WHANGAREI HARBOUR CATCHMENT

WATER QUALITY UPDATE

Date: May 2016

Version: 1.1

Putting Northland first

WAIORA NORTHLAND WATER

NORTHLAND REGIONAL COUNCIL

CONTENTS

FIGURES

TABLES

1 Current monitoring in the catchment

The following environmental monitoring is currently conducted by Northland Regional Council in the Whāngārei Harbour catchment:

River Water Quality Monitoring Network (RWQMN) established in 1996. Thirty six river sites throughout Northland encompassing 22 river catchments are monitored monthly for a range of parameters, including temperature, dissolved oxygen, pH, water clarity, nutrients and bacterial levels. This monitoring includes three sites: Hātea at Mair Park, Waiarohia at Second Avenue and Otaika at Otaika Valley Road in the Whāngārei Harbour catchment. These sites have been monitored since 2005, 2005 and 2011 respectively. Annual and five yearly reports are available here:
http://www.nrc.govt.nz/Resource-Library-Summary/Environmental-Monitoring/State-of-the-Environment-Monitoring/

Waiora Northland Water (WNW) water quality sites were established in July 2014 consisting of 29 sites distributed between the Whāngārei Harbour, Mangere, Waitangi and Doubtless Bay priority catchments and bringing the total number of sites monitored in Northland to 66. In total 12 sites are currently monitored in the Whāngārei Harbour catchment spread between the three main sub-catchments: Hātea River, Waiarohia River and Otaika River, including the three RWQMN sites (Figure 1).

Stream invertebrate (macroinvertebrate) monitoring at RWQMN sites since 1997. Every site in the network is monitored once a year in summer. Monitoring at the Hātea at Mair Park, Waiarohia at Second Avenue and Otaika at Otaika Valley Road started in 2009, 1997 and 2012 respectively, and in the priority sites in 2015. Annual reports are available here:
http://www.nrc.govt.nz/Resource-Library-Summary/Research-and-reports/Rivers-and-streams/

Stream habitat assessments at RWQMN sites since 2004. Historically assessments were carried out every second year. Since 2014 habitat assessments are undertaken alongside the macroinvertebrate monitoring programme annually. Reports are available here:
http://www.nrc.govt.nz/Resource-Library-Summary/Research-and-reports/Rivers-and-streams/

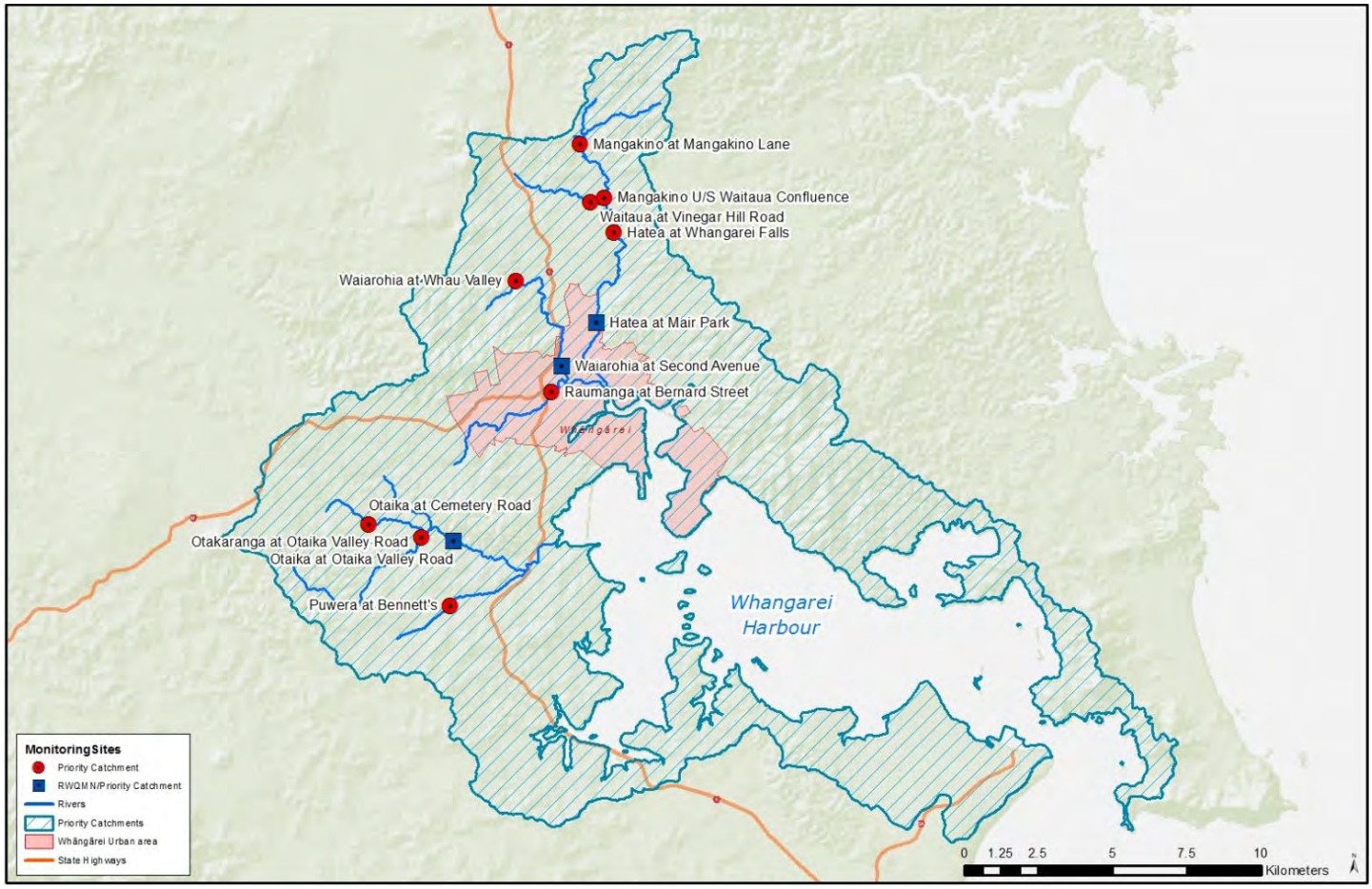

Figure 1: Whāngārei Harbour catchment RWQMN and WNW water quality monitoring sites.

Table 1: Whāngārei Harbour catchment water quality monitoring sites.

Site Name	Easting	Northing	Sub-catchment
Mangakino at Mangakino Lane	1719742	6053137	Hātea
Mangakino U/S Waitua confluence	1720580	6051553	Hātea
Waitaua at Vinegar Hill Road	1720067	6051316	Hātea
Hātea at Whāngārei Falls	1720854	6050268	Hātea
Hātea at Mair Park	1720284	6047290	Hātea
Waiarohia at Whau Valley	1717567	6048670	Waiarohia
Waiarohia at Second Avenue	1719097	6045830	Waiarohia
Raumanga at Bernard Street	1718769	6044944	Waiarohia
Otaika at Cemetery Road	1712613	6040510	Otaika
Otakaranga at Otaika Valley Road	1714399	6040069	Otaika
Otaika at Otaika Valley Road	1715476	6039940	Otaika
Puwera at Bennett's	1715350	6037753	Otaika

Photos of sampling sites are presented in the Appendix.

2 River ecosystem and water quality

The ecological health, or integrity of river ecosystems is related to a number of environmental factors including, but not limited to, the availability of suitable habitat types (e.g. diverse range of substrate sizes, aquatic plants, large woody debris and varied flow types), food and light availability, disturbance and water quality. It is important to note that the relationship between ecosystem health and environmental factors is often very complex and unpredictable.

Ecological health in rivers and streams is dependent on water quality parameters such as, in no particular order, temperature and dissolved oxygen, clarity, nutrients, suspended solids and faecal pathogens. Faecal pathogens are not known to affect aquatic ecosystems, but affect the suitability of a water body for swimming and stock drinking water. Biological monitoring information such as invertebrates, periphyton, habitat assessments and fish, can be used to help determine influences of water quality on river ecosystems, however as mentioned above causal effects are not always clear. Current national standards and guidelines outlined below are used to facilitate inter-site comparisons of the state of water quality in the region's rivers and streams.

2.1 Long term water quality results and trends

Currently the only sites with long term water quality data in the Whāngārei Harbour catchment are the Hātea at Mair Park, Waiarohia at Second Avenue and Otaika at Otaika Valley Road. These sites have been monitored since 2005, 2005 and 2011 respectively. Land Air Water Aotearoa (LAWA)[1], a website which brings together water quality data from regional councils throughout New Zealand, provides results for *E. coli*, turbidity and nitrogen levels at Hātea at Mair Park ranking amongst the worst 25 to 50 percent of similar sites in New Zealand (Figure 2). The Waiarohia at Second Avenue site recorded results for *E. coli*, turbidity, total oxidised nitrogen, ammoniacal nitrogen and dissolved reactive phosphorous levels ranking amongst the worst 25 to 50 percent of similar sites in New Zealand (Figure 3). The Otaika at Cemetery Road site is relatively new and is not yet on the LAWA website.

Trend analysis carried out on the last 10 years of data shows a number of meaningful improvements in water clarity and nutrient levels at the Waiarohia site (Figure 3). When the time period was reduced to five years however no trends were apparent (Figure 4). Although trend results are not presented on LAWA for the Hātea at Mair Park site, 10 years trend analysis indicated an annual reduction of 1.2 percent in dissolved oxygen levels and the Otaika at Otaika Valley Road site an annual reduction of 20 percent in *E. coli* levels.

The addition of nine monitoring sites within the catchment will help identify problematic areas/sub-catchments for targeted water quality management in the catchment. This report outlines preliminary results based on one year of data and compares them to appropriate national standards, guidelines and trigger values for this purpose.

[1] For more information visit: http://www.lawa.org.nz/explore-data/northland-region/

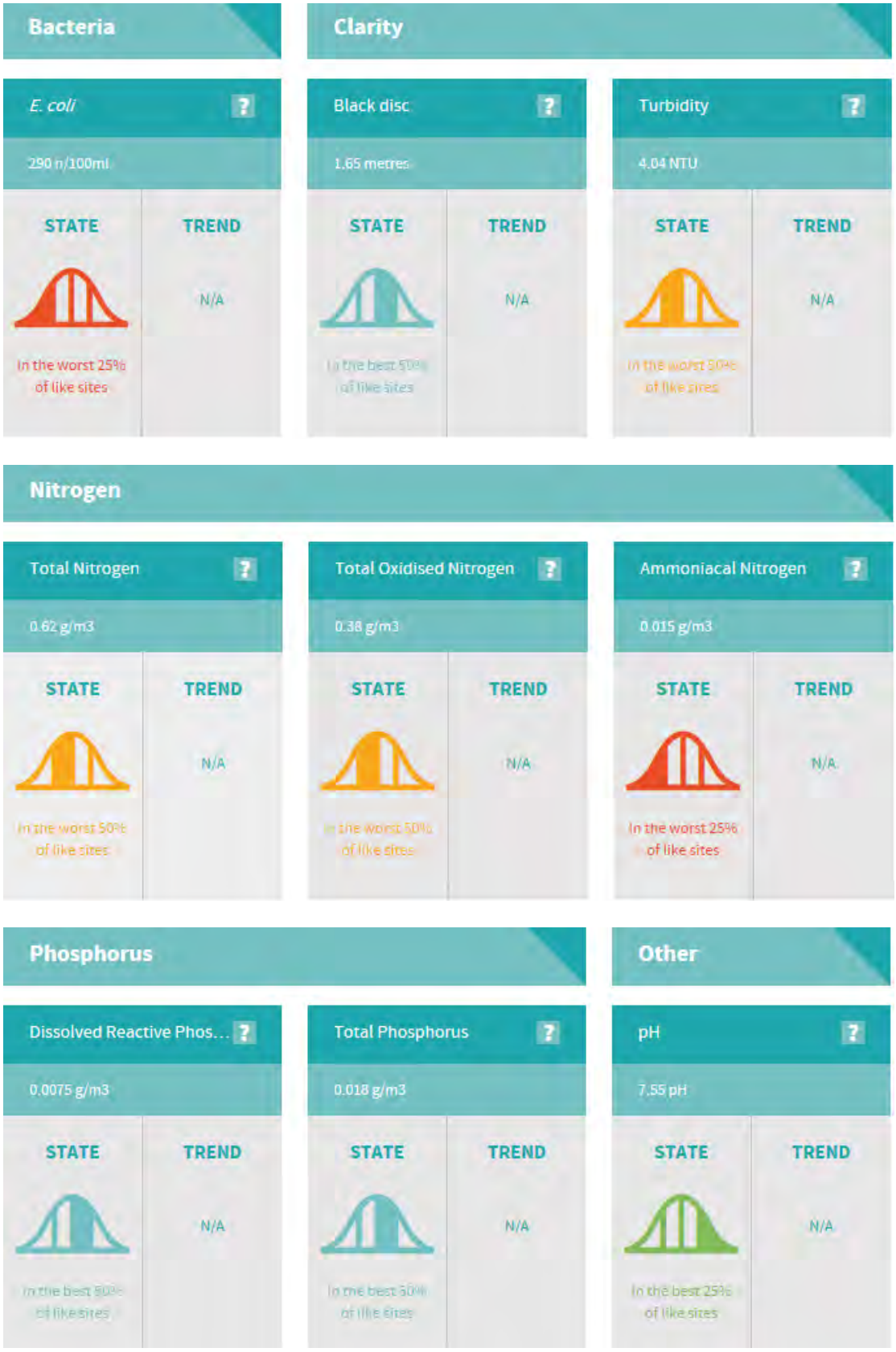

Figure 2: Current water quality state of the Hātea at Mair Park RWQMN site compared to similar sites in New Zealand with 10 year trends for nine water quality parameters (excerpt from Land Air Water Aotearoa (LAWA) website).

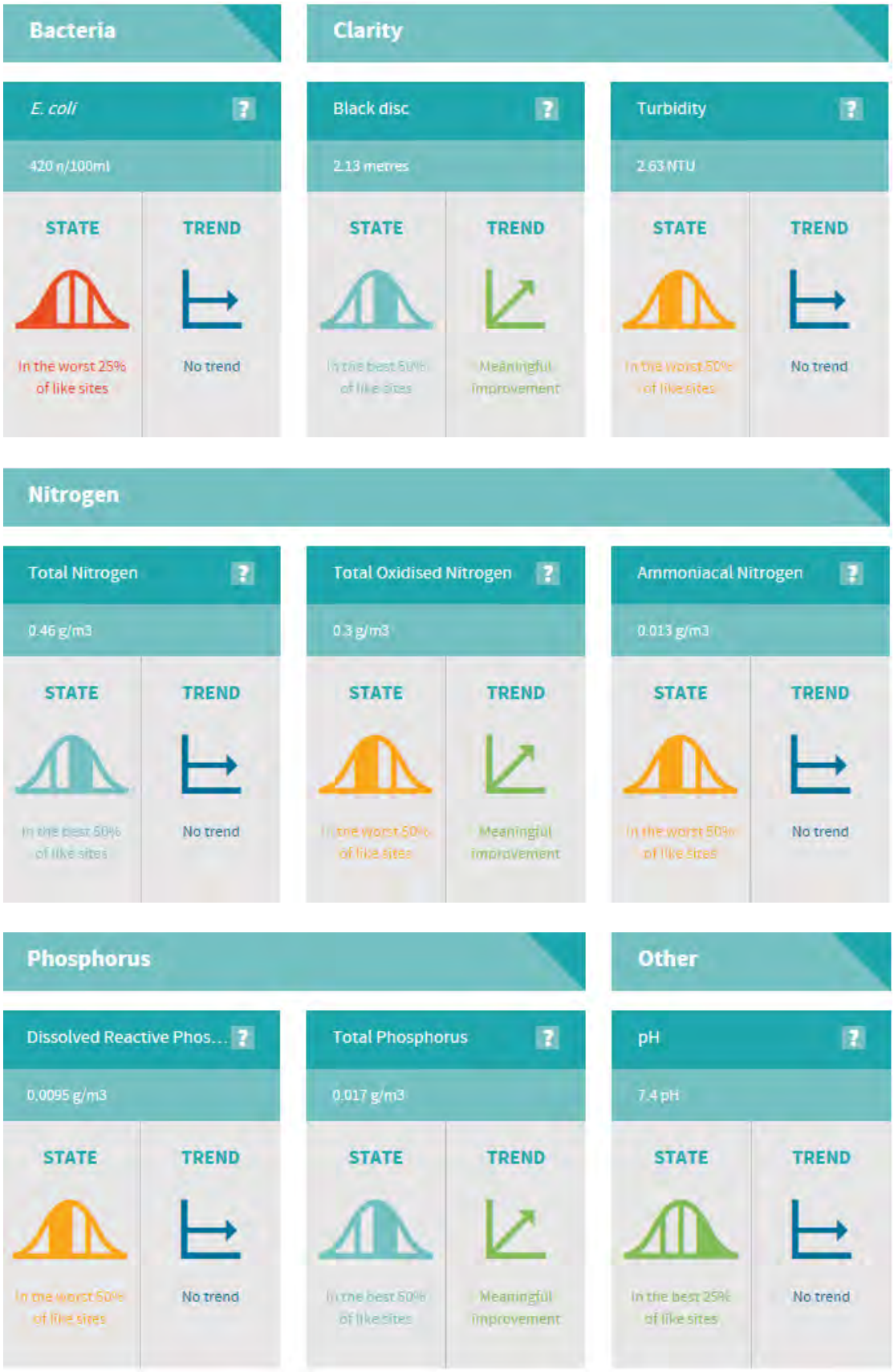

Figure 3: Current water quality state of the Waiarohia at Second Avenue RWQMN site compared to similar sites in New Zealand with 10 year trends for nine water quality parameters (excerpt from Land Air Water Aotearoa (LAWA) website).

Figure 4: Current water quality state of the Waiarohia at Second Avenue RWQMN site compared to similar sites in New Zealand with five year trends for nine water quality parameters (excerpt from Land Air Water Aotearoa (LAWA) website).

2.2 National water quality standards and guidelines

The National Policy Statement for Freshwater Management (NPS-FM) was introduced by the Government in 2011 as part of the first phase of freshwater reforms. It was updated in 2014 with a National Objectives Framework (NOF) and includes targets to provide direction to Regional Councils around maintaining and improving water quality. It includes a number of grades as well as 'national bottom lines' (Table 2) – thresholds of water quality attributes that good management should prevent our waterways from reaching in a consistent way across the country. Councils are obliged to maintain or improve water quality within their regions. They cannot simply let conditions degrade down to the bottom line. The NOF water quality grades provide a reporting framework to assess water quality. The bottom line is the point separating a C from a failing D grade.

Table 2: National Objectives Framework attributes and grades.

Attributes		**National Objectives Framework Grades**			
		A	B	C	D
Ammoniacal nitrogen (toxicity) (mg/L)	annual median	≤0.03	>0.03 and ≤0.24	>0.24 and ≤1.30	>1.30
	annual maximum	≤0.05	>0.05 and ≤0.40	>0.40 and ≤2.20	>2.20
Nitrate nitrogen (toxicity) (mg/L)	annual median	≤1	>1and ≤2.4	>2.4 and ≤6.9	>6.9
	annual 95th percentile	≤1.5	>1.5 and ≤3.5	>3.5 and ≤9.8	>9.8
Escherichia coli *E. coli*/100mL	annual median (2nd contact recreation)	≤260	>260 and ≤540	>540 and ≤1000	>1000
	annual 95th percentile	≤260	>260 and ≤540	National bottom line	
Periphyton chlorophyll-a (mg/m^2)	exceeds no more than 8% samples over 3 years	≤50	>50 and ≤120	>120 and ≤200	>200

Key

A	Similar to reference conditions
B	Slightly impacted
C	Moderately impacted (lower/upper limit national bottom line)
National bottom line	
D	Degraded/unacceptable (must be managed to C or better)

The NOF is still under development with a number of additional attributes to be added in the near future. In the interim other water quality parameters not currently covered by the NOF are assessed against relevant trigger/guideline values (Table 3). These values differ from the NOF in that they are not national standards and therefore do not entail statutory obligations, but instead provide conservative numbers for physical and chemical measurements in rivers above or below which aquatic ecosystems may be exposed to stress. In this report annual medians are compared to the trigger/guideline values (Table 3).

Table 3: National guideline values for the protection of aquatic ecosystems.

Identifier	Abbreviation	Reference	Trigger/guideline value
Dissolved Oxygen	DO	RMA 1991 Third Schedule	≥80 (% saturation)
Dissolved Reactive Phosphorus	DRP	ANZECC (2000)	<0.010 (mg/L)
Total Phosphorous	TP	ANZECC (2000)	<0.033 (mg/L)
Nitrate, nitrite, nitrogen	NNN	ANZECC (2000)	<0.444 (mg/L)
Ammoniacal nitrogen	NH_4	ANZECC (2000)	<0.021 (mg/L)
Total nitrogen	TN	ANZECC (2000)	<0.614 (mg/L)
Turbidity	TURB	ANZECC (2000)	<5.6 (NTU)

2.3 Water quality results

The following section describes water quality in the Whāngārei Harbour catchment using box and whisker plots to graphically display the distribution of water quality data based on a five value summary: the minimum value, first quartile, median, third quartile, and maximum. The central rectangle spans the first quartile to the third quartile (the *interquartile range* or *IQR*) covering the middle 50% of data. A segment inside the rectangle shows the median, and "whiskers" above and below the box show the minimum and maximum values, or the 95th percentile values, depending on the parameter being measured (Figure 5).

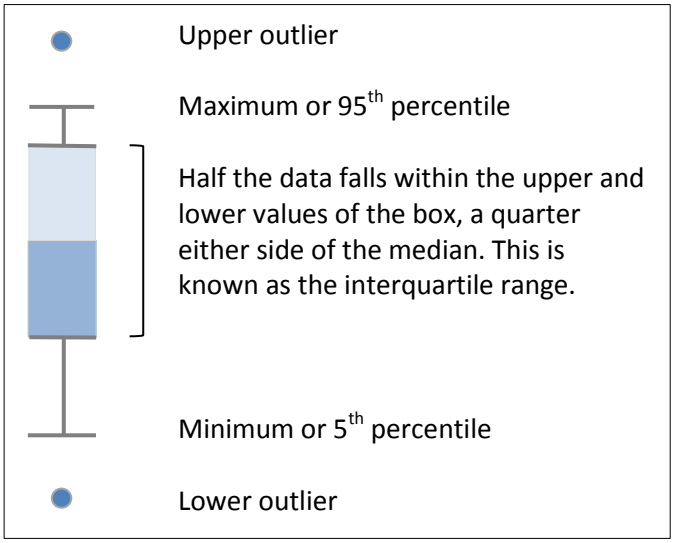

Figure 5: Boxplot description.

A year of water quality data has now been collected at the nine additional sites in the Whāngārei Harbour priority catchment since sampling began in July 2014 to add to data already collected at three existing RWQMN sampling sites. It is very difficult to accurately interpret water quality data without several years of data to smooth out the impacts of weather patterns, climatic conditions, seasonal variation, etc. However, current results from July 2014 to June 2015 indicate that the main water quality issues in the Whāngārei Harbour catchment may include elevated phosphate, sediment and *E. coli.* levels, and poor to average ecosystem health as indicated by habitat assessment and aquatic insects (macroinvertebrates). The Otaika catchment stands out as having sites with elevated nutrient levels particularly at the Puwera at Bennet's and Otaika at Otaika Valley Road sites. Note: results for the three RWQMN sites only include data for the same time period, i.e. July 2014 to June2015, to provide consistency.

2.3.1 Nutrient levels

Nitrogen and phosphorus are the two main nutrients required by algae, plants, and animals for metabolism and growth. Nitrogen and phosphorus naturally occur in water as a result of natural processes, such as the erosion of soil, atmospheric deposition, and the breakdown of organic matter. Nitrogen is highly soluble and can leach through soil, whereas phosphorus usually enters water in direct discharges or associated with sediment. Whilst nutrients are necessary for sustaining life, high levels of nitrogen and phosphorus can cause excessive growth of aquatic plants and algae and reduce overall water quality.

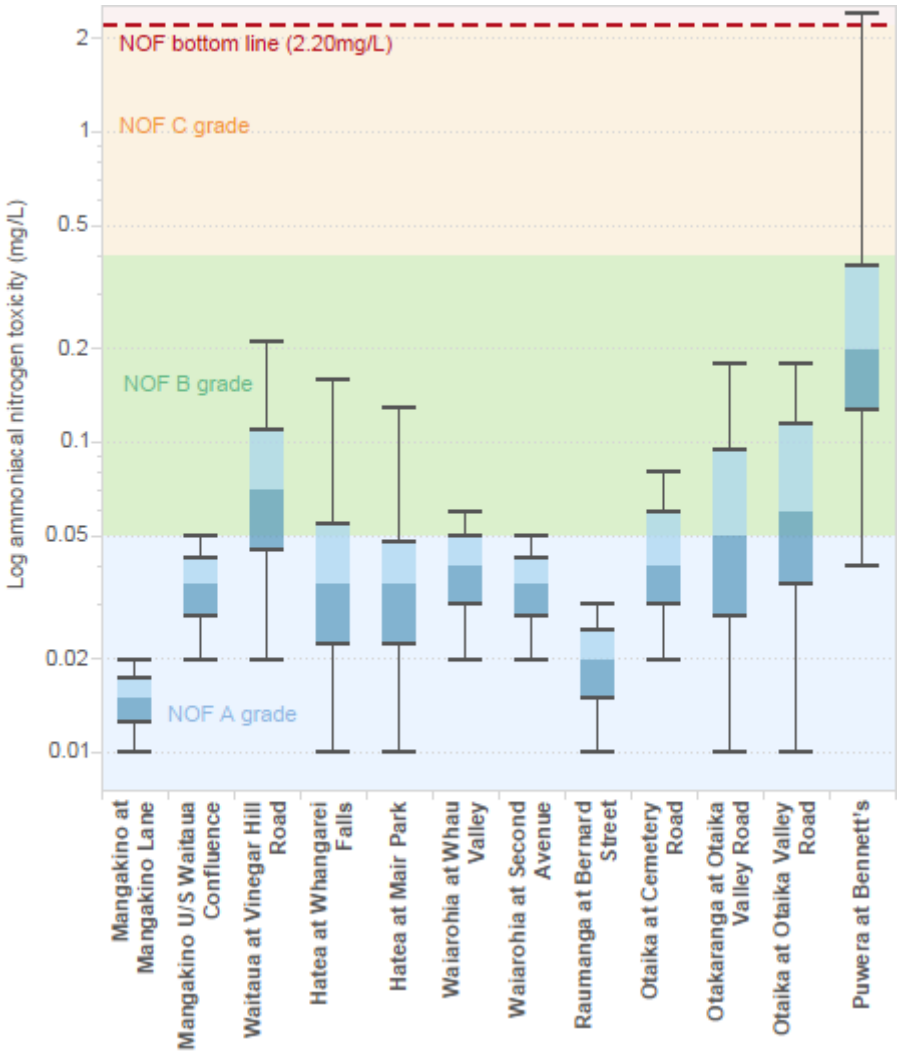

Figure 6: Ammoniacal nitrogen toxicity (July 2014 to June 2015) with annual maximum NOF grades.

Results indicate that ammoniacal nitrogen levels generally meet toxicity standard within the Whāngārei Harbour catchment with the maximum falling into the A or B NOF grades for all sites apart from the Puwera at Bennet's (Figure 6). At this site the maximum falls into the D grade, exceeding the NOF bottom line. Although more data is required to accurately assess toxicity at this site these high levels of ammoniacal nitrogen pose a high risk for most aquatic species.

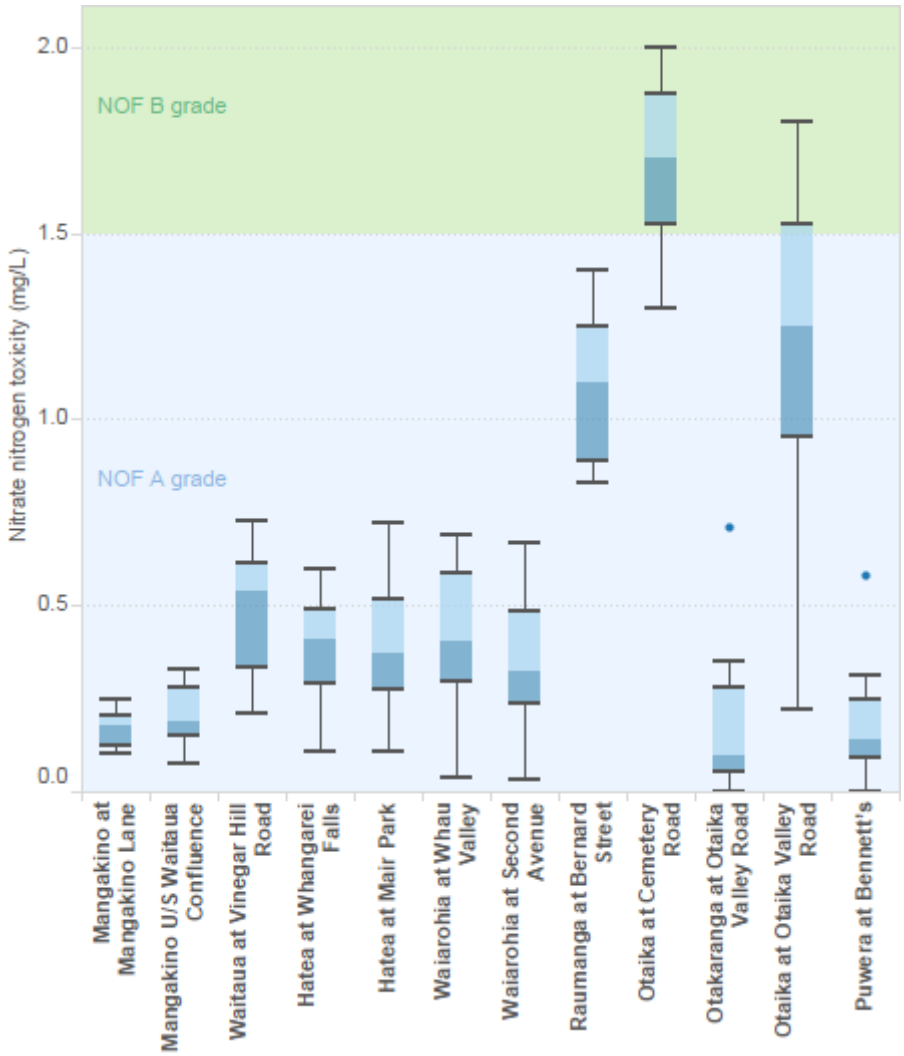

Figure 7: Nitrate nitrogen toxicity (July 2014 to June 2015) with 95th percentile NOF grades.

All 95th percentile results for nitrate toxicity (Figure 7) fall into the A or B grade indicating that nitrate toxicity is not a problem in the Whāngārei Harbour catchment.

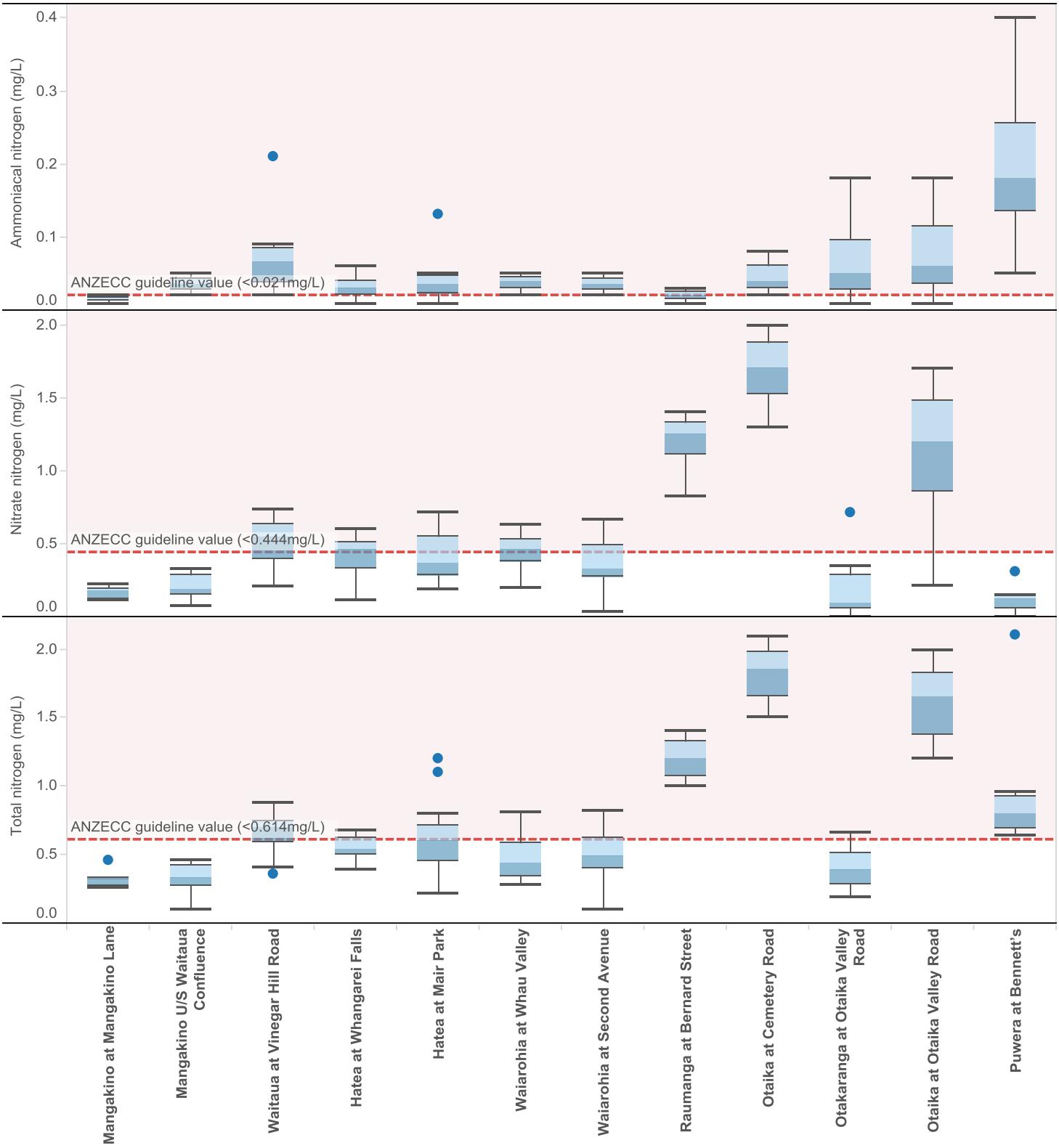

Figure 8: Ammoniacal nitrogen, nitrate nitrogen and total nitrogen (July 2014 to June 2015) with ANZECC guideline values.

Although toxicity levels for ammoniacal nitrogen and nitrate nitrogen generally meet national standards, 10 out of the 12 sites monitored within the Whangarei Harbour catchment recorded median levels exceeding the ANZECC guideline value for ammoniacal nitrogen and four, i.e. Waitaua at Vinegar Hill Road, Raumanga at Bernard Street, Otaika at Cemetery Road and Otaika at Otaika Valley Road, recorded median levels exceeding the ANZECC guideline value for nitrate nitrogen. Total nitrogen median levels recorded at Waitaua at Vinegar Hill Road, Raumanga at

Bernard Street, Otaika at Cemetery Road, Otaika at Otaika Valley Road and Puwera at Bennets Farm were also above ANZECC guideline value (Figure 8).

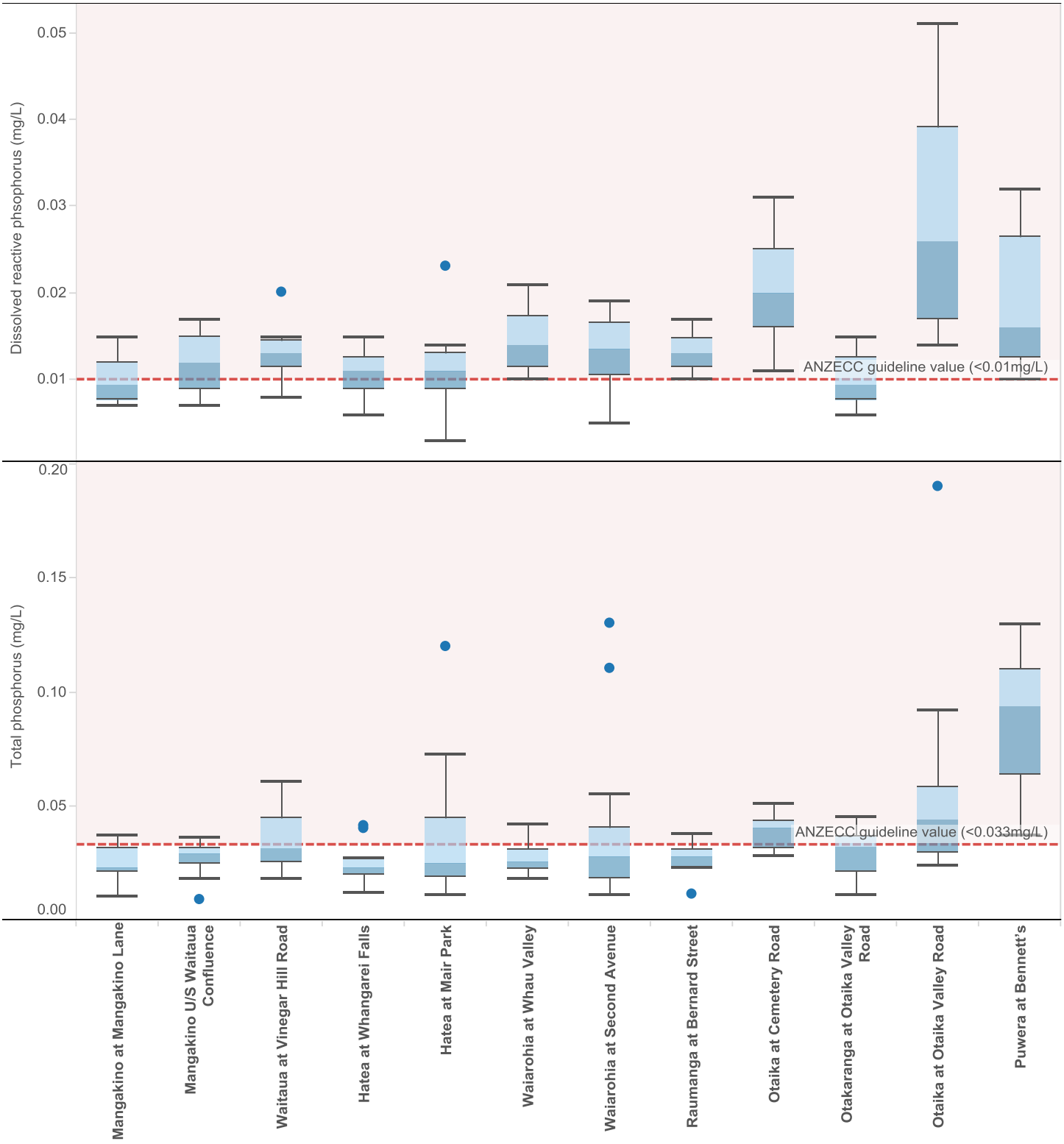

Figure 9: Dissolved reactive phosphorous and total phosphorous (July 2014 to June 2015) with ANZECC guideline values.

There is currently no guideline for dissolved reactive phosphorous in the NOF. However, median levels recorded were elevated within the Whāngārei Harbour catchment (Figure 9) with all but two sites – Mangakino at Mangakino Lane and Otakaranga at Otaika Valley Road sites – above the ANZECC guideline value for lowland rivers (0.01 mg/L) in particular at the Otaika at Cemetery Road, Otaika at Otaika Valley Road, Puwera at Bennet's and Waiarohia at Whau Valley sites. Total phosphorus median levels recorded at three of these sites also exceeded guidelines: Otaika at Cemetery Road, Otaika at Otaika Valley Road and Puwera at Bennets. Elevated dissolved reactive phosphorus median levels were also recorded at the closest reference site, i.e. Mangere at Pukenui Forest, indicating naturally elevated background levels possibly related to the surrounding geology.

2.3.2 Periphyton community

Periphyton is the slime and algae community growing on river and stream beds. As the primary producer in stream ecosystems, it is an important indicator of ecosystem health. It has the ability to respond quickly to changes in water quality and form excessive growths under ideal conditions, affecting instream values, such as biodiversity and recreational use.

Chlorophyll a (Chl a) levels are used as a measure of periphyton biomass in the NOF. The main drivers for periphyton growth include light and nutrient levels. However, periphyton growth normally requires a stable substrate such as rocks and cobbles to become established, and many streams in Northland have a substrate of mainly fine sediment which is easily disturbed, making it difficult for periphyton to become established. Just seven of the 12 Whāngārei Harbour catchment water quality sites have a stony substrate suitable for periphyton growth and therefore sampling and are monitored monthly for periphyton cover and Chl a levels (Figure 10).

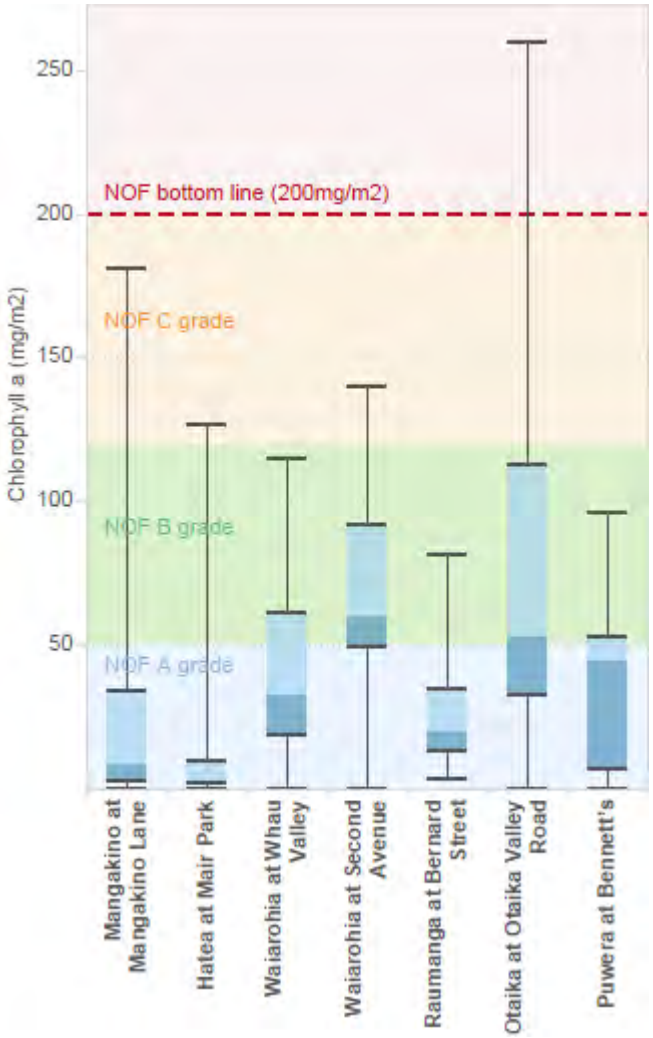

Figure 10: Chlorophyll a (July 2014 to June 2015) with corresponding NOF grades (Whiskers depict maximum results which can be exceeded on no more than two occasions within three years).

The NOF guidelines recommend at least three years of data to complete and interpret periphyton results. One year of data currently available suggest that only one site: Otaika at Otaika Valley Road may be prone to periphyton blooms and fail the bottom line of a maximum value of 200mg Chl a/m^2 exceeded on no more than two occasions within three years (Figure 10). This site, with the exception of the Otaika at Cemetery Road (unsuitable for periphyton monitoring), also recorded the highest annual median nutrient levels (nitrate nitrogen and dissolved reactive phosphorous, Figure 7 and Figure 9) compared to all other Whāngārei Harbour sites.

2.3.3 Water clarity

Good water clarity is important for light availability for periphyton growth, the primary food resource for stream life. Clear water is also important for visual feeding by fish and invertebrates. Water clarity is influenced by a number of factors including suspended sediment and algal biomass. Suspended sediments are typically elevated following large rainfall events, causing low water clarity and high turbidity. Turbidity is one measure of water clarity.

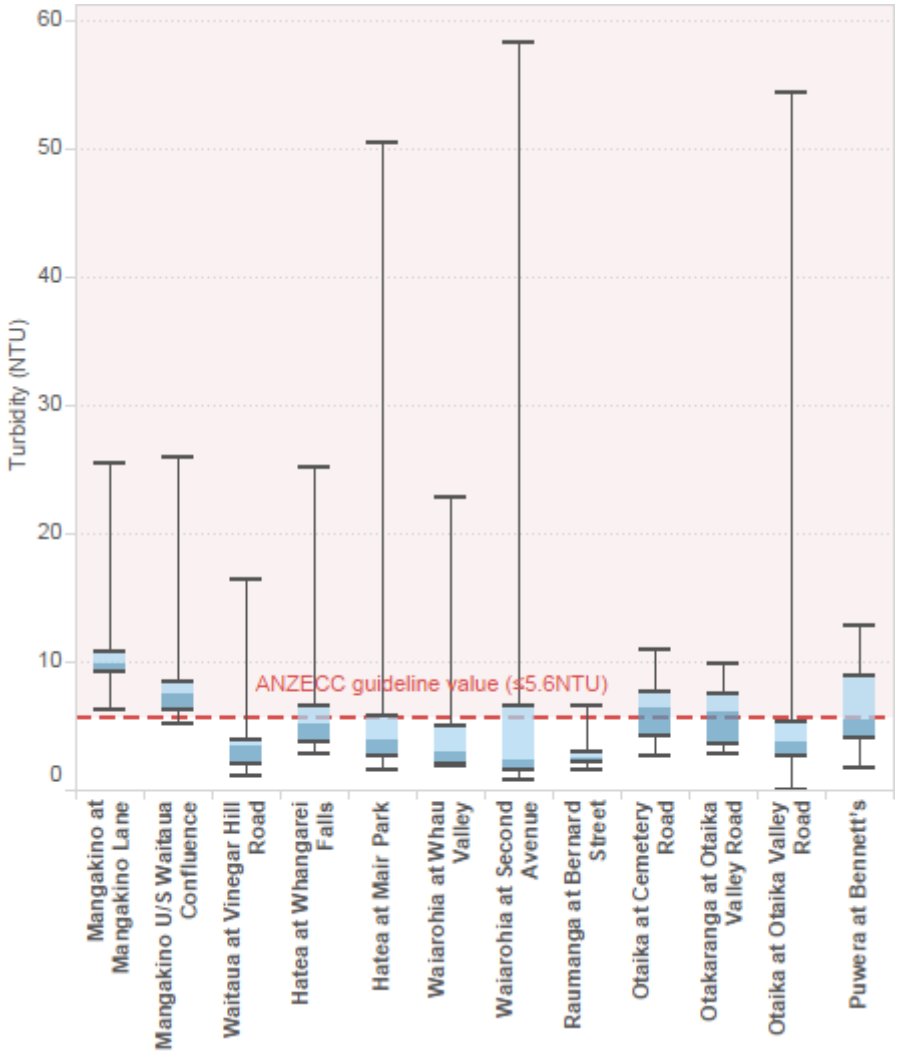

Figure 11: Turbidity (July 2014 to June 2015) with ANZECC guideline value.

Currently there is no measure for turbidity in the NOF. However median turbidity levels from July 2015 to June 2015 met ANZECC 2000 guidelines for lowland rivers (5.6NTU) at two thirds of the 12 sites (Figure 11). Of the four sites that exceeded the guideline, two were within the Hātea catchment: Mangakino at Mangakino Lane and Mangakino U/S Waitaua confluence; and two within the Otaika catchment: Otaika at Cemetery Road and Otakaranga at Otaika Valley Road. Highest turbidity levels of 58NTU were recorded at the Waiarohia at Second Avenue site.

Even rivers in pristine native forested catchments record elevated sediment levels following heavy rain, being a combination of sediment washed into the river from surrounding land, and sediment re-suspension from the river bottom due to the increased flows and streambank erosion. However, activities such as intensive agriculture, forestry harvesting and land subdivision, combined with a lack of riparian vegetation and/or stock access to waterways, generally increase considerably sediment loads. Good land management practices such as stock exclusion, riparian planting and setbacks, and sediment control in forestry harvesting can mitigate such impacts on waterways.

2.3.4 Faecal pathogens – Escherichia coli *(E. coli)*

Although faecal pathogens are not known to affect aquatic ecosystems they are of concern for both human and animal health. The faecal indicator bacterium *E. coli* indicates contamination from faecal matter which can potentially contain harmful pathogens. *E. coli* levels (Figure 12) at most sites in the Whāngārei Harbour catchment fell into the A or B grade for secondary contact recreation (activities involving occasional immersion such as wading, boating, etc.) with median levels below 1000 *E. coli*/100mL. However *E. coli* levels can be highly elevated; third quartile measures for Raumanga at Bernard Street and Otaika at Cemetery Road fell into the D grade where people are exposed to a high risk of infection (greater than 5% risk) from contact with water. Microbial source tracking results indicate that the primary source of contamination within the catchment is ruminant but human markers have also been detected on several occasions at the Waiarohia at Whau Valley and Raumanga at Bernard Street sites.

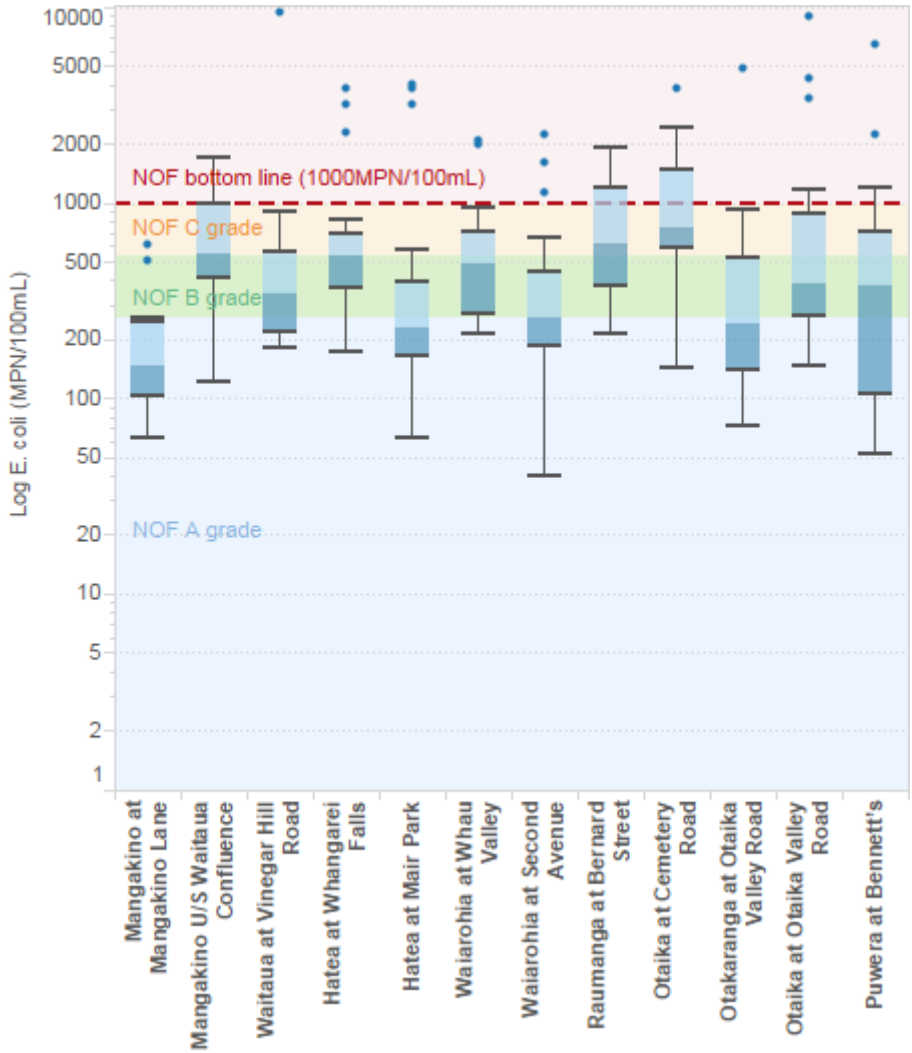

Figure 12: Annual *E. coli* levels (logarithmic scale) (July 2014 to June 2015) with corresponding NOF grades for secondary contact recreation.

The NOF guidelines for recreational swimming (primary contact recreation involving full immersion) have a limit of 540 *E. coli*/100mL for the annual 95th percentile (the C grade lower limit). Where *E. coli* levels are below 540 *E. coli*/100mL it is considered that people have a low risk of infection when undertaking activities likely to involve full immersion. The popular swimming site Hātea at Whāngārei Falls met these guidelines on half the sampling

occasions from July 2014 to June 2015 (Figure 12). These results were obtained from monthly samples collected year around which is a separate monitoring programme to the recreational swimming programme. In contrast the recreational swimming programme results for 2014/15, where sampling is carried out weekly over summer months (end of November to end of February), exceeded 540 *E. coli*/100mL on six out of 24 sampling occasions, or 25 percent of the time (Figure 13). Those lower results compared to the year round monthly monitoring are to be expected as summer months tend to be drier with less rainfall related land run-offs.

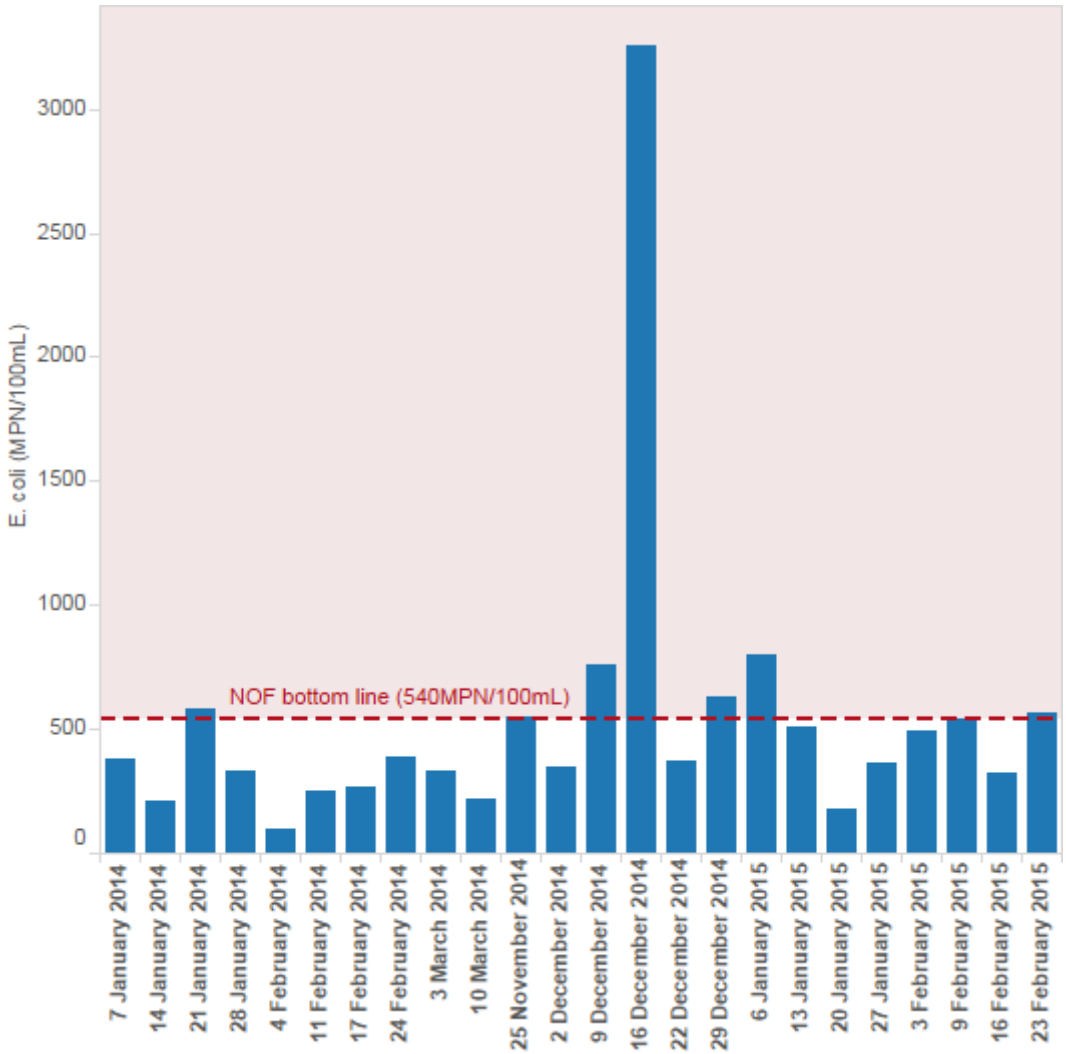

Figure 13: Weekly recreational swimming *E. coli* results (November2014 to February 2015) at the Whāngārei Falls site with corresponding NOF standard for primary contact recreation.

It should be noted that natural background levels of *E. coli* tend to be slightly higher in warm wet lowland areas compared to other river environments in New Zealand (McDowell et al, 2013). Nevertheless the occasionally excessive *E. coli* levels in the Whāngārei Harbour catchment highlight the need for good land and sewage disposal systems management in protecting both the freshwater and the receiving marine environment in Whāngārei Harbour.

2.3.5 Dissolved oxygen

Dissolved oxygen is important for freshwater invertebrates and fish, with some species being more sensitive to low oxygen levels than others. Dissolved oxygen levels vary with temperature, biological activity and how quickly it transfers from the atmosphere. Biological activity includes microbial activity by bacteria and primary production by plants and algae and can be associated with the presence of certain pollutants, particularly organic matter such as sewage effluent, decaying aquatic vegetation and animal manures. Aquatic plants photosynthesise during the day (producing oxygen) and respire at night (consuming oxygen). In a slow flowing stream containing macrophytes (aquatic plants), such as at the Otakaranga at Otaika Valley Road site, there are likely to be large fluctuations in dissolved oxygen throughout the day compared to streams such as at the Mangakino at Mangakino Lane site which is a fast flowing stream within a forested catchment (Figure 14).

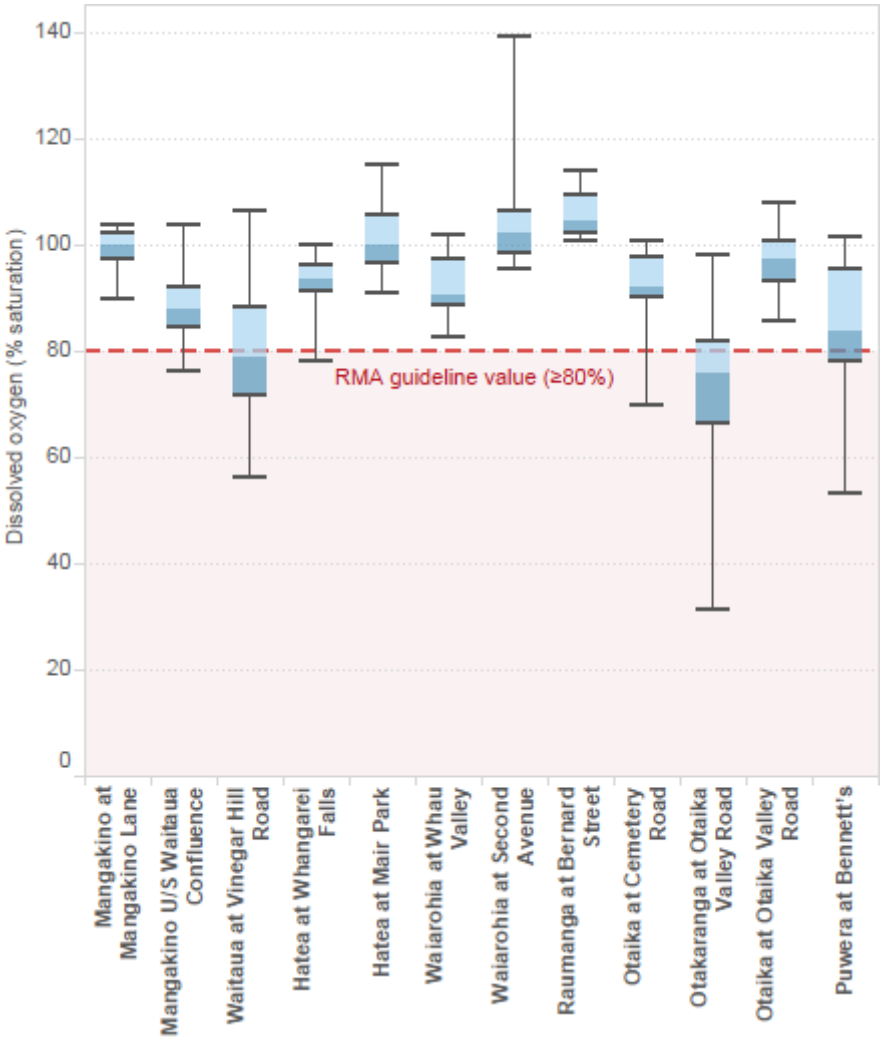

Figure 14: Dissolved oxygen (July 2014 to June 2015) with the RMA 1991 trigger value.

Dissolved oxygen levels recorded between July 2014 and June 2015 were mostly above the recommended trigger value in the Whāngārei Harbour catchment (Figure 14). All but two of the medians – Waitaua at Vinegar Hill Road and Otakaranga at Otaika Valley Road sites – were above RMA 1991 trigger value (≥80 % saturation).

The lowest dissolved oxygen level recorded at the Otakaranga at Otaika Valley Road site was 31.2%, well below recommended trigger value and at a level which would put aquatic plants

and animals under stress. The highest level recorded was 139.2% at the Waiarohia at Second Avenue site.

2.3.6 Invertebrate community health

Stream invertebrates (macroinvertebrates) are used as biological indicators of water quality and stream health. As they live in the stream environment over an extended period of time they are a good indicator of overall water quality/ecosystem health. The Macroinvertebrate Community Index (MCI) is an indicator of organic enrichment and pollution, where taxa are assigned predetermined scores on a scale of 1 to 10 depending on their inherent sensitivity to pollution. The MCI score at a site is based on taxa present, with categories in Table 4 used to determine the overall water quality level.

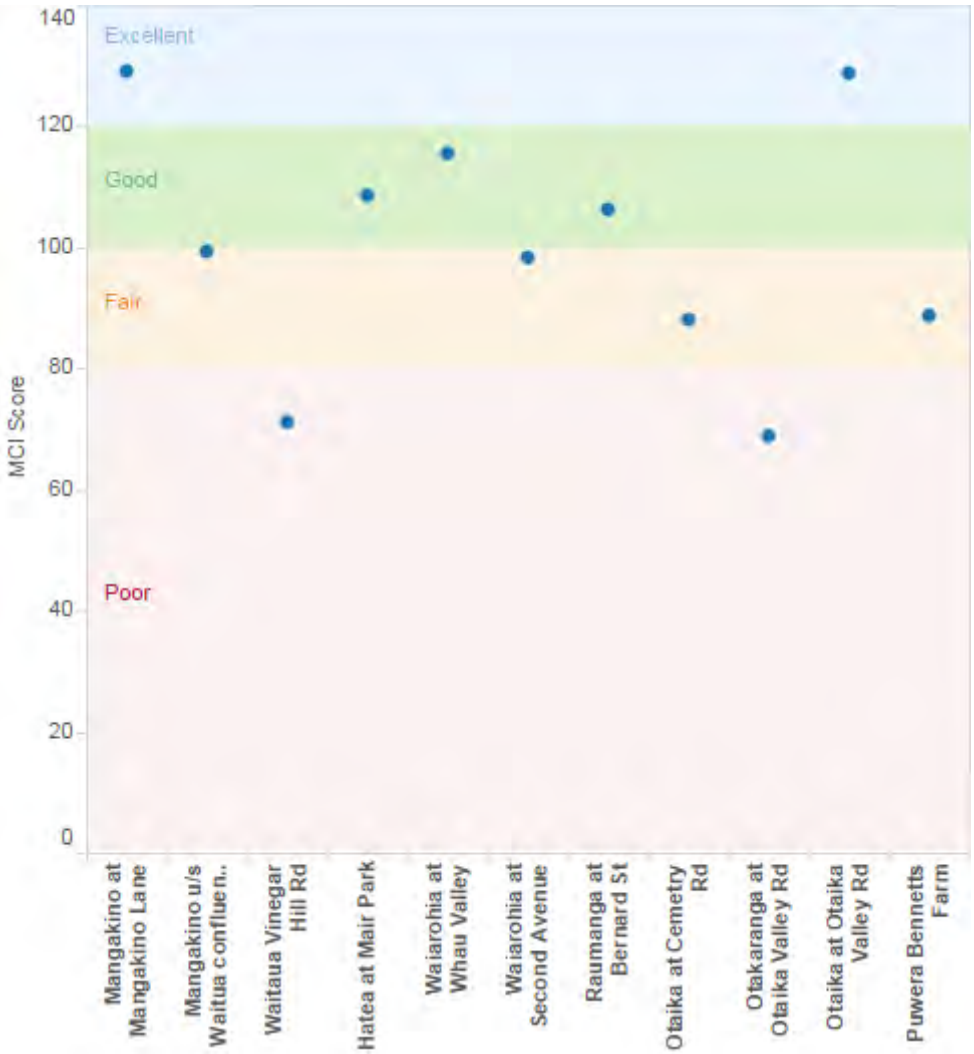

Figure 15: Macroinvertebrate Community Index (MCI) results, summer 2014/15.

Table 4: Macroinvertebrates Community Index scoring system (Boothroyd and Stark 2000).

Category	MCI	Stream/river state
Excellent	> 120	Clean water
Good	100 – 119.9	Possible mild pollution
Fair	80 – 99.9	Probable moderate pollution
Poor	< 80	Probable severe pollution

Results for summer 2014/15 (Figure 15) suggest that:

- two sites recorded excellent water quality,
- three sites recorded good water quality,
- four sites recorded fair water quality,
- and two recorded poor water quality.

The sites with the highest scores were Mangakino at Mangakino Lane and Otaika at Otaika Valley Road which both had MCI scores of 129. Both these sites also scored the highest for habitat quality (Figure 17). The lowest scoring sites were Otakaranga at Otaika Valley and Waitaua at Vinegar Hill Road with MCI scores of 69 and 71 respectively. Both these sites had poor habitat scores accordingly (Figure 17).

2.3.7 Fish community

The use of fish as an indicator of ecological health is complex in New Zealand by the fact that many species are diadromous (that is to say spend part of their life cycle at sea) so their presence is influenced by factors such as barriers to migration, distance inland as well as habitat availability, water quality, etc. However fish are an important part of the food web and their absence will skew normal predator-prey relationships. Their presence is an important measure of ecological stability and underpins a stream's ecological value.

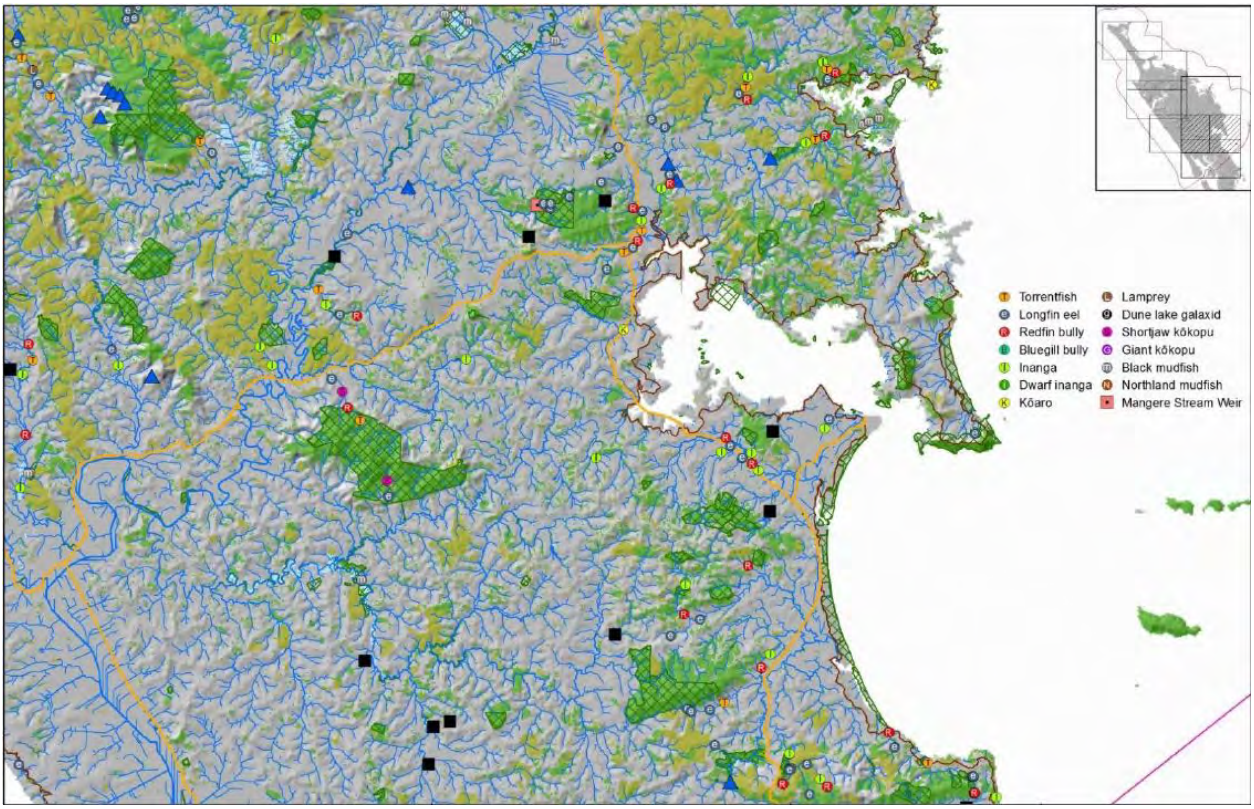

Figure 16: Distribution of threatened fish species in the Whāngārei Harbour catchment (McArthur and Beveridge, 2015)

To date nine native fish species as well as rainbow trout and three pest fish species (goldfish, catfish and gambusia) have been recorded in the Whāngārei Harbour catchment. Native species include several at risk or threatened species such as longfin eel, koaro, inanga, torrent fish and redfin bully (Figure 16).

2.3.8 Stream habitat quality

Where there is a diverse habitat available with a variety of flow types (runs riffles and pools), instream debris and good quality riparian vegetation, there tends to be high ecological health. Different flow types offer a variety of different habitats, encouraging greater diversity. Riparian cover stabilises banks, provides a sink for nutrients, traps sediment, and provides shade during hot summer months as well as a source of food in the form of falling vegetation and terrestrial invertebrates.

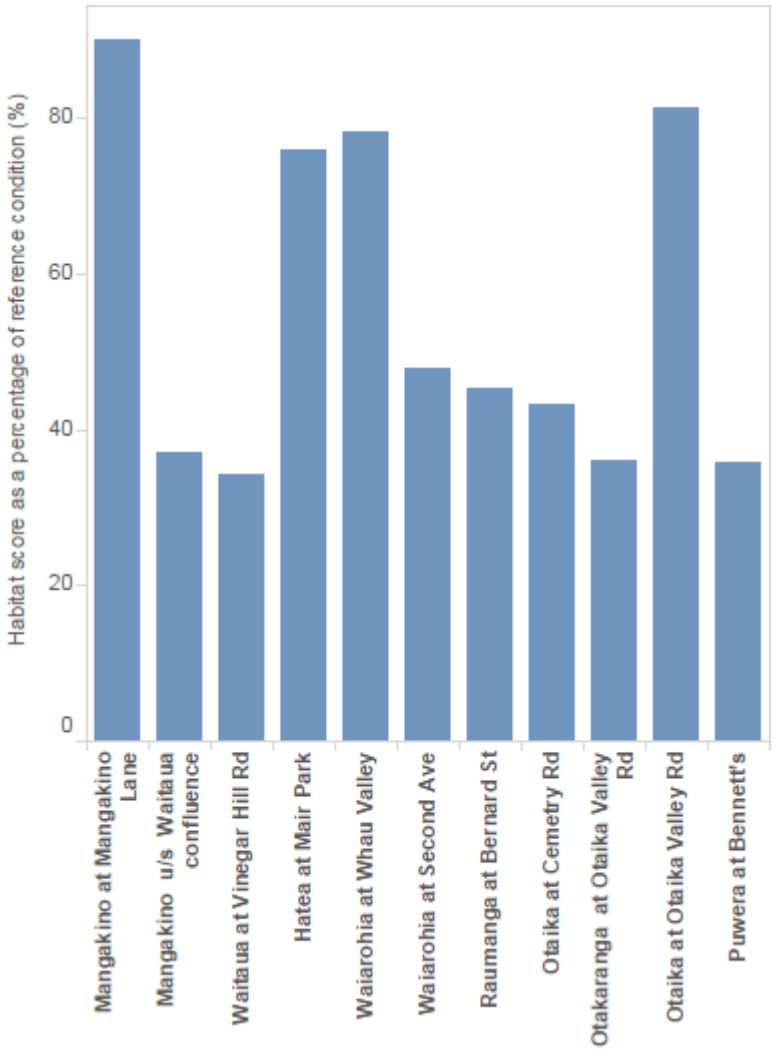

Figure 17: Rapid habitat results shown as a percentage of reference condition (Waipoua at SH12) for Whāngārei Harbour catchment water quality monitoring sites, summer 2014/15.

Seven of the sites monitored in the Whāngārei Harbour catchment recorded a habitat score of less than 50 percent of reference condition (Figure 17). Lower scoring sites such as the Otakaranga at Otaika Valley Road and Waitaua at Vinegar Hill Road have a surrounding land use of mainly pasture, stock have access to the river, and the banks are relatively unstable. These sites also show evidence of high sediment loads, often associated with high intensity land use and stock access, with most of the substrate being composed of sediment providing little habitat diversity with a mainly uniform substrate and flow type (NRC 2012) and recorded two of the lowest MCI scores (69 and 71 respectively, Figure 15).

The highest habitat score of 90 percent of reference condition was recorded at the Mangakino at Mangakino Lane. This site is draining land covered by plantation forestry and

native bush, has plenty of cover, a stony substrate and a variety of habitat types. It also recorded the highest MCI score (129) of all sites (Figure 15).

2.3.9 NOF results 2012 to 2014

NOF grades from 2012 to 2014 at the RWQMN sites Hātea at Mair Park, Waiarohia at Second Avenue and Otaika at Otaika Valley Road are presented in Table 5. The Hātea and Waiarohia sites consistently scored A or B grades for ammoniacal and nitrate nitrogen toxicity and human health (secondary contact recreation) while the Otaika site water quality seemed to have been impacted, recording several NOF C grades. Chlorophyll a results for both the Otaika and Waiarohia sites indicated a predisposition to periphyton blooms which may indicate nutrient enrichment.

Table 5: NOF grades from 2012 to 2014 at the RWQMN sites in the Whāngārei Harbour catchment.

Value	Ecosystem health						Human health	
Indicator (unit)	Nitrate nitrogen toxicity (mg/L)		Ammoniacal nitrogen toxicity (mg/L)		Periphyton (Chla mg/m^2)		*E. coli* (*E. coli*/100 mL)	
Site name	1 year median	1 year 95%ile	1 year median	1 year max	3 year max		1 year median (secondary contact)	
2012								
Hātea at Mair Park	0.385 A	0.611 A	0.013 A	0.027 A	ND	ND	190	A
Otaika at Otaika Valley Road	1.250 B	1.745 B	0.016 A	0.490 C	ND	ND	555	C
Waiarohia at Second Avenue	0.335 A	0.553 A	0.014 A	0.039 A	ND	ND	441	B
2013								
Hātea at Mair Park	0.335 A	0.523 A	0.024 A	0.083 B	ND	ND	214	A
Otaika at Otaika Valley Road	1.045 B	1.635 B	0.017 A	0.040 A	ND	ND	671	C
Waiarohia at Second Avenue	0.230 A	0.558 A	0.015 A	0.061 B	ND	ND	275	B
2014								
Hātea at Mair Park	0.440 A	0.690 A	0.019 A	0.07 B	57.05	B	393.0	B
Otaika at Otaika Valley Road	1.250 B	1.525 B	0.026 A	0.07 B	152.00	C	409.0	B
Waiarohia at Second Avenue	0.320 A	0.670 A	0.015 A	0.03 A	239.00	D	292.0	B

3 Water quality Summary

Table 6: Water quality summary (July 2014 to June 2015) for sites in the Whāngārei catchment as well as a reference site in the Pukenui Forest (draining native vegetation) using NOF attributes.

Water quality monitoring site	National Objective Framework (NOF) attributes						
	Nitrate nitrogen toxicity (mg/L)		Ammoniacal nitrogen toxicity (mg/L)		Escherichia coli (*E. coli*/100mL)		Periphyton exceeds no more than 8% of samples (Chl a mg/m^2)
	Annual median A ≤1 B >1≤2.4 C >2.4≤6.9 D >6.9	95th percentile A ≤1.5 B >1.5 ≤3.5 C >3.5≤9.8 D >9.8	Annual median A ≤0.03 B .0.3≤0.24 C .0.24≤1.3 D.1.3	Annual maximum A ≤0.05 B >.05≤0.4 C >0.4≤2.2 D >2.2	Annual median A ≤260 B >260≤540 C >540≤1000 D >1000	Annual 95th percentile A ≤260 B >260≤540 D >540	Chlorophyll a A ≤50 B >50≤120 C >120≤200 D >200
Mangere at Pukenui Forest	A	A	A	A	A	A	ND
Mangakino at Mangakino Lane	A	A	A	A	A	D	C
Mangakino U/S Waitaua confluence	A	A	A	B	C	D	ND
Waitaua at Vinegar Hill Road	A	A	B	B	B	D	ND
Hātea at Whāngārei Falls	A	A	A	B	B	D	ND
Hātea at Mair Park	A	A	A	B	A	D	C
Waiarohia at Whau Valley	A	A	A	B	B	D	B
Waiarohia at Second Avenue	A	A	A	B	B	D	C
Raumanga at Bernard Street	A	A	A	A	C	D	B
Otaika at Cemetery Road	B	B	A	B	C	D	ND
Otakaranga at Otaika Valley Road	A	A	A	B	A	D	ND
Otaika at Otaika Valley Road	A	B	B	B	B	D	D
Puwera at Bennett's	A	A	B	D	B	D	B

Table 7: Water quality summary (July 2014 to June 2015) for sites in the Whāngārei catchment as well as a reference site in the Pukenui Forest (draining native vegetation) using national guideline/trigger values.

Water quality monitoring site	ANZECC guidelines						RMA 1991	Ecological indicators	
	Nitrate, nitrite, nitrogen (mg/L)	Ammoniacal nitrogen (mg/L)	Total nitrogen (mg/L)	Dissolved reactive phosphorus (mg/L)	Total phosphorous (mg/L)	Turbidity (NTU)	Dissolved oxygen (% saturation)	Macro-invertebrates	Stream habitat
	Annual median <0.444	Annual median <0.021	Annual median <0.614	Annual median <0.01	Annual median <0.033	Annual median <5.6	Annual median ≥80	MCI score (Table 4)	% rating compared with reference site
Mangere at Pukenui Forest	Below	Below	Below	Above	Below	Below	Above	127	100
Mangakino at Mangakino Lane	Below	Below	Below	Below	Below	Above	Above	129	90
Mangakino U/S Waitaua confluence	Below	Above	Below	Above	Below	Above	Above	99	37
Waitaua at Vinegar Hill Road	Above	Above	Above	Above	Below	Below	Below	71	34
Hātea at Whāngārei Falls	Above	Above	Below	Below	Below	Below	Above	ND	ND
Hātea at Mair Park	Below	Above	Below	Above	Below	Below	Above	109	76
Waiarohia at Whau Valley	Above	Above	Below	Above	Below	Below	Above	115	78
Waiarohia at Second Avenue	Below	Above	Below	Above	Below	Below	Above	98	48
Raumanga at Bernard Street	Above	Below	Above	Above	Below	Below	Above	106	45
Otaika at Cemetery Road	Above	Above	Above	Above	Above	Above	Above	88	36
Otakaranga at Otaika Valley Road	Below	Above	Below	Below	Below	Above	Below	69	43
Otaika at Otaika Valley Road	Above	Above	Above	Above	Above	Below	Above	129	81
Puwera at Bennett's	Below	Above	Above	Above	Above	Below	Above	89	36

Values in Table 6 and Table 7 are not directly comparable; Table 6 refers to national standards (NOF) while Table 7 provides conservative numbers for physical and chemical measures in rivers above or below to indicate which aquatic ecosystems may be exposed to stress.

Results for the Mangere at Pukenui Forest draining native vegetation provides a reference of natural condition against which to compare results. The NOF is still under development with a number of additional attributes currently being evaluated. In its current form the NOF does not address all the water quality issues of concern in Northland. For this reason a number of other guidelines, trigger values and ecological indicators have been included to provide a more holistic overview of water quality in the catchment.

Based on very limited data, results indicate that:

- Nitrate nitrogen and ammoniacal nitrogen toxicity levels were low within the Whangarei harbour catchment (Figure 6) however nitrate nitrogen median levels recorded at four sites in particular, i.e. Waitaua at Vinegar Hill Road, Raumanga at Bernard Street, Otaika at Cemetery Road and Otaika at Otaika Valley Road were above ANZECC guideline value (Figure 8).
- Median dissolved reactive phosphorous levels were elevated within the catchment (Figure 9). The Mangere at Pukenui Forest site served as a reference site draining almost entirely native forest against which to compare results to. Even this site failed the ANZECC guideline value for dissolved reactive phosphorous indicating naturally elevated background levels possibly due to surrounding geology.
- Median total phosphorous levels were generally within guidelines but were elevated at three sites, i.e. Otaika at Cemetery Road, Otaika at Otaika Valley Road and in particular Puwera at Bennets Farm (Figure 9)
- Both ammoniacal nitrogen and total phosphorus median levels were elevated recorded at the Puwera at Bennets Farm site.
- *E. coli* levels met national standard for secondary contact recreation but recorded a NOF C grade at three sites: Mangakino U/S Waitaua Confluence, Raumanga at Bernard Street and Otaika at Cemetery Road (Figure 12).
- *E. coli* levels at the popular swimming site Hātea at Whāngārei falls frequently failed guidelines for swimming (Figure 12 and Figure 13).
- MCI and habitat health recorded were generally poor within the catchment compared to the reference site in the Pukenui Forest (Figure 15 and Figure 17). This also correlates with the low dissolved oxygen levels recorded at Otakaranga at Otaika Valley Road and Waitaua at Vinegar Hill Road (Figure 14).
- The most impacted sites exceeding several guideline values were those located in the Otaika sub-catchment as well as the Waitaua at Vinegar Hill Road site (Table 7). All these sites currently have stock access.

4 References

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5 Abbreviations

- ANZECC: Australian and New Zealand Environment and Conservation Council
- Chl a: chlorophyll a
- D/S: downstream
- DO: Dissolved Oxygen
- DRP: Dissolved Reactive Phosphorus
- *E. coli*: Escherichia coli
- IQR: interquartile range
- LAWA: Land Air Water Aotearoa
- MCI: Macroinvertebrate Community Index
- MfE: Ministry for the Environment
- NIWA: National Institute of Water and Atmospheric research
- NOF: National Objective Framework
- NPS-FM: National Policy Statement for Freshwater Management
- NTU: Nephelometric Turbidity Units
- RMA 1991: Resource Management Act 1991
- RWQMN: River Water Quality Monitoring Network
- SH: State Highway
- SPI: Submerged Plant Indicator
- TLI: Trophic Level Index
- TN: Total Nitrogen
- TP: Total Phosphorus
- TURB: Turbidity
- WNW: Waiora Northland Water

6 Appendix

Figure 18: Mangakino at Mangakino Lane

Figure 19: Mangakino U/S Waitua confluence

Figure 20: Waitaua at Vinegar Hill Road

Figure 21: Hātea at Whāngārei Falls.

Figure 22: Hātea at Mair Park

Figure 23: Waiarohia At Whau Valley

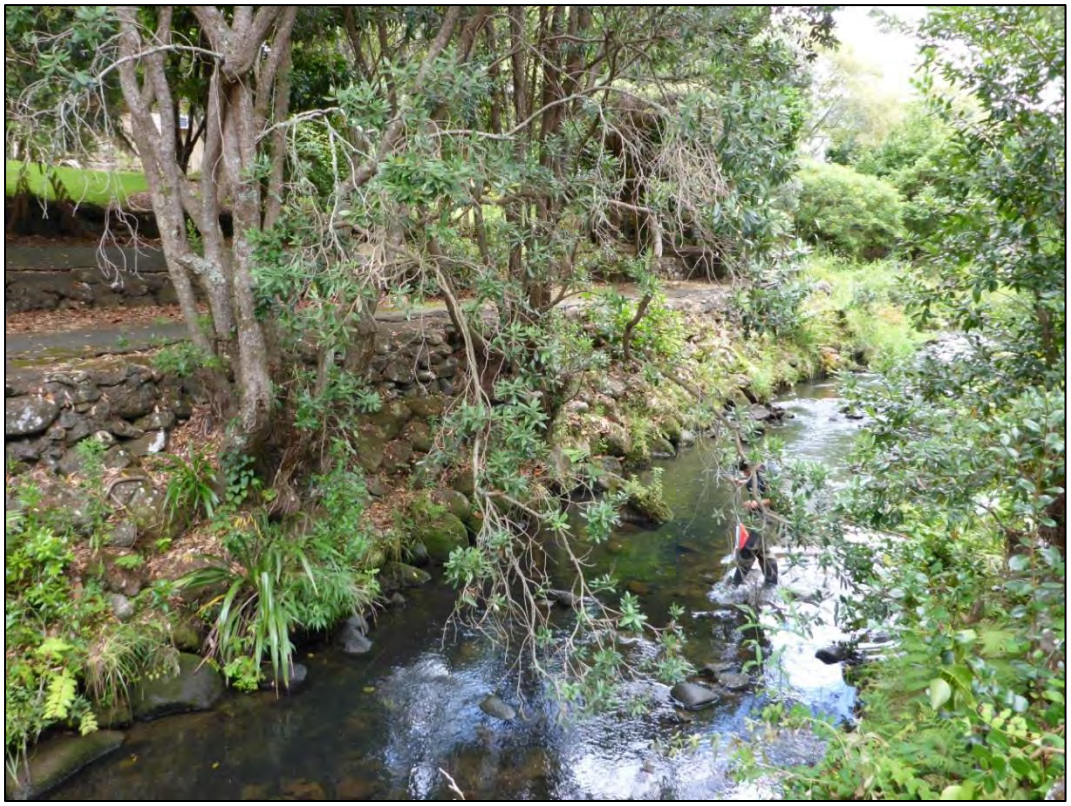

Figure 24: Waiarohia at Second Avenue

Figure 25: Raumanga at Bernard Street

Figure 26: Otaika at Cemetery Road.

Figure 27: Otakaranga at Otaika Valley Road

Figure 28: Otaika at Otaika Valley Road.

Figure 29: Puwera at Bennets Farm.