

Freshwater in the Bay of Plenty - Comparison against the National Framework Objectives



Bay of Plenty Regional Council
Environmental Publication 2015/04

5 Quay Street
PO Box 364
Whakatāne 3158
NEW ZEALAND

ISSN: 1175-9372 (Print)
ISSN: 1179-9471 (Online)





Freshwater in the Bay of Plenty – Comparison against the National Objectives Framework

Environmental Publication 2015/04

ISSN: 1175-9372 (Print)

ISSN: 1179-9471 (Online)

April 2015

Bay of Plenty Regional Council
5 Quay Street
PO Box 364
Whakatāne 3158
NEW ZEALAND

Prepared by Paul Scholes and Rochelle Carter, Environmental
Scientists

Cover photo: Algal samples from three Rotorua Lakes.

Acknowledgements

Thanks to document specialist for report formatting and to Rob Donald for reviewing this report.

Executive summary

The National Policy Statement (NPS) for Freshwater Management (2014) includes a National Objectives Framework (NOF) which sets compulsory national values for freshwater to protect 'human health for recreation' and 'ecosystem health'. The NOF defines thresholds for numeric attributes, ranked into four bands (A-D), which define water quality and effectively set 'National Bottom Lines'.

Water quality data for rivers, streams and lakes in the Bay of Plenty has been compared to the attribute states set in the NOF. This information will provide a baseline for discussions between the Regional Council and stakeholders regarding limit setting for water quality.

Current data shows one lake, Lake Ōkaro to be below the national bottom line for total nitrogen and cyanobacteria bio-volume.

River sites all fall in the 'A' or 'B' band for ecological attributes (one attribute, periphyton growth, is not currently monitored routinely). A similar result occurs for the human health attribute *E.coli* (as an indicator of faecal contamination) for secondary contact recreation.

For primary contact recreation 60% of the river and stream 'SOE' sites (monthly monitoring) and 50% of the summer recreational monitoring sites (weekly or bi-weekly sampling) are below the minimum acceptable state defined in the NOF. This indicates there is a greater than 5% risk of infection from pathogens in these waters with full immersion contact.

Contents

Acknowledgements	i
Executive summary	iii
Part 1: Overview	1
1.1 Introduction	1
1.2 Objectives and methods	2
Part 2: Assessment against the NOF	3
2.1 Lakes	3
2.2 Rivers and streams	7
Part 3: Summary	17
Part 4: References	19
Appendix 1 – The National Objectives Framework – values and related attributes (summarised from MfE, 2014)	23
Appendix 2 – Annual data for water quality parameters	26

Part 1: Overview

1.1 Introduction

The National Policy Statement (NPS) for Freshwater Management (2014) sets out objectives and policies that direct local government to manage water in an integrated and sustainable way, while providing for economic growth within set water quantity and quality limits.

The NPS includes a National Objectives Framework (NOF) which sets compulsory national values for freshwater to protect ‘human health for recreation’ and ‘ecosystem health’. The NOF defines thresholds for numeric attributes, ranked into four bands (A-D), which define water quality and effectively set ‘National Bottom Lines’. The narratives for these attributes are summarised in Table 1 below.

Table 1 Attribute states and related ‘ecological health’ and ‘human health for recreation’ effects (summarised from the NOF).

Value	Attribute State (Bands)			
	A	B	C (Bottom-line)	D
Ecosystem Health	Communities are healthy and resilient, similar to natural reference conditions. High conservation value systems. 99% species protection level.	Communities are slightly impacted. 5% potential toxicity impacts particularly on sensitive species. Occasional minor stress on sensitive organisms.	Communities are moderately impacted. 20% toxicity impacts particularly on sensitive species. Moderate stress on a number of aquatic organisms.	Communities have undergone or are at high risk of a regime shift to a persistent, degraded state. Potential for acute toxicity impacts. Significant, persistent stress on a range of aquatic organisms.
Human Health for Recreation	Very low risk.	Low risk (secondary contact) or moderate risk (primary contact).	Moderate risk for secondary contact, below minimum acceptable state for primary contact.	High risk.

A range of physical and chemical water quality parameters have been monitored at over 80 river and stream sites and in the 12 Rotorua Te Arawa Lakes since the early 1990s. Parameters monitored include the following NOF attributes:

- Chlorophyll-a – an ecosystem health attribute for lakes, this is an algal pigment that gives an indication of algal biomass (productivity).
- Total nitrogen (TN) – an ecosystem health attribute for lakes, nitrogen is a plant nutrient that can drive algal growth.
- Total phosphorus (TP) – an ecosystem health attribute for lakes, this along with nitrogen is a plant nutrient that can drive algal growth.
- Periphyton – an ecosystem health attribute for rivers, periphyton are attached (benthic) algae that live on the beds of rivers and streams.
- Nitrate – an ecosystem health attribute for rivers, this is included in the NOF as an attribute to manage toxicity effects on aquatic life.
- Ammonia – an ecosystem health attribute for rivers, like nitrate this is included in the NOF as an attribute to manage toxicity effects on aquatic life.

- Dissolved oxygen – an ecosystem health attribute for rivers, this is measured below point source discharges and is a key attribute for the protection of aquatic life.
- E.coli – a human health attribute for lakes and rivers, E.coli are an indicator of the presence of faecal contamination. The attribute state is based on the annual median level to protect secondary (non-contact) recreation, and the 95th percentile level to protect primary (contact, or full immersion) recreation.
- Planktonic cyanobacteria - a human health attribute for lakes and lake fed rivers, cyanobacteria can produce blooms that are potentially toxic.

The numerical values for each of these attributes are detailed in Appendix 1.

1.2 Objectives and methods

The objective of the report is to show how the freshwater sites monitored in the Bay of Plenty compare against the NOF attributes. This information will ultimately be used to guide Council and communities in setting numerical limits for freshwater.

The last five years of data (where appropriate) has been used to assess the status of the Bay of Plenty against the NOF attributes. Clear guidance is not yet available for some attributes in terms of the length and frequency of data required (e.g. for assessing *E.coli* levels against the attribute state for full immersion, or primary contact recreation), but this is expected to be given in 2015.

The NOF attributes have been compared over the required frequencies and with available data from the Regional Monitoring Network, and in some cases from the NIWA national rivers monitoring network. Data requirements are shown in the tables listed in Appendix 1.

Ten year trend information is given for the attributes where this is currently available and data summaries for a number of the attributes are provided in Appendix 2.

Part 2: Assessment against the NOF

2.1 Lakes

The Rotorua Te Arawa Lakes are monitored for a range of attributes, most notably total phosphorus (TP), total nitrogen (TN), chlorophyll-a and secchi depth (water clarity). These are used to calculate a trophic level index (TLI) for the lakes and targets for this are set in the Bay of Plenty Regional Water and Land Plan. Popular swimming locations are also monitored for *E.coli* during summer months as part of the Summer Recreational Monitoring.

NOF banding results for TP, TN, chlorophyll-a, ammonia and cyanobacteria bio-volume (some productive lakes) over the past five years are given in Tables 2 to 7. This shows that:

- The more productive (eutrophic) lakes, Ōkaro, Rotorua and Rotoehu, have at times had water quality that would not meet the National Bottom Lines for some parameters.
- Lake Ōkaro is the only lake to be below a National Bottom Line (exceeding Band C) recently and this is for TN (2013/2014) and planktonic cyanobacteria biovolume (2011 to 2014).
- Coarse 'trends' can be seen in the banding information, for example Lake Ōkaro recently moving from a 'D' to a 'C' band for TP.

In addition, most lake sites fall into the 'A' Band for the human health attribute *E.coli* (primary contact recreation) for the last five years, three sites fall into the 'B' Band (Table 8). All lake sites fall in the 'A' band for secondary contact recreation (e.g. wading or boating).

Table 2 NOF banding for Total Phosphorus (annual median) in lakes.

Total Phosphorus	2009/10	2010/11	2011/12	2012/13	2013/14
Ōkaro	D	D	D	D	C
Rotorua	C	C	B	B	B
Rotoehu	D	C	C	C	C
Rotomahana	B	C	C	C	C
Rerewhakaaitu	B	B	B	A	A
Rotoiti	B	C	B	B	B
Rotokakahi	C	B	B	B	B
Okareka	A	A	A	B	A
Tikitapu	A	A	A	A	A
Okataina	A	B	B	B	B
Tarawera	A	B	C	B	B
Rotoma	A	A	A	A	A

Table 3 *NOF banding for Total Nitrogen in lakes.*

Total Nitrogen	2009/10	2010/11	2011/12	2012/13	2013/14
Ōkaro	D	D	D	D	D
Rotorua	B	A	B	B	A
Rotoehu	B	A	A	A	A
Rotomahana	B	B	B	B	B
Rerewhakaaitu	B	B	B	B	B
Rotoiti	B	B	B	A	A
Rotokakahi	A	A	A	A	A
Okareka	B	B	B	B	B
Tikitapu	B	A	A	A	A
Okataina	A	A	A	A	A
Tarawera	A	A	A	A	A
Rotoma	A	A	A	A	A

Table 4 *NOF banding for Phytoplankton (Chlorophyll-a annual median) in lakes.*

Chlorophyll-a	2009/10	2010/11	2011/12	2012/13	2013/14
Ōkaro	C	C	C	C	B
Rotorua	D	D	C	C	C
Rotoehu	C	C	C	C	C
Rotomahana	B	B	B	B	B
Rerewhakaaitu	C	B	B	B	B
Rotoiti	C	C	C	B	B
Rotokakahi	A	A	A	A	A
Okareka	B	B	B	B	B
Tikitapu	A	A	A	A	B
Okataina	B	B	B	A	A
Tarawera	A	A	A	A	A
Rotoma	A	A	A	A	A

Table 5 NOF banding for Phytoplankton (Chlorophyll-a annual maximum) in lakes.

Chlorophyll-a (Max)	2009/10	2010/11	2011/12	2012/13	2013/14
Ōkaro	C	D	D	D	C
Rotorua	B	C	B	C	B
Rotoehu	B	B	B	B	A
Rotomahana	A	B	A	A	A
Rerewhakaaitu	A	A	A	A	A
Rotoiti	B	B	B	A	A
Rotokakahi	A	A	A	A	A
Okareka	A	A	A	A	A
Tikitapu	A	A	A	A	A
Okataina	A	A	A	A	A
Tarawera	A	A	A	A	A
Rotoma	A	A	A	A	A

Table 6 NOF banding (annual median) and 10 year trend, for Ammonia in bottom water of lakes (all data have been adjusted to relative pH=8).

	2009		2010		2011		2012		2013	
	Med	Max	Med	Max	Med	Max	Med	Max	Med	Max
Lake Okataina	A	A	A	A	A	A	A	A	A	A
Lake Rerewhakaaitu	B	A	B	A	A	A	A	A	A	A
Lake Rotoehu	B	A	A	A	B	A	B	A	A	A
Lake Rotoiti S3	B	A	A	A	A	A	A	A	A	A
Lake Rotoiti S4	B	A	B	A	B	A	B	A	A	A
Lake Okareka	A	A	A	A	A	A	A	A	A	A
Lake Rotoma	A	A	A	A	A	A	A	A	A	A
Lake Rotomahana	A	A	A	A	A	A	A	A	A	A
Lake Rotorua	B	A	B	A	B	A	B	A	B	A
Lake Tarawera	A	A	A	A	A	A	A	A	A	A
Lake Tikitapu	A	A	A	A	A	A	A	A	A	A
Lake Okaro	C	C	C	C	C	C	C	B	C	B

Table 7 *NOF banding for Cyanobacteria - planktonic (bio-volume, mm³/L), 2011 to 2014, in lakes and lake fed rivers.*

Cyanobacteria bio-volume	2011-2014
Kaituna @ Te Tumu	A
Kaituna @ Trout Pool	A
Kaituna @ Waitangi	A
Lake Ōkaro	D
Lake Rotoehu @ Kennedy Bay	A
Lake Rotoehu @ Otautu	A
Kake Rotoiti @ Hinehopu	A
Lake Rotoiti @ Okawa Bay	C
Lake Rotoiti @ Okere Arm	A
Lake Rotoiti @ Otaramarae	A
Lake Rotoiti @ Te Weta	A
Te Wairoa Stream (Lake Rotokakahi)	A
Lake Rotorua @ Hamurana	A
Lake Rotorua @ Holdens Bay	A
Lake Rotorua @ Ngongotaha	A
Ohau Channel	A

Table 8 NOF banding for Human Health for Primary Contact Recreation (2009-2014) and Secondary *E.coli* (2013/2014) from Summer Recreational Monitoring in lakes.

Site	95 th Percentile <i>E.coli</i>	NOF 1°	NOF 2°
Lake Rotomā at Matahī	143	A	A
Lake Rotomā at Whangaroa	208	A	A
Lake Rotoiti at Hinehopu Jetty	40	A	A
Lake Rotoiti at Gisborne Point	23	A	A
Lake Rotoiti at Ruato	53	A	A
Lake Rotoiti at Okawa Bay	131	A	A
Lake Rotoiti at Otaramarae	95	A	A
Lake Ōkāreka at Steep Street	183	A	A
Lake Ōkāreka at jetty	31	A	A
Lake Tikitapu	192	A	A
Lake Rotorua at Mourea	259	A	A
Lake Rotorua at Holdens Bay	96	A	A
Lake Rotorua at Ōhinemutu	20	A	A
Lake Rotorua at Ngongotahā	35	A	A
Lake Rotorua at Hamurana	79	A	A
Lake Tarawera at Rangiuuru Bay	131	A	A
Lake Ōkaro	130	A	A
Lake Rerewhakaaitu at Sports Ground	288	B	A
Lake Rerewhakaaitu at Brett Road boat ramp	338	B	A
Lake Tarawera at Te Karamea Bay	308	B	A

2.2 Rivers and streams

Rivers and streams are also monitored for a range of the NOF attributes, including nitrate, ammonia, *E.coli* and dissolved oxygen (DO). NOF banding results for these over the past five years are given in Tables 9 to 13 and Figure 1. This information shows that:

- No sites are currently below the National Bottom Line, or indeed in the ‘C’ Band, for nitrate, ammonia or *E.coli* (for secondary contact recreation).
- Five sites have fallen into the “C” Band for *E.coli*, secondary contact recreation, in previous years (Table 9).
- Of 47 river and stream sites with enough data to calculate a 95th percentile (from monthly sampling at ‘SOE’ sites), 19 meet the minimum acceptable state (MAS) for primary contact recreation (*E.coli*). The remaining 28 sites have *E.coli* levels which exceed the MAS for this attribute (Table 10).
- A similar situation exists for the summer surveillance *E.coli* monitoring (weekly or bi-weekly monitoring over the summer period) where half of the sites fail to meet the minimum acceptable state (MAS) for primary contact recreation, however all sites are banded ‘A’ for secondary contact recreation (Table 11).

- There is one site for which dissolved oxygen is measured at the frequency necessary to assess against the NOF (Tarawera River) - this site has recently fallen below the National Bottom Line for this attribute (Figure 1).

Table 9 NOF banding for Nitrate (annual median) and 10 year trends (2004-2013) in rivers and streams. NT = No Trend, ↓ = Meaningful decrease, ↘ = Significant decrease, ↑ = Meaningful increase, ↗ = Significant increase.

Site by WMA	2009	2010	2011	2012	2013	10 Yr Trend
Tauranga Harbour						
Aongatete River @ SH2		A	A		A	NT
Kopurererua @ SH2	A	A	A	A	A	NT
Kopurererua @ SH29	A	A	A	A	B	↗
Ngamuwahine @ Old Bridge		A	A		A	NT
Omanawa @ SH29	B	B	B	B	B	↑
Rocky @ Mangatawa	A	A	A		A	NT
Te Mania @ SH2	A	A	A	A	A	NT
Te Rereatukahia @ SH2		A	A		A	NT
Tuapiro @ Surtees Road		A	A		A	NT
Uretara at Henry Rd Ford		A			A	NT
Waiau @ Road Ford		A	A		A	NT
Waimapu @ 100m d/s of SH29	A	A	A	A	A	NT
Waimapu @ Pukemapui Rd		A	A		A	NT
Waipapa @ Old Bridge		A	A		A	NT
Wairoa at SH2 Bridge	A	A	A	A	A	NT
Wairoa d/s of Ruahihi		A	A		A	NT
Waitao @ Spensers farm		A	A	A	A	NT
Waitekohe @ SH2		A	A		A	NT
Kaituna, Maketu, Pongakawa						
Kaituna @ Maungarangi	A	A	A	A	A	↑
Kaituna @ Lake Rotoiti Outlet	A	A	A	A	A	↑
Kaituna @ Waitangi	A	A	A	A	A	↑
Pongakawa @ Old Coach	B	B		B	B	↑
Pongakawa @ SH2	B	B		B	B	↑
Pongakawa @ Forest	B	B		B	B	↑
Waitahanui @ SH2	A	A		A	A	↑
Rotorua Lakes						
Ngongotahā at Town Bridge	A	A	A	A	A	↗
Ōhau @ SH33	A	A	A	A	A	↑
Puarenga @ FRI	A	A	A	A	A	↓
Tarawera @ Lake Outlet	A	A	A	A	A	NT

Site by WMA	2009	2010	2011	2012	2013	10 Yr Trend
Tarawera						
Tarawera @ Awakaponga	A	A	A	A	A	↗
Tarawera @ Kawerau Bridge	A	A	A	A	A	↑
Tarawera @SH30 Bridge	A	A	A	A	A	NT
Rangitaiki						
Rangitaiki @ Matahina Dam	A			A		NT
Rangitaiki @ Te Teko	A	A	A	A	A	NT
Rangitāiki at Old Murupara Bridge	A	A	B	B	A	↑
Rangitaiki @ Aniwhenua Canal	A			A		
Whirinaki @ Galatea Bridge	A	A	A	A	A	↓
Whakatane and Waimana						
Tauranga @ Taneatua	A		A	A		NT
Whakatāne @ Rūātoki	A		A	A		NT
Whakatāne @ Pekatahi	A	A	A	A	A	↓
Ohiwa Harbour and Waiotahi						
Nukuhou @ Old Quarry	A	A	A	A	A	↓
Waioeka and Otara						
Otara @ Brown's Bridge	A		A	A		
Waioeka at Gorge Mouth	A	A	A	A	A	NT
East Coast						
Mōtū @ SH35	A	A	A	A	A	NT
Mōtū @ Waitangirua	A	A	A	A	A	↘
Haparapara a@ SH35	A		A	A		NT
Raukokore @ SH35	A		A	A		NT

Table 10 NOF banding (annual median) and 10 year Trend, for Ammonia in rivers and streams. NT = No Trend, ↓ = Meaningful decrease, ↘ = Significant decrease, ↑ = Meaningful increase, ↗ = Significant increase. (Median and maximum data have been adjusted to relative pH=8).

Site by WMA	2009		2010		2011		2012		2013		10 Yr Trend
	Med	Max	Med	Max	Med	Max	Med	Max	Med	Max	
Tauranga Harbour											
Aongatete River @ SH2			A	A	A	A			A	A	NT
Kopurererua @ SH2	A	B	A	B	A	B	A	B	A	B	NT
Kopurererua @ SH29	A	A	A	A	A	B	A	A	A	A	NT
Ngamuwahine @ Old Bridge			A	A	A	A			A	A	NT
Omanawa @ SH29	A	A	A	A	A	A	A	A	A	A	↓
Rocky @ Mangatawa	B	B	B	B	B	B			B	B	NT
Te Mania @ SH2	A	B	A	A	A	A	A	A	A	A	↘
Te Rereatukahia @ SH2			A	A	A	A			A	A	NT
Tuapiro @ Surtees Road			A	A	A	A			A	A	NT
Uretara at Henry Rd Ford			A	A	A	A			A	A	NT
Waiau @ Road Ford			A	A	A	A			A	A	NT
Waimapu @ 100m d/s of SH29	A	A	A	A	A	A	A	A	A	A	NT
Waimapu @ Pukemapui Rd			A	A	A	A			A	A	NT
Waipapa @ Old Bridge			A	A	A	A			A	A	NT
Wairoa at SH2 Bridge	A	A	A	A	A	A	A	A	A	A	NT

Site by WMA	2009		2010		2011		2012		2013		10 Yr Trend
	Med	Max	Med	Max	Med	Max	Med	Max	Med	Max	
Wairoa d/s of Ruahihi			A	A	A	A			A	A	NT
Waitao @ Spensers farm			A	A	A	A	A	A	A	A	NT
Waitekohe @ SH2			A	A	A	B			A	A	NT
Kaituna, Maketu and Pongakawa											
Kaituna @ Maungarangi	A	A	A	A	A	A	A	A	A	A	NT
Kaituna @ Lake Rotoiti Outlet	A	A	A	A	A	B	A	A	A	A	↑
Kaituna @ Waitangi	A	A	A	B	A	B	A	A	A	A	↓
Pongakawa @ Old Coach	A	A	A	A			A	A	A	A	NT
Pongakawa @ SH2	A	A	A	A			A	A	A	A	NT
Pongakawa @ Forest	A	A	A	A			A	A	A	A	NT
Waitahanui @ SH2	A	A	A	A			A	A	A	A	NT
Rotorua Lakes											
Ngongotahā at Town Bridge	A	A	A	B	A	A	A	A	A	A	NT
Ōhau @ SH33	A	A	A	A	A	A	A	A	A	A	NT
Puarenga @ FRI	A	A	A	A	A	A	A	A	A	A	NT
Tarawera @ Lake Outlet	A	A	A	A	A	A	A	A	A	A	NT
Tarawera											
Tarawera @ Awakaponga	A	A	A	B	A	A	A	A	A	A	↓
Tarawera @ Kawerau Bridge	A	A	A	A	A	A	A	A	A	A	↓
Tarawera @SH30 Bridge	B	B	B	B	B	B	B	B	B	B	NT
Rangitaiki											
Rangitaiki @ Matahina Dam	A	B			A	A	A	A			NT
Rangitaiki @ Te Teko	A	A	A	A	A	A	A	A	A	A	NT
Rangitāiki at Murupara	A	A	A	A	A	A	A	A	A	A	NT
Rangitaiki @ Aniwhenua Canal	A	A			A	A	A	A			NT
Whirinaki @ Galatea Bridge	A	A	A	A	A	A	A	A	A	A	NT
Whakatane and Waimana											
Tauranga @ Taneatua	A	A			A	A	A	A			NT
Whakatāne @ Rūātoki	A	A			A	A	A	A			NT
Whakatāne @ Pekatahi	A	B	A	A	A	A	A	A	A	A	↓
Ohiwa Harbour and Waiotahi											
Nukuhou @ Old Quarry	A	B	A	A	A	A	A	B	A	B	↓
Waioeka and Otara											
Otara @ Brown's Bridge	A	A			A	A	A	A			↓
Waioeka at Gorge Mouth	A	A	A	A	A	A	A	A	A	A	↓
East Coast											
Mōtū @ SH35	A	A	A	A	A	A	A	A	A	A	↑
Mōtū @ Waitangirua	A	A	A	A	A	A	A	A	A	A	NT
Raukokore @ SH35	A	A			A	A	A	A			NT
Haparapara a@ SH35	A	A			A	A	A	A			NT

Table 11 NOF banding for Human Health for Secondary Contact Recreation, *E.coli* (annual median) in rivers and streams.

Site by WMA	2009	2010	2011	2012	2013
Tauranga Harbour					
Aongatete River @ SH2		A	A		A
Kopurererua @ SH2	A	A	B	A	A
Kopurererua @ SH29	A	A	C	A	A
Ngamuwahine @ Old Bridge		A	A		A
Omanawa @ SH29	A	A	B	A	A
Rocky @ Mangatawa	A	A	A		A
Te Mania @ SH2	A	A	B	A	A
Te Rereatukahia @ SH2					A
Tuapiro @ Surtees Road		A			A
Uretara at Henry Rd Ford					A
Waiau @ Road Ford					A
Waimapu @ 100m d/s of SH29	B	A	C	B	B
Waimapu @ Pukemapui Rd		A	B		A
Waipapa @ Old Bridge		A			A
Wairoa at SH2 Bridge	A	A	C	A	A
Wairoa d/s of Ruahihi		A	B		A
Waitao @ Spensers farm		C	B	B	A
Waitekohe @ SH2					A
Kaituna, Maketu, Pongakawa					
Kaituna @ Maungarangi	A	A	A	A	A
Kaituna @ Lake Rotoiti Outlet	A	A	A	A	A
Kaituna @ Waitangi	A	A	A	A	A
Pongakawa @ Old Coach	A	A		A	A
Pongakawa @ SH2	A	A		A	A
Pongakawa @ Forest	A	A		A	A
Waitahanui @ SH2	A	B		A	A
Rotorua Lakes					
Ngongotahā at Town Bridge	A	A	B	A	A
Ōhau @ SH33	A	A	A	A	A
Puarenga @ FRI	A	A	A	A	A
Tarawera @ Lake Outlet	A	A	A	A	A
Tarawera					
Tarawera @ Awakaponga	A	A	A	A	A
Tarawera @ Kawerau Bridge	A	A	A	A	A
Tarawera @SH30 Bridge		A	A	A	A
Rangitāiki					
Rangitāiki @ Matahina Dam	A			A	
Rangitāiki @ Te Teko	A	A	A	A	A
Rangitāiki at Murupara	A	A	A	A	A
Rangitāiki @ Aniwhenua Canal	A			A	
Whirinaki @ Galatea Bridge	A	A	A	A	A

Site by WMA	2009	2010	2011	2012	2013
Whakatane and Waimana					
Tauranga @ Taneatua	A		A	A	
Whakatāne @ Rūātoki	A		A	A	
Whakatāne @ Pekatahi	A	A	A	A	A
Ohiwa Harbour and Waiotahi					
Nukuhou @ Old Quarry	B	B	C	B	A
Waioeka and Otara					
Otara @ Brown's Bridge	A		A	A	
Waioeka at Gorge Mouth	A	A	A	A	A
East Coast					
Mōtū @ SH35	A	A	A	A	A
Mōtū @ Waitangirua	A	A	A	A	A
Haparapara a@ SH35	A		A	A	
Raukokore @ SH35	A		A	A	

Table 12 *NOF banding for Human Health for Primary Contact Recreation, E.coli (95th Percentile), 2009-2013 in rivers and streams (>MAS = above minimum acceptable state) and 10 Year Trend. NT = No Trend, ↓ = Meaningful decrease, ↑ = Meaningful increase.*

Site	95th Percentile E.coli	NOF	10 Yr Trend	Site	95th Percentile E.coli	NOF	10 Yr Trend
Kaituna @ Lake Rotoiti Outlet	53	A	↑	Rangitaiki @ Matahina Dam	1006	>MAS	NT
Tarawera @ Lake Outlet	57	A	NT	Waitahanui @ SH2	1053	>MAS	NT
Kaituna @ Maungarangi	80	A	NT	Te Mania @ SH2	1076	>MAS	NT
Pongakawa @ Forest	85	A	NT	Wairoa at SH2 Bridge	1450	>MAS	NT
Otara @ Brown's Bridge	156	A	NT	Mōtū @ Waitangirua	1520	>MAS	NT
Rangitāiki at Murupara	160	A	NT	Waimapu @ 100m d/s of SH29	1520	>MAS	NT
Ōhau @ SH33	167	A	↑	Te Rereatukahia @ SH2	1542	>MAS	NT
Tauranga @ Taneatua	177	A	NT	Rocky @ Mangatawa	1575	>MAS	NT
Whakatāne @ Rūātoki	186	A	NT	Tuapiro @ Surtees Road	1633	>MAS	NT
Kaituna @ Waitangi	204	A	↑	Kopurererua @ SH29	1750	>MAS	NT
Tarawera @ Kawerau Bridge	240	A	↑	Waiiau @ Road Ford	1940	>MAS	NT
Tarawera @ Awakaponga	343	B	↑	Wairoa d/s of Ruahihi	1960	>MAS	NT
Haparapara a@ SH35	356	B	NT	Ngamuwahine @ Old Bridge	2020	>MAS	NT
Puarenga @ FRI	386	B	↑	Ngongotahā at Town Bridge	2200	>MAS	↑
Pongakawa @ SH2	403	B	NT	Aongatete River @ SH2	2204	>MAS	NT
Pongakawa @ Old Coach	418	B	NT	Kopurererua @ SH2	2310	>MAS	NT
Tarawera @SH30 Bridge	433	B	NT	Waipapa @ Old Bridge	2385	>MAS	NT
Whirinaki @ Galatea Bridge	438	B	NT	Waitekohe @ SH2	2481	>MAS	NT
Rangitaiki @ Te Teko	524	B	NT	Waitao @ Spencers farm	2545	>MAS	NT
Waioeka at Gorge Mouth	655	>MAS	↑	Uretara at Henry Rd Ford	2896	>MAS	NT
Rangitaiki @ Aniwhenua Canal	795	>MAS	NT	Nukuhou @ Old Quarry	3065	>MAS	↑
Omanawa @ SH29	830	>MAS	↑	Waimapu @ Pukemapui Rd	3353	>MAS	NT
Mōtū @ SH35	934	>MAS	NT	Raukokore @ SH35	5380	>MAS	NT
Whakatāne @ Pekatahi	968	>MAS	↑				

Table 13 *NOF banding for Human Health for Primary Contact Recreation (2009-2014) and Secondary E.coli (2013/2014) from Summer Recreational Monitoring in rivers and streams (>MAS = above minimum acceptable state).*

Site	95th Percentile <i>E.coli</i>	NOF 1°	NOF 2°
Kaituna River- Trout Pool	53	A	A
Whakatane River- Rūātoki	97	A	A
Ōhau Channel @ SH33	111	A	A
Tarawera River @ Kawerau	131	A	A
Waitangi Springs	158	A	A
Awahou Stream	170	A	A
Rangitaiki River- Thornton Domain	195	A	A
Tauranga River @ Resreve	226	A	A
Rangitaiki River- Te Teko	282	B	A
Waioeka River- SH2	303	B	A
Ruruanga Stream	340	B	A
Otara River @ SH35	343	B	A
Kaituna River- Te Matai	443	B	A
Waioeka River- Pa	472	B	A
Haparapara River @ SH35	543	>MAS	A
Whakatane River- Landing Rd	554	>MAS	A
Uretara Stream @ Henry	560	>MAS	A
Tuapiro Stream @ McMillan	622	>MAS	A
Pongakawa River @ SH2	628	>MAS	A
Utuhina Stream @ Lake Rd	692	>MAS	A
Waiteti Stream @ Ngongotahā	784	>MAS	A
Wairoa River @ SH2	830	>MAS	A
Ngongotaha Stream @ Railway	1040	>MAS	A
Ngamuwahine River	1083	>MAS	A
McClarens Falls	1092	>MAS	A
Puarenga Stream @ Whakarewarewa	1250	>MAS	A
Kaiate Falls	1360	>MAS	A
Waimapu River @ Greerton	1505	>MAS	A

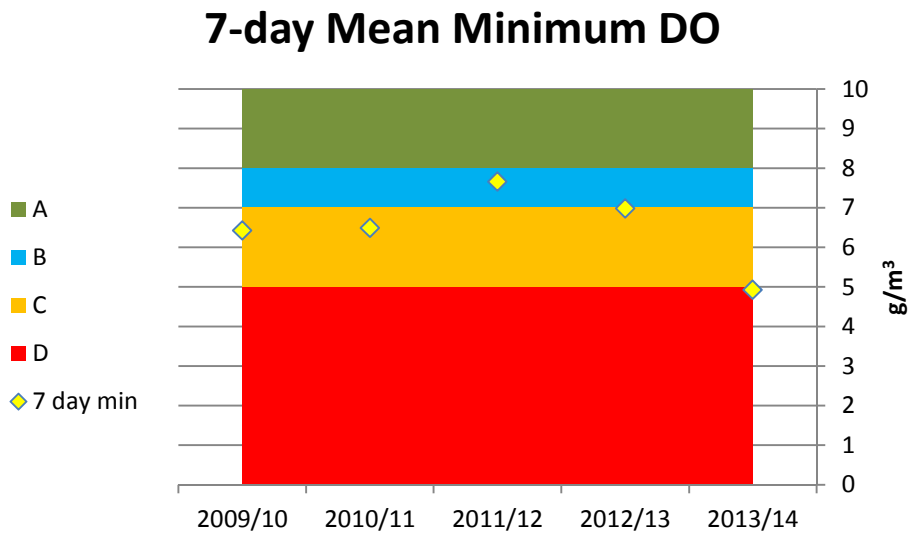
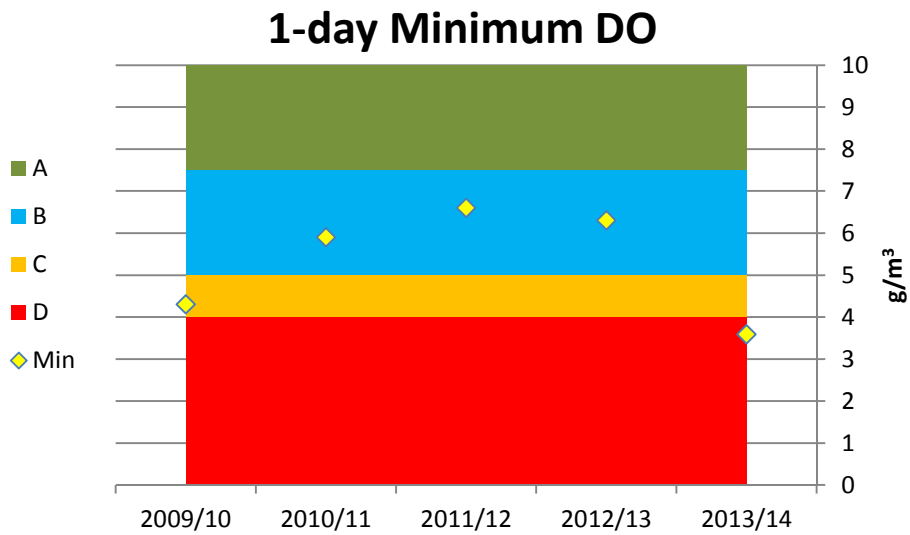


Figure 1 *NOF banding for Ecosystem Health – Dissolved Oxygen below point sources, dissolved oxygen summer minimum and 7-day mean daily minimum for the Tarawera River at Awakaponga.*

Part 3: Summary

Water quality data for rivers, streams and lakes in the Bay of Plenty has been compared to the attribute states set in the National Objectives Framework (NOF). This information will provide a baseline for discussions between the Regional Council and stakeholders regarding limit setting for water quality.

Current data shows one lake, Lake Ōkaro to be below the national bottom line for total nitrogen and cyanobacteria biovolume.

River sites all fall in the 'A' or 'B' band for ecological attributes (one attribute, periphyton growth, is not currently monitored routinely). A similar result occurs for the human health attribute *E.coli* (as an indicator of faecal contamination) for secondary contact recreation.

For primary contact recreation 60% of the river and stream 'SOE' sites (monthly monitoring) and 50% of the summer recreational monitoring sites (weekly or bi-weekly sampling) are below the minimum acceptable state defined in the NOF. This indicates there is a greater than 5% risk of infection from pathogens in these waters with full immersion contact.

Part 4: References

Ministry for the Environment (2014): National Policy Statement for Freshwater 2014.

Appendices

Appendix 1 – The National Objectives Framework – values and related attributes (summarised from MfE, 2014)

Table 1a Values and related attributes for lakes

Value	Attribute state - Lakes			
	A	B	C (Bottom-line)	D
Ecosystem health.	Lake ecological communities are healthy and resilient, similar to natural reference conditions.	Lake ecological communities are slightly impacted by additional algal and plant growth arising from nutrients levels that are elevated above natural reference conditions.	Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrient levels that are elevated well above natural reference conditions.	Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state, due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom waters of deep lakes.
Numeric state - Annual median (Annual maximum)				
Phytoplankton – chlorophyll-a (mg/m ³).	≤2 (≤10)	>2 & ≤ 5 (>10 & ≤ 25)	>5 & ≤12 (>25 & ≤60)	>12 (>60)
Total Nitrogen *(mg/m ³).	≤160; ≤300	>160 & ≤ 350; >300 & ≤ 500	>350 & ≤ 750; >500 & ≤ 800	> 750; >800
Total Phosphorus (mg/m ³).	≤10	>10 & ≤ 20	>20 & 50	>50

*Stratified lakes; polymictic lakes

Table 1b Ecosystem health based on nitrate concentrations in rivers.

Value	Attribute state – Rivers – Nitrate (Toxicity) (mg/L)			
	A	B	C (Bottom-line)	D
Numeric state: Annual median (95 th Percentile).	≤1.0 (≤1.5)	>1.0 & ≤ 2.4 (>1.5 & ≤ 3.5)	>2.4 & ≤6.9 (>3.5 & ≤9.8)	>6.9 (>9.8)
Ecosystem health.	High conservation value system. Unlikely to be effects even on sensitive species.	Some growth effect on up to 5% of species.	Growth effects on up to 20% of species (mainly sensitive species such as fish). No acute effects.	Impacts on growth of multiple species, and starts approaching acute impact level (i.e. risk of death) for sensitive species at higher concentrations (>20 mg/L).

Table 1c Ecosystem health based on ammonia concentrations in rivers and lakes.

Value	Attribute state – Rivers – Ammonia (Toxicity) (mg/L)			
	A	B	C (Bottom-line)	D
Numeric state: Annual median* (maximum*).	≤0.03 (≤0.05)	>0.03 & ≤ 0.24 (>0.05 & ≤ 0.40)	>0.24 & ≤1.30 (>0.40 & ≤2.20)	>1.30 (>2.20)
Ecosystem health.	99% species protection level: No observed effect on any species tested.	95% species protection level: Starts impacting occasionally on the 5% most sensitive species.	80% species protection level: Starts impacting regularly on the 20% most sensitive species (reduced survival of most sensitive species).	Starts approaching acute impact level (i.e. risk of death) for sensitive species.

Based on pH 8 and temperature of 20°C. Compliance with numerical attributes should be undertaken after pH adjustment.

Table 1d: Ecosystem health based on dissolved oxygen concentrations in rivers (November to end April).

Value	Attribute state – Rivers – Dissolved Oxygen (mg/L)			
	A	B	C (Bottom-line)	D
Numeric state: 7-day mean minimum (1-day minimum).	≥8.0 (≥7.5)	≥7.0 & <8.0 (≥5.0 & <7.5)	≥5.0 & <7.0 (≥5.0 & <7.5)	<5.0 (<4.0)
Ecosystem health.	No stress caused by low dissolved oxygen on any aquatic organisms that are present at matched reference (near-pristine) sites.	Occasional minor stress on sensitive organisms caused by short periods (a few hours each day) of lower dissolved oxygen. Risk of reduced abundance of sensitive fish and macroinvertebrate species.	Moderate stress on a number of aquatic organisms caused by dissolved oxygen levels exceeding preference levels for periods of several hours each day. Risk of sensitive fish and macroinvertebrate species being lost.	Significant, persistent stress on a range of aquatic organisms caused by dissolved oxygen exceeding tolerance levels. Likelihood of local extinctions of keystone species and loss of ecological integrity.

Table 1e Human health based on E.coli concentrations in rivers and lakes.

Value	Attribute state (E.coli/100 ml)			
	A	B	C (Bottom-line)	D
Numeric state	≤260	>260 and ≤ 540	>540 and ≤1000	>1000
Human health for secondary* contact (annual median).	Very low risk of infection (<0.1%) secondary exposure.	Low risk of infection (up to 1%) secondary exposure.	Moderate risk of infection (<5.0%) from secondary exposure.	High risk of infection (>5.0%) from secondary exposure.
Human health for primary** contact (95 th Percentile).	Low risk of infection (up to 1%) primary exposure.	Moderate risk of infection (<5.0%) from primary exposure. Minimum acceptable state.		

*Secondary activity occasional immersion and some ingestion: e.g. boating; wading.

**Primary likely to involve full immersion.

Table 1f Human health based on Cyanobacteria (Planktonic) in lakes fed rivers and lakes.

Value	Attribute state (E.coli/100 ml)			
	A	B	C (Bottom-line)	D
Numeric state 80 th Percentile*.	≤0.5 mm ³ /L bio-volume, or ≤500 cells/mL.	N/A	>0.5 and ≤1.8 mm ³ /L toxic cyanobacteria biovolume, or >0.5 and ≤10 mm ³ /L total cyanobacteria.	>1.8 mm ³ /L toxic cyanobacteria biovolume, OR 10 mm ³ /L total cyanobacteria.
Human health for secondary* contact (annual median).	Risk exposure from cyanobacteria is no different to that in natural conditions (from any contact with fresh water)..		Low risk of health effects from exposure to cyanobacteria (from any contact with fresh water).	Potential health risks (eg, respiratory, irritation and allergy symptoms) exist from exposure to cyanobacteria (from any contact with fresh water).

*80th Percentile must be calculated using a minimum of 12 samples collected over 3 years.

Appendix 2 – Annual data for water quality parameters

Table 2a Annual median results for Total Phosphorus in lakes (mg/m³).

Total Phosphorus	2009/10	2010/11	2011/12	2012/13	2013/14
Ōkaro	57	75	117	68	38.5
Rotorua	26	21	13.5	17.5	19
Rotoehu	52.5	30.5	28	23	25
Rotomahana	18.5	49.5	49	43.5	45
Rerewhakaaitu	12	11	10.5	9	9
Rotoiti	20	23.5	19.5	13	12
Rotokakahi	27	18	20	17	16
Okareka	7.65	9	9.5	10	9
Tikitapu	5	4	5	4	3.5
Okataina	8	12	11	11	10
Tarawera	9.5	20	20.5	19	17
Rotoma	3	5.5	7	6	6

Table 2b Annual median results for Total Nitrogen in lakes (mg/m³).

Total Nitrogen	2009/10	2010/11	2011/12	2012/13	2013/14
Ōkaro	797.5	893	1050	921	854.5
Rotorua	352	290	318.5	308.5	282.5
Rotoehu	332.5	262	273	211	221.5
Rotomahana	174.5	205.5	198.5	183.5	191
Rerewhakaaitu	412	363.5	366.5	365	339.5
Rotoiti	199.25	180.5	169.5	152.5	157.5
Rotokakahi					
Okareka	197.5	188	182	179	185
Tikitapu	188	156	160	148.5	157
Okataina	101.5	96.5	101	85	85
Tarawera	86	85	90	86.5	95
Rotoma	111	101.5	97.5	99.5	104

Table 2c Annual median results for Chlorophyll-a in lakes (mg/m³).

Chlorophyll-a	2009/10	2010/11	2011/12	2012/13	2013/14
Ōkaro	57.9	190	156.7	112	59.3
Rotorua	24.1	33.1	22	31	15.7
Rotoehu	14.6	12.8	12.8	10.2	9.8
Rotomahana	6.7	17.8	10	7.4	5.3
Rerewhakaaitu	9.8	6.1	6.6	5.7	6.3
Rotoiti	12	11.5	11	8.8	9.9
Rotokakahi					
Okareka	7.2	6.5	8.7	6.5	6.4
Tikitapu	3.5	2.8	3.2	8.6	3.1
Okataina	4.1	2.9	5.1	4.7	3.3
Tarawera	1.8	3.1	2.5	2.5	2.8
Rotoma	2.7	1.6	2.5	1.8	6.7

Table 2d Chlorophyll-a annual maximum (mg/m³) results in lakes.

Chlorophyll-a (Max)	2009/10	2010/11	2011/12	2012/13	2013/14
Ōkaro	9.1	6.8	9.35	10.35	4.05
Rotorua	15.1	13	8.65	9.35	9.95
Rotoehu	9.05	6.05	5.6	5.35	5.1
Rotomahana	3.3	4.4	4.9	3.9	2.9
Rerewhakaaitu	5.2	3.5	4.55	3.05	2.75
Rotoiti	6.45	5.95	5.35	5	4.4
Rotokakahi					
Okareka	4.1	3.85	4.4	3.05	2.55
Tikitapu	1.7	1.75	1.9	1.225	2.05
Okataina	2.05	2.05	2.4	1.5	1.3
Tarawera	1.25	1.45	1.35	1.45	1.7
Rotoma	0.8	1.05	1	1.19	1.05

Table 2e Annual Median Nitrate Values (g/m³), rivers.

Site	2009	2010	2011	2012	2013
Aongatete River @ SH2		0.226	0.4		0.267
Haparapara a@ SH35	0.003		0.035	0.012	
Kaituna @ Maungarangi	0.236	0.244	0.261	0.308	0.298
Kaituna @ Lake Rotoiti Outlet	0.007	0.021	0.039	0.102	0.053
Kaituna @ Waitangi	0.498	0.53	0.551	0.615	0.614
Kopurererua @ SH2	0.983	0.975	0.922	0.965	0.961
Kopurererua @ SH29	0.923	0.927	0.977	0.95	1.005
Mōtū @ SH35	0.03	0.042	0.065	0.064	0.029
Mōtū @ Waitangirua	0.079	0.047	0.146	0.199	0.113
Ngamuwahine @ Oldh Bridge		0.183	0.303		0.192
Ngongotahā at Town Bridge	0.86	0.821	0.896	0.842	0.821
Nukuhou @ Old Quarry	0.373	0.519	0.601	0.373	0.259
Ōhau @ SH33	0.009	0.008	0.027	0.18	0.104
Omanawa @ SH29	1.103	1.14	1.145	1.24	1.28
Otara @ Brown's Bridge	0.016		0.02	0.046	
Pongakawa @ Old Coach	1.44	1.43		1.625	1.59
Pongakawa @ SH2	1.43	1.42		1.565	1.56
Pongakawa @ Forest	1.27	1.27		1.41	1.415
Puarenga @ FRI	0.95	0.859	0.947	0.817	0.734
Rangitaiki @ Matahina Dam	0.346		0.449	0.491	
Rangitaiki @ Te Teko	0.379	0.431	0.53	0.497	0.405
Rangitāiki at Old Murupara Bridge	0.942	0.908	1.208	1.077	0.994
Rangitaiki @ Aniwhenua Canal	0.519		0.643	0.581	
Raukokore @ SH35	0.004		0.041	0.031	
Rocky @ Mangatawa	0.738	0.937	0.865		0.612
Tarawera @ Awakaponga	0.402	0.434	0.424	0.433	0.404
Tarawera @ Kawerau Bridge	0.273	0.265	0.323	0.289	0.262
Tarawera @ Lake Outlet	0.001	0.001	0.001	0.001	0.001
Tarawera @SH30 Bridge	0.278	0.275	0.325	0.311	0.279
Te Mania @ SH2	0.229	0.221	0.282	0.254	0.266
Te Rereatukahia @ SH2		0.378	0.43		0.258
Tuapiro @ Surtees Road		0.099	0.2		0.089
Uretara at Henry Rd Ford		0.282	0.531		0.245
Waiau @ Road Ford		0.465	0.449		0.24
Tauranga @ Taneatua	0.015		0.118	0.092	
Waimapu @ 100m d/s of SH29	0.864	0.788	0.948	0.796	0.828
Waimapu @ Pukemapui Rd		0.858	0.904		0.618
Waioeka at Gorge Mouth	0.033	0.01	0.035	0.042	0.008
Waipapa @ Old Bridge		0.761	0.853		0.552
Wairoa at SH2 Bridge	0.431	0.429	0.484	0.413	0.444
Wairoa d/s of Ruahihi Powerstation		0.317	0.411		0.31

Site	2009	2010	2011	2012	2013
Waitahanui @ SH2	0.738	0.653		0.764	0.675
Waitao @ Spensers farm		0.317	0.537	0.439	0.367
Waitekohe @ SH2		0.142	0.292		0.103
Whakatāne @ Rūātoki	0.045		0.024	0.023	
Whakatāne @ Pekatahi	0.082	0.043	0.128	0.061	0.045
Whirinaki @ Galatea Bridge	0.096	0.032	0.1	0.105	0.02

Table 2f Annual Median and Maximum Ammonia Values (g/m³), rivers (adjusted to pH=8).

Site	Maximum					Median				
	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
Aongatete River @ SH2		0.017	0.005		0.003	0.003	0.003			0.002
Haparapara a@ SH35	0.003		0.01	0.003	0.004	0.003		0.002	0.001	0.002
Kaituna @ Maungarangi	0.01	0.017	0.013	0.006	0.004	0.002	0.003	0.005	0.003	0.002
Kaituna @ Lake Rotoiti Outlet	0.008	0.026	0.024	0.014	0.016	0.004	0.005	0.006	0.009	0.005
Kaituna @ Waitangi	0.042	0.051	0.056	0.021	0.034	0.021	0.025	0.023	0.01	0.014
Kopurererua @ SH2	0.076	0.075	0.081	0.054	0.084	0.026	0.014	0.028	0.02	0.018
Kopurererua @ SH29	0.01	0.011	0.025	0.012	0.01	0.006	0.004	0.008	0.004	0.004
Mōtū @ SH35	0.006	0.005	0.005	0.014	0.007	0.002	0.002	0.002	0.002	0.002
Mōtū @ Waitangirua	0.008	0.009	0.009	0.016	0.007	0.005	0.006	0.005	0.005	0.003
Ngamuwahine @ Old Bridge		0.005	0.004		0.002		0.004	0.003		0.001
Ngongotahā at Town Bridge		0.01	0.029	0.02	0.008	0.006	0.006	0.007	0.006	0.005
Nukuhou @ Old Quarry	0.054	0.05	0.025	0.063	0.066	0.015	0.018	0.011	0.009	0.007
Ōhau @ SH33	0.026	0.008	0.021	0.016	0.039	0.005	0.002	0.011	0.007	0.006
Omanawa @ SH29	0.007	0.008	0.019	0.008	0.004	0.002	0.004	0.004	0.003	0.002
Otara @ Brown's Bridge	0.015		0.011	0.003		0.004		0.003	0.001	
Pongakawa @ Old Coach	0.007	0.008		0.004	0.005	0.002	0.004		0.002	0.003
Pongakawa @ SH2	0.011	0.026		0.016	0.015	0.006	0.004		0.002	0.003
Pongakawa @ Forest	0.005	0.002		0.002	0.003	0.002	0.001		0.001	0.001
Puaranga @ FRI	0.037	0.042	0.041	0.036	0.034	0.027	0.025	0.027	0.025	0.026
Rangitaiki @ Matahina Dam	0.056		0.017	0.01		0.012		0.009	0.005	
Rangitaiki @ Te Teko	0.012	0.01	0.008	0.006	0.008	0.006	0.006	0.004	0.004	0.004
Rangitāiki at Old Murupara Bridge	0.015	0.017	0.007	0.005	0.008	0.005	0.005	0.004	0.004	0.006
Rangitaiki @ Aniwhenua Canal	0.011		0.038	0.011		0.008		0.023	0.008	
Raukokere @ SH35	0.013		0.017	0.005		0.003		0.003	0.001	
Rocky @ Mangatawa	0.121	0.068	0.074		0.085	0.057	0.052	0.059		0.058
Tarawera @ Awakaponga	0.037	0.052	0.036	0.034	0.028	0.021	0.028	0.015	0.024	0.021
Tarawera @ Kawerau Bridge	0.011	0.016	0.011	0.016	0.004	0.003	0.005	0.004	0.002	0.002
Tarawera @ Lake Outlet	0.003	0.011	0.005	0.007	0.007	0.001	0.001	0.001	0.001	0.001
Tarawera @SH30 Bridge	0.06	0.1	0.065	0.076	0.17	0.057	0.066	0.037	0.055	0.036
Te Mania @ SH2	0.058	0.013	0.013	0.012	0.04	0.007	0.007	0.007	0.008	0.006
Te Rereatakahia @ SH2		0.003	0.012		0.003		0.003	0.003		0.001

Site	Maximum					Median				
	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
Tuapiro @ Surtees Road		0.005	0.012		0.002		0.004	0.003		0.002
Uretara at Henry Rd Ford		0.003	0.003		0.016		0.002	0.003		0.003
Waiau @ Road Ford		0.004	0.003		0.005		0.003	0.003		0.002
Waimana @ Taneatua	0.008		0.045	0.003		0.004		0.003	0.002	
Waimapu @ 100m d/s of SH29	0.018	0.015	0.018	0.011	0.012	0.01	0.009	0.01	0.008	0.006
Waimapu @ Pukemapui Rd		0.01	0.006		0.009		0.005	0.004		0.003
Waioeka at Gorge Mouth	0.005	0.017	0.01	0.004	0.003	0.002	0.003	0.002	0.001	0.001
Waipapa @ Old Bridge		0.006	0.005		0.004		0.006	0.004		0.003
Wairoa at SH2 Bridge	0.011	0.016	0.037	0.01	0.007	0.006	0.006	0.005	0.007	0.005
Wairoa d/s of Ruahihi Powerstation		0.008	0.006		0.005		0.004	0.004		0.004
Waitahanui @ SH2	0.007	0.016		0.012	0.013	0.004	0.005		0.003	0.004
Waitao @ Spensers farm		0.026	0.015	0.015	0.012		0.012	0.01	0.009	0.008
Waitekohe @ SH2		0.016	0.06		0.003		0.004	0.005		0.001
Whakatāne @ Rūātoki	0.006		0.006	0.003		0.004		0.003	0.001	
Whakatāne @ Pekatahi	0.119	0.012	0.008	0.003	0.007	0.002	0.003	0.003	0.002	0.002
Whirinaki @ Galatea Bridge	0.009	0.013	0.008	0.011	0.008	0.003	0.006	0.003	0.003	0.003

Table 2g Annual Median and Maximum Ammonia Values (g/m³), from lake samples at depth (hypolimnium) (adjusted to pH=8).

Maximum Ammonia						
Lake	2009	2010	2011	2012	2013	2014
Lake Okataina	0.012	0.006	0.013	0.011	0.003	0.002
Lake Rerewhakaaitu	0.086	0.068	0.028	0.017	0.033	0.008
Lake Rotoehu	0.139	0.034	0.063	0.051	0.026	0.027
Lake Rotoiti S3	0.066	0.043	0.044	0.025	0.02	0.051
Lake Rotoiti S4	0.071	0.057	0.059	0.06	0.042	0.067
Lake Okareka	0.018	0.006	0.015	0.015	0.018	0.065
Lake Rotoma	0.012	0.005	0.005	0.004	0.004	0.019
Lake Rotomahana	0.008	0.005	0.009	0.028	0.004	0.016
Lake Rotorua	0.155	0.261	0.062	0.072	0.085	0.022
Lake Tarawera	0.028	0.004	0.006	0.002	0.004	0.005
Lake Tikitapu	0.007	0.026	0.008	0.017	0.002	0.007
Lake Okaro	1.179	1.163	0.982	1.348	1.406	1.242
Median Ammonia						
	2009	2010	2011	2012	2013	2014
Lake Okataina	0.002	0.001	0.001	0.001	0.0005	0.0005
Lake Rerewhakaaitu	0.008	0.004	0.006	0.003	0.004	0.002
Lake Rotoehu	0.011	0.004	0.009	0.001	0.001	0.001
Lake Rotoiti S3	0.01	0.006	0.015	0.001	0.003	0.007
Lake Rotoiti S4	0.028	0.015	0.026	0.009	0.01	0.021
Lake Okareka	0.003	0.003	0.002	0.002	0.001	0.013
Lake Rotoma	0.002	0.001	0.002	0.001	0.001	0.0005
Lake Rotomahana	0.002	0.001	0.001	0.0005	0.0005	0.0005
Lake Rotorua	0.002	0.003	0.01	0.021	0.01	0.006
Lake Tarawera	0.003	0.001	0.001	0.001	0.001	0.001
Lake Tikitapu	0.002	0.004	0.002	0.0005	0.0005	0.001
Lake Okaro	0.317	0.28	0.414	0.22	0.381	0.209