



greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Benchmarking of aquatic ecosystem health and contact recreation outcomes in the Proposed Natural Resources Plan

S Greenfield
J Milne
A Perrie
M Oliver
S Tidswell
P Fairbrother

Environmental Science Department

For more information, contact the Greater Wellington Regional Council:

Wellington
PO Box 11646

Masterton
PO Box 41

T 04 384 5708
F 04 385 6960
www.gw.govt.nz

T 06 378 2484
F 06 378 2146
www.gw.govt.nz

GW/ESCI-T-15/46
ISBN: 978-1-927217-75-7 (online)

July 2015

www.gw.govt.nz
info@gw.govt.nz

Report prepared by:	S Greenfield	Senior Environmental Scientist – Freshwater	
Report prepared by:	JR Milne	Team Leader, Aquatic Ecosystems & Quality	
Report reviewed by:	H Vujcich	Policy Adviser – Environmental Management	
Report approved for release by:	G Sevicke-Jones	Manager, Environmental Science	 Date: July 2015

DISCLAIMER

This report has been prepared by Environmental Science staff of Greater Wellington Regional Council (GWRC) and as such does not constitute Council policy.

In preparing this report, the authors have used the best currently available data and have exercised all reasonable skill and care in presenting and interpreting these data. Nevertheless, GWRC does not accept any liability, whether direct, indirect, or consequential, arising out of the provision of the data and associated information within this report. Furthermore, as GWRC endeavours to continuously improve data quality, amendments to data included in, or used in the preparation of, this report may occur without notice at any time.

GWRC requests that if excerpts or inferences are drawn from this report for further use, due care should be taken to ensure the appropriate context is preserved and is accurately reflected and referenced in subsequent written or verbal communications. Any use of the data and information enclosed in this report, for example, by inclusion in a subsequent report or media release, should be accompanied by an acknowledgement of the source.

The report may be cited as:

Greenfield S, Milne J, Perrie A, Oliver M, Tidswell S and Fairbrother P. 2015. *Benchmarking of aquatic ecosystem health and contact recreation outcomes in the Proposed Natural Resources Plan*. Greater Wellington Regional Council, Publication No. GW/ESCI-T-15/46, Wellington.

Contents

1.	Introduction	1
2.	Aquatic ecosystem health	2
2.1	Rivers and streams	2
2.1.1	Attributes and outcomes	2
2.1.2	Measurement and assessment methods	2
2.1.3	Results	3
2.2	Lakes	5
2.2.1	Attributes and outcomes	5
2.2.2	Measurement and assessment methods	5
2.2.3	Results	6
2.3	Groundwater	8
2.3.1	Attributes and outcomes	8
2.3.2	Measurement and assessment methods	9
2.3.3	Results	9
2.4	Coastal waters	13
2.4.1	Attributes and outcomes	13
2.4.2	Measurement and assessment methods	14
2.4.3	Results	14
3.	Contact recreation	19
3.1	Fresh waters	19
3.1.1	Attributes and outcomes	19
3.1.2	Measurement and assessment methods	19
3.1.3	Results	21
3.2	Coastal waters	22
3.2.1	Attributes and outcomes	22
3.2.2	Measurement and assessment methods	22
3.2.3	Results	23
4.	Summary	24
	References	25
	Appendix 1: Aquatic ecosystem health benchmarking results – league tables	26
	Appendix 2: Contact recreation benchmarking results – league tables	40

1. Introduction

This report benchmarks the current state of fresh and coastal water in the Wellington Region against the contact recreation and aquatic ecosystem health outcomes in Tables 3.1–3.3 and Tables 3.4–3.8 (respectively) of the Proposed Natural Resources Plan for the Wellington Region (the proposed Plan) (GWRC 2015).

Benchmarking is presented separately for each of the following:

- Rivers and streams
- Lakes
- Groundwater
- Coastal water

Section two provides the benchmarking for each of these water body types against the aquatic ecosystem health outcomes in Table 3.4-3.8 of the proposed Plan. Section three provides benchmarking for each water body type against the contact recreation outcomes in Tables 3.1-3.3 of the proposed Plan. Each section provides a summary table of the benchmarking results and a brief commentary. League tables of data used in each section are provided in the appendices.

The benchmarking has been carried out in accordance with the technical guidance document prepared by Greenfield et al. (2015), a companion document to the proposed Plan and this report. The technical guidance document describes the data set sizes, sampling regimes, analytical methods and statistical tests that should be applied to establish whether an outcome is met. Where the proposed Plan includes a narrative outcome in Tables 3.1–3.8, the technical guidance document also provides guidance on how that outcome could be interpreted.

In many cases, the benchmarking undertaken here has required the interpretation of narrative outcomes. Further, in some cases, benchmarking is based on limited guidance and/or data. In these cases there is a level of uncertainty around the benchmarking and the results should be considered indicative only. Each section of this report identifies where results should be considered ‘indicative’ and the reason for the uncertainty. In this benchmarking assessment uncertainty is caused by:

- Insufficient data (eg, limited sites and/or sample results that mean the data are not representative and/or appropriate statistics cannot be applied), and/or
- An absence of sufficiently developed thresholds for assessing the recognised measure(s) of the attribute.

Where uncertainty exists, results are shown as ‘likely’ or ‘unlikely’ to meet an outcome in the league tables in the appendices.

There are also some gaps where benchmarking of the outcomes in Tables 3.1–3.8 is not currently possible. These include for natural wetlands for which there are currently insufficient nationally recognised/accepted measures, thresholds and regional data available to benchmark against. There is also insufficient national guidance and regional data available to benchmark outcomes for fish, mahinga kai and Māori customary use of water attributes.

2. Aquatic ecosystem health

This section benchmarks aquatic ecosystem health (aquatic ecosystem health) outcomes presented in Tables 3.1 (rivers and streams), 3.2 (lakes), 3.4 (groundwater) and 3.5 (coastal waters) of the proposed Plan.

2.1 Rivers and streams

2.1.1 Attributes and outcomes

Table 2.1 sets out the aquatic ecosystem health attributes and outcomes for rivers and streams contained in Table 3.4 of Objective O25 of the proposed Plan.

Table 2.1: River and stream aquatic ecosystem health and mahinga kai outcomes in Table 3.4 of the proposed Plan

River class ¹	Macrophytes	Periphyton (mg/m ² chlorophyll a)		Invertebrates (MCI)		Fish	Mahinga kai species	
		All rivers	Significant rivers ²	All rivers	Significant rivers ²			
1	Steep, hard sedimentary	Indigenous macrophyte communities are resilient and their structure, composition and diversity are balanced	≤50	≤50	≥120	≥130	Indigenous fish communities are resilient and their structure, composition and diversity are balanced	Mahinga kai species, including taonga species, are present in quantities, size and of a quality that is appropriate for the area
2	Mid-gradient, coastal and hard sedimentary		≤120	≤50	≥105	≥130		
3	Mid-gradient, soft sedimentary		≤120*	≤50*	≥105	≥130		
4	Lowland, large, draining ranges		≤120	≤50	≥110	≥130		
5	Lowland, large, draining plains and eastern Wairarapa		≤120*	≤50*	≥100	≥120		
6	Lowland, small		≤120*	≤50*	≥100	≥120		

¹ Shown on Maps 21a to 21e of the proposed Plan.

² Rivers or streams with high macroinvertebrate community health, identified in column 2 of Schedule F1 (rivers and lakes).

* This value shall not be exceeded by more than 17% of samples; for all other river classes, to be exceeded by no more than 8% of samples based on a minimum of three years of monthly sampling.

2.1.2 Measurement and assessment methods

Data set

Data from the Greater Wellington Regional Council’s (GWRC’s) Rivers State of the Environment (RSoE) monitoring programme were used to benchmark the macrophyte, periphyton and invertebrate outcomes in Table 3.4 of the proposed Plan.

Method

Methods for measuring the aquatic ecosystem health attributes and the associated outcomes are outlined in Table 2.4 of Greenfield et al. (2015). For the macrophytes attribute, benchmarking requires an interpretation of a narrative outcome.

Where an RSoE site falls in a reach that has been identified in Schedule F1 of the proposed Plan as having significant invertebrate values, results have been compared to the outcomes for 'significant rivers' in Table 3.4 of the proposed Plan.

Uncertainties

Benchmarking for both the macrophyte and periphyton outcomes is indicative only as there are insufficient data to allow a full assessment.

The macrophyte outcome has been assessed based on a provisional macrophyte cover threshold of 50% at soft bottomed sites only and one year of data.

The periphyton assessment method differs to that recommended in Greenfield et al. (2015) because periphyton biomass is currently only measured annually during summer/autumn rather than monthly as recommended. The annual data have been used to provide an indicative assessment of periphyton biomass against the threshold component of the outcome. Without monthly data, it is not possible to assess against the exceedance frequency component of the outcome.

2.1.3 Results

A summary of the benchmarking results for the periphyton and invertebrates outcomes is presented in Table 2.2.

(a) Macrophytes

With regard to macrophytes, the outcome is likely to be met at five of the eight sites for which there are sufficient macrophyte cover data to undertake this benchmarking. There are not enough monitoring sites in each river class to make an assessment of the likelihood of the outcome being met on a class by class basis.

(b) Periphyton

The indicative benchmarking results suggest that rivers and streams in river classes 1, 2 and 4 are likely to meet the outcome in most cases. There are insufficient monitoring sites to provide an adequate assessment of rivers and streams in classes 3, 5 and 6. However because rivers and streams in these classes are more susceptible to periphyton growth due to less frequent flushing flows, it is probable that the outcome will not be met in a number of cases. Table A2 shows the full league table of results.

(c) Invertebrates

The benchmarking shows that the river class in which most sites met the outcome was river class 1 (69% of sites). In contrast the outcome was not met at any of the RSoE sites in classes 5 and 6. There were insufficient sites in river class 3 to be representative of this class. Table A3 shows the full league table of results.

Table 2.2: Summary of benchmarking of proposed Plan aquatic ecosystem health outcomes for rivers and streams

Uncertainty factors are 0 = little or no uncertainty, 1 = insufficient data, 2 = absence of sufficiently developed thresholds

Attribute	Measure	Method/statistic	Assessment period	River class	No. of sites	Range of results	No. of sites that meet outcome	Uncertainty factor(s)
Periphyton	Periphyton biomass (mg/m ²)	Sites with >2 sampling results ≥80% of the threshold are unlikely to meet the outcome	2004–2015 (annual data)	1	13	0–124	12 (92%)	1
				2	12	0–178	11 (92%)	1
				3	2	3–693	0 (0%)	1
				4	15	0–360	10 (67%)	1
				5	3	8–1,221	1 (33%)	1
				6	1	1–78	1 (100%)	1
				Overall	46	0–1,221	35 (76%)	
Invertebrates	Macroinvertebrate community index (MCI)	Sites with a 3-year median ≥ numeric outcome in Table 3.4 of the proposed Plan are meeting the outcome	2012–2014 (annual data)	1	13	125–151	9 (69%)	0
				2	12	87–137	6 (50%)	0
				3	4	79–112	0 (0%)	1
				4	15	95–132	8 (53%)	0
				5	6	75–96	0 (0%)	0
				6	5	68–98	0 (0%)	0
				Overall	55	68–151	23 (42%)	

2.2 Lakes

2.2.1 Attributes and outcomes

Table 2.3 sets out the aquatic ecosystem health attributes and outcomes for lakes contained in Table 3.5 of Objective O25 in the proposed Plan. While these attributes apply to all lakes, they were developed with particular consideration of five key lakes in the Wellington Region; Kohangapiripiri, Kohangatera, Pounui, Wairarapa and Waitawa. Lake Onoke typically functions as an estuary (as the lake mouth is open much of the time) and as such should generally be managed as an estuary (refer Table 3.8 of the proposed Plan for coastal water outcomes). Lake outcomes in Table 3.5 of the proposed Plan only apply to Lake Onoke when the mouth of the lake is closed and is therefore dominated by fresh water inputs.

Table 2.3: Lake aquatic ecosystem health and mahinga kai outcomes in Table 3.5 of the proposed Plan

Lake type	Macrophytes	Phytoplankton	Fish	Mahinga kai species	Nutrients
All lakes ¹	Submerged and emergent macrophyte communities are resilient and occupy at least one third of the lake bed that is naturally available for macrophytes, and are dominated by indigenous species	Phytoplankton communities are balanced and there is a low frequency of nuisance blooms	Indigenous fish communities are resilient and their structure, composition and diversity are balanced	Mahinga kai species, including taonga species are present in quantities, size and of a quality that is appropriate for the area	Total nitrogen and phosphorus concentrations do not cause an imbalance in aquatic plant, invertebrate or fish communities

¹ Except for intermittently closed and open lakes or lagoons (ICOLLs), such as Lake Onoke. These should be treated as a lake when they are in a closed state. When open to the coast, they should be managed an estuary, in which case Table 3.8 applies.

2.2.2 Measurement and assessment methods

Data set

Data from GWRC’s Lakes State of the Environment monitoring programme were used to benchmark the macrophyte, phytoplankton and nutrient outcomes for lakes in Table 3.5 of the proposed Plan.

Method

Methods for measuring these attributes and the associated outcomes are outlined in Table 2.7 of Greenfield et al. (2015). For all attributes, benchmarking requires an interpretation of a narrative outcome.

Uncertainties

There are only sufficient data and guidance to allow benchmarking of the macrophyte outcomes for lakes Kohangapiripiri, Kohangatera and Pounui. Similarly, there are only sufficient data and guidance to allow benchmarking of the phytoplankton and nutrient outcomes for lakes Wairarapa and Waitawa.

Benchmarking for both the phytoplankton and nutrient outcomes is indicative only as there are insufficient data to allow a full assessment.¹

2.2.3 Results

A summary of the benchmarking results for lakes is presented in Table 2.4.

(a) Macrophytes

Lakes Kohangapiripiri, Kohangatera and Pounui meet their respective outcomes for macrophytes. While there is no formal aquatic plant monitoring information available for Lake Wairarapa, this lake is unlikely to meet the outcome in Table 3.5 of the proposed Plan because there is very little vegetation present (ie, macrophytes do not occupy at least one third of the lakebed).

(b) Phytoplankton

Of the two lakes able to be benchmarked (Lake Wairarapa and Lake Waitawa), only Lake Wairarapa meets the phytoplankton outcome in Table 3.5 of the proposed Plan.

Some limited data are available for other lakes:

- Five of 36 sampling occasions in Lake Onoke to date have coincided with a closed lake mouth, meaning that the narrative phytoplankton outcome in Table 3.5 of the proposed Plan applies. Concentrations of chlorophyll *a* recorded on these five occasions ranged from below detection to 10 mg/m³ (median 1.5 mg/m³) indicating that when Lake Onoke is functioning as a lake it is likely to be meeting this outcome.
- Two chlorophyll *a* sampling results exist for Lakes Kohangapiripiri and Kohangatera and both results were below the level of detection (<3 mg/m³). Further, these lakes support regionally and nationally significant macrophyte communities which are reliant on clear water. This suggests that the phytoplankton outcome for these lakes is likely being met.

(c) Nutrients

Only two lakes were able to be benchmarked (Lake Wairarapa and Lake Waitawa) against the narrative nutrient outcomes in Table 3.5 of the proposed Plan. Lake Wairarapa is likely to meet the outcome for total nitrogen (TN) but not for total phosphorus (TP). Lake Waitawa is unlikely to meet the outcome for either TN or TP.²

¹ Although Lake Wairarapa has been monitored since 1994, monthly data only exists from July 2012 onwards (see Cockeram & Perrie 2013) and it should also be noted that monthly sampling isn't always possible due to strong winds on the lake.

² Although data for Lake Waitawa were limited to 11 samples collected between August 2009 and July 2010, further data collected during 2014/15 to date also support the outcome analysis presented here.

Table 2.4: Summary of benchmarking of proposed Plan aquatic ecosystem health outcomes for lakes

Uncertainty factors are 0 = little or no uncertainty, 1 = insufficient data, 2 = absence of sufficiently developed thresholds

Attribute	Measure	Method/statistic	Lake	Assessment period	No. of samples	Results	Outcome met?	Uncertainty factor(s)
Macrophytes	Native vegetation cover (%) and LakeSPI score	Two thirds of the vegetation cover is native AND LakeSPI score $\geq 58^*$	Kohangapiripiri	2011	1	Native veg. cover = 76+% LakeSPI score = 63	Yes	0
		Two thirds of the vegetation cover is native AND LakeSPI score $\geq 83^*$	Kohangatera	2013	1	Native veg. cover = 96+% LakeSPI score = 87	Yes	0
		Two thirds of the vegetation cover is native AND LakeSPI score $\geq 51^*$	Pounui	2011	1	Native veg. cover = 76+% LakeSPI score = 56	Yes	0
Phytoplankton	Chlorophyll a	The outcome is met if the median concentration of chlorophyll a is $<12 \text{ mg/m}^3$ AND the maximum concentration is $\leq 60 \text{ mg/m}^3$	Wairarapa	Jul 2012– Jun 2014	19	Med = 7 mg/m^3 Max = 49 mg/m^3	Likely	1
	Chlorophyll a	The outcome is met if the median concentration of chlorophyll a is $<5 \text{ mg/m}^3$ AND the maximum concentration is $\leq 60 \text{ mg/m}^3$	Waitawa	Aug 2009– Jul 2010	11	Med = 16 mg/m^3 Max = 80 mg/m^3	Unlikely	1
Nutrients	Total nitrogen (TN)	Outcome likely to be met if median concentration of TN is $<0.725 \text{ mg/L}$	Wairarapa	Jul 2012– Jun 2014	19	Med = 0.48 mg/L	Likely	1, 2
	Total phosphorus (TP)	Outcome likely to be met if median concentration of TP is $<0.043 \text{ mg/L}$				Med = 0.066 mg/L	Unlikely	1, 2
	Total nitrogen (TN)	Outcome likely to be met if median concentration of TN is $<0.337 \text{ mg/L}$	Waitawa	Aug 2009– Jul 2010	11	Med = 1.5 mg/L	Unlikely	1, 2
	Total phosphorus (TP)	Outcome likely to be met if median concentration of TP is $<0.02 \text{ mg/L}$				Med = 0.151 mg/L	Unlikely	1, 2

* These thresholds incorporate the recommended five point tolerance for determining when a deterioration in the condition of the submerged plant community has occurred and hence differ from those provided in Table 2.7 presented in Greenfield et al. (2015).

Some limited data are available for other lakes:

- Five of 36 sampling occasions in Lake Onoke to date have coincided with a closed lake mouth. On these occasions, concentrations of TN ranged from 0.15 mg/L to 0.68 mg/L (median 0.26 mg/L) and concentrations of TP ranged from 0.013 mg/L to 0.032 mg/L (median 0.026 mg/L). This indicates that when Lake Onoke is functioning as a lake it is likely to be meeting the nutrient outcomes.
- Two sets of nutrient results exist for Lakes Kohangapiripiri and Kohangatera. While these results indicate TN and TP concentrations are above the thresholds suggested by Greenfield et al. (2015), very little nitrogen was present in the dissolved forms that support phytoplankton growth (ie, almost all of the TN present is organic and hence ‘unavailable’) and chlorophyll *a* concentrations were very low. This suggests nutrient concentrations in these lakes are not causing an imbalance in aquatic plant communities and the nutrient outcome is therefore being met. Given the low level of modification within the catchments of these lakes, these ‘elevated’ nutrient concentrations likely represent natural levels associated with naturally occurring dissolved organic matter.

2.3 Groundwater

2.3.1 Attributes and outcomes

Table 2.5 sets out the aquatic ecosystem health attributes and outcomes for groundwater contained in Table 3.6 of Objective O25 in the proposed Plan. The aquatic ecosystem health outcomes for groundwater are based around two principal types of groundwater:

- Groundwater that is directly connected to surface water (Category A), and
- Groundwater that is not directly connected to surface water (Category C).

For groundwater with a moderate degree of hydraulic connectivity to surface water (Category B), site-specific information on the location and nature of the adjacent surface water feature is needed to assign a groundwater type. It is possible that outcomes for both groundwater types may be applied.

Table 2.5: Groundwater aquatic ecosystem health and mahinga kai outcomes in Table 3.6 of the proposed Plan

Groundwater type	Nitrate	Quantity	Salt water intrusion
Directly connected to surface water	Nitrate concentrations do not cause unacceptable effects on groundwater-dependent ecosystems or on aquatic plants, invertebrate or fish communities in connected surface water bodies	The quantity of water is maintained to safeguard healthy groundwater-dependent ecosystems	The boundary between salt and fresh groundwater does not migrate between freshwater and salt water aquifers
Not directly connected to surface water	Nitrate concentrations do not cause unacceptable effects on stygofauna communities or other groundwater ecosystems		

2.3.2 Measurement and assessment methods

Data set

Data from GWRC's Groundwater State of the Environment monitoring programme were used to benchmark the nitrate attribute outcomes for groundwater in Table 3.6 of the proposed Plan.

Method

Methods for measuring the nitrate, quantity and saltwater intrusion attributes and the associated outcomes are outlined in Table 2.10 of Greenfield et al. (2015). For all attributes, benchmarking requires an interpretation of a narrative outcome.

Benchmarking of water quantity was based on existing groundwater allocation information presented in Appendix 5 of Thompson and Mzila (2015). Saltwater intrusion is addressed by Policy P121 of the proposed Plan.

Uncertainties

For nitrate Greenfield et al. (2015) recommends 30 data points for determining the 95th percentile. However, as groundwater sampling is only conducted quarterly 8 or more years of would be required. This assessment therefore uses five years of data (January 2010 to December 2014 inclusive) to ensure it is more representative of current groundwater state. In most cases this means around 20 data points are used for determining the 95th percentiles.

Benchmarking of the water quantity outcomes is indicative only. Actual water abstraction data are not yet readily available region-wide so benchmarking is based on consented water abstraction.

Greenfield et al. (2015) provides numeric guidance for preventing saltwater intrusion in aquifers in Lower Hutt and Kāpiti Coast. However, only sufficient monitoring data exists at present to benchmark the saltwater intrusion outcome for the Lower Hutt aquifer.

2.3.3 Results

(a) Nitrate

A summary of the benchmarking results is presented in Table 2.6. Of the 68 groundwater monitoring sites included in the benchmarking assessment:

- 52 (76%) sites had median nitrate concentrations below the recommended threshold of ≤ 2.4 mg/L; and
- 46 (68%) sites had 95th percentile nitrate concentrations below the recommended threshold of ≤ 3.5 mg/L.

Fifteen sites failed to meet either of the outcomes, seven sites failed to meet the 95th percentile outcome and one site failed to meet the median outcome, making a total of 23 sites that failed to meet the overall nitrate outcome of Table 3.6 of the proposed Plan. These sites tended to be located in the upper and middle Ruamāhanga valley and in the upper plains of the Kāpiti Coast (Figure 2.1).

Table 2.6: Summary of benchmarking of proposed Plan nitrate outcomes for groundwater – for simplicity, Category B sites are treated here as being directly connected to surface water

Uncertainty factors are 0 = little or no uncertainty, 1 = insufficient data, 2 = absence of sufficiently developed thresholds

Attribute	Measure	Method/statistic	Assessment period	Groundwater type	No. of sites	Range of results	No. of sites that meet outcome	Uncertainty factor(s)		
Nitrate	Nitrate nitrogen (N)	The outcome is met if the median concentration of N is ≤ 2.4 mg/L	Jan 2010–Dec 2014 (quarterly data)	Directly connected to surface water	53	0.001–11.4	40 (75%)	0		
				Not directly connected to surface water	10	0.002–9.6	7 (70 %)	0		
				Unknown	5	0.100–1.8	5 (100%)	0		
				Total	68	0.001–11.4	52 (76%)	0		
		the 95 th percentile of N is ≤ 3.5 mg/L	Jan 2010–Dec 2014 (quarterly data)	Directly connected to surface water	53	0.010–12.9	36 (68%)	1		
				Not directly connected to surface water	10	0.043–10.5	7 (70%)	1		
				Unknown	5	0.188–4.44	3 (60%)	1		
				Total	68	0.010–12.9	46 (68%)	1		
		AND								
		OVERALL (ie, sites meeting both measures)							45 (66%)	

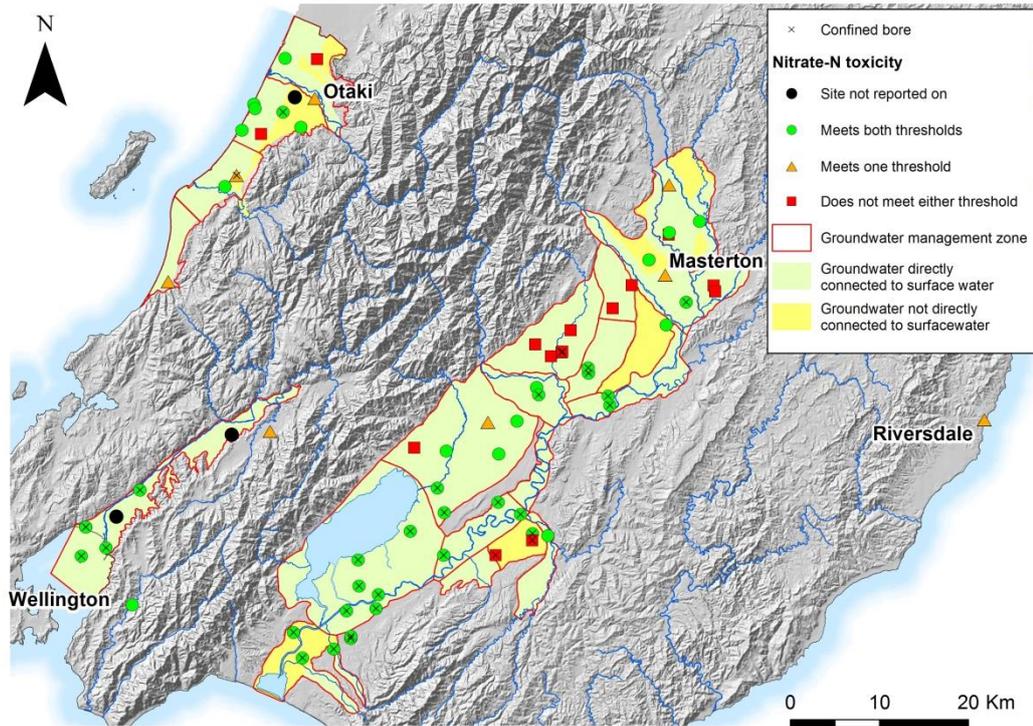


Figure 2.1: Benchmarking results for proposed Plan nitrate outcomes for groundwater

(b) Water quantity

A summary of the benchmarking results is presented in Table 2.7. The information shows where allocation has reached 100% of the limit. It does not attempt to illustrate where a zone is over-allocated (or the extent). The assessment however is conservative in nature as it is based on consented allocation as opposed to actual water usage data.

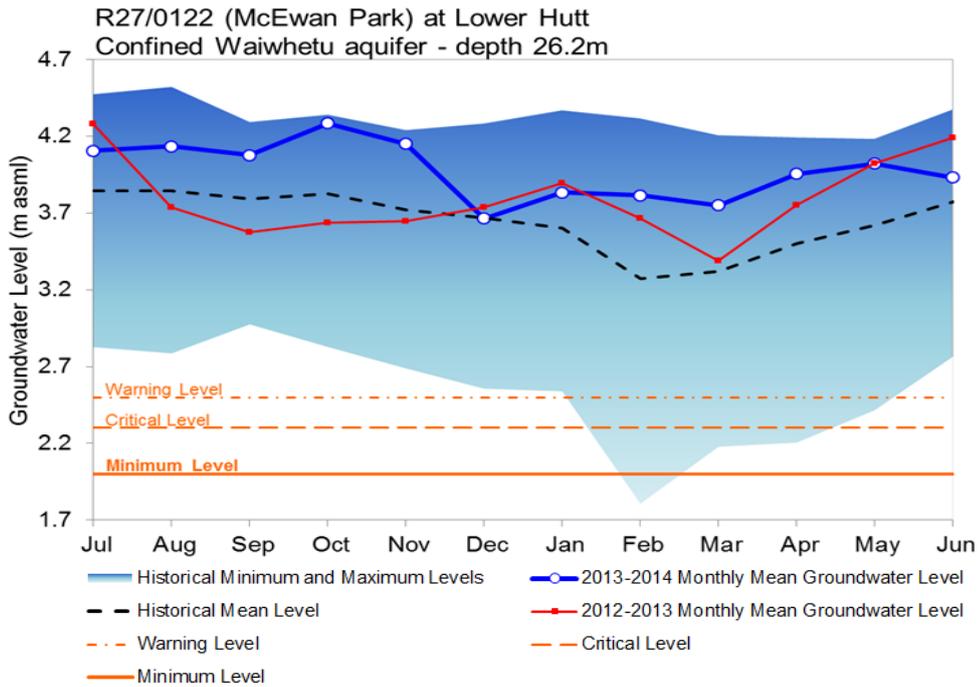
Twelve out of 15 groundwater management zones with direct connection to surface water and 7 out of 19 groundwater management zones not directly connected to surface water are at least 100% allocated.

Table 2.7: Summary of benchmarking of the proposed Plan water quantity outcome for groundwater

Groundwater management zone	100% allocated?	
	Directly linked to surface water	Not directly linked to surface water
<i>Kapiti Coast</i>		
Waitohu	Yes	Yes
Ōtaki (subzone of Waitohu)	No	No
Te Horo	N/A	Yes
Waikanae	Yes	Yes
Raumati	N/A	No
<i>Hutt Valley</i>		
Upper Hutt	Yes	No
Lower Hutt	N/A	No
<i>Wairarapa Valley</i>		
Upper Ruamahanga	Yes	No
Te Ore Ore	Yes	No
Waingawa	Yes	No
Fernhill-Tiffen	N/A	No
Middle Ruamahanga	Yes	N/A
Parkvale	N/A	Yes
Taratahi	N/A	No
Mangatarere	Yes	Yes
Waiohine	Yes	N/A
Tauherenikau	No	No
Lake	N/A	No
Lower Ruamahanga	Yes	N/A
Moiki	Yes	N/A
Martinborough	N/A	Yes
Huangaarua	Yes	Yes
Onoke	Unknown	No
Total	12 of 15	7 of 19

(c) Salt water intrusion

Continuous groundwater level monitoring records for bore R27/0122 on the Petone (Lower Hutt) foreshore indicate that the monthly mean groundwater level for the periods July 2012 to June 2013 and July 2013 to June 2014 did not drop below any of the critical levels set under Policy P121 (Figure 2.2).



(Source: Harkness 2014)

Figure 2.3: Monthly mean groundwater levels for 2012/13 (red line) and 2013/14 (blue line) compared to long-term monthly mean (black dashed line) at bore R27/0122 in Petone, Lower Hutt

2.4 Coastal waters

2.4.1 Attributes and outcomes

Table 2.8 sets out the aquatic ecosystem health attributes and outcomes for coastal waters in Table 3.8 of Objective 25 of the proposed Plan.

Table 2.8: Coastal aquatic ecosystem health and mahinga kai outcomes from Table 3.8 of the proposed Plan

Coastal water type	Macroalgae	Seagrass and saltmarsh	Invertebrates	Fish	Mahinga kai species	Sedimentation rate	Mud content
Open coast		N/A		N/A		N/A	
Estuaries and harbours ¹	The algae community is balanced with low frequency of nuisance blooms	Seagrass, saltmarsh and brackish water submerged macrophytes are resilient and diverse and their cover is sufficient to support invertebrate and fish communities	Invertebrate communities are resilient and their structure, composition and diversity are balanced	Indigenous fish communities are resilient and their structure, composition and diversity are balanced	Mahinga kai species, including taonga species are present in quantities, size and of a quality that is appropriate for the area	The sedimentation rate is within an acceptable range of that expected under natural conditions	The mud content and areal extent of soft mud habitats is within a range of that found under natural conditions

¹ Intermittently closed and open lakes or lagoons (ICOLLs), such as Lake Onoke, should be treated as an estuary when they are in an open state. When closed to the coast, they should be managed a lake, in which case Table 3.5 applies.

2.4.2 Measurement and assessment methods

Data set

Data from GWRC's Coastal State of the Environment monitoring programme were used to benchmark the outcomes in Table 3.8 of the proposed Plan. For detailed information about the number of monitoring sites in each estuary and data collection period refer to Appendix 1. It is important to note that although monitoring of the region's estuaries has been ongoing for five years or more, new guidance in 2015 (Robertson³, pers. comm.) proposes indices and ratings that will require significant retrospective calculation. In time, all of the past data will be assessed against the proposed new guidance though, in some cases, only the 2015 monitoring data has been used here for benchmarking.

Method

Methods for measuring the aquatic ecosystem health attributes and the associated outcomes are outlined in Table 2.16 of Greenfield et al. (2015). For all attributes, benchmarking requires an interpretation of a narrative outcome.

Uncertainties

There are only sufficient data and guidance to benchmark the macroalgae, seagrass and saltmarsh, invertebrates, sedimentation rate and mud content attributes for selected estuaries. Further, for most estuaries the benchmarking is indicative only as more data are needed to enable a full assessment.

2.4.3 Results

A summary of the benchmarking results is presented in Table 2.9.

(a) Macroalgae

Of the three estuaries for which macroalgae cover, biomass and entrainment are regularly assessed, the Hutt Estuary fails to meet the outcome because the 2015 Ecological Quality Rating (EQR) is less (0.39) than the guidance value of >0.5 and equates to a quality status of 'poor'. This indicates that the estuary has high cover and biomass of macroalgae. The EQR for Te Awarua-o-Porirua Harbour (Porirua Harbour) and Waikanae Estuary are 0.58 and 0.72, respectively.

While monitoring of macroalgae in these three estuaries dates back to 2010, biomass data were not collected before 2015 making it difficult to derive the EQR, for which biomass is required. However, the results of the 2010–2014 monitoring showed that cover and density of macroalgae did not change greatly. It can, therefore, be assumed that between 2010 and 2014 the outcome for macroalgae in Porirua Harbour, Waikanae and Hutt estuaries would be the same as in 2015 (Robertson, pers. comm.).

³ Dr Barry Robertson, Wriggle Coastal Management Ltd, Nelson.

Table 2.9: Summary of benchmarking of proposed Plan aquatic ecosystem health outcomes for coastal waters

Uncertainty factors are 0 = little or no uncertainty, 1 = insufficient data, 2 = absence of sufficiently developed thresholds

Attribute	Measure	Method/statistic	Assessment period	Estuary	No. of surveys	Results	Outcome met?	Uncertainty factor
Macroalgae	Ecological Quality Rating (EQR)	The outcome is likely to be met if the EQR is >0.5	2015	Porirua Harbour	1	0.58	Yes	2
				Waikanae Estuary	1	0.72	Yes	2
				Hutt Estuary	1	0.39	No	2
Seagrass & saltmarsh	Dense seagrass cover (ha)	The outcome is likely to be met if the area of dense seagrass does not decline significantly (ie, >10%) from the established baseline	2008 and 2013	Porirua Harbour	2	1.1% incr	Yes	2
	Saltmarsh cover (%)	The outcome is likely to be met if the area of saltmarsh does not decline significantly (ie, >10%) from the established baseline	2008 and 2013	Porirua Harbour	2	2% decline	Yes	2
Invertebrates	Mud and organic enrichment rating (WEBI)	The outcome is likely to be met if the WEBI rating is <3.3	2015	Porirua Harbour	1	1.8	Yes	2
			2012	Waikanae Estuary	1	<3	Likely	2
			2012	Hutt Estuary	1	<3	Likely	2
			2010	Whareama Estuary	1	<3	Likely	2
Sediment	Sedimentation rate (mm/yr)	The outcome is likely to be met if the mean annual sedimentation rate is 1 mm/yr	2011–2015	Porirua Harbour	5	1.5 mm/yr	No	0
			2009-2014	Porirua Harbour	Bathymetric survey	<2 mm/yr	Unlikely	0

Attribute	Measure	Method/statistic	Assessment period	Estuary	No. of surveys	Results	Outcome met?	Uncertainty factor
Mud	Mud content (%)	The outcome is likely to be met if the mud content of sediments does not increase significantly (ie, >10%) from the established baseline	2008–2015	Porirua Harbour	5	Significant decrease	Yes	2
			2011–2015	Waikanae Estuary	2	Significant decrease	Yes	2
			2011–2015	Hutt Estuary	2	Significant decrease	Yes	2
			2008–2015	Whareama Estuary	8	Significant increase	No	2
	Area of soft mud habitat (ha)	The outcome is likely to be met if the area of intertidal soft mud habitat does not increase significantly (ie, >10%) from the established baseline	2008, 2013	Porirua Harbour	2	566% incr	No	2

Seagrass and saltmarsh

The outcomes for seagrass and saltmarsh cover in Porirua Harbour are being met. The area of dense seagrass cover did not change significantly between 2008 (45.2 ha) and 2013 (45.7 ha); saltmarsh cover in Porirua Harbour was 51.4 ha and 50.4 ha in 2008 and 2013, respectively.

Habitat mapping of saltmarsh has also been carried out on a single occasion in the Waikanae and Hutt estuaries (5.7 ha and 0.56 ha, respectively). However, a second survey is required to determine whether cover in those estuaries has changed from the established baseline.

Invertebrates

The invertebrates outcome is being met in Porirua Harbour and this is the only estuary for which there is recent (2015) data to undertake benchmarking using the newly proposed guidance rating for mud and organic enrichment tolerance (ie, the WEBI rating).

Invertebrate monitoring was undertaken in the Waikanae, Hutt and Whareama estuaries between 2008 and 2012 to establish a baseline understanding of invertebrate community health for these estuaries. Based on an expert assessment of this earlier data, the Waikanae, Hutt and Whareama estuaries would have a WEBI rating of <3 (Robertson, pers.comm.) and would, therefore, likely meet the outcome for invertebrates.

Sedimentation rate

The sedimentation rate outcomes are not being met in Porirua Harbour; the mean annual sedimentation rate at intertidal sites for the most recent five years is 1.5 mm/yr. Annual sedimentation rates, including a breakdown of rates for the Pauatahanui and Onepoto arms of the harbour, are given in Appendix 2.

A bathymetric survey undertaken in late 2014, the second survey of this kind, reported a mean areal sedimentation rate of 2 mm/yr for the entire harbour between 2009 and 2014. This is consistent with the measurements recorded over sedimentation plates at eight intertidal sites throughout the harbour.

It is not possible to undertake benchmarking in the Waikanae, Hutt or Whareama estuaries because latest guidance recommends establishing retained natural sedimentation loads (RNSL) against which to compare current sedimentation rates. The RNSL can be determined using sediment retention models but this information is not currently available for these estuaries. However, in the absence of this information, the ratio between the natural state areal sediment loads and current areal sediment loads (both estimated using the CLUES model), indicates that Waikanae Estuary is likely to meet the outcome for sedimentation and the Whareama Estuary will likely not (Robertson, pers. comm.). Current sedimentation rates for these three estuaries are given in Appendix 2.

Mud content

Porirua Harbour, and Waikanae and Hutt estuaries all meet the outcome for mud content. The most recent 2015 monitoring results at selected sites indicate

that mud content has decreased significantly from the mean values established following three years of baseline monitoring. In contrast, Whareama Estuary fails to meet the outcome due to a significant increase in sediment mud content from the baseline value established at the outer estuary monitoring site.

Porirua Harbour does not meet the outcome for area of soft mud as determined from two substrate mapping surveys carried out in 2008 and 2013; the area of soft mud increased from 3 to 20 ha during this period. A single substrate mapping survey has been carried out in Waikanae and Hutt estuaries but in the absence of a second survey, benchmarking for this outcome is not possible at these sites.

3. Contact recreation

This section benchmarks contact recreation outcomes presented in Schedule H of the proposed Plan for fresh and coastal waters.

3.1 Fresh waters

3.1.1 Attributes and outcomes

Tables 3.1 and 3.2 set out the contact recreation attributes and outcomes for fresh waters.

Table 3.1: Freshwater contact recreation and Māori customary use outcomes for primary contact recreation from Table 4.1 of the proposed Plan

Water body type	<i>E. coli</i> /100mL	Cyanobacteria		Māori customary use	Toxicants and irritants
	95 th percentile	Planktonic	Benthic		
Rivers	≤ 540 at all flows below 3x median flow, September to April inclusive		Low risk of health effects from exposure	Fresh water is safe for primary contact and supports Māori customary use	Concentrations of toxicants or irritants do not pose a threat to water users
Lakes	≤ 540 September to April inclusive	≤ 1.8mm ³ /L biovolume equivalent of potentially toxic cyanobacteria OR ≤ 10mm ³ /L total biovolume of all cyanobacteria			

Table 3.2: Freshwater contact recreation and Māori customary use outcomes for secondary contact recreation from Table 4.2 of the proposed Plan

Water body type	<i>E. coli</i> /100mL median	Cyanobacteria	
		Planktonic	Benthic
Rivers	≤ 1,000		Low risk of health effects from exposure
Lakes		≤ 1.8mm ³ /L biovolume equivalent of potentially toxic cyanobacteria OR ≤ 10mm ³ /L total biovolume of all cyanobacteria	

3.1.2 Measurement and assessment methods

Rivers and streams

Data set

Data from GWRC’s Recreational Water Quality (RWQ) and Rivers State of the Environment (RSoE) monitoring programmes along with data from a single site (Enaki Stream) from GWRC’s Riparian Monitoring Trial were used to

benchmark the secondary contact *E. coli* outcome. RWQ sites are sampled weekly for 20 weeks between mid-November and March, while RSoE and riparian trial sites are sampled monthly year round.

Only data from the RWQ programme were used to benchmark the primary contact *E. coli* outcome.

Benchmarking of primary and secondary contact *E. coli* outcomes at RWQ sites was based on data collected over the 2012/13–2014/15 period (ie, the most recent three years). Benchmarking of secondary contact *E. coli* outcomes at RSoE sites was based on data collected between 2011/12 and 2013/14.

Method

Methods for measuring the contact recreation attributes and the associated outcomes are outlined in Table 3.3 of Greenfield et al. (2015). For some attributes, benchmarking requires an interpretation of a narrative outcome.

Uncertainties

Only the *E. coli* outcomes can be fully benchmarked at this time. While benthic cyanobacteria data are available further development of thresholds are required before the outcome can be assessed. For the attributes Māori customary use and toxicants and irritant, both lack of both data and threshold development means even indicative benchmarking cannot be undertaken.

Lakes

Data set

No lakes (or wetlands) are currently monitored under the RWQ programme. *E. coli* and planktonic cyanobacteria data for Lake Waitawa (Kapiti Coast) came from monitoring conducted during 2009/10 and also from monitoring that recommenced in July 2014. Some historic *E. coli* data exists for Lake Wairarapa and is used for this assessment.

Method

Methods for measuring the contact recreation attributes and the associated outcomes are outlined in Table 3.3 of Greenfield et al. (2015). For some attributes, benchmarking requires an interpretation of a narrative outcome.

Uncertainties

Due to the relatively limited *E. coli* data available, 95th percentile values could not be calculated as recommended in Greenfield et al. (2015). Instead the approach taken was to assess the range of *E. coli* counts recorded against the outcomes in Table 3.1 to provide an indication of whether or not these are likely to be met.

Caution is required when interpreting monitoring results because apart from one site sampled in Lake Waitawa between July and June 2015, none of the sites sampled are representative of areas that are likely to be used for contact recreation (ie, sampling sites are located in middle of the lake rather than the lake edges).

3.1.3 Results

Rivers and streams

A summary of the benchmarking results is presented in Table 3.3. Summary statistics are provided in Appendix 2.

Seventy five out of 76 sites (99%) met the *E. coli* outcome for secondary contact recreation. The site that did not meet the outcome was Karori Stream at Makara Peak Mountain Bike Park which had a median *E. coli* count of 1,700 cfu/100mL. The Mangapouri Stream at Bennetts Road site was marginal as it had a median *E. coli* count of 1,000 cfu/100mL.

Seventeen of 20 sites (85%) met the *E. coli* outcome for primary contact recreation. The sites that did not meet the outcome were Hutt River at Melling, Waikanae River at Jim Cooke Park and Wainuiomata River at Richard Prouse Park.

Table 3.3: Summary of benchmarking of proposed Plan contact recreation and Māori customary use outcomes for rivers and streams

Uncertainty factors are 0 = little or no uncertainty, 1 = insufficient data, 2 = absence of sufficiently developed thresholds

Attribute	Measure	Method/statistic	Assessment period	No. of sites	Range of results	No. of sites that meet outcome	Uncertainty factor
<i>E. coli</i> (Secondary contact)	<i>E. coli</i> (cfu/100mL)	Median is ≤ 1,000	Jul 2011–Jun 2014 (monthly RSoE data) and Nov 2012–March 2015 (weekly RWQ data over summer months)	76	5– 1,700	75 (99%)	0
<i>E. coli</i> (Primary contact)		95 th percentile is ≤ 540	Nov 2012–Mar 2015 (weekly data over summer months)	20	55–922	18 (90%)	0

The benthic cyanobacteria outcome could not be benchmarked due to lack of threshold development. However analysis of cyanobacteria data from RWQ monitoring sites over 2012/13–2014/15 indicates that sites on the lower reaches of the Hutt, Ruamahanga and Waipoua rivers most frequently exceed the 20% cover alert threshold (suggested threshold as per Greenfield et al. (2015)). The highest number of exceedances was recorded at the Ruamahanga River at Kokotau site where 17% of results exceeded the 20% cover threshold (Appendix 2).

Lakes

The limited data available for Lake Waitawa indicates that:

- The primary and secondary contact outcomes for *E. coli* are being met. There has been only a single exceedance of the 540 cfu/100mL threshold during 2014/15 to date (700 cfu/100mL on 22 December 2014) and this was following a significant rainfall event.

- The outcome for cyanobacteria is not being met. Three out of 11 samples collected in 2009/10 had planktonic cyanobacteria cell counts in excess of the outcome, and at least one of the two sites sampled between July and March 2015 did not meet the outcome on eight out of nine occasions.

The limited data available for Lake Wairarapa indicates that:

- The primary and secondary contact outcomes for *E. coli* are being met. The maximum *E. coli* count recorded during 14 sampling occasions across four sites between January 2006 and December 2010 was just 190cfu/100mL.
- The outcome for cyanobacteria is being met. Abundance of phytoplankton in water samples collected between July 2012 and March 2015 indicate that cyanobacteria is seldom seen in Lake Wairarapa and when it is present it is not abundant.

3.2 Coastal waters

3.2.1 Attributes and outcomes

Table 3.4 sets out the contact recreation attributes and outcomes for coastal waters.

Table 3.4: Coastal contact recreation and Māori customary use outcomes from Table 4.3 of the proposed Plan

Coastal water	Pathogens	Māori customary use	Shellfish quality
	Indicator bacteria/100mL 95 th percentile ¹		
Estuaries ²	≤ 540 <i>E. coli</i>	Coastal water is safe for primary contact and supports Māori use	Concentrations of contaminants, including pathogens, are sufficiently low for shellfish to be safe to collect and consume where appropriate
Open coast and harbours ³	≤ 500 enterococci		

¹ Derived using the Hazen method from a minimum of 30 data points collected over three years.

² Excludes Te Awarua o Porirua Harbour and includes Lake Onoke. Estuaries, including river mouth estuaries, should be treated as an estuary when they are dominated by saline water, in which case Table 4.1 applies, and as rivers when they are dominated by freshwater, in which case Table 4.2 or 4.3 applies.

³ Includes Wellington Harbour and Te Awarua o Porirua Harbour. Excludes the Lambton Harbour Commercial Port Zone delineated in Map 37.

3.2.2 Measurement and assessment methods

Data set

Data from GWRC's RWQ monitoring programme were used to benchmark the indicator bacteria outcomes. RWQ sites are sampled weekly for 20 weeks between mid-November and March.

Benchmarking of indicator bacteria outcomes was based on data collected over the 2012/13–2014/15 period (ie, the most recent three years).

Method

Methods for measuring the contact recreation attributes and the associated outcomes are outlined in Table 3.6 of Greenfield et al. (2015). For some attributes, benchmarking requires an interpretation of a narrative outcome.

Uncertainties

No benchmarking of Māori customary use or shellfish quality outcomes is currently possible due to a lack of nationally recognised/accepted measures (and associated thresholds) that represent these attributes.

3.2.3 Results

A summary of the benchmarking results is presented in Table 3.5. Summary statistics are provided in Appendix 2.

Table 3.5: Summary of benchmarking of proposed Plan contact recreation and Māori customary use outcomes for coastal waters

Uncertainty factors are 0 = little or no uncertainty, 1 = insufficient data, 2 = absence of sufficiently developed thresholds

Coastal water type	Measure	Method/statistic	Assessment period	No. of sites	Range of results	No. of sites that meet outcome	Uncertainty factor
Estuaries	<i>E. coli</i> (cfu/100mL)	95 th percentile is ≤ 540	Nov 2012– Mar 2015	1	1,016	0	0
Open coasts and harbours	Enterococci (cfu/100mL)	95 th percentile is ≤ 500	(weekly data over summer months)	61	12– 3,750	51 (84%)	0

The single estuarine site monitored, Riversdale Lagoon, did not meet the *E. coli* outcome.

Of the 61 coast and harbour sites monitored 51 (84%) met the outcome. The sites that did not meet the outcome were located in Porirua (Plimmerton Beach at Bath Street, South Beach at Plimmerton, Porirua Harbour at Rowing Club and Titahi Bay at South Beach Access Road) and Wellington City (Owhiro Bay and three sites at Island Bay, Shark Bay and Balaena Bay).

4. Summary

It is not possible at the present time to benchmark all of the aquatic ecosystem health and contact recreation outcomes outlined in the proposed Plan and in some cases the results are indicative only as further data and/or guidance is required before a full assessment can be made. Nonetheless, this benchmarking exercise has illustrated that few water bodies in the Wellington Region will meet all of the aquatic ecosystem health and contact recreation outcomes.

As noted in Greenfield et al. (2015), the benchmarking measurements and assessment methodology will continue to be reviewed and updated as more data and national guidance become available.

References

Cockeram B and Perrie A. 2013. *Lakes State of the Environment monitoring programme: Annual data report, 2012/13*. Greater Wellington Regional Council, Publication No. GW/ESCI-T-13/115, Wellington.

Greenfield S, Perrie A, Milne J, Oliver M, Tidswell S and Crisp P. 2015. *Technical guidance document for aquatic ecosystem health and contact recreation outcomes in the Proposed Natural Resources Plan*. Greater Wellington Regional Council, Publication No. GW/ESCI-T-15/45, Wellington.

GWRC. 2015. *Proposed Natural Resources Plan for the Wellington Region – Te Tikanga Taiao o Te Upoko o Te Ikaa a Maui*. Greater Wellington Regional Council, Publication No. GW/EP-G-15/44 Wellington.

Harkness M. 2014. *Hydrology State of the Environment monitoring programme: Annual data report, 2013/14*. Greater Wellington Regional Council, Publication No. GW/ESCI-T-14/117, Wellington.

Ministry for the Environment. 2006. *A national protocol for state of the environment groundwater sampling in New Zealand*. Ministry for the Environment, Wellington.

Thompson M and Mzila D. 2015. *Water allocation recommendations for the Wellington region: Technical report to support the Proposed Natural Resources Plan*. Greater Wellington Regional Council, Publication No. GW/EMI-T-15/84, Wellington.

Appendix 1: Aquatic ecosystem health benchmarking results – league tables

Table A1: Rivers – Monthly total macrophyte cover (%) measurements between July 2013 and June 2014 at nine soft-bottomed RSoE monitoring sites

Site code	Site name	River class	Outcome	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	No. of results	No. of results outcome not met	% results outcome not met	Outcome likely to be met?
RS36	Taueru River at Castlehill	3	< 50	*	*	0	0	0	0	0	0	0	0	0	*	9	0	0	Likely
RS39	Whangaehu River at 250m from Confluence	3	< 50	*	0	*	*	*		0	0	26	0	*	8	6	0	0	Likely
RS04	Waitohu Stream at Norfolk Crescent	5	< 50	*	3	10	*	12	14	42	44	*	54	5	18	9	1	11	Likely
RS07	Mangaone Stream at Sims Road Bridge	5	< 50	75	44	14	*	84	92	84	100	44	55	14	60	11	7	64	Unlikely
RS42	Whareama River at Gauge	5	< 50	*	*	*	20	*	*	*	*	0	*	*	*	2	0	0	Insufficient data
RS02	Mangapouri Stream at Bennetts Rd	6	< 50	80	84	90	*	94	86	100	100	86	85	13	34	11	9	82	Unlikely
RS08	Ngarara Stream at Field Way	6	< 50	*	0	0	*	0	0	0	7	11	0	0	6	10	0	0	Likely
RS12	Whareroa Stream at QE Park	6	< 50	*	6	4	6	3	6	8	32	42	60	70	48	11	2	18	Likely
RS57	Waiwhetu Stream at Whites Line East	6	< 50	44	58	96	22	64	100	22	18	15	97	18	0	12	5	42	Unlikely

* Not able to be assessed (eg, due to high river flow or turbidity).

Table A2: Rivers – Annual periphyton biomass (mg/m²) results from 46 hard-bottomed RSoE monitoring sites between 2004 and 2015

Site code	Site name	River class	Signif. river?	Outcome (mg/ m ²)	Allowable exceedance/yr	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	No. of results ≥80% of threshold	Outcome likely to be met?
RS03	Waitohu Stream at Forest Park	1	N	≤50	1	9	9	4	3	1	1	1	1	1	2	1	0	0	Likely
RS05	Ōtaki River at Pukehinau	1	Y	≤50	1	0	5	2	2	1	1	2	1	0	2	0	2	0	Likely
RS20	Hutt River at Te Marua Intake Site	1	Y	≤50	1	1	0	5	2	1	1	1	0	36	4	0	2	0	Likely
RS23	Pakuratahi River 50m Below Farm Creek	1	Y	≤50	1	1	1	60	16	28	4	20	0	38	18	1	16	1	Likely
RS24	Mangaroa River at Te Marua	1	N	≤50	1	1	10	58	58	52	60	73	84	124	96	12	67	9	Unlikely
RS25	Akatarawa River at Hutt Confluence	1	Y	≤50	1	0	3	2	2	39	2	0	8	46	1	0	1	1	Likely
RS28	Wainuiomata River at Manuka Track	1	Y	≤50	1	5	20	10	9	9	7	10	1	4	8	9	37	0	Likely
RS30	Orongorongo River at Orongorongo Station	1	Y	≤50	1	1	7	3	6	0	20	3	3	0	10	2	5	0	Likely
RS31	Ruamahanga River at McLays	1	N	≤50	1	2	6	0	1	0	0	0	2	0	0	0	0	0	Likely
RS47	Waiohine River at Gorge	1	Y	≤50	1	1	2	0	0	0	0	1	0	4	2	0	0	0	Likely
RS49	Beef Creek at headwaters	1	N	≤50	1	3	4	10	9	5	7	11	8	13	5	2	5	0	Likely
RS52	Tauanui River at Whakatomotomo Rd	1	N	≤50	1	3	7	9	11	35	1	31	2	6	2	0	2	0	Likely
RS56	Waiorongomai River at Forest Park	1	Y	≤50	1	3	1	4	10	1	2	0	1	1	28	0	1	0	Likely
RS09	Waikanae River at Mangaone Walkway	2	Y	≤50	1	3	3	10	4	4	0	1	0	3	0	0	2	0	Likely
RS11	Whareroa Stream at Waterfall Rd	2	N	≤120	1	1	0	5	3	5	30	1	1	10	0	1	4	0	Likely
RS13	Horokiri Stream at Snodgrass	2	N	≤120	1	6	15	43	50	12	34	46	77	73	54	12	147	1	Likely

Site code	Site name	River class	Signif. river?	Outcome (mg/ m ²)	Allowable exceedance/yr	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	No. of results ≥80% of threshold	Outcome likely to be met?
RS14	Pauatahanui Stream at Elmwood Bridge	2	N	≤120	1	20	34	33	114	51	141	23	53	35	77	44	178	3	Unlikely
RS15	Porirua Stream at Glenside Overhead Cable	2	N	≤120	1	7	37	12	39	64	43	77	30	51	26	9	33	0	Likely
RS16	Porirua Stream at Wall Park	2	N	≤120	1	12	24	10	11	109	39	55	20	21	39	11	61	1	Likely
RS17	Makara Stream at Kennels	2	N	≤120	1	2	1	3	120	2	6	15	0	14	6	9	2	1	Likely
RS18	Karori Stream at Makara Peak Mountain Bike	2	N	≤120	1	16	37	33	41	33	71	25	11	68	39	13	41	0	Likely
RS19	Kaiwharawhara Stream at Ngaio Gorge	2	N	≤120	1	33	47	22	88	89	61	34	38	75	144	9	61	1	Likely
RS35	Mataikona tributary at Sugar Loaf Rd	2	N	≤120	1	4	2	2	5	7	7	12	4	2	2	0	*	0	Likely
RS43	Motuwaireka Stream at headwaters	2	N	≤120	1	2	7	8	11	2	3	2	1	3	3	1	9	0	Likely
RS44	Totara Stream at Stronvar	2	N	≤120	1	3	28	28	5	6	15	8	26	7	9	2	3	0	Likely
RS37	Taueru River at Gladstone	3	N	≤120	2	346	87	85	241	693	477	584	487	36	98	115	141	9	Unlikely
RS54	Coles Creek tributary at Lagoon Hill Rd	3	Y	≤50	2	6	*	8	61	88	42	21	60	3	19	9	*	4	Unlikely
RS06	Ōtaki River at Mouth	4	Y	≤50	1	2	5	12	21	5	3	2	2	13	2	15	13	0	Likely
RS10	Waikanae River at Greenaway Rd	4	N	≤120	1	27	12	71	148	5	20	10	19	73	14	5	34	1	Likely
RS21	Hutt River Opposite Manor Park Golf Club	4	N	≤120	1	0	4	19	29	49	18	60	2	190	7	7	5	1	Likely
RS22	Hutt River at Boulcott	4	N	≤120	1	0	1	163	98	112	17	119	21	209	31	38	133	6	Unlikely
RS26	Whakatikei River at Riverstone	4	N	≤120	1	2	2	46	20	17	14	5	7	17	10	11	26	0	Likely

Site code	Site name	River class	Signif. river?	Outcome (mg/ m ²)	Allowable exceedance/yr	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	No. of results ≥80% of threshold	Outcome likely to be met?
RS29	Wainuiomata River Dwnstr of White Bridge	4	N	≤120	1	23	31	6	31	32	40	236	79	108	41	51	97	3	Unlikely
RS32	Ruamahanga River at Te Ore Ore	4	N	≤120	1	27	67	11	12	62	28	35	90	34	36	6	17	0	Likely
RS33	Ruamahanga River at Gladstone Bridge	4	N	≤120	1	13	12	4	46	59	47	65	58	114	62	10	79	1	Likely
RS34	Ruamahanga River at Pukio	4	N	≤120	1	61	0	5	63	99	22	91	49	139	151	1	44	3	Unlikely
RS40	Waipoua River at Colombo Rd Bridge	4	N	≤120	1	14	17	179	35	79	35	34	46	7	150	13	24	2	Likely
RS41	Waingawa River at South Rd	4	N	≤120	1	1	3	15	2	6	51	9	2	48	88	0	13	0	Likely
RS48	Waiohine River at Bicknells	4	N	≤120	1	4	3	4	27	1	48	51	6	58	18	0	28	0	Likely
RS50	Mangatarere Stream at State Highway 2	4	N	≤120	1	72	11	29	55	243	143	48	39	27	171	20	79	3	Unlikely
RS51	Huangarua River at Ponatahi Bridge	4	N	≤120	1	7	229	72	45	310	123	96	280	360	70	136	342	8	Unlikely
RS55	Tauherenikau River at Websters	4	Y	≤50	1	6	2	11	19	7	12	10	2	2	1	0	2	0	Likely
RS38	Kopuaranga River at Stewarts	5	N	≤120	2	19	204	195	173	1221	690	515	351	100	313	249	116	11	Unlikely
RS46	Parkvale Stream at weir	5	N	≤120	2	92	87	17	239	78	304	309	50	218	140	51	14	5	Unlikely
RS53	Awhea River at Tora Rd	5	N	≤120	2	19	35	57	140	331	36	29	61	15	23	8	27	2	Likely
RS45	Parkvale tributary at Lowes Reserve	6	N	≤120	2	19	10	65	78	29	18	41	30	25	6	1	5	0	Likely

Table A3: Rivers – Annual Macroinvertebrate Community Index (MCI) scores from 56 RSoE sites between 2012 and 2014

Site code	Site name	River class	Significant river?	Outcome	2012	2013	2014	Median	Outcome met?
RS03	Waitohu Stream at Forest Park	1	N	≥120	139	145	146	145	YES
RS05	Ōtaki River at Pukehinau	1	Y	≥130	135	127	131	131	YES
RS20	Hutt River at Te Marua Intake Site	1	Y	≥130	135	140	128	135	YES
RS23	Pakuratahi River 50m Below Farm Creek	1	Y	≥130	128	131	125	128	NO
RS24	Mangaroa River at Te Marua	1	N	≥120	127	118	128	127	YES
RS25	Akatarawa River at Hutt Confluence	1	Y	≥130	129	128	135	129	NO
RS28	Wainuiomata River at Manuka Track	1	Y	≥130	134	138	144	138	YES
RS30	Orongorongo River at Orongorongo Station	1	Y	≥130	125	125	107	125	NO
RS31	Ruamahanga River at McLays	1	N	≥120	151	145	151	151	YES
RS47	Waiohine River at Gorge	1	Y	≥130	151	126	136	136	YES
RS49	Beef Creek at headwaters	1	N	≥120	141	125	134	134	YES
RS52	Tauanui River at Whakatomotomo Rd	1	N	≥120	127	121	133	127	YES
RS56	Wairongomai River at Forest Park	1	Y	≥130	133	127	123	127	NO
RS09	Waikanae River at Mangaone Walkway	2	Y	≥130	139	137	130	137	YES
RS11	Whareroa Stream at Waterfall Rd	2	N	≥105	118	106	116	116	YES
RS13	Horokiri Stream at Snodgrass	2	N	≥105	108	117	115	115	YES
RS14	Pauatahanui Stream at Elmwood Bridge	2	N	≥105	94	100	106	100	NO
RS15	Porirua Stream at Glenside Overhead Cable	2	N	≥105	99	119	104	104	NO
RS16	Porirua Stream at Wall Park	2	N	≥105	91	94	87	91	NO
RS17	Makara Stream at Kennels	2	N	≥105	120	123	107	120	YES
RS18	Karori Stream at Makara Peak Mountain Bike Park	2	N	≥105	95	101	92	95	NO
RS19	Kaiwharawhara Stream at Ngaio Gorge	2	N	≥105	87	81	96	87	NO
RS35	Mataikona tributary at Sugar Loaf Rd	2	N	≥105	130	133	128	130	YES
RS43	Motuwaireka Stream at headwaters	2	N	≥105	137	125	136	136	YES

Site code	Site name	River class	Significant river?	Outcome	2012	2013	2014	Median	Outcome met?
RS44	Totara Stream at Stronvar	2	N	≥105	118	101	104	104	NO
RS36	Taueru River at Castlehill	3	N	≥105	104	110	102	104	NO
RS37	Taueru River at Gladstone	3	N	≥105	109	95	95	95	NO
RS39	Whangaehu River at 250m from Confluence	3	N	≥105	84	79	77	79	NO
RS54	Coles Creek tributary at Lagoon Hill Rd	3	Y	≥130	112	119	106	112	NO
RS06	Ōtaki River at Mouth	4	Y	≥130	127	105	116	116	NO
RS10	Waikanae River at Greenaway Rd	4	N	≥110	119	116	105	116	YES
RS21	Hutt River Opposite Manor Park Golf Club	4	N	≥110	110	127	128	127	YES
RS22	Hutt River at Boulcott	4	N	≥110	97	107	111	107	NO
RS26	Whakatikei River at Riverstone	4	N	≥110	132	130	138	132	YES
RS29	Wainuiomata River Dwnstr of White Bridge	4	N	≥110	105	107	109	107	NO
RS32	Ruamahanga River at Te Ore Ore	4	N	≥110	117	113	114	114	YES
RS33	Ruamahanga River at Gladstone Bridge	4	N	≥110	102	108	95	102	NO
RS34	Ruamahanga River at Pukio	4	N	≥110	114	113	103	113	YES
RS40	Waipoua River at Colombo Rd Bridge	4	N	≥110	95	94	97	95	NO
RS41	Waingawa River at South Rd	4	N	≥110	109	118	119	118	YES
RS48	Waiohine River at Bicknells	4	N	≥110	99	122	117	117	YES
RS50	Mangatarere Stream at State Highway 2	4	N	≥110	111	102	113	111	YES
RS51	Huangaaru River at Ponatahi Bridge	4	N	≥110	92	97	104	97	NO
RS55	Tauherenikau River at Websters	4	Y	≥130	131	111	111	111	NO
RS04	Waitohu Stream at Norfolk Crescent	5	N	≥100	95	97	96	96	NO
RS07	Mangaone Stream at Sims Road Bridge	5	N	≥100	75	72	91	75	NO
RS38	Kopuaranga River at Stewarts	5	N	≥100	94	95	98	95	NO
RS42	Whareama River at Gauge	5	N	≥100	82	93	99	93	NO
RS46	Parkvale Stream at weir	5	N	≥100	84	80	91	84	NO

Site code	Site name	River class	Significant river?	Outcome	2012	2013	2014	Median	Outcome met?
RS53	Awhea River at Tora Rd	5	N	≥100	78	80	99	80	NO
RS02	Mangapouri Stream at Bennetts Rd	6	N	≥100	75	71	83	75	NO
RS08	Ngarara Stream at Field Way	6	N	≥100	88	88	88	88	NO
RS12	Whareroa Stream at QE Park	6	N	≥100	77	81	92	81	NO
RS45	Parkvale tributary at Lowes Reserve	6	N	≥100	100	98	96	98	NO
RS57	Waiwhetu Stream at Whites Line East	6	N	≥100	72	60	68	68	NO

Table A4: Groundwater – Summary statistics calculated for nitrate nitrogen measured quarterly in 68 GQSoE bores between January 2010 and December 2014Sites that failed to meet both the suggested nitrate chronic toxicity median and 95th percentile thresholds are shaded in red.

Site No.	Depth (m)	Groundwater zone	No. of sample results	Nitrate nitrogen (mg/L)						
				Min	Max	Median	Outcome met (≤ 2.4 mg/L)	95th percentile	Outcome met (≤ 3.5 mg/L)	Overall outcome met?
Category A groundwater management zone										
R25/5233	18.70	Ōtaki	20	1.27	1.88	1.52	Yes	1.87	Yes	YES
R26/6587	12.96	Waikanae	19	0.480	1.60	0.730	Yes	1.50	Yes	YES
R27/1183	25.00	Hutt Valley	20	0.230	0.410	0.295	Yes	0.410	Yes	YES
S25/5125	10.00	Ōtaki	20	0.750	4.00	2.35	Yes	3.90	No	YES
S26/0117	5.00	Mangatarere	20	2.10	5.70	3.70	No	5.55	No	NO
S26/0457	6.06	Waiohine	19	0.210	1.53	0.50	Yes	1.48	Yes	YES
S26/0467	6.20	Mangatarere	20	1.47	5.80	2.55	No	5.05	No	NO
S26/0756	19.00	Middle Ruamahanga	19	0.010	0.520	0.01	Yes	0.308	Yes	YES
S26/0762	9.50	Middle Ruamahanga	20	0.010	0.142	0.01	Yes	0.076	Yes	YES
S26/0846	39.30	Waiohine	19	0.038	0.970	0.700	Yes	0.966	Yes	YES
S27/0299	17.40	Tauherenikau	19	0.300	0.840	0.330	Yes	0.624	Yes	YES
S27/0344	16.00	Lower Ruamahanga	15	0.100	0.260	0.100	Yes	0.220	Yes	YES
S27/0396	17.00	Lower Ruamahanga	20	0.147	1.08	0.340	Yes	1.06	Yes	YES
S27/0495	37.50	Lower Ruamahanga	17	0.010	0.200	0.010	Yes	0.144	Yes	YES
S27/0588	11.70	Onoke	20	0.027	0.100	0.100	Yes	0.100	Yes	YES
S27/0681	5.00	Huangaarua	19	0.037	0.720	0.300	Yes	0.702	Yes	YES

Site No.	Depth (m)	Groundwater zone	No. of sample results	Nitrate nitrogen (mg/L)						
				Min	Max	Median	Outcome met (≤ 2.4 mg/L)	95th percentile	Outcome met (≤ 3.5 mg/L)	Overall outcome met?
T26/0259	6.10	Upper Ruamahanga	20	0.350	3.60	0.830	Yes	3.20	Yes	YES
Category B groundwater management zone										
R25/5100	48.20	Te Horo	20	0.010	0.010	0.010	Yes	0.010	Yes	YES
R25/5164	Unknown	Te Horo	20	0.210	0.580	0.360	Yes	0.575	Yes	YES
R25/5165	8.00	Te Horo	14	0.001	1.74	0.061	Yes	1.63	Yes	YES
R25/5190	Unknown	Te Horo	20	2.200	7.90	4.60	No	7.75	No	NO
R26/6503	14.80	Raumati	20	0.004	9.40	0.023	Yes	4.73	No	YES
R26/6624	10.20	Waikanae	20	2.10	3.10	2.80	No	3.05	Yes	YES
R27/0320	114.60	Hutt Valley	20	0.001	0.089	0.001	Yes	0.068	Yes	YES
R27/1171	23.20	Hutt Valley	20	0.001	0.104	0.004	Yes	0.065	Yes	YES
R27/1182	38.00	Hutt Valley	20	0.640	0.790	0.725	Yes	0.785	Yes	YES
R27/1265	48.30	Hutt Valley	20	0.004	0.190	0.087	Yes	0.181	Yes	YES
S26/0223	9.92	Taratahi	20	4.10	12.50	10.65	No	12.50	No	NO
S26/0299	8.10	Taratahi	20	1.78	4.30	2.95	No	4.25	No	NO
S26/0439	11.50	Mangatarere	20	2.70	4.90	3.10	No	4.65	No	NO
S26/0568	45.00	Parkvale	20	0.010	0.740	0.010	Yes	0.375	Yes	YES
S26/0576	31.00	Parkvale	20	0.005	0.115	0.005	Yes	0.081	Yes	YES
S26/0705	27.40	Mangatarere	20	2.30	5.50	4.65	No	5.30	No	NO
S26/0824	20.60	Mangatarere	20	4.30	5.80	4.85	No	5.50	No	NO
S27/0009	10.50	Tauherenikau	20	1.91	3.80	3.10	No	3.70	No	NO

Site No.	Depth (m)	Groundwater zone	No. of sample results	Nitrate nitrogen (mg/L)						
				Min	Max	Median	Outcome met (≤ 2.4 mg/L)	95th percentile	Outcome met (≤ 3.5 mg/L)	Overall outcome met?
S27/0070	14.60	Tauherenikau	20	0.120	1.56	0.595	Yes	1.40	Yes	YES
S27/0136	20.40	Tauherenikau	20	0.176	4.90	2.15	Yes	4.85	No	YES
S27/0156	20.70	Tauherenikau	20	0.001	3.60	0.005	Yes	1.82	Yes	YES
S27/0202	4.80	Tauherenikau	20	1.77	3.60	2.30	Yes	3.25	Yes	YES
S27/0268	58.40	Lake	20	0.050	0.050	0.05	Yes	0.050	Yes	YES
S27/0283	19.00	Tauherenikau	17	0.100	0.220	0.100	Yes	0.178	Yes	YES
S27/0433	44.60	Lake	20	0.050	0.050	0.050	Yes	0.050	Yes	YES
S27/0435	44.00	Lake	20	0.010	0.010	0.010	Yes	0.010	Yes	YES
S27/0442	177.70	Lake	20	0.010	0.128	0.010	Yes	0.069	Yes	YES
S27/0602	60.95	Lake	20	0.100	0.100	0.100	Yes	0.100	Yes	YES
S27/0607	38.00	Lake	17	0.100	0.900	0.100	Yes	0.620	Yes	YES
T26/0003	5.50	Upper Ruamahanga	20	0.240	7.40	1.11	Yes	7.10	No	YES
T26/0099	15.00	Upper Ruamahanga	20	2.70	4.70	3.25	No	4.55	No	NO
T26/0206	28.70	Upper Ruamahanga	19	1.30	2.10	1.67	Yes	2.05	Yes	YES
T26/0413	23.30	Waingawa	20	0.001	0.058	0.001	Yes	0.035	Yes	YES
T26/0430	0 (spring)	Waingawa	20	1.05	3.80	1.57	Yes	3.55	No	YES
T26/0489	54.00	Te Ore Ore	20	9.30	12.90	11.35	No	12.90	No	NO
T26/0538	9.00	Te Ore Ore	20	6.60	10.80	8.75	No	10.50	No	NO

Site No.	Depth (m)	Groundwater zone	No. of sample results	Nitrate nitrogen (mg/L)						
				Min	Max	Median	Outcome met (≤ 2.4 mg/L)	95th percentile	Outcome met (≤ 3.5 mg/L)	Overall outcome met?
Category C groundwater management zone										
R25/5135	93.27	Te Horo	20	0.010	0.125	0.010	Yes	0.108	Yes	YES
S25/5200	45.80	Te Horo	20	0.010	0.056	0.010	Yes	0.043	Yes	YES
S25/5322	27.00	Ōtaki	20	9.10	10.50	9.60	No	10.45	No	NO
S27/0389	17.85	Martinborough	17	0.001	0.780	0.002	Yes	0.678	Yes	YES
S27/0522	21.00	Martinborough	19	3.00	3.80	3.30	No	3.67	No	NO
S27/0571	32.00	Martinborough	20	5.60	9.40	7.25	No	9.35	No	NO
S27/0585	42.00	Onoke	19	0.020	0.194	0.020	Yes	0.184	Yes	YES
S27/0594	44.00	Onoke	20	0.005	0.107	0.005	Yes	0.079	Yes	YES
T26/0087	36.00	Waingawa	20	0.086	3.70	1.25	Yes	3.30	Yes	YES
T26/0332	13.40	Fernhill – Tiffen	20	0.370	1.22	0.81	Yes	1.21	Yes	YES
Unknown groundwater management zone										
R27/6418	8.00	Wainuiomata	20	0.850	2.60	1.80	Yes	2.55	Yes	YES
R27/6833	24.50	Mangaroa	15	0.270	4.10	1.35	Yes	3.98	No	YES
S27/0614	35.80	Unknown	16	0.100	3.20	0.100	Yes	2.27	Yes	YES
S27/0615	18.20	Unknown	19	0.100	0.260	0.100	Yes	0.188	Yes	YES
T27/0063	3.59	Riversdale	19	0.005	5.20	1.35	Yes	4.44	No	YES

Site No.	Depth (m)	Groundwater zone	No. of sample results	Nitrate nitrogen (mg/L)						
				Min	Max	Median	Outcome met (≤ 2.4 mg/L)	95th percentile	Outcome met (≤ 3.5 mg/L)	Overall outcome met?
Not reported on (insufficient number of data points)										
R27/1137	20.40	Hutt Valley	3	1.40	2.00					
R27/1180	39.00	Hutt Valley	8	0.780	1.02					
S25/5256	30.78	Te Horo	9	7.70	9.70					

Coast – Detail of attribute monitoring data used in benchmarking aquatic ecosystem health outcomes for selected estuaries

Note that although the entire data record is shown, generally only the most recent five years of data (2010–2015) were used in the calculation of mean values.

Attribute	Suggested guidance	Estuary	No. sites	Data period	n	2004	2008	2009	2010	2011	2012	2013	2014	2015	Mean	Meet outcome?	
Macroalgae	The Ecological Quality Rating (EQR) for opportunistic macroalgae should be >0.5	Porirua Harbour	Estuary wide intertidal	2015	1									0.58		YES	
		Waikanae Estuary	Estuary wide intertidal	2015	1									0.72		YES	
		Hutt Estuary	Estuary wide intertidal	2015	1									0.39		NO	
Seagrass & saltmarsh	No significant decline (ie, >10%) in the area of dense seagrass cover (ha) from established baseline	Porirua Harbour	Estuary wide intertidal	2008, 2013	2		45.2					45.7				YES	
		Porirua Harbour	Estuary wide margin	2008, 2013	2		51.4					50.4				YES	
	No significant decline (ie, >10%) in saltmarsh area (ha) from established baseline	Waikanae Estuary	Estuary wide margin	2015	1									5.7		ND	
		Hutt Estuary	Estuary wide margin	2004	1	0.56										ND	
Invertebrates	The mud and organic enrichment rating (WEBI) is <3.3	Porirua Harbour	4 sites, 10 reps	2015	1									1.8		YES	
		Waikanae Estuary	1 site, 10 reps	2015	1									<3 ¹		LIKELY	
		Hutt Estuary	1 site, 10 reps	2015	1										<3 ¹		LIKELY
		Whareama Estuary	1 site, 10 reps	2015	1										<3 ¹		LIKELY
Sedimentation rate	The mean annual sedimentation rate should be 1 mm/yr for Porirua Harbour (areal	Onepoto Arm	<i>Onepoto – 3 intertidal sites²</i>	2009-2015	7			3.9	1.4	-1.3	0.0	10.3	-0.9	2.0	2.9	NO	
		Pauatahanui Arm	<i>Pauatahanui -5 intertidal sites²</i>	2009-2015	7			2.3	2.2	-0.3	-2.5	2.2	2.2	-2.3	0.7	YES	

Attribute	Suggested guidance	Estuary	No. sites	Data period	n	2004	2008	2009	2010	2011	2012	2013	2014	2015	Mean	Meet outcome?
	sedimentation rate of 1 mm/yr by 2035); and the mean annual sedimentation rate for other estuaries should not exceed 5 x the RNSL (Retained Natural Sediment Load)	Porirua Harbour	All sites combined	2009–2015	7			3.1	1.8	-0.8	-1.3	6.3	0.6	-0.2	1.5	NO
		Waikanae Estuary	1 site, 4 plates	2011–2015	5					45	25.3	16.5	19	22	25.6	ND
		Hutt Estuary	1 site, 4 plates	2011–2015	5					-0.8	-4.8	-2	-9.3	-1.5	-3.7	ND
		Whareama Estuary	1 site, 4 plates	2009–2015	7			14.5	-2	21.8	3	10	20	6	12.2	ND
Mud content	No significant increase (ie, >10%) in mud content (%) from established baseline	Porirua Harbour	Outer Onepoto Arm	2008–2015	8		10	9	10	10	6	9	7	8		YES
		Porirua Harbour	Inner Onepoto Arm	2008–2015	8		4	6	9	10	5	3	8	4		YES
		Porirua Harbour	Outer Pauatahanui Arm	2008–2015	8		12	10	15	9	13	8	6	9		YES
		Porirua Harbour	Inner Pauatahanui Arm	2008–2015	8		5	4	8	5	5	3	3	4		YES
		Waikanae Estuary	1 site	2010–2015	5				27	18	39		32	19		YES
		Hutt Estuary	1 site	2010–2015	5				51	43	28		22	12		YES
		Whareama Estuary	Outer estuary	2008–2015	8		68	43	23	39	51	86	82	81		NO
		Whareama Estuary	Inner estuary	2008–2015	8		73	60	65	81	71	79	73	68		YES
	No significant increase (ie, >10%) in intertidal soft mud (ie, >20% mud content) areas (ha) from established baseline	Porirua Harbour	Estuary wide intertidal	2008, 2013	2		3					20				NO
		Waikanae Estuary	Estuary wide intertidal	2015	1									2		ND
Hutt Estuary		Estuary wide intertidal	2004	1	1.98										ND	

Shaded cells represent the established baseline; where there are three consecutive baseline surveys (eg, mud content) the mean of these represents the baseline.

¹WEBI ratings have not been calculated for these estuaries, however, expert assessment of invertebrate data collected previously indicates these estuaries meet the outcome for invertebrates.

²Only the data from intertidal plates with more than three annual measurements have been used for benchmarking, Data from the single subtidal plate in Onepoto Arm have been excluded because this site does not represent subtidal areas within the harbour. The data from the Browns Bay sediment plates have also been excluded because changes recorded here have been identified as localised movement of sands not deposition of muds.

ND = not determined

Appendix 2: Contact recreation benchmarking results – league tables

Rivers (secondary contact) – Median *E. coli* count (cfu/100mL) for 20 RWQ, 55 RSoE and 1 riparian monitoring sites based on sample results collected over 2011/12–2013/14 for RSoE and riparian sites and 2012/13–2014/15 for RWQ sites

RWQ sites are sampled weekly during summer (November to March inclusive) while RSoE and riparian sites are sampled monthly year round.

Programme	Site code	Site	No. of results	Hazen median	Outcome met? (≤ 1,000)
RWQ	-	Hutt River at Birchville	60	55	YES
RWQ	-	Hutt River at Maoribank Corner	60	37	YES
RWQ	-	Hutt River at Melling Bridge	60	62	YES
RWQ	-	Hutt River at Poets Park	60	37	YES
RWQ	-	Hutt River at Silverstream Bridge	60	54	YES
RWQ	-	Ōtaki River at State Highway One	60	25	YES
RWQ	-	Pakuratahi River at Hutt Forks	60	71	YES
RWQ	-	Ruamahanga River at Double Bridges	60	30	YES
RWQ	-	Ruamahanga River at Kokotau	60	23	YES
RWQ	-	Ruamahanga River at Morrisons Bush	60	15	YES
RWQ	-	Ruamahanga River at Te Ore Ore	60	57	YES
RWQ	-	Ruamahanga River at The Cliffs	60	14	YES
RWQ	-	Ruamahanga River at Waihenga Bridge	60	19	YES
RWQ	-	Waikanae River at Jim Cooke Park	60	75	YES
RWQ	-	Waikanae River at State Highway One	60	95	YES
RWQ	-	Waingawa River at Kaituna	60	9	YES
RWQ	-	Waingawa River at South Road	60	16	YES
RWQ	-	Wainuiomata River at Richard Prouse Park	60	122	YES
RWQ	-	Waiohine River at State Highway 2	60	7	YES
RWQ	-	Waipoua River at Colombo Road	60	55	YES
RSoE	RS02	Mangapouri Stream at Bennetts Rd	36	1,000	YES
RSoE	RS03	Waitohu Stream at Forest Park	36	8	YES
RSoE	RS04	Waitohu Stream at Norfolk Crescent	36	600	YES
RSoE	RS05	Ōtaki River at Pukehinau	36	5	YES
RSoE	RS06	Ōtaki River at Mouth	36	45	YES
RSoE	RS07	Mangaone Stream at Sims Road Bridge	36	900	YES
RSoE	RS08	Ngarara Stream at Field Way	36	190	YES
RSoE	RS09	Waikanae River at Mangaone Walkway	36	12	YES
RSoE	RS10	Waikanae River at Greenaway Rd	36	37	YES
RSoE	RS11	Whareroa Stream at Waterfall Rd	36	150	YES
RSoE	RS12	Whareroa Stream at QE Park	36	125	YES
RSoE	RS13	Horokiri Stream at Snodgrass	36	345	YES
RSoE	RS14	Pauatahanui Stream at Elmwood Bridge	36	330	YES
RSoE	RS15	Porirua Stream at Glenside Overhead Cable	36	280	YES
RSoE	RS16	Porirua Stream at Wall Park	36	940	YES

Programme	Site code	Site	No. of results	Hazen median	Outcome met? ($\leq 1,000$)
RSoE	RS17	Makara Stream at Kennels	36	340	YES
RSoE	RS18	Karori Stream at Makara Peak Mountain Bike Pk	36	1,700	NO
RSoE	RS19	Kaiwharawhara Stream at Ngaio Gorge	36	500	YES
RSoE	RS20	Hutt River at Te Marua Intake Site	36	22	YES
RSoE	RS21	Hutt River Opposite Manor Park Golf Club	36	95	YES
RSoE	RS22	Hutt River at Boulcott	36	85	YES
RSoE	RS23	Pakuratahi River 50m Below Farm Creek	36	85	YES
RSoE	RS24	Mangaroa River at Te Marua	36	225	YES
RSoE	RS25	Akatarawa River at Hutt Confluence	36	43	YES
RSoE	RS26	Whakatikei River at Riverstone	36	33	YES
RSoE	RS28	Wainuiomata River at Manuka Track	35	10	YES
RSoE	RS29	Wainuiomata River Dwnstr of White Bridge	36	90	YES
RSoE	RS30	Orongorongo River at Orongorongo Station	36	14	YES
RSoE	RS31	Ruamahanga River at McLays	36	6	YES
RSoE	RS32	Ruamahanga River at Te Ore Ore	36	105	YES
RSoE	RS33	Ruamahanga River at Gladstone Bridge	36	36	YES
RSoE	RS34	Ruamahanga River at Pukio	36	56	YES
RSoE	RS35	Mataikona tributary at Sugar Loaf Rd	35	32	YES
RSoE	RS36	Taueru River at Castlehill	36	110	YES
RSoE	RS37	Taueru River at Gladstone	36	155	YES
RSoE	RS38	Kopuaranga River at Stewarts	36	215	YES
RSoE	RS39	Whangaehu River at 250m from Confluence	36	305	YES
RSoE	RS40	Waipoua River at Colombo Rd Bridge	36	39	YES
RSoE	RS41	Waingawa River at South Rd	36	16	YES
RSoE	RS42	Whareama River at Gauge	36	130	YES
RSoE	RS43	Motuwaireka Stream at headwaters	34	8	YES
RSoE	RS44	Totara Stream at Stronvar	34	24	YES
RSoE	RS45	Parkvale tributary at Lowes Reserve	31	11	YES
RSoE	RS46	Parkvale Stream at weir	36	365	YES
RSoE	RS47	Waiohine River at Gorge	36	8	YES
RSoE	RS48	Waiohine River at Bicknells	36	48	YES
RSoE	RS49	Beef Creek at headwaters	35	8	YES
RSoE	RS50	Mangatarere Stream at State Highway 2	36	170	YES
RSoE	RS51	Huangarua River at Ponatahi Bridge	36	95	YES
RSoE	RS52	Tauanui River at Whakatomotomo Rd	36	6	YES
RSoE	RS53	Awhea River at Tora Rd	36	66	YES
RSoE	RS54	Coles Creek tributary at Lagoon Hill Rd	25	28	YES
RSoE	RS55	Tauherenkau River at Websters	36	19	YES
RSoE	RS56	Waiorongomai River at Forest Park	36	9	YES
RSoE	RS57	Waiwhetu Stream at Whites Line East	36	500	YES
Riparian	-	Enaki Stream D/S site for Riparian	33	120	YES

Rivers – Number and percentage of benthic cyanobacteria mat cover results greater than the 20% alert threshold suggested in Greenfield et al. (2015) at RWQ monitoring sites

Results are based on weekly summer-time (November to March inclusive) assessments undertaken between summers 2012/13–2014/15

Site name	No. of results	No. of results >20%	% of results >20%
Hutt River at Birchville	56	3	5
Hutt River at Maoribank Corner	55	4	7
Hutt River at Melling Bridge	46	0	0
Hutt River at Poets Park	51	1	2
Hutt River at Silverstream Bridge	53	7	13
Ōtaki River at State Highway One	53	0	0
Pakuratahi River at Hutt Forks	57	0	0
Ruamahanga River at Double Bridges	50	0	0
Ruamahanga River at Kokotau	41	7	17
Ruamahanga River at Morrisons Bush	40	0	0
Ruamahanga River at Te Ore Ore	49	1	2
Ruamahanga River at The Cliffs	44	2	5
Ruamahanga River at Waihenga Bridge	47	0	0
Waikanae River at Jim Cooke Park	59	0	0
Waikanae River at State Highway One	59	0	0
Waingawa River at Kaituna	50	0	0
Waingawa River at South Road	47	0	0
Wainuiomata River at Richard Prouse Park	59	0	0
Waiohine River at State Highway 2	48	0	0
Waipoua River at Colombo Road	56	5	9

Rivers – Hazen 95th percentile *E. coli* (cfu/100mL) count at RWQ monitoring sites based on results collected weekly over 2012/13–2014/15 summers (November to March inclusive) at or below 3x median flow

Site	No. of results	Hazen 95th percentile	Outcome met? ≤ 540)
Hutt River at Birchville	58	340	YES
Hutt River at Maoribank Corner	58	368	YES
Hutt River at Melling Bridge	59	922	NO
Hutt River at Poets Park	58	168	YES
Hutt River at Silverstream Bridge	59	515	YES
Ōtaki River at State Highway One	55	143	YES
Pakuratahi River at Hutt Forks	53	165	YES
Ruamahanga River at Double Bridges	54	120	YES
Ruamahanga River at Kokotau	58	190	YES
Ruamahanga River at Morrisons Bush	58	211	YES
Ruamahanga River at Te Ore Ore	57	372	YES
Ruamahanga River at The Cliffs	58	172	YES
Ruamahanga River at Waihenga Bridge	58	176	YES

Site	No. of results	Hazen 95th percentile	Outcome met? ≤ 540
Waikanae River at Jim Cooke Park	57	257	YES
Waikanae River at State Highway One	57	237	YES
Waingawa River at Kaituna	56	82	YES
Waingawa River at South Road	53	109	YES
Wainuiomata River at Richard Prouse Park	59	682	NO
Waiohine River at State Highway 2	56	55	YES
Waipoua River at Colombo Road	57	239	YES

Coast – Hazen 95th percentile enterococci (cfu/100mL) count at RWQ monitoring sites based on results collected weekly over 2012/13–2014/15 summers (November to March inclusive)

Site	No. of sample results	Hazen 95th percentile	Outcome met? (≤ 500)
Kapiti			
Ōtaki Beach at Surf Club	60	104	YES
Paekakariki Beach at Surf Club	60	69	YES
Paekakariki Beach at Whareroa Road	60	159	YES
Paraparaumu Beach at Maclean Park	60	288	YES
Paraparaumu Beach at Nathan Avenue	60	228	YES
Paraparaumu Beach at Ngapotiki Street	60	254	YES
Paraparaumu Beach at Toru Road	60	313	YES
Peka Peka Beach at Road End	60	52	YES
Raumati Beach at Aotea Road	60	250	YES
Raumati Beach at Marine Gardens	60	298	YES
Raumati Beach at Tainui Street	60	290	YES
Te Horo Beach at Sea Road	60	250	YES
Waikanae Beach at Ara Kuaka Carpark	60	118	YES
Waikanae Beach at William Street	60	45	YES
Porirua			
Karehana Bay at Cluny Road	60	230	YES
Pauatahanui Inlet at Paremata Bridge	60	455	YES
Pauatahanui Inlet at Water Ski Club	60	380	YES
Plimmerton Beach at Bath Street	60	530	NO
Porirua Harbour at Rowing Club	60	870	NO
Pukerua Bay	60	255	YES
South Beach at Plimmerton	60	1,400	NO
Titahi Bay at Bay Drive	60	235	YES
Titahi Bay at South Beach Access Road	60	630	NO
Titahi Bay at Toms Road	60	445	YES
Wellington			
Aotea Lagoon	60	120	YES
Balaena Bay	60	550	NO
Breaker Bay	60	110	YES

Site	No. of sample results	Hazen 95th percentile	Outcome met? (≤ 500)
Hataitai Beach	60	495	YES
Island Bay at Derwent Street	60	980	NO
Island Bay at Reef St Recreation Ground	60	2,350	NO
Island Bay at Surf Club	60	1,850	NO
Lyll Bay at Onepu Road	60	170	YES
Lyll Bay at Queens Drive	60	260	YES
Lyll Bay at Tirangi Road	60	405	YES
Mahanga Bay	60	385	YES
Oriental Bay at Band Rotunda	60	215	YES
Oriental Bay at Freyberg Beach	60	120	YES
Oriental Bay at Wishing Well	60	125	YES
Owhiro Bay	60	3,750	NO
Princess Bay	60	50	YES
Scorching Bay	60	315	YES
Seatoun Beach at Inglis Street	60	310	YES
Seatoun Beach at Wharf	60	330	YES
Shark Bay	60	560	NO
Worser Bay	60	310	YES
Hutt			
Days Bay at Moana Road	60	210	YES
Days Bay at Wellesley College	60	130	YES
Days Bay at Wharf	60	145	YES
Lowry Bay at Cheviot Road	60	430	YES
Petone Beach at Kiosk	60	495	YES
Petone Beach at Sydney Street	60	440	YES
Petone Beach at Water Ski Club	60	420	YES
Robinson Bay at HW Shortt Rec Ground	60	225	YES
Robinson Bay at Nikau Street	60	195	YES
Rona Bay at N end of Cliff Bishop Park	60	475	YES
Rona Bay at Wharf	60	375	YES
Sorrento Bay	60	435	YES
York Bay	60	125	YES
Wairarapa			
Castlepoint Beach at Castlepoint Stream	60	12	YES
Castlepoint Beach at Smelly Creek	60	74	YES
Riversdale Beach Between the Flags	59	35	YES