

# **Waikato River Water Quality Monitoring Programme: Data Report 2009**

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# 1 Introduction

## 1.1 Background

The year 2009 report follows the format of the previous data report (Beard, 2008).

To effectively manage water quality, the Waikato River monitoring programme addresses the following questions:

1. What is the quality of the water now?
2. Why is the water of the observed level of quality?
3. Is water quality getting better or worse? If so - what makes it change?
4. How can we improve the quality, ecological health and integrity of the Waikato River?

The monitoring information allows Environment Waikato to:

- determine compliance with classification standards
- define the suitability of the resource for various beneficial uses and values of the water
- monitor the impact of major discrete point source discharges on water quality
- monitor the impacts of diffuse discharges on water quality
- provide a basis for evaluating the effectiveness of resource management measures.

This dataset is invaluable for the evaluation of the Waikato River: its state, the pressures on it and its response to these pressures. We need to continue to gather comprehensive, reliable and good quality data on the Waikato River to protect and enhance its values into the future.

This report is the 19<sup>th</sup> since the re-design of the Waikato River Monitoring Programme (WARIMP) implemented in 1989. Copies of reports can be obtained via the Environment Waikato Internet site <http://www.ew.govt.nz/Publications/> or by contacting Environment Waikato (the Library) on 0800 800 401, e-mail: [inforeq@ew.govt.nz](mailto:inforeq@ew.govt.nz).

## 1.2 Report content

The report provides information on:

1. Routine monthly monitoring of water quality at 10 sites:
  - Year 2009 summary data, tabulated by parameter for each location and reported with the median of the previous 5 years.
  - Key parameter graphs showing the average water quality for 2009 at each location, compared to results of the previous 5 years.
  - Summary tables identifying the number of samples meeting 'satisfactory' and 'excellent' water quality standards and guidelines.
  - Raw data for 2009.
2. Additional information is provided in the appendices on:
  - Flow (*Appendix I*).
    - The effect of flow is important to assessing water quality and making comparisons between years. Appendix I provides information on annual median flow at some locations for the previous 10 years.
  - Datasonde deployments
    - Plots of deployments undertaken during 2009 showing the level of diurnal and seasonal variation at five Waikato River sites (*Appendix II*).

## 1.3 Water quality guidelines and standards

Table 1 lists the physical and chemical water quality standards and guidelines used to assess the condition of the Waikato River in 2009. The standards mainly relate to either the protection of the ecological health of rivers and streams or to whether they are suitable for water-based recreation, especially swimming.

Some water quality guidelines and standards are relevant to the use of the Waikato River for both general water supply (industrial/cooling water, irrigation, stock water etc.) and as a source of municipal drinking water. In most cases two criteria are shown. The less stringent criteria define water that is “satisfactory” for the desired use; these are mostly based on existing national and other guidelines and standards (Appendix IV). The more stringent criteria identify “excellent” water, and reflect expert opinion. Samples gathered in 2009 whose results do not comply with the “satisfactory” criteria (Table 1) are underlined in raw data summaries.

**Table 1: Guidelines and standards for physicochemical water quality for ecological health and for human uses of water**

Water Quality Measure	Relevance <sup>1</sup>	Satisfactory	Excellent
<b>Ecological health</b>			
Dissolved oxygen (% saturation)	aquatic life (breathing)	>80	>90
pH	aquatic life (acidity)	6.5–9	7–8
Turbidity (NTU)	plant growth (clarity)	<5	<2
Ammoniacal-N (g/m <sup>3</sup> )	aquatic life (toxicity)	<0.88	<0.1
Temperature (°C) (May-Sep)	fish (spawning)	<12	<10
(Oct-Apr)		<20	<16
Total phosphorus (g/m <sup>3</sup> )	nuisance plant growth	<0.04	<0.01
Total nitrogen (g/m <sup>3</sup> )	nuisance plant growth	<0.5	<0.1
<b>Human uses - recreation</b>			
Baseflow water clarity (m)	visibility	>1.6	>4
Escherichia coli (no./100 mL)	human health	<550	<55
Median Escherichia coli (no./100 mL)	human health	<126	<23
<b>Human uses - water supply</b>			
Phytoplankton chlorophyll a (g/m <sup>3</sup> )	filter blockage	<0.02	<0.005
<b>Human uses - drinking water</b>			
Arsenic (g/m <sup>3</sup> )	human health (toxicity)	<0.01	–
Boron (g/m <sup>3</sup> )	human health (toxicity)	<1.4	–

<sup>1</sup> Refer to Appendix IV for description of guideline and standards values used. These guidelines and standards are also defined on the Environment Waikato Internet site; [www.ew.govt.nz](http://www.ew.govt.nz)

## 2 The Waikato River monitoring programme design

### 2.1 Sampling collection

Sample collection occurs monthly, as two sampling runs. Locations in the upper catchment from Taupo to Waipapa are visited as part of the first run, and locations in the middle and lower catchments from Hamilton (at the Narrows) to Tuakau are visited on the next. Each location is sampled at a similar time on each occasion (coefficient of variation  $\approx 2-6\%$ ) to minimise the effect of diurnal variation on the measurement of water quality parameters. Sample times are recorded in New Zealand Standard Time (NZST). Because of the controlled nature of the river, our daytime samples are generally collected at higher than median flows.

### 2.2 Sample locations

Routine water quality monitoring locations of the Waikato River Monitoring Programme and additional locations used during the summer microbiological surveys are summarised in *Table 2* and illustrated in *Figure 1*.

**Table 2: Routine sampling and bathing water monitoring locations**

Location Number	Distance <sup>1</sup> (km)	Location name	Map Ref.	Field <sup>x</sup> Measurements
1131.127	0.1	Taupo Gates	U18:772-757	–
1131.119 <sup>*d</sup>	1.2	Taupo – Reids Farm	U18:778:763	true left bank
1131.70 <sup>b</sup>	6.0	Huka Falls	U18:789-792	–
1131.244 <sup>d</sup>	7.8	Downstream Huka Falls	U18:797-809	river boat jetty <sup>2</sup>
1131.105 <sup>d</sup>	36.5	Ohaaki Bridge	U17:981-914	at bridge, true left bank
1131.107	75.8	Ohakuri Tailrace Bridge	U17:796-061	boat ramp <sup>3</sup>
1131.147	105.0	Whakamaru Tailrace	T17:552-056	boat ramp <sup>4</sup>
1131.143	126.1	Waipapa Tailrace	T16:448-200	boat ramp <sup>5</sup>
1131.81 <sup>b</sup>	166.7	Lake Karapiro Boat Ramp	T15:436-570	Horahora domain
1131.328	202.2	Hamilton – Narrows	S14:168-710	boat ramp <sup>6</sup>
1131.145 <sup>*b</sup>	210.8	Hamilton – Wellington St Bch	S14:117-757	at jetty, true right bank
1131.64 <sup>d</sup>	211.5	Hamilton – Traffic Bridge	S14:118-764	true right bank
1131.121 <sup>b</sup>	219.8	Hamilton – Sewer Bridge	S14:082-823	true left bank
1131.69	225.6	Horotiu Bridge	S14:048-871	d/s of bridge
1131.102 <sup>b</sup>	232.3	Ngaruawahia Bridge	S14:997-912	u/s of confluence <sup>7</sup>
1131.77	246.5	Huntly – Tainui Bridge	S13:003-018	true left bank
1131.117 <sup>*d</sup>	262.3	Rangiriri Bridge	S13:989-167	true right bank
1131.91	286.3	Mercer Bridge	S12:919-336	–
1131.133	296.8	Tuakau Bridge	R12:828-320	boat ramp <sup>8</sup>
1131.131 <sup>d</sup>	306.5	Tuakau – Elbows Landing	R12:745-352	NZ Steel Ltd pumping station

<sup>1</sup> approximate distance (in kilometres) from Lake Taupo's outlet.

<sup>2</sup> river boat jetty and boat ramp, true left bank, about 1.8km downstream of Huka Falls

<sup>3</sup> boat ramp in recreation reserve immediately upstream from dam (true left bank).

<sup>4</sup> boat ramp at Whakamaru Power Station.

<sup>5</sup> river access d/s of Lake Waipapa, about 500 m off S.H. 32 along a gravel road (true left bank).

<sup>6</sup> boat ramp accessed via Narrows Lane (true right bank)

<sup>7</sup> road bridge upstream of Waipa River confluence.

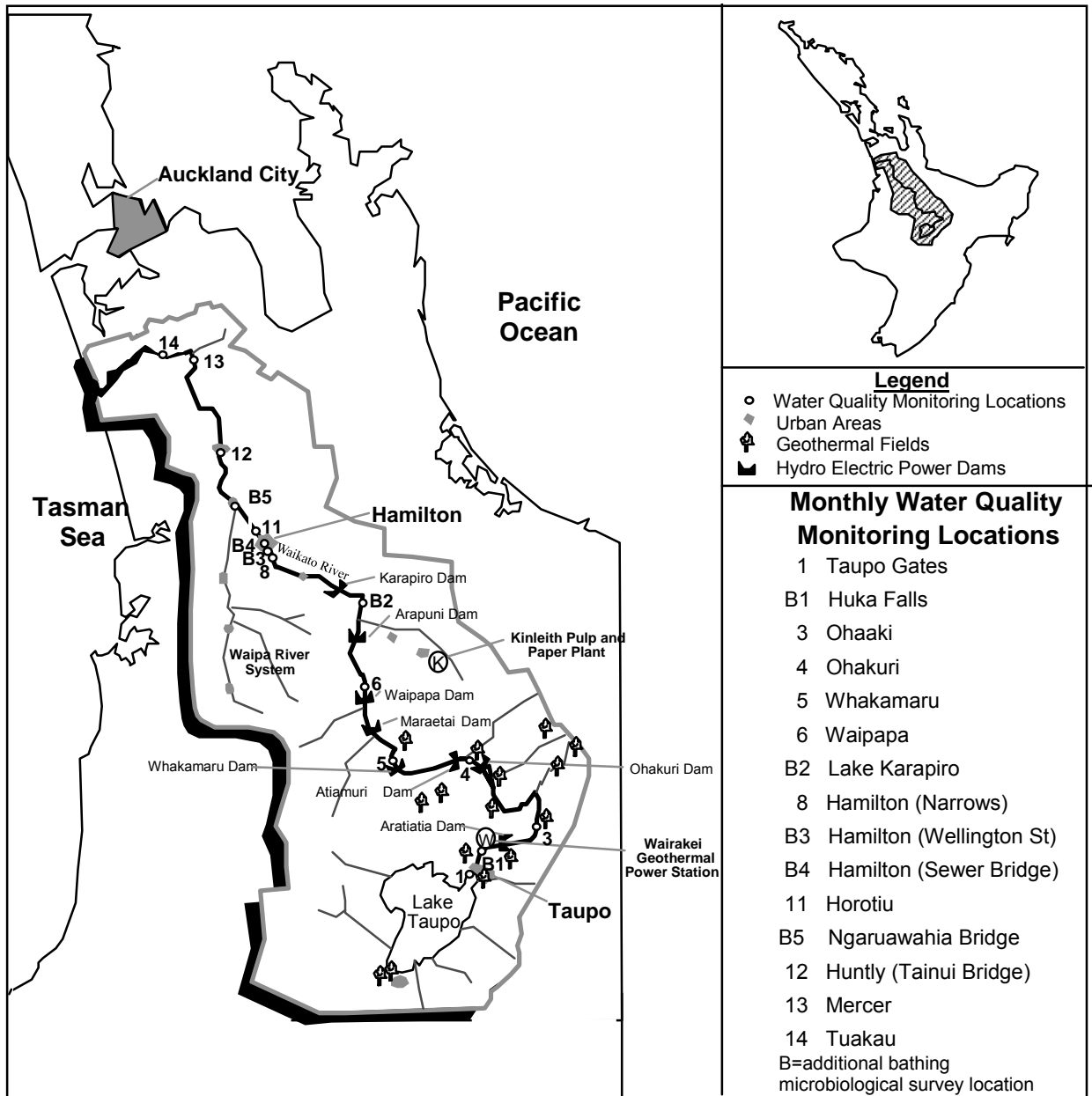
<sup>8</sup> immediately d/s of bridge, at Reserve (true right bank).

<sup>b</sup> bathing season intensive microbiological survey locations only – survey conducted over the 2008/09 summer.

\* Locations at **Taupo (Reids Farm)**, 1.1 km d/s from Taupo Gates), at **Hamilton** (Wellington Street jetty) and at **Rangiriri** (Rangiriri Bridge) are sampled and reported as part of the National River Water Quality Network undertaken by NIWA. Contact person: Graham Bryers, NIWA, Hamilton.

<sup>T</sup> Logistic considerations mean field measurements are often made at slightly different locations from sample collection (e.g. sampling from bridges).

<sup>d</sup> Datasonde deployment sites.



**Figure 1: Waikato River water quality monitoring locations**

Ten locations along the river are visited monthly (Taupo, Ohaaki, Ohakuri, Whakamaru, Waipapa, Hamilton-Narrows, Hamilton-Horotiu, Huntly, Mercer and Tuakau), and an additional four locations are included for the summer intensive microbiological survey (see Table 2, Figure 1). The major tributaries that enter the Waikato River are also monitored monthly as part of the Regional River Monitoring Programme (RERIMP) initiated in 1993 (Huser and Wilson, 1996b). Three locations (Taupo at Reids Farm, Hamilton at Wellington Street, and Rangiriri) are sampled by NIWA as part of the 'National River Water Quality Network' (Table 2).

## 2.3 Water quality parameters

Water quality of the Waikato River is assessed by measuring up to 40 parameters (27 routinely). Some parameters are measured in the field, but the majority of parameters are analysed in a laboratory using standard analytical methods. Details of field measurements and analytical methods used are appended (Appendix IV).

## 2.4 Quality control, data storage and analysis

Quality control measures are undertaken in accordance with Environment Waikato's ISO 9001:2000 standards including procedures for the collection, transport, storage, of samples, and methods for data verification and quality assurance to ensure the consistency of data across the programme. Samples are sent to IANZ registered laboratories for analysis. Back-up samples are held for two months until results have been verified by routine quality assurance procedures. All data from field measurements and laboratory analyses are stored in Environment Waikato's water quality archiving database (TimeStudio).

Data analysis was performed using Statistica (version 6.0) and DataDesk (version 6.0.1). For the purpose of data analysis, non-detect results (i.e. results with "less than" values) were assumed to be equal to half the corresponding limit of detection (i.e.  $<x = x/2$ ), and results greater than the value reported were taken as equal to the value reported (i.e.  $>x = x$ ).

## 2.5 Reports

Environment Waikato's State of the Environment Report summarises the state of the Waikato River, other rivers in the region, and common pressures (Environment Waikato, 1999).

Environment Waikato Technical Report 2008/33, Trends in River Water Quality in the Waikato Region, 1987–2007 (Vant, 2008) outlines the trends in the Waikato River and other rivers in the region. Copies are available in electronic format from the publications page of the Environment Waikato website:

<http://www.ew.govt.nz/Publications/Technical-Reports/>

The data contained in these Waikato River reports is updated to the Environment Waikato "Waikato River" Internet page:

<http://www.ew.govt.nz/Environmental-information/Rivers-lakes-and-wetlands/>

The "How healthy are our rivers?" link provides details of the guidelines and standards used to assess the condition of the Waikato River and other rivers in the region. A link to water quality at other regional river monitoring sites is also available from this page.

## 3 Results

The results are divided up into 2 sections. Section 3.1 contains the results and statistical summaries of the routine analysis monitoring of the Waikato River. Section 3.2 reports the results and statistical summaries of the summer intensive microbiological survey. The raw data is included with each section, placed last.

## **3.1 Waikato River monitoring programme**

### **Routine water quality monitoring**

**Summary statistics**

**Key parameter graphs**

**Comparison with water quality standards**

**Raw data**

**Absorbance of filtered sample at 340 nm (units: /cm)**

Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.001	0.001	0.001	0.001	0.000	-1.00	0.001
Ohaaki Bridge	12	0.004	0.003	0.001	0.006	0.002	0.04	0.003
Ohakuri Tailrace Bridge	12	0.005	0.005	0.002	0.006	0.002	-0.78	0.005
Whakamaru Tailrace	10	0.006	0.006	0.003	0.010	0.004	0.24	0.007
Waipapa Tailrace	12	0.009	0.009	0.005	0.012	0.005	-0.17	0.010
Narrows	12	0.012	0.010	0.007	0.028	0.007	1.47	0.012
Horotiu Bridge	12	0.013	0.011	0.007	0.032	0.010	1.46	0.013
Huntly-Tainui Bridge	12	0.022	0.018	0.010	0.046	0.020	0.76	0.019
Mercer Bridge	12	0.027	0.022	0.010	0.056	0.028	0.51	0.022
Tuakau Bridge	12	0.028	0.023	0.010	0.060	0.032	0.53	0.027

**Absorbance of filtered sample at 440 nm (units: /cm)**

Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.001	0.001	0.001	0.001	0.000	-1.00	0.001
Ohaaki Bridge	12	0.001	0.001	0.001	0.001	0.000	-1.00	0.001
Ohakuri Tailrace Bridge	12	0.001	0.001	0.001	0.003	0.000	<u>3.02</u>	0.001
Whakamaru Tailrace	10	0.001	0.001	0.001	0.001	0.000	-1.00	0.001
Waipapa Tailrace	12	0.001	0.001	0.001	0.003	0.001	1.27	0.001
Narrows	12	0.002	0.002	0.001	0.006	0.002	1.37	0.002
Horotiu Bridge	12	0.002	0.002	0.001	0.006	0.002	1.38	0.002
Huntly-Tainui Bridge	12	0.004	0.003	0.001	0.009	0.003	0.76	0.004
Mercer Bridge	12	0.004	0.004	0.001	0.010	0.006	0.34	0.005
Tuakau Bridge	12	0.005	0.004	0.001	0.011	0.006	0.45	0.005

**Arsenic - Total (g/m<sup>3</sup>)**

Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.010	0.011	0.010	0.011	0.001	-0.01	0.011
Ohaaki Bridge	12	0.030	0.027	0.021	0.050	0.004	1.54	0.027
Ohakuri Tailrace Bridge	12	0.033	0.034	0.025	0.040	0.004	-0.43	0.035
Whakamaru Tailrace	10	0.031	0.031	0.028	0.036	0.006	0.23	0.034
Waipapa Tailrace	12	0.026	0.026	0.023	0.032	0.005	0.44	0.028
Narrows	12	0.023	0.023	0.016	0.035	0.007	0.70	0.025
Horotiu Bridge	12	0.023	0.023	0.016	0.034	0.006	0.64	0.024
Huntly-Tainui Bridge	12	0.017	0.019	0.006	0.030	0.009	-0.02	0.019
Mercer Bridge	12	0.016	0.016	0.008	0.029	0.010	0.50	0.017
Tuakau Bridge	12	0.017	0.017	0.008	0.031	0.010	0.52	0.017

**Boron (g/m<sup>3</sup>)**

Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.16	0.17	0.14	0.19	0.02	0.03	0.17
Ohaaki Bridge	12	0.35	0.34	0.25	0.52	0.19	0.31	0.30
Ohakuri Tailrace Bridge	12	0.35	0.34	0.29	0.42	0.05	0.55	0.33
Whakamaru Tailrace	10	0.33	0.33	0.29	0.36	0.04	-0.01	0.33
Waipapa Tailrace	12	0.29	0.28	0.24	0.36	0.03	1.02	0.29
Narrows	12	0.26	0.26	0.21	0.32	0.07	0.16	0.25
Horotiu Bridge	12	0.27	0.27	0.20	0.33	0.06	-0.28	0.26
Huntly-Tainui Bridge	12	0.20	0.20	0.09	0.29	0.11	-0.11	0.20
Mercer Bridge	12	0.20	0.20	0.12	0.30	0.10	0.15	0.21
Tuakau Bridge	12	0.21	0.21	0.13	0.32	0.11	0.30	0.21

Skew = skewness. Underlined values = non-normal distribution. IQR = Inter Quartile Range



Black Disk (m)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	-	-	-	-	-	-	-	-
Ohaaki Bridge	11	4.7	4.4	2.9	8.0	2.0	0.83	5.1
Ohakuri Tailrace Bridge	11	2.0	2.0	1.3	2.9	1.0	0.06	2.5
Whakamaru Tailrace	9	1.8	1.7	1.1	2.6	0.9	0.29	2.0
Waipapa Tailrace	11	1.7	1.6	1.3	2.4	0.5	0.45	2.0
Narrows	12	1.3	1.2	0.4	2.4	0.7	0.53	1.4
Horotiu Bridge	12	1.1	1.1	0.4	1.9	0.5	0.21	1.2
Huntly-Tainui Bridge	12	0.9	0.8	0.3	2.1	0.5	1.14	0.8
Mercer Bridge	-	-	-	-	-	-	-	-
Tuakau Bridge	12	0.6	0.7	0.3	1.3	0.4	0.66	0.6

Biochemical Oxygen Demand - 5 day (g/m <sup>3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.6	0.5	0.2	1.4	0.3	0.79	0.4
Ohaaki Bridge	12	0.6	0.5	0.2	1.0	0.3	0.37	0.4
Ohakuri Tailrace Bridge	12	1.0	0.9	0.5	2.0	0.5	1.26	0.7
Whakamaru Tailrace	10	1.0	0.9	0.6	1.7	0.5	0.70	0.8
Waipapa Tailrace	12	0.9	0.9	0.6	1.1	0.3	-0.38	0.6
Narrows	12	1.1	1.1	0.4	1.6	0.7	-0.19	0.8
Horotiu Bridge	12	1.2	1.0	0.6	2.2	0.9	0.66	0.8
Huntly-Tainui Bridge	12	1.2	1.1	0.5	2.8	1.0	0.96	0.9
Mercer Bridge	12	1.4	1.6	0.7	2.4	0.9	0.20	1.2
Tuakau Bridge	12	1.3	1.2	0.5	2.6	0.8	0.79	1.2

Carbon - Dissolved Organic (g/m <sup>3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.91	0.81	0.38	2.00	0.43	1.36	0.80
Ohaaki Bridge	12	0.90	0.84	0.59	1.80	0.28	<u>1.87</u>	0.80
Ohakuri Tailrace Bridge	12	0.93	0.89	0.69	1.30	0.19	0.93	0.89
Whakamaru Tailrace	10	1.12	1.05	0.74	1.60	0.21	0.57	1.10
Waipapa Tailrace	12	1.36	1.30	0.85	2.50	0.35	1.62	1.20
Narrows	12	1.57	1.30	0.98	2.90	0.80	1.08	1.30
Horotiu Bridge	12	1.73	1.40	1.00	3.00	1.05	0.69	1.40
Huntly-Tainui Bridge	12	2.61	2.05	1.10	4.70	2.50	0.51	1.75
Mercer Bridge	12	2.68	2.35	1.10	6.20	2.25	0.95	1.95
Tuakau Bridge	12	2.69	2.35	1.10	5.50	2.00	0.78	2.10

Carbon - Total Organic (g/m <sup>3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	1.14	1.20	0.63	2.20	0.57	1.05	1.00
Ohaaki Bridge	12	0.91	0.79	0.59	1.80	0.26	1.63	1.10
Ohakuri Tailrace Bridge	12	1.14	1.10	0.89	1.50	0.49	0.45	1.30
Whakamaru Tailrace	10	1.37	1.30	0.83	2.60	0.20	1.62	1.40
Waipapa Tailrace	12	1.65	1.55	0.95	2.70	0.35	0.97	1.60
Narrows	12	1.98	2.00	1.20	3.70	0.85	1.17	1.90
Horotiu Bridge	12	2.26	2.30	1.20	4.40	1.20	0.88	2.10
Huntly-Tainui Bridge	12	3.17	3.05	0.93	5.50	1.95	0.00	2.70
Mercer Bridge	12	4.08	3.65	1.30	8.70	3.35	0.68	3.15
Tuakau Bridge	12	3.98	3.30	1.20	7.50	3.25	0.51	3.20

Skew = skewness. Underlined values = non-normal distribution. IQR = Inter Quartile Range

Chloride (g/m <sup>3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	8	8	8	9	0	-1.26	9
Ohaaki Bridge	12	20	19	15	32	6	1.22	17
Ohakuri Tailrace Bridge	12	22	22	16	28	4	0.09	21
Whakamaru Tailrace	10	22	22	20	25	3	0.58	21
Waipapa Tailrace	12	19	19	16	23	3	0.32	19
Narrows	12	18	19	15	21	3	-0.46	18
Horotiu Bridge	12	19	19	16	21	2	-0.31	18
Huntly-Tainui Bridge	12	17	17	13	21	5	0.16	17
Mercer Bridge	12	17	17	14	22	3	0.40	17
Tuakau Bridge	12	18	17	14	22	3	0.41	17

Chlorophyll a (g/m <sup>3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.002	0.002	0.002	0.002	0.000	1.00	0.002
Ohaaki Bridge	12	0.002	0.002	0.002	0.002	0.000	1.00	0.002
Ohakuri Tailrace Bridge	12	0.005	0.004	0.002	0.010	0.003	0.78	0.004
Whakamaru Tailrace	10	0.008	0.007	0.002	0.024	0.005	1.49	0.007
Waipapa Tailrace	12	0.006	0.006	0.002	0.013	0.005	0.52	0.005
Narrows	12	0.008	0.008	0.002	0.012	0.006	-0.11	0.008
Horotiu Bridge	12	0.008	0.009	0.002	0.016	0.005	0.13	0.009
Huntly-Tainui Bridge	12	0.007	0.006	0.002	0.018	0.003	1.19	0.008
Mercer Bridge	12	0.010	0.009	0.002	0.029	0.008	1.43	0.013
Tuakau Bridge	12	0.013	0.012	0.003	0.031	0.012	0.82	0.015

Colour (Munsell Colour Units)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	-	-	-	-	-	-	-	-
Ohaaki Bridge	10	50.0	50.0	42.5	60.0	7.5	0.29	48.8
Ohakuri Tailrace Bridge	10	40.0	38.8	32.5	50.0	5.0	0.63	40.0
Whakamaru Tailrace	8	42.2	38.8	30.0	60.0	12.5	0.85	37.5
Waipapa Tailrace	10	37.3	37.5	30.0	50.0	7.5	1.01	35.0
Narrows	12	35.2	35.0	30.0	42.5	3.8	0.28	35.0
Horotiu Bridge	12	35.6	35.0	30.0	45.0	3.8	1.12	32.5
Huntly-Tainui Bridge	12	34.0	32.5	25.0	45.0	7.5	0.44	32.5
Mercer Bridge	-	-	-	-	-	-	-	-
Tuakau Bridge	12	32.3	32.5	25.0	40.0	7.5	-0.10	30.0

Conductivity at 25 °C (ms/m)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	11.9	11.9	11.7	12.3	0.3	0.90	12.0
Ohaaki Bridge	12	16.6	15.8	14.0	21.2	2.5	0.99	15.3
Ohakuri Tailrace Bridge	12	17.8	18.0	15.4	20.2	1.1	-0.03	17.7
Whakamaru Tailrace	10	17.5	17.3	16.4	19.1	1.5	0.45	17.0
Waipapa Tailrace	12	16.3	16.2	15.0	18.6	1.5	0.73	16.3
Narrows	12	15.9	15.8	13.9	17.2	1.5	-0.44	15.8
Horotiu Bridge	12	16.1	16.0	14.6	17.5	1.5	-0.05	16.0
Huntly-Tainui Bridge	12	15.0	15.1	12.1	17.1	2.7	-0.32	14.9
Mercer Bridge	12	15.6	15.6	13.1	17.8	2.0	-0.33	15.3
Tuakau Bridge	12	15.7	15.6	13.4	17.3	1.9	-0.30	15.5

Skew = skewness. Underlined values = non-normal distribution. IQR = Inter Quartile Range

Dissolved Oxygen (g/m <sup>3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	10.1	9.7	8.4	12.5	1.6	0.71	9.7
Ohaaki Bridge	12	9.8	9.6	8.3	11.6	1.9	0.18	9.6
Ohakuri Tailrace Bridge	12	9.7	10.0	8.1	10.7	1.6	-0.54	9.7
Whakamaru Tailrace	10	10.2	10.2	8.8	12.0	1.3	0.17	10.0
Waipapa Tailrace	12	10.1	10.2	8.4	11.2	1.4	-0.45	9.8
Narrows	12	9.8	9.7	8.1	11.1	1.7	-0.28	9.8
Horotiu Bridge	12	9.7	9.8	8.2	11.0	2.2	-0.19	9.7
Huntly-Tainui Bridge	12	9.5	9.6	7.8	10.9	1.4	-0.24	9.3
Mercer Bridge	12	9.5	9.6	7.9	11.1	0.9	0.04	9.2
Tuakau Bridge	12	9.5	9.7	8.4	10.8	0.7	0.09	9.5

Dissolved Oxygen (% Saturation)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	103.5	99.2	94.0	130.0	4.1	<u>1.82</u>	100.1
Ohaaki Bridge	12	102.4	102.3	95.4	110.3	5.0	0.32	101.9
Ohakuri Tailrace Bridge	12	101.7	99.3	95.2	130.0	7.1	<u>2.41</u>	101.6
Whakamaru Tailrace	10	105.6	103.4	94.5	130.0	3.0	<u>1.84</u>	103.0
Waipapa Tailrace	12	102.8	101.8	96.7	120.0	4.6	<u>1.78</u>	99.3
Narrows	12	97.6	98.0	89.6	107.4	4.6	0.41	97.3
Horotiu Bridge	12	96.8	96.7	92.8	105.0	3.6	1.31	96.8
Huntly-Tainui Bridge	12	94.9	94.4	88.3	105.4	7.6	0.55	95.9
Mercer Bridge	12	95.1	95.7	85.5	108.3	7.1	0.49	95.4
Tuakau Bridge	12	97.7	97.0	85.5	120.3	12.1	0.90	97.1

Enterococci (cfu/100 mL)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	2	1	1	10	2	<u>2.75</u>	1
Ohaaki Bridge	12	12	6	1	48	11	1.59	7
Ohakuri Tailrace Bridge	12	3	2	1	10	3	1.46	2
Whakamaru Tailrace	10	8	7	1	20	6	0.78	6
Waipapa Tailrace	11	9	3	1	35	15	1.32	4
Narrows	12	89	24	5	700	36	<u>2.91</u>	24
Horotiu Bridge	12	98	61	18	270	130	0.81	54
Huntly-Tainui Bridge	12	111	55	4	700	83	<u>2.78</u>	51
Mercer Bridge	12	78	38	5	330	87	1.63	29
Tuakau Bridge	12	85	53	6	240	122	0.88	27

Escherichia coli (cfu/100 mL)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	2	2	1	3	1	0.34	1
Ohaaki Bridge	12	19	13	5	56	30	0.93	12
Ohakuri Tailrace Bridge	12	3	3	1	9	3	0.94	4
Whakamaru Tailrace	10	10	5	2	51	5	<u>2.48</u>	6
Waipapa Tailrace	11	24	7	1	200	5	<u>2.82</u>	8
Narrows	12	321	39	15	3200	46	<u>2.99</u>	39
Horotiu Bridge	12	375	125	30	3000	185	<u>2.96</u>	120
Huntly-Tainui Bridge	12	446	100	42	3000	160	<u>2.37</u>	130
Mercer Bridge	12	366	130	10	1800	234	<u>1.78</u>	105
Tuakau Bridge	12	503	125	17	2300	300	<u>1.70</u>	80

Skew = skewness. Underlined values = non-normal distribution. IQR = Inter Quartile Range

Faecal Coliforms (cfu/100 mL)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	2	2	1	4	1	0.63	2
Ohaaki Bridge	12	21	14	5	67	30	1.23	17
Ohakuri Tailrace Bridge	12	3	3	1	9	3	0.96	4
Whakamaru Tailrace	10	10	5	3	51	5	<u>2.49</u>	6
Waipapa Tailrace	11	24	7	1	200	6	<u>2.80</u>	8
Narrows	12	382	48	15	3800	53	<u>2.99</u>	45
Horotiu Bridge	12	1217	195	30	9100	200	<u>2.36</u>	180
Huntly-Tainui Bridge	12	546	120	49	3800	211	<u>2.45</u>	135
Mercer Bridge	12	460	165	23	2100	259	<u>1.72</u>	160
Tuakau Bridge	12	575	180	17	2600	355	<u>1.70</u>	120

Lithium (g/m <sup>3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.040	0.040	0.034	0.044	0.006	-0.16	0.039
Ohaaki Bridge	12	0.110	0.100	0.076	0.180	0.038	0.97	0.090
Ohakuri Tailrace Bridge	12	0.127	0.125	0.100	0.150	0.015	0.09	0.125
Whakamaru Tailrace	10	0.122	0.120	0.110	0.140	0.010	0.51	0.120
Waipapa Tailrace	12	0.106	0.100	0.086	0.130	0.025	0.60	0.103
Narrows	12	0.095	0.091	0.074	0.120	0.029	0.24	0.090
Horotiu Bridge	12	0.094	0.092	0.073	0.120	0.022	0.32	0.090
Huntly-Tainui Bridge	12	0.067	0.068	0.031	0.100	0.041	-0.05	0.068
Mercer Bridge	12	0.068	0.064	0.037	0.110	0.036	0.41	0.068
Tuakau Bridge	12	0.069	0.067	0.042	0.110	0.039	0.41	0.068

Nitrate/Nitrite Nitrogen (g/m <sup>3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.009	0.001	0.001	0.046	0.004	<u>1.78</u>	0.001
Ohaaki Bridge	12	0.036	0.039	0.010	0.075	0.016	0.70	0.035
Ohakuri Tailrace Bridge	12	0.082	0.066	0.016	0.150	0.098	0.14	0.083
Whakamaru Tailrace	10	0.099	0.091	0.014	0.200	0.155	0.16	0.090
Waipapa Tailrace	12	0.166	0.160	0.060	0.280	0.121	0.10	0.160
Narrows	12	0.267	0.215	0.089	0.460	0.265	0.30	0.210
Horotiu Bridge	12	0.292	0.230	0.110	0.500	0.295	0.40	0.239
Huntly-Tainui Bridge	12	0.515	0.310	0.054	1.200	0.510	0.77	0.345
Mercer Bridge	12	0.494	0.345	0.001	1.200	0.495	0.66	0.355
Tuakau Bridge	12	0.471	0.315	0.001	1.200	0.505	0.74	0.317

Nitrogen - Ammoniacal (g/m <sup>3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.01	0.01	0.01	0.01	0.00	<u>3.02</u>	0.005
Ohaaki Bridge	12	0.01	0.01	0.01	0.02	0.01	0.56	0.005
Ohakuri Tailrace Bridge	12	0.01	0.01	0.01	0.02	0.01	0.68	0.005
Whakamaru Tailrace	10	0.01	0.01	0.01	0.02	0.01	0.90	0.005
Waipapa Tailrace	12	0.01	0.01	0.01	0.03	0.01	0.46	0.012
Narrows	12	0.02	0.01	0.01	0.05	0.03	0.76	0.020
Horotiu Bridge	12	0.01	0.01	0.01	0.04	0.02	1.16	0.010
Huntly-Tainui Bridge	12	0.02	0.02	0.01	0.05	0.02	0.62	0.010
Mercer Bridge	12	0.01	0.01	0.01	0.04	0.00	<u>2.06</u>	0.005
Tuakau Bridge	12	0.01	0.01	0.01	0.03	0.01	1.42	0.005

Skew = skewness. Underlined values = non-normal distribution. IQR = Inter Quartile Range

Nitrogen - Total Kjeldahl (g/m <sup>3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.09	0.08	0.03	0.21	0.03	1.15	0.07
Ohaaki Bridge	12	0.07	0.07	0.06	0.09	0.02	0.27	0.09
Ohakuri Tailrace Bridge	12	0.14	0.14	0.09	0.28	0.03	<u>2.06</u>	0.13
Whakamaru Tailrace	10	0.15	0.14	0.06	0.24	0.03	0.27	0.16
Waipapa Tailrace	12	0.15	0.15	0.09	0.21	0.04	0.37	0.16
Narrows	12	0.22	0.20	0.12	0.43	0.08	1.45	0.21
Horotiu Bridge	12	0.22	0.20	0.14	0.42	0.05	<u>1.92</u>	0.22
Huntly-Tainui Bridge	12	0.30	0.24	0.18	0.52	0.20	0.64	0.27
Mercer Bridge	12	0.37	0.32	0.22	0.64	0.28	0.56	0.33
Tuakau Bridge	12	0.36	0.32	0.20	0.55	0.22	0.46	0.34

Nitrogen - Total (g/m <sup>3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.10	0.08	0.03	0.25	0.03	1.36	0.07
Ohaaki Bridge	12	0.11	0.11	0.07	0.14	0.01	-0.77	0.11
Ohakuri Tailrace Bridge	12	0.23	0.21	0.15	0.43	0.11	1.23	0.21
Whakamaru Tailrace	10	0.24	0.25	0.15	0.38	0.10	0.41	0.26
Waipapa Tailrace	12	0.31	0.32	0.19	0.44	0.13	0.24	0.31
Narrows	12	0.49	0.45	0.26	0.87	0.23	0.78	0.43
Horotiu Bridge	12	0.51	0.45	0.29	0.91	0.28	0.83	0.46
Huntly-Tainui Bridge	12	0.82	0.60	0.26	1.57	0.79	0.63	0.61
Mercer Bridge	12	0.87	0.75	0.24	1.74	0.83	0.48	0.71
Tuakau Bridge	12	0.83	0.68	0.26	1.59	0.78	0.47	0.65

pH (pH Units)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	7.7	7.7	7.4	8.0	0.4	-0.05	7.7
Ohaaki Bridge	12	7.3	7.3	7.0	7.6	0.3	-0.08	7.3
Ohakuri Tailrace Bridge	12	7.4	7.4	7.2	7.6	0.2	-0.14	7.4
Whakamaru Tailrace	10	7.5	7.6	7.4	7.7	0.3	0.08	7.5
Waipapa Tailrace	12	7.4	7.5	7.2	7.6	0.2	-0.58	7.4
Narrows	12	7.4	7.5	7.0	7.7	0.2	-0.93	7.5
Horotiu Bridge	12	7.5	7.5	7.2	7.8	0.2	-0.01	7.5
Huntly-Tainui Bridge	12	7.5	7.5	7.0	8.0	0.3	0.28	7.5
Mercer Bridge	12	7.5	7.5	7.0	8.3	0.4	0.80	7.5
Tuakau Bridge	12	7.6	7.5	7.1	8.5	0.4	1.29	7.5

Phosphorus - Dissolved Reactive (g/m <sup>3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.003	0.002	0.002	0.008	0.001	<u>1.69</u>	0.002
Ohaaki Bridge	12	0.008	0.008	0.002	0.016	0.005	0.55	0.006
Ohakuri Tailrace Bridge	12	0.010	0.010	0.005	0.020	0.007	0.61	0.008
Whakamaru Tailrace	10	0.009	0.008	0.002	0.018	0.006	0.22	0.008
Waipapa Tailrace	12	0.015	0.015	0.005	0.028	0.006	0.47	0.016
Narrows	12	0.017	0.017	0.002	0.034	0.013	0.20	0.016
Horotiu Bridge	12	0.022	0.021	0.002	0.038	0.010	-0.19	0.024
Huntly-Tainui Bridge	12	0.025	0.026	0.009	0.036	0.012	-0.54	0.024
Mercer Bridge	12	0.023	0.023	0.008	0.042	0.019	0.26	0.020
Tuakau Bridge	12	0.021	0.022	0.004	0.037	0.014	-0.15	0.016

Skew = skewness. Underlined values = non-normal distribution. IQR = Inter Quartile Range

Phosphorus - Total (g/m <sup>3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.006	0.006	0.002	0.011	0.006	0.12	0.005
Ohaaki Bridge	12	0.018	0.017	0.009	0.030	0.010	0.59	0.016
Ohakuri Tailrace Bridge	12	0.027	0.028	0.018	0.037	0.009	0.10	0.027
Whakamaru Tailrace	10	0.030	0.028	0.022	0.045	0.007	1.16	0.028
Waipapa Tailrace	12	0.033	0.034	0.020	0.043	0.007	-0.58	0.035
Narrows	12	0.042	0.041	0.024	0.082	0.010	<u>1.76</u>	0.042
Horotiu Bridge	12	0.050	0.046	0.027	0.089	0.010	1.13	0.052
Huntly-Tainui Bridge	12	0.067	0.063	0.037	0.100	0.016	0.28	0.066
Mercer Bridge	12	0.073	0.070	0.034	0.110	0.024	0.27	0.070
Tuakau Bridge	12	0.077	0.071	0.030	0.120	0.041	0.41	0.069

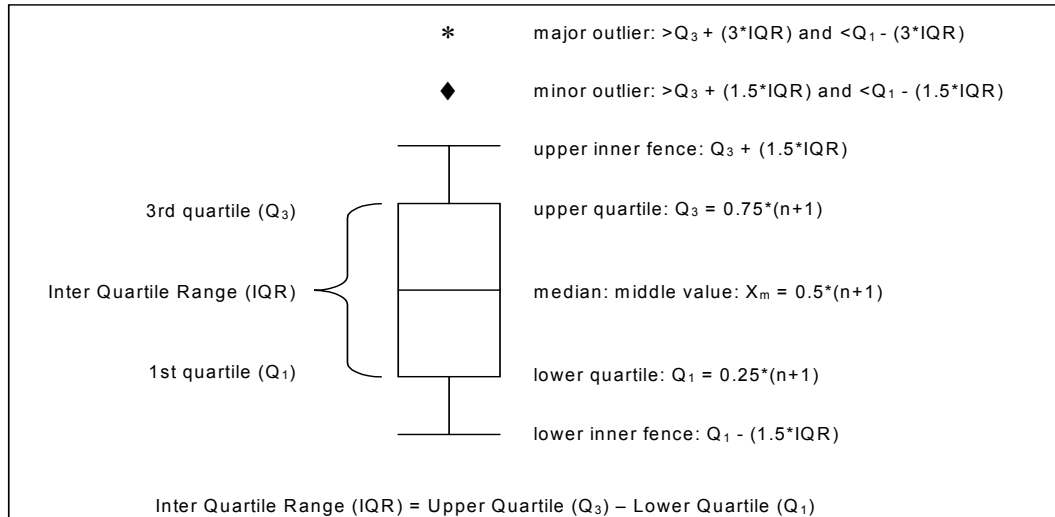
Temperature (°C)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	15.0	15.2	9.8	21.3	7.7	0.11	15.0
Ohaaki Bridge	12	16.1	15.7	11.4	22.7	7.5	0.44	16.2
Ohakuri Tailrace Bridge	12	16.4	16.9	10.9	22.6	7.6	0.12	16.5
Whakamaru Tailrace	10	16.7	16.9	10.9	22.8	10.2	0.10	16.4
Waipapa Tailrace	12	16.1	15.8	10.6	22.7	6.6	0.27	16.1
Narrows	12	15.8	15.5	10.6	22.2	7.8	0.22	16.2
Horotiu Bridge	12	15.5	15.0	10.3	21.8	7.7	0.22	16.1
Huntly-Tainui Bridge	12	15.8	15.1	10.3	22.3	8.5	0.31	16.0
Mercer Bridge	12	16.3	15.8	9.6	23.8	8.5	0.25	16.6
Tuakau Bridge	12	16.7	15.7	10.6	25.3	8.5	0.45	17.1

Dissolved Solids - Total (g/m <sup>3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	88	87	84	96	5	0.89	87
Ohaaki Bridge	12	116	115	95	150	10	0.73	110
Ohakuri Tailrace Bridge	12	131	130	110	150	20	0.14	130
Whakamaru Tailrace	10	130	130	120	140	0	0.00	130
Waipapa Tailrace	12	123	120	110	140	15	0.22	126
Narrows	12	122	125	100	130	15	-0.86	121
Horotiu Bridge	12	124	130	95	130	10	<u>-1.96</u>	121
Huntly-Tainui Bridge	12	113	120	95	130	21	-0.35	119
Mercer Bridge	12	118	120	100	140	25	-0.11	120
Tuakau Bridge	12	117	120	88	140	20	-0.42	119

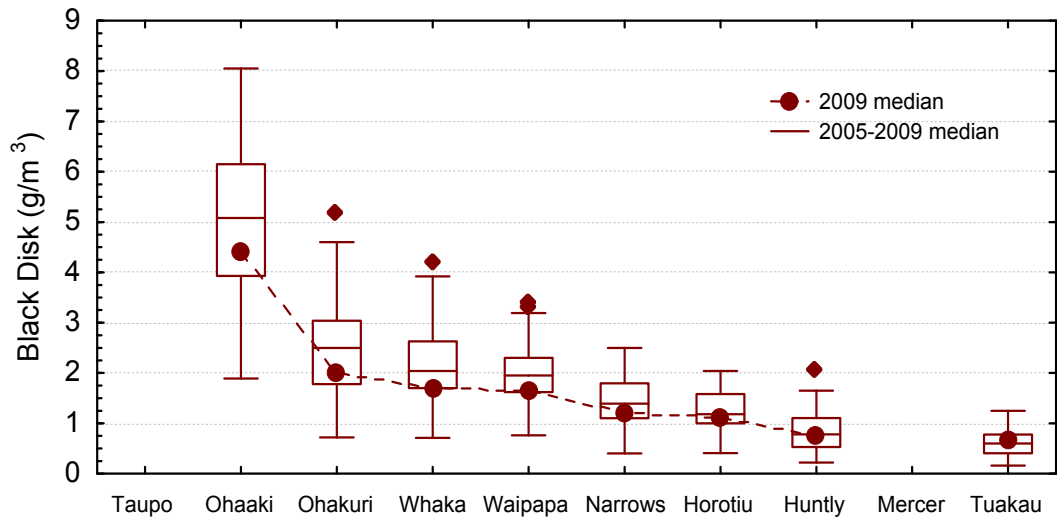
Turbidity (NTU)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.7	0.6	0.3	1.6	0.5	1.23	0.3
Ohaaki Bridge	12	0.6	0.6	0.4	0.9	0.2	0.55	0.6
Ohakuri Tailrace Bridge	12	1.1	1.0	0.8	1.8	0.3	1.09	1.0
Whakamaru Tailrace	10	1.3	1.2	0.7	2.4	0.7	1.01	1.2
Waipapa Tailrace	12	1.4	1.3	0.9	2.2	0.6	0.53	1.4
Narrows	12	2.7	2.3	1.2	8.8	1.1	<u>2.61</u>	2.1
Horotiu Bridge	12	3.4	2.7	1.7	11.0	0.8	<u>2.54</u>	2.6
Huntly-Tainui Bridge	12	8.5	5.0	2.4	23	8.4	1.07	5.7
Mercer Bridge	12	12.5	8.7	3.8	28	12.4	0.64	7.7
Tuakau Bridge	12	12.6	8.2	3.0	27.0	16.4	0.54	8.6

Skew = skewness. Underlined values = non-normal distribution. IQR = Inter Quartile Range

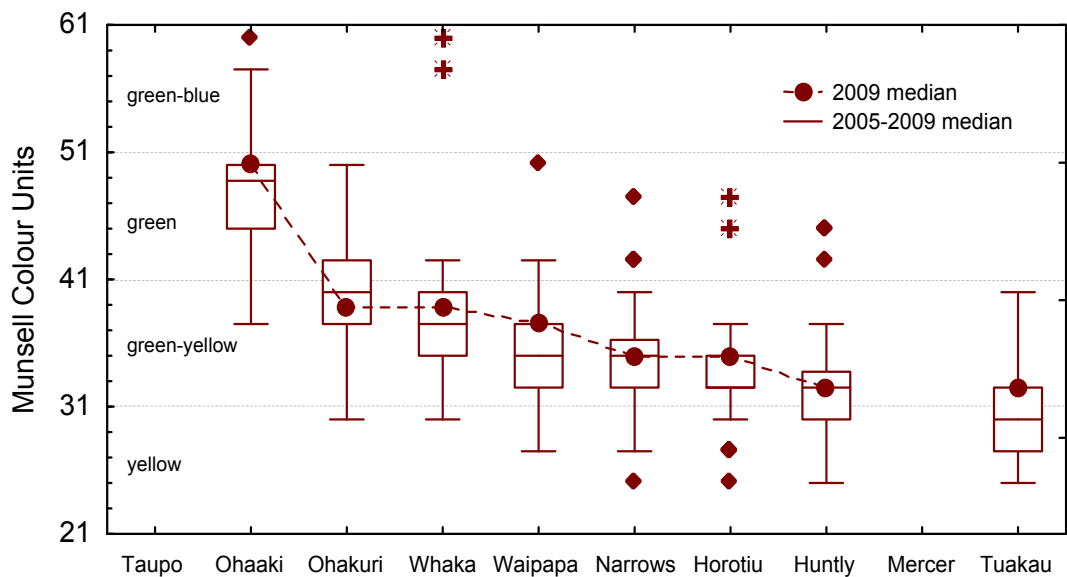
## Boxplots are used to present data



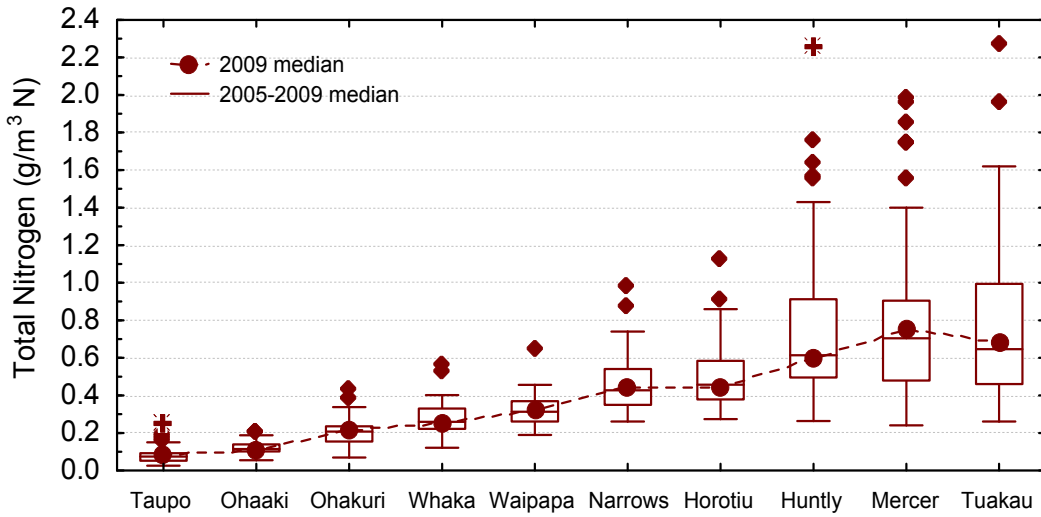
### Black Disk, 2005-2009 Data



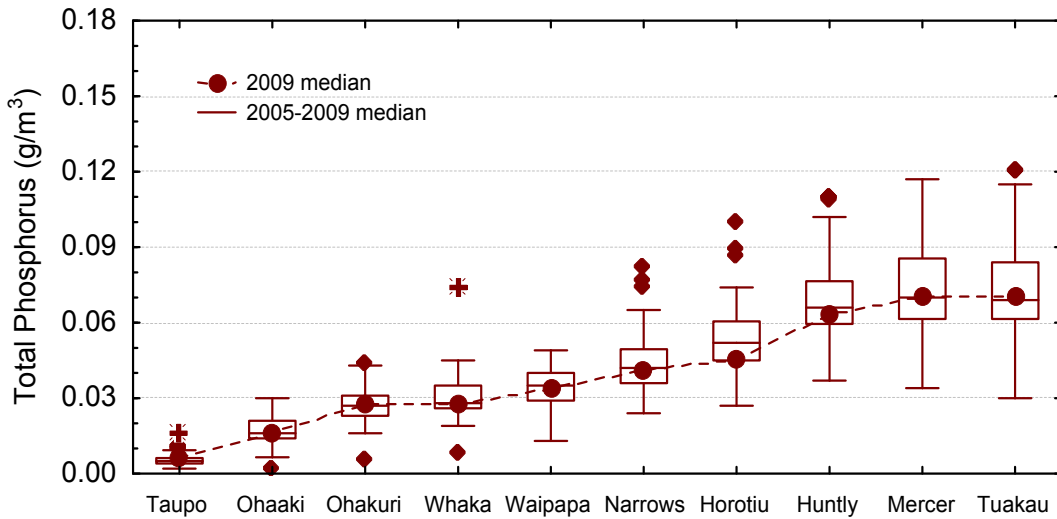
### Colour, 2005-2009 Data



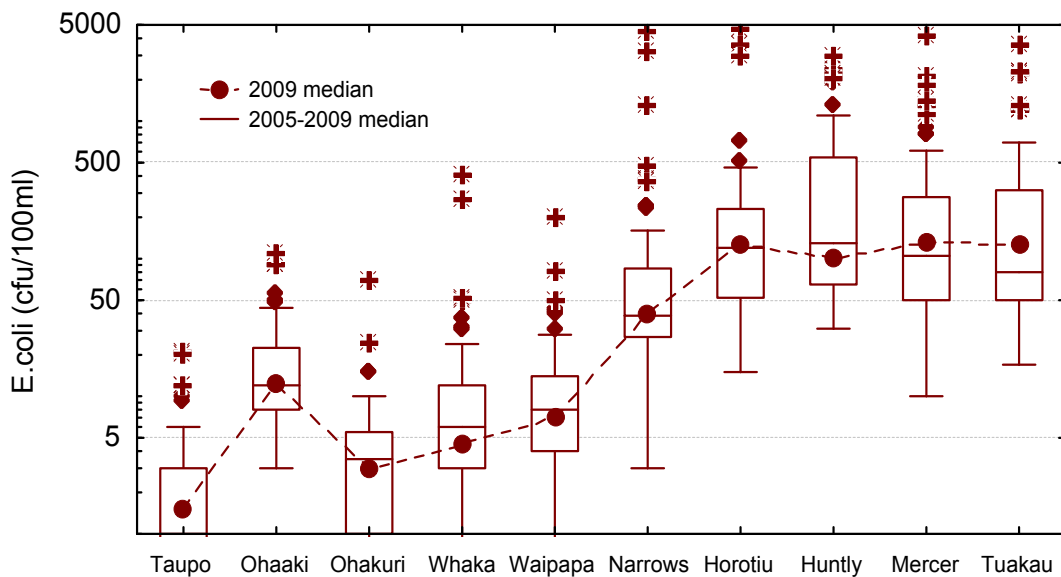
### Total Nitrogen, 2005-2009 Data



### Total Phosphorus, 2005-2009 Data

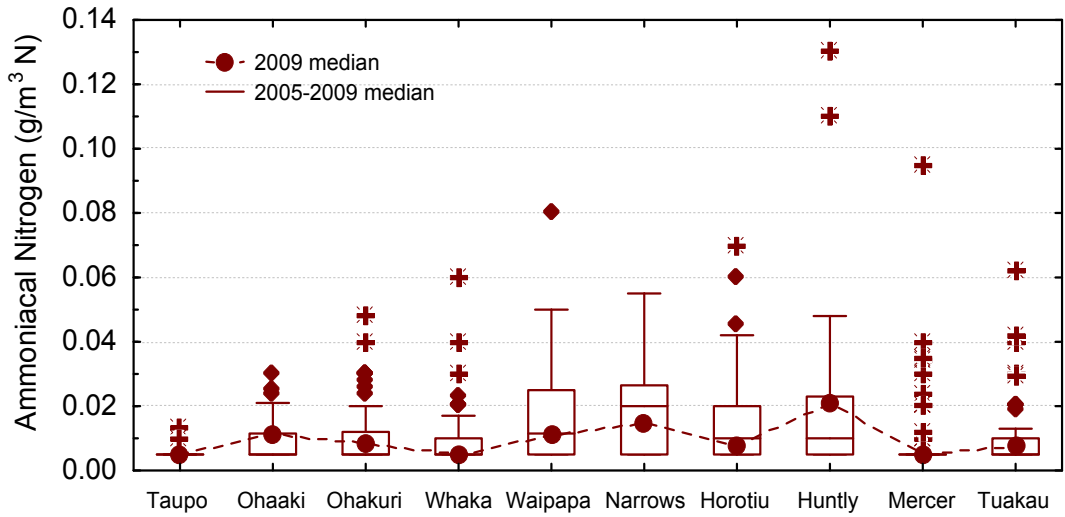


### E.coli, 2005-2009 Data

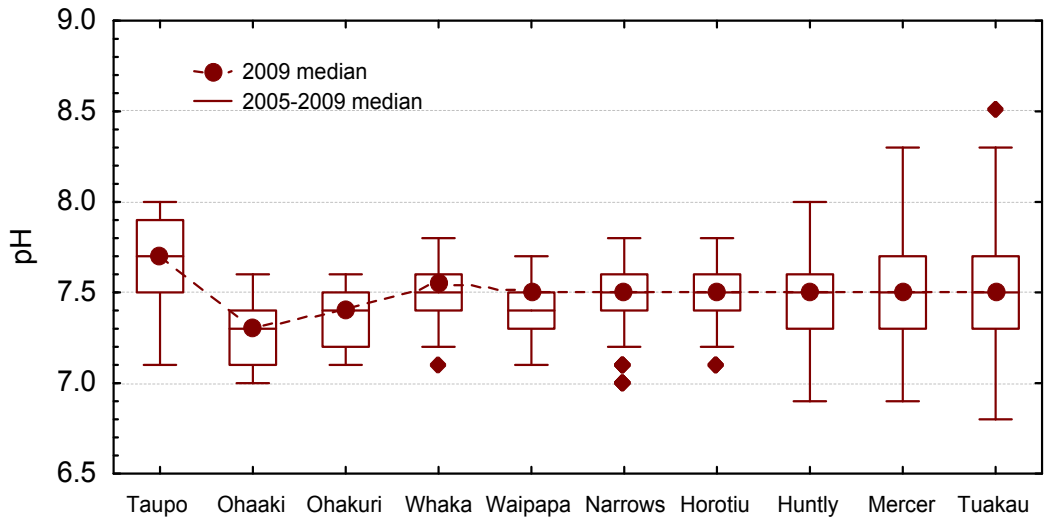




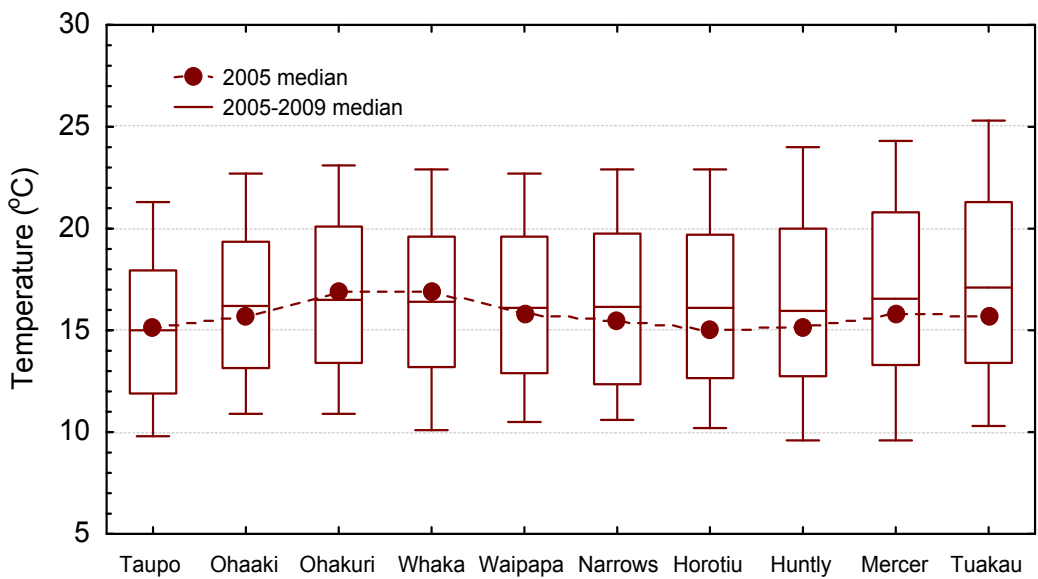
### Ammoniacal Nitrogen, 2005-2009 Data



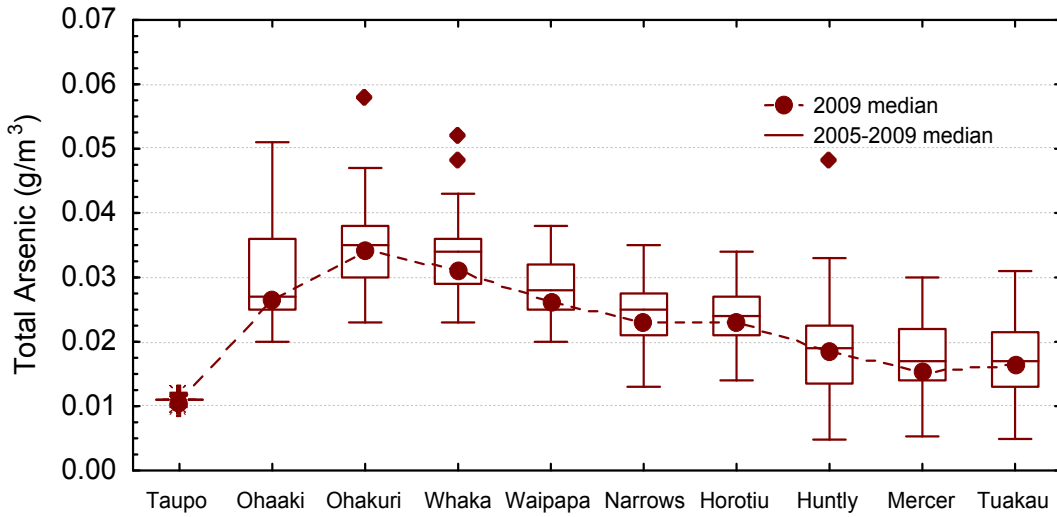
### pH, 2005-2009 Data



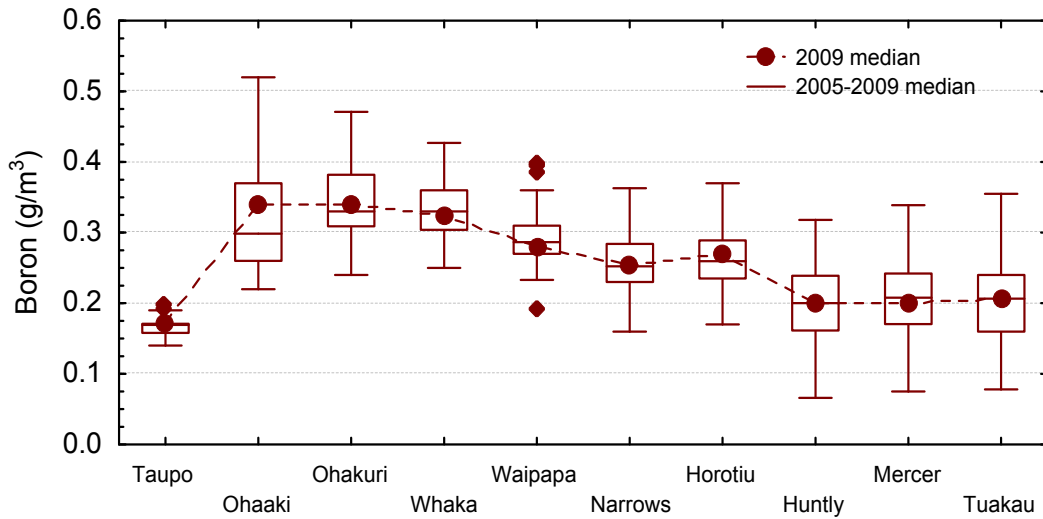
### Temperature, 2005-2009 Data



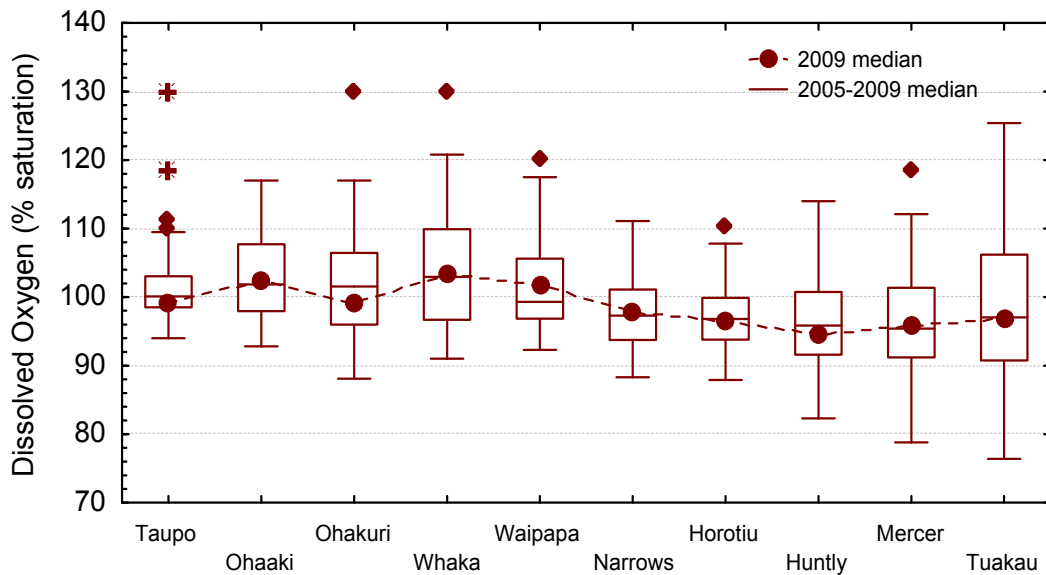
### Total Arsenic, 2005-2009 Data



### Boron, 2005-2009 Data



### Dissolved Oxygen, 2005-2009 Data



**Table 3: Samples (year 2009) complying with the ‘satisfactory’ water quality guidelines and standards. n = 12 (except ^ where n = 11 and \* where n=10).**

Location	ECOLOGICAL HEALTH							HUMAN USES					
								Recreation			water supply	drinking water	
	DO	pH	Turb	NH <sub>4</sub> N	Temp	TP	TN	Bk <sup>1</sup> Disk	E coli	Median E coli	CHLa	As	B
Taupo Gates	12	12	12	12	9	12	12	-	12	Y	12	1	12
Ohaaki Bridge	12	12	12	12	6	12	12	10/10	12	Y	12	0	5
Ohakuri Tailrace Br	12	12	12	12	7	12	12	6/9	12	Y	12	0	1
Whakamaru Tailrace	10*	10*	10*	10*	5*	9*	10*	5/9	10*	Y*	9*	0*	1*
Waipapa Tailrace	12	12	12	12	6	11	12	7/10	11^	Y	12	0	9
Hamilton – Narrows	12	12	12	12	7	6	8	4/10	11	Y	12	0	9
Horotiu Bridge	12	12	11	12	7	2	8	1/11	11	Y	12	0	9
Huntly – Tainui Br	12	12	7	12	7	1	4	1/11	10	Y	12	3	12
Mercer Bridge	12	12	2	12	7	1	4	-	10	N	11	2	11
Tuakau Bridge	12	12	3	12	7	1	3	-	10	Y	10	2	10

<sup>1</sup> samples complying with the baseflow water clarity guideline from the number of samples measured when flow was below the upper decile of all flows

**Table 4: Samples (year 2009) complying with the ‘excellent’ water quality guidelines and standards. n = 12 (except \* where n = 11 and ^ where n=10).**

Location	ECOLOGICAL HEALTH							HUMAN USES					
								Recreation			water supply	Drinking water	
	DO	pH	Turb	NH <sub>4</sub> N	Temp	TP	TN	Bk <sup>1</sup> Disk	E coli	Median E coli	CHLa	As	B
Taupo Gates	12	12	12	12	3	10	12	-	12	Y	12	n/a	n/a
Ohaaki Bridge	12	12	12	12	2	1	2	7/10	11	Y	12	n/a	n/a
Ohakuri Tailrace Br	12	12	12	12	2	0	0	0/9	12	Y	6	n/a	n/a
Whakamaru Tailrace	10*	10*	9*	10*	0*	0*	0*	0/9	10*	Y*	3*	n/a	n/a
Waipapa Tailrace	12	12	10	12	0	0	0	0/10	10^	Y	6	n/a	n/a
Hamilton – Narrows	11	12	4	12	2	0	0	0/10	9	N	3	n/a	n/a
Horotiu Bridge	12	12	2	12	2	0	0	0/11	3	N	2	n/a	n/a
Huntly – Tainui Br	9	12	0	12	2	0	0	0/11	3	N	3	n/a	n/a
Mercer Bridge	10	11	0	12	2	0	0	-	4	N	1	n/a	n/a
Tuakau Bridge	9	11	0	12	1	0	0	-	3	N	2	n/a	n/a

<sup>1</sup> samples complying with the baseflow water clarity guideline from the number of samples measured when flow was below the upper decile of all flows

DATE	TIME*	FLOW	BDISK	COLOR	COND	pH	TEMP	DO	PCDO	BOD5	TURB	TDS	NNN	NO3-N	NH4-N
dd/mm/yy	hh:mm	m <sup>3</sup> /s	m	units	mS/m	units	°C	g/m <sup>3</sup>	%Sat	g/m <sup>3</sup>	NTU	g/m <sup>3</sup>	g/m <sup>3</sup>	g/m <sup>3</sup>	g/m <sup>3</sup>
Satisfactory Water Quality Guideline/Standard			>1.6	-	-	6.5-9	<12 (May-Sep)	>80	-	<5	-	-	-	-	<0.88
							<20 (Oct-Apr)								

1131-127 UD = 262 m<sup>3</sup>/m (Flows from "Reids Farm")

**Waikato River at Taupo Control Gates**

07/01/09	8:45 a.m.	122	-	-	11.7	7.9	19.7	12.5	130.0	0.5	0.53	86	0.007	0.007	< 0.01
03/02/09	8:20 a.m.	223	-	-	11.7	8.0	<u>21.3</u>	8.4	99.1	< 0.4	0.72	84	< 0.002	< 0.002	< 0.01
03/03/09	8:15 a.m.	200	-	-	11.9	8.0	19.8	9.1	103.1	0.5	0.36	85	0.003	0.003	< 0.01
07/04/09	9:20 a.m.	62	-	-	11.9	7.7	17.3	9.2	99.3	0.5	0.35	85	0.004	< 0.002	< 0.01
05/05/09	9:23 a.m.	206	-	-	12.3	7.7	<u>17.1</u>	9.0	99.0	0.4	1.00	90	0.046	0.046	< 0.01
03/06/09	9:35 a.m.	193	-	-	11.7	8.0	<u>12.5</u>	9.4	94.0	1.2	1.20	95	0.038	0.038	0.01
07/07/09	8:50 a.m.	206	-	-	11.8	7.5	10.0	10.7	100.0	0.6	0.28	96	< 0.002	< 0.002	< 0.01
03/08/09	8:55 a.m.	151	-	-	11.9	7.7	9.8	10.7	98.8	0.7	0.58	87	< 0.002	< 0.002	< 0.01
03/09/09	9:00 a.m.	274	-	-	12.0	7.6	10.7	10.6	98.5	0.8	0.44	84	< 0.002	< 0.002	< 0.01
07/10/09	8:00 a.m.	293	-	-	11.8	7.6	11.0	12.2	118.3	1.4	1.60	89	< 0.002	< 0.002	< 0.01
03/11/09	8:30 a.m.	289	-	-	12.0	7.8	14.2	9.6	98.8	< 0.4	0.44	85	< 0.002	< 0.002	< 0.01
01/12/09	8:25 a.m.	232	-	-	12.0	7.4	16.1	9.7	102.6	0.8	0.59	90	< 0.002	< 0.002	< 0.01

1131-105 UD = 273 m<sup>3</sup>/s (Flows from Ohaaki Bridge Recorder, +/- 20%)

**Waikato River at Ohaaki Br**

07/01/09	9:35 a.m.	60	6.1	45.0	20.8	7.2	<u>22.7</u>	8.4	104.1	< 0.4	0.75	150	0.039	0.039	0.01
03/02/09	9:20 a.m.	230	4.2		14.6	7.6	<u>22.5</u>	8.3	98.8	0.6	0.41	110	0.010	0.010	< 0.01
03/03/09	8:55 a.m.	149	4.1	50.0	15.4	7.5	<u>21.2</u>	8.6	99.5	0.5	0.65	110	0.023	0.023	< 0.01
07/04/09	10:00 a.m.	114	8.0	50.0	17.2	7.1	17.9	9.5	102.6	0.4	0.66	120	0.030	0.030	0.01
05/05/09	10:10 a.m.	100	4.6	52.5	17.6	7.0	<u>15.5</u>	9.7	101.1	0.5	0.69	120	0.039	0.039	0.02
03/06/09	10:30 a.m.	131			16.1	7.0	<u>12.4</u>	10.8	102.6	0.5	0.50	120	0.043	0.043	0.02
07/07/09	9:50 a.m.	118	2.9	50.0	14.7	7.3	11.4	11.3	107.5	0.8	0.58	110	0.047	0.046	< 0.01
03/08/09	9:40 a.m.	51	3.1	60.0	21.2	7.3	<u>12.7</u>	9.8	95.4	0.5	0.94	130	0.075	0.073	0.02
03/09/09	9:45 a.m.	119	5.9	57.5	15.1	7.2	11.8	11.1	105.1	1.0	0.58	95	0.039	0.038	0.01
07/10/09	8:40 a.m.	283	(5.2)	42.5	14.0	7.4	11.8	11.6	110.3	1.0	0.54	96	0.018	0.018	< 0.01
03/11/09	9:10 a.m.	159	3.6	50.0	17.1	7.4	15.9	9.5	99.8	< 0.4	0.79	120	0.042	0.040	0.02
01/12/09	9:05 a.m.	177	4.4	42.5	15.1	7.4	16.9	9.5	101.9	0.6	0.55	110	0.030	0.029	< 0.01

1131-107 UD = 316 m<sup>3</sup>/s (Flows from Ohakuri Dam - Total)

**Waikato River at Ohakuri Tailrace Br**

07/01/09	10:25 a.m.	140	<u>1.4</u>	35.0	19.5	7.2	<u>21.2</u>	10.4	130.0	0.7	1.50	150	0.035	0.033	< 0.01
03/02/09	10:15 a.m.	298	2.9		16.4	7.5	<u>22.6</u>	8.4	99.6	1.4	1.10	120	0.016	0.015	0.01
03/03/09	10:10 a.m.	285	<u>1.3</u>	40.0	18.1	7.5	<u>22.2</u>	8.1	96.0	0.6	0.77	130	0.037	0.036	0.01
07/04/09	10:55 a.m.	171	2.6	37.5	16.9	7.4	<u>18.3</u>	8.7	95.2	0.7	1.00	120	0.045	0.045	0.01
05/05/09	10:58 a.m.	229	1.9	42.5	18.2	7.2	<u>18.3</u>	9.2	95.8	0.7	1.80	140	0.087	0.085	0.02
03/06/09	11:15 a.m.	319			18.1	7.4	10.9	10.5	95.3	2.0	1.00	150	0.150	0.150	0.02
07/07/09	10:40 a.m.	149	2.0	50.0	18.2	7.3	11.5	10.7	101.4	0.9	1.00	130	0.140	0.140	0.02
03/08/09	10:30 a.m.	179	<u>1.4</u>	37.5	17.9	7.4	11.3	10.5	98.9	0.5	0.96	120	0.130	0.130	< 0.01
03/09/09	10:35 a.m.	239	2.3	32.5	20.2	7.3	<u>12.9</u>	10.6	102.3	1.3	1.00	140	0.140	0.140	< 0.01
07/10/09	9:35 a.m.	364	(2.6)	40.0	17.3	7.4	13.4	9.9	97.6	1.0	1.10	130	0.130	0.120	< 0.01
03/11/09	10:10 a.m.	380	(1.8)	47.5	15.4	7.6	15.4	10.1	104.5	1.0	1.50	110	0.040	0.039	< 0.01
01/12/09	10:00 a.m.	271	2.4	37.5	17.9	7.5	18.3	9.4	103.6	0.8	1.00	130	0.038	0.037	< 0.01

1131-147 UD = 305 m<sup>3</sup>/s (Flows from Whakamaru Dam - Total)

**Waikato River at Whakamaru Tailrace**

07/01/09	11:10 a.m.	164	<u>1.1</u>	35.0	18.2	7.7	<u>22.1</u>	12.0	130.0	1.7	2.40	140	0.041	0.039	0.01
03/02/09	11:00 a.m.	286	2.4		16.4	7.6	<u>22.8</u>	8.8	104.5	1.2	1.20	130	0.014	0.014	0.02
03/03/09	11:05 a.m.	261	<u>1.3</u>	40.0	17.4	7.7	<u>22.5</u>	8.9	105.0	0.8	1.10	130	0.025	0.024	< 0.01
07/04/09	11:35 a.m.	219	<u>1.5</u>	40.0	17.2	7.6	18.5	9.5	103.8	1.0	1.20	130	0.031	0.030	< 0.01
05/05/09	11:55 a.m.	188	2.6	60.0	18.1	7.4	<u>15.5</u>	10.0	102.9	0.7	0.76	130	0.140	0.140	< 0.01
03/06/09	11:50 a.m.	298			17.1	7.4	11.9	10.2	94.5	0.6	0.69	140	0.140	0.140	< 0.01
07/07/09	11:35 a.m.	200	2.1	57.5	16.6	7.4	10.9	11.0	102.0	0.9	0.93	120	0.180	0.180	< 0.01
03/08/09	11:10 a.m.	203	<u>1.3</u>	37.5	18.0	7.5	11.2	10.8	100.9	0.6	1.00	130	0.200	0.200	< 0.01
03/09/09	11:15 a.m.	224	1.9	30.0	19.1	7.4	<u>12.9</u>	10.7	102.7	1.4	1.80	130	0.200	0.200	< 0.01
07/10/09	10:20 a.m.	433													
03/11/09	10:55 a.m.	483													
01/12/09	11:05 a.m.	249	1.7	37.5	16.6	7.7	18.2	10.1	109.9	1.1	1.60	120	0.017	0.017	0.02

Note: < = less than value stated  
UD = upper decile flow (period 1990-2009 inclusive)

Underlined values don't comply with the "satisfactory" water quality Guidelines and Standards – Table 1

\* New Zealand Standard Time

() black disk measurements taken in flows above upper decile value – don't assess for compliance

TKN g/m <sup>3</sup>	TN g/m <sup>3</sup>	DRP g/m <sup>3</sup>	TP g/m <sup>3</sup>	CL g/m <sup>3</sup>	AS g/m <sup>3</sup>	B g/m <sup>3</sup>	LI g/m <sup>3</sup>	A340F /cm	A440F /cm	ENT cfu/100mL	FC cfu/100mL	E coli	CHLA g/m <sup>3</sup>	DOC g/m <sup>3</sup>	TOC g/m <sup>3</sup>
-	<0.5	-	<0.04	-	<0.01	<0.3	-	-	-	<77	-	<550	<0.02		

0.09	0.09	<0.004	<0.004	8.5	<u>0.010</u>	0.17	0.039	<0.002	<0.002	1	2	1	<0.003	1.2	1.4
<0.05	<0.05	<0.004	<0.004	8.3	<u>0.011</u>	0.15	0.040	<0.002	<0.002	<1	2	2	<0.003	0.8	1.2
0.06	0.07	<0.004	<0.004	8.6	<u>0.010</u>	0.14	0.034	<0.002	<0.002	2	1	1	<0.003	0.38	1.2
0.07	0.07	<0.004	0.007	8.4	<u>0.011</u>	0.17	0.044	<0.002	<0.002	2	2	2	<0.003	0.77	0.83
0.20	0.25	0.008	0.009	8.7	<u>0.011</u>	0.17	0.040	<0.002	<0.002	1	4	3	<0.003	2	2.2
0.21	0.25	<0.004	0.010	8.6	0.010	0.19	0.043	<0.002	<0.002	<1	2	2	<0.003	1.2	1.3
<0.05	<0.05	<0.004	<0.004	7.9	<u>0.011</u>	0.17	0.039	<0.002	<0.002	<1	<1	<1	<0.003	0.94	0.76
0.07	0.07	0.004	0.006	8.4	<u>0.011</u>	0.16	0.038	<0.002	<0.002	1	2	2	<0.003	0.73	1.4
0.09	0.09	0.005	0.011	8.4	<u>0.010</u>	0.14	0.035	<0.002	<0.002	2	<1	<1	<0.003	0.96	0.71
0.08	0.08	<0.004	0.006	8.3	<u>0.010</u>	0.17	0.042	<0.002	<0.002	1	3	3	<0.003	0.81	1.2
0.08	0.08	<0.004	0.008	8.5	<u>0.010</u>	0.19	0.044	<0.002	<0.002	<1	<1	<1	<0.003	0.58	0.63
0.10	0.10	<0.004	0.006	8.6	<u>0.011</u>	0.15	0.036	<0.002	<0.002	10	1	1	<0.003	0.5	0.8

0.07	0.11	0.010	0.027	31.0	<u>0.049</u>	<u>0.52</u>	0.180	0.006	<0.002	4	18	15	<0.003	1.1	1
0.06	0.07	<0.004	0.012	16.0	<u>0.027</u>	0.25	0.090	<0.002	<0.002	33	34	34	<0.003	1	0.93
0.07	0.09	<0.004	0.014	18.0	<u>0.027</u>	0.25	0.082	0.002	<0.002	48	36	36	<0.003	0.59	1.3
0.08	0.11	0.008	0.020	22.0	<u>0.026</u>	<u>0.48</u>	0.120	0.006	<0.002	20	12	12	<0.003	0.62	0.62
0.06	0.10	0.014	0.017	22.0	<u>0.030</u>	<u>0.41</u>	0.120	0.005	<0.002	4	5	5	<0.003	1.8	1.8
0.07	0.12	0.009	0.018	20.0	<u>0.026</u>	<u>0.41</u>	0.110	0.005	<0.002	5	6	5	<0.003	0.8	0.96
0.06	0.10	0.005	0.016	16.0	<u>0.026</u>	<u>0.30</u>	0.089	0.004	<0.002	4	5	5	<0.003	0.88	0.74
0.06	0.14	0.016	0.028	32.0	<u>0.050</u>	<u>0.47</u>	0.170	0.004	<0.002	<1	5	5	<0.003	0.92	0.59
0.08	0.12	0.007	0.015	17.0	<u>0.023</u>	0.26	0.076	0.003	<0.002	9	67	56	<0.003	0.63	0.73
0.09	0.11	0.004	0.009	15.0	<u>0.021</u>	0.25	0.077	<0.002	<0.002	6	15	13	<0.003	0.9	0.71
0.08	0.12	0.008	0.030	19.0	<u>0.029</u>	<u>0.38</u>	0.120	0.003	<0.002	6	7	5	<0.003	0.76	0.8
0.08	0.11	0.005	0.013	17.0	<u>0.025</u>	0.26	0.082	0.003	<0.002	<1	37	37	<0.003	0.74	0.78

0.13	0.17	0.005	0.037	26.0	<u>0.040</u>	<u>0.42</u>	0.150	0.006	0.003	2	4	4	0.010	1.3	1.5
0.14	0.16	0.006	0.033	19.0	<u>0.035</u>	0.29	0.120	0.002	<0.002	2	<1	<1	0.005	0.88	1.4
0.11	0.15	0.014	0.027	24.0	<u>0.034</u>	<u>0.31</u>	0.120	0.006	<0.002	1	4	4	0.004	0.82	1.4
0.10	0.15	0.009	0.028	20.0	<u>0.036</u>	<u>0.33</u>	0.130	0.004	<0.002	1	1	1	<0.003	0.9	0.93
0.14	0.23	0.020	0.028	22.0	<u>0.034</u>	<u>0.35</u>	0.130	0.005	<0.002	1	4	4	<0.003	0.98	1.1
0.28	0.43	0.016	0.030	23.0	<u>0.032</u>	<u>0.41</u>	0.150	0.004	<0.002	2	<1	<1	<0.003	0.82	0.89
0.09	0.23	0.012	0.020	23.0	<u>0.031</u>	<u>0.36</u>	0.120	0.006	<0.002	1	2	2	0.004	1.3	1.5
0.15	0.28	0.010	0.024	21.0	<u>0.031</u>	<u>0.33</u>	0.120	0.005	<0.002	10	6	6	0.006	0.94	0.9
0.15	0.29	0.009	0.031	28.0	<u>0.035</u>	<u>0.37</u>	0.140	0.006	<0.002	1	4	4	0.010	0.99	0.97
0.13	0.26	0.011	0.024	20.0	<u>0.030</u>	<u>0.36</u>	0.130	0.006	<0.002	7	9	9	0.005	0.77	0.89
0.13	0.17	0.005	0.018	16.0	<u>0.025</u>	<u>0.32</u>	0.100	0.005	<0.002	3	2	1	0.005	0.69	1.1
0.16	0.20	0.005	0.020	22.0	<u>0.035</u>	<u>0.32</u>	0.110	0.005	<0.002	<10	2	2	0.004	0.72	1.1

0.24	0.28	0.008	<u>0.045</u>	24.0	<u>0.035</u>	<u>0.36</u>	0.130	0.009	<0.002	6	12	12	<u>0.024</u>	1.6	2.6
0.14	0.15	0.007	0.038	20.0	<u>0.036</u>	0.29	0.120	0.003	<0.002	20	3	3	0.005	1	1.3
0.14	0.17	0.007	0.026	23.0	<u>0.033</u>	<u>0.30</u>	0.110	0.008	<0.002	6	4	2	0.009	0.94	1.7
0.15	0.18	<0.004	0.028	21.0	<u>0.031</u>	<u>0.35</u>	0.130	0.004	<0.002	9	3	3	0.007	1.2	1.3
0.12	0.26	0.018	0.026	22.0	<u>0.034</u>	<u>0.36</u>	0.140	0.005	<0.002	3	4	4	0.004	0.99	1.1
0.13	0.27	0.014	0.028	21.0	<u>0.028</u>	<u>0.33</u>	0.120	0.004	<0.002	<1	5	4	<0.003	0.74	0.83
0.06	0.24	0.013	0.028	20.0	<u>0.028</u>	<u>0.35</u>	0.120	0.006	<0.002	8	6	6	0.004	1.1	0.95
0.14	0.34	0.010	0.026	22.0	<u>0.028</u>	<u>0.31</u>	0.120	0.010	<0.002	<1	5	5	0.007	1.2	1.3
0.18	0.38	0.009	0.033	25.0	<u>0.028</u>	<u>0.32</u>	0.120	0.008	<0.002	14	51	51	0.014	1.4	1.3

0.16	0.18	<.004	0.022	20.0	<u>0.031</u>	<u>0.31</u>	0.110	0.006	<0.002	8	9	8	0.008	1	1.3
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Note: < = less than value stated

Underlined values don't comply with the "satisfactory" water quality Guidelines and Standards – Table 1

DATE	TIME*	FLOW	BDISK	COLOR	COND	PH	TEMP	DO	PCDO	BOD5	TURB	TDS	NNN	NO3-N	NH4-N
dd/mm/yy	hh:mm	m <sup>3</sup> /s	m	units	mS/m	units	'C	g/m <sup>3</sup>	%Sat	g/m <sup>3</sup>	NTU	g/m <sup>3</sup>	g/m <sup>3</sup>	g/m <sup>3</sup>	g/m <sup>3</sup>
Satisfactory Water Quality Guideline/Standard			>1.6	-	-	6.5-9	<12 (May-Sep)	>80	-	<5	-	-	-	-	<0.88
							<20 (Oct-Apr)								

1131-143 UD = 358 m<sup>3</sup>/s (Flows from Waipapa Dam - Total)

**Waikato River at Waipapa Tailrace**

07/01/09	11:50 a.m.	215	<u>1.4</u>	30.0	15.8	7.5	<u>20.1</u>	11.0	120.0	1.1	2.20	130	0.120	0.120	0.02
03/02/09	11:30 a.m.	280	1.9		16.2	7.5	<u>22.4</u>	8.4	98.1	0.9	1.20	120	0.060	0.057	0.03
03/03/09	12:00 p.m.	169	<u>1.3</u>	40.0	16.2	7.6	<u>22.7</u>	8.8	103.0	0.6	1.20	120	0.110	0.110	0.03
07/04/09	12:15 p.m.	243	1.6	50.0	16.9	7.2	18.1	9.3	100.1	0.6	1.20	130	0.110	0.110	0.01
05/05/09	12:59 p.m.	171	1.6	37.5	18.6	7.5	<u>16.0</u>	9.8	103.0	0.8	1.00	140	0.200	0.190	0.02
03/06/09	12:25 p.m.	250			17.5	7.5	<u>12.3</u>	10.5	98.0	0.9	0.91	140	0.220	0.220	0.01
07/07/09	12:20 p.m.	201	2.4	37.5	15.2	7.3	10.6	11.2	102.8	1.1	0.95	130	0.230	0.220	< 0.01
03/08/09	11:45 a.m.	237	<u>1.3</u>	37.5	16.1	7.4	10.8	10.8	98.7	0.7	1.40	110	0.280	0.280	0.01
03/09/09	11:40 a.m.	316	2.0	32.5	17.0	7.2	<u>12.7</u>	10.7	101.3	1.0	1.60	120	0.270	0.260	0.01
07/10/09	10:45 a.m.	352	2.0	32.5	15.0	7.4	13.9	9.8	96.7	1.1	2.00	110	0.220	0.210	< 0.01
03/11/09	11:20 a.m.	450	(1.7)	40.0	15.2	7.6	15.5	10.8	109.4	0.8	1.60	110	0.098	0.096	0.01
01/12/09	11:45 a.m.	357	1.6	35.0	16.1	7.6	17.7	9.6	102.2	1.1	1.70	120	0.078	0.075	0.02

1131-328 UD = 362 m<sup>3</sup>/s (Flows from Karapiro Dam - Total)

**Waikato River at Narrows Boat Ramp**

07/01/09	8:00 a.m.	153	1.6	30.0	15.5	7.5	<u>20.6</u>	8.1	89.6	0.5	2.10	120	0.180	0.180	0.04
02/02/09	6:45 a.m.	202	<u>1.0</u>	32.5	17.2	7.7	<u>22.2</u>	8.1	93.6	1.3	2.40	130	0.091	0.087	0.03
04/03/09	8:00 a.m.	190	1.7	35.0	15.8	7.5	<u>21.8</u>	9.1	103.1	1.1	1.70	130	0.089	0.089	0.01
09/04/09	8:35 a.m.	153	2.4	35.0	16.9	7.4	17.6	9.3	98.9	0.4	1.50	110	0.170	0.170	0.02
07/05/09	8:55 a.m.	235	2.2	37.5	16.8	7.0	<u>15.1</u>	9.5	95.1	0.6	1.40	130	0.250	0.250	0.02
04/06/09	8:40 a.m.	313	<u>1.3</u>	42.5	16.2	7.5	11.4	10.8	98.1	1.5	1.20	130	0.290	0.290	< 0.01
08/07/09	8:30 a.m.	155	<u>0.9</u>	37.5	16.8	7.3	10.6	10.9	98.3	1.0	2.80	130	0.430	0.420	0.01
05/08/09	9:15 a.m.	286	<u>1.2</u>	37.5	15.2	7.5	10.6	11.1	97.8	0.8	2.50	110	0.460	0.450	< 0.01
03/09/09	8:40 a.m.	423	(1.1)	35.0	15.8	7.5	<u>12.0</u>	10.8	98.9	1.1	2.90	120	0.460	0.450	0.01
07/10/09	7:45 a.m.	430	(0.4)	30.0	13.9	7.0	13.2	9.9	93.4	1.6	<u>8.80</u>	120	0.440	0.430	0.05
04/11/09	8:00 a.m.	364	<u>0.9</u>	35.0	15.0	7.7	15.9	10.6	107.4	1.6	2.50	100	0.170	0.160	< 0.01
02/12/09	7:55 a.m.	262	<u>1.3</u>	35.0	15.5	7.6	18.4	9.1	97.4	1.2	2.20	130	0.170	0.170	0.04

1131-69 UD = 385 m<sup>3</sup>/s (Flows from Hamilton - Bridge Street Bridge)

**Waikato River at Horotiu Br**

07/01/09	9:00 a.m.	157	<u>1.3</u>	35.0	15.8	7.6	<u>20.3</u>	8.4	93.8	0.6	2.60	120	0.200	0.190	0.02
02/02/09	8:05 a.m.	200	<u>0.9</u>	32.5	17.5	7.6	<u>21.3</u>	8.3	94.3	1.2	2.50	130	0.110	0.110	< 0.01
04/03/09	9:10 a.m.	203	<u>1.5</u>	35.0	15.9	7.6	<u>21.8</u>	8.2	92.8	0.9	2.30	130	0.130	0.130	< 0.01
09/04/09	9:30 a.m.	171	1.9	35.0	17.1	7.4	17.0	9.2	96.6	0.6	2.60	130	0.200	0.190	< 0.01
07/05/09	9:40 a.m.	200	<u>1.6</u>	37.5	17.0	7.3	<u>14.7</u>	9.7	96.0	0.8	1.70	130	0.260	0.260	0.01
04/06/09	9:40 a.m.	191	<u>1.2</u>	45.0	16.4	7.5	11.2	10.9	97.8	1.7	1.70	130	0.300	0.290	< 0.01
08/07/09	9:20 a.m.	191	<u>0.9</u>	37.5	17.1	7.4	10.3	10.9	98.0	2.2	4.70	130	0.500	0.500	0.02
05/08/09	10:00 a.m.	193	<u>1.0</u>	35.0	15.5	7.5	10.4	11.0	96.9	0.8	3.00	130	0.490	0.480	< 0.01
03/09/09	9:30 a.m.	249	<u>1.1</u>	32.5	16.1	7.5	<u>12.1</u>	10.8	99.1	1.0	2.80	120	0.460	0.460	0.01
07/10/09	8:25 a.m.	486	(0.4)	30.0	14.6	7.2	13.3	9.9	94.4	1.6	<u>11.00</u>	120	0.490	0.490	0.04
04/11/09	8:30 a.m.	345	<u>0.8</u>	35.0	15.1	7.8	15.3	10.5	105.0	1.7	3.30	95	0.170	0.160	< 0.01
02/12/09	8:30 a.m.	209	<u>1.1</u>	37.5	15.6	7.5	18.4	9.0	96.7	0.8	2.70	120	0.190	0.180	0.04

1131-77 UD = 583 m<sup>3</sup>/s (Flows from Huntly Power Station Recorder)

**Waikato River at Huntly-Tainui Br**

07/01/09	10:20 a.m.	211	<u>1.0</u>	30.0	15.0	7.6	<u>22.3</u>	8.7	99.1	0.6	5.00	120	0.290	0.290	< 0.01
02/02/09	9:25 a.m.	244	<u>1.0</u>	32.5	17.1	8.0	<u>22.3</u>	9.1	105.4	1.6	4.00	130	0.054	0.052	< 0.01
04/03/09	10:00 a.m.	270	<u>0.9</u>	37.5	15.1	7.5	<u>21.8</u>	7.8	88.3	0.8	4.60	120	0.280	0.280	0.02
09/04/09	10:15 a.m.	216	2.1	32.5	17.1	7.5	17.1	9.2	96.8	0.5	2.40	120	0.250	0.250	0.01
07/05/09	10:15 a.m.	254	<u>1.6</u>	42.5	16.8	7.4	<u>14.7</u>	9.6	94.9	0.6	3.00	110	0.320	0.320	0.02
04/06/09	10:10 a.m.	296	<u>1.1</u>	45.0	15.9	7.5	10.3	10.9	96.2	1.3	3.30	120	0.510	0.510	0.02
08/07/09	10:10 a.m.	464	<u>0.5</u>	37.5	16.0	7.3	10.6	10.4	93.9	2.8	<u>10.00</u>	120	1.100	1.100	0.04
05/08/09	10:30 a.m.	433	<u>0.5</u>	32.5	13.1	7.2	10.7	10.3	91.2	0.8	<u>14.00</u>	95	1.200	1.100	0.03
03/09/09	10:10 a.m.	581	<u>0.6</u>	25.0	12.8	7.3	<u>12.8</u>	9.6	89.1	1.3	<u>19.00</u>	99	0.910	0.910	0.02
07/10/09	8:55 a.m.	920	(0.3)	27.5	12.1	7.0	12.6	9.5	89.6	1.8	<u>23.00</u>	100	0.680	0.670	0.05
04/11/09	8:55 a.m.	446	<u>0.6</u>	30.0	14.4	7.6	15.5	10.2	101.5	1.8	<u>9.30</u>	97	0.300	0.300	< 0.01
02/12/09	9:05 a.m.	392	<u>0.7</u>	35.0	14.6	7.6	18.4	8.7	92.9	0.8	4.90	120	0.290	0.290	0.02

Note: < = less than value stated  
UD = upper decile flow (period 1990-2009 inclusive)

Underlined values don't comply with the "satisfactory" water quality Guidelines and Standards – Table 1

\* New Zealand Standard Time

() black disk measurements taken in flows above upper decile value – don't assess for compliance

TKN g/m <sup>3</sup>	TN g/m <sup>3</sup>	DRP g/m <sup>3</sup>	TP g/m <sup>3</sup>	CL g/m <sup>3</sup>	AS g/m <sup>3</sup>	B g/m <sup>3</sup>	LI g/m <sup>3</sup>	A340F /cm	A440F /cm	ENT cfu/100mL	FC cfu/100mL	E coli cfu/100mL	CHLA g/m <sup>3</sup>	DOC g/m <sup>3</sup>	TOC g/m <sup>3</sup>
-	<0.5	-	<0.04	-	<0.01	<0.3	-	-	-	<77	-	<550	<0.02		
0.21	0.33	0.014	0.037	19.0	<u>0.028</u>	0.28	0.100	0.010	<0.002	4	7	7	0.012	1.6	2.3
0.13	0.19	0.014	<u>0.043</u>	19.0	<u>0.032</u>	0.29	0.130	0.005	<0.002	3	<1	<1	0.003	1.6	1.8
0.15	0.26	0.018	0.037	20.0	<u>0.026</u>	0.24	0.086	0.010	<0.002	2	8	8	<0.003	1.4	1.7
0.12	0.23	0.013	0.034	20.0	<u>0.028</u>	<u>0.31</u>	0.120	0.007	<0.002	<1	3	3	0.004	1.2	1.4
0.13	0.33	0.028	0.035	23.0	<u>0.029</u>	<u>0.31</u>	0.120	0.012	0.002				0.004	2.5	2.7
0.11	0.33	0.018	0.032	22.0	<u>0.026</u>	<u>0.36</u>	0.130	0.006	<0.002	3	2	2	<0.003	0.96	0.95
0.09	0.32	0.015	0.028	18.0	<u>0.023</u>	0.28	0.093	0.009	<0.002	6	4	4	<0.003	1.1	1.6
0.16	0.44	0.017	0.040	18.0	<u>0.023</u>	0.27	0.097	0.012	0.002	22	22	17	0.008	1.3	1.5
0.15	0.42	0.011	0.034	22.0	<u>0.023</u>	0.28	0.100	0.010	<0.002	2	9	8	0.013	1.2	1.4
0.21	0.43	0.015	0.033	18.0	<u>0.023</u>	0.27	0.100	0.012	0.002	35	200	200	0.007	1.3	1.7
0.14	0.24	0.005	0.020	16.0	<u>0.023</u>	0.29	0.097	0.006	<0.002	<1	3	3	0.007	0.85	1.3
0.17	0.25	0.006	0.025	18.0	<u>0.028</u>	0.27	0.093	0.008	0.003	20	8	8	0.008	1.3	1.4
0.21	0.39	0.015	<u>0.042</u>	18.0	<u>0.025</u>	0.21	0.077	0.012	0.002	23	40	31	0.006	2	2.3
0.17	0.26	0.010	<u>0.042</u>	21.0	<u>0.035</u>	<u>0.32</u>	0.120	0.007	<0.002	24	39	39	0.009	1.9	2.2
0.19	0.28	0.010	<u>0.044</u>	18.0	<u>0.026</u>	0.26	0.094	0.011	0.002	35	50	40	0.012	1.2	2
0.18	0.35	0.016	0.036	20.0	<u>0.026</u>	0.29	0.100	0.007	<0.002	50	37	28	0.004	1.3	1.4
0.23	0.48	0.027	0.035	20.0	<u>0.025</u>	0.28	0.110	0.008	<0.002	16	28	26	<0.003	1.2	1.3
0.15	0.44	0.018	0.034	19.0	<u>0.021</u>	<u>0.31</u>	0.110	0.007	<0.002	14	51	38	0.004	0.98	1.2
0.12	<u>0.55</u>	0.025	<u>0.045</u>	20.0	<u>0.021</u>	<u>0.32</u>	0.110	0.013	0.002	<u>110</u>	45	39	0.006	1.8	2.1
0.18	<u>0.64</u>	0.021	0.040	18.0	<u>0.017</u>	0.23	0.081	0.016	0.003	23	130	110	0.012	1.1	2
0.28	<u>0.74</u>	0.019	<u>0.050</u>	19.0	<u>0.017</u>	0.25	0.088	0.019	0.003	52	300	240	0.012	2	2.5
0.43	<u>0.87</u>	0.034	<u>0.082</u>	16.0	<u>0.016</u>	0.21	0.074	0.028	0.006	<u>700</u>	3800	<u>3200</u>	0.008	2.9	3.7
0.28	0.45	<0.004	0.030	15.0	<u>0.021</u>	0.23	0.082	0.009	<0.002	<10	15	15	0.009	1.3	1.7
0.21	0.38	0.010	0.024	17.0	<u>0.025</u>	0.25	0.088	0.009	<0.002	10	50	41	0.007	1.1	1.4
0.22	0.42	0.018	<u>0.052</u>	18.0	<u>0.024</u>	0.20	0.076	0.013	0.002	30	110	110	0.009	2.2	2.6
0.18	0.29	0.014	<u>0.044</u>	21.0	<u>0.034</u>	<u>0.31</u>	0.110	0.007	<0.002	30	50	50	0.010	1.8	2.3
0.18	0.31	0.021	<u>0.045</u>	18.0	<u>0.026</u>	0.26	0.091	0.012	0.002	<u>120</u>	9100	300	0.008	1.3	2.5
0.19	0.39	0.020	<u>0.055</u>	20.0	<u>0.025</u>	<u>0.31</u>	0.100	0.008	<0.002	<u>220</u>	210	160	0.004	1.4	1.3
0.19	0.45	0.028	<u>0.045</u>	20.0	<u>0.024</u>	0.28	0.110	0.008	<0.002	<u>110</u>	180	100	<0.003	1	1.2
0.17	0.47	0.021	<u>0.044</u>	19.0	<u>0.022</u>	<u>0.33</u>	0.120	0.007	<0.002	32	50	47	0.005	1	1.3
0.22	<u>0.72</u>	0.035	<u>0.064</u>	20.0	<u>0.021</u>	0.29	0.099	0.019	0.003	<u>200</u>	250	250	0.006	2.8	3.6
0.14	<u>0.63</u>	0.026	<u>0.046</u>	18.0	<u>0.016</u>	0.23	0.083	0.018	0.003	20	100	70	0.011	1.4	2.4
0.24	<u>0.70</u>	0.023	<u>0.052</u>	19.0	<u>0.018</u>	0.28	0.093	0.017	0.003	31	300	240	0.013	2.3	2.3
0.42	<u>0.91</u>	0.038	<u>0.089</u>	16.0	<u>0.016</u>	0.20	0.073	0.032	0.006	<u>270</u>	4000	<u>3000</u>	0.009	3	4.4
0.27	0.44	<0.004	0.032	16.0	<u>0.021</u>	0.25	0.083	0.010	<0.002	18	30	30	0.016	1.1	1.8
0.20	0.39	0.016	0.027	18.0	<u>0.025</u>	0.26	0.085	0.009	<0.002	<u>90</u>	220	140	0.009	1.4	1.4
0.20	0.49	0.025	<u>0.063</u>	17.0	<u>0.020</u>	0.17	0.056	0.020	0.003	4	59	51	0.006	2.2	3.2
0.21	0.26	0.013	<u>0.057</u>	21.0	<u>0.030</u>	0.28	0.100	0.011	<0.002	10	49	42	0.018	1.9	2.8
0.21	0.49	0.035	<u>0.069</u>	16.0	<u>0.019</u>	0.20	0.069	0.022	0.004	<u>120</u>	250	130	0.007	1.7	2.8
0.18	0.43	0.028	<u>0.063</u>	20.0	<u>0.023</u>	0.29	0.093	0.010	0.002	<u>80</u>	50	50	0.005	1.1	0.93
0.21	<u>0.53</u>	0.036	<u>0.062</u>	20.0	<u>0.021</u>	0.27	0.100	0.010	<0.002	59	110	100	<0.003	4.2	4
0.23	<u>0.74</u>	0.027	<u>0.050</u>	18.0	<u>0.018</u>	0.24	0.085	0.013	0.002	33	120	100	<0.003	1.6	1.6
0.47	<u>1.57</u>	0.031	<u>0.075</u>	17.0	<u>0.013</u>	0.19	0.062	0.032	0.005	50	120	90	0.004	3.9	4.3
0.35	<u>1.55</u>	0.023	<u>0.076</u>	14.0	0.006	0.09	0.031	0.031	0.005	51	290	290	0.005	2.7	3.6
0.45	<u>1.36</u>	0.023	<u>0.087</u>	14.0	0.007	0.12	0.037	0.035	0.006	<u>120</u>	1500	<u>1300</u>	0.007	4.3	4.8
0.52	<u>1.20</u>	0.034	<u>0.100</u>	13.0	0.009	0.12	0.040	0.046	0.009	<u>700</u>	3800	<u>3000</u>	0.006	4.7	5.5
0.37	<u>0.67</u>	0.009	<u>0.063</u>	15.0	<u>0.016</u>	0.20	0.069	0.015	0.003	12	60	60	0.014	1.5	2.9
0.24	<u>0.53</u>	0.019	0.037	17.0	<u>0.020</u>	0.20	0.067	0.016	0.002	<u>90</u>	140	140	0.009	1.5	1.6

Note: < = less than value stated

Underlined values don't comply with the "satisfactory" water quality Guidelines and Standards – Table 1

DATE	TIME*	FLOW	BDISK	COLOR	COND	PH	TEMP	DO	PCDO	BOD5	TURB	TDS	NNN	NO3-N	NH4-N
dd/mm/yy	hh:mm	m <sup>3</sup> /s	m	units	mS/m	units	'C	g/m <sup>3</sup>	%Sat	g/m <sup>3</sup>	NTU	g/m <sup>3</sup>	g/m <sup>3</sup>	g/m <sup>3</sup>	g/m <sup>3</sup>
Satisfactory Water Quality			>1.6	-	-	6.5-9	<12 (May-Sep)	>80	-	<5	-	-	-	-	<0.88
Guideline/Standard							<20 (Oct-Apr)								

1131-91 UD = 632 m<sup>3</sup>/s (Flows from Mercer Bridge Recorder)

**Waikato River at Mercer Br**

07/01/09	11:00 a.m.	237	-	-	15.5	7.8	<u>22.8</u>	8.9	101.9	0.9	<u>7.30</u>	110	0.210	0.210	< 0.01
02/02/09	10:25 a.m.	266	-	-	17.8	8.3	<u>23.8</u>	9.1	108.3	2.4	<u>5.70</u>	140	< 0.002	< 0.002	< 0.01
04/03/09	11:10 a.m.	281	-	-	15.7	7.6	<u>22.5</u>	7.9	91.0	1.8	<u>10.00</u>	130	0.270	0.260	< 0.01
09/04/09	11:10 a.m.	292	-	-	17.1	7.6	17.7	9.3	98.2	0.7	3.80	100	0.250	0.240	< 0.01
07/05/09	10:55 a.m.	310	-	-	16.8	7.5	<u>14.9</u>	9.7	96.3	0.8	4.70	130	0.340	0.340	< 0.01
04/06/09	10:50 a.m.	298	-	-	16.5	7.5	9.6	11.1	96.6	1.9	<u>6.60</u>	130	0.590	0.580	< 0.01
08/07/09	11:00 a.m.	568	-	-	16.7	7.2	11.0	9.7	88.2	1.6	<u>18.00</u>	130	1.200	1.200	0.04
05/08/09	11:05 a.m.	462	-	-	14.5	7.2	11.5	10.2	92.5	1.1	<u>19.00</u>	120	1.000	1.000	0.01
03/09/09	10:45 a.m.	557	-	-	13.3	7.2	<u>13.3</u>	9.6	90.3	1.5	<u>28.00</u>	100	0.820	0.820	< 0.01
07/10/09	9:30 a.m.	832	-	-	13.1	7.0	<u>13.2</u>	10.0	85.5	1.6	<u>24.00</u>	110	0.660	0.660	0.02
04/11/09	9:35 a.m.	412	-	-	15.1	7.5	16.6	9.5	97.3	1.8	<u>16.00</u>	100	0.350	0.350	< 0.01
02/12/09	9:50 a.m.	381	-	-	15.0	7.6	19.1	8.7	95.1	1.0	<u>7.20</u>	120	0.240	0.240	< 0.01

**1131-133**

**Waikato River at Tuakau Br**

07/01/09	11:40 a.m.	-	<u>0.8</u>	32.5	15.6	7.9	<u>23.2</u>	9.5	110.4	0.9	<u>8.60</u>	120	0.210	0.210	< 0.01
02/02/09	12:10 p.m.	-	<u>0.7</u>	32.5	17.3	8.5	<u>25.3</u>	9.8	120.3	2.6	4.00	140	< 0.002	< 0.002	< 0.01
04/03/09	11:50 a.m.	-	<u>0.7</u>	40.0	15.5	7.6	<u>23.0</u>	8.4	97.4	1.2	<u>7.80</u>	120	0.230	0.230	0.01
09/04/09	11:40 a.m.	-	<u>1.3</u>	37.5	17.3	7.7	17.6	9.7	102.7	0.5	3.00	110	0.220	0.220	0.01
07/05/09	11:30 a.m.	-	<u>1.0</u>	35.0	16.9	7.5	<u>14.7</u>	9.8	96.5	0.6	3.80	130	0.330	0.330	< 0.01
04/06/09	11:30 a.m.	-	<u>0.6</u>	37.5	16.7	7.4	10.6	10.8	95.8	1.1	<u>6.20</u>	130	0.540	0.540	< 0.01
08/07/09	11:30 a.m.	-	<u>0.3</u>	30.0	16.5	7.2	11.2	9.6	87.4	1.2	<u>25.00</u>	130	1.200	1.200	0.03
05/08/09	11:30 a.m.	-	<u>0.4</u>	30.0	14.7	7.2	11.8	10.0	90.5	0.9	<u>18.00</u>	88	0.980	0.980	0.01
03/09/09	11:20 a.m.	-	<u>0.3</u>	25.0	13.7	7.4	<u>13.4</u>	9.3	87.8	1.5	<u>27.00</u>	100	0.780	0.770	0.01
07/10/09	10:00 a.m.	-	<u>0.3</u>	25.0	13.4	7.1	13.4	8.9	85.5	1.8	<u>26.00</u>	120	0.660	0.650	0.02
04/11/09	10:00 a.m.	-	<u>0.3</u>	27.5	15.1	7.5	16.7	9.7	99.8	2.0	<u>16.00</u>	110	0.300	0.300	< 0.01
02/12/09	10:15 a.m.	-	<u>0.7</u>	35.0	15.1	7.6	19.1	9.0	97.8	1.1	<u>6.20</u>	110	0.200	0.200	< 0.01

Note: < = less than value stated  
UD = upper decile flow (period 1990-2009 inclusive)

\* New Zealand Standard Time

Underlined values don't comply with the "satisfactory" water quality Guidelines and Standards – Table 1

() black disk measurements taken in flows above upper decile value – don't assess for compliance



TKN g/m <sup>3</sup>	TN g/m <sup>3</sup>	DRP g/m <sup>3</sup>	TP g/m <sup>3</sup>	CL g/m <sup>3</sup>	AS g/m <sup>3</sup>	B g/m <sup>3</sup>	LI g/m <sup>3</sup>	A340F /cm	A440F /cm	ENT cfu/100mL	FC cfu/100mL	E coli cfu/100mL	CHLA g/m <sup>3</sup>	DOC g/m <sup>3</sup>	TOC g/m <sup>3</sup>
-	<0.5	-	<0.04	-	<0.01	<0.3	-	-	-	<77	-	<550	<0.02		

0.27	0.48	0.012	<u>0.069</u>	17.0	<u>0.018</u>	0.20	0.064	0.019	0.003	6	42	42	0.016	2.5	3.7
0.24	0.24	0.037	<u>0.063</u>	22.0	<u>0.029</u>	<u>0.30</u>	0.110	0.010	<0.002	5	23	23	<u>0.029</u>	1.5	3.6
0.35	<u>0.62</u>	0.011	<u>0.076</u>	17.0	<u>0.017</u>	0.20	0.064	0.024	0.004	22	140	100	0.012	2.2	4.3
0.22	0.47	0.042	<u>0.062</u>	19.0	<u>0.022</u>	0.29	0.092	0.010	<0.002	34	50	50	0.006	1.1	1.3
0.24	<u>0.58</u>	0.028	<u>0.060</u>	19.0	<u>0.021</u>	0.27	0.097	0.012	<0.002	18	90	60	0.005	1.3	1.6
0.29	<u>0.88</u>	0.022	<u>0.056</u>	18.0	<u>0.014</u>	0.23	0.076	0.018	0.003	41	230	160	<0.003	1.1	2.3
0.54	<u>1.74</u>	0.023	<u>0.083</u>	18.0	<u>0.012</u>	0.17	0.053	0.048	0.008	<u>110</u>	190	190	0.005	6.2	8.7
0.40	<u>1.40</u>	0.022	<u>0.087</u>	15.0	0.008	0.12	0.037	0.039	0.007	65	340	290	0.010	2.8	3.5
0.49	<u>1.31</u>	0.024	<u>0.110</u>	14.0	0.009	0.13	0.042	0.041	0.007	<u>210</u>	2100	<u>1800</u>	0.008	4.4	6.6
0.64	<u>1.30</u>	0.036	<u>0.110</u>	14.0	<u>0.010</u>	0.13	0.044	0.056	0.010	<u>330</u>	2000	<u>1400</u>	0.007	5.1	7
0.55	<u>0.90</u>	0.008	<u>0.071</u>	16.0	<u>0.014</u>	0.20	0.061	0.032	0.006	8	40	10	0.015	2.6	4.4
0.24	0.48	0.014	0.034	17.0	<u>0.020</u>	0.21	0.073	0.012	<0.002	<u>90</u>	270	270	0.009	1.4	2
0.35	<u>0.56</u>	0.010	<u>0.069</u>	17.0	<u>0.019</u>	0.17	0.057	0.021	0.003	8	90	70	0.019	2.3	3.6
0.26	0.26	0.004	<u>0.052</u>	22.0	<u>0.031</u>	<u>0.32</u>	0.110	0.010	<0.002	6	17	17	<u>0.031</u>	1.8	3
0.29	<u>0.52</u>	0.027	<u>0.072</u>	17.0	<u>0.018</u>	0.23	0.070	0.022	0.004	27	160	120	0.012	2	3
0.20	0.42	0.025	<u>0.060</u>	20.0	<u>0.022</u>	<u>0.30</u>	0.092	0.010	<0.002	70	51	41	0.006	1.1	1.2
0.22	<u>0.55</u>	0.032	<u>0.060</u>	19.0	<u>0.021</u>	0.27	0.096	0.012	0.002	35	160	110	0.004	1.3	1.4
0.26	<u>0.80</u>	0.026	<u>0.058</u>	19.0	<u>0.015</u>	0.24	0.082	0.023	0.004	28	200	130	0.003	2.4	2.5
0.39	<u>1.59</u>	0.021	<u>0.120</u>	18.0	<u>0.010</u>	0.16	0.051	0.045	0.008	<u>180</u>	350	350	0.006	5.5	7.5
0.42	<u>1.40</u>	0.022	<u>0.080</u>	16.0	0.008	0.13	0.042	0.043	0.007	<u>80</u>	490	320	0.012	3.2	4.8
0.55	<u>1.33</u>	0.021	<u>0.120</u>	15.0	0.008	0.13	0.044	0.048	0.009	<u>240</u>	2400	<u>2200</u>	0.012	4	6.6
0.55	<u>1.21</u>	0.037	<u>0.120</u>	14.0	<u>0.011</u>	0.13	0.045	0.060	0.011	<u>230</u>	2600	<u>2300</u>	0.007	4.7	7.5
0.54	<u>0.84</u>	0.008	<u>0.080</u>	16.0	<u>0.015</u>	0.19	0.063	0.031	0.006	10	20	20	<u>0.024</u>	2.6	4.3
0.26	0.46	0.015	0.030	17.0	<u>0.020</u>	0.22	0.074	0.013	<0.002	<u>100</u>	360	360	0.017	1.4	2.4

Note: < = less than value stated

Underlined values don't comply with the "satisfactory"

water quality Guidelines and Standards – Table 1

# References

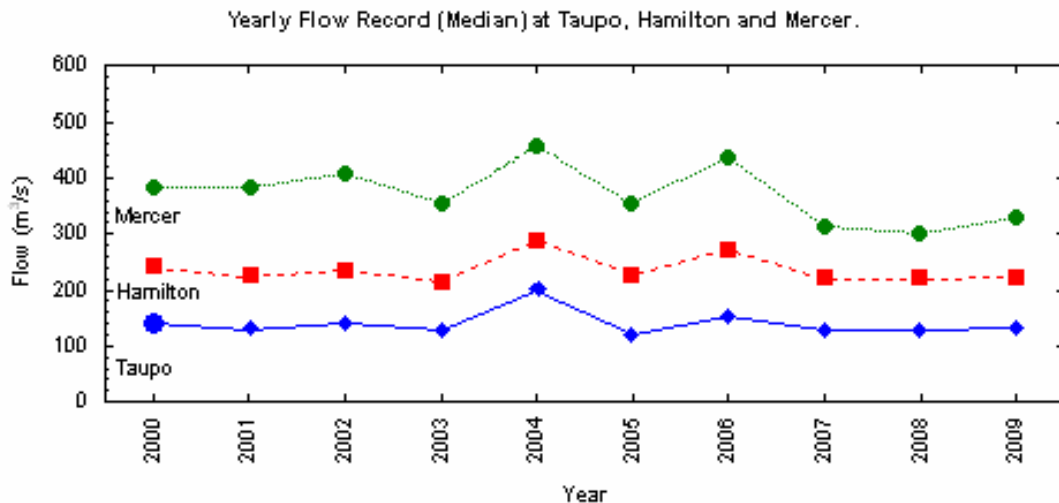
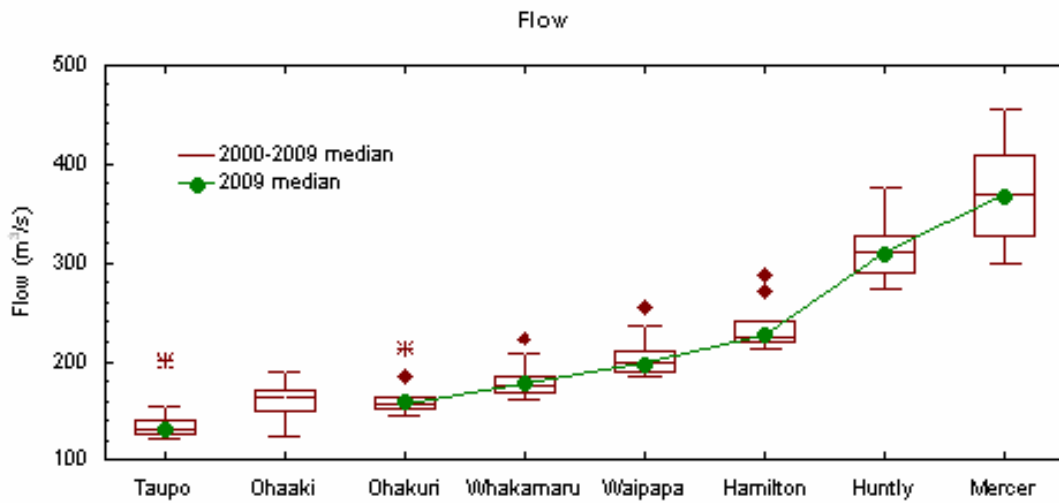
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## Appendix I: Flow information

Median Flows of the Waikato River and Main Tributaries

Location	DISTANCE	FLOW RATE* (m <sup>3</sup> /s)											10 YEAR
	km	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Median	
Taupo	4.2	139	130	141	127	200	121	154	128	127	133	131	
Ohakuri	75.8	158	150	164	157	214	152	184	157	163	145	158	
Whakamaru	105.0	168	161	183	168	224	175	208	178	186	170	177	
Waipapa	126.1	196	186	211	192	256	200	237	190	211	184	198	
Hamilton	211.5	241	225	234	213	288	226	273	220	220	224	226	
Huntly	246.5	314	299	328	315	376	290	343	282	274	306	310	
Mercer	286.3	381	383	408	353	455	355	437	312	299	328	368	
Waiootapu Stm	46.6	2.8	3.2	2.8	2.6	3.7	3.6	3.8	2.9	3.0	2.7	3.0	
Waipa River	232.7	52	62	73	61	87	56	61	39	43	52	59	

\*Rating curve errors mean estimates of flow are  $\pm 8\%$

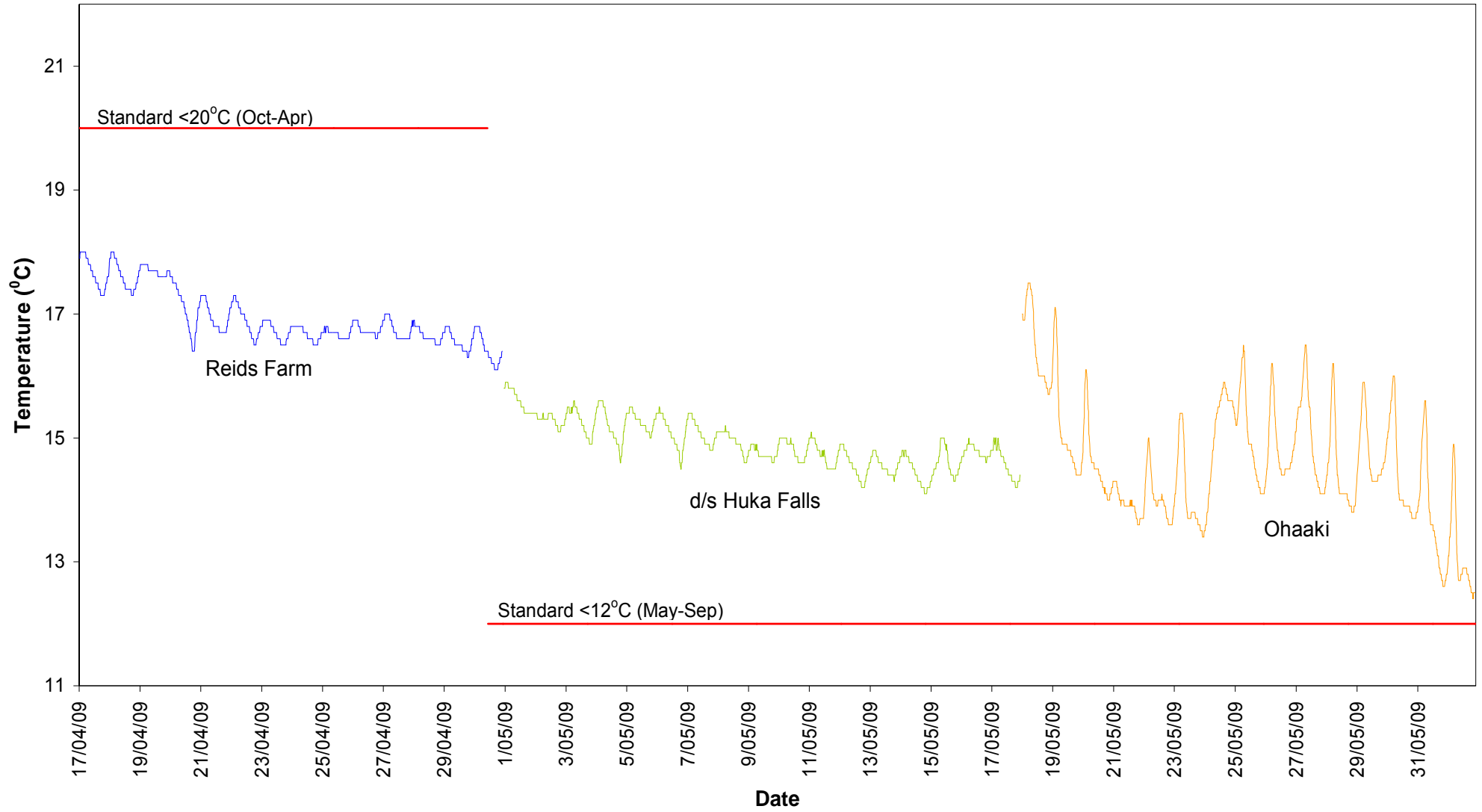


# **Appendix II**

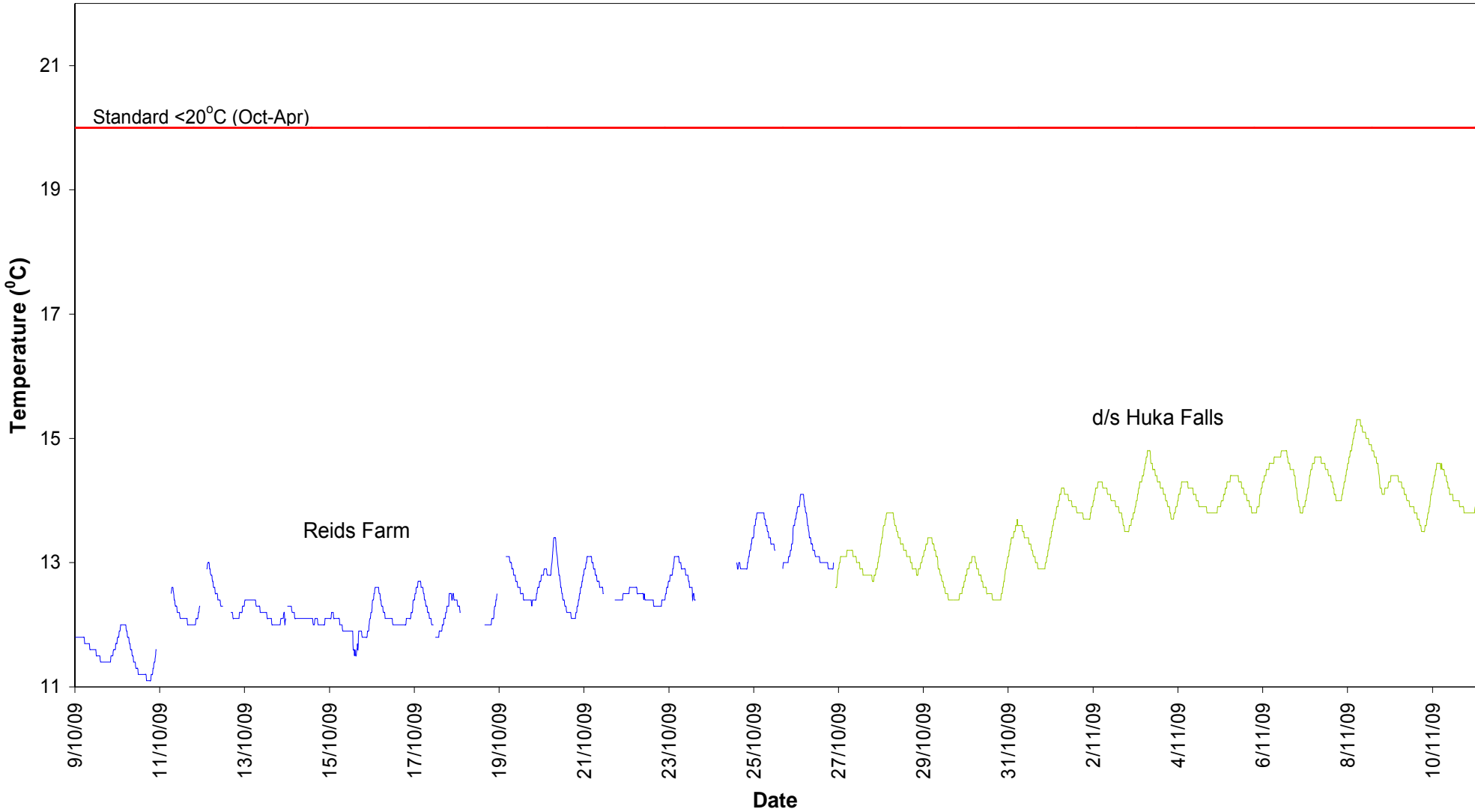
## **Datasonde deployments**

### **Diurnal variation of some water quality parameters**

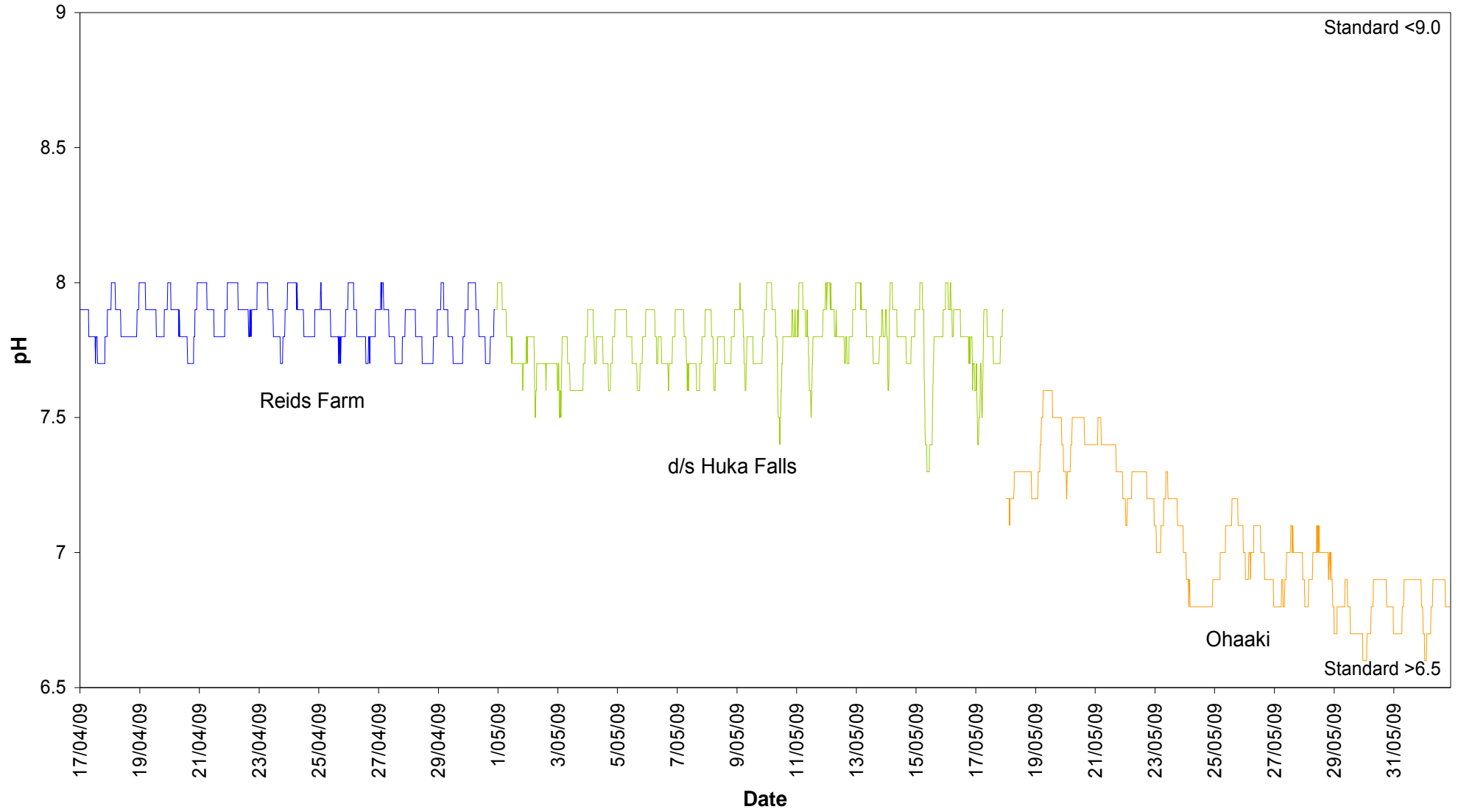
### Temperature: Upper Waikato (April - May)



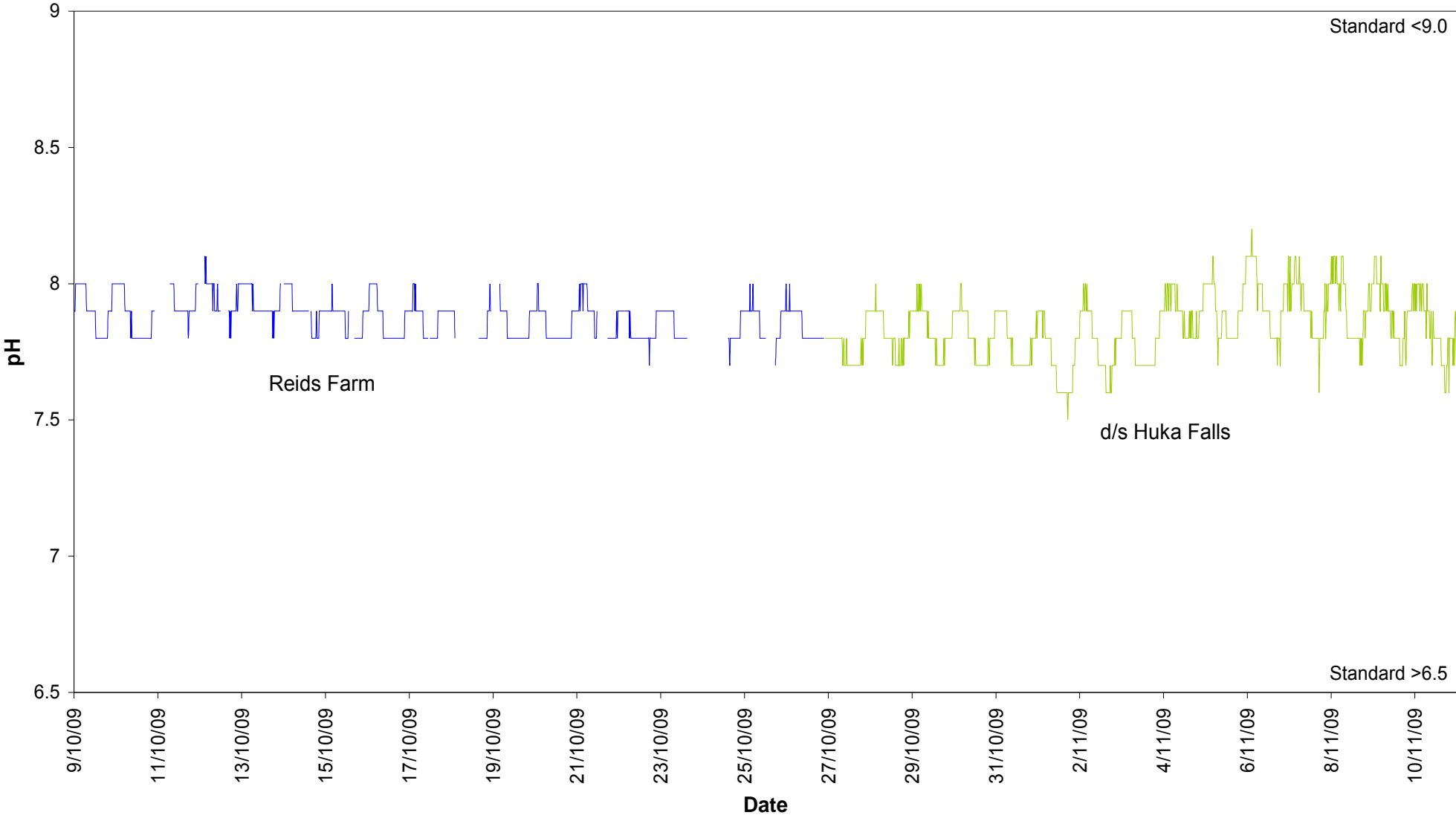
Temperature: Upper Waikato (October - November)



# pH: Upper Waikato (April-May)

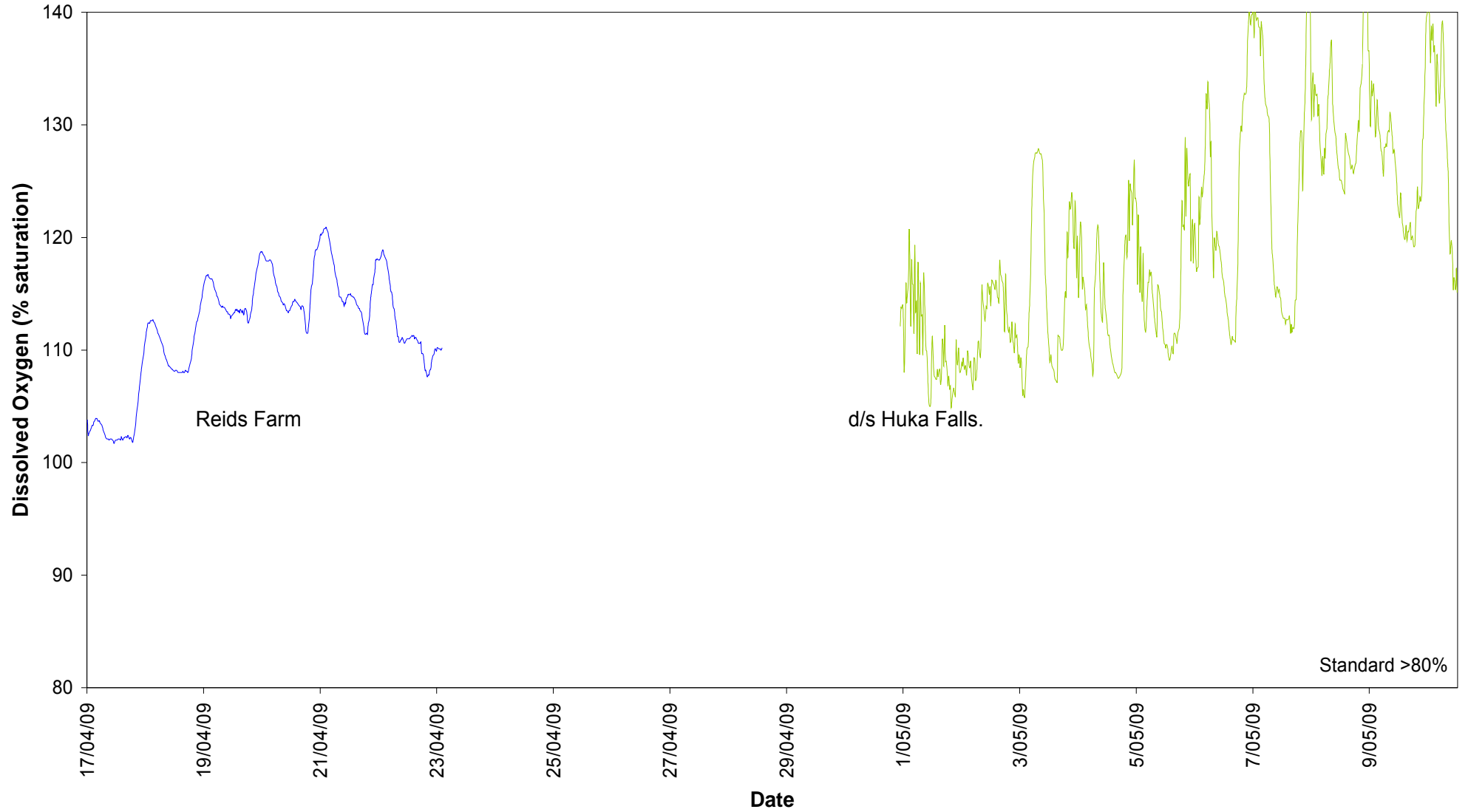


# pH: Upper Waikato (October-November)

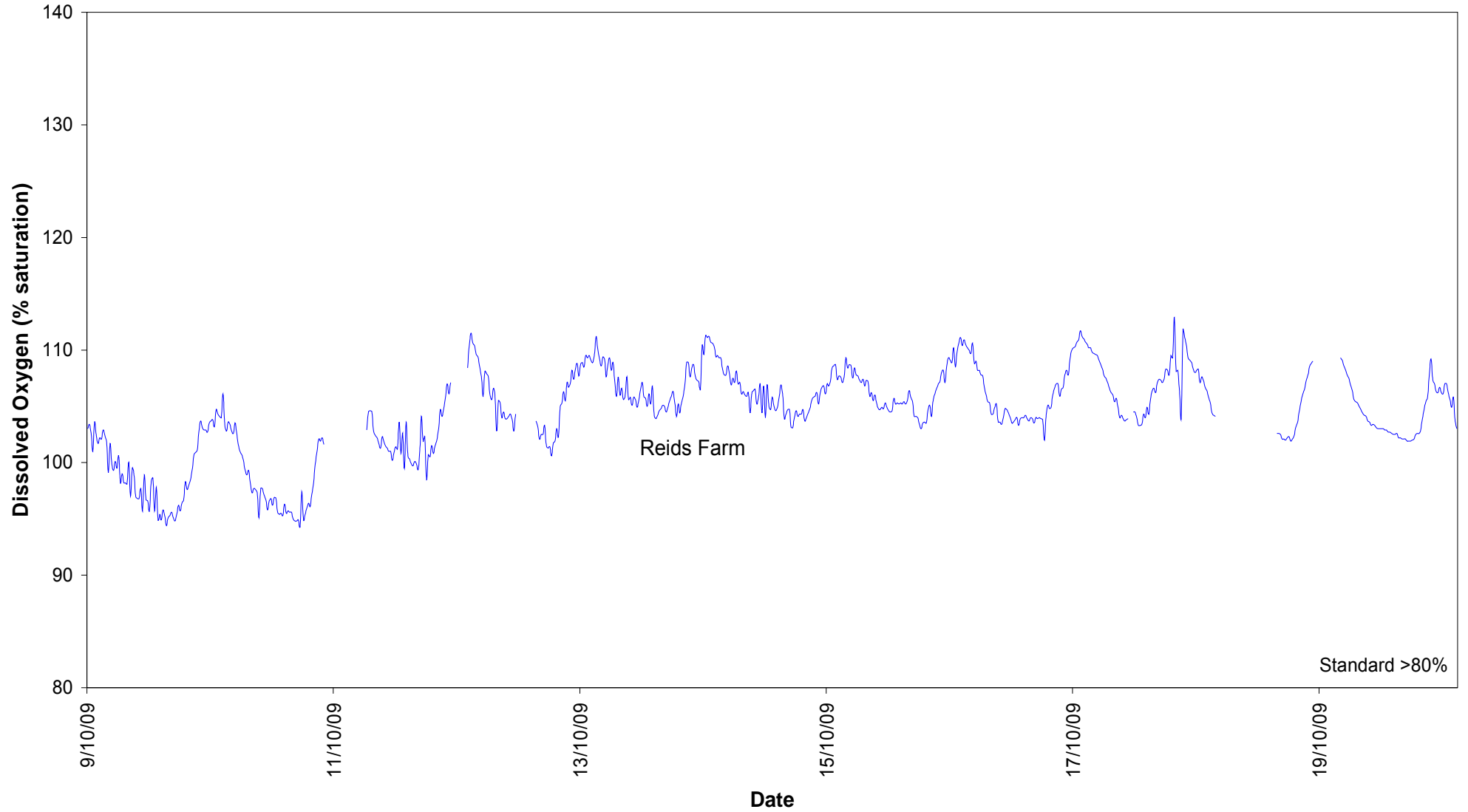




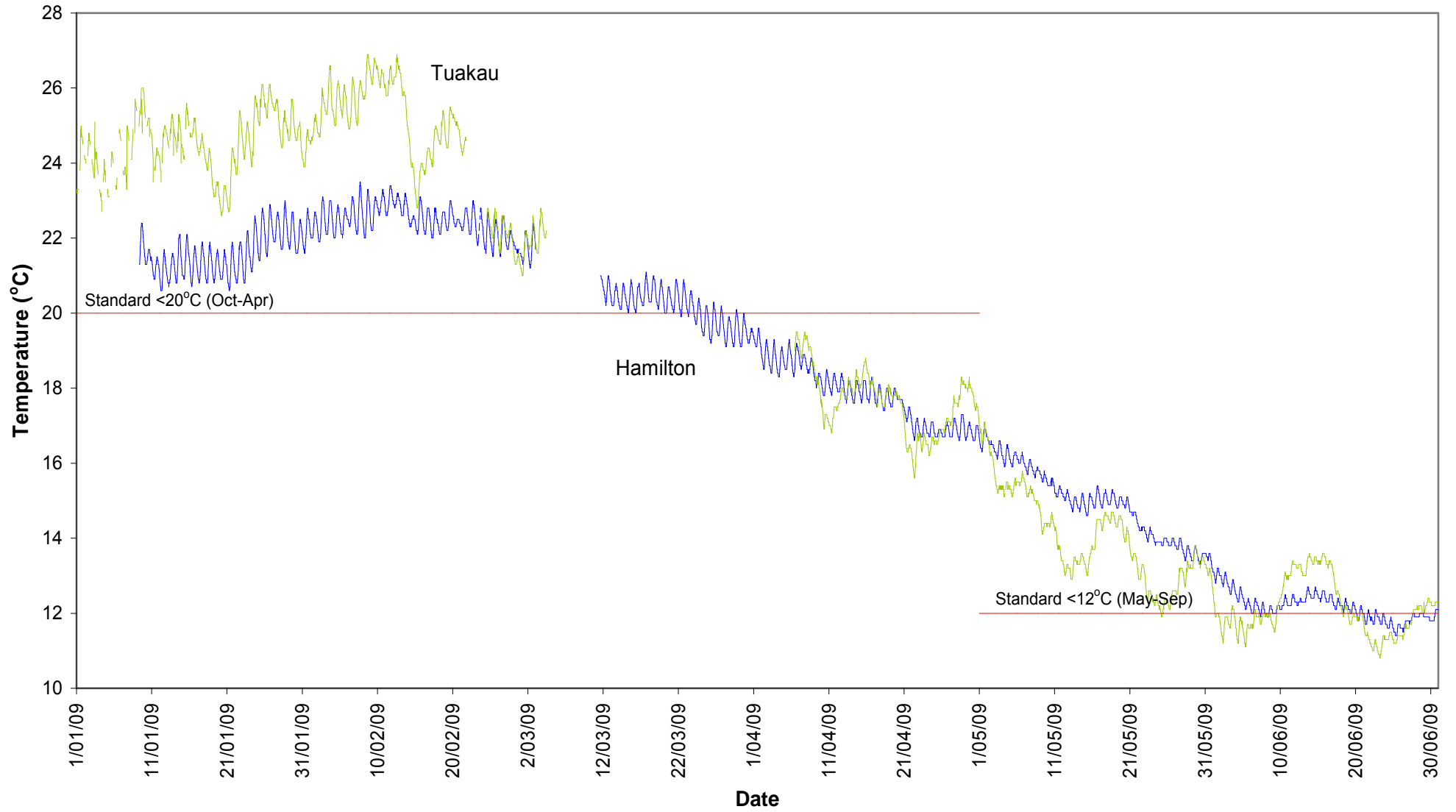
### Dissolved Oxygen, % saturation: Upper Waikato (April - May)



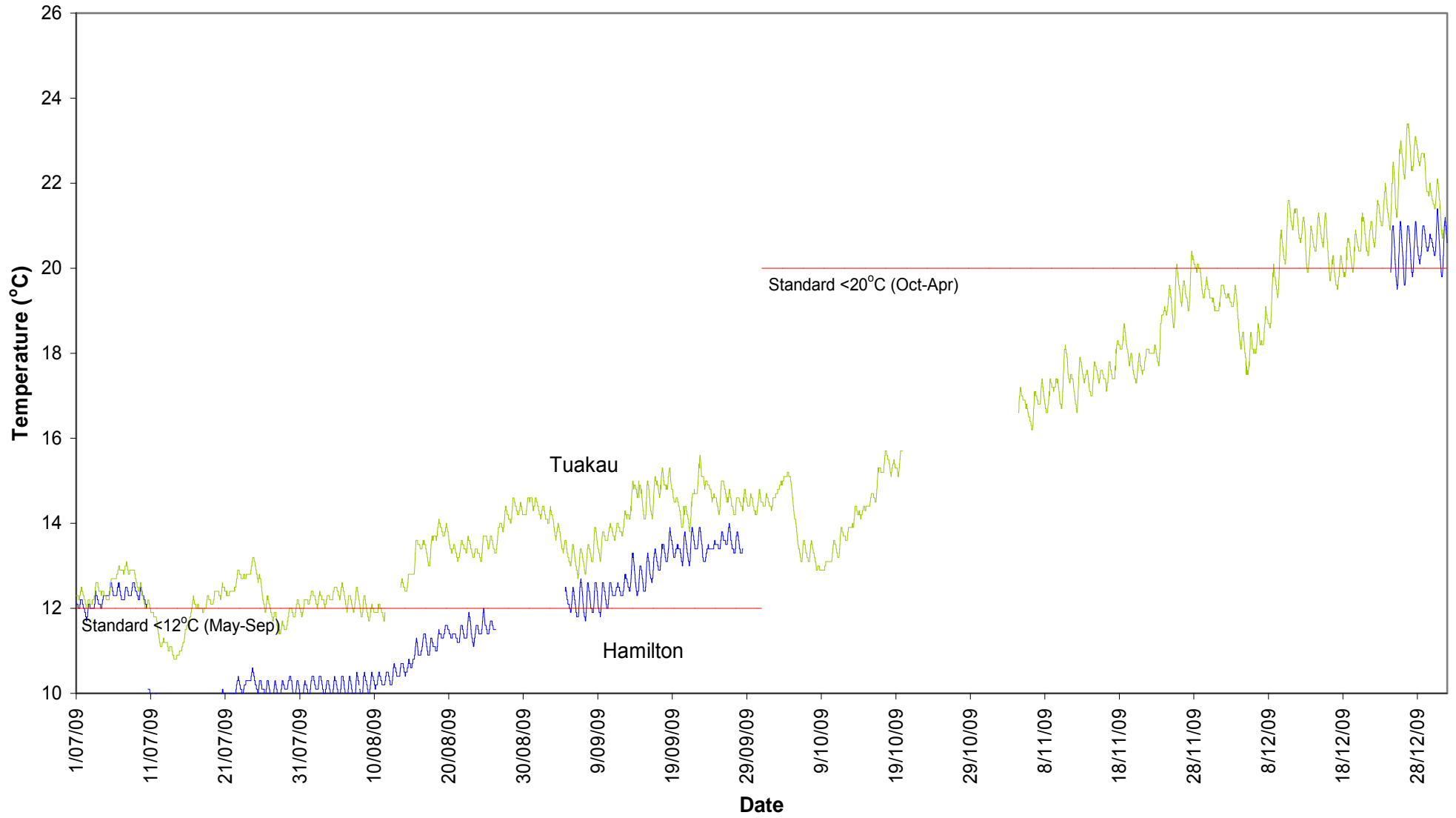
### Dissolved Oxygen, % saturation: Upper Waikato (October)



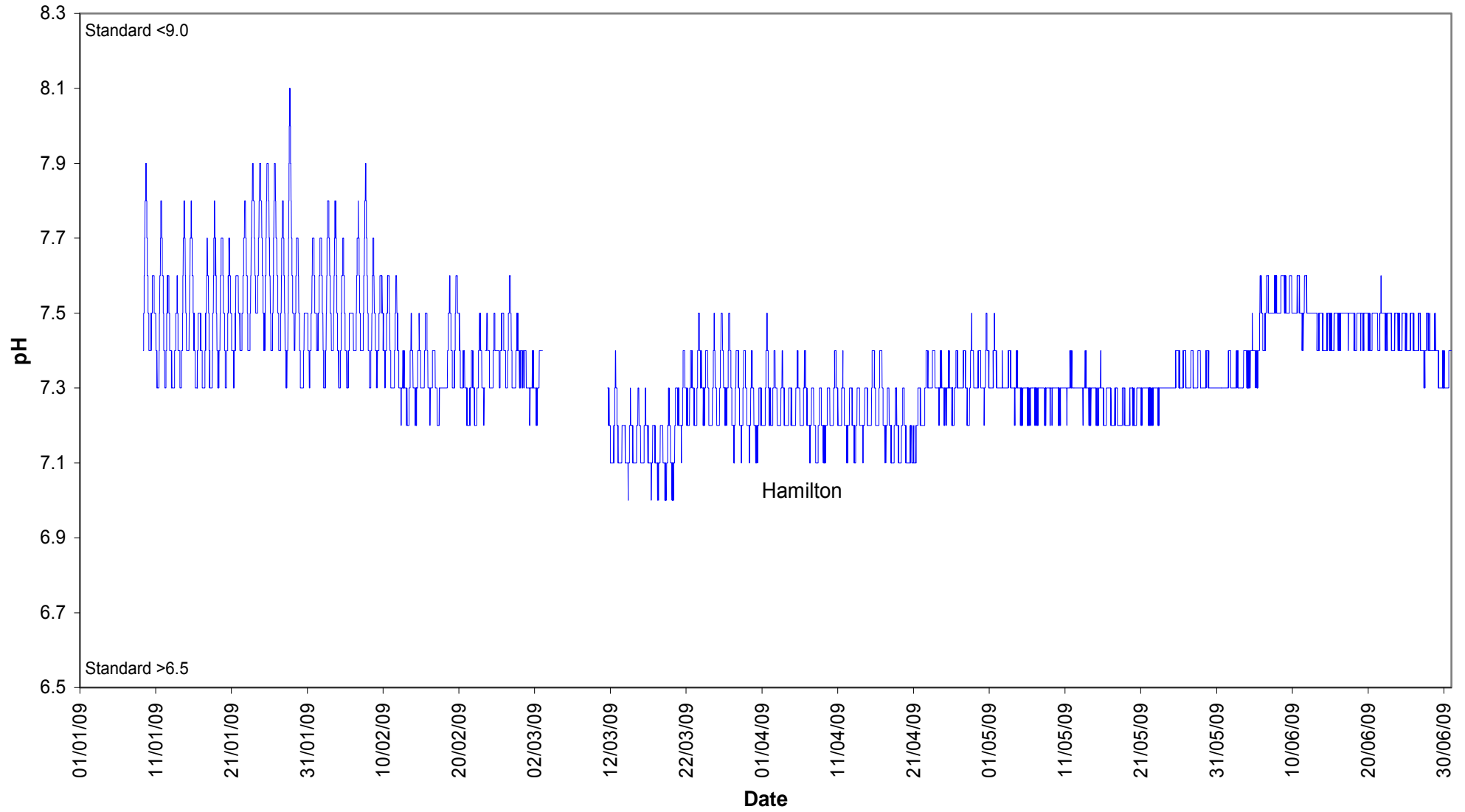
### Temperature: Lower Waikato (January-June)



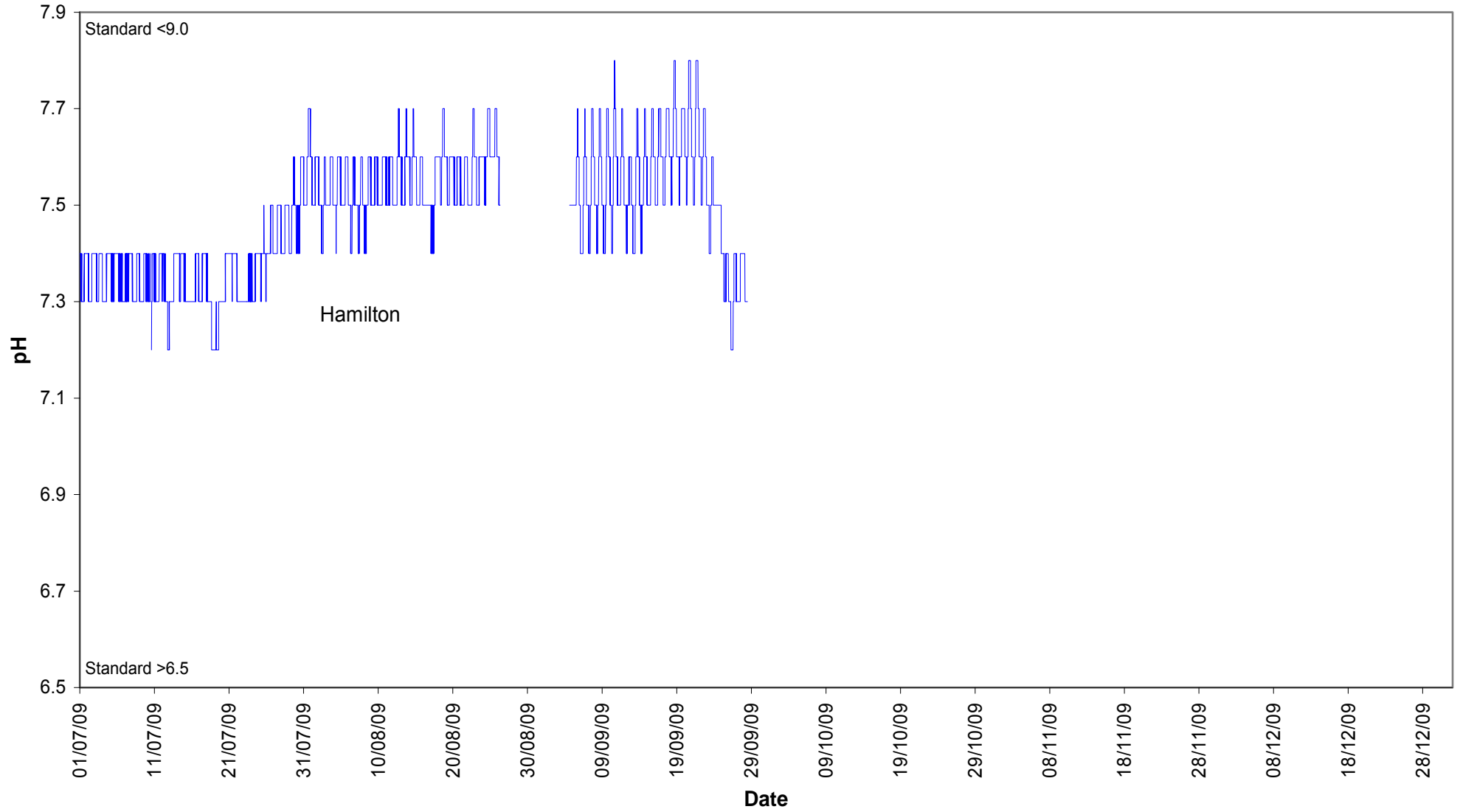
### Temperature: Lower Waikato (July-December)



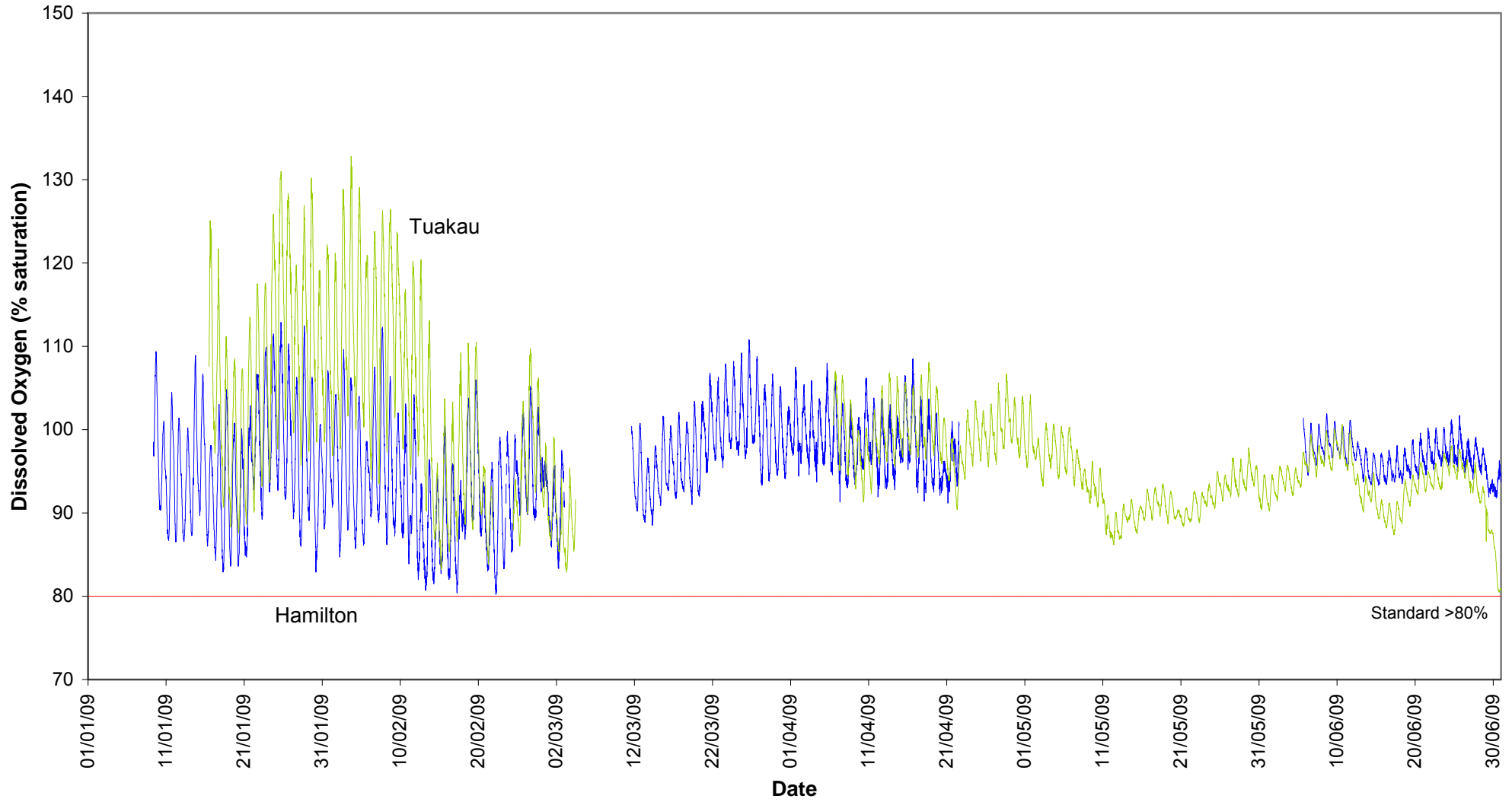
### pH: Lower Waikato (January - June)



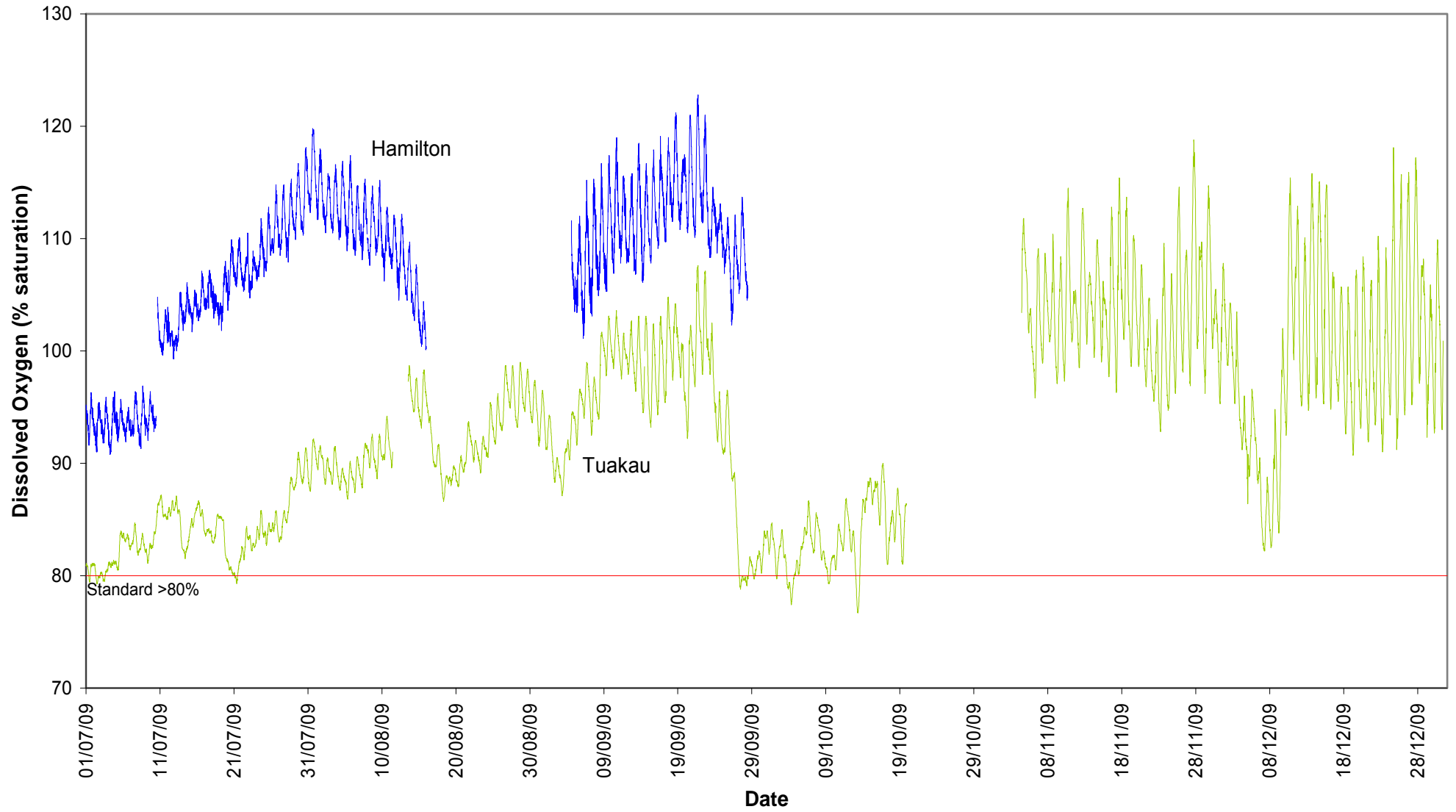
### pH: Lower Waikato (July - December)



### Dissolved Oxygen (% saturation): Lower Waikato (January - June)

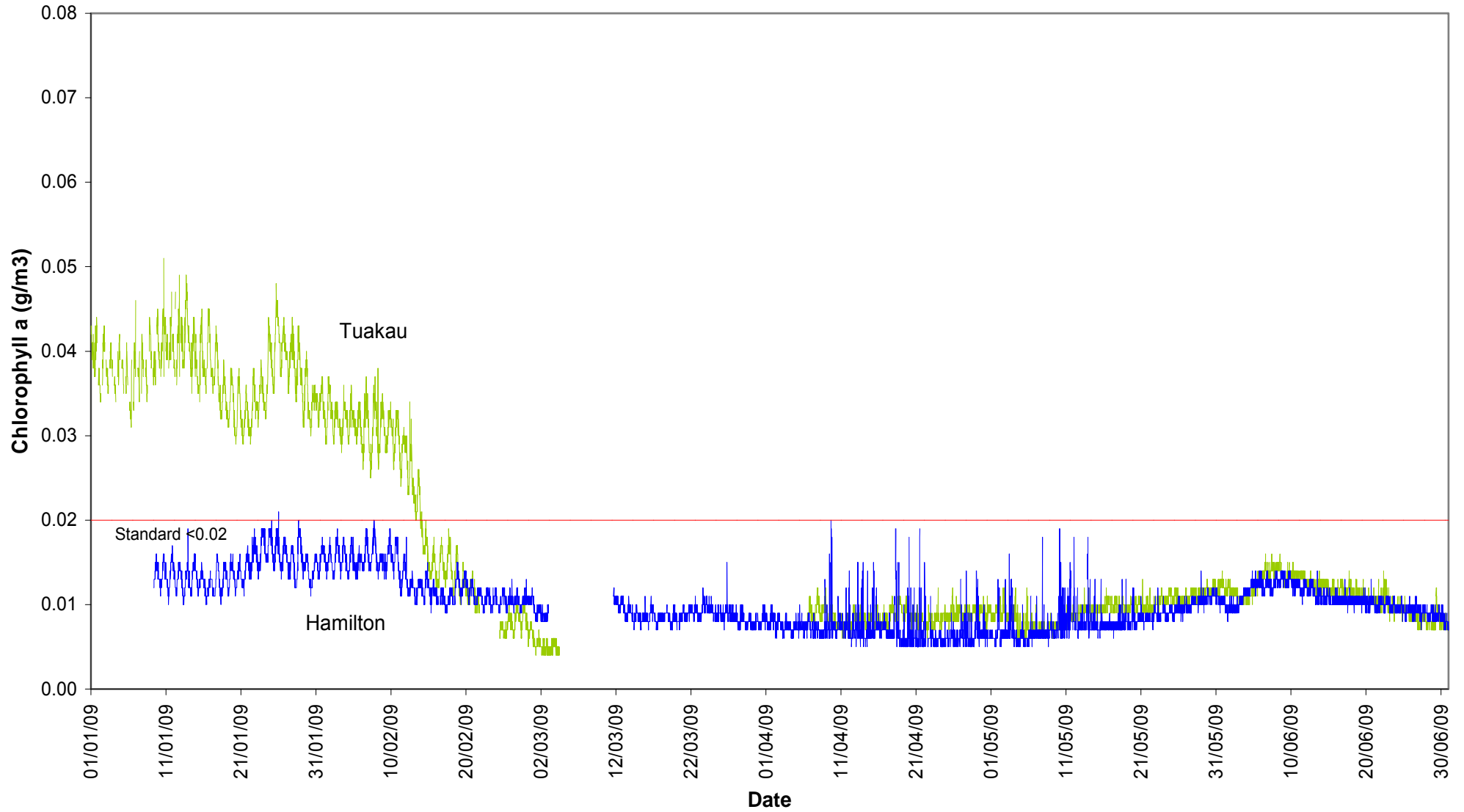


### Dissolved Oxygen (% saturation): Lower Waikato (July - December)

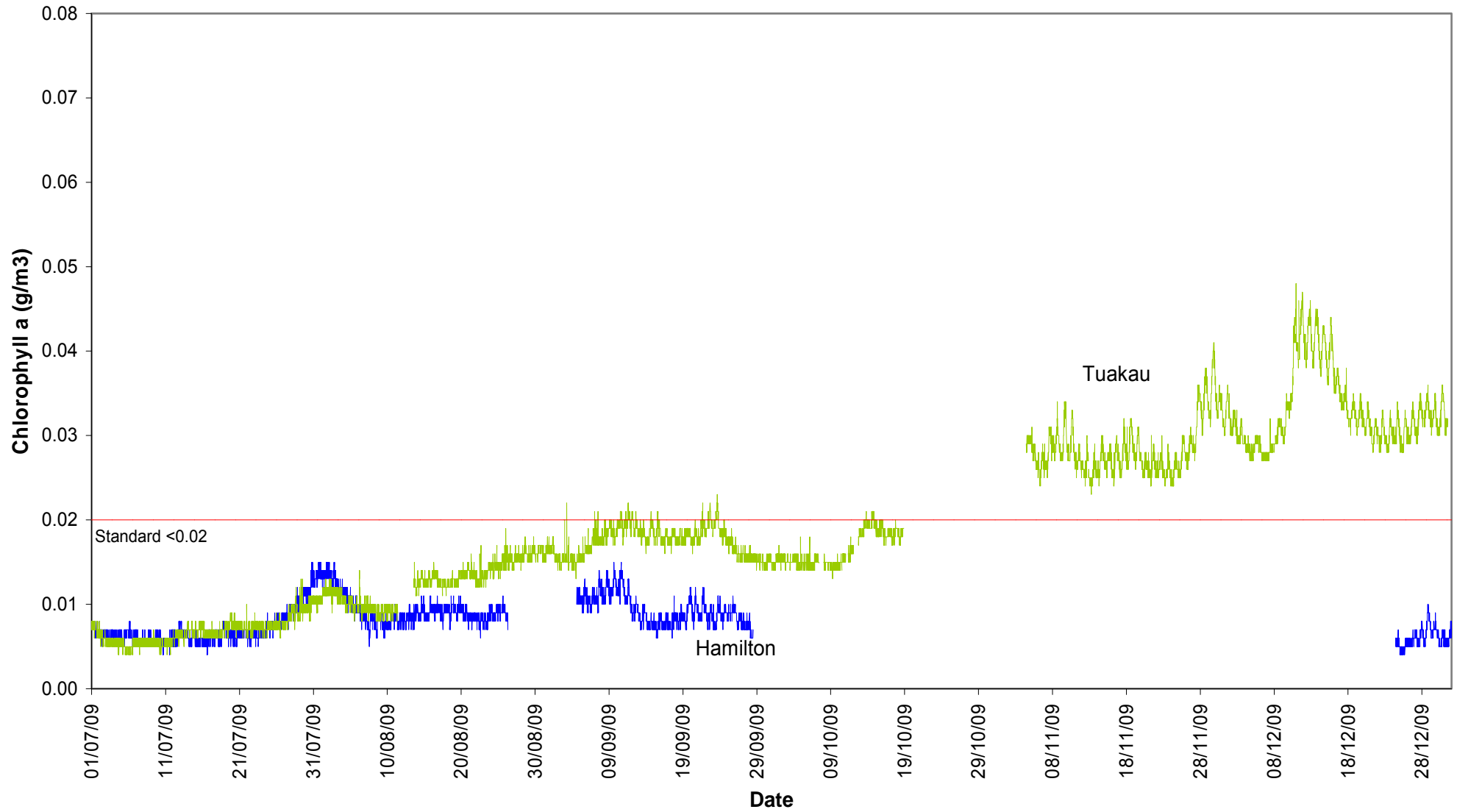




### Chlorophyll a: Lower Waikato (Jan - June)



### Chlorophyll a: Lower Waikato (July - December)



# **Appendix III:**

**Water quality parameters**

**Guidelines and standards**

**Analytical methods**

## Waikato River water quality monitoring programme parameters

Water quality parameter	Reason for monitoring	Parameter monitored <sup>1</sup>	Comments <sup>2</sup>
<b>Dissolved oxygen</b>	- requirement for aquatic life	DO (conc.)	routine (field)
	- indicator of organic pollution	DO (%sat.)	routine (field)
	- indicator of photosynthesis (plant growth)		
<b>Temperature</b>	- indicator of biological activity	Temperature	routine (field)
	- requirement for aquatic life		
	- mixing processes		
	- modelling studies (e.g. nutrient uptake)		
<b>Conductivity</b>	- indicator of total salts dissolved in water	Conductivity	routine
	- indicator for geothermal input	TDS	routine
<b>pH</b>	- aquatic life protection	pH	routine
	- indicator of industrial discharges, mining		
<b>Clarity</b> - turbidity - black disk (visual clarity)	- aesthetic appearance	Turbidity	routine
	- light availability for excessive plant growth	Black disk	routine (field)
	- aquatic life protection		
	- indicator of catchment condition, land use		
<b>Colour</b> - light absorption	- aesthetic appearance	Munsell colour	routine (field)
	- light availability for excessive plant growth	Absorbance at:	routine
	- indicator of presence of organic matter	340,440,780nm	
<b>Nutrients (N and P) chlorophyll a</b>	- enrichment, excessive plant growth	NO <sub>3</sub> -N+NO <sub>2</sub> -N	routine
	- nutrient limitation for plant/algal growth	NH <sub>4</sub> -N,TKN	
		DRP, TP, Chl a	
<b>Geothermal contaminants</b>	- indicators of geothermal inflows	Cl, Li, B, As	routine
	- aquatic life protection (ecotoxicity)		
	- drinking water (human health aspects)		
<b>Organic carbon</b>	- indicator of organic pollution	BOD <sub>5</sub>	routine
	- catchment characteristics	TOC/DOC	routine
<b>Faecal bacteria</b> - E. coli - enterococci - faecal coliforms	- indicator of pollution with faecal matter	E. Coli	routine
	- disease risk for swimming etc.	ENT	routine
		FC	routine

<sup>1</sup> see the page 54 for the meaning of the abbreviations.

<sup>2</sup> routine means sampled monthly.

## Details of water quality standards and guidelines for “satisfactory” water quality

Parameter	Critical value(s)	Source
Dissolved oxygen	>80% of saturation concentration	RMA Third Schedule, Classes AE, F, and FS.
pH	6.5–9	ANZECC (1992) and Canadian guidelines for freshwater aquatic life (1987).
Turbidity	<5 NTU	Studies of adverse effects on underwater light—and thus on plant and invertebrate production—in certain South Island streams (Davies-Colley 1991).
Ammoniacal-nitrogen	<0.88 g/m <sup>3</sup>	USEPA (1998) value for 1-hour exposure at pH 9.
Temperature	<12°C (May – Sep) <20°C (Oct – Apr)	Environment Waikato Proposed Regional Plan standards for trout fisheries and trout spawning (1998).
Total phosphorus	<0.04 g/m <sup>3</sup>	From upper quartile values for 77 New Zealand rivers in NIWA’s National Water Quality Network (after Smith & Maasdam 1994)—note that the guidelines for “excellent” conditions are the lower quartile concentrations for these rivers.
Total nitrogen	<0.5 g/m <sup>3</sup>	From upper quartile values for 77 New Zealand rivers in NIWA’s National Water Quality Network (after Smith & Maasdam 1994)—note that the guidelines for “excellent” conditions are the lower quartile concentrations for these rivers.
Water clarity at baseflow	>1.6 m	“Baseflow” defined as flows less than the upper decile flow. Guideline from Ministry for the Environment (1994).
Escherichia coli	<550/100 mL	Ministry for the Environment (2003) guidelines for the management of recreational and marine shellfish-gathering waters.
Median Escherichia coli	<126/100 mL	Ministry for the Environment (1999) guidelines for the management of recreational and marine shellfish-gathering waters.
Enterococci	<77/100 mL	Department of Health (1992) guidelines for “moderate” level of recreational use.
Chlorophyll a	<0.02 g/m <sup>3</sup>	Ministry for the Environment (1992).
Arsenic	<0.01 g/m <sup>3</sup>	Ministry of Health (2001).
Boron	<1.4 g/m <sup>3</sup>	Ministry of Health (2001).

## Waikato River monitoring programme - water quality parameters and analytical methods

Id <sup>1</sup>	Parameter	Method
A340F	Absorbance @ 340 nm filtered	Spectrophotometer, 1 cm path length, APHA method 5910B
A440F	Absorbance @ 440 nm filtered	Spectrophotometer, 1 cm path length, APHA method 5910B
A780F <sup>†</sup>	Absorbance @ 780 nm filtered	Spectrophotometer, 1 cm path length, APHA method 5910B
As	Arsenic total	Nitric acid digestion, ICP-MS, APHA method 3125B
B	Boron	ICP-MS, APHA method 3125B
BDISK	Black disk	Field measurement, horizontal water transparency (20mm, 60mm, 100mm, 200mm disk) in river or trough (20mm only)
BOD <sub>5</sub>	Biochemical oxygen Demand (5 day)	Incubation 5 days at 20°C, DO-meter, No nitrification inhibitor added, unseeded, APHA method 5210B
CHLA CI	Chlorophyll a Chloride	Acetone extraction. Spectroscopy. APHA method 10200H Filtered sample. Ion Chromatography APHA method 4110B
COLOUR	Colour	Field measurement, Munsell Colour Patches
COND	Conductivity	Lab Meter @ 25°C. APHA method 2510B
DO	Dissolved oxygen	Field measurement (WTW DO meter, model 340A)
DO (% Sat)	Dissolved oxygen (percent saturation)	Field measurement (WTW DO meter, model 340A)
DOC	Dissolved organic Carbon	Filtration, acidification, purging to remove inorganic C, catalytic oxidation, IR detection. APHA method 5310B (modified)
DRP	Dissolved reactive Phosphorus	Molybdenum Blue Colorimetry. Flow injection analyser. APHA 4500 PG (proposed)
E. coli	Escherichia coli	Membrane Filtration (mFC Agar) confirmation by NA-MUG Agar. APHA method 9222G
ENT	Enterococci bacteria	Membrane Filtration (mE Agar) confirmation by EIA Agar. APHA method 9230C
FC	Faecal coliforms	Membrane Filtration with resuscitation(mFC Agar). APHA method 9222D
Flow	Flow – instantaneous	Calculated from rating curve ± 8%
Li	Lithium	ICP-MS, method APHA 3125B
NH <sub>4</sub> -N	Ammoniacal Nitrogen (Total)	Phenol/Hypochlorite Colorimetry. Flow injection analyser. APHA method 4500-NH <sub>3</sub> H
NNN	Nitrite/Nitrate Nitrogen	Automated Cadmium reduction. Flow injection analyser. APHA method 4500 – NO <sub>3</sub> I (proposed).
NO <sub>3</sub> -N	Nitrate nitrogen	Calculation: (Nitrate-N + Nitrite –N) – Nitrite - N
pH	pH	Lab Meter @ 25°C. APHA method 4500-H <sup>+</sup> B
TDS	Total dissolved solids	Filtration, gravimetric. APHA 2540C (modified)
TEMP	Temperature	Field measurement (WTW DO meter, model 340A)
TKN	Total Kjeldahl-Nitrogen	Acid digestion. Phenol/Hypochlorite colorimetry. Flow injection analyser. APHA method 4500-N <sub>org</sub> D (modified)
TOC	Total Organic Carbon	Acidification, purging to remove inorganic C, catalytic oxidation, IR detection. APHA method 5310B (modified)
TN	Total Nitrogen	Calculated from NNN + TKN (Nitrite/Nitrate Nitrogen + Total Kjeldahl-Nitrogen)
TP	Total Phosphorus	Acid persulphate digestion, Colorimetry. Discrete Analyser. APHA method 4500-PE (modified)
TURB	Turbidity	Turbidity Meter Hach 2100N. APHA method 2130B

<sup>1</sup> Water quality parameter identification code refers to Environment Waikato's water quality database (TimeStudio) parameter short name.

APHA = Standards Methods for the Examination of Water and Wastewater, 20<sup>th</sup> Edition, 1998, APHA, AWWA, WEF

ICP-MS = Inductively Coupled Plasma – Mass Spectroscopy