



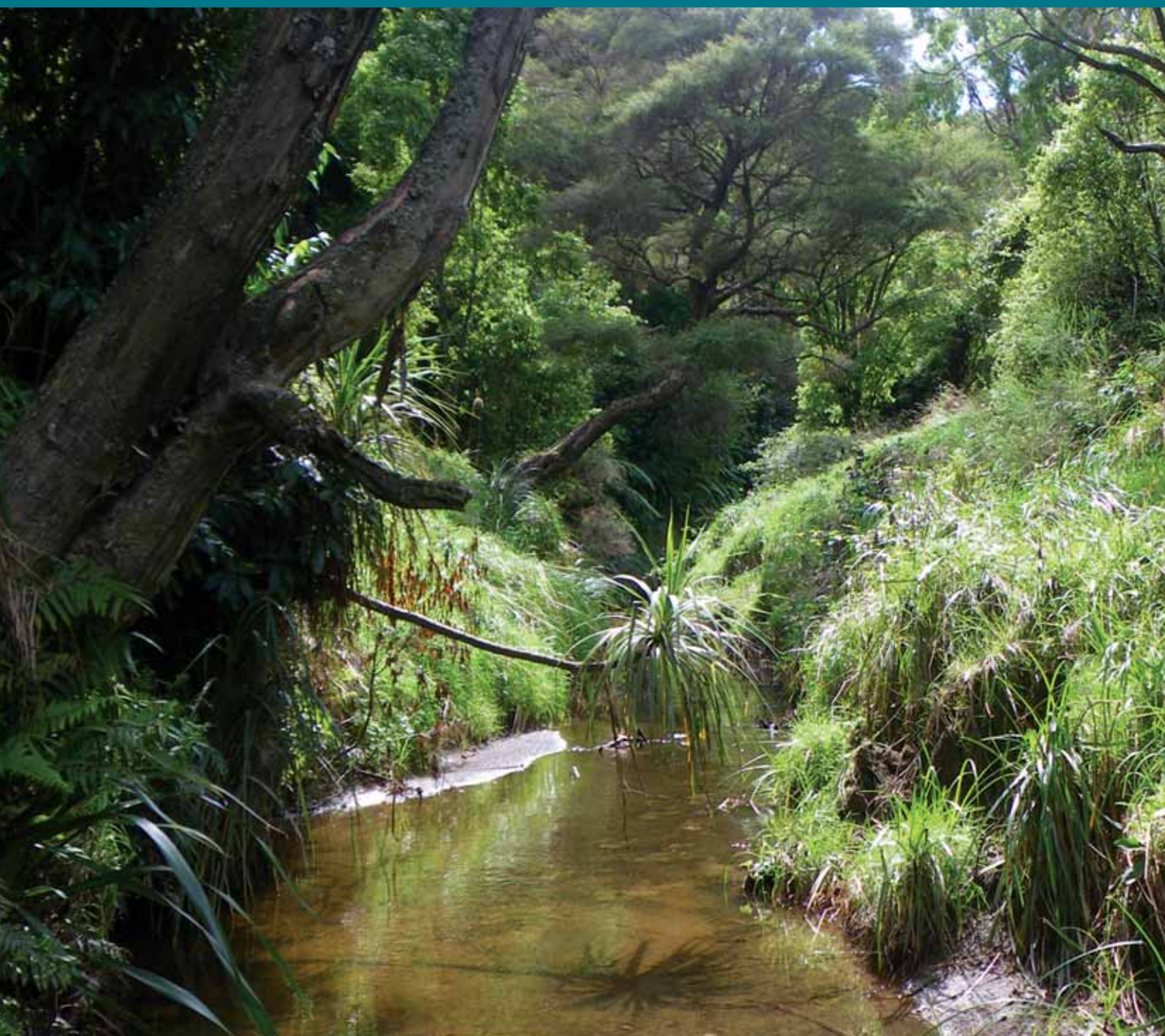
Annual freshwater quality monitoring report for the Wellington region, 2009/10

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Annual freshwater quality monitoring report for the Wellington region, 2009/10

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1. Introduction

Greater Wellington Regional Council (Greater Wellington) manages water quality in lakes, rivers and streams of the Wellington region for natural state, public water supply, recreation and amenity, fish spawning, and aquatic ecosystem health. Regular monitoring of physico-chemical and microbiological water quality, together with assessments of ecosystem health, are integral in managing water for these purposes.

Greater Wellington conducts a range of freshwater quality monitoring, including routine state of the environment monitoring in rivers and streams (55 sites), lake monitoring (four sites on Lake Wairarapa and one site on Lake Onoke), recreational water quality monitoring (21 sites) and monitoring associated with a riparian rehabilitation programme (see Perrie 2008). In addition, where warranted, targeted water quality investigations are carried out (e.g., Milne et al. 2010)

This report summarises routine monitoring results from the Rivers State of the Environment (RSoE) programme for July 2009 to June 2010 inclusive and relevant targeted freshwater investigations undertaken or completed during this period. A report containing a detailed analysis of long-term trends is produced every six years (see Milne & Perrie 2005). Recreational water quality monitoring results are reported on separately (for the 2009/10 results, see Ryan & Warr 2010).

2. Overview of RSoE monitoring programme

2.1 Background

Surface water quality has been routinely monitored in the western half 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. These changes have been made to improve the representativeness and quality of the information collected (Milne & Perrie 2005).

2.2 Monitoring objectives

The aims of Greater Wellington's Rivers State of the Environment (RSoE) water quality monitoring programme are to:

1. Assist in the detection of spatial and temporal changes in fresh waters;
2. Contribute to our understanding of freshwater biodiversity in the region;
3. Determine the suitability of fresh waters for designated uses*;
4. Provide information to assist in targeted investigations where remediation or mitigation of poor water quality is desired; and
5. Provide a mechanism to determine the effectiveness of regional policies and plans.

*Note: the suitability of fresh waters for contact recreation purposes is assessed separately under Greater Wellington's recreational water quality monitoring programme (see Ryan & Warr 2010).

2.3 Monitoring sites

There are 55 river and stream sites currently monitored under the RSoE programme (Figure 2.1, Appendix 1). These sites were chosen to represent the natural diversity of rivers and streams, and the major land uses and human activities in the region.

2.3.1 Changes to the monitoring network in 2009/10

In September 2009, regular monitoring of the Mangapouri Stream at Rahui Road (site RS01) was discontinued because previous monitoring results (e.g., Perrie 2009a) showed that this site did not represent the relatively pristine state, or reference condition, that it was originally chosen for.

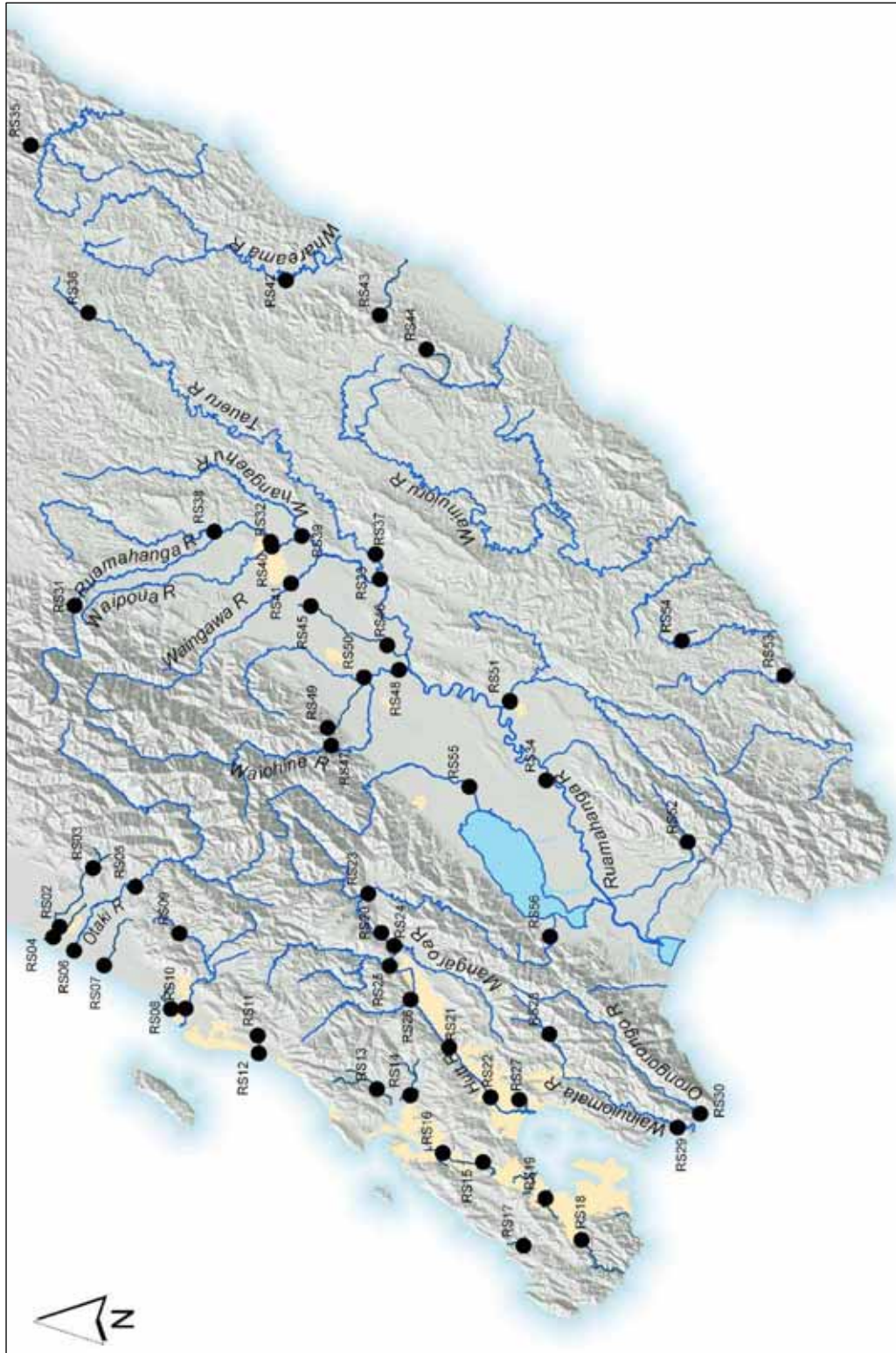


Figure 2.1: RSOE sites monitored over 2009/10

2.4 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, suspended solids, faecal indicator bacteria, total organic carbon, and dissolved and total nutrients. Water samples from ten RSoE sites (see Appendix 1) located in urban catchments and considered at risk from heavy metal contamination, or which discharge into sensitive downstream receiving environments (e.g., harbours and estuaries), were also analysed for dissolved concentrations of copper, lead and zinc. Additionally, water samples from the Waiwhetu Stream at Wainuiomata Hill Bridge were analysed for dissolved concentrations of arsenic, cadmium, chromium and nickel. The full list of variables monitored, together with details of field and analytical methods is provided in Appendix 2.

2.5 Biological monitoring

Water quality in the region's rivers and streams is also assessed through annual biological monitoring, incorporating 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 (46 in total, see Appendix 1 for RSoE site substrate types). Periphyton cover is also assessed monthly at these sites at the time of water sample collection. Details of current biological monitoring methods are summarised in Appendix 3.

3. Physico-chemical and microbiological water quality

3.1 Introduction

In this section a water quality index (WQI) is used as a comparative measure to summarise water quality across the region, based on physico-chemical and microbiological data collected monthly from July 2009 to June 2010 inclusive (see Appendix 4 for full data summaries). Concentrations of heavy metals recorded at selected urban sites are also summarised. The summary information is typically based on 12 sampling events for all 55 sites. However, access to two sites (Parkvale tributary at Lowes Reserve, and Coles Creek tributary at Lagoon Hill Road) was not always permitted by the landowner (e.g., during lambing or calving) or possible during winter. Furthermore, due to unreliable instrument readings on some occasions and/or environmental conditions, not all sites have 12 data points for all variables assessed in the field (e.g., periphyton cover, pH, 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 (e.g., a value of <2 became 1, a value of >400 became 400).

3.1.1 Water quality index

A water quality index (WQI), as described in Perrie (2007), 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 for 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 comply¹
- 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.

The guidelines used to compare the median values against the six key water quality variables in WQI are listed in Table 3.1. Refer to Perrie (2007) for further discussion on these guidelines.

¹ 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

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/100 mL)	≤100	ANZECC & ARMCANZ (2000)

3.1.2 Heavy metals

Median heavy metal concentrations are compared against ANZECC (2000) chronic toxicity “trigger values” (95% level of protection, Table 3.2). Where a median concentration exceeds the trigger value, site-specific, hardness-modified² trigger values are calculated based on recommendations and equations in ANZECC (2000). The median concentrations are then compared against this site-specific, hardness-modified trigger value (see Appendix 5). Because water hardness is not part of the existing suite of variables analysed in the RSoE programme, the median water hardness from monthly monitoring over January 2008 to December 2009 (inclusive) is used as a surrogate of local water hardness conditions (see Perrie 2009b).

Table 3.2: ANZECC (2000) chronic toxicity (95% level of protection) trigger values. For site-specific, hardness-modified trigger values see Appendix 5.

Variable	Chronic toxicity trigger value (mg/L)
Dissolved arsenic	0.0130
Dissolved cadmium	0.0002
Dissolved chromium	0.0010
Dissolved copper	0.0014
Dissolved lead	0.0034
Dissolved nickel	0.0110
Dissolved zinc	0.0080

3.2 Results and discussion

3.2.1 Water quality index

Application of the WQI resulted in the following overall water quality grades for the 55 RSoE sites monitored in the Wellington region over the July 2009 to June 2010 reporting period (Figure 3.1, Table 3.3):

- Excellent: 15 sites (27.3%)
- Good: 11 sites (20.0%)
- Fair: 14 sites (25.5%)
- Poor 15 sites (27.3%)

² Water hardness affects the toxicity of some heavy metals.

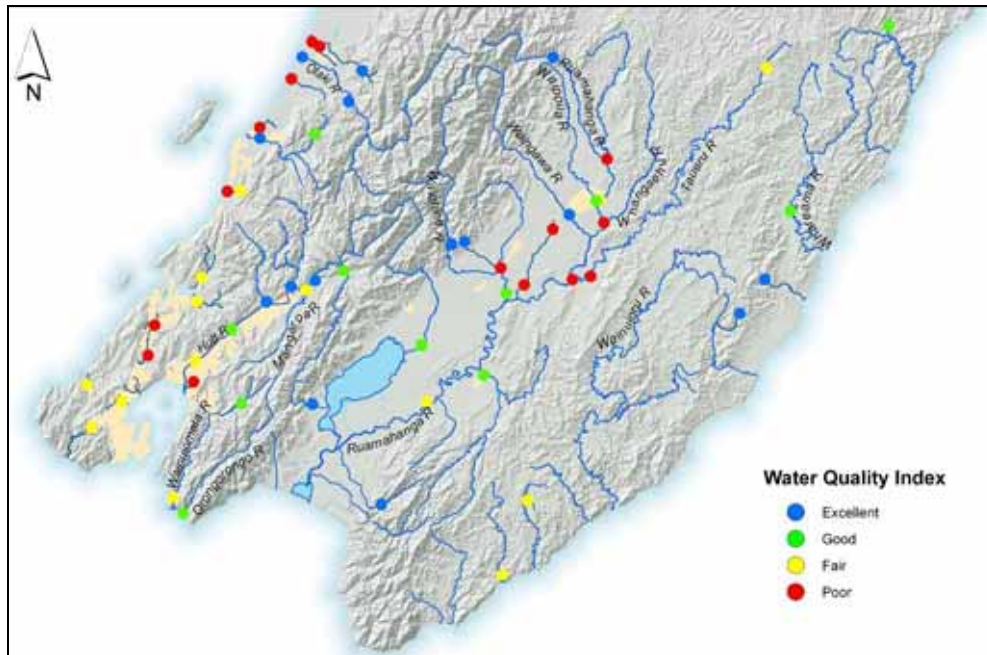


Figure 3.1: Water Quality Index grades for RSoE sites sampled at monthly intervals over June 2009 to July 2010, based on compliance of median dissolved oxygen, visual clarity, nitrite-nitrate nitrogen, ammoniacal nitrogen, dissolved reactive phosphorus and *E. coli* values with guideline values

The majority of RSoE sites graded “excellent” (14 of 15 sites) are located on river and stream reaches in catchments with predominantly unmodified indigenous forest cover (refer Appendix 1 for dominant land cover). These tend to be sites on rivers flowing out of the Aorangi, Tararua and Rimutaka ranges and include the Akatarawa, Hutt, Otaki, and Waingawa rivers, and the upper reaches of the Waitohu, Waiohine and Ruamahanga rivers. In contrast, RSoE sites graded “poor” were typically located on small rivers or streams draining predominantly pastoral (10 sites) or urban (5 sites) catchments. Sites with the poorest water quality during 2009/10 included the Mangaone Stream at Sims Road Bridge, Mangapouri Stream at Bennetts Road, Mangatarere Stream at State Highway 2, Parkvale Stream at Weir, Whareroa Stream at Queen Elizabeth Park, and the Whangaehu River at 250m from the confluence of the Ruamahanga River.

As outlined in Section 3.2, 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 because the median value of at least one of the six physico-chemical or microbiological variables in the WQI exceeded a guideline value. In addition, as the WQI is based on median values (i.e., 50% compliance), sites awarded the same water quality grade may exhibit varying degrees of compliance (from 51 to 100%) with the guideline value, and so while two sites may fall within the same WQI class they may differ in actual water quality. Therefore to differentiate between “better” and “poorer” sites within a water quality grade, in Table 3.3 the sites within each WQI grade have been ranked based on the number of guideline exceedances for each of the six key variables (i.e., a site that exceeded a guideline on 40% of sampling occasions will be ranked lower than a site with the same WQI grade that exceeded the guideline on 10% of sampling occasions).

Table 3.3: Water Quality Index grades for RSoE sites sampled at monthly intervals over June 2009 to July 2010 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
<i>Excellent water quality</i>								
1	RS47	Waiohine River at Gorge	✓	✓	✓	✓	✓	✓
2	RS31	Ruamahanga River at McLays	✓	✓	✓	✓	✓	✓
3	RS25	Akatarawa River at Hutt Confluence	✓	✓	✓	✓	✓	✓
3	RS26	Whakatikei River at Riverstone	✓	✓	✓	✓	✓	✓
3	RS44	Totara Stream at Stronvar	✓	✓	✓	✓	✓	✓
3	RS56	Waiorongomai River at Forest Park	✓	✓	✓	✓	✓	✓
3	RS43	Motuwaireka Stream at headwaters	✓	✓	✓	✓	✓	✓
3	RS10	Waikanae River at Greenaway Rd	✓	✓	✓	✓	✓	✓
9	RS03	Waitohu Stream at Forest Park	✓	✓	✓	✓	✓	✓
9	RS05	Otaki River at Pukehinau	✓	✓	✓	✓	✓	✓
9	RS20	Hutt River at Te Marua Intake Site	✓	✓	✓	✓	✓	✓
9	RS49	Beef Creek at headwaters	✓	✓	✓	✓	✓	✓
9	RS52	Tauanui River at Whakatomotomo Rd	✓	✓	✓	✓	✓	✓
14	RS41	Waingawa River at South Rd	✓	✓	✓	✓	✓	✓
15	RS06	Otaki River at Mouth	✓	✓	✓	✓	✓	✓
<i>Good water quality</i>								
16	RS55	Tauherenikau River at Websters	✓	x	✓	✓	✓	✓
17	RS28	Wainuiomata River at Manuka Track	✓	✓	✓	✓	✓	x
18	RS30	Orongorongo River at Orongorongo St.	✓	x	✓	✓	✓	✓
19	RS09	Waikanae River at Mangaone Walkway	✓	✓	✓	✓	✓	x
20	RS23	Pakuratahi River 50m Below Farm Creek	✓	✓	x	✓	✓	✓
21	RS35	Mataikona tributary at Sugar Loaf Rd	✓	x	✓	✓	✓	✓
22	RS21	Hutt River Opposite Manor Park Golf Club	✓	x	✓	✓	✓	✓
23	RS40	Waipoua River at Colombo Rd Bridge	✓	✓	✓	x	✓	✓
24	RS42	Whareama River at Gauge	✓	x	✓	✓	✓	✓
25	RS51	Huangarua River at Ponatahi Bridge	✓	x	✓	✓	✓	✓
26	RS48	Waiohine River at Bicknells	✓	✓	✓	✓	✓	x
<i>Fair water quality</i>								
27	RS22	Hutt River at Boulcott	✓	x	x	✓	✓	✓
28	RS36	Taueru River at Castlehill	✓	x	x	✓	✓	✓
29	RS54	Coles Creek tributary at Lagoon Hill Rd	✓	x	x	✓	✓	✓
30	RS53	Awhea River at Tora Rd	✓	x	x	✓	✓	✓
31	RS13	Horokiri Stream at Snodgrass	✓	x	x	✓	✓	✓
31	RS32	Ruamahanga River at Te Ore Ore	✓	x	x	✓	✓	✓
33	RS29	Wainuiomata River Upstr of White Bridge	✓	x	x	✓	✓	x
34	RS11	Whareroa Stream at Waterfall Rd	✓	x	✓	✓	✓	x
35	RS24	Mangaroa River at Te Marua	✓	x	x	✓	✓	x
35	RS34	Ruamahanga River at Pukio	✓	x	x	✓	✓	x
37	RS17	Makara Stream at Kennels	✓	x	x	✓	✓	x
38	RS14	Pauatahanui Stream at Elmwood Bridge	✓	x	x	✓	✓	x
39	RS18	Karori Stream at Makara Peak Mountain	✓	✓	x	x	✓	x
40	RS19	Kaiwharawhara Stream at Ngaio Gorge	✓	✓	x	x	✓	x
<i>Poor water quality</i>								
41	RS45	Parkvale tributary at Lowes Reserve	x	✓	✓	x	✓	x
42	RS08	Ngarara Stream at Field Way	x	x	✓	✓	✓	x
43	RS37	Taueru River at Gladstone	✓	x	x	x	✓	x
44	RS33	Ruamahanga River at Gladstone Bridge	✓	x	x	x	x	x
45	RS15	Porirua Stream at Glenside Overhead Ca.	✓	x	x	x	✓	x
46	RS46	Parkvale Stream at Weir	✓	x	x	x	✓	x
47	RS38	Kopuaranga River at Stewarts	✓	x	x	x	✓	x
48	RS50	Mangatarere Stream at State Highway 2	✓	x	x	x	x	x
49	RS16	Porirua S at Wall Park (Milk Depot)	✓	x	x	x	✓	x
50	RS39	Whangaehu River at 250m from Conf.	✓	x	x	x	✓	x
51	RS27	Waiwhetu Stream at Wainui Hill Bridge	x	x	x	x	x	x
52	RS04	Waitohu Stream at Norfolk Crescent	✓	x	x	x	x	x
52	RS12	Whareroa Stream at QE Park	x	x	x	x	x	x
52	RS02	Mangapouri Stream at Bennetts Rd	x	x	x	x	x	x
55	RS07	Mangaone Stream at Sims Road Bridge	x	x	x	x	x	x

The water quality variables that most commonly exceeded guideline values (based on median values) were visual clarity (32 sites), followed by *E. coli* (27 sites) dissolved reactive phosphorus (26 sites), and nitrite-nitrate nitrogen (15 sites). Guidelines for ammoniacal nitrogen and dissolved oxygen were not met at seven and six sites respectively.

3.2.2 Heavy metals

Median dissolved lead concentrations were below the ANZECC (2000) default trigger level at all sites. Median concentrations of dissolved copper and zinc exceeded their respective default trigger values at three and four sites respectively. However, once local water hardness was taken into account and the ANZECC (2000) site-specific, hardness-modified trigger values applied, the only guideline exceedences were dissolved zinc at three sites: the Porirua Stream at Wall Park, Karori Stream at Makara Mountain Bike Park and the Waiwhetu Stream at Wainuiomata Hill Bridge. Median concentrations for additional heavy metals (dissolved arsenic, cadmium, chromium and nickel) analysed in water samples collected from the Waiwhetu Stream at Wainuiomata Hill Bridge were also below their respective ANZECC (2000) default trigger values.

4. Periphyton

4.1 Introduction

Assessment of periphyton data is limited to RSoE sites with hard substrates (46 of the 55 sites). Monthly observations of percent streambed periphyton cover, from July 2009 to June 2010 inclusive, and an assessment of periphyton biomass (chlorophyll *a* and Ash Free Dry Mass (AFDM)) undertaken in late summer/early autumn 2010 are compared against various MfE (2000) guidelines (Table 4.1).

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

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 AFDM (g/m ²)	35 g/m ²	35 g/m ²
Maximum cover of visible streambed	N/A	30% >2 cm long

4.2 Results and discussion

The number of observations of streambed periphyton cover made during the reporting period varied among the 46 RSoE sites due to either site access being restricted or because turbid water or high flows made assessment of cover impossible.

Of the 46 RSoE sites, 20 exceeded the MfE (2000) guideline for filamentous periphyton streambed cover on at least one sampling occasion (Table 4.2). The sites that most often exceeded the guideline were the Taueru River at Gladstone and the Huangarua River at Ponatahi Bridge (six times each from a total of seven sampling occasions) along with the Pauatahanui Stream at Elmwood Bridge and the Kaiwharawhara Stream at Ngaio Gorge (five times each). These sites are all located in catchments dominated by pastoral or urban (Kaiwharawhara Stream) land use and some (especially the Taueru and Huangarua rivers) can frequently experience prolonged periods without sufficient flows to remove algal growth.

Table 4.2: Summary of monthly observations at RSoE sites, over July 2009 to June 2010 inclusive, of visible streambed cover for filamentous and mat-forming periphyton in relation to exceedances of the MfE (2000) guidelines

Site No.	Site Name	Streambed cover (%)					
		Filamentous (>2 cm long)			Mats (>0.3 cm thick)		
		Max	n >30 % cover	n	Max	n >60 % cover	n
RS03	Waitohu S at Forest Pk	15	0	12	0	0	12
RS05	Otaki R at Pukehinau	39	1	11	4	0	11
RS06	Otaki R at Mouth	50	1	12	12	0	12
RS09	Waikanae R at Mangaone Walkway	0	0	12	0	0	12
RS10	Waikanae R at Greenaway Rd	15	0	12	43	0	12
RS11	Whareroa S at Waterfall Rd	0	0	11	0	0	11
RS13	Horokiri S at Snodgrass	62	1	12	6	0	12
RS14	Pauatahanui S at Elmwood Br	100	5	12	0	0	12
RS15	Porirua S at Glenside	68	1	10	20	0	10
RS16	Porirua S at Wall Park (Milk Depot)	70	4	11	17	0	11
RS17	Makara S at Kennels	28	0	11	0	0	11
RS18	Karori S at Makara Peak	64	2	11	23	0	11
RS19	Kaiwharawhara S at Ngaio Gorge	77	5	12	26	0	12
RS20	Hutt R at Te Marua Intake Site	0	0	8	0	0	8
RS21	Hutt R opp. Manor Park G.C.	7	0	10	58	0	10
RS22	Hutt R at Boulcott	2	0	7	51	0	7
RS23	Pakuratahi R 50m d/s Farm Ck	0	0	9	29	0	9
RS24	Mangaroa R at Te Marua	28	0	9	19	0	9
RS25	Akatarawa R at Hutt confl.	0	0	11	0	0	11
RS26	Whakatikei R at Riverstone	8	0	11	6	0	11
RS28	Wainuiomata R at Manuka Track	0	0	12	1	0	12
RS29	Wainuiomata R u/s of White Br	19	0	12	43	0	12
RS30	Orongorongo R at Orongorongo Stn	49	2	7	6	0	7
RS31	Ruamahanga R at McLays	0	0	12	0	0	12
RS32	Ruamahanga R at Te Ore Ore	6	0	6	2	0	6
RS33	Ruamahanga R at Gladstone Br	0	0	8	0	0	8
RS34	Ruamahanga R at Pukio	0	0	6	0	0	6
RS35	Mataikona Trib at Sugar Loaf Rd	3	0	12	0	0	12
RS37	Taueru R at Gladstone	100	6	7	0	0	7
RS38	Kopuaranga R at Stewarts	98	4	7	23	0	7
RS40	Waipoua R at Colombo Rd Br	32	1	12	85	2	12
RS41	Waingawa R at South Rd	0	0	11	5	0	11
RS43	Motuwaiereka S at Headwaters	0	0	12	0	0	12
RS44	Totara S at Stronvar	100	2	11	32	0	11
RS45	Parkvale Trib at Lowes Res.	0	0	9	0	0	9
RS46	Parkvale S at Weir	73	3	11	22	0	11
RS47	Waiohine R at Gorge	0	0	11	0	0	11
RS48	Waiohine R at Bicknells	27	0	11	6	0	11
RS49	Beef Ck at Headwaters	0	0	12	3	0	12
RS50	Mangatarere S at SH 2	100	2	10	2	0	10
RS51	Huangaaru R at Ponatahi Br	85	6	7	61	1	7
RS52	Tauanui R at Whakatomotomo Rd	2	0	10	0	0	10
RS53	Awhea R at Tora Rd	100	4	6	0	0	6
RS54	Coles Ck Trib at Lagoon Hill Rd	39	2	10	0	0	10
RS55	Tauherenikau R at Websters	40	1	11	0	0	11
RS56	Waiorongomai R at Forest Pk	31	1	11	0	0	11

Exceedance of the MfE (2000) guideline for mat-forming periphyton cover occurred at two RSoE sites during the reporting period: the Waipoua River at Colombo Road (on two occasions) and the Huangarua River at Ponatahi Bridge (once). It is important to note that observations of periphyton cover are typically undertaken in run habitat³, whereas some mat-forming periphyton (particularly cyanobacteria) tend to proliferate initially in riffle habitat⁴ and then in runs (MfE 2009). Thus the results presented here may not accurately represent the presence of mat-forming periphyton, or exceedance of mat-forming periphyton guidelines.

Thirteen RSoE sites exceeded the MfE (2000) chlorophyll *a* guideline for benthic biodiversity (Table 4.3). The highest chlorophyll *a* biomass recorded was in the Taueru River at Gladstone (583.6 mg/m²). Two sites exceeded the MfE (2000) AFDM guideline for trout habitat and angling with the highest biomass recorded in the Kopuaranga River at Stewarts (114.3 g/m²).

There was a reasonable correlation between exceedance of periphyton guidelines and WQI grades. Sites with excellent water quality were more likely to comply with guidelines for both periphyton cover and biomass than sites with poor or fair WQI grades. At some sites it was clear that variables other than water quality, such as accrual periods and streamside shade, are more strongly influencing the periphyton community and hence compliance with guidelines.

³ A run has a character in between that of a riffle and pool, it is moderate in depth and typically has a uniform current and an unbroken surface.

⁴ A riffle is an area of shallow depth, moderate to fast water velocity, with mixed currents and an unbroken but rippled surface.

Table 4.3: Periphyton biomass (AFDM and chlorophyll *a*) from one-off sampling during late summer/ autumn of 2010. Non-compliance with MfE (2000) guidelines is highlighted in bold type.

Site No.	Site Name	AFDM (g/m ²)	Chlorophyll <i>a</i> (mg/m ²)
RS03	Waitohu S at Forest Pk	0.43	0.78
RS05	Otaki R at Pukehinau	0.58	2.22
RS06	Otaki R at Mouth	0.98	2.12
RS09	Waikanae R at Mangaone Walkway	0.80	0.90
RS10	Waikanae R at Greenaway Rd	1.44	9.73
RS11	Whareroa S at Waterfall Rd	2.32	0.56
RS13	Horokiri S at Snodgrass	3.31	46.14
RS14	Pauatahanui S at Elmwood Br	15.23	23.27
RS15	Porirua S at Glenside	7.59	76.73
RS16	Porirua S at Wall Park (Milk Depot)	6.57	55.30
RS17	Makara S at Kennels	3.05	15.37
RS18	Karori S at Makara Peak	5.03	25.07
RS19	Kaiwharawhara S at Ngaio Gorge	5.81	34.22
RS20	Hutt R at Te Marua Intake Site	0.71	0.89
RS21	Hutt R opp. Manor Park G.C.	5.23	59.77
RS22	Hutt R at Boulcott	9.98	119.27
RS23	Pakuratahi R 50m d/s Farm Ck	1.86	20.17
RS24	Mangaroa R at Te Marua	12.48	72.58
RS25	Akatarawa R at Hutt confl.	0.14	0.28
RS26	Whakatikei R at Riverstone	1.67	4.96
RS28	Wainuiomata R at Manuka Track	2.86	10.18
RS29	Wainuiomata R u/s of White Br	34.36	236.30
RS30	Orongorongo R at Orongorongo Stn	1.48	3.33
RS31	Ruamahanga R at McLays	0.17	0.41
RS32	Ruamahanga R at Te Ore Ore	3.91	34.75
RS33	Ruamahanga R at Gladstone Br	6.74	64.96
RS34	Ruamahanga R at Pukio	11.62	91.48
RS35	Mataikona Trib at Sugar Loaf Rd	1.88	11.68
RS37	Taueru R at Gladstone	76.81	583.65
RS38	Kopuaranga R at Stewarts	114.26	515.16
RS40	Waipoua R at Colombo Rd Br	12.04	33.72
RS41	Waingawa R at South Rd	1.56	8.60
RS43	Motuwaireka S at Headwaters	1.17	1.64
RS44	Totara S at Stronvar	4.61	7.89
RS45	Parkvale Trib at Lowes Res.	12.07	41.44
RS46	Parkvale S at Weir	31.65	309.26
RS47	Waiohine R at Gorge	0.25	0.70
RS48	Waiohine R at Bicknells	12.00	51.43
RS49	Beef Ck at Headwaters	1.37	10.53
RS50	Mangatarere S at SH 2	6.63 ¹	47.76 ¹
RS51	Huangarua R at Ponatahi Br	18.88	96.34
RS52	Tauanui R at Whakatomotomo Rd	4.88	30.58
RS53	Awhea R at Tora Rd	14.46	29.31
RS54	Coles Ck Trib at Lagoon Hill Rd	5.24	21.48
RS55	Tauherenikau R at Websters	2.96	10.24
RS56	Waiorongomai R at Forest Pk	0.36	0.43

¹ Note in Perrie (2009a) the AFDM and chlorophyll *a* concentrations for this site were incorrectly reported. The correct concentrations from sampling in 2009 were 13.4 g/m³ and 143.2 mg/m³ respectively.

5. Macroinvertebrates

5.1 Introduction

This section presents the results of macroinvertebrate sampling undertaken at the 55 RSoE sites during late summer/early autumn 2010. The Macroinvertebrate Community Index (MCI) – an index of sensitivity to a complex of environmental variables (Stark & Maxted 2007) – is used to summarise macroinvertebrate health. Additional macroinvertebrate indices (QMCI, %EPT taxa, and taxa richness) are presented in Appendix 5. Refer to Perrie (2007) for further explanation on these indices.

The quality classification, as recommended by Stark & Maxted (2007), for interpretation of the MCI scores is outlined in Table 5.1. Soft bottomed MCI scores (MCI-sb) were calculated for the nine RSoE sites with soft substrates (see Appendix 1).

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

Quality Class	MCI and MCI-sb
Excellent	>119
Good	100-119
Fair	80-99
Poor	<80

5.2 Results and discussion

The MCI scores based on one sample collected from each monitoring site are presented in Table 5.2. The 55 RSoE sites fell into the following MCI quality classes (Figure 5.1):

- Excellent: 17 sites (30.9%)
- Good: 21 sites (38.2%)
- Fair: 11 sites (20.0%)
- Poor: 6 sites (10.9%)

The majority (14 of 17) of the RSoE sites in the “excellent” MCI quality class are located in catchments dominated by indigenous forest cover (e.g., Ruamahanga River at McLays). The six RSoE sites in the “poor” quality class were typically located in catchments dominated by pastoral landcover (e.g., Mangaone Stream at Sims Road Bridge), except in the case of the Mangapouri Stream at Bennetts Road and the Waiwhetu Stream at Wainuiomata Hill Bridge (urban). Sites with soft-sediment substrate were also over-represented in this poor category (five of six sites).

Table 5.2: MCI scores for RSoE sites sampled in 2010

Site No.	Site Name	MCI score	MCI Quality Class
RS02	Mangapouri S at Bennetts Rd	77.0	Poor
RS03	Waitohu S at Forest Pk	150.0	Excellent
RS04	Waitohu S at Norfolk Cres	110.0	Good
RS05	Otaki R at Pukehinau	129.4	Excellent
RS06	Otaki R at Mouth	92.9	Fair
RS07	Mangaone S at Sims Rd Br	60.7	Poor
RS08	Ngarara S at Field Way	80.1	Fair
RS09	Waikanae R at Mangaone Walkway	142.2	Excellent
RS10	Waikanae R at Greenaway Rd	117.7	Good
RS11	Whareroa S at Waterfall Rd	105.6	Good
RS12	Whareroa S at QE Park	83.5	Fair
RS13	Horokiri S at Snodgrass	120.0	Excellent
RS14	Pauatahanui S at Elmwood Br	108.6	Good
RS15	Porirua S at Glenside	103.0	Good
RS16	Porirua S at Wall Park (Milk Depot)	96.2	Fair
RS17	Makara S at Kennels	111.8	Good
RS18	Karori S at Makara Peak	81.7	Fair
RS19	Kaiwharawhara S at Ngaio Gorge	90.5	Fair
RS20	Hutt R at Te Marua Intake Site	138.3	Excellent
RS21	Hutt R opp. Manor Park G.C.	124.8	Excellent
RS22	Hutt R at Boulcott	115.0	Good
RS23	Pakuratahi R 50m d/s Farm Ck	116.0	Good
RS24	Mangaroa R at Te Marua	120.7	Excellent
RS25	Akatarawa R at Hutt confl.	125.2	Excellent
RS26	Whakatiwai R at Riverstone	126.9	Excellent
RS27	Waiwhetu S at Wainui Hill Br	56.2	Poor
RS28	Wainuiomata R at Manuka Track	135.3	Excellent
RS29	Wainuiomata R u/s of White Br	103.2	Good
RS30	Orongorongo R at Orongorongo Stn	110.0	Good
RS31	Ruamahanga R at McLays	152.9	Excellent
RS32	Ruamahanga R at Te Ore Ore	107.5	Good
RS33	Ruamahanga R at Gladstone Br	98.8	Fair
RS34	Ruamahanga R at Pukio	101.5	Good
RS35	Mataikona Trib at Sugar Loaf Rd	133.1	Excellent
RS36	Taueru R at Castlehill	113.5	Good
RS37	Taueru R at Gladstone	96.7	Fair
RS38	Kopuaranga R at Stewarts	96.9	Fair
RS39	Whangaehu R 250m u/s confl.	55.5	Poor
RS40	Waipoua R at Colombo Rd Br	105.8	Good
RS41	Waingawa R at South Rd	111.8	Good
RS42	Whareama R at Gauge	70.2	Poor
RS43	Motuwaireka S at Headwaters	135.5	Excellent
RS44	Totara S at Stronvar	107.5	Good
RS45	Parkvale Trib at Lowes Res.	95.0	Fair
RS46	Parkvale S at Weir	77.5	Poor
RS47	Waiohine R at Gorge	141.1	Excellent
RS48	Waiohine R at Bicknells	114.0	Good
RS49	Beef Ck at Headwaters	134.2	Excellent
RS50	Mangatarere S at SH 2	92.8	Fair
RS51	Huangaaru R at Ponatahi Br	107.8	Good
RS52	Tauanui R at Whakatomotomo Rd	125.2	Excellent
RS53	Awhea R at Tora Rd	118.0	Good
RS54	Coles Ck Trib at Lagoon Hill Rd	109.6	Good
RS55	Tauherenikau R at Websters	118.3	Good
RS56	Waiorongomai R at Forest Pk	126.7	Excellent

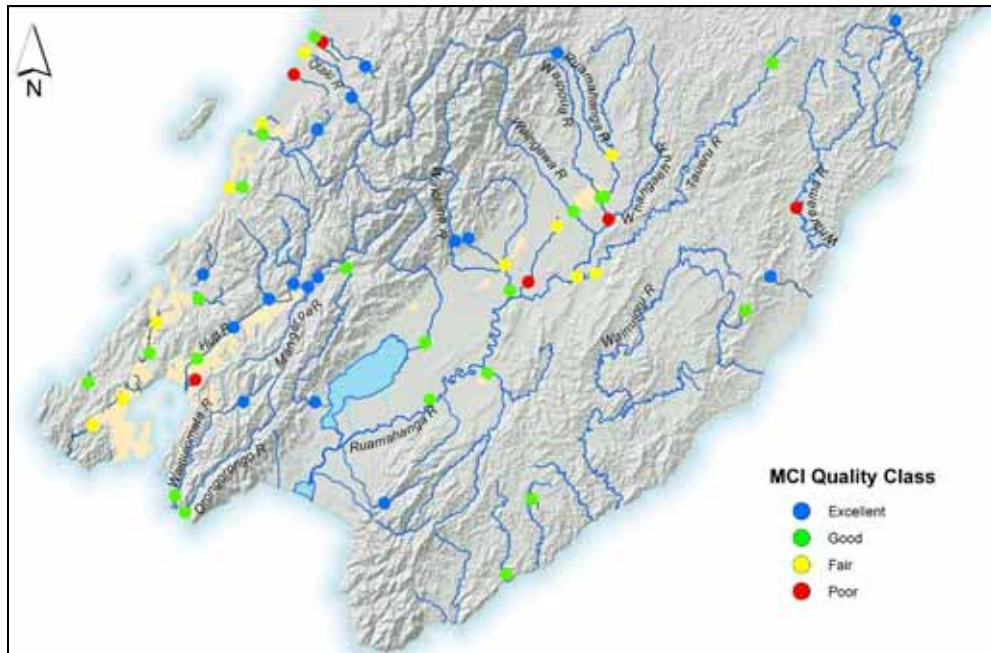


Figure 5.1: MCI quality classes for the 55 RSoE sites, determined from one sampling event over summer/autumn 2010

There was a reasonable correlation between the MCI quality classes and WQI grades. For example, of the 17 RSoE sites with an “excellent” MCI quality class, 11 had a WQI grade of “excellent”, four a WQI grade of “good”, and two had a WQI grade of “fair” (refer Section 3.2.1). Similarly, five of the six RSoE sites with an MCI quality class of “poor” also had a WQI grade of “poor” the other a WQI grade of “good”. The correlation between water quality and macroinvertebrate health based on WQI grades and MCI quality grades was less clear in the “good” and “fair” classes.

Sites that recorded higher MCI scores were also more likely to comply with both periphyton cover and biomass guidelines. For example, out of the 19 sites that complied with all periphyton guidelines, 12 had MCI grades of “excellent”, six had MCI scores of “good” and one site had an MCI score of “fair”.

6. Targeted investigations

In addition to routine monitoring under the RSoE programme, some specific freshwater investigations were also undertaken or completed in 2009/10. These included investigations into nutrient sources in the Mangatarere Stream catchment, the ecological values of intermittent headwater streams, the effects of river channel realignment on aquatic ecosystems, the water quality status of Lake Waitawa and one-off sampling of shallow groundwater bores and surface water sites around Lake Wairarapa.

6.1 Mangatarere Stream catchment investigation

In September 2008 Greater Wellington commenced a year-long integrated study (i.e., soil, groundwater and surface water quality) of the Mangatarere catchment in Carterton. Water quality in the lower reaches of the Mangatarere Stream is amongst the poorest in rivers and streams in the Wellington region, particularly in terms of dissolved nutrient concentrations (e.g., Perrie 2009). Therefore there was a need for more information to better understand water quality within the catchment, and to determine the primary nutrient sources and the potential migration of nutrients from the soil zone to groundwater aquifers to surface water.

The findings of the investigation are documented in a detailed report by Milne et al. (2010) and so only a brief summary of the surface water quality component of the investigation is made here. This component involved monthly (September 2008 to August 2009 inclusive) testing of water quality at 11 stream sites (five on the Mangatarere Stream, three on the Enaki Stream⁵, and one each on the Kaipaitangata Stream, Beef Creek and the Carrington Water Race) and a one-off ecological assessment (undertaken during summer) at ten stream sites (Figure 6.1).

An overview of water quality in the catchment – using the WQI – is presented in Figure 6.2. Monitoring of stream sites showed that a number of site-specific impacts were present, such as stock access in the Enaki Stream subcatchment. In terms of dissolved inorganic nitrogen, there was a steady increase in loads with distance down the catchment and both intensive agriculture and wastewater discharges to land at Reid's piggery are making a significant contribution (Beef Creek contributed the highest nitrogen load of the three subcatchments). Dissolved reactive phosphorus concentrations were highest in the lower reaches of the Mangatarere Stream, with the Carterton Wastewater Treatment Plant responsible for the majority of the phosphorus load.

Low stream flows and a general lack of riparian vegetation throughout the catchment are also likely to be exacerbating the effects of elevated nutrients on the stream ecosystem and contributing to the nuisance periphyton and degraded invertebrate health that was observed, particularly in the lower reaches of the Mangatarere Stream and its tributaries.

⁵ One branch of this stream is known as the Hinau Gully Stream.



Figure 6.1: Location of the surface water and ecological sites sampled in the Mangatarere catchment over September 2008 to August 2009. Greater Wellington's SoE monitoring sites on Beef Creek and the Waiohine River (also sampled monthly, but on a different day) are also shown.
 (Source: Milne et al. 2010)

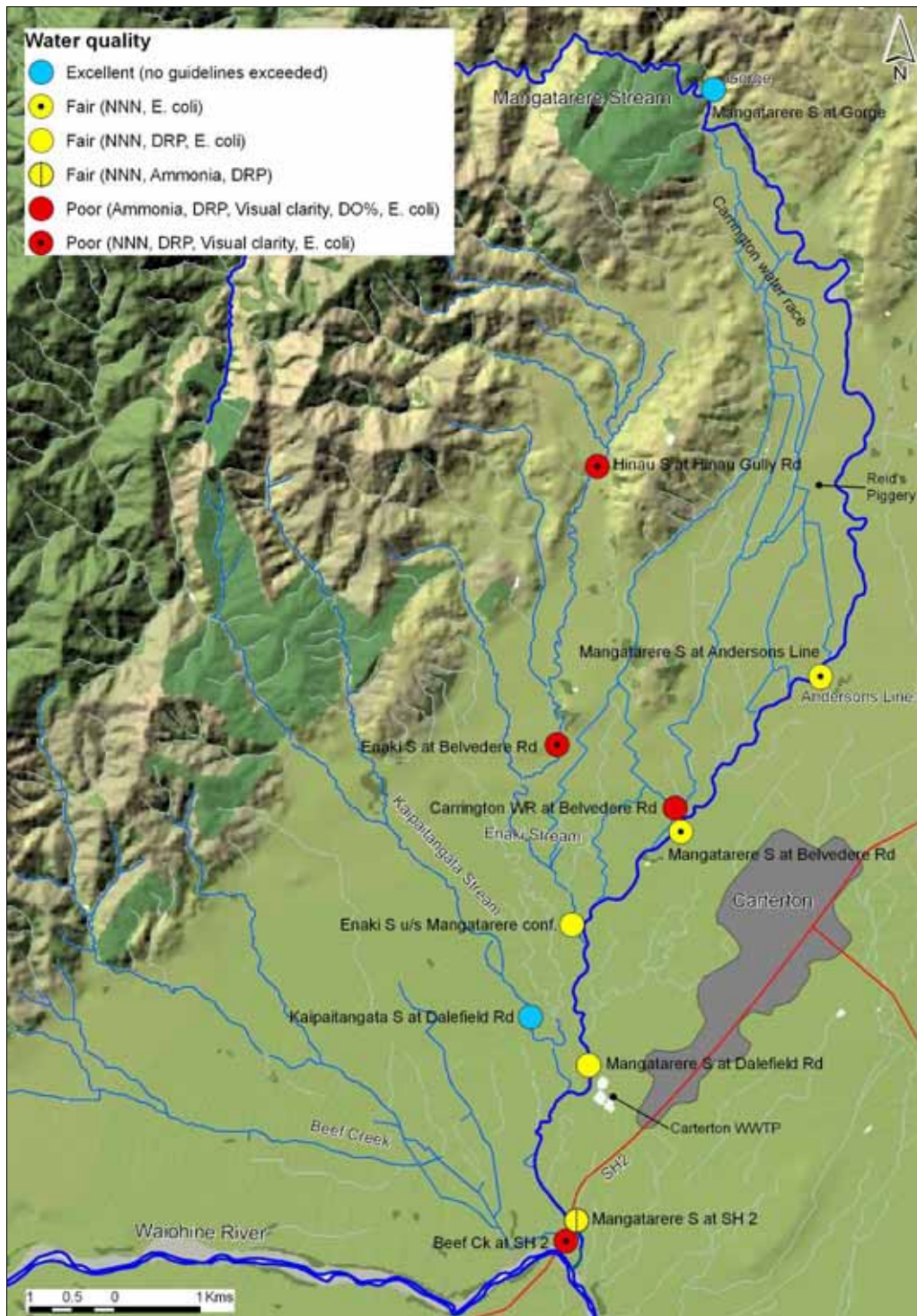


Figure 6.2: Overview of surface water quality in the Mangatarere catchment, based on the WQI (from monthly sampling over September 2008 to August 2009). The legend indicates the variables that had median values outside guideline values.

(Source: Milne et al. 2010)

6.2 Ecological values of intermittent streams

Small headwater streams that can dry up during the summer months (known as intermittently flowing streams) are commonly overlooked and undervalued when it comes to stream biodiversity. As such, they are often at risk from being filled in and piped during land development and in rural areas can be degraded by stock access.

To further understand the ecological values of small intermittent streams in the region, Greater Wellington commissioned NIWA to undertake an investigation of these streams, with the aim of documenting their ecological values. Sampling at six sites (tributaries of the Kiriwhakapapa, Korokoro, Rimutaka, Takapu Wahia, Waiwhetu and York Bay streams) during 2009/10 revealed that some sites had aquatic invertebrate communities distinct from those in permanently flowing streams and were home to several species unlikely to occur in other types of habitat. Several insects of conservation interest were also recorded, confirming that small intermittently flowing streams add to the overall aquatic biodiversity of the region and need greater protection.

Full details of the investigation into the ecological values of intermittent streams can be found in Storey (2010).

6.3 Effects of flood protection works on aquatic ecosystems

Greater Wellington is required to manage the region's rivers and streams to protect adjacent land and infrastructure from erosion and flood damage. Realignment of river channels is one practice that is commonly used to protect river banks and adjacent land from erosion (e.g., Figure 6.3). However, the effects of channel realignment on aquatic ecosystems are largely unknown.

During 2009, Greater Wellington undertook a preliminary investigation into the effects of extensive channel realignment on the aquatic ecosystem in a 1.5 km long reach of the Waingawa River near Masterton. The aims of the investigation were to:

- 1) measure changes in riverine habitat (e.g., pools, runs and riffles) and indicators of ecosystem health (e.g., periphyton, macroinvertebrates and fish) and;
- 2) where changes occurred, measure the recovery time to "pre-channel realignment" conditions.

Preliminary analysis of the results has shown that channel realignment immediately reduced the number and quality of deep water habitats (e.g., pools) within the study reach and while the re-establishment of pools and other deep water habitats did begin to occur, it took several months. Some aquatic fauna, such as redfin bullies and large longfin eels, which were observed prior to channel realignment and are known to prefer to live in or around deep pools, were not observed post channel realignment. Further work is required to see how the localised loss of habitat may impact on the wider river ecosystem and whether these effects are typical of channel realignment activities. Investigations are also planned to look at ways to lessen the potential impact from flood protection activities.



Figure 6.3 A bulldozer realigning a section of the Waingawa River channel to reduce erosion that is occurring along the left bank

6.4 Lake Waitawa water quality investigation

Lake Waitawa is a small (~ 16 ha), shallow (typically $\leq 7\text{m}$ deep) dune lake situated just north of Otaki and is part of a group of highly modified small dune lake/wetland systems found in this area. The lake is surrounded by private land but has high recreational use (swimming, boating, water skiing etc.) with a campground and conference centre situated along one shore. The lake is fed by several small streams/wetlands that run into eastern arms of the lake. Input from groundwater may also be an important source of water into the lake. The lake outflow is located in the western arm of the lake and eventually discharges into the Waitohu Stream.

The lake has a history of poor water quality which has led to nuisance growths of invasive macrophytes (e.g., *Ceratophyllum demersum*) and algal blooms, including toxin producing species of cyanobacteria. Water quality problems within the lake are not surprising given that the land use within the lake catchment is dominated by pastoral agriculture (> 80%) with intensive farming practices such as dairying bordering the lake edge. Treated wastewater from the Forest Lakes Camp and Conference Centre is also discharged into the lake, indirectly through a wetland.

To better understand the current water quality status of Lake Waitawa and to provide further information for the development of a lake restoration plan, Greater Wellington undertook an assessment of water quality during 2008/09. This involved regular sampling from one site situated in the deepest part of the lake (every 4-6 weeks from August 2008 to July 2009 – 11 sampling occasions) for a variety of physico-chemical and bacteriological water quality variables (dissolved oxygen, temperature, pH, conductivity, visual clarity, turbidity, faecal indicator bacteria, total organic carbon, and dissolved and total

nutrients). Water temperature and dissolved oxygen depth profiles were also carried out on each sampling occasion to assess stratification. In addition, assessments of the phytoplankton community (biomass and species identification) were undertaken.

A detailed report on the results from this investigation is expected in 2011. Preliminary analysis of the results to date indicates elevated concentrations of nutrients (both nitrogen and phosphorus) and high algal biomass. The lake was also found to regularly stratify, which at times resulted in very low concentrations of dissolved oxygen. High concentrations of potentially toxic cyanobacteria were also recorded on several occasions.

6.5 Water quality sampling of tributaries and shallow groundwater flowing into Lake Wairarapa

Lake Wairarapa is classified as supertrophic (Perrie 2005), indicating that nutrient concentrations are elevated, water clarity is poor and the algal biomass is high. Results from Greater Wellington's River State of the Environment monitoring programme indicate that water quality in two of the lake's more significant tributaries – Tauherenikau River and Waiorongomai River – is generally good with low nutrient concentrations (Perrie 2009a). This suggests that nutrient enrichment of the lake arises from other sources, such as the numerous small streams and drainage schemes that discharge into the lake at a variety of locations. Flood flows from the Ruamahanga River that enter the lake via the Oporua Floodway, along with back-flow through the barrage gates from the lower reaches of the Ruamahanga River/Lake Onoke are other potential nutrient sources. Also, little is known about the nutrient contribution from shallow groundwater, which may be significant given the intensive landuse in the surrounding catchment area.

Water samples from 15 surface water sites and four shallow groundwater bores were collected on one occasion over 16-17 December 2009 and tested for a range of variables, including dissolved and total nutrients, major ions and *E. coli* bacteria. The aim of the investigation was to obtain some initial information on the quality of streams, drains and shallow groundwater entering Lake Wairarapa.

The results suggest that elevated concentrations of nutrients are entering the Lake Wairarapa from drainage and stream networks located on the northern and eastern margins of Lake Wairarapa. General inspection of the catchment indicates that intensive agriculture (dairy, sheep, beef, piggery) tends to dominate land use in the northern and eastern areas of the lake catchment. This intensive land use will be influencing the water quality of shallow (unconfined) groundwater and surface water draining to the lake from these areas. Determining the relative contribution of nutrients from these sources to Lake Wairarapa water quality, as well as further investigation into groundwater and surface water interaction around the lake margins, is required.

6.6 Other monitoring and investigations

In August 2009, water quality monitoring (every 4 to 8 weeks) commenced at one site on Lake Onoke, with samples tested for a variety of physico-chemical and microbiological variables. Information gathered from the monitoring will be reported in late 2011.

In late 2009, to further our understanding on the interactions between surface water and groundwater interactions, GNS Science were engaged to undertake a hydrochemical analysis of the region's SoE surface and groundwater quality monitoring data. Full details of this analysis can be found in Daughney (2010).

During the 2009/10 summer, Greater Wellington, along with other regional councils across New Zealand, participated in two nation-wide research trials. The first of these trials involved carrying out assessments of streambed sedimentation using several different methods. The results from the trial will be evaluated with the aim being to develop standardised national methods for assessing streambed sedimentation, a growing problem in many water bodies across the country. The second research trial involved the collection of stream biofilm samples from a variety of streams running through different land uses to assess the potential for the bacteriological communities living in the biofilms to be used as ecological indicators of river and stream health (in much the same way as macroinvertebrates are currently used).

7. Summary

Using the WQI, 15 of the 55 RSoE sites were allocated water quality grades of “excellent” for the 2009/10 reporting period. Eleven sites scored grades of “good”, 14 sites “fair” and 15 sites “poor”. Of the ten sites routinely monitored for selected heavy metals, three exceeded the guideline used to assess the chronic toxicity of dissolved zinc concentrations: Porirua Stream at Wall Park, Karori Stream at Makara Mountain Bike Park and the Waiwhetu Stream at Wainuiomata Hill Bridge.

Of the 46 RSoE sites monitored for periphyton, 20 sites exceeded the MfE (2000) streambed cover guidelines for filamentous growths at least once and two sites exceeded the guideline for mat growths on one or more occasions. The chlorophyll *a* guideline for benthic biodiversity was exceeded at 13 sites while the AFDM guideline for trout habitat and angling was exceeded at two sites.

Based on MCI scores, the majority of the 55 RSoE sites received quality classifications of “excellent” (17 sites) or “good” (21 sites). Eleven sites were classed as “fair” and six sites were classed as “poor”.

Water quality and aquatic ecosystem health are strongly influenced by land cover; WQI and MCI scores are highest at RSoE sites located on hill-fed river and stream reaches with upstream catchments dominated by unmodified indigenous forest cover. Approximately one third of the rivers and streams within the Wellington region have upstream catchments dominated by indigenous forest. These rivers and streams can generally be expected to have excellent water quality and aquatic ecosystem health. In contrast, RSoE sites with poor WQI and MCI scores are typically located on smaller, low elevation streams draining predominantly pastoral or urban catchments. These sites were also more likely to exceed guidelines for periphyton cover and biomass. Approximately two thirds of rivers and streams in the region are located in pastoral (~60%) or urban catchments (~3%). Water quality and aquatic ecosystem health in these rivers and streams are likely to be impacted to some degree, and in a few cases, may be severely degraded.

During 2009/10, a number of other freshwater-related projects and investigations were also undertaken and/or completed, including investigations into the nutrient sources in the Mangatarere Stream catchment, the ecological values of intermittent headwater streams, the effects of river channel realignment on aquatic ecosystems, the water quality status of Lake Waitawa and one-off sampling of shallow groundwater bores and surface water sites around Lake Wairarapa.

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Appendix 1: RSoE monitoring sites

Site No.	Site Name	Site Coordinates		Substrate (hard or soft bottomed)	REC	Dominant Land Cover
		Easting	Northing			
RS02	Mangapouri S at Bennetts Rd*	2690920	6049359	Soft	WD/L/AI/P	Urban
RS03	Waitohu S at Forest Pk	2697610	6045404	Hard	CW/H/HS/IF	Indigenous forest
RS04	Waitohu S at Norfolk Cres	2689554	6050018	Soft	CW/L/HS/P	Pasture
RS05	Otaki R at Pukehinau	2695443	6040464	Hard	CW/H/HS/IF	Indigenous forest
RS06	Otaki R at Mouth	2688000	6047600	Hard	CW/H/HS/IF	Indigenous forest
RS07	Mangaone S at Sims Rd Br	2686260	6044122	Soft	WW/L/AL/P	Pasture
RS08	Ngarara S at Field Way*	2681198	6036335	Soft	WW/L/AL/P	Urban
RS09	Waikanae R at Mangaone Walkway	2689992	6035353	Hard	CW/L/HS/IF	Indigenous forest
RS10	Waikanae R at Greenaway Rd*	2681241	6034630	Hard	CW/L/HS/P	Indigenous forest
RS11	Whareroa S at Waterfall Rd	2678093	6026247	Hard	WW/L/HS/P	Pasture
RS12	Whareroa S at QE Park	2675995	6026115	Soft	WW/L/HS/P	Pasture
RS13	Horokiri S at Snodgrass	2671824	6012367	Hard	CW/L/HS/P	Pasture
RS14	Pauatahanui S at Elmwood Br	2671117	6008497	Hard	CW/L/HS/P	Pasture
RS15	Porirua S at Glenside*	2663310	6000077	Hard	CW/L/HS/U	Urban
RS16	Porirua S at Wall Park (Milk Depot)*	2664386	6004745	Hard	WW/L/HS/U	Urban
RS17	Makara S at Kennels	2653551	5995347	Hard	CW/L/HS/P	Pasture
RS18	Karori S at Makara Peak*	2654234	5988585	Hard	CW/L/HS/U	Urban
RS19	Kaiwharawhara S at Ngaio*	2659090	5992789	Hard	CW/L/HS/U	Urban
RS20	Hutt R at Te Marua Intake Site	2690091	6011874	Hard	CX/H/HS/IF	Indigenous forest
RS21	Hutt R opp. Manor Park G.C.*	2676700	6004000	Hard	CW/H/HS/IF	Indigenous forest
RS22	Hutt R at Boulcott*	2670879	5999200	Hard	CW/L/HS/IF	Indigenous forest
RS23	Pakuratahi R 50m d/s Farm Ck	2694627	6013394	Hard	CX/H/HS/IF	Indigenous forest
RS24	Mangaroa R at Te Marua	2688563	6010359	Hard	CW/L/HS/P	Pasture
RS25	Akatarawa R at Hutt confl.	2686203	6010900	Hard	CW/L/HS/IF	Indigenous forest
RS26	Whakatikei R at Riverstone	2682276	6008463	Hard	CW/L/HS/S	Indigenous forest
RS27	Waiwhetu S at Wainui Hill Br*	2670587	5995855	Soft	WW/L/HS/U	Urban*
RS28	Wainuiomata R at Manuka Track	2678265	5992349	Hard	CW/L/HS/IF	Indigenous forest
RS29	Wainuiomata R u/s of White Br	2667340	5977436	Hard	CW/L/HS/IF	Indigenous forest
RS30	Orongorongo R at Orongorongo Stn	2668955	5974807	Hard	CW/H/HS/IF	Indigenous forest
RS31	Ruamahanga R at McLays	2728161	6047524	Hard	CX/H/HS/S	Indigenous forest
RS32	Ruamahanga R at Te Ore Ore	2735588	6024740	Hard	CW/L/SS/P	Pasture
RS33	Ruamahanga R at Gladstone Br	2731225	6012049	Hard	CW/L/SS/P	Pasture
RS34	Ruamahanga R at Pukio	2707855	5992730	Hard	CW/L/SS/P	Pasture
RS35	Mataikona Trib at Sugar Loaf Rd	2781839	6052625	Hard	CW/L/SS/P	Pasture
RS36	Taueru R at Castlehill	2762304	6045917	Soft	CW/L/SS/P	Pasture
RS37	Taueru R at Gladstone	2734164	6012538	Hard	CD/L/SS/P	Pasture
RS38	Kopuaranga R at Stewarts	2736773	6031289	Hard	CW/L/SS/P	Pasture
RS39	Whangaehu R 250m u/s confl.	2736281	6021129	Soft	CD/L/SS/P	Pasture
RS40	Waipoua R at Colombo Rd Br	2735032	6024611	Hard	CW/L/HS/P	Pasture
RS41	Waingawa R at South Rd	2730731	6022370	Hard	CX/H/HS/IF	Indigenous forest
RS42	Whareama R at Gauge	2766097	6022956	Soft	WW/L/SS/P	Pasture
RS43	Motuwaireka S at Headwaters	2762028	6012031	Hard	CW/L/HS/S	Indigenous forest
RS44	Totara S at Stronvar	2758038	6006645	Hard	CW/L/HS/EF	Exotic forest
RS45	Parkvale Trib at Lowes Res.	2728110	6020073	Hard	WD/L/AI/P	Pasture
RS46	Parkvale S at Weir	2723533	6011190	Hard	WD/L/AI/P	Pasture
RS47	Waiohine R at Gorge	2711907	6017714	Hard	CX/H/HS/IF	Indigenous forest
RS48	Waiohine R at Bicknells	2720633	6009820	Hard	CW/H/HS/P	Pasture
RS49	Beef Ck at Headwaters	2713981	6018117	Hard	CW/L/HS/S	Indigenous forest
RS50	Mangatarere S at SH 2	2719786	6013880	Hard	CW/L/HS/P	Pasture
RS51	Huangaaru R at Ponatahi Br	2717030	5996934	Hard	CD/L/SS/P	Pasture
RS52	Tauanui R at Whakatomotomo Rd	2700674	5976234	Hard	CW/H/HS/IF	Indigenous forest
RS53	Awhea R at Tora Rd	2719980	5965013	Hard	WW/L/SS/P	Pasture
RS54	Coles Ck Trib at Lagoon Hill Rd	2724046	5976941	Hard	WW/L/SS/S	Indigenous forest
RS55	Tauherenikau R at Websters	2707103	6001661	Hard	CW/H/HS/IF	Indigenous forest
RS56	Waiorongomai R at Forest Pk	2689627	5992276	Hard	CW/H/HS/IF	Indigenous forest

*Denotes RSoE sites where water samples are also analysed for selected heavy metals.

Appendix 2: Water quality variables and analytical methods

Variable	Method	Detection Limit
Temperature	Field Meter - YSI 550A and YSI 556 Meters	0.01 °C
Dissolved Oxygen	Field Meter - YSI 550A and YSI 556 Meters	0.01 mg/L
Visual Clarity	Black disc	0.01 m
pH	Field Meter - YSI 550A and YSI 556 Meters	0.01 units
Conductivity	Field Meter - YSI 550A and YSI 556 Meters	0.1 uS/cm
Turbidity	Analysis using a Hach 2100N, Turbidity meter. APHA 2130 B 21 st ed. 2005	0.05 NTU
Total Organic Carbon	Catalytic oxidation, IR detection, for Total C. Acidification, purging for Total Inorganic C. TOC = TC - TIC. APHA5310 B 21 st ed. 2005	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) 21 st ed. 2005	0.001 mg/L
Nitrite	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO ₃ ⁻ I (proposed) 21 st ed. 2005	0.002 mg/L
Nitrate	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N	0.002 mg/L
Nitrate + Nitrite Nitrogen	Total oxidised nitrogen. Automated cadmium reduction, Flow injection analyser. APHA 4500-NO ₃ ⁻ I (Proposed) 21 st ed. 2005	0.002 mg/L
Total Kjeldahl Nitrogen	Kjeldahl digestion, phenol/hyperchlorite colorimetry (Discrete Analysis). APHA 4500-Norg C. (modified) 4500-NH ₃ F (modified) 21 st ed. 2005	0.1 mg/L
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N	0.1 mg/L
Total Phosphorus	Total Phosphorus digestion, ascorbic acid colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 21 st ed. 2005	0.004 mg/L
Dissolved Reactive Phosphorus	Filtered Sample. Molybdenum blue colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 21 st ed. 2005	0.004 mg/L
Faecal Coliforms	APHA 21 st Ed. Method 9222 D	1 cfu/100 mL
<i>E. coli</i>	APHA 21 st Ed. Method 9222 G	1 cfu/100 mL
Dissolved Arsenic	Filtered sample, ICP-MS, trace level. APHA 3125 B 21 st ed. 2005	0.001 mg/L
Dissolved Cadmium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21 st ed. 2005	0.00005 mg/L
Dissolved Chromium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21 st ed. 2005	0.0005 mg/L
Dissolved Copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 21 st ed. 2005	0.0005 mg/L
Dissolved Lead	Filtered sample, ICP-MS, trace level. APHA 3125 B 21 st ed. 2005	0.0001 mg/L
Dissolved Nickel	Filtered sample, ICP-MS, trace level. APHA 3125 B 21 st ed. 2005	0.0005 mg/L
Dissolved Zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 21 st ed. 2005	0.0010 mg/L

Appendix 3: Biological monitoring methods

Periphyton

Periphyton assessments were limited to the 46 RSoE sites with hard bottomed substrates.

Monthly assessment of visible streambed cover

Over the reporting period, periphyton cover was determined by estimating the percentage of visible mats (>0.3 cm thick) and filaments (>2 cm long) present on the stream or river bed within a 20 cm diameter metal ring. Ten observations were made across the width of the stream or river, along a transect. If the stream or river was not wide enough for 10 observations, five observations were made across the width of the waterway in two locations at the site. Two transects of five observations (usually to 0.6 m depth) were also used where it was not possible to wade across more than half of the river's width.

Visible streambed assessments were typically carried out in a run, as opposed to riffle or pool-type habitats.

Annual assessment of biomass

Periphyton samples for quantitative biomass assessments (chlorophyll *a* and AFDM) were collected over late summer/early autumn 2010 at the time of macroinvertebrate sample collection. Sampling protocols followed quantitative method 1a (QM-1a), as outlined in the stream periphyton monitoring manual (Biggs & Kilroy 2000).

Biomass assessments were carried out on periphyton samples collected in riffle-type habitats in close proximity to macroinvertebrate sampling sites.

Macroinvertebrates

One macroinvertebrate sample was collected from cobbly riffle areas at or adjacent to each RSoE water sampling site over late summer/early autumn 2010. The timing of sampling was determined at random, although no macroinvertebrate sampling was undertaken within two weeks of any flood event. Flood events were defined as flows greater than three times the median river flow.

Samples were collected with the use of a kick-net (250 µm mesh size) following Protocol C1 of the national macroinvertebrate sampling protocols (Stark et al. 2001) for the 46 RSoE sites with hard bottom substrate and Protocol C2 for the nine RSoE sites with a soft bottom substrate. All samples were processed in accordance with protocol P2 (Stark et al. 2001).

Appendix 4: Physico-chemical and bacteriological data

Table A4.1: Water temperature (°C)

Site No.	Site Name	Median	Minimum	5 th percentile	95 th percentile	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	13.0	8.4	8.5	17.3	17.5	12
RS03	Waitohu S at Forest Pk	9.4	5.7	6.0	16.3	16.4	12
RS04	Waitohu S at Norfolk Cres	12.8	7.8	8.3	17.7	18.3	12
RS05	Otaki R at Pukehinau	9.7	5.3	5.5	15.2	17.1	12
RS06	Otaki R at Mouth	11.3	6.5	6.9	17.5	18.9	12
RS07	Mangaone S at Sims Rd Br	11.7	8.0	8.2	15.7	16.1	12
RS08	Ngarara S at Field Way	13.7	7.3	8.0	19.8	21.0	12
RS09	Waikanae R at Mangaone Walkway	10.5	6.3	6.5	15.2	16.5	12
RS10	Waikanae R at Greenaway Rd	14.8	8.2	8.7	20.9	22.2	12
RS11	Whareroa S at Waterfall Rd	11.1	6.2	6.5	14.3	15.1	12
RS12	Whareroa S at QE Park	13.1	7.7	7.8	17.2	18.3	12
RS13	Horokiri S at Snodgrass	12.3	6.8	7.2	16.0	17.2	12
RS14	Pauatahanui S at Elmwood Br	12.3	6.5	6.5	16.8	18.4	12
RS15	Porirua S at Glenside	11.9	8.0	8.4	17.0	17.0	12
RS16	Porirua S at Wall Park (Milk Depot)	11.5	8.1	8.2	16.5	16.6	12
RS17	Makara S at Kennels	11.8	7.6	8.4	18.6	19.5	12
RS18	Karori S at Makara Peak	12.7	8.6	9.3	17.3	17.4	12
RS19	Kaiwharawhara S at Ngaio Gorge	12.5	7.7	8.3	19.0	19.3	12
RS20	Hutt R at Te Marua Intake Site	10.5	6.7	6.9	14.1	15.9	12
RS21	Hutt R opp. Manor Park G.C.	13.8	8.7	8.9	18.0	18.5	12
RS22	Hutt R at Boulcott	13.7	8.3	8.4	17.5	18.0	12
RS23	Pakuratahi R 50m d/s Farm Ck	11.2	7.5	7.5	14.5	15.6	12
RS24	Mangaroa R at Te Marua	12.6	8.1	8.2	16.1	16.3	12
RS25	Akatarawa R at Hutt confl.	11.5	7.6	7.6	15.2	15.9	12
RS26	Whakatikei R at Riverstone	11.7	7.3	7.8	15.6	16.4	12
RS27	Waiwhetu S at Wainui Hill Br	13.9	9.6	9.9	16.7	16.8	12
RS28	Wainuiomata R at Manuka Track	10.0	5.7	6.3	13.2	13.6	12
RS29	Wainuiomata R u/s of White Br	12.3	8.1	8.3	16.3	16.7	12
RS30	Orongorongo R at Orongorongo Stn	12.9	8.6	8.9	17.8	18.2	12
RS31	Ruamahanga R at McLays	9.8	5.7	6.1	14.0	14.2	12
RS32	Ruamahanga R at Te Ore Ore	13.3	9.2	9.2	20.2	20.4	12
RS33	Ruamahanga R at Gladstone Br	13.9	8.7	9.2	21.9	22.2	12
RS34	Ruamahanga R at Pukio	13.9	8.4	9.1	21.8	22.1	12
RS35	Mataikona Trib at Sugar Loaf Rd	10.3	8.1	8.1	15.7	16.4	12
RS36	Taueru R at Castlehill	10.0	7.3	7.6	15.5	16.1	12
RS37	Taueru R at Gladstone	13.8	7.4	7.8	20.2	20.7	12
RS38	Kopuaranga R at Stewarts	12.2	7.6	8.6	17.7	18.0	12
RS39	Whangaehu R 250m u/s confl.	13.0	7.5	8.6	20.0	20.6	12
RS40	Waipoua R at Colombo Rd Br	15.6	9.2	9.4	18.2	18.4	12
RS41	Waingawa R at South Rd	14.7	8.1	8.2	18.6	18.8	12
RS42	Whareama R at Gauge	13.0	6.4	7.8	19.8	20.3	12
RS43	Motuwaireka S at Headwaters	10.8	6.4	6.9	15.4	16.6	12
RS44	Totara S at Stronvar	14.4	7.2	7.9	19.9	20.2	12
RS45	Parkvale Trib at Lowes Res.	14.1	10.7	10.7	15.4	15.9	12
RS46	Parkvale S at Weir	13.9	8.4	9.3	19.6	20.9	12
RS47	Waiohine R at Gorge	9.7	5.2	6.4	12.9	13.1	12
RS48	Waiohine R at Bicknells	12.3	7.2	7.8	16.2	16.2	12
RS49	Beef Ck at Headwaters	9.8	6.1	7.4	12.5	12.7	12
RS50	Mangatarere S at SH 2	13.4	8.3	9.1	17.8	18.4	12
RS51	Huangarua R at Ponatahi Br	15.0	8.4	9.4	23.2	23.5	12
RS52	Tauanui R at Whakatomotomo Rd	11.7	6.2	7.1	15.1	15.5	12
RS53	Awhea R at Tora Rd	17.1	7.2	8.9	20.6	21.0	12
RS54	Coles Ck Trib at Lagoon Hill Rd	13.8	6.4	7.4	18.0	18.9	12
RS55	Tauherenikau R at Websters	12.6	8.1	8.1	18.6	20.0	12
RS56	Waiorongomai R at Forest Pk	11.5	7.4	8.0	14.8	14.9	12

Table A4.2: Dissolved oxygen (% saturation)

Site No.	Site Name	Median	Minimum	5 th percentile	95 th percentile	Maximum	n
RS02	Mangapouri S at Bennetts Rd	70.2	53.8	56.5	85.6	88.7	12
RS03	Waitohu S at Forest Pk	100.0	71.6	84.0	108.9	110.0	12
RS04	Waitohu S at Norfolk Cres	82.9	68.2	69.2	94.7	95.2	12
RS05	Otaki R at Pukehinau	100.0	74.8	85.3	108.7	112.0	12
RS06	Otaki R at Mouth	101.0	67.5	81.9	115.7	119.0	12
RS07	Mangaone S at Sims Rd Br	71.3	46.1	49.4	81.9	82.5	12
RS08	Ngarara S at Field Way	56.5	36.0	37.2	70.9	72.4	12
RS09	Waikanae R at Mangaone Walkway	96.7	80.8	87.5	108.7	112.0	12
RS10	Waikanae R at Greenaway Rd	98.6	65.4	82.0	113.7	117.0	12
RS11	Whareroa S at Waterfall Rd	92.8	86.7	87.6	100.6	102.0	12
RS12	Whareroa S at QE Park	75.4	59.2	59.6	83.4	84.1	12
RS13	Horokiri S at Snodgrass	103.0	88.2	91.9	117.9	119.0	12
RS14	Pauatahanui S at Elmwood Br	97.8	86.0	87.1	110.9	112.0	12
RS15	Porirua S at Glenside	109.5	78.7	91.0	128.2	132.0	12
RS16	Porirua S at Wall Park (Milk Depot)	106.5	79.2	91.7	129.3	132.0	12
RS17	Makara S at Kennels	107.0	77.5	90.4	116.2	120.0	12
RS18	Karori S at Makara Peak	106.0	78.4	90.0	115.9	117.0	12
RS19	Kaiwharawhara S at Ngaio Gorge	107.5	77.8	90.0	115.9	117.0	12
RS20	Hutt R at Te Marua Intake Site	103.5	79.3	89.3	108.9	110.0	12
RS21	Hutt R opp. Manor Park G.C.	103.5	71.3	73.4	115.9	117.0	12
RS22	Hutt R at Boulcott	103.5	71.7	72.7	110.0	110.0	12
RS23	Pakuratahi R 50m d/s Farm Ck	100.1	83.6	89.2	114.4	116.0	12
RS24	Mangaroa R at Te Marua	102.0	75.7	86.0	110.4	112.0	12
RS25	Akatarawa R at Hutt confl.	103.0	76.5	86.4	108.0	108.0	12
RS26	Whakatikei R at Riverstone	102.0	78.9	86.1	109.5	110.0	12
RS27	Waiwhetu S at Wainui Hill Br	79.5	49.3	57.6	112.9	135.0	12
RS28	Wainuiomata R at Manuka Track	104.5	75.4	87.5	110.0	110.0	12
RS29	Wainuiomata R u/s of White Br	99.3	77.0	85.9	112.8	115.0	12
RS30	Orongorongo R at Orongorongo Stn	101.5	72.2	85.3	108.3	111.0	12
RS31	Ruamahanga R at McLays	99.2	82.7	88.5	115.2	130.0	12
RS32	Ruamahanga R at Te Ore Ore	97.3	69.1	79.5	114.7	118.0	12
RS33	Ruamahanga R at Gladstone Br	98.7	68.6	76.4	107.4	109.0	12
RS34	Ruamahanga R at Pukio	97.1	71.7	77.6	108.4	110.0	12
RS35	Mataikona Trib at Sugar Loaf Rd	100.5	88.2	89.1	107.3	110.0	12
RS36	Taueru R at Castlehill	97.5	86.6	88.5	107.3	110.0	12
RS37	Taueru R at Gladstone	101.5	74.8	77.3	151.8	160.0	12
RS38	Kopuaranga R at Stewarts	93.7	68.7	76.3	109.7	119.0	12
RS39	Whangaehu R 250m u/s confl.	86.4	68.0	70.3	126.5	127.0	12
RS40	Waipoua R at Colombo Rd Br	103.5	73.6	82.8	117.4	119.0	12
RS41	Waingawa R at South Rd	104.0	79.8	80.3	114.6	119.0	12
RS42	Whareama R at Gauge	98.4	87.3	88.4	107.4	109.0	12
RS43	Motuwaikeka S at Headwaters	100.5	89.7	90.8	108.7	112.0	12
RS44	Totara S at Stronvar	99.2	77.3	83.2	112.0	112.0	12
RS45	Parkvale Trib at Lowes Res.	72.9	63.2	66.2	81.8	82.4	9
RS46	Parkvale S at Weir	98.8	80.7	83.3	118.0	124.0	12
RS47	Waiohine R at Gorge	103.5	90.8	94.5	110.0	110.0	12
RS48	Waiohine R at Bicknells	97.9	70.3	82.1	107.1	112.0	12
RS49	Beef Ck at Headwaters	102.0	93.7	95.3	112.6	117.0	12
RS50	Mangatarere S at SH 2	94.1	85.8	87.3	122.3	125.0	12
RS51	Huangarua R at Ponatahi Br	104.3	74.9	83.3	150.4	163.0	12
RS52	Tauanui R at Whakatomotomo Rd	99.2	87.1	92.1	108.1	113.0	12
RS53	Awhea R at Tora Rd	105.0	76.2	86.5	123.9	125.0	12
RS54	Coles Ck Trib at Lagoon Hill Rd	95.4	79.8	84.2	106.2	108.0	10
RS55	Tauherenikau R at Websters	98.6	79.1	80.5	107.4	109.0	12
RS56	Waiorongomai R at Forest Pk	103.0	98.7	98.9	111.5	117.0	12

Table A4.3: Dissolved oxygen (mg/L)

Site No.	Site Name	Median	Minimum	5 th percentile	95 th percentile	Maximum	n
RS02	Mangapouri S at Bennetts Rd	7.5	5.7	5.8	9.5	9.7	12
RS03	Waitohu S at Forest Pk	11.1	8.9	9.5	12.3	12.4	12
RS04	Waitohu S at Norfolk Cres	9.0	7.1	7.3	10.4	10.8	12
RS05	Otaki R at Pukehinou	11.3	9.4	9.7	12.5	12.6	12
RS06	Otaki R at Mouth	10.9	8.2	9.3	12.5	12.6	12
RS07	Mangaone S at Sims Rd Br	7.9	4.6	4.9	9.3	9.6	12
RS08	Ngarara S at Field Way	5.9	3.4	3.7	7.5	8.4	12
RS09	Waikanae R at Mangaone Walkway	10.8	9.5	9.5	12.1	12.4	12
RS10	Waikanae R at Greenaway Rd	10.2	7.5	8.4	11.5	11.5	12
RS11	Whareroa S at Waterfall Rd	10.5	8.9	9.3	11.1	11.2	12
RS12	Whareroa S at QE Park	8.1	5.8	5.8	9.1	9.2	12
RS13	Horokiri S at Snodgrass	11.0	10.2	10.4	12.7	13.2	12
RS14	Pauatahanui S at Elmwood Br	10.9	8.3	8.5	12.0	12.1	12
RS15	Porirua S at Glenside	11.8	9.1	10.3	13.3	13.9	12
RS16	Porirua S at Wall Park (Milk Depot)	11.7	9.2	10.1	13.2	13.6	12
RS17	Makara S at Kennels	11.4	9.0	9.8	12.4	12.7	12
RS18	Karori S at Makara Peak	11.2	8.6	9.7	11.8	11.9	12
RS19	Kaiwharawhara S at Ngaio Gorge	11.4	8.7	9.7	11.9	12.0	12
RS20	Hutt R at Te Marua Intake Site	11.6	9.6	9.9	12.8	13.3	12
RS21	Hutt R opp. Manor Park G.C.	10.9	8.0	8.1	12.0	12.1	12
RS22	Hutt R at Boulcott	10.5	8.1	8.2	11.9	12.4	12
RS23	Pakuratahi R 50m d/s Farm Ck	10.7	9.7	9.9	13.1	13.4	12
RS24	Mangaroa R at Te Marua	10.8	8.9	9.5	12.3	12.5	12
RS25	Akatarawa R at Hutt confl.	11.0	9.2	9.8	12.3	12.6	12
RS26	Whakatikei R at Riverstone	10.9	9.5	9.7	12.1	12.6	12
RS27	Waiwhetu S at Wainui Hill Br	8.2	4.8	5.7	11.5	14.0	12
RS28	Wainuiomata R at Manuka Track	11.8	8.9	9.7	12.4	12.4	12
RS29	Wainuiomata R u/s of White Br	11.1	8.8	9.8	11.5	11.6	12
RS30	Orongorongo R at Orongorongo Stn	10.6	8.2	8.9	11.9	12.0	12
RS31	Ruamahanga R at McLays	11.1	10.0	10.3	14.0	16.0	12
RS32	Ruamahanga R at Te Ore Ore	10.4	7.5	8.4	11.6	12.4	12
RS33	Ruamahanga R at Gladstone Br	9.7	7.6	8.2	11.4	11.9	12
RS34	Ruamahanga R at Pukio	9.6	8.1	8.2	11.4	11.9	12
RS35	Mataikona Trib at Sugar Loaf Rd	10.8	9.8	9.9	12.6	12.9	12
RS36	Taueru R at Castlehill	10.8	9.5	9.7	11.7	11.7	12
RS37	Taueru R at Gladstone	10.1	8.1	8.4	15.3	15.8	12
RS38	Kopuaranga R at Stewarts	9.9	7.8	8.2	11.9	13.3	12
RS39	Whangaehu R 250m u/s confl.	9.1	7.0	7.4	12.8	13.8	12
RS40	Waipoua R at Colombo Rd Br	10.2	8.3	8.8	12.0	12.6	12
RS41	Waingawa R at South Rd	10.2	8.4	8.8	12.2	13.1	12
RS42	Whareama R at Gauge	10.4	7.7	8.1	11.7	12.1	12
RS43	Motuwaikeka S at Headwaters	11.0	10.0	10.0	12.3	13.0	12
RS44	Totara S at Stronvar	10.3	7.8	8.6	11.8	13.0	12
RS45	Parkvale Trib at Lowes Res.	7.4	6.7	6.9	8.9	9.0	9
RS46	Parkvale S at Weir	10.6	8.0	8.4	12.2	12.4	12
RS47	Waiohine R at Gorge	11.7	10.3	10.3	13.0	13.2	12
RS48	Waiohine R at Bicknells	10.3	7.9	8.9	11.9	12.1	12
RS49	Beef Ck at Headwaters	11.4	10.3	10.5	12.6	12.8	12
RS50	Mangatarere S at SH 2	10.1	8.5	8.9	12.0	12.1	12
RS51	Huangarua R at Ponatahi Br	10.7	8.3	8.3	14.4	14.8	12
RS52	Tauanui R at Whakatomotomo Rd	10.6	9.1	9.5	12.8	12.8	12
RS53	Awhea R at Tora Rd	10.8	8.4	8.5	11.9	12.1	12
RS54	Coles Ck Trib at Lagoon Hill Rd	9.9	8.3	8.6	12.2	12.6	10
RS55	Tauherenikau R at Websters	10.4	8.9	9.1	11.9	12.8	12
RS56	Waiorongomai R at Forest Pk	11.1	10.0	10.2	13.0	13.7	12

Table A4.4: pH

Site No.	Site Name	Median	Minimum	5 th percentile	95 th percentile	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	6.8	6.6	6.6	7.8	7.9	12
RS03	Waitohu S at Forest Pk	7.2	6.9	6.9	8.1	8.2	12
RS04	Waitohu S at Norfolk Cres	6.8	6.5	6.6	7.8	7.9	12
RS05	Otaki R at Pukehinau	7.2	6.9	6.9	8.0	8.1	12
RS06	Otaki R at Mouth	7.3	6.6	6.9	8.1	8.4	12
RS07	Mangaone S at Sims Rd Br	6.8	6.4	6.4	8.1	8.3	12
RS08	Ngarara S at Field Way	6.8	6.6	6.6	7.8	7.8	12
RS09	Waikanae R at Mangaone Walkway	7.3	6.9	6.9	8.0	8.2	12
RS10	Waikanae R at Greenaway Rd	7.1	6.9	6.9	8.0	8.3	12
RS11	Whareroa S at Waterfall Rd	7.5	7.2	7.2	8.2	8.6	12
RS12	Whareroa S at QE Park	6.8	6.4	6.4	7.6	7.8	12
RS13	Horokiri S at Snodgrass	7.3	6.9	7.0	8.2	8.6	12
RS14	Pauatahanui S at Elmwood Br	7.2	6.6	6.8	8.1	8.4	12
RS15	Porirua S at Glenside	7.6	7.0	7.1	8.3	8.3	12
RS16	Porirua S at Wall Park (Milk Depot)	7.4	7.0	7.0	7.9	8.0	12
RS17	Makara S at Kennels	7.3	6.8	6.9	7.6	7.6	12
RS18	Karori S at Makara Peak	7.3	6.6	6.8	7.5	7.5	11
RS19	Kaiwharawhara S at Ngaio Gorge	7.6	7.0	7.0	8.5	8.8	11
RS20	Hutt R at Te Marua Intake Site	7.2	6.4	6.4	7.5	7.5	12
RS21	Hutt R opp. Manor Park G.C.	7.3	6.8	6.8	8.2	8.2	12
RS22	Hutt R at Boulcott	7.0	6.6	6.6	7.6	8.0	12
RS23	Pakuratahi R 50m d/s Farm Ck	6.7	6.2	6.2	7.4	7.5	12
RS24	Mangaroa R at Te Marua	6.8	6.4	6.5	7.3	7.5	12
RS25	Akatarawa R at Hutt confl.	7.2	6.7	6.7	7.6	7.7	12
RS26	Whakatikei R at Riverstone	7.4	7.1	7.1	7.8	8.0	12
RS27	Waiwhetu S at Wainui Hill Br	6.8	6.3	6.4	8.1	9.2	12
RS28	Wainuiomata R at Manuka Track	7.0	6.2	6.3	7.4	7.4	12
RS29	Wainuiomata R u/s of White Br	7.2	6.7	6.7	8.0	8.0	12
RS30	Orongorongo R at Orongorongo Stn	7.4	6.9	7.0	7.7	7.9	12
RS31	Ruamahanga R at McLays	6.9	6.5	6.5	7.6	7.9	12
RS32	Ruamahanga R at Te Ore Ore	7.6	7.3	7.3	8.2	8.4	12
RS33	Ruamahanga R at Gladstone Br	7.4	7.1	7.1	7.9	8.1	12
RS34	Ruamahanga R at Pukio	7.5	6.9	7.0	8.0	8.4	12
RS35	Mataikona Trib at Sugar Loaf Rd	7.9	7.2	7.5	8.5	8.9	12
RS36	Taueru R at Castlehill	7.4	7.1	7.1	8.1	8.5	12
RS37	Taueru R at Gladstone	7.9	7.1	7.3	8.7	9.0	12
RS38	Kopuaranga R at Stewarts	7.6	7.4	7.4	8.2	8.5	12
RS39	Whangaehu R 250m u/s confl.	7.3	7.0	7.1	8.0	8.2	12
RS40	Waipoua R at Colombo Rd Br	7.4	6.6	6.8	8.0	8.3	12
RS41	Waingawa R at South Rd	7.2	6.2	6.5	7.8	8.3	12
RS42	Whareama R at Gauge	7.8	7.4	7.6	8.4	9.0	11
RS43	Motuwaikeka S at Headwaters	7.4	7.2	7.3	8.1	8.5	12
RS44	Totara S at Stronvar	7.4	7.3	7.3	8.3	8.6	12
RS45	Parkvale Trib at Lowes Res.	6.3	6.2	6.2	6.7	6.9	9
RS46	Parkvale S at Weir	7.4	6.8	6.9	7.7	7.7	12
RS47	Waiohine R at Gorge	7.0	6.8	6.8	7.6	7.6	12
RS48	Waiohine R at Bicknells	6.6	6.5	6.5	7.3	7.3	12
RS49	Beef Ck at Headwaters	7.2	6.8	7.0	7.6	7.6	12
RS50	Mangatarere S at SH 2	6.8	6.5	6.5	7.2	7.4	12
RS51	Huangarua R at Ponatahi Br	8.2	7.8	7.8	8.7	8.7	12
RS52	Tauanui R at Whakatomotomo Rd	7.4	6.9	7.0	7.6	7.6	12
RS53	Awhea R at Tora Rd	8.0	7.7	7.8	8.5	8.6	12
RS54	Coles Ck Trib at Lagoon Hill Rd	8.0	7.7	7.7	8.1	8.1	10
RS55	Tauherenikau R at Websters	7.1	6.9	6.9	8.5	9.4	12
RS56	Waiorongomai R at Forest Pk	7.1	6.9	6.9	7.5	7.5	12

Table A4.5: Visual clarity (m)

Site No.	Site Name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	0.43	0.25	0.65	12
RS03	Waitohu S at Forest Pk	2.25	1.13	3.66	12
RS04	Waitohu S at Norfolk Cres	0.41	0.31	0.81	12
RS05	Otaki R at Pukehinau	2.87	0.55	6.19	12
RS06	Otaki R at Mouth	2.02	0.32	4.66	12
RS07	Mangaone S at Sims Rd Br	0.30	0.22	1.24	12
RS08	Ngarara S at Field Way	0.30	0.22	0.45	12
RS09	Waikanae R at Mangaone Walkway	2.92	1.63	3.89	12
RS10	Waikanae R at Greenaway Rd	2.17	1.32	3.48	12
RS11	Whareroa S at Waterfall Rd	0.48	0.03	1.46	12
RS12	Whareroa S at QE Park	0.41	0.17	0.62	12
RS13	Horokiri S at Snodgrass	1.58	1.04	2.59	12
RS14	Pauatahanui S at Elmwood Br	1.32	0.46	1.82	12
RS15	Porirua S at Glenside	1.54	0.45	3.12	12
RS16	Porirua S at Wall Park (Milk Depot)	1.44	0.21	1.69	12
RS17	Makara S at Kennels	1.32	0.29	1.47	12
RS18	Karori S at Makara Peak	2.35	0.33	3.42	12
RS19	Kaiwharawhara S at Ngaio Gorge	1.62	1.24	2.72	12
RS20	Hutt R at Te Marua Intake Site	1.82	0.28	4.74	12
RS21	Hutt R opp. Manor Park G.C.	1.17	0.17	3.27	12
RS22	Hutt R at Boulcott	1.04	0.15	3.42	12
RS23	Pakuratahi R 50m d/s Farm Ck	1.89	0.27	4.52	12
RS24	Mangaroa R at Te Marua	0.96	0.17	2.28	12
RS25	Akatarawa R at Hutt confl.	2.58	0.44	5.13	12
RS26	Whakatikei R at Riverstone	1.91	0.63	4.84	12
RS27	Waiwhetu S at Wainui Hill Br	0.61	0.15	1.61	12
RS28	Wainuiomata R at Manuka Track	2.46	1.00	3.36	12
RS29	Wainuiomata R u/s of White Br	1.16	0.50	1.70	12
RS30	Orongorongo R at Orongorongo Stn	0.74	0.10	3.67	12
RS31	Ruamahanga R at McLays	3.19	1.07	5.61	12
RS32	Ruamahanga R at Te Ore Ore	0.75	0.17	2.63	12
RS33	Ruamahanga R at Gladstone Br	0.94	0.11	2.31	12
RS34	Ruamahanga R at Pukio	0.39	0.09	1.62	12
RS35	Mataikona Trib at Sugar Loaf Rd	1.28	0.34	2.22	12
RS36	Taueru R at Castlehill	0.91	0.23	1.55	12
RS37	Taueru R at Gladstone	0.54	0.13	2.08	12
RS38	Kopuaranga R at Stewarts	0.46	0.12	1.87	12
RS39	Whangaehu R 250m u/s confl.	0.44	0.07	1.91	12
RS40	Waipoua R at Colombo Rd Br	2.58	0.58	3.88	12
RS41	Waingawa R at South Rd	2.60	0.22	4.83	12
RS42	Whareama R at Gauge	0.48	0.03	1.20	12
RS43	Motuwaireka S at Headwaters	1.99	0.98	3.65	12
RS44	Totara S at Stronvar	2.04	0.94	4.70	12
RS45	Parkvale Trib at Lowes Res.	2.23	1.21	2.52	9
RS46	Parkvale S at Weir	0.45	0.16	1.21	12
RS47	Waiohine R at Gorge	2.84	1.14	5.58	12
RS48	Waiohine R at Bicknells	1.86	0.21	3.19	12
RS49	Beef Ck at Headwaters	1.69	0.49	3.10	12
RS50	Mangatarere S at SH 2	1.48	0.22	4.18	11
RS51	Huangaaru R at Ponatahi Br	0.89	0.06	1.90	12
RS52	Tauanui R at Whakatomotomo Rd	2.70	0.41	4.82	12
RS53	Awhea R at Tora Rd	0.79	0.02	2.68	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.56	0.15	1.28	10
RS55	Tauherenikau R at Websters	1.51	0.31	3.38	12
RS56	Waiorongomai R at Forest Pk	2.03	0.37	3.56	12

Table A4.6: Turbidity (NTU)

Site No.	Site Name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	4.9	4.1	11.9	12
RS03	Waitohu S at Forest Pk	0.7	0.4	1.4	12
RS04	Waitohu S at Norfolk Cres	5.0	3.0	11.0	12
RS05	Otaki R at Pukehinau	1.2	0.4	7.8	12
RS06	Otaki R at Mouth	1.4	0.5	5.8	12
RS07	Mangaone S at Sims Rd Br	6.0	3.0	10.1	12
RS08	Ngarara S at Field Way	10.1	3.9	24.0	12
RS09	Waikanae R at Mangaone Walkway	0.6	0.3	1.4	12
RS10	Waikanae R at Greenaway Rd	0.6	0.4	2.1	12
RS11	Whareroa S at Waterfall Rd	8.4	3.2	190	12
RS12	Whareroa S at QE Park	8.9	5.3	16.0	12
RS13	Horokiri S at Snodgrass	1.2	0.7	2.8	12
RS14	Pauatahanui S at Elmwood Br	2.3	0.9	5.6	12
RS15	Porirua S at Glenside	2.0	0.5	6.9	12
RS16	Porirua S at Wall Park (Milk Depot)	2.1	1.1	14.3	12
RS17	Makara S at Kennels	2.9	1.4	9.1	12
RS18	Karori S at Makara Peak	1.0	0.6	9.8	12
RS19	Kaiwharawhara S at Ngaio Gorge	1.4	0.5	2.5	12
RS20	Hutt R at Te Marua Intake Site	1.6	0.3	9.6	12
RS21	Hutt R opp. Manor Park G.C.	2.1	0.3	21.0	12
RS22	Hutt R at Boulcott	2.5	0.4	32.0	12
RS23	Pakuratahi R 50m d/s Farm Ck	1.3	0.3	8.3	12
RS24	Mangaroa R at Te Marua	1.9	0.6	31.0	12
RS25	Akatarawa R at Hutt confl.	0.6	0.3	7.2	12
RS26	Whakatikei R at Riverstone	0.8	0.3	5.0	12
RS27	Waiwhetu S at Wainui Hill Br	5.2	2.4	30.0	12
RS28	Wainuiomata R at Manuka Track	0.9	0.5	1.7	12
RS29	Wainuiomata R u/s of White Br	2.7	1.2	4.8	12
RS30	Orongorongo R at Orongorongo Stn	7.8	0.6	102	12
RS31	Ruamahanga R at McLays	0.9	0.3	2.8	12
RS32	Ruamahanga R at Te Ore Ore	5.6	0.9	37.0	12
RS33	Ruamahanga R at Gladstone Br	3.7	1.1	54.0	12
RS34	Ruamahanga R at Pukio	8.3	1.1	43.0	12
RS35	Mataikona Trib at Sugar Loaf Rd	1.6	0.7	4.8	12
RS36	Taueru R at Castlehill	3.6	2.2	36.0	12
RS37	Taueru R at Gladstone	4.1	1.2	42.0	12
RS38	Kopuaranga R at Stewarts	6.5	1.0	68.0	12
RS39	Whangaehu R 250m u/s confl.	10.7	0.9	180	12
RS40	Waipoua R at Colombo Rd Br	0.6	0.3	4.0	12
RS41	Waingawa R at South Rd	0.8	0.4	11.8	12
RS42	Whareama R at Gauge	7.8	2.7	520	12
RS43	Motuwaireka S at Headwaters	0.9	0.3	3.0	12
RS44	Totara S at Stronvar	0.4	0.1	3.7	12
RS45	Parkvale Trib at Lowes Res.	1.3	0.6	2.6	9
RS46	Parkvale S at Weir	4.2	1.6	19.9	12
RS47	Waiohine R at Gorge	0.9	0.4	2.8	12
RS48	Waiohine R at Bicknells	1.4	0.9	17.0	12
RS49	Beef Ck at Headwaters	1.3	0.5	4.3	12
RS50	Mangatarere S at SH 2	2.1	0.9	28.0	12
RS51	Huangarua R at Ponatahi Br	6.1	0.5	110	12
RS52	Tauanui R at Whakatomotomo Rd	0.8	0.3	12.8	12
RS53	Awhea R at Tora Rd	12.6	0.5	850	12
RS54	Coles Ck Trib at Lagoon Hill Rd	3.3	1.4	21.0	10
RS55	Tauherenikau R at Websters	2.9	1.1	7.4	12
RS56	Waiorongomai R at Forest Pk	1.0	0.4	11.1	12

Table A4.7: Conductivity ($\mu\text{S}/\text{cm}$)

Site No.	Site Name	Median	Minimum	5 th percentile	95 th percentile	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	210	184	192	218	220	12
RS03	Waitohu S at Forest Pk	85	67	74	90	91	12
RS04	Waitohu S at Norfolk Cres	158	118	120	194	204	12
RS05	Otaki R at Pukehinau	69	57	58	76	76	12
RS06	Otaki R at Mouth	68	59	60	78	78	12
RS07	Mangaone S at Sims Rd Br	204	172	174	228	231	12
RS08	Ngarara S at Field Way	300	242	244	321	322	12
RS09	Waikanae R at Mangaone Walkway	86	78	79	89	90	12
RS10	Waikanae R at Greenaway Rd	103	95	97	120	130	12
RS11	Whareroa S at Waterfall Rd	239	192	198	264	267	12
RS12	Whareroa S at QE Park	261	215	217	284	285	12
RS13	Horokiri S at Snodgrass	185	167	168	197	198	12
RS14	Pauatahanui S at Elmwood Br	173	152	153	194	195	12
RS15	Porirua S at Glenside	252	219	221	275	278	12
RS16	Porirua S at Wall Park (Milk Depot)	254	227	227	276	277	12
RS17	Makara S at Kennels	258	228	234	311	317	12
RS18	Karori S at Makara Peak	226	144	184	231	232	12
RS19	Kaiwharawhara S at Ngaio Gorge	282	207	231	315	316	12
RS20	Hutt R at Te Marua Intake Site	61	52	53	79	80	12
RS21	Hutt R opp. Manor Park G.C.	100	72	79	113	116	12
RS22	Hutt R at Boulcott	81	68	71	100	104	12
RS23	Pakuratahi R 50m d/s Farm Ck	80	66	68	86	87	12
RS24	Mangaroa R at Te Marua	101	89	91	116	121	12
RS25	Akatarawa R at Hutt confl.	82	59	65	87	89	12
RS26	Whakatikei R at Riverstone	111	89	93	119	121	12
RS27	Waiwhetu S at Wainui Hill Br	230	155	190	282	288	11
RS28	Wainuiomata R at Manuka Track	109	83	89	115	116	12
RS29	Wainuiomata R u/s of White Br	138	116	125	151	153	12
RS30	Orongorongo R at Orongorongo Stn	131	105	113	161	163	12
RS31	Ruamahanga R at McLays	46	31	33	56	57	12
RS32	Ruamahanga R at Te Ore Ore	125	64	76	155	159	12
RS33	Ruamahanga R at Gladstone Br	121	65	76	130	134	12
RS34	Ruamahanga R at Pukio	135	51	76	168	170	12
RS35	Mataikona Trib at Sugar Loaf Rd	406	320	323	487	487	12
RS36	Taueru R at Castlehill	212	162	166	282	284	12
RS37	Taueru R at Gladstone	434	293	294	507	510	12
RS38	Kopuaranga R at Stewarts	229	135	147	363	386	12
RS39	Whangaehu R 250m u/s confl.	269	185	222	316	324	12
RS40	Waipoua R at Colombo Rd Br	102	83	85	115	116	12
RS41	Waingawa R at South Rd	60	44	50	65	67	12
RS42	Whareama R at Gauge	608	287	317	715	718	12
RS43	Motuwaikeka S at Headwaters	282	188	207	370	372	12
RS44	Totara S at Stronvar	319	201	222	367	369	12
RS45	Parkvale Trib at Lowes Res.	188	158	164	196	197	9
RS46	Parkvale S at Weir	142	130	132	176	182	12
RS47	Waiohine R at Gorge	54	48	50	58	59	12
RS48	Waiohine R at Bicknells	72	64	66	79	80	12
RS49	Beef Ck at Headwaters	89	78	81	111	116	12
RS50	Mangatarere S at SH 2	104	84	91	133	143	12
RS51	Huangarua R at Ponatahi Br	365	217	240	464	466	12
RS52	Tauanui R at Whakatomotomo Rd	145	111	113	176	184	12
RS53	Awhea R at Tora Rd	380	274	294	498	499	12
RS54	Coles Ck Trib at Lagoon Hill Rd	580	245	259	1,082	1,297	10
RS55	Tauherenikau R at Websters	68	62	64	77	80	12
RS56	Waiorongomai R at Forest Pk	112	90	92	140	143	12

Table A4.8: Total organic carbon (mg/L)

Site No.	Site Name	Median	Minimum	Maximum	n
RS02	Mangapouri S at Bennetts Rd	5.2	3.2	7.2	12
RS03	Waitohu S at Forest Pk	1.9	1.2	3.1	12
RS04	Waitohu S at Norfolk Cres	4.2	3.0	5.7	12
RS05	Otaki R at Pukehinau	1.2	<0.5	1.6	12
RS06	Otaki R at Mouth	1.0	0.5	1.8	12
RS07	Mangaone S at Sims Rd Br	4.9	4.2	8.3	12
RS08	Ngarara S at Field Way	15.8	8.2	24	12
RS09	Waikanae R at Mangaone Walkway	1.3	0.7	2.1	12
RS10	Waikanae R at Greenaway Rd	1.5	0.7	1.9	12
RS11	Whareroa S at Waterfall Rd	3.8	3.1	7.8	12
RS12	Whareroa S at QE Park	11.5	6.8	22	12
RS13	Horokiri S at Snodgrass	2.0	1.3	4.0	12
RS14	Pauatahanui S at Elmwood Br	4.0	2.4	7.1	12
RS15	Porirua S at Glenside	3.6	1.7	5.2	12
RS16	Porirua S at Wall Park (Milk Depot)	3.5	1.6	5.0	12
RS17	Makara S at Kennels	4.6	3.2	5.7	12
RS18	Karori S at Makara Peak	1.9	1.3	3.3	12
RS19	Kaiwharawhara S at Ngaio Gorge	3.1	0.5	4.7	12
RS20	Hutt R at Te Marua Intake Site	3.5	1.6	7.2	12
RS21	Hutt R opp. Manor Park G.C.	3.2	1.5	7.2	12
RS22	Hutt R at Boulcott	3.0	1.6	8.0	12
RS23	Pakuratahi R 50m d/s Farm Ck	3.5	1.8	6.0	12
RS24	Mangaroa R at Te Marua	4.8	1.8	8.8	12
RS25	Akatarawa R at Hutt confl.	2.0	1.2	6.9	12
RS26	Whakatikei R at Riverstone	1.7	0.8	5.1	12
RS27	Waiwhetu S at Wainui Hill Br	4.0	2.7	4.7	12
RS28	Wainuiomata R at Manuka Track	2.0	1.2	4.2	12
RS29	Wainuiomata R u/s of White Br	1.8	1.2	3.1	12
RS30	Orongorongo R at Orongorongo Stn	1.8	0.8	2.7	12
RS31	Ruamahanga R at McLays	1.8	0.7	4.3	12
RS32	Ruamahanga R at Te Ore Ore	3.0	2.0	6.5	12
RS33	Ruamahanga R at Gladstone Br	2.6	1.7	7.3	12
RS34	Ruamahanga R at Pukio	3.8	1.8	6.4	12
RS35	Mataikona Trib at Sugar Loaf Rd	3.3	2.0	5.1	12
RS36	Taueru R at Castlehill	5.8	4.4	8.6	12
RS37	Taueru R at Gladstone	6.6	3.3	10	12
RS38	Kopuaranga R at Stewarts	4.1	0.5	8.6	12
RS39	Whangaehu R 250m u/s confl.	8.7	4.7	17	12
RS40	Waipoua R at Colombo Rd Br	1.8	0.8	4.3	12
RS41	Waingawa R at South Rd	1.2	0.9	3.0	12
RS42	Whareama R at Gauge	6.5	3.8	11	12
RS43	Motuwaireka S at Headwaters	2.2	1.1	3.5	12
RS44	Totara S at Stronvar	3.0	1.5	4.5	12
RS45	Parkvale Trib at Lowes Res.	4.7	3.2	8.1	9
RS46	Parkvale S at Weir	6.2	4.2	11	12
RS47	Waiohine R at Gorge	1.3	0.7	2.2	12
RS48	Waiohine R at Bicknells	1.3	1.0	2.4	12
RS49	Beef Ck at Headwaters	1.8	1.4	3.4	12
RS50	Mangatarere S at SH 2	2.4	1.6	4.7	12
RS51	Huangarua R at Ponatahi Br	4.6	2.1	8.9	12
RS52	Tauanui R at Whakatomotomo Rd	2.9	1.2	6.3	12
RS53	Awhea R at Tora Rd	4.8	0.7	11	12
RS54	Coles Ck Trib at Lagoon Hill Rd	5.2	2.9	8.9	10
RS55	Tauherenikau R at Websters	1.7	0.9	3.4	12
RS56	Waiorongomai R at Forest Pk	3.2	1.9	7.3	12

Table A4.9: Ammoniacal nitrogen (mg/L)

Site No.	Site Name	Median	Minimum	Maximum	n
RS02	Mangapouri S at Bennetts Rd	0.035	<0.010	0.061	12
RS03	Waitohu S at Forest Pk	0.005	<0.010	<0.010	12
RS04	Waitohu S at Norfolk Cres	0.060	0.021	0.110	12
RS05	Otaki R at Pukehinau	0.005	<0.010	0.024	12
RS06	Otaki R at Mouth	0.005	<0.010	0.029	12
RS07	Mangaone S at Sims Rd Br	0.091	<0.010	0.143	12
RS08	Ngarara S at Field Way	0.021	<0.010	0.050	12
RS09	Waikanae R at Mangaone Walkway	0.005	<0.010	<0.010	12
RS10	Waikanae R at Greenaway Rd	0.005	<0.010	0.010	12
RS11	Whareroa S at Waterfall Rd	0.005	<0.010	0.023	12
RS12	Whareroa S at QE Park	0.074	0.018	0.210	12
RS13	Horokiri S at Snodgrass	0.005	<0.010	0.016	12
RS14	Pauatahanui S at Elmwood Br	0.014	<0.010	0.024	12
RS15	Porirua S at Glenside	0.005	<0.010	0.011	12
RS16	Porirua S at Wall Park (Milk Depot)	0.018	<0.010	0.090	12
RS17	Makara S at Kennels	0.012	<0.010	0.021	12
RS18	Karori S at Makara Peak	0.013	<0.010	0.026	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.005	<0.010	0.148	12
RS20	Hutt R at Te Marua Intake Site	0.005	<0.010	<0.0100	12
RS21	Hutt R opp. Manor Park G.C.	0.005	<0.010	0.034	12
RS22	Hutt R at Boulcott	0.005	<0.010	0.010	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.005	<0.010	0.016	12
RS24	Mangaroa R at Te Marua	0.005	<0.010	0.034	12
RS25	Akatarawa R at Hutt confl.	0.005	<0.010	0.012	12
RS26	Whakatikei R at Riverstone	0.005	<0.010	<0.0100	12
RS27	Waiwhetu S at Wainui Hill Br	0.044	0.012	0.170	12
RS28	Wainuiomata R at Manuka Track	0.005	<0.010	0.000	12
RS29	Wainuiomata R u/s of White Br	0.005	<0.010	0.024	12
RS30	Orongorongo R at Orongorongo Stn	0.005	<0.010	0.011	12
RS31	Ruamahanga R at McLays	0.005	<0.010	0.012	12
RS32	Ruamahanga R at Te Ore Ore	0.005	<0.010	0.034	12
RS33	Ruamahanga R at Gladstone Br	0.022	<0.010	0.062	12
RS34	Ruamahanga R at Pukio	0.009	<0.010	0.028	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.005	<0.010	0.014	12
RS36	Taueru R at Castlehill	0.005	<0.010	0.011	12
RS37	Taueru R at Gladstone	0.005	<0.010	0.031	12
RS38	Kopuaranga R at Stewarts	0.013	<0.010	0.034	12
RS39	Whangaehu R 250m u/s confl.	0.013	<0.010	0.043	12
RS40	Waipoua R at Colombo Rd Br	0.005	<0.010	0.000	12
RS41	Waingawa R at South Rd	0.005	<0.010	<0.010	12
RS42	Whareama R at Gauge	0.005	<0.010	0.034	12
RS43	Motuwaireka S at Headwaters	0.005	<0.010	<0.010	12
RS44	Totara S at Stronvar	0.005	<0.010	0.012	12
RS45	Parkvale Trib at Lowes Res.	0.005	<0.010	0.015	9
RS46	Parkvale S at Weir	0.019	<0.010	0.048	12
RS47	Waiohine R at Gorge	0.005	<0.010	0.010	12
RS48	Waiohine R at Bicknells	0.012	<0.010	0.027	12
RS49	Beef Ck at Headwaters	0.005	<0.010	<0.010	12
RS50	Mangatarere S at SH 2	0.104	<0.010	0.350	12
RS51	Huangarua R at Ponatahi Br	0.005	<0.010	0.028	12
RS52	Tauanui R at Whakatomotomo Rd	0.005	<0.010	0.027	12
RS53	Awhea R at Tora Rd	0.005	<0.010	0.024	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.008	<0.010	0.014	10
RS55	Tauherenikau R at Websters	0.005	<0.010	0.014	12
RS56	Waiorongomai R at Forest Pk	0.005	<0.010	<0.010	12

Table A4.10: Nitrite-nitrate nitrogen (mg/L)

Site No.	Site Name	Median	Minimum	Maximum	n
RS02	Mangapouri S at Bennetts Rd	2.700	1.700	3.600	12
RS03	Waitohu S at Forest Pk	0.026	0.009	0.054	12
RS04	Waitohu S at Norfolk Cres	0.525	0.350	0.960	12
RS05	Otaki R at Pukehinau	0.027	0.006	0.057	12
RS06	Otaki R at Mouth	0.041	<0.002	0.079	12
RS07	Mangaone S at Sims Rd Br	1.990	1.310	2.700	12
RS08	Ngarara S at Field Way	0.089	0.004	0.450	12
RS09	Waikanae R at Mangaone	0.097	0.031	0.154	12
RS10	Waikanae R at Greenaway Rd	0.170	0.031	8.500	12
RS11	Whareroa S at Waterfall Rd	0.320	0.157	0.670	12
RS12	Whareroa S at QE Park	0.385	0.070	1.040	12
RS13	Horokiri S at Snodgrass	0.360	0.007	0.900	12
RS14	Pauatahanui S at Elmwood Br	0.210	<0.002	0.620	12
RS15	Porirua S at Glenside	0.990	0.650	1.800	12
RS16	Porirua S at Wall Park (Milk Depot)	1.050	0.540	4.400	12
RS17	Makara S at Kennels	0.230	0.022	1.280	12
RS18	Karori S at Makara Peak	1.300	0.650	1.700	12
RS19	Kaiwharawhara S at Ngaio Gorge	1.230	0.720	2.300	12
RS20	Hutt R at Te Marua Intake Site	0.071	0.026	0.110	12
RS21	Hutt R opp. Manor Park G.C.	0.190	0.050	0.370	12
RS22	Hutt R at Boulcott	0.185	0.044	0.290	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.188	0.077	0.280	12
RS24	Mangaroa R at Te Marua	0.430	0.260	0.750	12
RS25	Akatarawa R at Hutt confl.	0.075	0.011	0.190	12
RS26	Whakatikei R at Riverstone	0.073	0.037	0.260	12
RS27	Waiwhetu S at Wainui Hill Br	0.485	0.130	0.640	12
RS28	Wainuiomata R at Manuka Track	0.070	0.025	0.098	12
RS29	Wainuiomata R u/s of White Br	0.205	0.002	0.530	12
RS30	Orongorongo R at Orongorongo	0.037	0.004	0.079	12
RS31	Ruamahanga R at McLays	0.024	0.004	0.046	12
RS32	Ruamahanga R at Te Ore Ore	0.355	0.075	0.940	12
RS33	Ruamahanga R at Gladstone Br	0.360	0.150	0.970	12
RS34	Ruamahanga R at Pukio	0.320	0.077	0.930	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.016	<0.002	0.128	12
RS36	Taueru R at Castlehill	0.061	0.009	0.260	12
RS37	Taueru R at Gladstone	0.565	0.190	1.670	12
RS38	Kopuaranga R at Stewarts	0.795	0.460	1.200	12
RS39	Whangaehu R 250m u/s confl.	0.785	0.220	2.200	12
RS40	Waipoua R at Colombo Rd Br	0.820	0.490	1.600	12
RS41	Waingawa R at South Rd	0.056	0.014	0.120	12
RS42	Whareama R at Gauge	0.004	<0.002	0.240	12
RS43	Motuwaireka S at Headwaters	0.024	0.004	0.102	12
RS44	Totara S at Stronvar	0.004	<0.002	0.113	12
RS45	Parkvale Trib at Lowes Res.	5.500	3.400	6.800	9
RS46	Parkvale S at Weir	1.000	0.320	2.800	12
RS47	Waiohine R at Gorge	0.025	0.006	0.050	12
RS48	Waiohine R at Bicknells	0.280	0.180	0.670	12
RS49	Beef Ck at Headwaters	0.016	0.008	0.059	12
RS50	Mangatarere S at SH 2	0.815	0.500	1.520	12
RS51	Huangarua R at Ponatahi Br	0.169	0.005	0.440	12
RS52	Tauanui R at Whakatomotomo Rd	0.009	0.004	0.047	12
RS53	Awhea R at Tora Rd	0.036	0.003	0.280	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.007	<0.002	0.023	10
RS55	Tauherenikau R at Websters	0.032	0.011	0.170	12
RS56	Waiorongomai R at Forest Pk	0.007	<0.002	0.071	12

Table A4.11: Total Kjeldahl nitrogen (mg/L)

Site No.	Site Name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	0.47	0.33	0.68	12
RS03	Waitohu S at Forest Pk	0.50	<0.10	0.50	12
RS04	Waitohu S at Norfolk Cres	0.32	0.24	0.50	12
RS05	Otaki R at Pukehinau	0.50	<0.10	0.50	12
RS06	Otaki R at Mouth	0.50	<0.10	0.50	12
RS07	Mangaone S at Sims Rd Br	0.50	0.42	0.93	12
RS08	Ngarara S at Field Way	0.70	0.38	1.10	12
RS09	Waikanae R at Mangaone	0.50	<0.10	0.50	12
RS10	Waikanae R at Greenaway Rd	0.50	0.50	0.50	12
RS11	Whareroa S at Waterfall Rd	0.21	0.13	0.34	12
RS12	Whareroa S at QE Park	0.60	0.33	0.94	12
RS13	Horokiri S at Snodgrass	0.15	0.10	0.19	12
RS14	Pauatahanui S at Elmwood Br	0.20	0.16	0.29	12
RS15	Porirua S at Glenside	0.22	0.17	0.43	12
RS16	Porirua S at Wall Park (Milk Depot)	0.28	0.14	0.51	12
RS17	Makara S at Kennels	0.25	0.13	0.49	12
RS18	Karori S at Makara Peak	0.20	0.15	0.37	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.25	0.16	0.38	12
RS20	Hutt R at Te Marua Intake Site	0.50	<0.10	0.50	12
RS21	Hutt R opp. Manor Park G.C.	0.36	<0.10	0.50	12
RS22	Hutt R at Boulcott	0.39	<0.10	0.50	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.50	<0.10	0.50	12
RS24	Mangaroa R at Te Marua	0.16	<0.10	0.50	12
RS25	Akatarawa R at Hutt confl.	0.50	<0.10	0.50	12
RS26	Whakatikei R at Riverstone	0.50	<0.10	0.50	12
RS27	Waiwhetu S at Wainui Hill Br	0.38	<0.10	0.54	12
RS28	Wainuiomata R at Manuka Track	0.50	<0.10	0.50	12
RS29	Wainuiomata R u/s of White Br	0.16	<0.10	0.50	12
RS30	Orongorongo R at Orongorongo	0.50	<0.10	0.50	12
RS31	Ruamahanga R at McLays	0.50	<0.10	0.50	12
RS32	Ruamahanga R at Te Ore Ore	0.29	<0.10	0.50	12
RS33	Ruamahanga R at Gladstone Br	0.20	<0.10	0.66	12
RS34	Ruamahanga R at Pukio	0.23	<0.10	0.70	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.13	<0.10	0.50	12
RS36	Taueru R at Castlehill	0.31	<0.10	0.50	12
RS37	Taueru R at Gladstone	0.44	0.19	0.69	12
RS38	Kopuaranga R at Stewarts	0.35	0.21	0.91	12
RS39	Whangaehu R 250m u/s confl.	0.62	0.30	1.40	12
RS40	Waipoua R at Colombo Rd Br	0.18	<0.10	0.50	12
RS41	Waingawa R at South Rd	0.50	<0.10	0.50	12
RS42	Whareama R at Gauge	0.35	0.25	1.49	12
RS43	Motuwaireka S at Headwaters	0.50	<0.10	0.50	12
RS44	Totara S at Stronvar	0.50	<0.10	0.50	12
RS45	Parkvale Trib at Lowes Res.	0.41	0.23	0.70	9
RS46	Parkvale S at Weir	0.59	0.45	0.96	12
RS47	Waiohine R at Gorge	0.50	<0.10	0.50	12
RS48	Waiohine R at Bicknells	0.33	<0.10	0.50	12
RS49	Beef Ck at Headwaters	0.50	<0.10	0.50	12
RS50	Mangatarere S at SH 2	0.33	0.21	0.57	12
RS51	Huangarua R at Ponatahi Br	0.26	0.17	0.75	12
RS52	Tauanui R at Whakatomotomo Rd	0.50	<0.10	0.50	12
RS53	Awhea R at Tora Rd	0.24	0.14	1.02	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.22	0.12	0.30	10
RS55	Tauherenikau R at Websters	0.50	<0.10	0.50	12
RS56	Waiorongomai R at Forest Pk	0.50	<0.10	0.50	12

Table A4.12: Total nitrogen (mg/L)

Site No.	Site Name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	3.10	2.10	4.20	12
RS03	Waitohu S at Forest Pk	0.06	<0.11	0.11	12
RS04	Waitohu S at Norfolk Cres	0.87	0.61	1.50	12
RS05	Otaki R at Pukehinau	0.06	<0.11	0.13	12
RS06	Otaki R at Mouth	0.08	<0.11	0.15	12
RS07	Mangaone S at Sims Rd Br	2.65	1.86	3.10	12
RS08	Ngarara S at Field Way	0.87	0.41	1.40	12
RS09	Waikanae R at Mangaone	0.15	<0.11	0.29	12
RS10	Waikanae R at Greenaway Rd	0.25	<0.11	8.50	12
RS11	Whareroa S at Waterfall Rd	0.55	0.29	1.01	12
RS12	Whareroa S at QE Park	1.02	0.47	1.98	12
RS13	Horokiri S at Snodgrass	0.49	0.18	1.06	12
RS14	Pauatahanui S at Elmwood Br	0.41	0.18	0.91	12
RS15	Porirua S at Glenside	1.20	0.84	2.20	12
RS16	Porirua S at Wall Park (Milk Depot)	1.35	0.75	4.60	12
RS17	Makara S at Kennels	0.51	0.24	1.77	12
RS18	Karori S at Makara Peak	1.50	1.00	1.90	12
RS19	Kaiwharawhara S at Ngaio Gorge	1.51	1.00	2.50	12
RS20	Hutt R at Te Marua Intake Site	0.17	<0.11	0.28	12
RS21	Hutt R opp. Manor Park G.C.	0.29	0.18	0.75	12
RS22	Hutt R at Boulcott	0.28	0.19	0.51	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.28	0.19	0.41	12
RS24	Mangaroa R at Te Marua	0.63	0.43	0.91	12
RS25	Akatarawa R at Hutt confl.	0.13	<0.11	0.34	12
RS26	Whakatikei R at Riverstone	0.14	<0.11	0.39	12
RS27	Waiwhetu S at Wainui Hill Br	0.75	0.43	1.10	12
RS28	Wainuiomata R at Manuka Track	0.15	<0.11	0.26	12
RS29	Wainuiomata R u/s of White Br	0.31	<0.11	0.69	12
RS30	Orongorongo R at Orongorongo	0.10	<0.11	0.20	12
RS31	Ruamahanga R at McLays	0.06	<0.11	0.17	12
RS32	Ruamahanga R at Te Ore Ore	0.50	0.18	1.10	12
RS33	Ruamahanga R at Gladstone Br	0.57	0.26	1.25	12
RS34	Ruamahanga R at Pukio	0.60	0.23	1.32	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.13	<0.11	0.25	12
RS36	Taueru R at Castlehill	0.34	<0.11	0.69	12
RS37	Taueru R at Gladstone	0.98	0.72	1.93	12
RS38	Kopuaranga R at Stewarts	1.18	0.95	1.97	12
RS39	Whangaehu R 250m u/s confl.	1.40	1.10	3.30	12
RS40	Waipoua R at Colombo Rd Br	0.99	0.57	1.70	12
RS41	Waingawa R at South Rd	0.06	<0.11	0.19	12
RS42	Whareama R at Gauge	0.36	0.25	1.72	12
RS43	Motuwaireka S at Headwaters	0.12	<0.11	0.19	12
RS44	Totara S at Stronvar	0.06	<0.11	0.25	12
RS45	Parkvale Trib at Lowes Res.	5.90	3.80	7.20	9
RS46	Parkvale S at Weir	1.64	0.78	3.30	12
RS47	Waiohine R at Gorge	0.06	<0.11	0.06	12
RS48	Waiohine R at Bicknells	0.37	0.26	0.80	12
RS49	Beef Ck at Headwaters	0.06	<0.11	0.14	12
RS50	Mangatarere S at SH 2	1.12	0.79	2.10	12
RS51	Huangarua R at Ponatahi Br	0.44	0.21	1.20	12
RS52	Tauanui R at Whakatomotomo Rd	0.06	<0.11	0.28	12
RS53	Awhea R at Tora Rd	0.28	0.14	1.13	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.23	0.13	0.31	10
RS55	Tauherenikau R at Websters	0.11	<0.11	0.26	12
RS56	Waiorongomai R at Forest Pk	0.06	<0.11	0.52	12

Table A4.13: Dissolved reactive phosphorus (mg/L)

Site No.	Site Name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	0.032	0.021	0.041	12
RS03	Waitohu S at Forest Pk	0.008	0.006	0.011	12
RS04	Waitohu S at Norfolk Cres	0.021	0.014	0.034	12
RS05	Otaki R at Pukehinau	0.005	<0.004	0.011	12
RS06	Otaki R at Mouth	0.005	<0.004	0.009	12
RS07	Mangaone S at Sims Rd Br	0.026	0.016	0.054	12
RS08	Ngarara S at Field Way	0.050	0.025	0.069	12
RS09	Waikanae R at Mangaone Walkway	0.012	0.009	0.016	12
RS10	Waikanae R at Greenaway Rd	0.007	<0.004	0.012	12
RS11	Whareroa S at Waterfall Rd	0.027	0.017	0.041	12
RS12	Whareroa S at QE Park	0.047	0.035	0.055	12
RS13	Horokiri S at Snodgrass	0.009	0.006	0.017	12
RS14	Pauatahanui S at Elmwood Br	0.014	0.011	0.024	12
RS15	Porirua S at Glenside	0.020	0.013	0.026	12
RS16	Porirua S at Wall Park (Milk Depot)	0.023	0.013	0.044	12
RS17	Makara S at Kennels	0.026	0.013	0.044	12
RS18	Karori S at Makara Peak	0.037	0.022	0.058	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.032	0.020	0.079	12
RS20	Hutt R at Te Marua Intake Site	0.005	<0.004	0.008	12
RS21	Hutt R opp. Manor Park G.C.	0.007	<0.004	0.010	12
RS22	Hutt R at Boulcott	0.004	<0.004	0.010	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.007	0.005	0.013	12
RS24	Mangaroa R at Te Marua	0.014	0.005	0.019	12
RS25	Akatarawa R at Hutt confl.	0.002	<0.004	0.007	12
RS26	Whakatikei R at Riverstone	0.009	0.005	0.012	12
RS27	Waiwhetu S at Wainui Hill Br	0.030	0.015	0.084	12
RS28	Wainuiomata R at Manuka Track	0.011	0.009	0.013	12
RS29	Wainuiomata R u/s of White Br	0.014	0.009	0.017	12
RS30	Orongorongo R at Orongorongo Stn	0.006	<0.004	0.008	12
RS31	Ruamahanga R at McLays	0.002	<0.004	0.007	12
RS32	Ruamahanga R at Te Ore Ore	0.010	<0.004	0.023	12
RS33	Ruamahanga R at Gladstone Br	0.026	0.013	0.032	12
RS34	Ruamahanga R at Pukio	0.018	0.009	0.034	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.005	<0.004	0.007	12
RS36	Taueru R at Castlehill	0.009	0.007	0.013	12
RS37	Taueru R at Gladstone	0.017	<0.004	0.038	12
RS38	Kopuaranga R at Stewarts	0.016	0.010	0.027	12
RS39	Whangaehu R 250m u/s confl.	0.043	0.017	0.093	12
RS40	Waipoua R at Colombo Rd Br	0.006	<0.004	0.009	12
RS41	Waingawa R at South Rd	0.002	<0.004	0.006	12
RS42	Whareama R at Gauge	0.007	<0.004	0.023	12
RS43	Motuwaireka S at Headwaters	0.003	<0.004	0.007	12
RS44	Totara S at Stronvar	0.002	<0.004	0.006	12
RS45	Parkvale Trib at Lowes Res.	0.014	0.006	0.036	9
RS46	Parkvale S at Weir	0.034	0.018	0.096	12
RS47	Waiohine R at Gorge	0.002	<0.004	0.007	12
RS48	Waiohine R at Bicknells	0.016	0.011	0.030	12
RS49	Beef Ck at Headwaters	0.008	0.004	0.010	12
RS50	Mangatarere S at SH 2	0.073	0.024	0.300	12
RS51	Huangarua R at Ponatahi Br	0.008	<0.004	0.085	12
RS52	Tauanui R at Whakatomotomo Rd	0.007	0.005	0.009	12
RS53	Awhea R at Tora Rd	0.009	<0.004	0.030	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.007	<0.004	0.011	10
RS55	Tauherenikau R at Websters	0.002	<0.004	0.005	12
RS56	Waiorongomai R at Forest Pk	0.002	<0.004	0.006	12

Table A4.14: Total phosphorus (mg/L)

Site No.	Site Name	Median	Minimum	Maximum	n
RS02	Mangapouri S at Bennetts Rd	0.061	0.048	0.120	12
RS03	Waitohu S at Forest Pk	0.009	0.007	0.013	12
RS04	Waitohu S at Norfolk Cres	0.045	0.034	0.070	12
RS05	Otaki R at Pukehinau	0.005	<0.004	0.010	12
RS06	Otaki R at Mouth	0.005	<0.004	0.025	12
RS07	Mangaone S at Sims Rd Br	0.052	0.024	0.100	12
RS08	Ngarara S at Field Way	0.110	0.042	0.330	12
RS09	Waikanae R at Mangaone Walkway	0.012	0.010	0.023	12
RS10	Waikanae R at Greenaway Rd	0.008	0.004	0.013	12
RS11	Whareroa S at Waterfall Rd	0.041	0.028	0.120	12
RS12	Whareroa S at QE Park	0.083	0.054	0.110	12
RS13	Horokiri S at Snodgrass	0.015	0.009	0.026	12
RS14	Pauatahanui S at Elmwood Br	0.026	0.018	0.032	12
RS15	Porirua S at Glenside	0.025	0.014	0.037	12
RS16	Porirua S at Wall Park (Milk Depot)	0.036	0.028	0.053	12
RS17	Makara S at Kennels	0.042	0.024	0.055	12
RS18	Karori S at Makara Peak	0.045	0.029	0.062	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.040	0.030	0.084	12
RS20	Hutt R at Te Marua Intake Site	0.006	<0.004	0.017	12
RS21	Hutt R opp. Manor Park G.C.	0.010	<0.004	0.036	12
RS22	Hutt R at Boulcott	0.009	<0.004	0.041	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.011	0.004	0.023	12
RS24	Mangaroa R at Te Marua	0.018	0.012	0.080	12
RS25	Akatarawa R at Hutt confl.	0.005	<0.004	0.017	12
RS26	Whakatikei R at Riverstone	0.010	0.007	0.020	12
RS27	Waiwhetu S at Wainui Hill Br	0.053	0.024	0.140	12
RS28	Wainuiomata R at Manuka Track	0.013	0.010	0.940	12
RS29	Wainuiomata R u/s of White Br	0.019	0.012	0.026	12
RS30	Orongorongo R at Orongorongo Stn	0.010	<0.004	0.100	12
RS31	Ruamahanga R at McLays	0.003	<0.004	0.007	12
RS32	Ruamahanga R at Te Ore Ore	0.020	0.009	0.072	12
RS33	Ruamahanga R at Gladstone Br	0.035	0.018	0.110	12
RS34	Ruamahanga R at Pukio	0.040	0.022	0.094	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.007	<0.004	0.013	12
RS36	Taueru R at Castlehill	0.022	0.007	0.070	12
RS37	Taueru R at Gladstone	0.055	0.011	0.087	12
RS38	Kopuaranga R at Stewarts	0.035	0.018	0.110	12
RS39	Whangaehu R 250m u/s confl.	0.089	0.026	0.280	12
RS40	Waipoua R at Colombo Rd Br	0.008	<0.004	0.042	12
RS41	Waingawa R at South Rd	0.004	<0.004	0.038	12
RS42	Whareama R at Gauge	0.024	0.007	0.270	12
RS43	Motuwaireka S at Headwaters	0.005	<0.004	0.240	12
RS44	Totara S at Stronvar	0.002	<0.004	0.520	12
RS45	Parkvale Trib at Lowes Res.	0.021	0.012	0.047	9
RS46	Parkvale S at Weir	0.072	0.033	0.157	12
RS47	Waiohine R at Gorge	0.004	<0.004	0.012	11
RS48	Waiohine R at Bicknells	0.022	0.015	0.042	12
RS49	Beef Ck at Headwaters	0.010	0.007	0.014	12
RS50	Mangatarere S at SH 2	0.091	0.043	0.340	12
RS51	Huangaui R at Ponatahi Br	0.023	0.006	0.181	12
RS52	Tauanui R at Whakatomotomo Rd	0.009	<0.004	0.032	12
RS53	Awhea R at Tora Rd	0.026	<0.004	0.550	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.015	0.010	0.033	10
RS55	Tauherenikau R at Websters	0.005	<0.004	0.041	12
RS56	Waiorongomai R at Forest Pk	0.004	<0.004	0.025	12

Table A4.15: *E. coli* (cfu/100mL)

Site No.	Site Name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	500	270	5,400	12
RS03	Waitohu S at Forest Pk	3	1	110	12
RS04	Waitohu S at Norfolk Cres	310	120	3,500	12
RS05	Otaki R at Pukehinau	6	1	12	12
RS06	Otaki R at Mouth	29	4	570	12
RS07	Mangaone S at Sims Rd Br	440	95	1,200	12
RS08	Ngarara S at Field Way	100	42	300	12
RS09	Waikanae R at Mangaone Walkway	11	3	33	12
RS10	Waikanae R at Greenaway Rd	14	9	60	12
RS11	Whareroa S at Waterfall Rd	85	8	600	12
RS12	Whareroa S at QE Park	255	45	1,200	12
RS13	Horokiri S at Snodgrass	220	100	460	12
RS14	Pauatahanui S at Elmwood Br	345	80	850	12
RS15	Porirua S at Glenside	210	90	2,900	12
RS16	Porirua S at Wall Park (Milk Depot)	1,100	300	11,000	12
RS17	Makara S at Kennels	210	60	510	12
RS18	Karori S at Makara Peak	1,000	150	11,000	12
RS19	Kaiwharawhara S at Ngaio Gorge	260	160	22,000	12
RS20	Hutt R at Te Marua Intake Site	36	12	140	12
RS21	Hutt R opp. Manor Park G.C.	90	19	1,000	12
RS22	Hutt R at Boulcott	110	20	600	12
RS23	Pakuratahi R 50m d/s Farm Ck	110	60	950	12
RS24	Mangaroa R at Te Marua	235	34	1,300	12
RS25	Akatarawa R at Hutt confl.	39	13	120	12
RS26	Whakatikei R at Riverstone	18	6	60	12
RS27	Waiwhetu S at Wainui Hill Br	300	90	3,000	12
RS28	Wainuiomata R at Manuka Track	4	<1	58	12
RS29	Wainuiomata R u/s of White Br	135	24	7,400	12
RS30	Orongorongo R at Orongorongo Stn	36	5	350	12
RS31	Ruamahanga R at McLays	3	1	260	12
RS32	Ruamahanga R at Te Ore Ore	115	36	2,500	12
RS33	Ruamahanga R at Gladstone Br	120	10	5,100	12
RS34	Ruamahanga R at Pukio	200	28	3,700	12
RS35	Mataikona Trib at Sugar Loaf Rd	48	2	3,600	12
RS36	Taueru R at Castlehill	110	41	500	12
RS37	Taueru R at Gladstone	110	30	540	12
RS38	Kopuaranga R at Stewarts	375	180	6,000	12
RS39	Whangaehu R 250m u/s confl.	520	130	22,000	12
RS40	Waipoua R at Colombo Rd Br	44	7	1,100	12
RS41	Waingawa R at South Rd	24	4	170	12
RS42	Whareama R at Gauge	52	15	12,000	12
RS43	Motuwaireka S at Headwaters	2	<1	26	12
RS44	Totara S at Stronvar	4	<1	37	12
RS45	Parkvale Trib at Lowes Res.	25	3	120	9
RS46	Parkvale S at Weir	510	100	3,600	12
RS47	Waiohine R at Gorge	8	1	46	12
RS48	Waiohine R at Bicknells	71	8	440	12
RS49	Beef Ck at Headwaters	4	<1	410	12
RS50	Mangatarere S at SH 2	175	47	2,300	12
RS51	Huangarua R at Ponatahi Br	50	10	2,300	12
RS52	Tauanui R at Whakatomotomo Rd	4	<1	520	12
RS53	Awhea R at Tora Rd	240	29	2,900	12
RS54	Coles Ck Trib at Lagoon Hill Rd	120	5	250	10
RS55	Tauherenikau R at Websters	17	3	48	12
RS56	Waiorongomai R at Forest Pk	10	1	1,400	12

Table A4.16: Faecal coliforms (cfu/100mL)

Site No.	Site Name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	710	400	5,400	12
RS03	Waitohu S at Forest Pk	5	1	110	12
RS04	Waitohu S at Norfolk Cres	325	130	3,500	12
RS05	Otaki R at Pukehinau	6	1	12	12
RS06	Otaki R at Mouth	38	4	640	12
RS07	Mangaone S at Sims Rd Br	490	100	1,300	12
RS08	Ngarara S at Field Way	125	54	350	12
RS09	Waikanae R at Mangaone Walkway	13	3	45	12
RS10	Waikanae R at Greenaway Rd	17	9	70	12
RS11	Whareroa S at Waterfall Rd	95	8	630	12
RS12	Whareroa S at QE Park	270	73	1,200	12
RS13	Horokiri S at Snodgrass	265	100	620	12
RS14	Pauatahanui S at Elmwood Br	390	110	900	12
RS15	Porirua S at Glenside	215	140	5,100	12
RS16	Porirua S at Wall Park (Milk Depot)	1,200	300	11,000	12
RS17	Makara S at Kennels	240	60	510	12
RS18	Karori S at Makara Peak	1,000	150	11,000	12
RS19	Kaiwharawhara S at Ngaio Gorge	345	160	22,000	12
RS20	Hutt R at Te Marua Intake Site	38	12	160	12
RS21	Hutt R opp. Manor Park G.C.	125	22	1,000	12
RS22	Hutt R at Boulcott	130	26	600	12
RS23	Pakuratahi R 50m d/s Farm Ck	125	78	1,000	12
RS24	Mangaroa R at Te Marua	290	52	1,300	12
RS25	Akatarawa R at Hutt confl.	55	20	120	12
RS26	Whakatikei R at Riverstone	22	6	60	12
RS27	Waiwhetu S at Wainui Hill Br	445	120	5,800	12
RS28	Wainuiomata R at Manuka Track	5	<1	58	12
RS29	Wainuiomata R u/s of White Br	155	29	7,900	12
RS30	Orongorongo R at Orongorongo Stn	46	6	350	12
RS31	Ruamahanga R at McLays	3	1	280	12
RS32	Ruamahanga R at Te Ore Ore	125	42	2,500	12
RS33	Ruamahanga R at Gladstone Br	120	10	5,900	12
RS34	Ruamahanga R at Pukio	215	39	4,100	12
RS35	Mataikona Trib at Sugar Loaf Rd	90	2	3,600	12
RS36	Taueru R at Castlehill	110	45	500	12
RS37	Taueru R at Gladstone	120	40	540	12
RS38	Kopuaranga R at Stewarts	405	180	6,000	12
RS39	Whangaehu R 250m u/s confl.	700	130	22,000	12
RS40	Waipoua R at Colombo Rd Br	50	7	1,100	12
RS41	Waingawa R at South Rd	31	6	170	12
RS42	Whareama R at Gauge	54	17	14,000	12
RS43	Motuwaireka S at Headwaters	3	<1	26	12
RS44	Totara S at Stronvar	4	<1	50	12
RS45	Parkvale Trib at Lowes Res.	26	5	120	9
RS46	Parkvale S at Weir	640	100	4,000	12
RS47	Waiohine R at Gorge	8	1	46	12
RS48	Waiohine R at Bicknells	73	11	490	12
RS49	Beef Ck at Headwaters	4	<1	410	12
RS50	Mangatarere S at SH 2	175	60	2,300	12
RS51	Huangarua R at Ponatahi Br	59	12	2,500	12
RS52	Tauanui R at Whakatomotomo Rd	8	1	570	12
RS53	Awhea R at Tora Rd	245	37	2,900	12
RS54	Coles Ck Trib at Lagoon Hill Rd	120	5	450	10
RS55	Tauherenikau R at Websters	20	3	50	12
RS56	Waiorongomai R at Forest Pk	11	1	1,400	12

Table A4.17: Total suspended solids (mg/L)

Site No.	Site Name	Median	Minimum	Maximum	n
RS02	Mangapouri S at Bennetts Rd	3.2	2.0	11.0	12
RS03	Waitohu S at Forest Pk	1.0	<2.0	2.1	12
RS04	Waitohu S at Norfolk Cres	5.4	3.5	18.0	12
RS05	Otaki R at Pukehinau	1.0	<2.0	6.3	12
RS06	Otaki R at Mouth	1.0	<2.0	6.9	12
RS07	Mangaone S at Sims Rd Br	4.4	2.1	11.0	12
RS08	Ngarara S at Field Way	5.0	<2.0	31.0	12
RS09	Waikanae R at Mangaone	1.0	<2.0	1.0	12
RS10	Waikanae R at Greenaway Rd	1.0	<2.0	5.6	12
RS11	Whareroa S at Waterfall Rd	3.4	<2.0	110	12
RS12	Whareroa S at QE Park	5.2	<2.0	13.0	12
RS13	Horokiri S at Snodgrass	1.0	<2.0	3.0	12
RS14	Pauatahanui S at Elmwood Br	1.0	<2.0	3.9	12
RS15	Porirua S at Glenside	1.0	<2.0	7.0	12
RS16	Porirua S at Wall Park (Milk)	1.0	<2.0	14.0	12
RS17	Makara S at Kennels	1.7	<2.0	13.0	12
RS18	Karori S at Makara Peak	1.0	<2.0	7.3	12
RS19	Kaiwharawhara S at Ngaio	1.0	<2.0	2.3	12
RS20	Hutt R at Te Marua Intake Site	1.0	<2.0	8.0	12
RS21	Hutt R opp. Manor Park G.C.	1.0	<2.0	23.0	12
RS22	Hutt R at Boulcott	1.6	<2.0	44.0	12
RS23	Pakuratahi R 50m d/s Farm Ck	1.0	<2.0	6.1	12
RS24	Mangaroa R at Te Marua	1.0	<2.0	45.0	12
RS25	Akatarawa R at Hutt confl.	1.0	<2.0	10.0	12
RS26	Whakatikei R at Riverstone	1.0	<2.0	6.0	12
RS27	Waiwhetu S at Wainui Hill Br	4.5	<2.0	35.0	12
RS28	Wainuiomata R at Manuka	1.0	<2.0	1.0	12
RS29	Wainuiomata R u/s of White Br	1.5	<2.0	5.7	12
RS30	Orongorongo R at Orongorongo	3.7	<2.0	89.0	12
RS31	Ruamahanga R at McLays	1.0	<2.0	2.9	12
RS32	Ruamahanga R at Te Ore Ore	6.0	<2.0	33.0	12
RS33	Ruamahanga R at Gladstone Br	2.9	<2.0	52.0	12
RS34	Ruamahanga R at Pukio	7.4	<2.0	57.0	12
RS35	Mataikona Trib at Sugar Loaf	2.2	<2.0	5.5	12
RS36	Taueru R at Castlehill	2.6	<2.0	33.0	12
RS37	Taueru R at Gladstone	4.5	<2.0	31.0	12
RS38	Kopuaranga R at Stewarts	6.1	<2.0	73.0	12
RS39	Whangaehu R 250m u/s confl.	6.5	<2.0	180	12
RS40	Waipoua R at Colombo Rd Br	1.0	<2.0	6.5	12
RS41	Waingawa R at South Rd	1.0	<2.0	7.0	12
RS42	Whareama R at Gauge	7.9	<2.0	680	12
RS43	Motuwaireka S at Headwaters	1.0	<2.0	4.0	12
RS44	Totara S at Stronvar	1.0	<2.0	2.3	12
RS45	Parkvale Trib at Lowes Res.	2.7	<2.0	6.7	9
RS46	Parkvale S at Weir	6.1	2.6	21.0	12
RS47	Waiohine R at Gorge	1.0	<2.0	1.0	12
RS48	Waiohine R at Bicknells	1.0	<2.0	11.0	12
RS49	Beef Ck at Headwaters	1.0	<2.0	3.0	12
RS50	Mangatarere S at SH 2	2.7	<2.0	42.0	12
RS51	Huangaaru R at Ponatahi Br	4.0	<2.0	124	12
RS52	Tauanui R at Whakatomotomo	1.0	<2.0	10.0	12
RS53	Awhea R at Tora Rd	11.0	<2.0	950	12
RS54	Coles Ck Trib at Lagoon Hill Rd	2.3	<2.0	8.2	10
RS55	Tauherenikau R at Websters	2.2	<2.0	33.0	12
RS56	Waiorongomai R at Forest Pk	1.0	<2.0	8.0	12

Appendix 5: Heavy metal data

Table A5.1: Site-specific, hardness-modified trigger values for chronic copper and zinc toxicity calculated from equations in ANZECC (2000) for sites where median concentrations exceeded the ANZECC (2000) default trigger values

Site No.	Site Name	Dissolved copper trigger value (mg/L)	Dissolved zinc trigger value (mg/L)
RS16	Porirua S at Wall Park (Milk Depot)	0.00183	0.01043
RS18	Karori S at Makara Peak	0.00152	0.00868
RS19	Kaiwharawhara S at Ngaio Gorge	0.00199	0.01140
RS27	Waiwhetu S at Wainui Hill Br	n/a	0.01245

Table A5.2: Summary of dissolved copper (mg/L) concentrations measured at 10 RSoE sites. Median concentrations in bold exceed the ANZECC (2000) default trigger value.

Site No.	Site Name	Median	Minimum	Maximum	<i>n</i>	<i>n</i> < D.L.
RS02	Mangapouri S at Bennetts Rd	0.00077	0.00054	0.00170	12	0
RS08	Ngarara S at Field Way	0.00060	<0.000500	0.00300	12	5
RS10	Waikanae R at Greenaway Rd	0.00025	<0.000500	0.00060	12	9
RS15	Porirua S at Glenside	0.00095	0.00060	0.00870	12	0
RS16	Porirua S at Wall Park (Milk Depot)	0.00158	0.00091	0.00290	12	0
RS18	Karori S at Makara Peak	0.00145	0.00090	0.00470	12	0
RS19	Kaiwharawhara S at Ngaio Gorge	0.00150	0.00110	0.00490	12	0
RS21	Hutt R opp. Manor Park G.C.	0.00025	<0.000500	0.00280	12	7
RS22	Hutt R at Boulcott	0.00025	<0.000500	0.00280	12	8
RS27	Waiwhetu S at Wainui Hill Br	0.00120	0.00063	0.00370	12	0

Table A5.3: Summary of dissolved lead (mg/L) concentrations measured at 10 RSoE sites

Site No.	Site Name	Median	Minimum	Maximum	<i>n</i>	<i>n</i> < D.L.
RS02	Mangapouri S at Bennetts Rd	0.00020	0.00014	0.00027	12	0
RS08	Ngarara S at Field Way	0.00005	<0.00010	0.00040	12	10
RS10	Waikanae R at Greenaway Rd	0.00005	<0.00010	0.00022	12	10
RS15	Porirua S at Glenside	0.00005	0.00005	0.00018	12	9
RS16	Porirua S at Wall Park (Milk Depot)	0.00057	<0.00010	0.00200	12	3
RS18	Karori S at Makara Peak	0.00011	<0.00010	0.00052	12	5
RS19	Kaiwharawhara S at Ngaio Gorge	0.00005	<0.00010	0.00040	12	7
RS21	Hutt R opp. Manor Park G.C.	0.00010	<0.00010	0.00085	12	4
RS22	Hutt R at Boulcott	0.00005	<0.00010	0.00015	12	10
RS27	Waiwhetu S at Wainui Hill Br	0.00042	0.00019	0.00076	12	0

Table A5.4: Summary of dissolved zinc (mg/L) concentrations measured at 10 RSoE sites. Median concentrations in bold exceed the ANZECC (2000) trigger value and median concentrations underlined exceed the site-specific, hardness-modified trigger value.

Site No.	Site Name	Median	Minimum	Maximum	<i>n</i>	<i>n</i> < D.L.
RS02	Mangapouri S at Bennetts Rd	0.00340	0.00200	0.00930	12	0
RS08	Ngarara S at Field Way	0.00240	<0.0010	0.00510	12	1
RS10	Waikanae R at Greenaway Rd	0.00150	<0.0010	0.01160	12	3
RS15	Porirua S at Glenside	0.00455	0.00230	0.01900	12	0
RS16	Porirua S at Wall Park (Milk Depot)	<u>0.02750</u>	0.00640	0.04600	12	0
RS18	Karori S at Makara Peak	0.01740	0.01100	0.03600	12	0
RS19	Kaiwharawhara S at Ngaio Gorge	0.00835	0.00450	0.01350	12	0
RS21	Hutt R opp. Manor Park G.C.	0.00230	<0.0010	0.01150	12	1
RS22	Hutt R at Boulcott	0.00175	<0.0010	0.00350	12	2
RS27	Waiwhetu S at Wainui Hill Br	<u>0.01500</u>	0.00410	0.09200	12	0

Table A5.5: Summary concentrations of additional heavy metals analysed in water samples collected from the Waiwhetu Stream at Wainuiomata Hill Bridge

Variable	Median	Minimum	Maximum	<i>n</i>	<i>n</i> < D.L.
Dissolved arsenic (mg/L)	0.0005	<0.0010	0.0015	12	10
Dissolved cadmium (mg/L)	0.000025	<0.000050	<0.000050	12	12
Dissolved chromium (mg/L)	0.00025	<0.00050	0.00059	12	11
Dissolved nickel (mg/L)	0.00025	<0.00050	0.00070	12	10

Appendix 6: Macroinvertebrate indices

QMCI, %EPT taxa and taxa richness

Site No.	Site Name	QMCI	%EPT taxa	Taxa richness
RS02	Mangapouri S at Bennetts Rd	4.42	0.3	22
RS03	Waitohu S at Forest Pk	8.33	93.9	26
RS04	Waitohu S at Norfolk Cres	4.31	5.5	14
RS05	Otaki R at Pukehinau	7.16	88.7	17
RS06	Otaki R at Mouth	7.39	84.3	14
RS07	Mangaone S at Sims Rd Br	4.42	0.0	12
RS08	Ngarara S at Field Way	4.80	1.0	19
RS09	Waikanae R at Mangaone Walkway	8.26	90.2	27
RS10	Waikanae R at Greenaway Rd	6.20	53.2	26
RS11	Whareroa S at Waterfall Rd	4.95	47.0	25
RS12	Whareroa S at QE Park	4.44	0.0	11
RS13	Horokiri S at Snodgrass	6.11	69.1	21
RS14	Pauatahanui S at Elmwood Br	6.15	68.6	21
RS15	Porirua S at Glenside	5.54	62.8	20
RS16	Porirua S at Wall Park (Milk Depot)	3.88	39.0	21
RS17	Makara S at Kennels	5.09	17.7	17
RS18	Karori S at Makara Peak	2.80	30.4	24
RS19	Kaiwharawhara S at Ngaio Gorge	3.26	32.6	19
RS20	Hutt R at Te Marua Intake Site	8.60	93.0	23
RS21	Hutt R opp. Manor Park G.C.	5.87	59.6	21
RS22	Hutt R at Boulcott	6.75	71.5	16
RS23	Pakuratahi R 50m d/s Farm Ck	7.17	77.8	25
RS24	Mangaroa R at Te Marua	6.21	70.4	27
RS25	Akatarawa R at Hutt confl.	7.47	79.8	27
RS26	Whakatikei R at Riverstone	6.33	66.6	26
RS27	Waiwhetu S at Wainui Hill Br	4.51	0.4	12
RS28	Wainuiomata R at Manuka Track	7.53	69.3	38
RS29	Wainuiomata R u/s of White Br	4.81	55.4	25
RS30	Orongorongo R at Orongorongo Stn	6.62	53.7	12
RS31	Ruamahanga R at McLays	8.11	93.1	14
RS32	Ruamahanga R at Te Ore Ore	6.85	78.8	16
RS33	Ruamahanga R at Gladstone Br	7.35	88.4	16
RS34	Ruamahanga R at Pukio	6.94	83.5	13
RS35	Mataikona Trib at Sugar Loaf Rd	6.97	78.9	26
RS36	Taueru R at Castlehill	5.00	56.9	19
RS37	Taueru R at Gladstone	4.05	6.2	18
RS38	Kopuaranga R at Stewarts	3.91	56.7	26
RS39	Whangaehu R 250m u/s confl.	4.04	0.0	16
RS40	Waipoua R at Colombo Rd Br	5.13	81.4	24
RS41	Waingawa R at South Rd	7.59	91.1	17
RS42	Whareama R at Gauge	3.96	0.0	11
RS43	Motuwaireka S at Headwaters	6.86	57.7	31
RS44	Totara S at Stronvar	4.92	72.4	24
RS45	Parkvale Trib at Lowes Res.	4.32	25.7	16
RS46	Parkvale S at Weir	3.66	15.0	24
RS47	Waiohine R at Gorge	8.04	95.7	18
RS48	Waiohine R at Bicknells	6.73	76.6	20
RS49	Beef Ck at Headwaters	6.80	67.5	31
RS50	Mangatarere S at SH 2	4.66	18.6	25
RS51	Huangaru R at Ponatahi Br	5.79	76.1	23
RS52	Tauanui R at Whakatomotomo Rd	6.33	64.0	27
RS53	Awhea R at Tora Rd	7.90	96.7	10
RS54	Coles Ck Trib at Lagoon Hill Rd	6.66	65.5	27
RS55	Tauherenikau R at Websters	7.60	94.1	23
RS56	Waiorongomai R at Forest Pk	6.82	76.1	27

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