10	0.27	10
RS04	Waitohu S at Norfolk Cres	0.29	0.18	0.59	12
RS05	Otaki R at Pukehinau	0.05	<0.10	0.10	12
RS06	Otaki R at Mouth	0.05	<0.10	<0.10	12
RS07	Mangaone S at Sims Rd Br	0.47	0.16	0.96	12
RS08	Ngarara S at Field Way	0.58	0.50	0.80	11
RS09	Waikanae R at Mangaone Walkway	0.05	<0.10	0.15	12
RS10	Waikanae R at Greenaway Rd	0.05	<0.10	0.11	12
RS11	Whareroa S at Waterfall Rd	0.13	0.10	0.20	11
RS12	Whareroa S at QE Park	0.43	0.34	0.76	11
RS13	Horokiri S at Snodgrass	0.13	0.05	0.20	11
RS14	Pauatahanui S at Elmwood Br	0.19	0.13	0.28	12
RS15	Porirua S at Glenside	0.20	0.13	0.32	12
RS16	Porirua S at Wall Park (Milk Depot)	0.22	0.16	3.60	12
RS17	Makara S at Kennels	0.30	0.18	0.60	12
RS18	Karori S at Makara Peak	0.23	0.14	0.46	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.19	0.13	0.37	12
RS20	Hutt R at Te Marua Intake Site	0.05	<0.10	0.10	12
RS21	Hutt R opp. Manor Park G.C.	0.05	<0.10	0.15	12
RS22	Hutt R at Boulcott	0.05	<0.10	0.21	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.05	<0.10	0.14	12
RS24	Mangaroa R at Te Marua	0.16	<0.10	0.34	12
RS25	Akatarawa R at Hutt confl.	0.05	<0.10	<0.10	12
RS26	Whakatikei R at Riverstone	0.05	<0.10	<0.10	12
RS28	Wainuiomata R at Manuka Track	0.05	<0.10	0.11	12
RS29	Wainuiomata R d/s of White Br	0.08	<0.10	0.16	12
RS30	Orongorongo R at Orongorongo Stn	0.05	<0.10	0.17	12
RS31	Ruamahanga R at McLays	0.05	<0.10	0.11	11
RS32	Ruamahanga R at Te Ore Ore	0.11	<0.10	0.25	12
RS33	Ruamahanga R at Gladstone Br	0.08	<0.10	0.24	12
RS34	Ruamahanga R at Pukio	0.16	<0.10	0.24	12
RS36	Taueru R at Castlehill	0.27	0.16	0.52	12
RS37	Taueru R at Gladstone	0.34	0.21	0.72	11
RS38	Kopuaranga R at Stuarts	0.29	0.16	0.56	12
RS39	Whangaehu R 250m u/s confl.	0.48	0.27	0.88	12
RS40	Waipoua R at Colombo Rd Br	0.19	<0.10	0.29	12
RS41	Waingawa R at South Rd	0.05	<0.10	0.58	12
RS42	Whareama R at Gauge	0.32	0.23	0.53	11
RS43	Motuwaireka S at Headwaters	0.05	<0.10	0.17	11
RS44	Totara S at Stronvar	0.12	<0.10	0.21	9
RS45	Parkvale Trib at Lowes Res.	0.32	0.20	0.52	10
RS46	Parkvale S at Weir	0.45	0.24	0.98	11
RS47	Waiohine R at Gorge	0.05	<0.10	0.25	12
RS48	Waiohine R at Bicknells	0.08	<0.10	0.21	12
RS49	Beef Ck at Headwaters	0.08	<0.10	0.17	10
RS50	Mangatarere S at SH 2	0.20	0.13	0.83	12
RS51	Huangarua R at Ponatahi Br	0.16	<0.10	0.32	12
RS52	Tauanui R at Whakatomotomo Rd	0.05	<0.10	0.05	8
RS53	Awhea R at Tora Rd	0.18	0.11	0.41	12
RS55	Tauherenikau R at Websters	0.05	<0.10	1.77	11
RS56	Waiorongomai R at Forest Pk	0.05	<0.10	0.52	11
RS57	Waiwhetu S at Whites Line East	0.34	0.19	0.64	12

*Lower n counts for some sites reflect sampling occasions when a site could not be accessed.

Table A3.14: Total nitrogen (mg/L)

Site no.	Site name	Median	Minimum	Maximum	n*
RS02	Mangapouri S at Bennetts Rd	2.45	0.80	3.70	12
RS03	Waitohu S at Forest Pk	0.06	<0.11	0.30	10
RS04	Waitohu S at Norfolk Cres	0.74	0.44	1.50	12
RS05	Otaki R at Pukehinau	0.06	<0.11	0.12	12
RS06	Otaki R at Mouth	0.08	<0.11	0.16	12
RS07	Mangaone S at Sims Rd Br	1.92	1.05	3.50	12
RS08	Ngarara S at Field Way	0.61	0.51	1.28	11
RS09	Waikanae R at Mangaone Walkway	0.20	0.14	0.32	12
RS10	Waikanae R at Greenaway Rd	0.30	0.14	0.49	12
RS11	Wharetoa S at Waterfall Rd	0.44	0.35	0.93	11
RS12	Wharetoa S at QE Park	0.51	0.37	1.41	11
RS13	Horokiri S at Snodgrass	0.75	0.19	1.17	11
RS14	Pauatahanui S at Elmwood Br	0.51	0.16	0.97	12
RS15	Porirua S at Glenside	0.98	0.61	1.72	12
RS16	Porirua S at Wall Park (Milk Depot)	1.14	0.44	4.70	12
RS17	Makara S at Kennels	0.46	0.25	1.42	12
RS18	Karori S at Makara Peak	1.52	1.33	1.76	12
RS19	Kaiwharawhara S at Ngaio Gorge	1.39	1.20	1.75	12
RS20	Hutt R at Te Marua Intake Site	0.15	0.11	0.20	12
RS21	Hutt R opp. Manor Park G.C.	0.28	0.20	0.50	12
RS22	Hutt R at Boulcott	0.29	0.20	0.54	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.29	0.22	0.45	12
RS24	Mangaroa R at Te Marua	0.65	0.48	0.87	12
RS25	Akatarawa R at Hutt confl.	0.13	<0.11	0.24	12
RS26	Whakatikei R at Riverstone	0.17	0.10	0.38	12
RS28	Wainuiomata R at Manuka Track	0.12	<0.11	0.18	12
RS29	Wainuiomata R d/s of White Br	0.19	<0.11	0.53	12
RS30	Orongorongo R at Orongorongo Stn	0.06	<0.11	0.20	12
RS31	Ruamahanga R at McLays	0.06	<0.11	0.13	11
RS32	Ruamahanga R at Te Ore Ore	0.43	0.25	0.87	12
RS33	Ruamahanga R at Gladstone Br	0.43	0.23	0.93	12
RS34	Ruamahanga R at Pukio	0.43	0.12	1.03	12
RS36	Taueru R at Castlehill	0.35	0.17	1.23	12
RS37	Taueru R at Gladstone	1.42	0.84	1.98	11
RS38	Kopuaranga R at Stuarts	1.23	0.96	1.94	12
RS39	Whangaehu R 250m u/s confl.	1.15	0.69	2.50	12
RS40	Waipoua R at Colombo Rd Br	0.79	0.45	1.66	12
RS41	Waingawa R at South Rd	0.14	<0.11	0.67	12
RS42	Whareama R at Gauge	0.32	0.23	1.07	11
RS43	Motuwaireka S at Headwaters	0.11	0.06	0.27	11
RS44	Totara S at Stronvar	0.15	0.11	0.59	9
RS45	Parkvale Trib at Lowes Res.	5.75	3.60	6.70	10
RS46	Parkvale S at Weir	2.10	0.28	4.30	11
RS47	Waiohine R at Gorge	0.06	<0.11	0.26	12
RS48	Waiohine R at Bicknells	0.33	0.21	0.76	12
RS49	Beef Ck at Headwaters	0.13	<0.11	0.18	10
RS50	Mangatarere S at SH 2	1.29	0.70	2.20	12
RS51	Huangaaru R at Ponatahi Br	0.44	0.10	0.79	12
RS52	Tauanui R at Whakatomotomo Rd	0.06	<0.11	0.12	8
RS53	Awhea R at Tora Rd	0.22	0.15	0.55	12
RS55	Tauherenikau R at Websters	0.10	<0.11	1.84	11
RS56	Waiorongomai R at Forest Pk	0.06	<0.11	0.64	11
RS57	Waiwhetu S at Whites Line East	0.64	0.25	1.12	12

*Lower n counts for some sites reflect sampling occasions when a site could not be accessed.

Table A3.15: Dissolved reactive phosphorus (mg/L)

Site no.	Site name	Median	Minimum	Maximum	n*
RS02	Mangapouri S at Bennetts Rd	0.031	0.018	0.051	12
RS03	Waitohu S at Forest Pk	0.009	0.006	0.012	10
RS04	Waitohu S at Norfolk Cres	0.015	0.011	0.021	12
RS05	Otaki R at Pukehinau	0.005	0.003	0.007	12
RS06	Otaki R at Mouth	0.005	0.003	0.007	12
RS07	Mangaone S at Sims Rd Br	0.028	0.020	0.034	12
RS08	Ngarara S at Field Way	0.037	0.019	0.048	11
RS09	Waikanae R at Mangaone Walkway	0.013	0.012	0.015	12
RS10	Waikanae R at Greenaway Rd	0.007	0.006	0.017	12
RS11	Whareroa S at Waterfall Rd	0.026	0.014	0.039	11
RS12	Whareroa S at QE Park	0.038	0.024	0.052	11
RS13	Horokiri S at Snodgrass	0.008	0.003	0.016	11
RS14	Pauatahanui S at Elmwood Br	0.014	0.008	0.021	12
RS15	Porirua S at Glenside	0.017	0.001	0.027	12
RS16	Porirua S at Wall Park (Milk Depot)	0.017	0.011	0.031	12
RS17	Makara S at Kennels	0.031	0.013	0.081	12
RS18	Karori S at Makara Peak	0.042	0.025	0.063	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.054	0.028	0.082	12
RS20	Hutt R at Te Marua Intake Site	0.004	0.002	0.005	12
RS21	Hutt R opp. Manor Park G.C.	0.003	<0.001	0.007	12
RS22	Hutt R at Boulcott	0.004	<0.001	0.007	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.004	0.002	0.005	12
RS24	Mangaroa R at Te Marua	0.008	0.002	0.013	12
RS25	Akatarawa R at Hutt confl.	0.003	0.002	0.006	12
RS26	Whakatikei R at Riverstone	0.008	0.006	0.011	12
RS28	Wainuiomata R at Manuka Track	0.012	0.009	0.014	12
RS29	Wainuiomata R d/s of White Br	0.011	0.008	0.015	12
RS30	Orongorongo R at Orongorongo Stn	0.005	0.001	0.007	12
RS31	Ruamahanga R at McLays	0.003	0.001	0.004	11
RS32	Ruamahanga R at Te Ore Ore	0.006	0.003	0.007	12
RS33	Ruamahanga R at Gladstone Br	0.008	0.004	0.025	12
RS34	Ruamahanga R at Pukio	0.011	0.003	0.020	12
RS36	Taueru R at Castlehill	0.006	0.005	0.016	12
RS37	Taueru R at Gladstone	0.010	0.003	0.046	11
RS38	Kopuaranga R at Stuarts	0.015	0.007	0.074	12
RS39	Whangaehu R 250m u/s confl.	0.025	0.006	0.073	12
RS40	Waipoua R at Colombo Rd Br	0.003	<0.001	0.009	12
RS41	Waingawa R at South Rd	0.004	<0.001	0.008	12
RS42	Whareama R at Gauge	0.003	<0.001	0.015	11
RS43	Motuwaireka S at Headwaters	0.005	0.002	0.009	11
RS44	Totara S at Stronvar	0.001	<0.001	0.007	9
RS45	Parkvale Trib at Lowes Res.	0.013	<0.001	0.019	10
RS46	Parkvale S at Weir	0.019	0.013	0.047	11
RS47	Waiohine R at Gorge	0.004	0.002	0.005	12
RS48	Waiohine R at Bicknells	0.010	0.005	0.036	12
RS49	Beef Ck at Headwaters	0.008	0.006	0.012	10
RS50	Mangatarere S at SH 2	0.029	0.016	0.440	12
RS51	Huangarua R at Ponatahi Br	0.004	0.001	0.018	12
RS52	Tauanui R at Whakatomotomo Rd	0.006	0.003	0.007	8
RS53	Awhea R at Tora Rd	0.004	<0.001	0.014	12
RS55	Tauherenikau R at Websters	0.003	0.001	0.004	11
RS56	Waiorongomai R at Forest Pk	0.003	0.003	0.004	11
RS57	Waiwhetu S at Whites Line East	0.026	0.014	0.052	12

*Lower n counts for some sites reflect sampling occasions when a site could not be accessed.

Table A3.16: Total phosphorus (mg/L)

Site no.	Site name	Median	Minimum	Maximum	n*
RS02	Mangapouri S at Bennetts Rd	0.080	0.044	0.600	12
RS03	Waitohu S at Forest Pk	0.010	0.006	0.035	10
RS04	Waitohu S at Norfolk Cres	0.044	0.021	0.092	12
RS05	Otaki R at Pukehinau	0.007	<0.004	0.010	12
RS06	Otaki R at Mouth	0.006	<0.004	0.010	12
RS07	Mangaone S at Sims Rd Br	0.067	0.035	0.121	12
RS08	Ngarara S at Field Way	0.082	0.067	0.163	11
RS09	Waikanae R at Mangaone Walkway	0.014	0.011	0.021	12
RS10	Waikanae R at Greenaway Rd	0.009	0.006	0.014	12
RS11	Whareroa S at Waterfall Rd	0.026	0.020	0.041	11
RS12	Whareroa S at QE Park	0.069	0.048	0.086	11
RS13	Horokiri S at Snodgrass	0.011	0.006	0.021	11
RS14	Pauatahanui S at Elmwood Br	0.024	0.013	0.041	12
RS15	Porirua S at Glenside	0.026	0.018	0.053	12
RS16	Porirua S at Wall Park (Milk Depot)	0.028	0.020	0.230	12
RS17	Makara S at Kennels	0.072	0.025	0.110	12
RS18	Karori S at Makara Peak	0.056	0.031	0.106	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.058	0.037	0.102	12
RS20	Hutt R at Te Marua Intake Site	0.006	<0.004	0.008	12
RS21	Hutt R opp. Manor Park G.C.	0.007	<0.004	0.014	12
RS22	Hutt R at Boulcott	0.008	<0.004	0.014	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.007	<0.004	0.009	12
RS24	Mangaroa R at Te Marua	0.014	0.005	0.024	12
RS25	Akatarawa R at Hutt confl.	0.006	<0.004	0.009	12
RS26	Whakatikei R at Riverstone	0.010	0.005	0.015	12
RS28	Wainuiomata R at Manuka Track	0.013	0.011	0.016	12
RS29	Wainuiomata R d/s of White Br	0.019	0.010	0.023	12
RS30	Orongorongo R at Orongorongo Stn	0.006	<0.004	0.011	12
RS31	Ruamahanga R at McLays	0.002	<0.004	0.006	11
RS32	Ruamahanga R at Te Ore Ore	0.013	0.006	0.044	12
RS33	Ruamahanga R at Gladstone Br	0.015	0.008	0.036	12
RS34	Ruamahanga R at Pukio	0.020	0.008	0.038	12
RS36	Taueru R at Castlehill	0.018	0.013	0.040	12
RS37	Taueru R at Gladstone	0.024	0.013	0.094	11
RS38	Kopuaranga R at Stuarts	0.032	0.015	0.082	12
RS39	Whangaehu R 250m u/s confl.	0.050	0.020	0.210	12
RS40	Waipoua R at Colombo Rd Br	0.007	<0.004	0.031	12
RS41	Waingawa R at South Rd	0.007	<0.004	0.155	12
RS42	Whareama R at Gauge	0.018	0.008	0.076	11
RS43	Motuwaireka S at Headwaters	0.004	<0.004	0.012	11
RS44	Totara S at Stronvar	0.004	<0.004	0.006	9
RS45	Parkvale Trib at Lowes Res.	0.015	0.004	0.022	10
RS46	Parkvale S at Weir	0.041	0.030	0.072	11
RS47	Waiohine R at Gorge	0.006	<0.004	0.045	12
RS48	Waiohine R at Bicknells	0.016	0.012	0.049	12
RS49	Beef Ck at Headwaters	0.012	0.006	0.016	10
RS50	Mangatarere S at SH 2	0.038	0.021	0.500	12
RS51	Huangarua R at Ponatahi Br	0.008	<0.004	0.038	12
RS52	Tauanui R at Whakatomotomo Rd	0.006	<0.004	0.009	8
RS53	Awhea R at Tora Rd	0.012	<0.004	0.080	12
RS55	Tauherenikau R at Websters	0.004	<0.004	1.700	11
RS56	Waiorongomai R at Forest Pk	0.006	<0.004	0.089	11
RS57	Waiwhetu S at Whites Line East	0.053	0.024	0.154	12

*Lower n counts for some sites reflect sampling occasions when a site could not be accessed.

Table A3.17: *E. coli* (cfu/100mL)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i> *
RS02	Mangapouri S at Bennetts Rd	1,450	600	18,000	12
RS03	Waitohu S at Forest Pk	5	<1	100	10
RS04	Waitohu S at Norfolk Cres	650	180	1,800	12
RS05	Otaki R at Pukehinau	3	1	42	12
RS06	Otaki R at Mouth	12	2	180	12
RS07	Mangaone S at Sims Rd Br	1,100	400	5,600	12
RS08	Ngarara S at Field Way	200	16	2,500	11
RS09	Waikanae R at Mangaone Walkway	9	2	210	12
RS10	Waikanae R at Greenaway Rd	12	6	42	12
RS11	Whareroa S at Waterfall Rd	230	38	900	11
RS12	Whareroa S at QE Park	90	38	220	11
RS13	Horokiri S at Snodgrass	300	40	1,100	11
RS14	Pauatahanui S at Elmwood Br	185	93	360	12
RS15	Porirua S at Glenside	785	140	3,800	12
RS16	Porirua S at Wall Park (Milk Depot)	1,450	300	4,900	12
RS17	Makara S at Kennels	350	130	900	12
RS18	Karori S at Makara Peak	1,350	200	4,300	12
RS19	Kaiwharawhara S at Ngaio Gorge	600	60	4,700	12
RS20	Hutt R at Te Marua Intake Site	13	5	70	12
RS21	Hutt R opp. Manor Park G.C.	55	24	150	12
RS22	Hutt R at Boulcott	50	22	100	12
RS23	Pakuratahi R 50m d/s Farm Ck	65	16	220	12
RS24	Mangaroa R at Te Marua	160	60	650	12
RS25	Akatarawa R at Hutt confl.	35	11	90	12
RS26	Whakatikei R at Riverstone	16	8	32	12
RS28	Wainuiomata R at Manuka Track	4	<1	15	12
RS29	Wainuiomata R d/s of White Br	75	12	390	12
RS30	Orongorongo R at Orongorongo Stn	15	2	180	12
RS31	Ruamahanga R at McLays	9	<1	26	11
RS32	Ruamahanga R at Te Ore Ore	80	12	410	12
RS33	Ruamahanga R at Gladstone Br	20	7	230	12
RS34	Ruamahanga R at Pukio	45	11	200	12
RS36	Taueru R at Castlehill	160	18	3,800	12
RS37	Taueru R at Gladstone	100	15	380	11
RS38	Kopuaranga R at Stuarts	180	31	700	12
RS39	Whangaehu R 250m u/s confl.	135	30	300	12
RS40	Waipoua R at Colombo Rd Br	47	3	1,100	12
RS41	Waingawa R at South Rd	14	<1	3,100	12
RS42	Whareama R at Gauge	40	8	900	11
RS43	Motuwaireka S at Headwaters	4	<1	270	11
RS44	Totara S at Stronvar	17	13	700	9
RS45	Parkvale Trib at Lowes Res.	14	3	33	10
RS46	Parkvale S at Weir	220	60	1,600	11
RS47	Waiohine R at Gorge	7	<1	80	12
RS48	Waiohine R at Bicknells	44	10	170	12
RS49	Beef Ck at Headwaters	28	1	370	10
RS50	Mangatarere S at SH 2	110	30	490	12
RS51	Huangarua R at Ponatahi Br	31	15	550	12
RS52	Tauanui R at Whakatomotomo Rd	3	<1	100	8
RS53	Awhea R at Tora Rd	25	5	1,000	12
RS55	Tauherenikau R at Websters	12	3	7,000	11
RS56	Waiorongomai R at Forest Pk	10	2	2,900	11
RS57	Waiwhetu S at Whites Line East	700	220	3,600	12

*Lower *n* counts for some sites reflect sampling occasions when a site could not be accessed.

Table A3.18: Faecal coliforms (cfu/100mL)

Site no.	Site name	Median	Minimum	Maximum	n*
RS02	Mangapouri S at Bennetts Rd	2,350	900	20,000	12
RS03	Waitohu S at Forest Pk	5	<1	100	10
RS04	Waitohu S at Norfolk Cres	750	220	1,800	12
RS05	Otaki R at Pukehinau	3	1	47	12
RS06	Otaki R at Mouth	13	2	240	12
RS07	Mangaone S at Sims Rd Br	1,300	400	6,900	12
RS08	Ngarara S at Field Way	240	19	3,700	11
RS09	Waikanae R at Mangaone Walkway	10	2	260	12
RS10	Waikanae R at Greenaway Rd	20	6	48	12
RS11	Whareroa S at Waterfall Rd	230	40	1,100	11
RS12	Whareroa S at QE Park	90	38	250	11
RS13	Horokiri S at Snodgrass	360	60	1,200	11
RS14	Pauatahanui S at Elmwood Br	205	110	430	12
RS15	Porirua S at Glenside	830	210	3,800	12
RS16	Porirua S at Wall Park (Milk Depot)	1,800	300	11,000	12
RS17	Makara S at Kennels	410	130	900	12
RS18	Karori S at Makara Peak	1,600	200	5,500	12
RS19	Kaiwharawhara S at Ngaio Gorge	600	60	4,700	12
RS20	Hutt R at Te Marua Intake Site	14	5	80	12
RS21	Hutt R opp. Manor Park G.C.	85	24	200	12
RS22	Hutt R at Boulcott	73	27	110	12
RS23	Pakuratahi R 50m d/s Farm Ck	75	20	240	12
RS24	Mangaroa R at Te Marua	175	60	650	12
RS25	Akatarawa R at Hutt confl.	36	15	90	12
RS26	Whakatikei R at Riverstone	18	11	42	12
RS28	Wainuiomata R at Manuka Track	4	<1	16	12
RS29	Wainuiomata R d/s of White Br	85	12	470	12
RS30	Orongorongo R at Orongorongo Stn	15	2	210	12
RS31	Ruamahanga R at McLays	9	<1	31	11
RS32	Ruamahanga R at Te Ore Ore	95	16	490	12
RS33	Ruamahanga R at Gladstone Br	22	7	260	12
RS34	Ruamahanga R at Pukio	50	14	270	12
RS36	Taueru R at Castlehill	160	18	4,000	12
RS37	Taueru R at Gladstone	120	20	440	11
RS38	Kopuaranga R at Stuarts	200	32	700	12
RS39	Whangaehu R 250m u/s confl.	155	30	320	12
RS40	Waipoua R at Colombo Rd Br	51	3	1,100	12
RS41	Waingawa R at South Rd	15	<1	3,800	12
RS42	Whareama R at Gauge	40	9	900	11
RS43	Motuwaireka S at Headwaters	4	<1	300	11
RS44	Totara S at Stronvar	19	13	1,000	9
RS45	Parkvale Trib at Lowes Res.	16	3	45	10
RS46	Parkvale S at Weir	300	70	1,700	11
RS47	Waiohine R at Gorge	8	1	80	12
RS48	Waiohine R at Bicknells	58	10	170	12
RS49	Beef Ck at Headwaters	28	1	370	10
RS50	Mangatarere S at SH 2	150	50	490	12
RS51	Huangarua R at Ponatahi Br	45	16	630	12
RS52	Tauanui R at Whakatomotomo Rd	3	<1	100	8
RS53	Awhea R at Tora Rd	26	5	1,300	12
RS55	Tauherenikau R at Websters	13	3	7,000	11
RS56	Waiorongomai R at Forest Pk	10	2	3,000	11
RS57	Waiwhetu S at Whites Line East	850	260	4,300	12

*Lower n counts for some sites reflect sampling occasions when a site could not be accessed

Appendix 4: Tabulated heavy metal data

The default trigger values presented here represent the ANZECC (2000) 95% species protection level for slightly modified freshwater ecosystems.

Table A4.1: Summary of dissolved copper (mg/L) concentrations measured at 10 RSoE sites between July 2015 and June 2016 (D.L.= detection limit). The percentages of samples exceeding the ANZECC (2000) default and hardness-modified trigger values (TVs) are also presented

Site no.	Site name	Median	Minimum	Maximum	n	n <D.L.	% of samples (n) or median compliance with ANZECC (2000) ¹	
							Default TV (≤ 0.0014)	Hardness modified TV
RS02	Mangapouri S at Bennetts Rd	0.001	<0.0005	0.002	12	1	25	8.3
RS08	Ngarara S at Field Way	0.0003	<0.0005	0.0006	11	10	Med. complies	Med. complies
RS10	Waikanae R at Greenaway Rd	0.0003	<0.0005	<0.0005	12	12	Med. complies	Med. complies
RS15	Porirua S at Glenside	0.0009	0.0006	0.0015	12	0	8.3	0
RS16	Porirua S at Wall Park (Milk Depot)	0.0012	0.0007	0.0141	12	0	41.7	33.3
RS18	Karori S at Makara Peak	0.0017	0.0008	0.0131	12	0	75	41.7
RS19	Kaiwharawhara S at Ngaio Gorge	0.0015	0.0009	0.0033	12	0	58.3	16.7
RS21	Hutt R opp. Manor Park G.C.	0.0003	<0.0005	0.0006	12	10	Med. complies	Med. complies
RS22	Hutt R at Boulcott	0.0003	<0.0005	<0.0005	12	12	Med. complies	Med. complies
RS57	Waiwhetu S at Whites Line East	0.0011	0.0005	0.0035	12	0	25	16.7

¹Refer to Section 3.1.2 for an explanation on why two approaches have been undertaken to assess compliance with ANZECC (2000) default and hardness-modified trigger values.

Table A4.2: Summary of dissolved zinc (mg/L) concentrations measured at 10 RSoE sites between July 2015 and June 2016 (D.L.= detection limit). The percentages of samples exceeding the ANZECC (2000) default and hardness-modified trigger values (TVs) are also presented

Site no.	Site name	Median	Minimum	Maximum	n	n <D.L.	% of samples (n) or median compliance with ANZECC (2000) ¹	
							Default TV (≤ 0.008)	Hardness modified TV
RS02	Mangapouri S at Bennetts Rd	0.0031	0.0015	0.008	12	0	0	0
RS08	Ngarara S at Field Way	0.0014	<0.001	0.0053	11	4	Med. complies	Med. complies
RS10	Waikanae R at Greenaway Rd	0.0005	<0.001	<0.001	12	12	Med. complies	Med. complies
RS15	Porirua S at Glenside	0.0036	0.0028	0.0149	12	0	16.7	16.7
RS16	Porirua S at Wall Park (Milk Depot)	0.0094	0.0043	0.33	12	0	58.3	41.7
RS18	Karori S at Makara Peak	0.02500	0.0128	0.082	12	0	100	100
RS19	Kaiwharawhara S at Ngaio Gorge	0.0061	0.0022	0.0161	12	0	33.3	8.3
RS21	Hutt R opp. Manor Park G.C.	0.0005	<0.001	0.0027	12	10	Med. complies	Med. complies
RS22	Hutt R at Boulcott	0.0005	<0.001	0.0042	12	10	Med. complies	Med. complies
RS57	Waiwhetu S at Whites Line East	0.0176	0.005	0.064	12	0	66.7	66.7

¹Refer to Section 3.1.2 for an explanation on why two approaches have been undertaken to assess compliance with ANZECC (2000) default and hardness-modified trigger values.

Table A4.3: Summary of total recoverable copper (mg/L) concentrations measured at six RSoE sites between July 2015 and June 2016

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	0.0015	0.0008	0.0080	12
RS15	Porirua S at Glenside	0.0011	0.0006	0.0019	12
RS16	Porirua S at Wall Park (Milk Depot)	0.0015	0.0008	0.0310	12
RS18	Karori S at Makara Peak	0.0019	0.0009	0.0158	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.0018	0.0010	0.0043	12
RS57	Waiwhetu S at Whites Line East	0.0017	0.0008	0.0114	12

Table A4.4: Summary of total recoverable zinc (mg/L) concentrations measured at six RSoE sites between July 2015 and June 2016

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	0.0063	0.0022	0.0460	12
RS15	Porirua S at Glenside	0.0049	0.0032	0.0240	12
RS16	Porirua S at Wall Park (Milk Depot)	0.0134	0.0058	0.3900	12
RS18	Karori S at Makara Peak	0.0245	0.0149	0.0880	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.0063	0.0042	0.0197	12
RS57	Waiwhetu S at Whites Line East	0.0183	0.0062	0.1200	12

Appendix 5: Additional macroinvertebrate indices for RSoE sites

Table A5.1: QMCI, %EPT* taxa and taxa richness scores for RSoE sites sampled in summer 2015/16

Site no.	Site name	QMCI	%EPT* taxa	Taxa richness
RS02	Mangapouri S at Bennetts Rd	4.10	25	24
RS05	Otaki R at Pukehinau	7.46	45	20
RS06	Otaki R at Mouth	6.44	48	21
RS07	Mangaone S at Sims Rd Br	4.13	0	14
RS09	Waikanae R at Mangaone Walkway	7.47	60	25
RS10	Waikanae R at Greenaway Rd	7.37	55	22
RS13	Horokiri S at Snodgrass	5.98	52	23
RS14	Pauatahanui S at Elmwood Br	4.04	33	27
RS15	Porirua S at Glenside	6.39	40	25
RS16	Porirua S at Wall Park (Milk Depot)	4.32	18	28
RS18	Karori S at Makara Peak	2.92	22	23
RS19	Kaiwharawhara S at Ngaio Gorge	2.52	5	21
RS20	Hutt R at Te Marua Intake Site	8.08	68	22
RS21	Hutt R opp. Manor Park G.C.	5.26	52	23
RS22	Hutt R at Boulcott	5.53	43	23
RS23	Pakuratahi R 50m d/s Farm Ck	6.15	42	26
RS24	Mangaroa R at Te Marua	5.98	46	26
RS25	Akatarawa R at Hutt confl.	7.64	67	33
RS26	Whakatikei R at Riverstone	6.61	61	28
RS28	Wainuiomata R at Manuka Track	6.68	58	33
RS29	Wainuiomata R d/s of White Br	4.91	44	25
RS31	Ruamahanga R at McLays	7.80	68	19
RS32	Ruamahanga R at Te Ore Ore	7.37	55	20
RS33	Ruamahanga R at Gladstone Br	5.65	47	17
RS34	Ruamahanga R at Pukio	5.66	44	18
RS37	Taueru R at Gladstone	3.72	33	21
RS38	Kopuaranga R at Stuarts	3.87	43	23
RS39	Whangaehu R 250m u/s confl.	3.95	6	18
RS40	Waipoua R at Colombo Rd Br	4.65	40	25
RS41	Waingawa R at South Rd	6.42	45	20
RS42	Whareama R at Gauge	3.99	11	18
RS47	Waiohine R at Gorge	8.04	73	22
RS48	Waiohine R at Bicknells	6.94	53	19
RS50	Mangatarere S at SH 2	5.00	41	27
RS51	Huangarua R at Ponatahi Br	3.89	29	24
RS53	Awhea R at Tora Rd	4.26	15	26
RS57	Waiwhetu S at Whites Line East	3.96	0	15

*Pollution tolerant EPT taxa (*Oxyethira* and *Paroxythira*) were excluded from this calculation.

Appendix 6: Habitat scores for RSoE sites assessed in summer 2015/16

Site no.	Site name	Substrate (hard or soft bottomed)	Dominant Landcover	Deposited sediment	Invertebrate habitat diversity	Invertebrate habitat abundance	Fish cover diversity	Fish cover abundance	Hydraulic heterogeneity	Bank erosion	Bank vegetation	Riparian width	Riparian shade	Sum	Rank
RS02	Mangapouri S at Bennetts Rd	Soft	Urban	1	6	2	8	9	2	6	4	6	6	50	30
RS05	Otaki R at Pukehinau	Hard	Indigenous forest	9	8	10	8	9	9	9	9	9	5	85	5=
RS06	Otaki R at Mouth	Hard	Indigenous forest	9	6	8	5	8	7	9	5	8	1	66	23
RS07	Mangaone S at Sims Rd Br	Soft	Pasture	1	1	1	5	5	1	8	3	6	2	33	36
RS09	Waikanae R at Mangaone Walkway	Hard	Indigenous forest	9	10	10	10	10	10	8	10	10	10	97	1
RS10	Waikanae R at Greenaway Rd	Hard	Indigenous forest	9	6	9	5	7	7	9	7	6	3	68	18=
RS13	Horokiri S at Snodgrass	Hard	Pasture	8	9	9	8	9	7	6	3	7	6	72	11=
RS14	Pauatahanui S at Elmwood Br	Soft/Hard	Pasture	2	7	2	10	10	4	8	7	8.5	9	67.5	21
RS15	Porirua S at Glenside	Hard	Urban	9	8	9	8	9	8	6	5	6	5	73	10
RS16	Porirua S at Wall Park (Milk Depot)	Hard	Urban	4	8	5	5	5	5	7	2	4	3	48	31
RS18	Karori S at Makara Peak	Hard	Urban	5	9	8	8	9	8	9	8	6	8	78	9
RS19	Kaiwharawhara S at Ngaio Gorge	Hard	Urban	6	8	4	7	7	7	5	8.5	9.5	7	69	16
RS20	Hutt R at Te Marua Intake Site	Hard	Indigenous forest	10	8.5	9	7	8	8.5		8.5	10	2	71.5	15
RS21	Hutt R opp. Manor Park G.C.	Hard	Indigenous forest	7	8	6	6	5	6	8	5	10	1	62	26
RS22	Hutt R at Boulcott	Hard	Indigenous forest	7	7	7	7	7	5	7.5	7	9	5	68.5	17
RS23	Pakuratahi R 50m d/s Farm Ck	Hard	Indigenous forest	9.5	8	9	7	8	7	9	9	9	3	78.5	8
RS24	Mangaroa R at Te Marua	Hard	Pasture	10	6	7	7	9	6	9	6	6	6	72	11=
RS25	Akatarawa R at Hutt confl.	Hard	Indigenous forest	8.5	9	10	8	9	10	9	9	9.5	7	89	3=
RS26	Whakatikei R at Riverstone	Hard	Indigenous forest	9	9	9	8	9	9	9	10	10	7	89	3=
RS28	Wainuiomata R at Manuka Track	Hard	Indigenous forest	10	10	10	10	10	7	10	10	10	8.5	95.5	2
RS29	Wainuiomata R d/s of White Br	Hard	Indigenous forest	7	8	9	8	9	9	8	3.5	3	1	65.5	24
RS31	Ruamahanga R at McLays	Hard	Indigenous forest	0	10	10	9	10	10	10	8	10	6	83	7
RS32	Ruamahanga R at Te Ore Ore	Hard	Pasture	8	10	8	10	7	5	7	5	6	2	68	18=
RS33	Ruamahanga R at Gladstone Br	Hard	Pasture	9	7	4	7	8	7	9	6	9	2	68	18=
RS34	Ruamahanga R at Pukio	Hard	Pasture	10	8	2	8	6	5	7	5	6	4	61	27
RS37	Taueru R at Gladstone	Hard	Pasture	9	10	2	9	6	5	8	1	1	1	52	29

Site no.	Site name	Substrate (hard or soft bottomed)	Dominant Landcover	Deposited sediment	Invertebrate habitat diversity	Invertebrate habitat abundance	Fish cover diversity	Fish cover abundance	Hydraulic heterogeneity	Bank erosion	Bank vegetation	Riparian width	Riparian shade	Sum	Rank
RS38	Kopuaranga R at Stuarts	Hard	Pasture	10	8	2	6	7	7	7	5	4	3	59	28
RS39	Whangaehu R 250m u/s confl.	Soft	Pasture	1	4	2	4	3	1	6	5	4	4	34	35
RS40	Waipoua R at Colombo Rd Br	Hard	Pasture	9	10	8	10	8	6	8	5	4	4	72	11=
RS41	Waingawa R at South Rd	Hard	Indigenous forest	7	10	10	5	10	5	6	5	8	1	67	22
RS42	Whareama R at Gauge	Hard	Pasture	1	8	1	8	7	3	3	3	1	2	37	33
RS47	Waiohine R at Gorge	Hard	Indigenous forest	10	10	10	5	10	10	9	8	9	4	85	5=
RS48	Waiohine R at Bicknells	Hard	Pasture	1	10	9	7	9	9	9	5	8	5	72	11=
RS50	Mangatarere S at SH 2	Hard	Pasture	3	6	4	4	6	5	2	4	6	5	45	32
RS51	Huangarua R at Ponatahi Br	Hard	Pasture	1	10	7	7	7	6	8	6	7	4	63	25
RS53	Awhea R at Tora Rd	Hard	Pasture	1	4	2	2	3	2	7	4	1	1	27	37
RS57	Waiwhetu S at Whites Line East	Soft	Urban	1	6	1	6	4	1	8	2	1.5	6	36.5	34

Appendix 7: Additional monitoring data

Table A7.1 summarises the additional macroinvertebrate indices for data collected from seven sites that were trialled as part of the development of an ecologically focused monitoring programme that utilises sites randomly selected across the region (refer Sections 2.4 and 7.2). Table A7.2 summarises the habitat scores from these sites.

Table A7.1: QMCI, %EPT* taxa and taxa richness scores for the seven sites that were trialled as part of an ecologically focused monitoring programme that utilises sites randomly selected across the region

Site no.	Site name	QMCI	%EPT* taxa	Taxa richness
RAN20	Opaki S off Paierau Rd	3.48	31.6	19
RAN25	Hutt R U/S of Akatarawa confl.	6.03	57.7	26
RAN35	Enaki S off Hururua Rd	2.80	13.0	23
RAN36	Ruamahanga R U/S of Te Ore Ore	6.66	33.3	27
RAN54	Horokiri S at Battlehill Park	6.90	59.3	27
RAN68	Waipoua R off Matahiwi Rd	4.37	41.7	24
RAN70	Stokes Valley S at Delaney Park	4.11	26.1	23

*Pollution tolerant EPT taxa (*Oxyethira* and *Paroxythira*) were excluded from this calculation.

Table A7.2: Habitat scores for the seven sites that were trialled as part of an ecologically focused monitoring programme that utilises sites randomly selected across the region

Site no.	Site name	Deposited sediment	Invertebrate habitat diversity	Invertebrate habitat abundance	Fish cover diversity	Fish cover abundance	Hydraulic heterogeneity	Bank erosion	Bank vegetation	Riparian width	Riparian shade	Sum
RAN20	Opaki S off Paierau Rd	4	6	7	4	4	2	9	1	1	1	39
RAN25	Hutt R U/S of Akatarawa confl.	10	9	10	5	6	5	7	7	8	2	69
RAN35	Enaki S off Hururua Rd	1	10	1	10	3	9	5	1	1	1	42
RAN36	Ruamahanga R U/S of Te Ore Ore	9	9	8	10	6	7	8	5	6	1	69
RAN54	Horokiri S at Battlehill Park	7	10	8	10	7	10	6	7	8	8	81
RAN68	Waipoua R off Matahiwi Rd	9	8	8	8	9	8	8	6	8	6.5	78.5
RAN70	Stokes Valley S at Delaney Park	7	1	1	1	1	1	10	1	1	2	26