Auckland Regional Council
TE RAUHITANGA TAIAO

Annual Report
January – December 2003

Water Quality Surveys of the Mahurangi Harbour, Upper Waitemata Harbour and Tamaki Estuary

October 2004 Technical Publication 235

Auckland Regional Council
Technical Publication No. 235, October 2004
ISSN 1175 205X ISBN 1-877353-43-4

Water Quality Surveys of Mahurangi Harbour, Upper Waitemata Harbour and Tamaki Estuary Annual Report - January – December 2003

J.B. Macaskill
M.L. Martin

Prepared for
Auckland Regional Council

NIWA Client Report: HAM2004-045
October 2004

NIWA Project: ARC04277

National Institute of Water & Atmospheric Research Ltd
Gate 10, Silverdale Road, Hamilton
P O Box 11115, Hamilton, New Zealand
Phone +64-7-856 7026, Fax +64-7-856 0151
www.niwa.co.nz

Contents

1 Executive Summary

This report summarises and reviews the water quality data collected from special investigation sites located in Mahurangi Harbour, Upper Waitemata Harbour, and Tamaki Estuary. The Auckland Regional Council and its antecedent organisations have been monitoring water quality as part of the Long-Term Baseline (LTB) monitoring programme since the mid-1980s. In this report monitoring data are treated in the same way as the other LTB sites that are reported annually. Time series graphs are presented for the period 1992 to 2003 and statistical analyses have been carried out summarising the year January-December 2003.

The 2003 data are similar to those for recent years and reinforce previous conclusions that Mahurangi Harbour and Upper Waitemata Harbour have generally good water quality, with improving trends for water clarity. Tamaki freshwater stream sites have the poorest water quality in terms of dissolved oxygen, associated with high rates of primary production, and elevated levels of faecal bacteria. Several sites of Tamaki Estuary and, to a lesser extent, Mahurangi Harbour have high faecal bacteria concentrations that probably derive from human activities.

.

2 Introduction

The Auckland Regional Council (ARC) and its predecessor agency, the Auckland Regional Authority's Regional Water Board (ARWB), have regularly monitored freshwater streams since 1986, lakes since 1992 and saline (coastal and harbour) sites since 1987. This monitoring is referred to as the Long-Term Baseline Water Quality (LTB-WQ) network. The data are reviewed annually.

Sampling of sites in Upper Waitemata Harbour (UWH) and Tamaki Estuary commenced during the mid-1980s and was followed by sampling of sites within Mahurangi Harbour. The monitoring of sites within the three water bodies, referred to as the "special survey sites", was undertaken because of specific local issues within each of these semi-enclosed water bodies. Monitoring sites were chosen to represent particular local components of each survey area, in contrast to the other LTB sites, which are chosen to be regionally representative. In the Mahurangi catchment there is a small rural township at the head of the estuary, and rural and lifestyle land use elsewhere in the catchment. There is proposed urban development around the township and alongside the harbour near the mouth. Within the harbour there is commercial oyster farming and high recreation use near the mouth. UWH has five estuarine arms (Rangitopuni is the largest freshwater input); there are some urban developments, two military airfields, a maximum-security prison and light commercial activity. Tamaki Estuary is one of the most highly impacted water bodies in the Auckland region and water quality has been monitored since 1985 (ARC 1999).

The purpose of the special surveys is to answer the key questions:

1. What is the current water quality of these water bodies, and are they getting better or worse?
2. How does land use affect water quality?
3. How does water quality affect regional policy and programmes (and *vice versa*), and public perception of water?

Subsidiary to these aims are:

1. Identification of the present and potential impacts of catchment development activities;
2. Collection of baseline data for calibration of short-term surveys of similar areas;
3. Evaluation of improvement in water quality in response to pollution abatement activities;
4. Assessment of the effectiveness of land use planning policies intended to protect water quality;
5. Ensuring that existing environmental controls are adequate to avoid unacceptable adverse environmental impacts.

This annual report reviews all data collected at monthly intervals from the special survey sites for the period January-December 2003. From time to time reviews will be carried out examining the whole dataset from 1992, when improved quality control and assurance measures were introduced in a regular and systematic manner, to the present. The first of these review documents was compiled in 2001 (Wilcock & Kemp, 2002).

3 Sampling Sites and Survey Details

All monitoring of the special survey sites is done either from land access bridges or from boats. The locations of sites in Mahurangi Harbour, Tamaki Estuary and UWH are shown in Figs. 3.1-3.3.

A list of sites and their locations (map references), as well as periods that each has been monitored, is given in Table 3.1 in the order in which they are sampled in each area.

Figure 3.1:
Location of Mahurangi Harbour special survey sites.

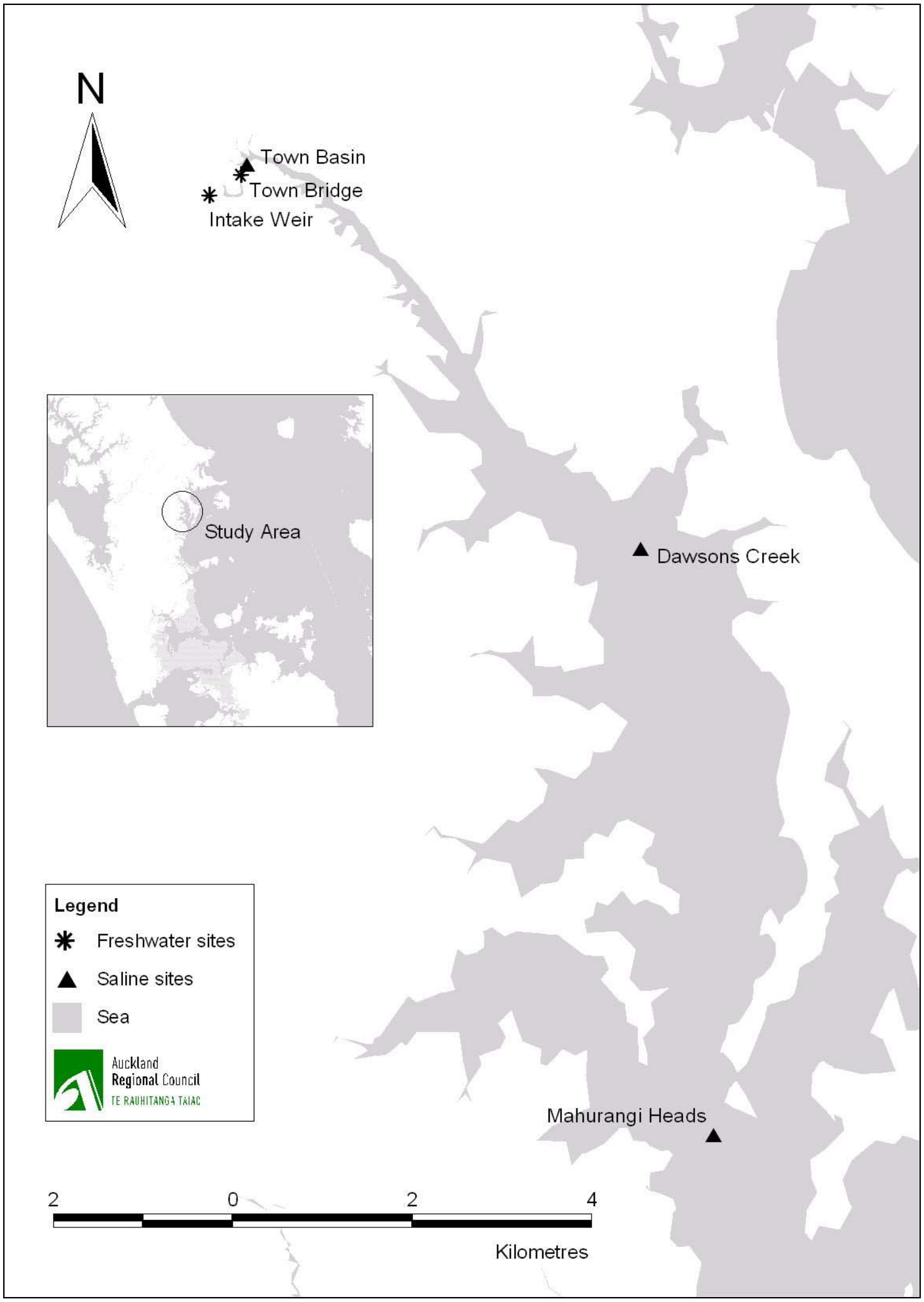


Figure 3.2:
Location of Tamaki Estuary special survey sites.

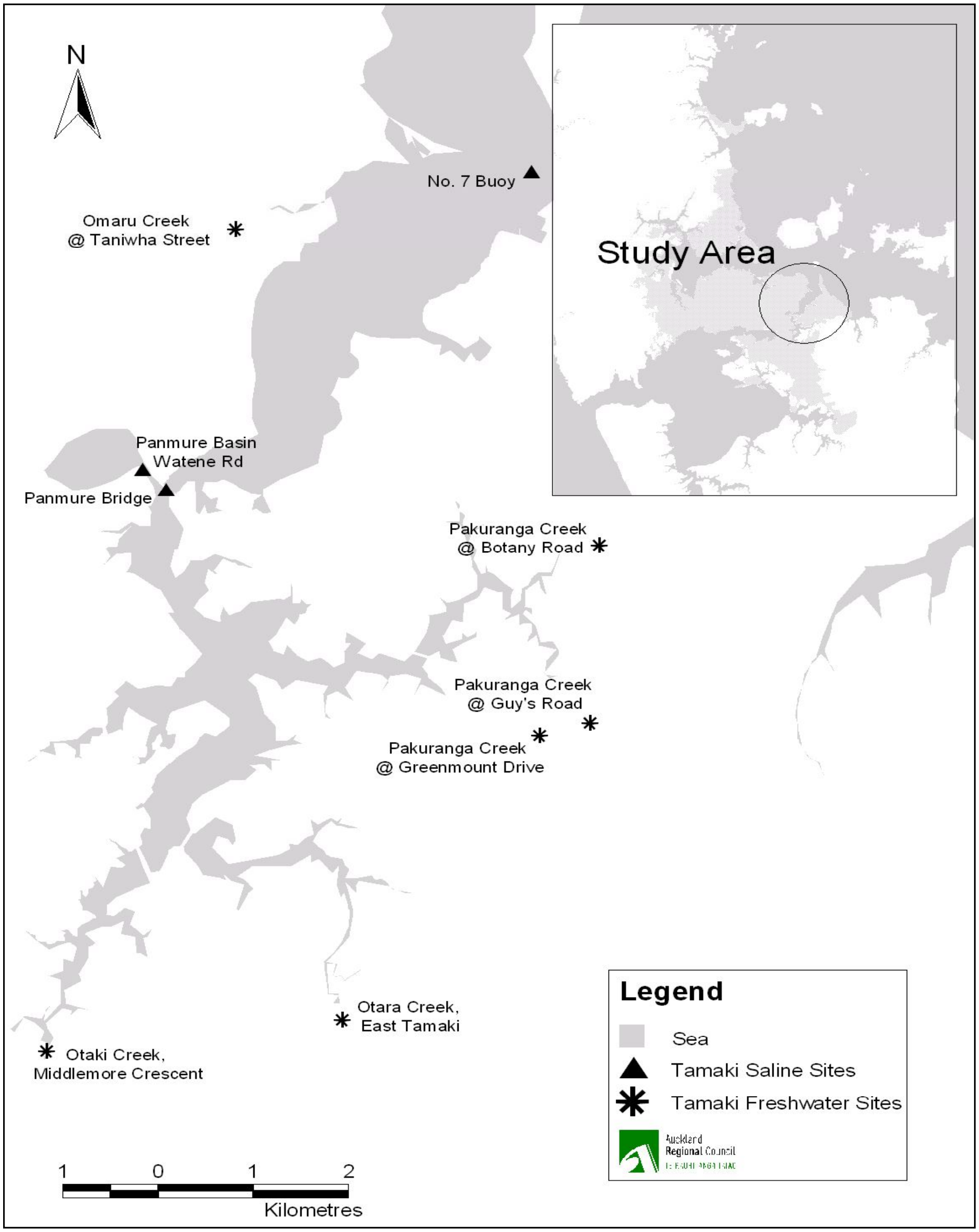


Figure 3.3:

Location of Upper Waitemata Harbour special survey sites.

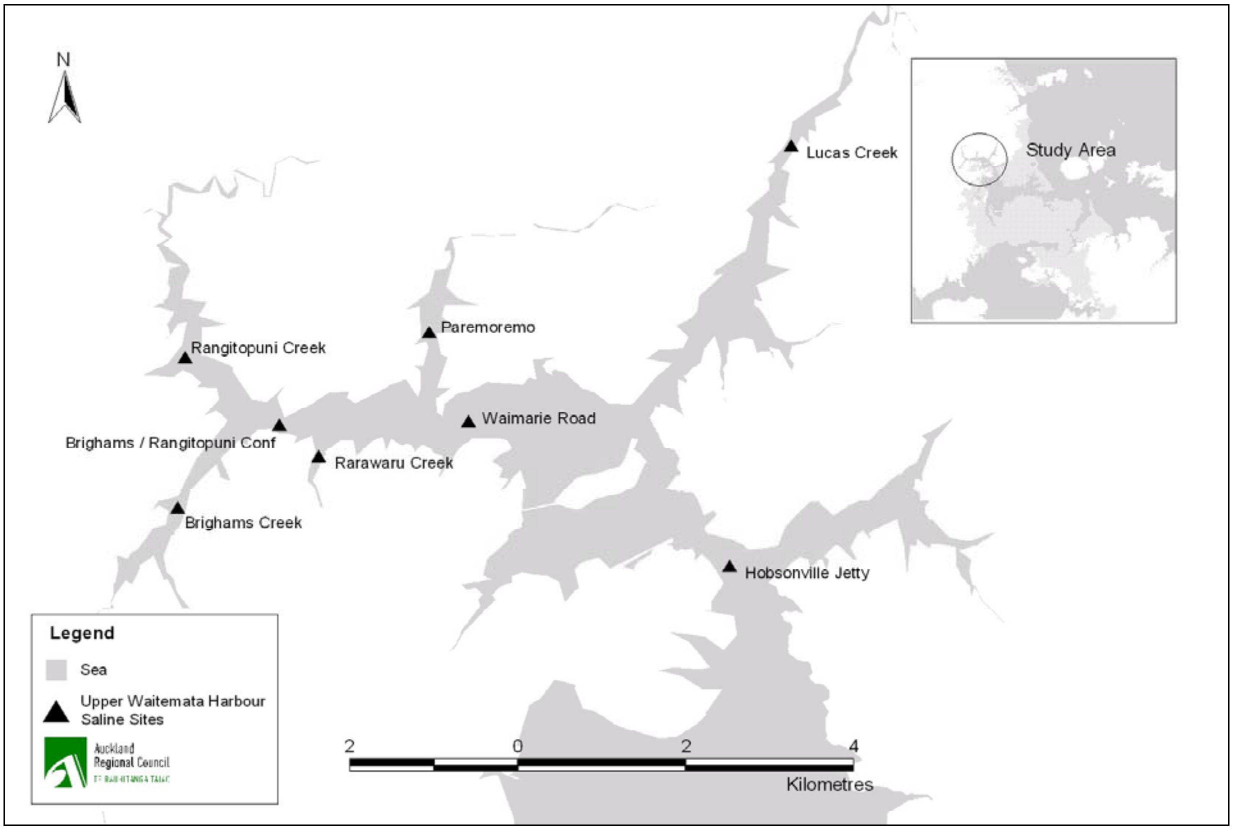


Table 3.1:

Special survey monitoring sites (codes), map references and monitoring periods.

Site (code)	Depths (m)	Map reference NZMS 260	Monitoring period
Mahurangi streams			
Supply Intake Jetty (M01)	0	R09: 593 321	7/7/93 – 9/12/03
Warkworth Town Bridge (M02)	0	R09: 596 323	7/7/93 – 9/12/03
Mahurangi saline			
Warkworth Town Basin – surface (M03) and subsurface (M04)	0, 1	R09: 597 324	7/7/93 –9/12/03
Dawsons Creek – surface (M05) and subsurface (M06)	0, 1	R09: 640 280	6/5/93 –9/12/03
Mahurangi Heads – surface (M07) and subsurface (M08)	0, 5	R09: 649 216	2/9/93 –9/12/03
Tamaki streams			
Otara Creek - East Tamaki Rd (T1)	0	R11: 778 693	9/11/92 –5/12/03
Pakuranga Creek - Greenmount Drive (T2)	0	R11: 799 725	9/11/92 – 5/12/03
Pakuranga Creek - Guys Rd (T3)	0	R11: 804 727	9/11/92 – 5/12/03
Pakuranga Creek - Botany Rd (T4)	0	R11: 812 747	9/11/92 – 5/12/03
Omaru Creek - Taniwha St (T6)	0	R11: 771 786	9/11/92 – 5/12/03
Otaki Creek – Middlemore Crescent (T7)	0	R11: 747 689	9/11/92 – 5/12/03
Tamaki saline			
No. 7 Buoy (saline site 1)	0, 5, bottom	R11: 799 792 approximate	9/11/92 – 5/12/03
Panmure Basin	0	R11: 758 756	9/11/92 – 15/4/99
Panmure Bridge (saline site 2)	0	R11: 759 754	14/5/99 – 5/12/03
Otara Lake at weir	0	R11: 762 713	16/5/95 – 20/2/01
Upper Waitemata Harbour			
Hobsonville Jetty (UW1)	0, 1	R11: 597 891	22/7/93 – 10/12/03
Lucas Creek (UW2)	0, 1	R10: 588 911	22/7/93 – 10/12/03
Waimarie Road (UW3)	0, 1	R10: 567 907	22/7/93 – 10/12/03
Paremoremo Ski Club (UW4)	0, 1	R10: 562 919	22/7/93 – 10/12/03
Rarawaru Creek (UW5)	0, 1	R10: 549 904	22/7/93 – 10/12/03
Brighams/Rangitopuni Confluence (UW6)	0, 1	R10: 541 909	22/7/93 – 10/12/03
Brighams Creek (1 km from confluence) (UW7)	0, 1	R10: 534 900	22/7/93 – 10/12/03
Rangitopuni Creek (UW8)	0, 1	R10: 534 915	22/7/93 – 10/12/03

4 Water quality variables

The water quality variables measured during each sampling run are a combination of physical observations, *in situ* meter readings (Table 4.1), and chemical and biological analysis of collected samples in the laboratory (Table 4.2).

Some observations have not been transcribed to a spreadsheet format and are only documented on ARC field notes, or laboratory notes. These are indicated (*).

Water quality data for the period 1992-2003 that are the primary focus of this report are underlined.

A description of the reasons for choosing to monitor these variables, their major sources and their impacts on water quality and aquatic life is given elsewhere (ARWB 1982; ARC 1995; Wilcock & Stroud 2000). The chosen variables principally describe water clarity and appearance, nutrient status, biological productivity (in response to nutrient inputs) and physical conditions important for supporting aquatic life. They do not include toxicants, such as heavy metals and organochlorine insecticides.

Table 4.1:
Field measurements

Sample collection time (*)	(NZ Standard Time, 24 h clock)
Ambient weather conditions (*)	(Beaufort scale)
Ambient water conditions (*)	(Colour, Clarity, Odour)
Sample depth	m
Water temperature	°C
Dissolved oxygen	mg/L
Dissolved oxygen saturation	%
Salinity	ppt
Conductivity	mS/m
Secchi disc depth (saline only)	m
Black disk (streams only)	m
General comments	

Table 4.2:

Laboratory analyses

Presumptive (total) coliforms	(MPN/100 ml)	M, T, U
Faecal coliforms	(MPN/100 ml)	M, T, U
E. coli (freshwater sites only)	(MPN/100 ml)	T
Enterococci (saline sites only)	(cfu/100 ml)	M, T, U
pH	units	M, T, U
Turbidity	(NTU)	M, T, U
Conductivity	(mS/m at 25^oC)	M
Suspended solids (Non-filtrable residue)	(mg/L)	M, T, U
Dissolved oxygen saturation	(%)	M, T, U
Biochemical oxygen demand	(mg/L)	M, T, U
Chloride	(mg/L)	M, T, U
Nitrite nitrogen, NO_2-N	(mg/L)	M, T, U
Nitrate nitrogen, NO_3-N	(mg/L)	M, T, U
Total ammonia nitrogen, NH_4-N	(mg/L)	M, T, U
Total phosphorus, TP	(mg/L)	M, T, U
Dissolved (soluble) reactive phosphorus, DRP	(mg/L)	M, T, U
Salinity	ppt	M, U
Chlorophyll *a*	mg/L	M, T (saline), U

Notes

M = Mahurangi Harbour; T = Tamaki Estuary; U = Upper Waitemata Harbour

Throughout this report we refer to concentrations for many water quality variables (SS, Cl, DO, NH_4-N, NO_2-N, NO_3-N, DRP, TP, BOD) in units of milligrams per litre, or mg/L. Note that mg/L = g/m^3 ($g\ m^{-3}$) = parts per million (ppm).

MPN = most probable number; cfu = colony-forming units (APHA 1992).

Presumptive coliform may be approximated to "Total coliform".

Chemical oxygen demand (COD) and total copper, iron and zinc were determined on samples from Pakuranga Creek (at Greenmount Drive only), over the period January 2001 – November 2002, as a cross-reference to landfill Consent monitoring activities. Results have been reported in Wilcock & Martin (2003).

5 Methods

5.1 Sampling Procedures

Sampling protocols for the special survey sites are detailed in the following ARC reports for Long Term Baseline Program Coastal/Saline Sampling Protocols: Mahurangi Estuary 2nd Edition (May 1999), Upper Waitemata Harbour 2nd Edition (May 2002), and Tamaki Estuary 3rd Edition (May 2002). Timing of each run is critical, to ensure samples are collected on the same relative stage of the tide, and to ensure that temporal variability is minimised. Samples at all sites are collected within the time window: 08:00 - 12:00, New Zealand Standard Time (NZST).

All samples collected in the surveys were analysed by the Watercare Services Ltd Laboratory at Mangere. Analytical methods utilised in these surveys are described in Chemical Methods Manual and Microbiological and Biological Methods Manual compiled by Laboratory Services, Watercare Services Ltd. These methods generally follow the Standard Methods for the Examination of Water and Wastewater 18th Edition (APHA 1992).

5.2 Statistical Analysis

Statistical treatment of the data follows the protocol described in TP190 (Wilcock & Kemp, 2002), which is that used for the LTB water quality surveys.

Water quality results are characteristically highly variable because of the wide variety of external factors influencing them. Because most of the parameters are non-normally distributed the median has been used in this report as the measure of central tendency (typical value). The median is the middle value (or the mean of two middle values) when data are arranged in increasing or decreasing order of magnitude. Because it is based on rank rather than value, the median is not as easily affected by extreme values as the mean. All outliers were included in calculation of summary statistics unless they were obvious typographical errors.

Variability in the data has been expressed as the interquartile range divided by the median (IQR/M). This value is the non-parametric equivalent of the coefficient of variance.

Until March 1994 UWH sites were taken at both the surface and at a depth of one metre. For a time after this, composite samples were collected for analysis. Currently, samples are taken from the surface and for that reason only surface water quality data from UWH sites has been subjected to statistical analysis.

Tables are listed in the Appendices giving monthly data for each variable at all sites, and are summarised by median and IQR/M (%) values for the year Jan-Dec 2003. Time-series plots for the entire monitoring records of each site, for which data with adequate quality assurance has been recorded, follow the tables of data.

6 Results

6.1 Water Quality Data

6.1.1 What it tells us

A comprehensive description of each of the water quality variables cited in this report is given in Appendix 63. Black disc and Secchi disc depth data tell us how clear or turbid the water is. This is inversely correlated with turbidity and suspended solids and generally has larger values (i.e., greater clarity) in pristine sites than in sites affected by inputs of sediment (such as urban stormwater from new subdivisions) and the presence of algae caused by high nutrient concentrations.

Chloride and conductivity are not as affected by human activities as the other variables, reflecting more the relative proportions of freshwater and salt water. Conductivity in freshwater streams is affected by large rainfall events that generate runoff.

Dissolved oxygen (DO) varies diurnally depending upon the amount of plant biomass in the channel producing photosynthetic inputs, the demand on oxygen (BOD) caused by decomposing organic matter, and exchange with the atmosphere produced by turbulence at the air-water interface. Low DO often indicates inputs of degrading organic wastes (such as from sewage and farm effluents), whereas high DO values (> 100%) are attributable to photosynthesis by aquatic plants, including algae. The DO regime dictates the type of aquatic ecosystem that can survive in a given water body.

Presumptive and faecal coliform counts indicate the presence of faecal material and the possible presence of pathogenic organisms, such as *Campylobacter, Giardia* cysts and *Cryptosporidium* oocysts.

Ammonia, nitrite and nitrate are indicative of waste inputs from warm-blooded animals, including humans (from sewage effluent), and fertiliser. Nitrite (NO_2-N) is a short-lived intermediate for the transformation of ammonia nitrogen (NH_4-N) to nitrate nitrogen (NO_3-N) and is a useful indicator of how recently pollution events may have occurred. High NH_4-N, in concert with elevated pH and temperatures, can be harmful to many aquatic species because the proportion of the toxic un-ionised NH_3 increases with respect to the more common and much less toxic ammonium ion, NH_4-N (see Appendix 63).

Dissolved reactive phosphorus (DRP) concentration indicates the potential for eutrophication, whereas total phosphorus (TP) includes DRP and P that is in algal biomass. TP and DRP levels should decline with distance away from land-based sources, such as streams and discharges from wastewater treatment plants.

Temperature and pH are master variables that affect the biological activity of other pollutants as well as determining habitat quality. Seawater pH is strongly buffered so that small changes indicate either large inputs of freshwater, or faulty measuring technique.

6.2 Results falling below method detection limits.

In previous reports, where datasets included an entry as being less than a detection limit, the result was cited in the relevant table as equal to half the detection limit (e.g., < 2 mg/L for BOD would have been cited as 1.0 mg/L). At ARC request, we have this year included the raw result in all tables: this offers the advantage that a result falling below a method detection limit is clearly identifiable. Note though that the accompanying summary statistics and time-series plots still make use of the convention that "less than" entries assume values equal to half the detection limit.

In many cases detection limits are set too high for useful information about water quality of natural waters. For example, a DL of 2 mg/L for BOD is not useful, when the majority of results fall below this value.

6.3 The Data

6.3.1 Water clarity and suspended solids

Water clarity in Mahurangi Harbour is moderate-to-good, typical of estuarine and harbour waters. Results are strongly influenced by recent rainfall events and this is perhaps evidenced by the high values for suspended solids (SS) and turbidity observed on the September and October sampling rounds. In general, data are similar to those for 2002 and to long-term median values (Wilcock & Martin, 2003).

Results for the Tamaki and UWH sites are similar to those observed for previous years (Wilcock & Martin, 2003).

6.3.2 Chloride, conductivity and salinity

Chloride, conductivity and salinity data indicate the degree of mixing of saltwater with freshwater and hence, the consistency of timing of sampling. Results for Mahurangi Harbour sites are similar to those for other years. For the Town Basin site, the unusually low values observed in September and October 2003 represent freshwater influence and correlate strongly with the high SS values obtained on those dates to suggest significant rainfall events during or recently preceding these sampling rounds. Results for Tamaki Estuary and UWH are similar to other years and show the variable mixtures of saline and freshwater at some Tamaki sites, and the comparative uniformity of the UWH sites, albeit with a gradient from Rangitopuni Creek to Hobsonville Jetty.

6.3.3 BOD

For the UWH sites, all but one result is below the detection limit of 2 mg/L. For the Mahurangi sites, although there is an occasional result in the 2-3 mg/L range, the median value for all sites is taken as 1 mg/L. For the Tamaki sites, results above detection limit are more numerous, although still not common except for the Pakuranga (Botany Rd) and Omaru Ck sites. The value 180 mg/L recorded for Omaru Ck on 6 November is highly anomalous and would be considered false were it not supported by replicate measurement and the results obtained for a bottom sample at the site. These results suggest a recently preceding spillage event.

6.3.4 Dissolved oxygen

Mahurangi and UWH site DO results were similar to those for previous years, showing these waters to be well-oxygenated with daytime medians of 77-99% saturation. Tamaki Estuary sites were also similar to data from previous years, with Pakuranga Creek – Botany Road having supersaturated waters on all-but-one sampling occasion, indicative of vigorous plant growth and photosynthetic oxygen production.

Omaru Creek had consistently lower values than did other Tamaki sites, with a minimum value of 13.4% saturation on 6 November, consistent with and weakly supporting a speculated spillage event causing the very high BOD of 180 mg/L.

6.3.5 Microbial quality

For all sites, concentrations of presumptive and faecal coliforms were similar to values measured in recent years. Faecal coliform medians showed a pattern of being highest in creeks and headwater sites, and lowest in open harbour waters nearest the heads. Median faecal coliform levels were 1-1100 MPN/100 mL in Mahurangi Harbour, 1-5000 and 3-215 MPN/100 mL in Tamaki Estuary and UWH, respectively. The highest observed value was 80,000 MPN/100 mL recorded for Pakuranga Creek-Botany Road (also having the highest median at 5000 MPN/100 mL).

Enterococci and *E. coli* levels (measured only for freshwater sites in Tamaki estuary) were similar to the previous year and declined with distance from land sources and freshwaters. As expected, *E. coli* levels largely mirrored those for faecal coliforms.

Enterococci median values were highest for the Town basin site in Mahurangi Harbour, where counts frequently exceeded the Alert/Amber mode single sample value of 136 enterococci/100 mL (MfE, 2002)

6.3.6 Nutrients

For NH_4-N, the highest concentrations were observed at the Omaru Ck (Tamaki Estuary) and Warkworth Town Basin (Mahurangi) sites with median values of 0.13, 0.075 mg/L respectively. These sites had similarly elevated levels of NO_2-N, median values being 0.015, 0.005 mg/L respectively. The ANZECC (2000) NH_4-N trigger value for protection of 95% of freshwater species is 0.90 mg/L, and the corresponding value for 80% species protection is 2.3 mg/L (these values are for total ammonia at pH 8).

Consistent with the historic data (see the attached time-series plots), the highest NO_3-N values were observed in freshwater sites draining to the Tamaki Estuary.

For phosphorus, concentrations of DRP and TP were consistently low, with the median values for all sites being 0.03, 0.10 mg/L respectively

6.3.7 pH and temperature

pH and temperature values were similar to those for previous years. A pH value of 9.21 was recorded for the Pakuranga – Guys Road site on 5 December 2003. High values have been observed intermittently at this site in the past, so there is no reason to doubt the result.

6.3.8 Chlorophyll *a*

Results for 2003 are entirely consistent with the long-term median concentrations of 0.002-0.008 mg/L chlorophyll *a* for those sites included in the monitoring programme. The highest results were again obtained for the more riverine of the UWH sites.

6.4 Between-site Comparisons

6.4.1 Mahurangi Harbour

Nutrient data for 2003 are entirely consistent with the long-term time-series plots which show that concentrations of all forms of nitrogen and phosphorus are lowest at the Dawson's Ck and Mahurangi Heads sites. Chlorophyll *a* results indicate little difference between sites.

Dissolved oxygen concentrations are satisfactory at all sites. BOD is measurable occasionally and then only at the Town Basin site.

Bacterial quality varies greatly between sites and there is a clear distinction between the inner (Supply Jetty, Town Bridge and Town Basin surface) and the outer sites (Dawson's Creek and Mahurangi Heads).

6.4.2 Upper Waitemata Harbour

Secchi disk depths indicate that the Hobsonville site has better visual clarity than other sites in UWH. Harbour water (Hobsonville and Waimarie) nutrient concentrations are generally lower than are those in river estuaries, but differences are small and UWH has the most uniform water quality of the three water bodies.

Bacterial quality is best at Hobsonville Jetty and worst for Rarawaru and Rangitopuni Creek.

6.4.3 Tamaki Estuary

There was a clear pattern for nitrate nitrogen concentrations and faecal bacteria counts, with the freshwater sites (Otara Creek, the three Pakuranga Creek sites, Omaru Creek and Otaki Creek) markedly higher than the saline sites (the No. 7 Buoy sites and Panmure Bridge).

7.0 Summary and Conclusions

The monitoring data for freshwater and saline sites in Mahurangi Harbour, Upper Waitemata Harbour and Tamaki Estuary provides a valuable resource describing three different but important water bodies in the Auckland region. Each water body is being subjected to different kinds of pressure from urban development and increasing population in the region. Monitoring projects such as this serve as a basis for rational decision making by enabling changes over time to be observed continuously.

The 2003 monitoring record is of high standard and establishes that water quality is very similar to that observed in recent years.

7. References

ANZECC (2000). National water quality management strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.

APHA (1992). Standard methods for the examination of water and wastewater 18th edition. American Public Health Association, American Waterworks Association, Water Environment Federation. 949p.

ARC (1995). Baseline water quality survey of the Auckland region. Annual report April 1993-March 1994. Technical Publication 65, Auckland Regional Council Environment.

ARC (1999). Tamaki Estuary water quality survey 1985-1997. Review report. Technical Publication 105, Auckland Regional Council.

ARWB (1982). Baseline data on water quality in the Auckland region obtained from 1977-82. Technical Report 22, Auckland Regional Water Board.

MfE & MOH (2003). Microbial Water Quality Guidelines for Marine and Freshwater Recreational Areas, Ministry for the Environment and Ministry of Health, Wellington.

MoH (2000). Drinking water standards for New Zealand, Ministry of Health, Wellington.

MWD (1987). Lake Managers Handbook. Miscellaneous Publication 103, Water and Soil Conservation Authority, Ministry of Works and Development, Wellington.

USEPA (1986). Quality criteria for water. EPA-440/5-86-001. US Environmental Protection Agency, Washington, DC. May 1986.

USEPA (1999). 1999 Update of ambient water quality criteria for ammonia. EPA-822-R-99-014. US Environmental protection Agency, Washington, DC.

Wilcock, R.J.; Stroud, M.J. (2000). Summary Report – Long-term baseline water quality – stream, lake and saline waters. Prepared by the National Institute of Water and Atmospheric Research under contract with the Auckland Regional Council. Technical Publication 132.

Wilcock, R.J.; Kemp, C.L.S. (2002). Water quality surveys of Mahurangi Harbour, Upper Waitemata Harbour and Tamaki Estuary 1992-2001. Client Report ARC02277/2, prepared for ARC.

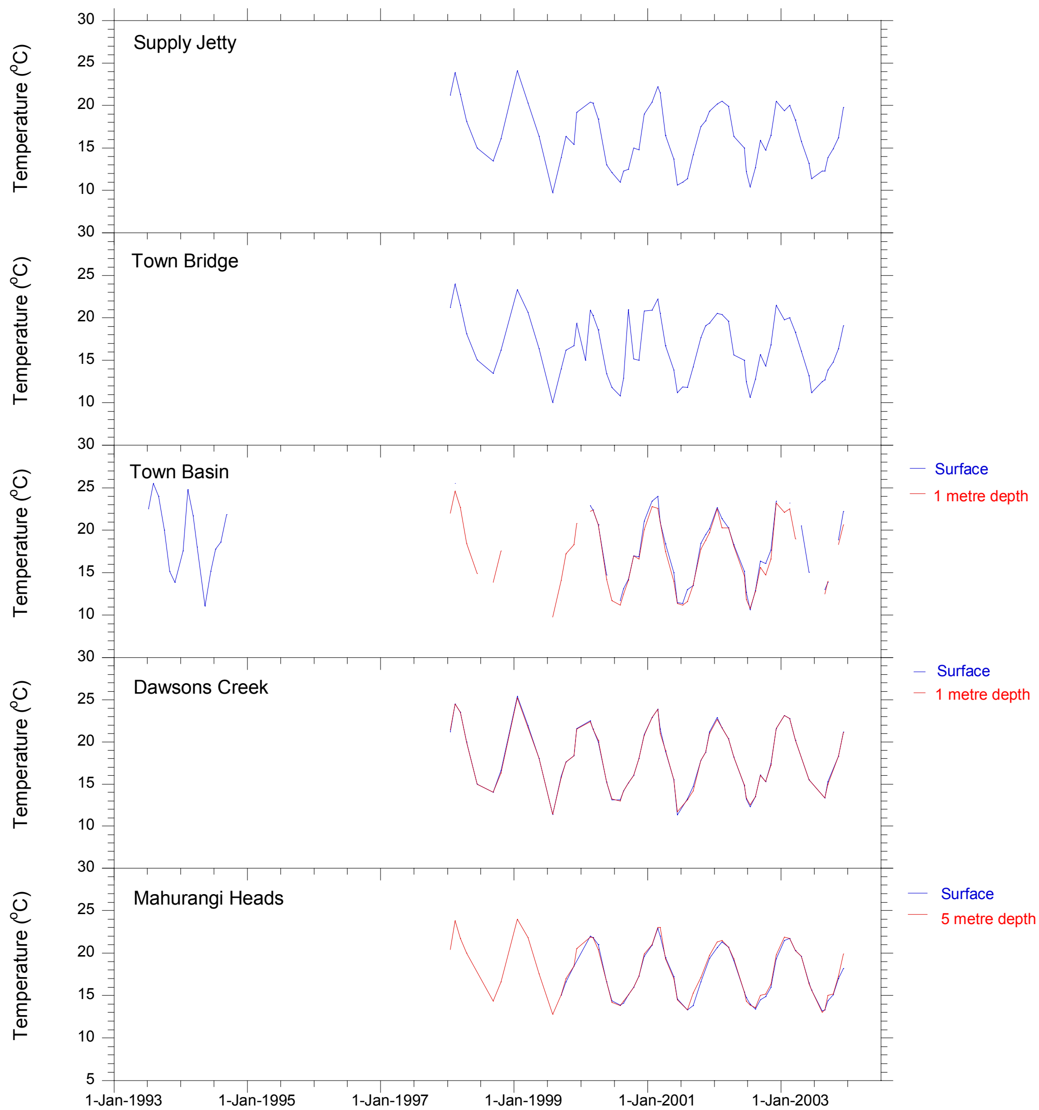
Wilcock, R.J.; Martin, M.L. (2003). Water quality surveys of Mahurangi Harbour, Upper Waitemata Harbour and Tamaki Estuary. Annual Report January-December 2002. NIWA Client Report HAM2003-078, prepared for ARC.

APPENDIX 1: MAHURANGI HARBOUR – TEMPERATURE

a) Temperature (^{o}C) for the period January 2003 - December 2003

Date	Supply Intake Jetty	Town Bridge	Town Basin surface	Town Basin 1 m	Dawsons Creek surface	Dawsons Creek 1 m	Mahurangi Heads surface	Mahurangi Heads 5 m
21-Jan-03								
18-Feb-03								
20-Mar-03								
22-Apr-03	15.8	16.1					19.6	19.6
4-Jun-03	13.2	13.2	14.1	15.1	15.5	15.5	16.4	16.5
16-Jun-03	11.4	11.2					15.6	15.6
14-Aug-03	12.3	12.5					13	13.2
29-Aug-03	12.3	12.7	12.5	13	13.3	13.3	13.3	13.3
15-Sep-03	13.9	13.9	14	13.9	15.3	15	15	14.4
13-Oct-03	14.9	14.8					15.2	15.1
11-Nov-03	16.2	16.4	18.3	18.9	18.3	18.3	17.3	17
9-Dec-03	19.8	19.1	20.6	22.2	21.2	21.1	19.9	18.2
Median	13.9	13.9	14.1	15.1	15.5	15.5	15.6	15.6
IQR/Median %	25	24	30	33	19	21	15	17

b) The graphs on the following page show temperature results for the period 1993 to December 2003 (where data available).

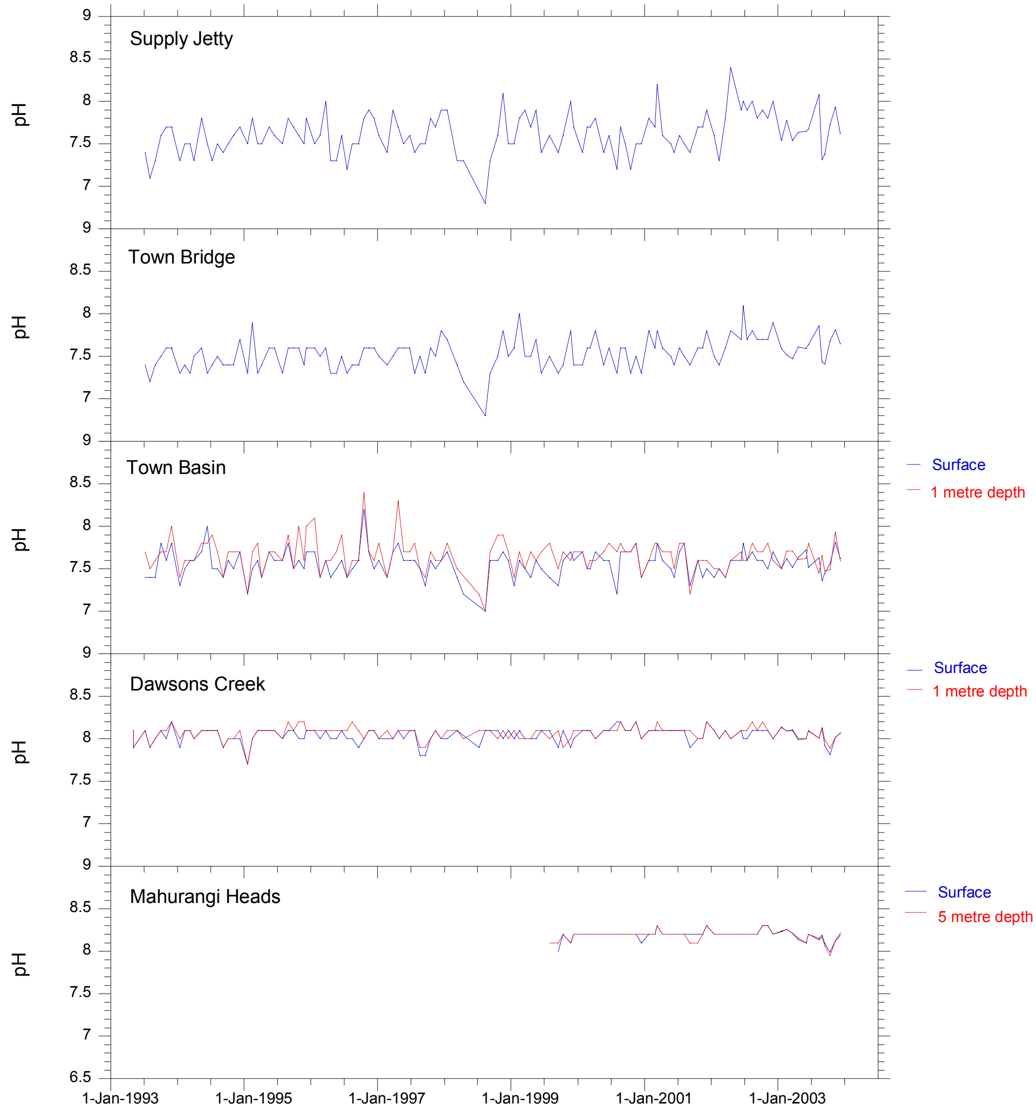

Supply Jetty
Town Bridge
Town Basin
Dawsons Creek
Mahurangi Heads
Temperature (°C)
30
25
20
15
10
5
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003
Surface
1 metre depth
Surface
1 metre depth
Surface
5 metre depth

APPENDIX 2: MAHURANGI HARBOUR – pH

a) pH for the period January 2003 - December 2003

Date	Supply Intake	Town Bridge	Town Basin	Town Basin	Dawsons Creek	Dawsons Creek	Mahurangi Heads	Mahurangi Heads
	Jetty		surface	1 m	surface	1 m	surface	5 m
21-Jan-03	7.54	7.59	7.51	7.50	8.14	8.13	8.23	8.24
18-Feb-03	7.78	7.52	7.62	7.71	8.09	8.09	8.26	8.26
20-Mar-03	7.54	7.47	7.52	7.71	8.10	8.11	8.21	8.21
22-Apr-03	7.64	7.61	7.63	7.61	7.99	8.01	8.16	8.14
4-Jun-03	7.65	7.59	7.72	7.62	8.00	8.00	8.10	8.10
16-Jun-03	7.67	7.64	7.52	7.80	8.09	8.10	8.20	8.20
14-Aug-03	8.08	7.86	7.63	7.45	8.01	8.01	8.13	8.15
29-Aug-03	7.31	7.43	7.36	7.66	8.12	8.13	8.17	8.19
15-Sep-03	7.38	7.41	7.45	7.47	7.92	7.99	8.06	8.09
13-Oct-03	7.73	7.68	7.56	7.49	7.81	7.89	7.95	7.99
11-Nov-03	7.93	7.81	7.81	7.93	8.02	8.02	8.12	8.12
9-Dec-03	7.62	7.65	7.62	7.59	8.06	8.07	8.18	8.21
median	7.65	7.60	7.59	7.62	8.04	8.05	8.17	8.17
%IQR/M	3	2	1	3	1	1	1	1

b) The graphs on the following page show pH results for the period 1993 to December 2003 (where data available).

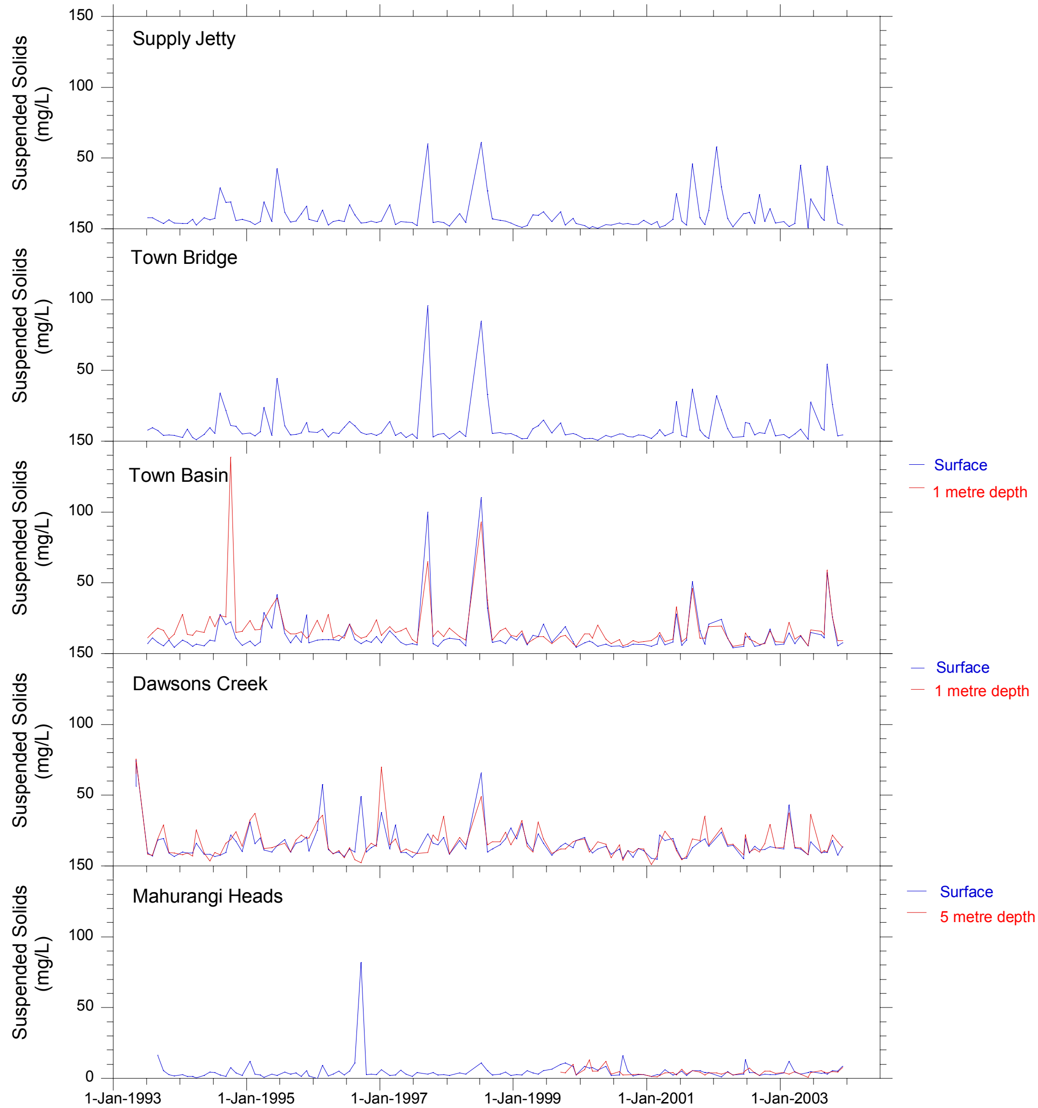

Supply Jetty
Town Bridge
Town Basin
Dawsons Creek
Mahurangi Heads
pH
Surface
1 metre depth
5 metre depth
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003

APPENDIX 3: MAHURANGI HARBOUR – SUSPENDED SOLIDS

a) Suspended solids (mg/L) for the period January 2003 - December 2003

Date	Supply Intake	Town Bridge	Town Basin	Town Basin	Dawsons Creek	Dawsons Creek	Mahurangi Heads	Mahurangi Heads
	Jetty		surface	1 m	surface	1 m	surface	5 m
21-Jan-03	5.1	4.8	6.7	7.9	12.0	13.5	3.6	4.0
18-Feb-03	1.8	2.5	14.7	22.3	43.0	37.5	11.8	3.1
20-Mar-03	3.8	5.2	7.2	10.2	12.8	13.3	4.5	4.9
22-Apr-03	44.9	8.8	12.3	12.9	11.9	13.1	3.0	3.0
4-Jun-03	0.7	1.4	5.4	5.5	7.7	7.8	4.1	0.7
16-Jun-03	21.1	27.7	15.2	16.7	17.0	36.5	4.9	4.2
14-Aug-03	7.7	9.3	13.5	15.8	9.3	9.3	3.5	5.7
29-Aug-03	6.1	8.0	11.2	13.6	10.1	10.9	3.6	4.7
15-Sep-03	44.3	54.5	57.0	59.0	9.5	10.0	3.3	3.6
13-Oct-03	23.6	25.8	26.1	26.1	18.0	21.7	5.4	4.9
11-Nov-03	4.3	3.8	5.5	9.2	7.6	17.2	5.0	4.4
9-Dec-03	2.7	4.7	7.6	9.1	13.8	13.5	8.6	7.6
Median	5.6	6.6	11.8	13.3	12.0	13.4	4.3	4.3
IQR/Median %	325	136	66	67	43	57	35	33

b) The graphs on the following page show suspended solids results for the period 1993 to December 2003 (where data available).

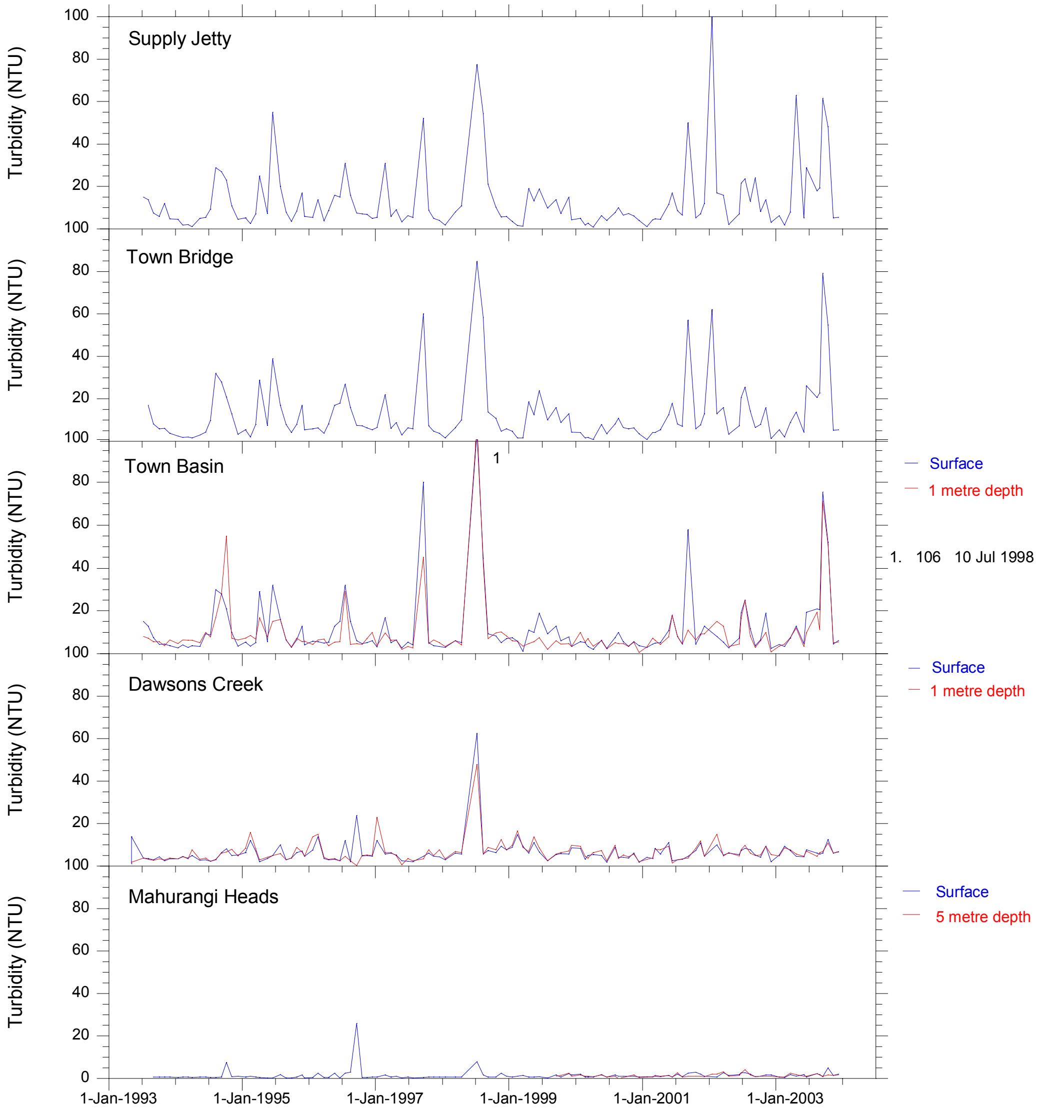

Supply Jetty
Town Bridge
Town Basin
Dawsons Creek
Mahurangi Heads
Suspended Solids (mg/L)
150
100
50
0
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003
Surface
1 metre depth
5 metre depth

APPENDIX 4: MAHURANGI HARBOUR – TURBIDITY

a) Turbidity (NTU) for the period January 2003 - December 2003

Date	Supply Intake	Town Bridge	Town Basin	Town Basin	Dawsons Creek	Dawsons Creek	Mahurangi Heads	Mahurangi Heads
	Jetty		surface	1 m	surface	1 m	surface	5 m
21-Jan-03	6.3	5.5	4.3	3.6	5.2	4.9	0.7	0.7
18-Feb-03	1.8	2.1	3.5	4.5	9.5	8.6	0.5	0.8
20-Mar-03	8.1	8.8	7.1	7.5	7.4	7.8	1.9	2.5
22-Apr-03	63.0	14.0	13.0	12.0	4.7	5.7	1.3	1.8
4-Jun-03	5.2	4.4	4.8	3.3	4.3	4.5	1.8	1.2
16-Jun-03	29.0	26.2	19.4	9.6	7.8	7.0	0.8	1.1
14-Aug-03	18.0	20.6	21.1	19.4	6.2	4.5	2.4	2.3
29-Aug-03	19.4	22.8	20.5	11.3	5.8	6.3	1.8	1.7
15-Sep-03	61.5	79.2	75.4	71.2	6.3	6.9	2.1	1.1
13-Oct-03	48.1	54.9	52.1	50.9	12.4	11.0	5.0	1.6
11-Nov-03	5.4	5.1	4.5	5.3	6.2	6.2	1.3	1.4
9-Dec-03	5.5	5.5	6.1	5.4	6.6	6.9	2.0	1.5
Median	13.0	11.4	10.1	8.5	6.2	6.6	1.8	1.4
IQR/Median %	217	160	158	102	30	26	47	42

b) The graphs on the following pages show turbidity results for the period 1993 to December 2003 (where data available).

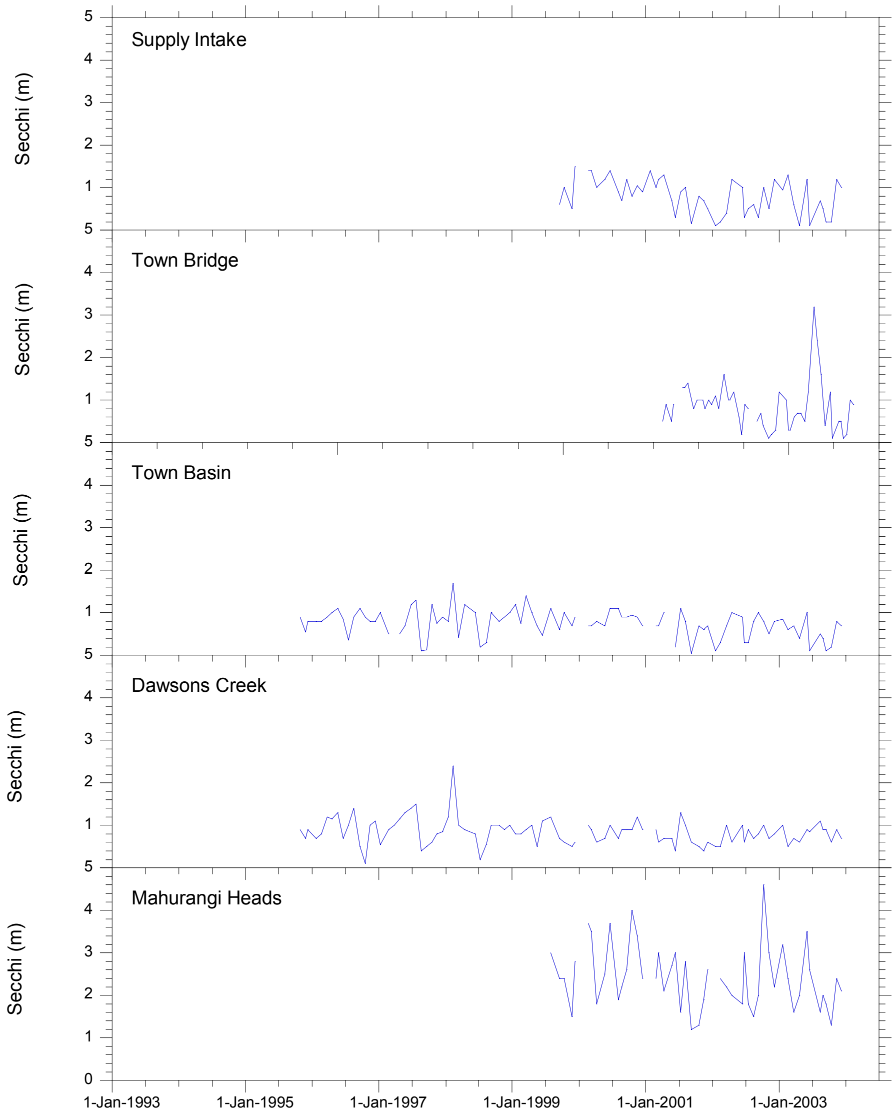

Supply Jetty
Town Bridge
Town Basin
Dawsons Creek
Mahurangi Heads
Turbidity (NTU)
100
80
60
40
20
0
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003
1
Surface
1 metre depth
1. 106 10 Jul 1998
Surface
1 metre depth
Surface
5 metre depth

APPENDIX 5: MAHURANGI HARBOUR – SECCHI DISK

a) Secchi disk depth (m) for the period January 2003 - December 2003

Date	Supply Intake	Town Bridge	Town Basin	Dawsons Creek	Mahurangi Heads
	Jetty		surface	surface	surface
21-Jan-03	0.95	0.95	0.85	1.0	3.2
18-Feb-03	1.3	1	0.6	0.5	2.4
20-Mar-03	0.6	0.7	0.7	0.7	1.6
22-Apr-03	0.1	0.4	0.4	0.6	2.0
4-Jun-03	1.2	1.2	1.0	0.9	3.5
16-Jun-03	0.1	0.1	0.1	0.9	2.6
14-Aug-03	0.7	0.5	0.5	1.1	1.6
29-Aug-03	0.5	0.5	0.4	0.9	2.0
15-Sep-03	0.2	0.1	0.1	0.9	1.8
13-Oct-03	0.2	0.2	0.2	0.6	1.3
11-Nov-03	1.2	1.0	0.8	0.9	2.4
9-Dec-03	1	0.9	0.7	0.7	2.1
Median	0.7	0.6	0.6	0.9	2.1
IQR/Median %	131	102	68	26	34

b) The graphs on the following page show secchi disk depth results for the period 1993 to December 2003 (where data available).

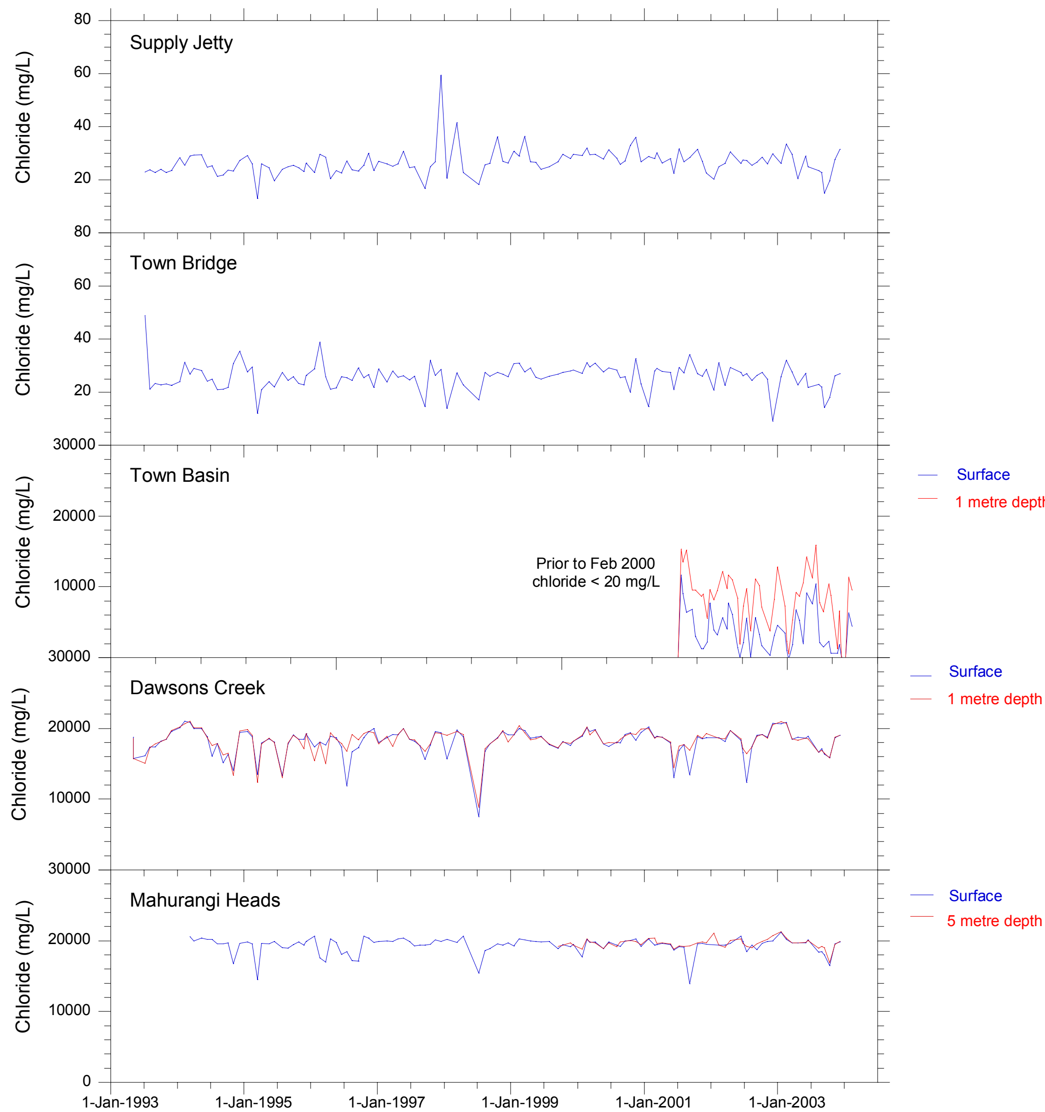

Supply Intake
Town Bridge
Town Basin
Dawsons Creek
Mahurangi Heads
Secchi (m)
5
4
3
2
1
0
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003

APPENDIX 6: MAHURANGI HARBOUR – CHLORIDE

a) Chloride (mg/L) for the period January 2003 - December 2003

Date	Supply Intake Jetty	Town Bridge	Town Basin surface	Town Basin 1 m	Dawsons Creek surface	Dawsons Creek 1 m	Mahurangi Heads surface	Mahurangi Heads 5 m
21-Jan-03	26.2	25.8	7597	11260	20664	20958	21215	21322
18-Feb-03	33.4	32.1	10459	15942	20854	20744	20231	20427
20-Mar-03	29.7	27.6	2099	7781	18451	18564	19724	19737
22-Apr-03	20.3	22.8	1508	6516	18748	18370	19756	19749
4-Jun-03	28.9	27.2	2337	10440	18599	18666	19748	19779
16-Jun-03	24.9	21.9	624	8848	18942	18553	20130	20051
14-Aug-03	23.6	22.9	645	1241	16675	16654	18398	18962
29-Aug-03	22.8	22.1	1813	6637	17125	16910	18498	19240
15-Sep-03	15	14.2	17.4	13.8	16387	16524	18005	19060
13-Oct-03	19.6	18	21.6	40	15927	15838	16536	16917
11-Nov-03	27.6	26.2	6359	11382	18693	18725	19543	19507
9-Dec-03	31.6	27	4444	9585	18997	19037	19846	19921
Median	25.6	24.4	1956	8315	18646	18559	19736	19743
IQR/Median %	27	21	219	66	10	11	7	4

b) The graphs on the following page show chloride results for the period 1993 to December 2003 (where data available).



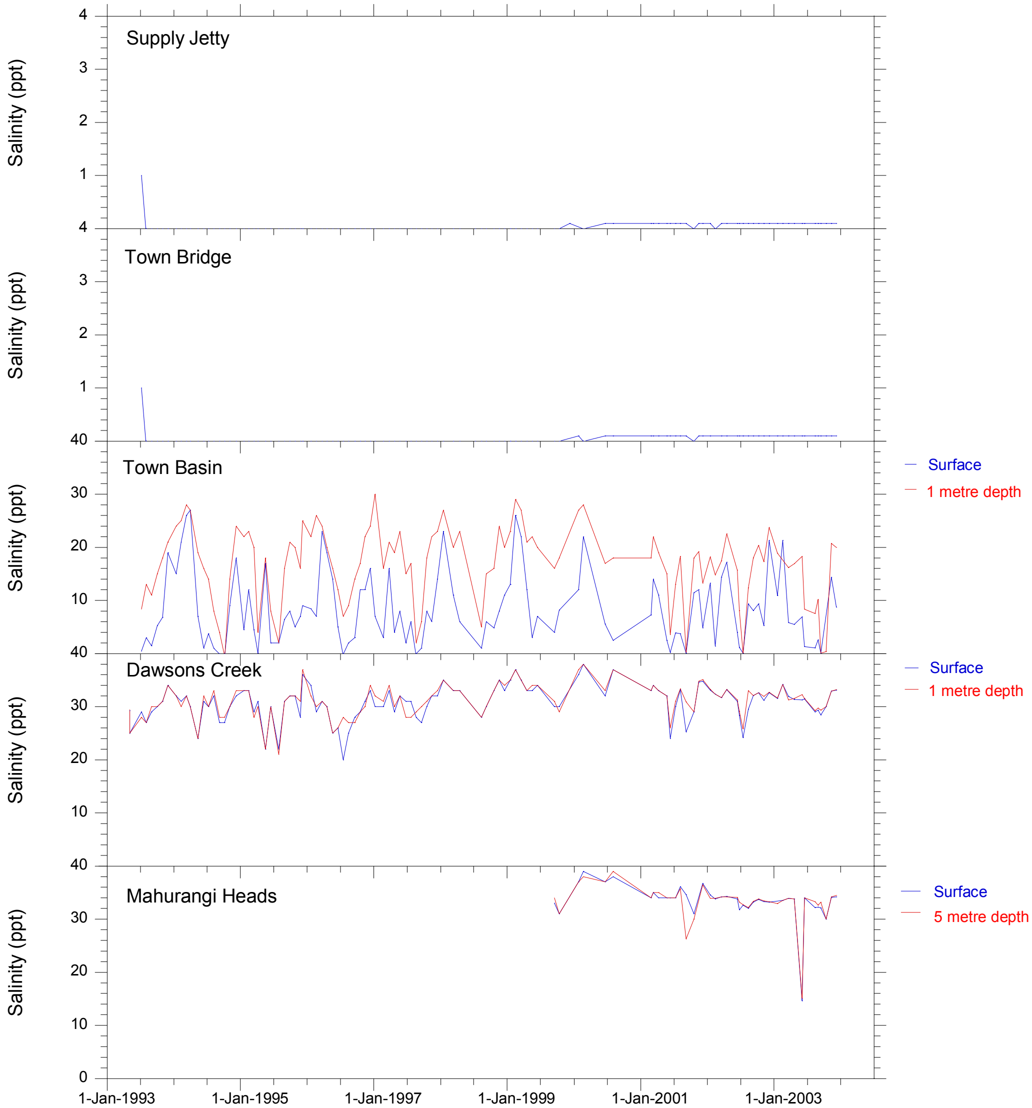
Supply Jetty
Town Bridge
Town Basin
Dawsons Creek
Mahurangi Heads
Chloride (mg/L)
Prior to Feb 2000
chloride < 20 mg/L
Surface
1 metre depth
Surface
1 metre depth
Surface
5 metre depth
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003

APPENDIX 7: MAHURANGI HARBOUR – SALINITY

a) Salinity (ppt) for the period January 2003 - December 2003

Date	Supply Intake Jetty	Town Bridge	Town Basin surface	Town Basin 1 m	Dawsons Creek surface	Dawsons Creek 1 m	Mahurangi Heads surface	Mahurangi Heads 5 m
21-Jan-03	0.1	0.1	10.9	18.9	31.6	31.7		32.9
18-Feb-03	0.1	0.1	21.3		34.2	34.2	33.6	33.6
20-Mar-03	0.1	0.1	5.8	16.2	31.9	31.3	33.9	33.9
22-Apr-03	0.1	0.1	5.5	16.9	31.4	31.6	33.8	33.8
4-Jun-03	0.1	0.1	6.9	18.3	31.3	32.3	14.7	15.1
16-Jun-03	0.1	0.1	1.3	8.4	31.5	31.6	34	34
14-Aug-03	0.1	0.1	1.1	7.6	29	29.3	32.2	33.3
29-Aug-03	0.1	0.1	2.6	10.2	29.4	29.7	32.3	32.6
15-Sep-03	0.1	0.1	0.1	0.1	28.5	29.4	32.1	33.2
13-Oct-03	0.1	0.1		0.4	30	30	30	30
11-Nov-03	0.1	0.1	14.4	20.7	32.9	32.9	34.1	34.2
9-Dec-03	0.1	0.1	8.7	20	33.1	33.2	34.2	34.5
Median	0.1	0.1	5.8	16.2	31.5	31.6	33.6	33.5
IQR/Median %	0	0	135	65	7	8	5	3

b) The graphs on the following page show salinity results for the period 1993 to December 2003 (where data available).



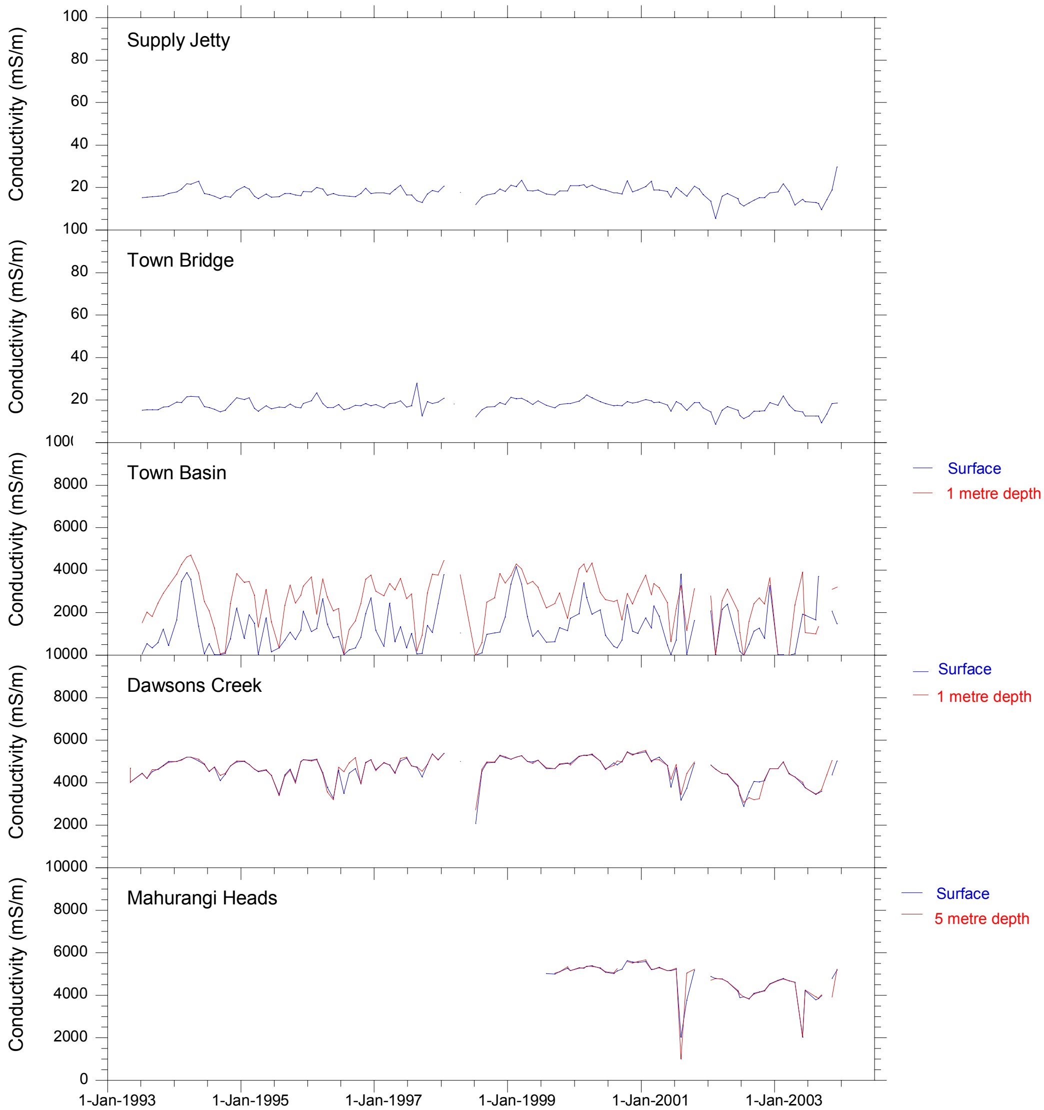
Supply Jetty
Town Bridge
Town Basin
Dawsons Creek
Mahurangi Heads
Salinity (ppt)
Surface
1 metre depth
5 metre depth
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003

APPENDIX 8: MAHURANGI HARBOUR – CONDUCTIVITY

a) Conductivity (mS/m) for the period January 2003 - December 2003

Date	Supply Intake Jetty	Town Bridge	Town Basin surface	Town Basin 1 m	Dawsons Creek surface	Dawsons Creek 1 m	Mahurangi Heads surface	Mahurangi Heads 5 m
21-Jan-03	17.9	17.6						
18-Feb-03	21.9	22.2						
20-Mar-03	18.2	17.8						
22-Apr-03	11.95	14.96	82.4	2362	4268	4287	4610	4610
4-Jun-03	14.6	14.54	1948	3907	3933	4032	2023	2066
16-Jun-03	13.35	12.42	1895	1067	3770	3784	4239	4240
14-Aug-03	13.08	12.62	1677	1007	3449	3484	3801	3935
29-Aug-03	12.58	12.46	3699	1334	3525	3552	3840	3869
15-Sep-03	9.6	9.28			3588	3675	3975	4040
13-Oct-03	14.36	13.36				4368		
11-Nov-03	18.83	18.43	2061	3101	4370	5050	4799	3909
9-Dec-03	29.9	18.74	1492	3208	5040		5180	5230
Median	14.5	14.8	1895	2362	3852	3908	4107	3988
IQR/Median %	37	36	22	83	19	17	20	11

b) The graphs on the following page show conductivity results for the period 1993 to December 2003 (where data available).



Supply Jetty
Town Bridge
Town Basin
Dawsons Creek
Mahurangi Heads
Conductivity (mS/m)
Surface
1 metre depth
5 metre depth
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003

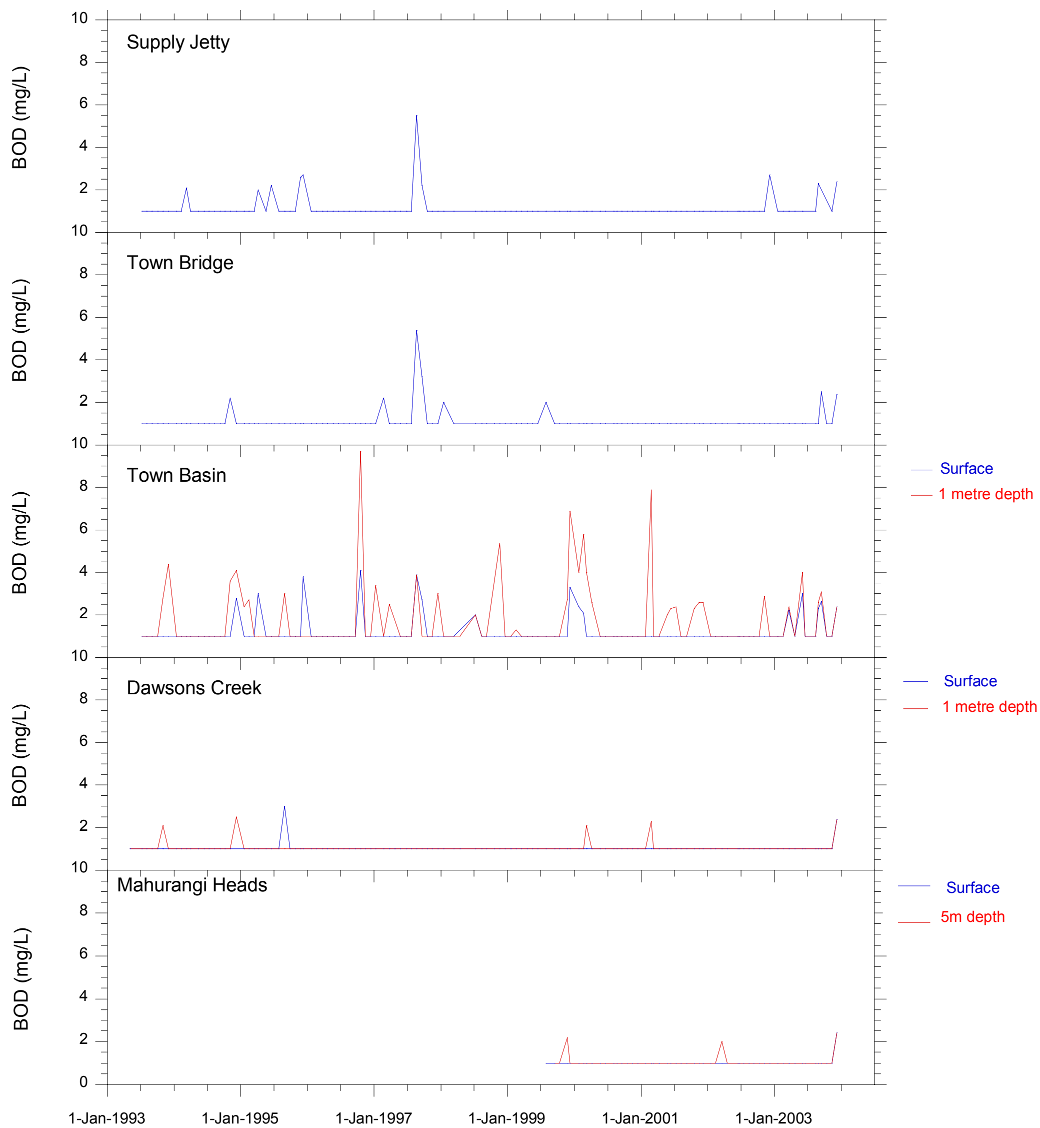
APPENDIX 9: MAHURANGI HARBOUR – BIOCHEMICAL OXYGEN DEMAND

a) BOD (mg/L) for the period January 2003 - December 2003

Date	Supply Intake Jetty	Town Bridge	Town Basin surface	Town Basin 1 m	Dawsons Creek surface	Dawsons Creek 1 m	Mahurangi Heads surface	Mahurangi Heads 5 m
21-Jan-03	<2	<2	<2	<2	<2	<2	<2	<2
18-Feb-03	<2	<2	<2	<2	<2	<2	<2	<2
20-Mar-03	<2	<2	2.2	2.2	<2	<2	<2	<2
22-Apr-03	<2	<2	<2	<2	<2	<2	<2	<2
4-Jun-03	<2	<2	3	3	<2	<2	<2	<2
16-Jun-03		<2	<2	<2	<2	<2	<2	<2
14-Aug-03	<2	<2	<2	<2	<2	<2	<2	<2
29-Aug-03	2.3	<2	2.3	2.3	<2	<2	<2	<2
15-Sep-03		2.5	2.65	2.65	<2	<2	<2	<2
13-Oct-03		<2	<2	<2	<2	<2	<2	<2
11-Nov-03	<2	<2	<2	<2	<2	<2	<2	<2
9-Dec-03	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Median	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
IQR/Median %	0	0	133	133	0	0	0	0

b) The graphs on the following page show BOD results for the period 1993 to December 2003 (where data available).

Method detection limit is 2.0 mg/L. For summary statistics, a result of "<2.0" is taken to have the value 1.0.

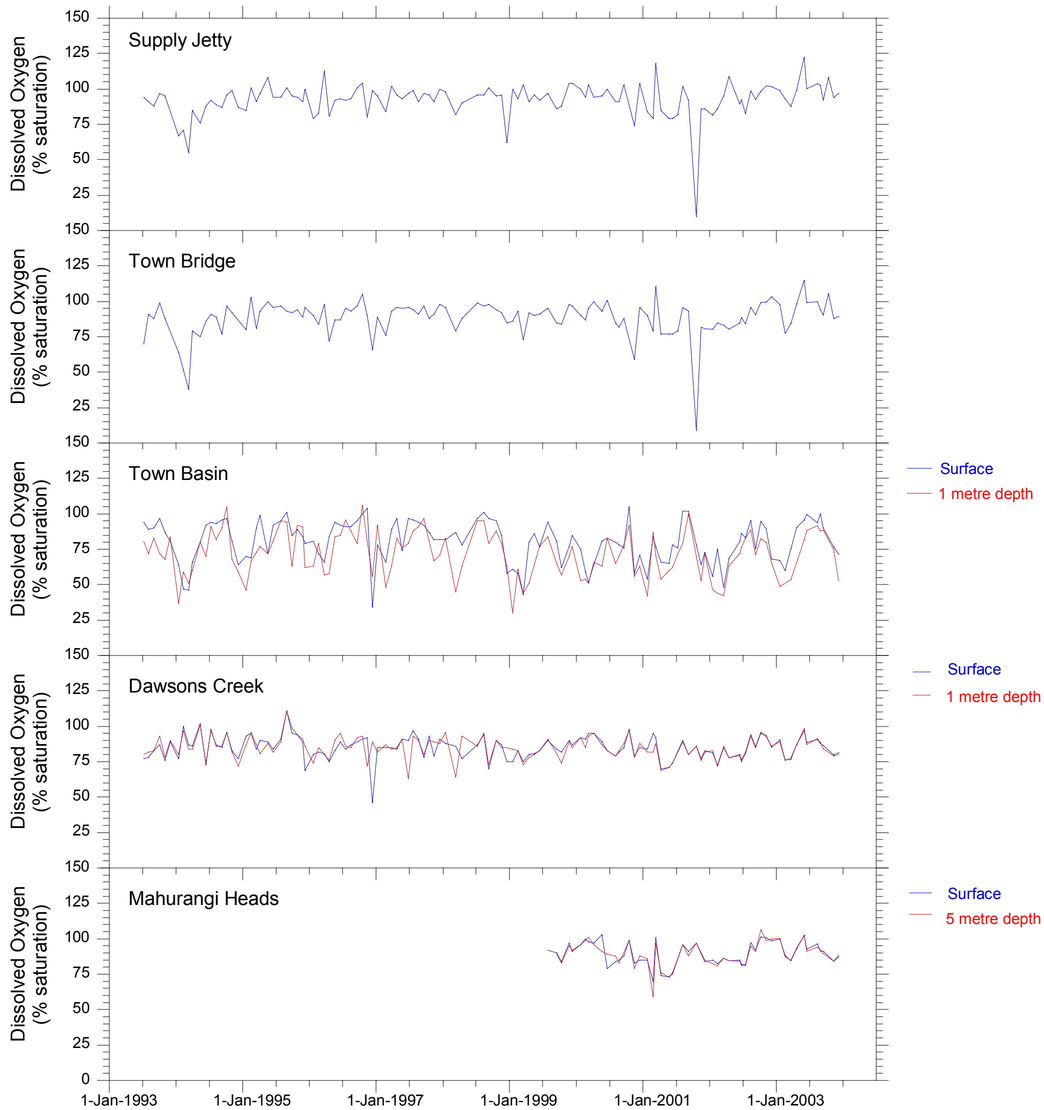

Supply Jetty
Town Bridge
Town Basin
Dawsons Creek
Mahurangi Heads
BOD (mg/L)
Surface
1 metre depth
5m depth
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003

APPENDIX 10: MAHURANGI HARBOUR – DISSOLVED OXYGEN, % SATURATION

a) Dissolved oxygen (% saturation) for the period January 2003 - December 2003

Date	Supply Intake Jetty	Town Bridge	Town Basin surface	Town Basin 1 m	Dawsons Creek surface	Dawsons Creek 1 m	Mahurangi Heads surface	Mahurangi Heads 5 m
21-Jan-03	98.9	97.9	67.2	48.8	90.4	89.1	100.1	100.2
18-Feb-03	93.3	77.3	60.1		76.5	76.1	88.5	87.5
20-Mar-03	87.8	84.5	75.3	53.5	76.8	77.9	84.7	84.8
22-Apr-03	99.1	98.2	90.4	65.4	87.2	87.1	93.0	93.4
4-Jun-03	122.3	115.0	95.9	81.5	96.8	98.5	102.4	102.7
16-Jun-03	100.3	99.3	99.5	88.2	88.8	87.3	92.7	91.6
14-Aug-03	103.7	100.1	93.6	91.8	90.7	91.3	96.6	94.3
29-Aug-03	102.6	94.2	100.2	87.9	88.1	88.6	91.4	92.1
15-Sep-03	92.2	90.4	90.1	88.7	86.6	84.3	91.3	89.8
13-Oct-03	108.3	105.3						
11-Nov-03	93.7	88.0	76.7	74.6	79.9	79.2	84.3	84.4
9-Dec-03	97.0	89.4	71.7	53.0	81.2	80.3	87.5	88.6
Median	99.0	96.1	90.1	78.1	87.2	87.1	91.4	91.6
IQR/Median %	9	11	24	41	10	10	7	6

b) The graphs on the following page show dissolved oxygen results for the period 1993 to December 2003 (where data available).


Supply Jetty
Town Bridge
Town Basin
Dawsons Creek
Mahurangi Heads
Dissolved Oxygen (% saturation)
Surface
1 metre depth
5 metre depth
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003

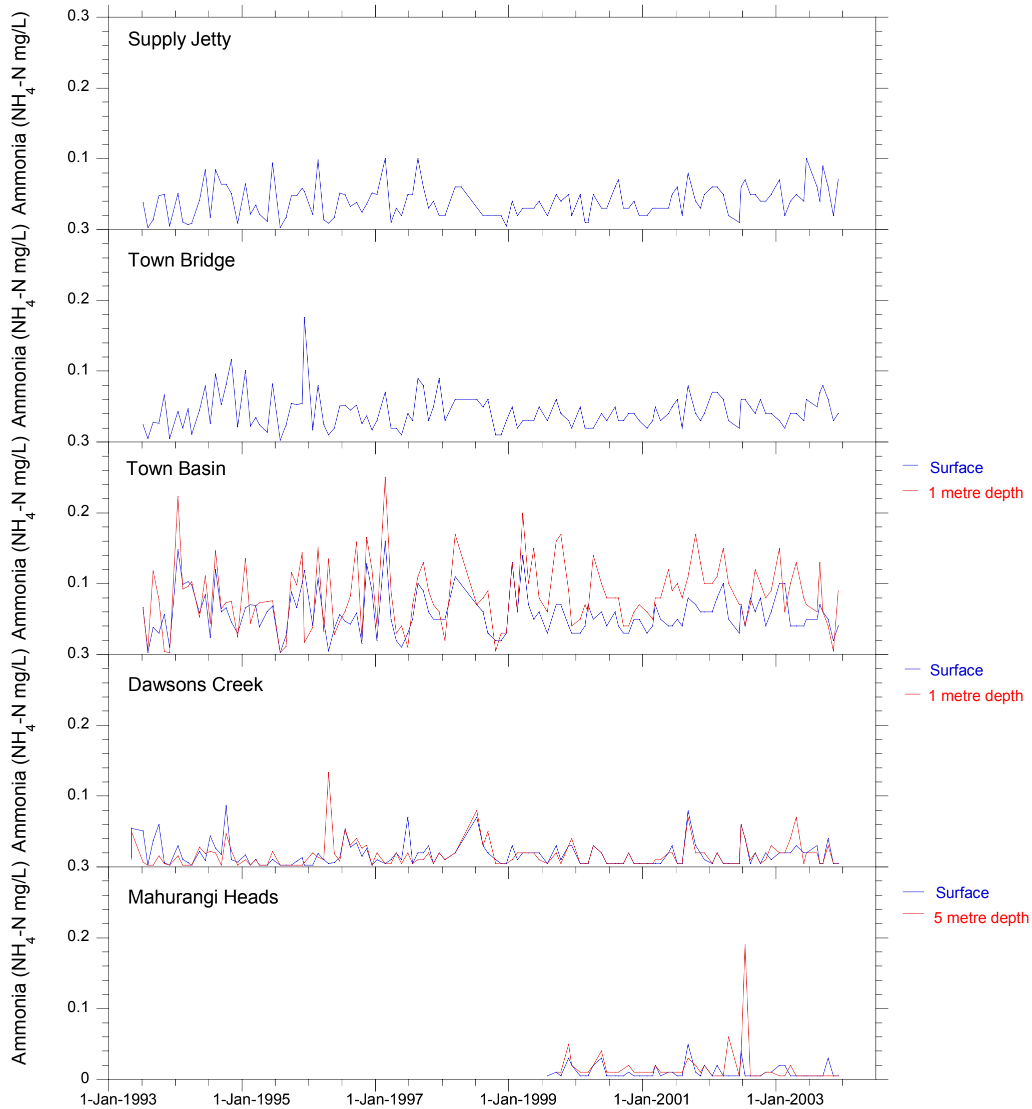
APPENDIX 11: MAHURANGI HARBOUR – AMMONIA NITROGEN

a) Ammonia nitrogen (mg/L) for the period January 2003 - December 2003

Date	Supply Intake Jetty	Town Bridge	Town Basin surface	Town Basin 1 m	Dawsons Creek surface	Dawsons Creek 1 m	Mahurangi Heads surface	Mahurangi Heads 5 m
21-Jan-03	0.07	0.03	0.1	0.15	0.02	0.02	0.02	<0.01
18-Feb-03	0.02	0.02	0.1	0.06	0.02	0.02	0.02	<0.01
20-Mar-03	0.04	0.04	0.04	0.1	0.02	0.04	<0.01	0.02
22-Apr-03	0.05	0.04	0.04	0.13	0.03	0.07	<0.01	<0.01
4-Jun-03	0.04	0.03	0.04	0.08	0.02	<0.01	<0.01	<0.01
16-Jun-03	0.1	0.06	0.05	0.07	0.02	0.02	<0.01	<0.01
14-Aug-03	0.06	0.05	0.05	0.06	0.03	0.02	<0.01	<0.01
29-Aug-03	0.04	0.07	0.07	0.13	<0.01	<0.01	<0.01	<0.01
15-Sep-03	0.09	0.08	0.06	0.06	<0.01	<0.01	<0.01	<0.01
13-Oct-03	0.06	0.06	0.05	0.04	0.04	0.03	0.03	<0.01
11-Nov-03	0.02	0.03	0.02	<0.01	<0.01	<0.01	<0.01	<0.01
9-Dec-03	0.07	0.04	0.04	0.09	<0.01	<0.01	<0.01	<0.01
Median	0.055	0.040	0.050	0.075	0.020	0.020	0.005	0.005
IQR/Median %	55	75	45	63	88	88	75	0

b) The graphs on the following page show ammonia nitrogen results for the period 1993 to December 2003 (where data available).

Method detection limit is 0.01 mg/L. For summary statistics, a result of “<0.01” is taken to have the value 0.005.



Supply Jetty
Town Bridge
Town Basin
Surface
1 metre depth
Dawsons Creek
Surface
1 metre depth
Mahurangi Heads
Surface
5 metre depth
Ammonia (NH$_4$-N mg/L)
0.3
0.2
0.1
0
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003

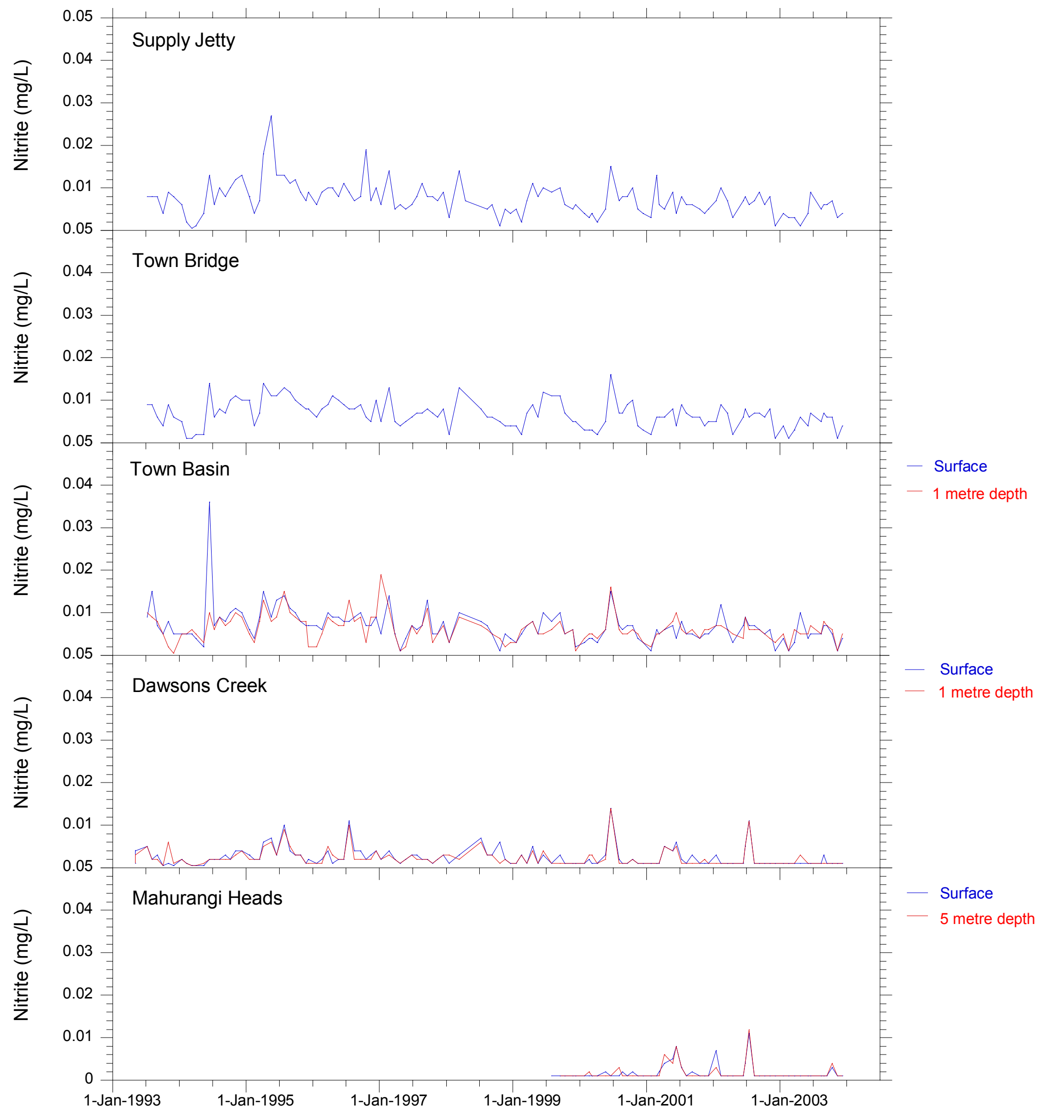
APPENDIX 12: MAHURANGI HARBOUR – NITRITE NITROGEN

a) Nitrite nitrogen (mg/L) for the period January 2003 - December 2003

Date	Supply Intake	Town Bridge	Town Basin	Town Basin	Dawsons Creek	Dawsons Creek	Mahurangi Heads	Mahurangi Heads
	Jetty		surface	1 m	surface	1 m	surface	5 m
21-Jan-03	0.004	0.004	0.004	0.005	<0.002	<0.002	<0.002	<0.002
18-Feb-03	0.003	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
20-Mar-03	0.003	0.003	0.003	0.006	<0.002	<0.002	<0.002	<0.002
22-Apr-03	<0.002	0.006	0.01	0.005	<0.002	0.003	<0.002	<0.002
4-Jun-03	0.004	0.004	0.004	0.005	<0.002	<0.002	<0.002	<0.002
16-Jun-03	0.009	0.007	0.005	0.007	<0.002	<0.002	<0.002	<0.002
14-Aug-03	0.005	0.005	0.005	0.005	<0.002	<0.002	<0.002	<0.002
29-Aug-03	0.006	0.007	0.007	0.008	0.003	<0.002	<0.002	<0.002
15-Sep-03	0.006	0.006	0.007	0.007	<0.002	<0.002	<0.002	<0.002
13-Oct-03	0.007	0.006	0.005	0.006	<0.002	<0.002	0.003	0.004
11-Nov-03	0.003	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
9-Dec-03	0.004	0.004	0.004	0.005	<0.002	<0.002	<0.002	<0.002
Median	0.004	0.005	0.005	0.005	0.001	0.001	0.001	0.001
IQR/Median %	75	50	39	25	0	0	0	0

b) The graphs on the following page show nitrite nitrogen results for the period 1993 to December 2003 (where data available).

Method detection limit is 0.002 mg/L. For summary statistics, a result of “<0.002” is taken to have the value 0.001.


Supply Jetty
Town Bridge
Town Basin
Dawsons Creek
Mahurangi Heads
Nitrite (mg/L)
0.05
0.04
0.03
0.02
0.01
0
Surface
1 metre depth
5 metre depth
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003

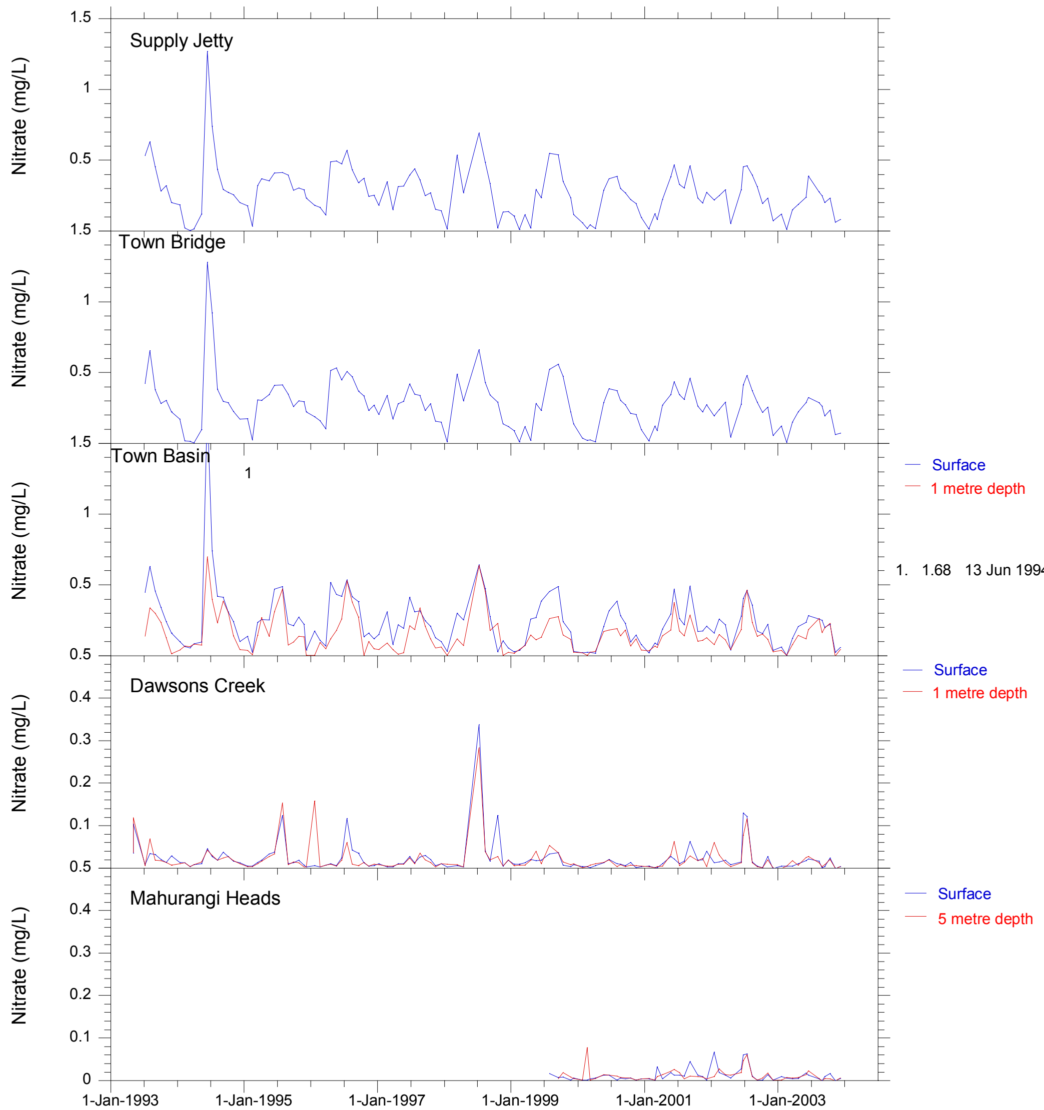
APPENDIX 13: MAHURANGI HARBOUR – NITRATE NITROGEN

a) Nitrate nitrogen (mg/L) for the period January 2003 - December 2003

Date	Supply Intake Jetty	Town Bridge	Town Basin surface	Town Basin 1 m	Dawsons Creek surface	Dawsons Creek 1 m	Mahurangi Heads surface	Mahurangi Heads 5 m
21-Jan-03	0.121	0.125	0.062	0.038	0.004	0	0.008	0.001
18-Feb-03	0.011	0.007	0.004	0.004	0.004	0.004	0.005	0.006
20-Mar-03	0.151	0.15	0.124	0.08	0.004	0.016	0.001	0.005
22-Apr-03	0.186	0.224	0.206	0.143	0.01	0.007	0.004	0.006
4-Jun-03	0.239	0.287	0.238	0.118	0.016	0.024	0.016	0.013
16-Jun-03	0.39	0.326	0.284	0.184	0.021	0.027	0.011	0.022
14-Aug-03	0.277	0.286	0.258	0.263	0.015	0.011	0.003	0.004
29-Aug-03	0.249	0.265	0.249	0.166	0.0015	0.003	0	0
15-Sep-03	0.201	0.197	0.201	0.198	0.003	0.007	0.008	0.004
13-Oct-03	0.231	0.237	0.224	0.227	0.023	0.02	0.016	0.004
11-Nov-03	0.063	0.062	0.024	0.001	0	0	0	0
9-Dec-03	0.081	0.071	0.058	0.046	0.001	0.001	0.004	0.005
Median	0.194	0.211	0.204	0.131	0.004	0.007	0.005	0.005
IQR/Median %	67	75	88	110	316	207	139	61

b) The graphs on the following page show nitrate nitrogen results for the period 1993 to December 2003 (where data available).

NO_3-N is calculated from the difference between NNN and NO_2-N. Zero or negative results may be obtained and are recorded as zero.



Supply Jetty
Town Bridge
Town Basin
1
Dawsons Creek
Mahurangi Heads
Nitrate (mg/L)
1.5
1
0.5
0.4
0.3
0.2
0.1
0
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003
Surface
1 metre depth
5 metre depth
1. 1.68 13 Jun 1994

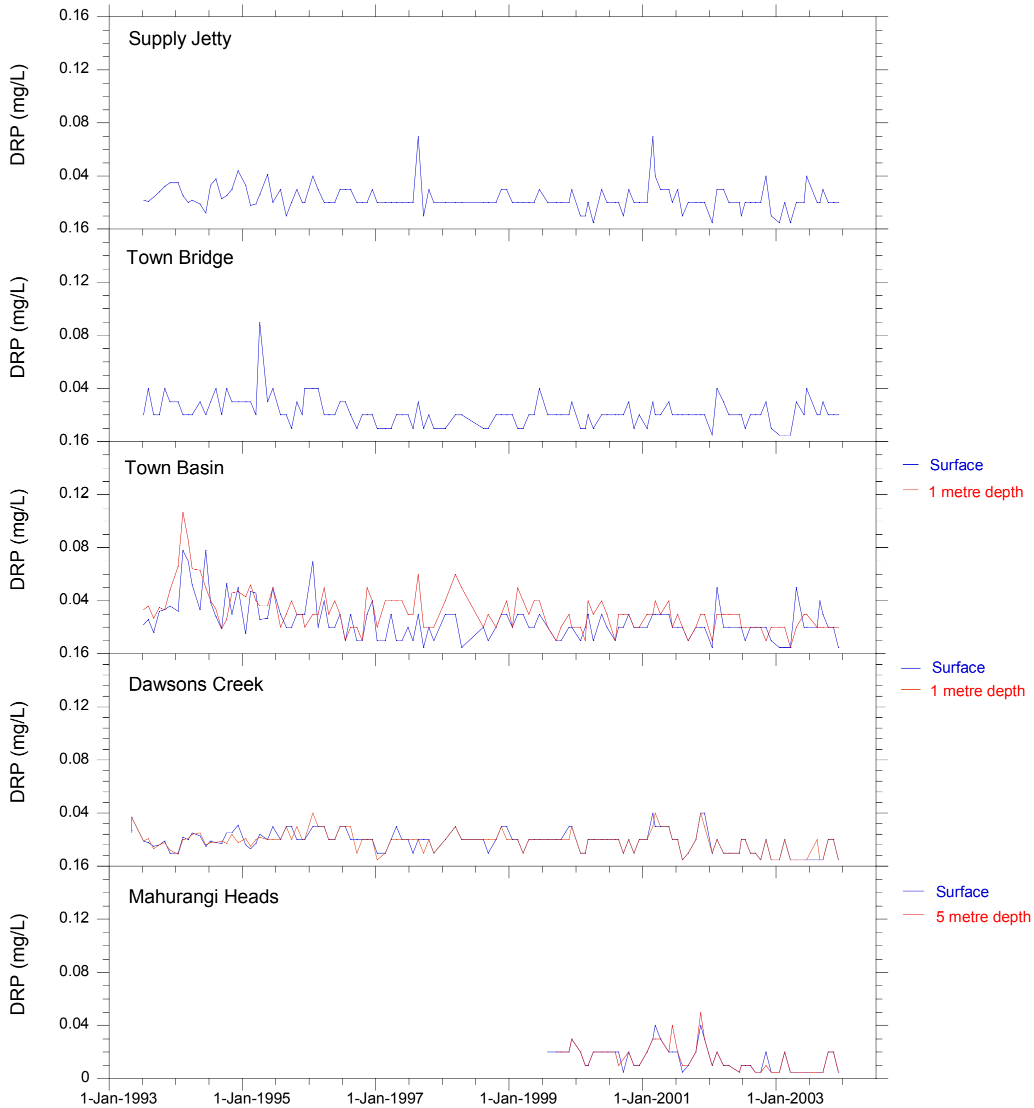
APPENDIX 14: MAHURANGI HARBOUR – DISSOLVED REACTIVE PHOSPHORUS

a) Dissolved reactive phosphorus (mg/L) for the period January 2003 - December 2003

Date	Supply Intake Jetty	Town Bridge	Town Basin surface	Town Basin 1 m	Dawsons Creek surface	Dawsons Creek 1 m	Mahurangi Heads surface	Mahurangi Heads 5 m
21-Jan-03	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
18-Feb-03	0.02	<0.01	<0.01	0.02	0.02	0.02	0.02	0.02
20-Mar-03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
22-Apr-03	0.02	0.03	0.05	0.02	<0.01	<0.01	<0.01	<0.01
4-Jun-03	0.02	0.02	0.02	0.03	<0.01	<0.01	<0.01	<0.01
16-Jun-03	0.04	0.04	0.02	0.03	<0.01	<0.01	<0.01	<0.01
14-Aug-03	0.02	0.02	0.02	0.02	<0.01	0.02	<0.01	<0.01
29-Aug-03	0.02	0.02	0.04	0.02	<0.01	<0.01	<0.01	<0.01
15-Sep-03	0.03	0.03	0.03	0.02	<0.01	<0.01	<0.01	<0.01
13-Oct-03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
11-Nov-03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
9-Dec-03	0.02	0.02	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Median	0.020	0.020	0.020	0.020	0.005	0.005	0.005	0.005
IQR/Median %	0	31	88	0	75	300	75	75

b) The graphs on the following page show dissolved reactive phosphorus results for the period 1993 to December 2003 (where data available).

Method detection limit is 0.01 mg/L. For summary statistics, a result of "<0.01" is taken to have the value 0.005.


Supply Jetty
Town Bridge
Town Basin
Dawsons Creek
Mahurangi Heads
DRP (mg/L)
0.16
0.12
0.08
0.04
0
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003
Surface
1 metre depth
5 metre depth

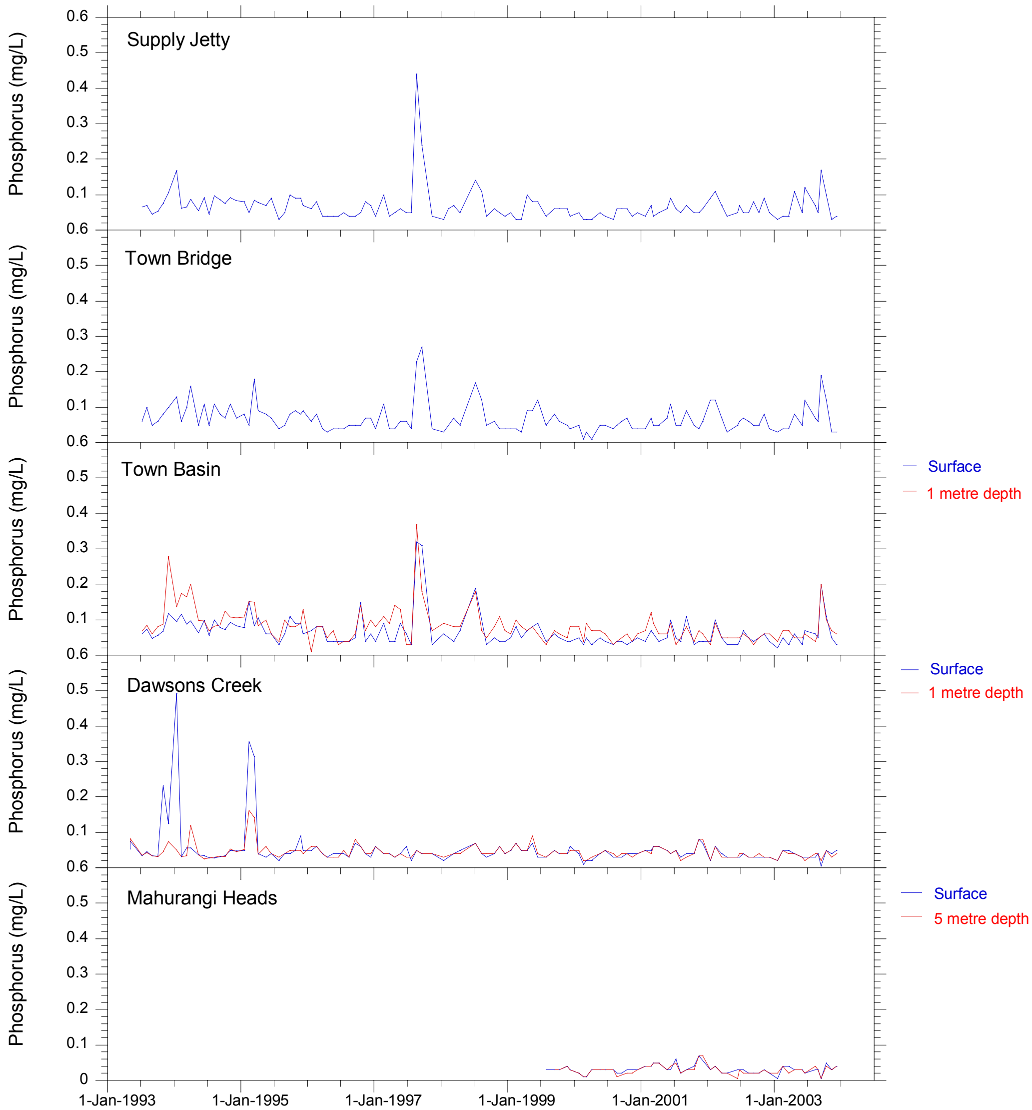
APPENDIX 15: MAHURANGI HARBOUR –TOTAL PHOSPHORUS

a) Total phosphorus (mg/L) for the period January 2003 - December 2003

Date	Supply Intake Jetty	Town Bridge	Town Basin surface	Town Basin 1 m	Dawsons Creek surface	Dawsons Creek 1 m	Mahurangi Heads surface	Mahurangi Heads 5 m
21-Jan-03	0.03	0.03	0.02	0.04	0.02	0.02	<0.01	0.02
18-Feb-03	0.04	0.04	0.05	0.07	0.05	0.05	0.04	0.04
20-Mar-03	0.04	0.04	0.03	0.07	0.05	0.04	0.04	0.02
22-Apr-03	0.11	0.08	0.06	0.05	0.04	0.04	0.03	0.03
4-Jun-03	0.05	0.05	0.03	0.05	0.03	0.03	0.03	0.03
16-Jun-03	0.12	0.12	0.07	0.06	0.03	0.02	0.02	0.02
14-Aug-03	0.07	0.07	0.06	0.04	0.03	0.04	0.03	0.04
29-Aug-03	0.05	0.06	0.05	0.06	0.04	0.04	0.03	0.03
15-Sep-03	0.17	0.19	0.2	0.2	<0.01	0.02	<0.01	<0.01
13-Oct-03	0.1	0.12	0.11	0.1	0.05	0.05	0.05	0.04
11-Nov-03	0.03	0.03	0.05	0.07	0.04	0.03	0.03	0.03
9-Dec-03	0.04	0.03	0.03	0.06	0.05	0.04	0.04	0.04
Median	0.05	0.06	0.05	0.06	0.04	0.04	0.03	0.03
IQR/Median %	125	95	65	33	50	31	42	67

b) The graphs on the following page show total phosphorus results for the period 1993 to December 2003 (where data available).

Method detection limit is 0.01 mg/L. For summary statistics, a result of “<0.01” is taken to have the value 0.005.


Supply Jetty
Town Bridge
Town Basin
Dawsons Creek
Mahurangi Heads
Phosphorus (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0
Surface
1 metre depth
5 metre depth
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003

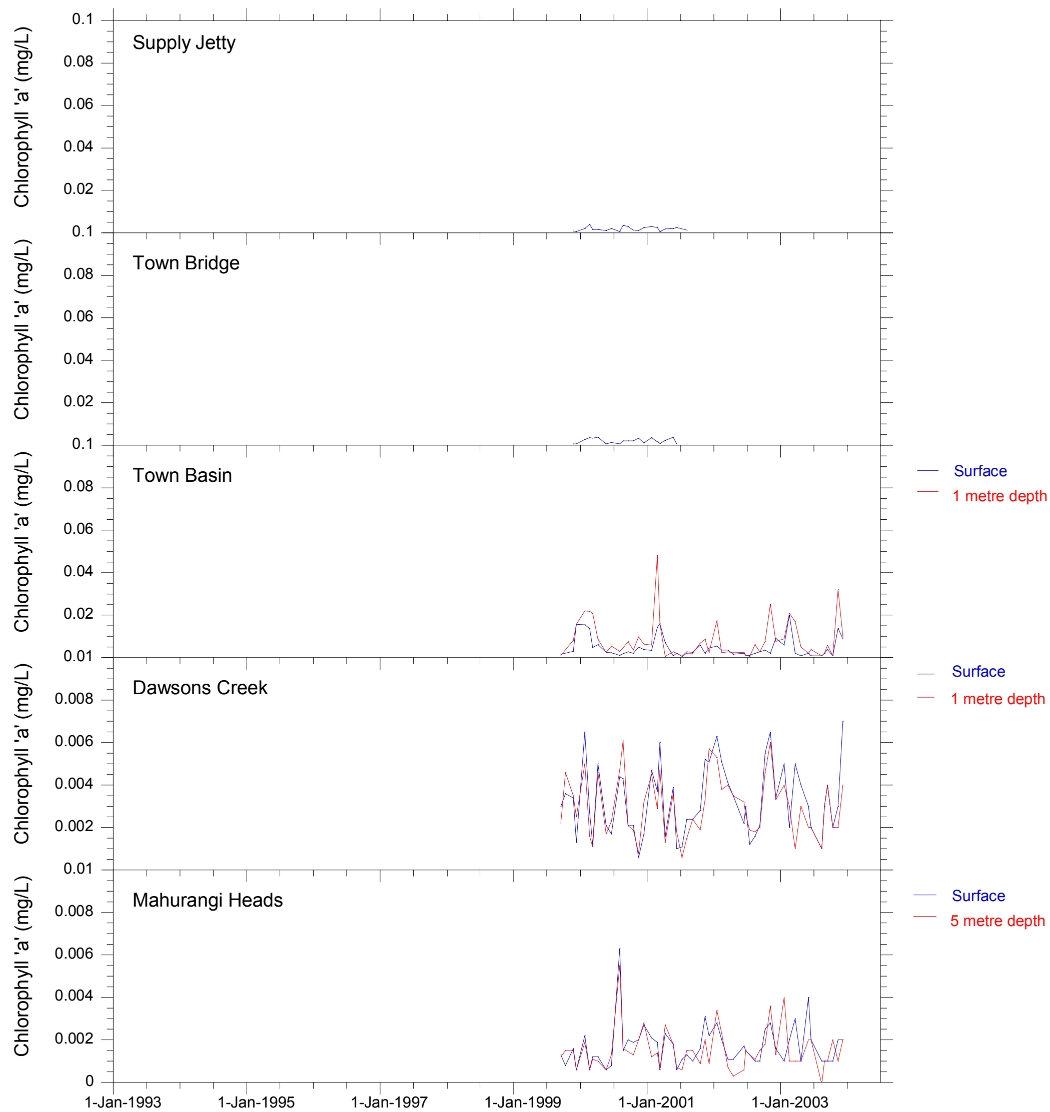
APPENDIX 16: MAHURANGI HARBOUR – CHLOROPHYLL a

a) Chlorophyll *a* (mg/L) for the period January 2003 - December 2003

Date	Supply Intake Jetty [1]	Town Bridge [1]	Town Basin surface	Town Basin 1 m	Dawsons Creek surface	Dawsons Creek 1 m	Mahurangi Heads surface	Mahurangi Heads 5 m
21-Jan-03			0.0055	0.0085	0.0045	0.0037	0.0013	0.0041
18-Feb-03			0.0202	0.0209	0.0018	0.0029	0.0017	0.0013
20-Mar-03			0.0016	0.0174	0.0052	0.0013	0.0034	0.0006
22-Apr-03			0.0014	0.0045	0.0036	0.0029	0.0009	0.0013
4-Jun-03			0.0020	0.0023	0.0033	0.0021	0.0038	0.0016
16-Jun-03			0.0010	0.0039	0.0017	0.0017	0.0015	0.0017
14-Aug-03			0.0007	0.0007	0.0012	0.0013	0.0014	0.0004
29-Aug-03			0.0018	0.0016	0.0026	0.0026	0.0012	0.0008
15-Sep-03			0.0038	0.0056	0.0036	0.0036	0.0014	0.0014
13-Oct-03			0.0010	0.0006	0.0016	0.0016	0.0011	0.0015
11-Nov-03			0.0143	0.0318	0.0026	0.0016	0.0017	0.0014
9-Dec-03			0.0089	0.0099	0.0067	0.0038	0.0023	0.0024
Median			0.0019	0.0051	0.0030	0.0024	0.0015	0.0014
IQR/Median %			266	191	69	62	40	32

[1] Supply Intake Jetty and Town Bridge samples not analysed (J. Wilkes email 24/9/04).

b) The graphs on the following page show chlorophyll *a* results for the period 1993 to December 2003 (where data available).



Supply Jetty
Town Bridge
Town Basin
Dawsons Creek
Mahurangi Heads
Chlorophyll 'a' (mg/L)
0.1
0.08
0.06
0.04
0.02
0.01
0.008
0.006
0.004
0.002
0
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003
Surface
1 metre depth
Surface
1 metre depth
Surface
5 metre depth

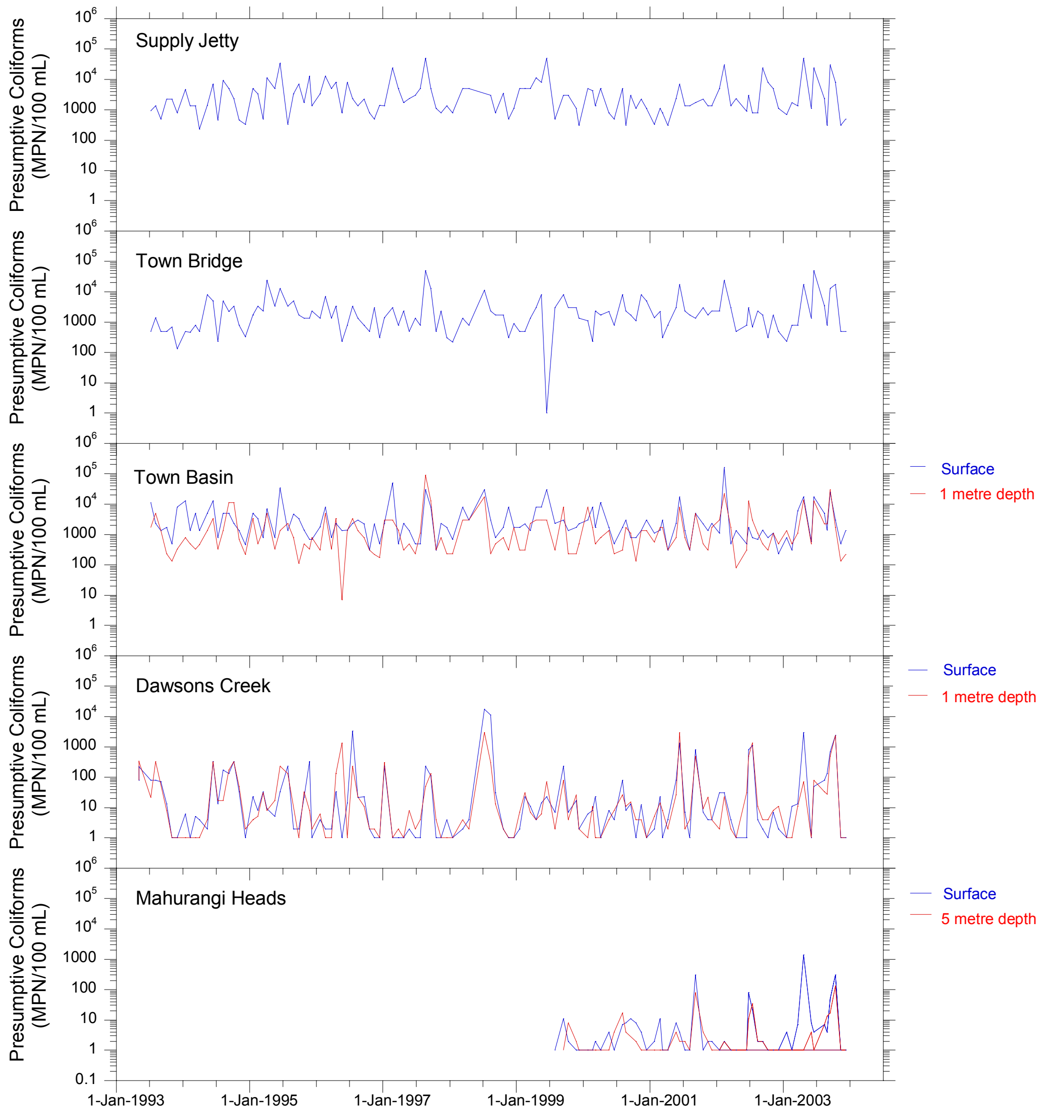
APPENDIX 17: MAHURANGI HARBOUR – PRESUMPTIVE COLIFORMS

a) Presumptive coliform counts (MPN/100mL) for the period January 2003 - December 2003

Date	Supply Intake Jetty	Town Bridge	Town Basin surface	Town Basin 1 m	Dawsons Creek surface	Dawsons Creek 1 m	Mahurangi Heads surface	Mahurangi Heads 5 m
21-Jan-03	700	230	800	1300	<2	<2	4	<2
18-Feb-03	1700	800	300	500	11	<2	<2	<2
20-Mar-03	1300	800	6000	1100	13	11	7	<2
22-Apr-03	50000	17000	17000	14000	3000	70	1400	<2
4-Jun-03	1100	1300	600	500	<2	<2	8	4
16-Jun-03	24000	50000	17000	13000	50	80	4	<2
14-Aug-03	2300	3500	5000	2200	80	33	7	7
29-Aug-03	300	800	1400	2200	130	27	4	13
15-Sep-03	30000	13000	24000	30000	700	500	50	17
13-Oct-03	8000	17000	3000	1700	2400	2400	300	130
11-Nov-03	300	500	500	130	<2	<2	<2	<2
9-Dec-03	500	500	1300	220	<2	<2	<2	<2
Median	1500	1050	2200	1500	32	19	6	1
IQR/Median %	757	1264	364	293	862	376	277	750

b) The graphs on the following page show presumptive coliform results for the period 1993 to December 2003 (where data available).

Method detection limit is 2 MPN/100 mL. For summary statistics, a result of "<2" is taken to have the value 1.


Supply Jetty
Town Bridge
Town Basin
Dawsons Creek
Mahurangi Heads
Presumptive Coliforms (MPN/100 mL)
Surface
1 metre depth
Surface
1 metre depth
Surface
5 metre depth
10^6
10^5
10^4
1000
100
10
1
0.1
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003

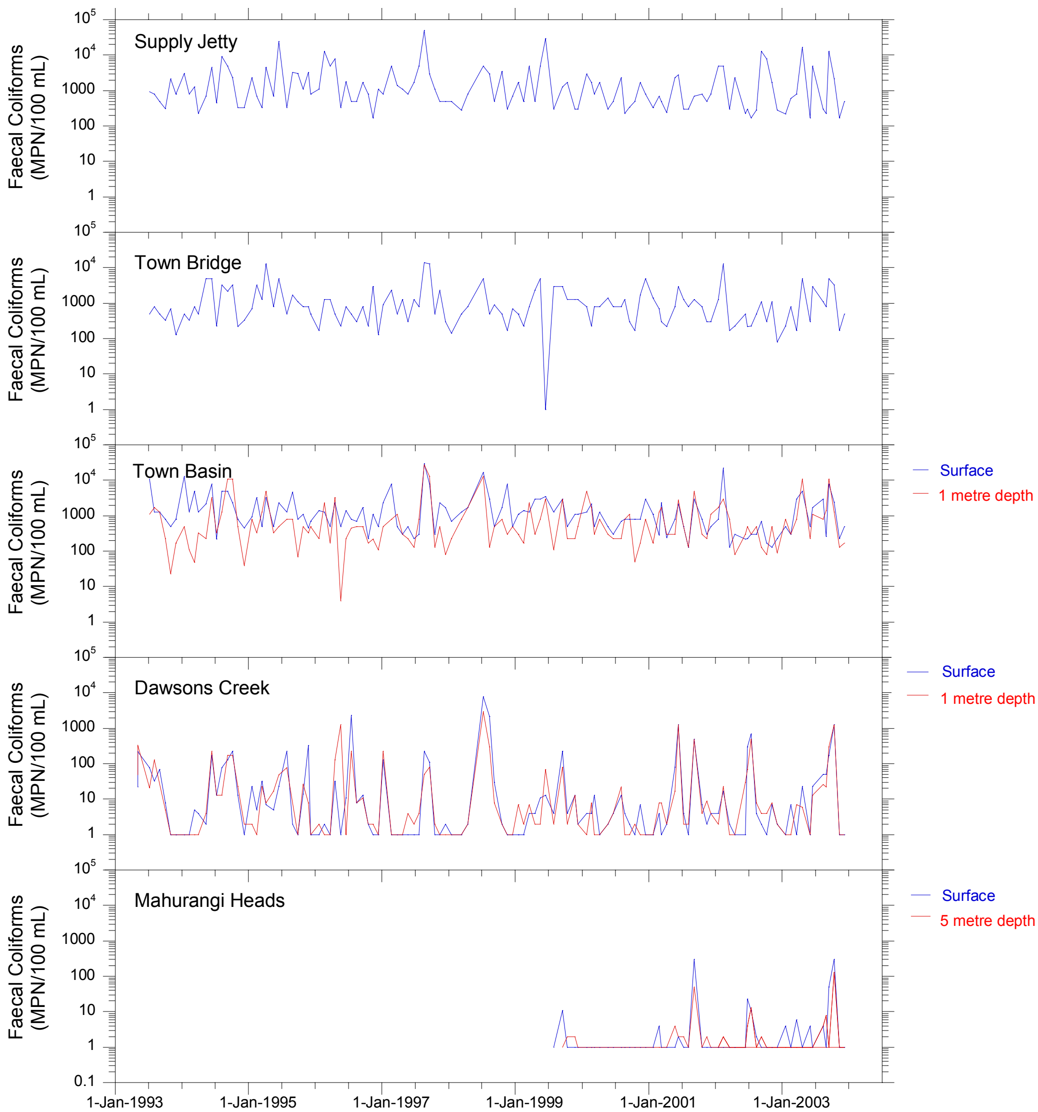
APPENDIX 18: MAHURANGI HARBOUR – FAECAL COLIFORMS

a) Faecal coliform counts (MPN/100mL) for the period January 2003 - December 2003

Date	Supply Intake Jetty	Town Bridge	Town Basin surface	Town Basin 1 m	Dawsons Creek surface	Dawsons Creek 1 m	Mahurangi Heads surface	Mahurangi Heads 5 m
21-Jan-03	220	230	500	800	<2	<2	4	<2
18-Feb-03	600	800	300	300	7	<2	<2	<2
20-Mar-03	800	170	3000	800	<2	7	6	<2
22-Apr-03	17000	5000	5000	11000	23	6	<2	<2
4-Jun-03	170	300	500	230	<2	<2	4	<2
16-Jun-03	5000	3000	1700	1100	23	13	<2	<2
14-Aug-03	300	1100	3000	800	50	26	4	4
29-Aug-03	230	800	260	1400	50	22	<2	8
15-Sep-03	13000	5000	8000	11000	170	300	50	<2
13-Oct-03	2200	3300	2400	1300	1300	1300	300	130
11-Nov-03	170	170	230	130	<2	<2	<2	<2
9-Dec-03	500	500	500	170	<2	<2	<2	<2
Median	550	800	1100	800	15	7	3	1
IQR/Median %	486	349	232	130	327	338	140	75

b) The graphs on the following page show faecal coliform results for the period 1993 to December 2003 (where data available).

Method detection limit is 2 MPN/100 mL. For summary statistics, a result of “<2” is taken to have the value 1.


Supply Jetty
Town Bridge
Town Basin
Dawsons Creek
Mahurangi Heads
Faecal Coliforms (MPN/100 mL)
Surface
1 metre depth
5 metre depth
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003

APPENDIX 19: MAHURANGI HARBOUR – ENTEROCOCCI

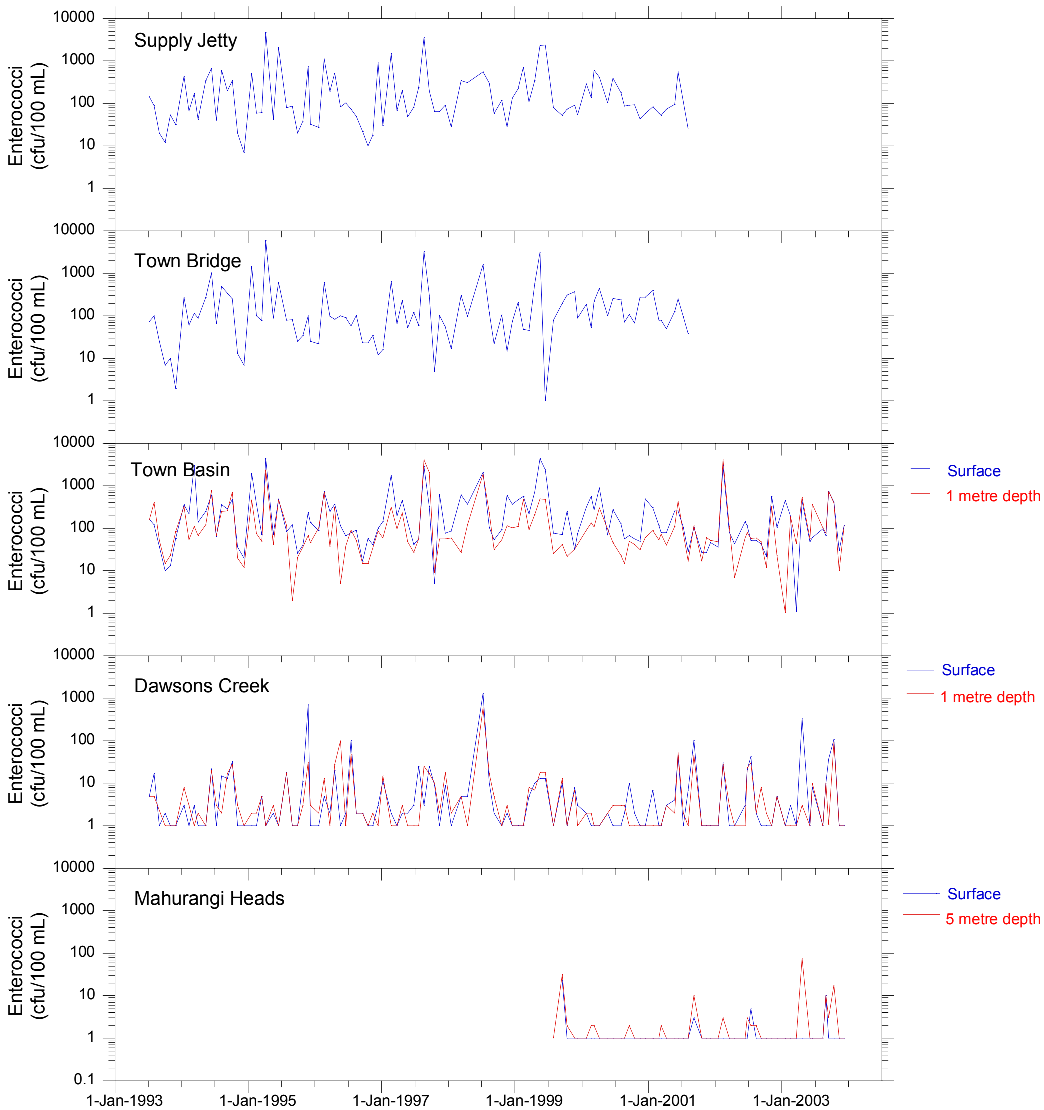
a) Enterococci (cfu/100mL) for the period January 2003 - December 2003

Date	Supply Intake Jetty [1]	Town Bridge [1]	Town Basin surface	Town Basin 1 m	Dawsons Creek surface	Dawsons Creek 1 m	Mahurangi Heads surface	Mahurangi Heads 5 m
21-Jan-03			460	<2	<2	<2	<2	<2
18-Feb-03			196	190	3	<2	<2	<2
20-Mar-03			<2	44	<2	<2	<2	<2
22-Apr-03			450	530	340	3	78	<2
4-Jun-03			48	58	<2	<2	<2	<2
16-Jun-03			61	370	8	10	<2	<2
14-Aug-03			98	104	<2	<2	<2	<2
29-Aug-03			68	78	10	10	10	10
15-Sep-03			730	750	37	1.07	3	<2
13-Oct-03			410	390	108	94	18	<2
11-Nov-03			30	10	<2	<2	<2	<2
9-Dec-03			118	114	<2	<2	<2	<2
Median			108	109	2	1	1	1
IQR/Median %			335	294	788	375	375	0

[1] Supply Intake Jetty and Town Bridge samples not analysed (J. Wilkes email 24/9/04).

b) The graphs on the following page show enterococci results for the period January 1993 to December 2003 (where data available).

Method detection limit is 2 cfu/100 mL. For summary statistics, a result of “<2” is taken to have the value 1.

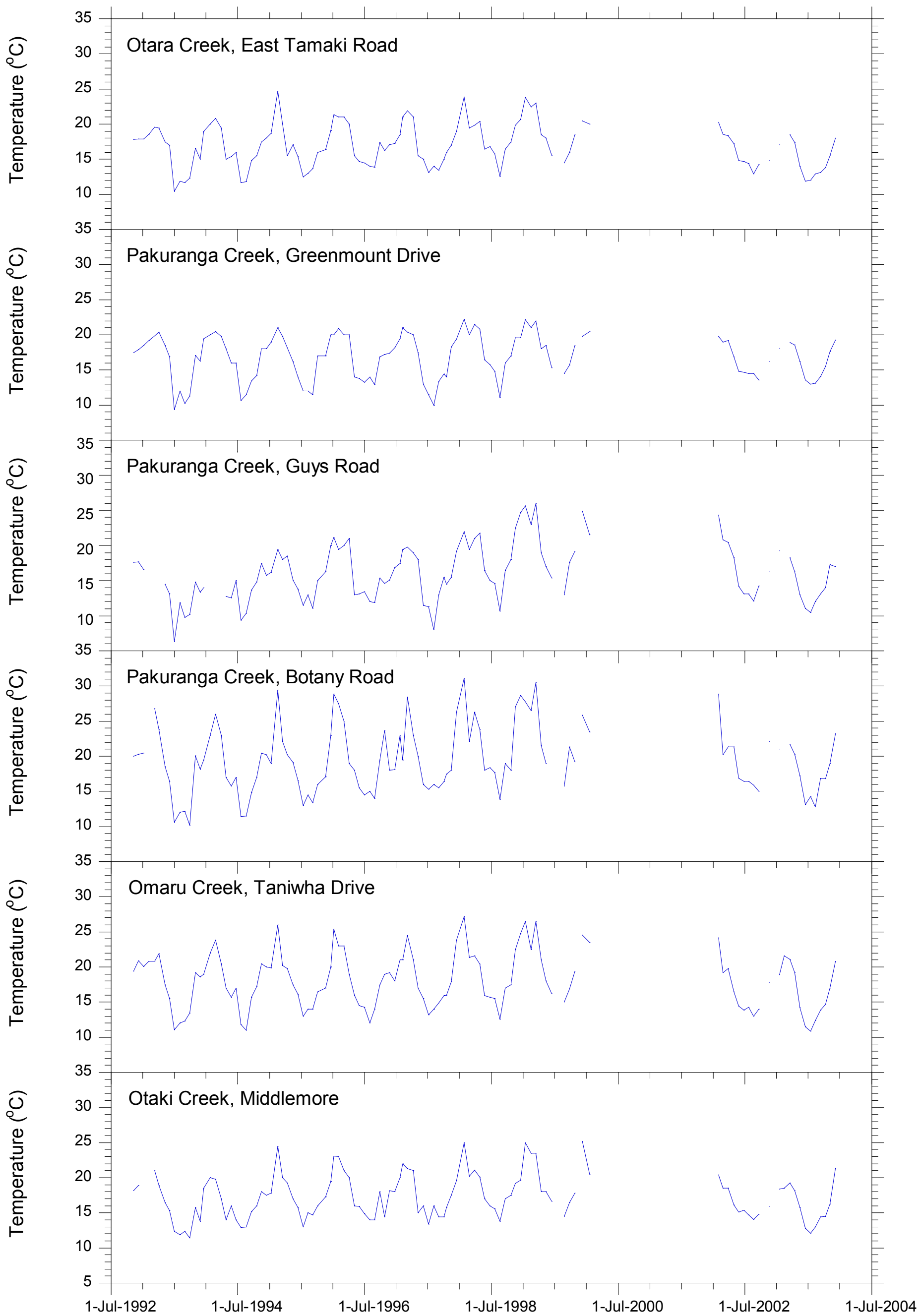

Supply Jetty
Town Bridge
Town Basin
Surface
1 metre depth
Dawsons Creek
Surface
1 metre depth
Mahurangi Heads
Surface
5 metre depth
Enterococci (cfu/100 mL)
10000
1000
100
10
1
0.1
1-Jan-1993
1-Jan-1995
1-Jan-1997
1-Jan-1999
1-Jan-2001
1-Jan-2003

APPENDIX 20: TAMAKI ESTUARY – TEMPERATURE

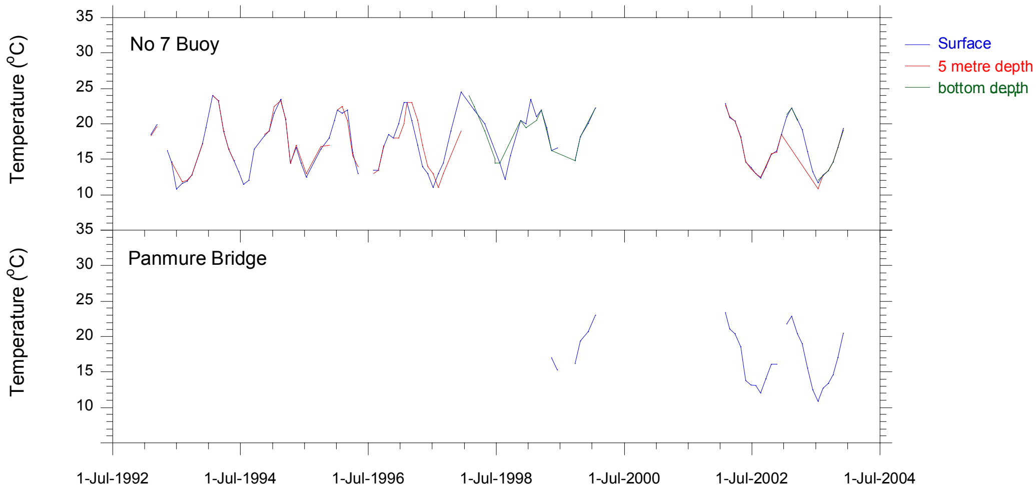
a) Temperature (°C) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	17.1	18.1	19.3	21.0	18.9	18.4	21.0	21.3	21.8
14-Feb-03					21.6	18.5	22.3	22.3	22.9
18-Mar-03	18.5	18.9	18.3	21.7	21.1	19.3	20.6	20.5	20.4
15-Apr-03	17.4	18.6	16.3	20.3	19.2	18.2	19.2		19.0
15-May-03	14.0	16.2	13.0	17.2	14.2	15.8	16.1	16.1	15.6
13-Jun-03	11.9	13.6	11.1	13.1	11.5	12.8	13.3		12.5
14-Jul-03	12.0	13.0	10.5	14.3	10.9	12.1	11.7	12.0	10.9
11-Aug-03	12.9	13.1	12.0	12.8	12.4	13.0	12.8	12.7	12.7
10-Sep-03	13.1	14.1	13.1	16.9	13.9	14.4	13.4	13.4	13.4
08-Oct-03	13.8	15.5	14.0	16.8	14.7	14.5	14.6	14.6	14.6
06-Nov-03	15.5	17.6	17.3	19.0	17.0	16.3	16.7	16.7	17.1
05-Dec-03	18.0	19.3	17.0	23.2	20.8	21.4	19.4	19.1	20.5
Median	14.0	16.2	14.0	17.2	15.9	16.1	16.4	16.4	16.4
IQR/Median %	30	28	33	30	38	27	39	39	44

b) The graphs on the following pages show temperature results for the period November 1992 to December 2003 (where data available).



Otara Creek, East Tamaki Road
Pakuranga Creek, Greenmount Drive
Pakuranga Creek, Guys Road
Pakuranga Creek, Botany Road
Omaru Creek, Taniwha Drive
Otaki Creek, Middlemore
Temperature (°C)
35
30
25
20
15
10
5
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

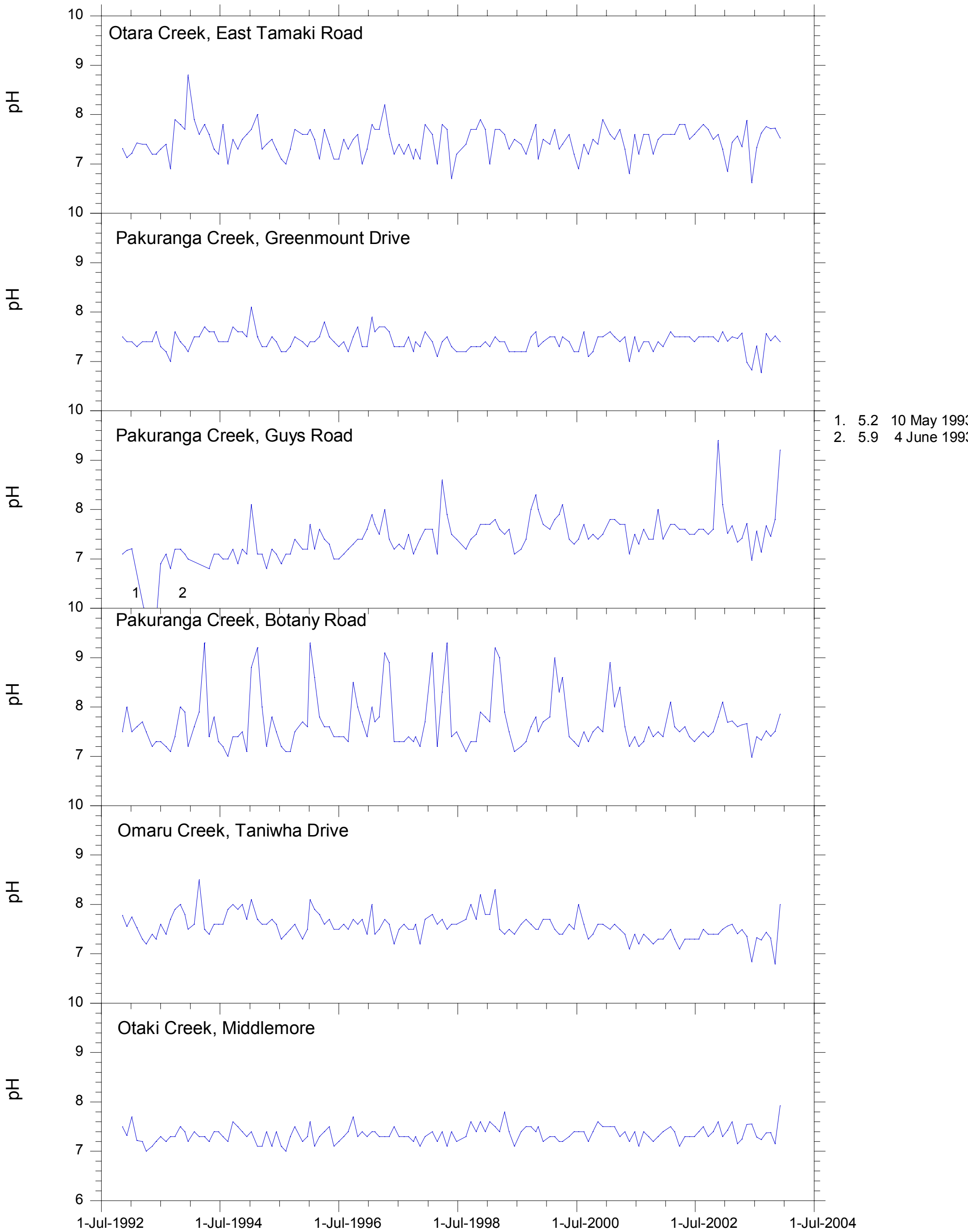

No 7 Buoy
Panmure Bridge
Temperature (°C)
Temperature (°C)
35
30
25
20
15
10
Surface
5 metre depth
bottom depth
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

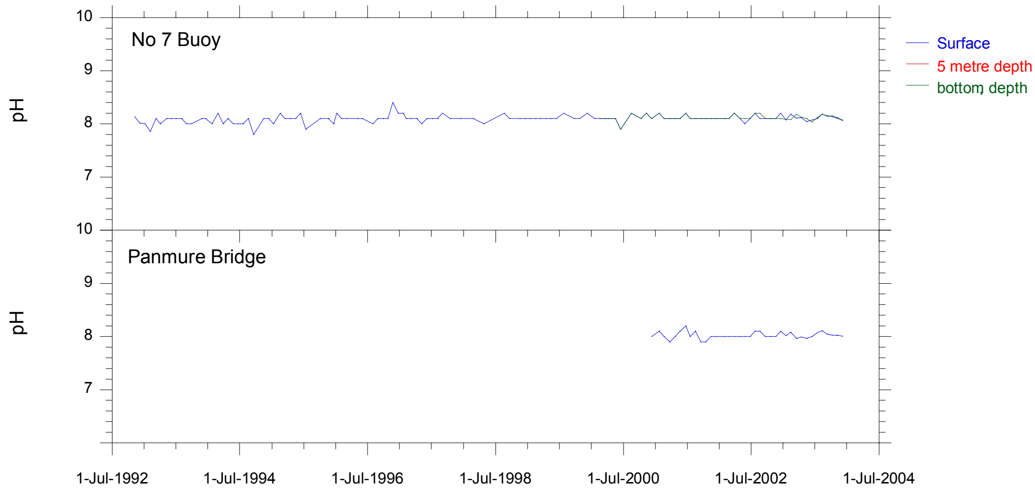
APPENDIX 21: TAMAKI ESTUARY – pH

a) pH for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	6.85	7.41	7.52	7.69	7.57	7.43	8.07	8.08	8.02
14-Feb-03	7.44	7.50	7.67	7.72	7.60	7.60	8.18	8.08	8.08
18-Mar-03	7.57	7.47	7.34	7.60	7.41	7.16	8.11	8.18	7.97
15-Apr-03	7.35	7.58	7.42	7.64	7.49	7.25	8.12	8.13	7.99
15-May-03	7.88	6.98	7.72	7.66	7.36	7.55	8.05	8.10	7.97
13-Jun-03	6.62	6.83	6.97	6.98	6.84	7.56	8.07	8.04	8.00
14-Jul-03	7.33	7.32	7.57	7.40	7.33	7.29	8.10	8.12	8.07
11-Aug-03	7.63	6.78	7.14	7.33	7.28	7.24	8.18	8.18	8.11
10-Sep-03	7.76	7.57	7.67	7.52	7.44	7.37	8.16	8.15	8.05
08-Oct-03	7.72	7.42	7.46	7.41	7.32	7.38	8.14	8.16	8.03
06-Nov-03	7.73	7.52	7.80	7.51	6.79	7.16	8.11	8.12	8.03
05-Dec-03	7.53	7.40	9.21	7.86	8.00	7.93	8.06	8.07	8.01
Median	7.55	7.42	7.55	7.56	7.39	7.38	8.11	8.12	8.03
IQR/Median %	5	4	4	3	3	4	1	1	1

b) The graphs on the following pages show pH results for the period November 1992 to December 2003 (where data available).


Otara Creek, East Tamaki Road
Pakuranga Creek, Greenmount Drive
Pakuranga Creek, Guys Road
1. 5.2 10 May 199
2. 5.9 4 June 199
1
2
Pakuranga Creek, Botany Road
Omaru Creek, Taniwha Drive
Otaki Creek, Middlemore
pH
10
9
8
7
6
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

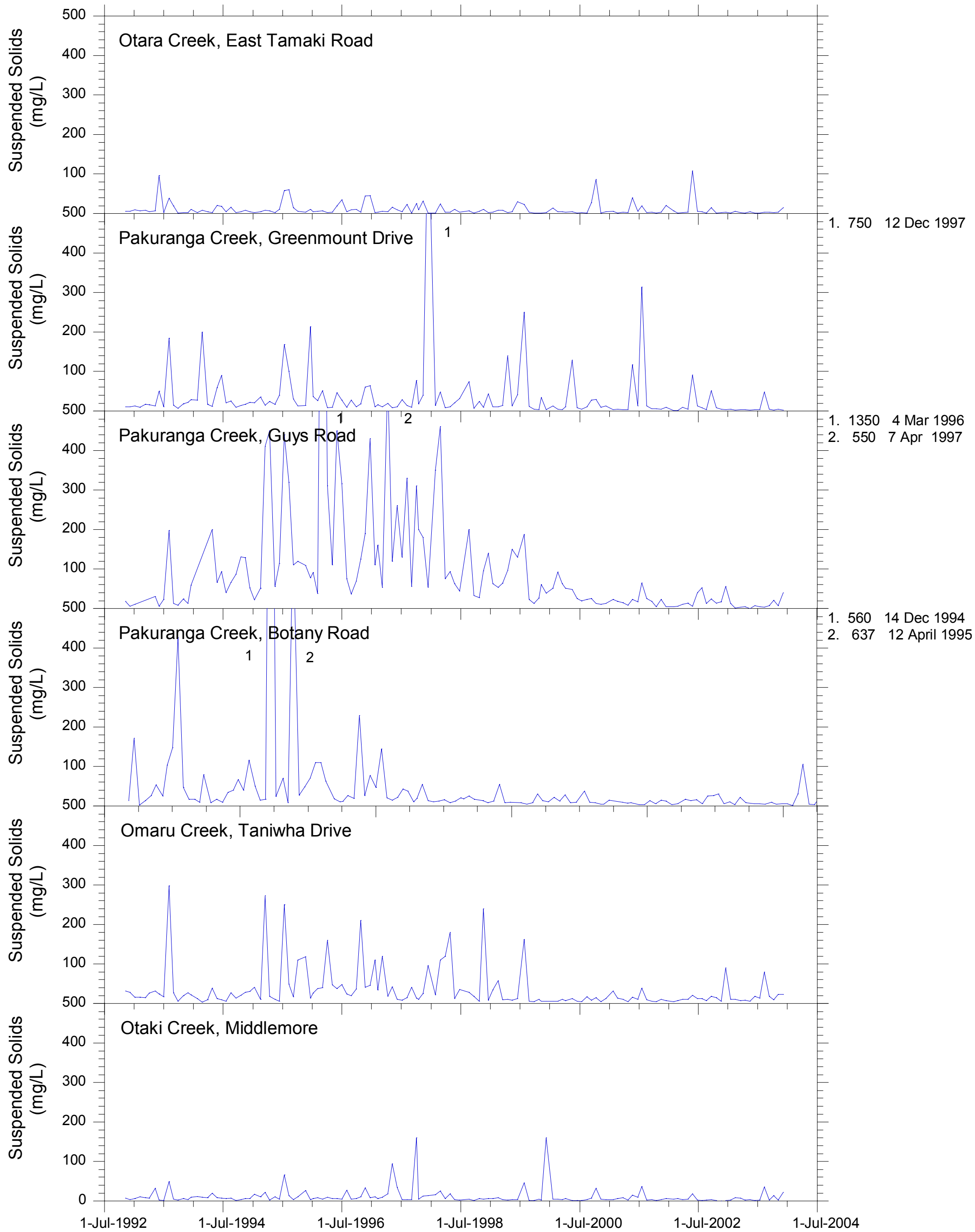

No 7 Buoy
Panmure Bridge
pH
pH
10
9
8
7
10
9
8
7
Surface
5 metre depth
bottom depth
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

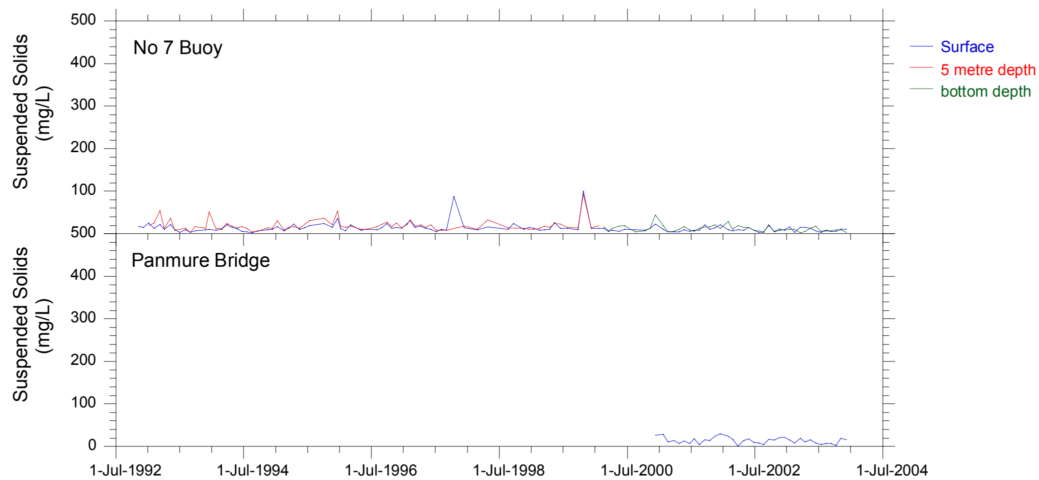
APPENDIX 22: TAMAKI ESTUARY – SUSPENDED SOLIDS

a) Suspended solids (mg/L) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	1.7	4.3	12.0	25.0	10.0	2.7	16.0	11.0	15.2
14-Feb-03	5.4	2.8	2.0	4.2	10.9	7.5	3.1	11.0	7.9
18-Mar-03	2.7	3.3	3.6	3.1	6.8	7.1	15.7	2.3	19.4
15-Apr-03	1.3	3.1	4.4	3.7	7.6	2.6	14.5	5.6	10.8
15-May-03	4.7	2.2	0.4	4.0	6.6	3.2	12.6	13.0	15.9
13-Jun-03	1.7	3.4	7.2	73.2	18.0	1.8	6.9	18.9	7.9
14-Jul-03	1.5	3.1	4.9	4.6	13.7	2.4	3.8	6.2	5.0
11-Aug-03	3.8	48.0	3.0	28.4	80.0	35.6	6.8	8.0	6.9
10-Sep-03	3.6	5.0	7.4	3.7	18.2	2.8	5.7	7.4	6.9
08-Oct-03	2.5	2.2	20.5	4.8	9.7	14.2	5.7	8.9	2.2
06-Nov-03	2.9	4.8	6.8	6.1	22.8	2.4	10.4	9.5	19.2
05-Dec-03	15.0	2.3	40.0	15.0	22.5	22.0	11.0	4.0	16.0
Median	2.8	3.2	5.9	4.7	12.3	3.0	8.7	8.5	9.4
IQR/Median %	83	55	87	289	82	221	85	59	97

b) The graphs on the following pages show suspended solids results for the period November 1992 to December 2003 (where data available).


Otara Creek, East Tamaki Road
Pakuranga Creek, Greenmount Drive
1. 750 12 Dec 1997
Pakuranga Creek, Guys Road
1. 1350 4 Mar 1996
2. 550 7 Apr 1997
Pakuranga Creek, Botany Road
1. 560 14 Dec 1994
2. 637 12 April 1995
Omaru Creek, Taniwha Drive
Otaki Creek, Middlemore
Suspended Solids (mg/L)
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

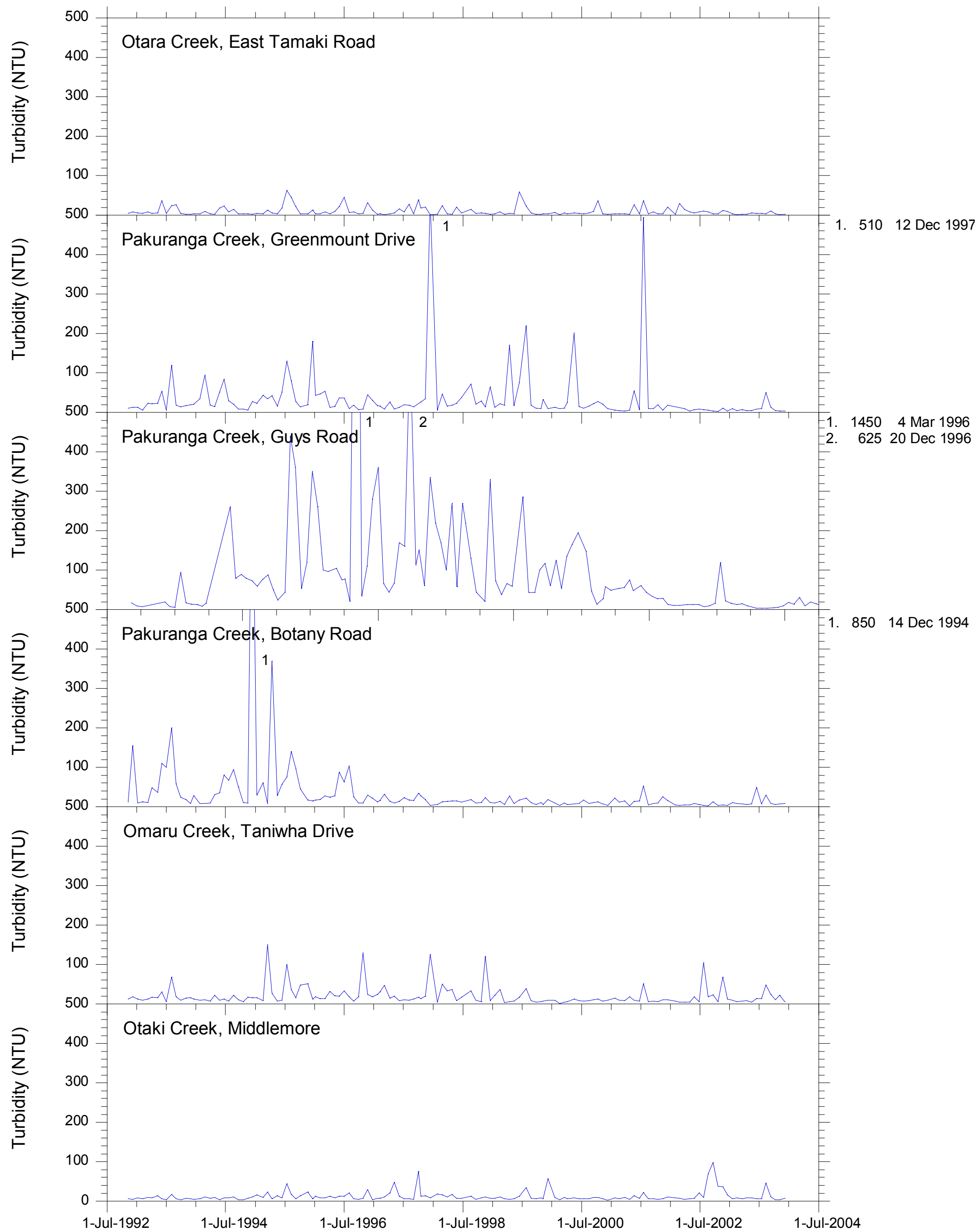

No 7 Buoy
Panmure Bridge
Suspended Solids (mg/L)
Suspended Solids (mg/L)
500
400
300
200
100
500
400
300
200
100
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004
Surface
5 metre depth
bottom depth

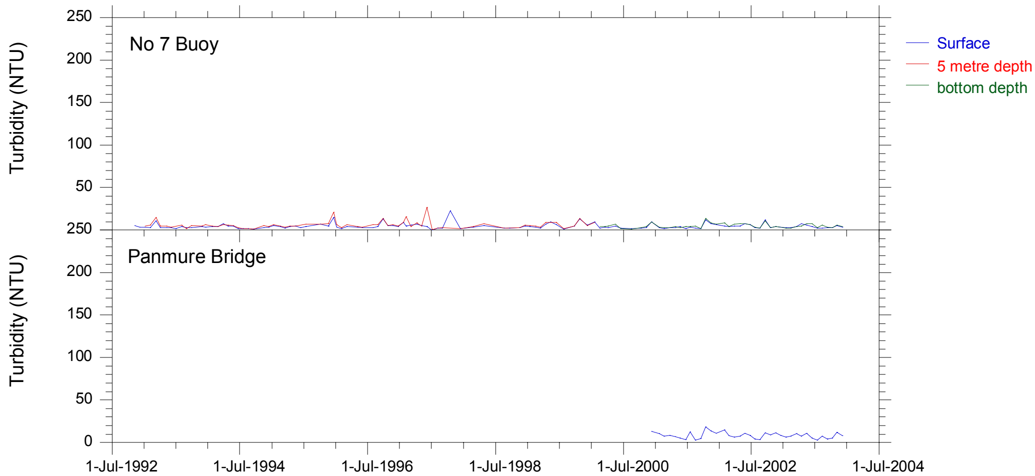
APPENDIX 23: TAMAKI ESTUARY – TURBIDITY

a) Turbidity (NTU) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	3.3	8.7	7.8	11.0	9.1	5.6	3.0	2.2	6.0
14-Feb-03	2.0	5.3	1.9	8.0	6.0	8.2	3.2	2.2	7.5
18-Mar-03	2.5	7.1	6.4	7.3	7.1	6.1	4.0	4.2	10.5
15-Apr-03	2.7	4.4	1.9	6.5	8.5	7.5	7.3	4.5	7.5
15-May-03	6.2	4.6	1.6	7.1	5.1	8.3	5.6	7.3	10.8
13-Jun-03	4.7	7.7	21.3	48.8	13.6	5.6	4.2	7.6	5.3
14-Jul-03	5.2	9.0	18.8	7.0	14.2	6.3	2.3	2.9	2.7
11-Aug-03	4.1	50.6	2.3	29.9	48.1	46.0	2.3	5.7	7.4
10-Sep-03	10.3	12.8	26.0	8.5	24.4	10.3	3.2	3.4	4.2
08-Oct-03	3.8	4.8	16.5	5.9	10.3	4.0	3.0	3.2	5.5
06-Nov-03	2.1	4.1	3.0	6.8	22.1	3.8	5.5	5.7	11.8
05-Dec-03	2.8	3.2	2.3	7.7	5.9	7.1	3.5	3.7	8.0
Median	3.5	6.2	4.7	7.5	9.7	6.7	3.3	3.9	7.5
IQR/Median %	62	68	316	30	97	39	45	66	42

b) The graphs on the following pages show turbidity results for the period November 1992 to December 2003 (where data available).


Otara Creek, East Tamaki Road
Pakuranga Creek, Greenmount Drive
Pakuranga Creek, Guys Road
Pakuranga Creek, Botany Road
Omaru Creek, Taniwha Drive
Otaki Creek, Middlemore
Turbidity (NTU)
1. 510 12 Dec 1997
1. 1450 4 Mar 1996
2. 625 20 Dec 1996
1. 850 14 Dec 1994
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

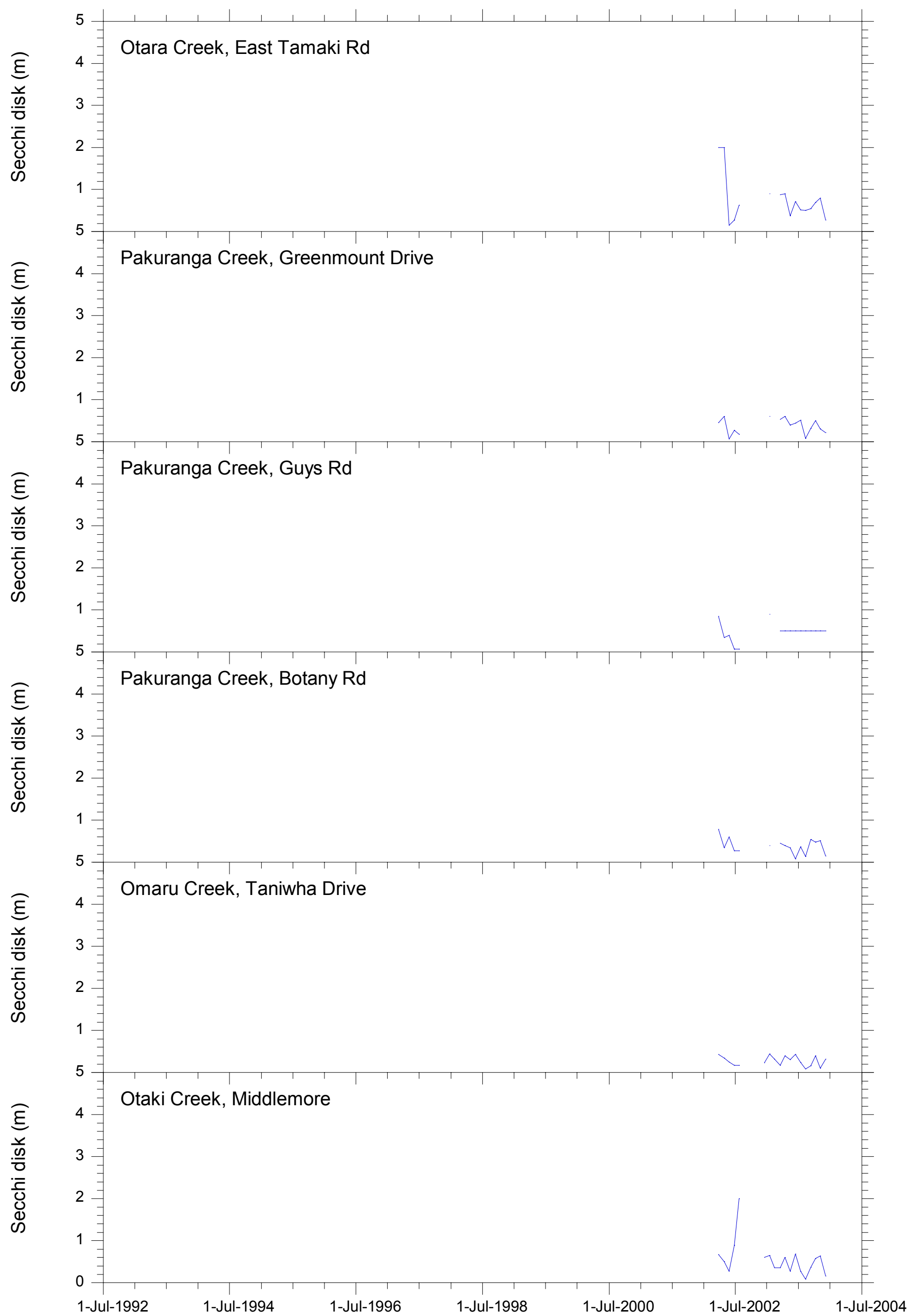

No 7 Buoy
Panmure Bridge
Turbidity (NTU)
Turbidity (NTU)
250
200
150
100
50
250
200
150
100
50
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004
Surface
5 metre depth
bottom depth

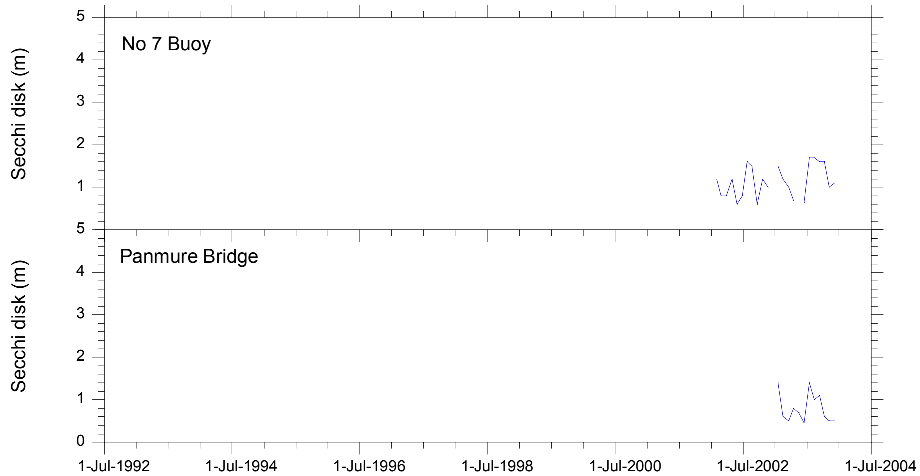
APPENDIX 24: TAMAKI ESTUARY – SECCHI DEPTH

a) Secchi disk depth (m) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	Panmure Bridge
15-Jan-03	0.9	0.6	0.9	0.4	0.5	0.7	1.5	1.4
14-Feb-03					0.3	0.4	1.2	0.6
18-Mar-03	0.9	0.5	0.5	0.5	0.2	0.4	1.0	0.5
15-Apr-03	0.9	0.6	0.5	0.4	0.4	0.6	0.7	0.8
15-May-03	0.4	0.4	0.5	0.3	0.3	0.3		0.7
13-Jun-03	0.7	0.4	0.5	0.1	0.4	0.7	0.6	0.5
14-Jul-03	0.5	0.5	0.5	0.4	0.2	0.3	1.7	1.4
11-Aug-03	0.5	0.1	0.5	0.1	0.1	0.1	1.7	1.0
10-Sep-03	0.6	0.3	0.5	0.6	0.2	0.4	1.6	1.1
08-Oct-03	0.7	0.5	0.5	0.5	0.4	0.6	1.6	0.6
06-Nov-03	0.8	0.3	0.5	0.5	0.1	0.6	1.0	0.5
05-Dec-03	0.3	0.2	0.5	0.2	0.3	0.2	1.1	0.5
Median	0.7	0.4	0.5	0.4	0.3	0.4	1.2	0.7
IQR/Median %	48	47	0	56	74	92	50	81

b) The graphs on the following pages show secchi disk depth results for the period November 1992 to December 2003 (where data available).


Otara Creek, East Tamaki Rd
Pakuranga Creek, Greenmount Drive
Pakuranga Creek, Guys Rd
Pakuranga Creek, Botany Rd
Omaru Creek, Taniwha Drive
Otaki Creek, Middlemore
Secchi disk (m)
0
1
2
3
4
5
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

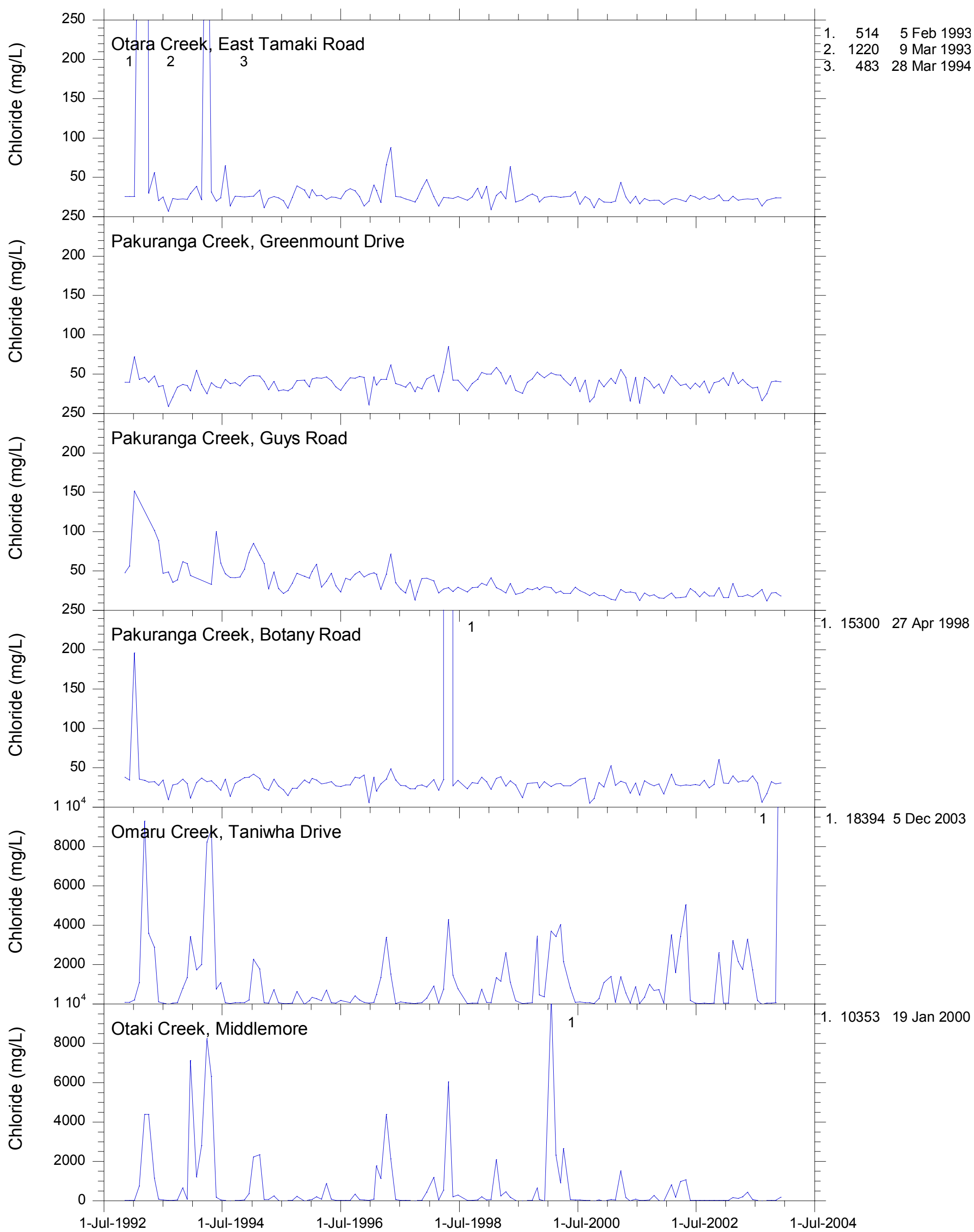

No 7 Buoy
Panmure Bridge
Secchi disk (m)
Secchi disk (m)
0
1
2
3
4
5
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

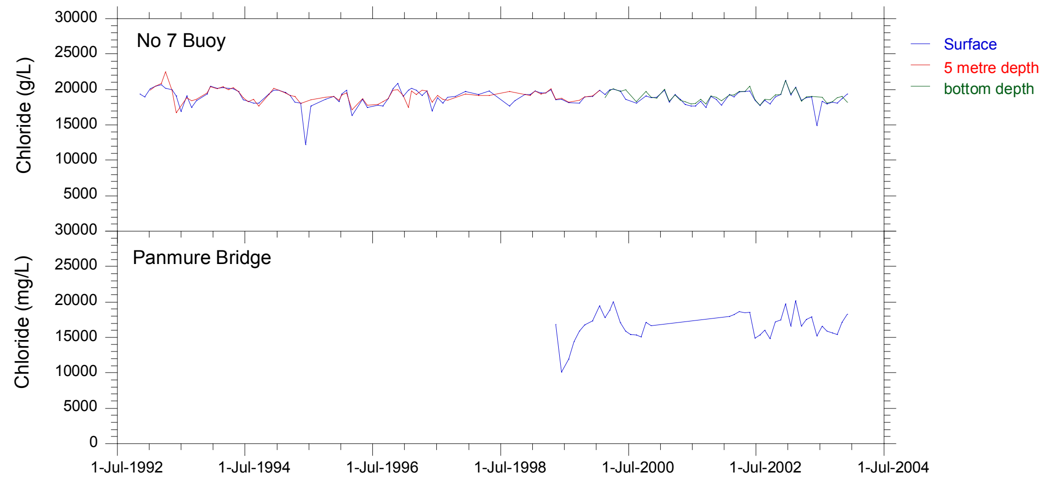
APPENDIX 25: TAMAKI ESTUARY – CHLORIDE

a) Chloride (mg/L) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	20.8	35.8	16.5	30.5	50.6	28.1	19217	19382	16573
14-Feb-03	26.4	52.2	34.2	40.0	3237	153	20315	20305	20173
18-Mar-03	21.2	38.3	17.9	31.7	2169	119	18470	18386	16591
15-Apr-03	22.0	43.4	17.6	33.6	1749	202	18841	18960	17531
15-May-03	22.8	37.0	19.7	32.9	3295	434	18982	19038	17868
13-Jun-03	22.4	32.3	17.2	39.7	1732	60.9	14891		15187
14-Jul-03	23.3	33.3	21.9	30.8	191	25.9	18345	18883	16584
11-Aug-03	13.5	16.6	26.6	6.2	10.5	12.3	17907	18062	15878
10-Sep-03	21.1	24.9	12.1	17.3	44.4	24.2	18188	18279	15632
08-Oct-03	23.1	40.2	22.4	32.3	42.6	25.8	18118	18822	15397
06-Nov-03	24.0	41.8	22.8	29.9	62.1	29.9	18708	19000	17092
05-Dec-03	24.1	40.7	18.2	30.7	18394	186	19377	18222	18308
Median	22.6	37.7	19.0	31.3	961	45.4	18589	18883.0	16587
IQR/Median %	10	21	26	9	248	298	5	4	11

b) The graphs on the following pages show chloride results for the period November 1992 to December 2003 (where data available).


Otara Creek, East Tamaki Road
1. 514 5 Feb 1993
2. 1220 9 Mar 1993
3. 483 28 Mar 1994
Pakuranga Creek, Greenmount Drive
Pakuranga Creek, Guys Road
Pakuranga Creek, Botany Road
1. 15300 27 Apr 1998
Omaru Creek, Taniwha Drive
1. 18394 5 Dec 2003
Otaki Creek, Middlemore
1. 10353 19 Jan 2000
Chloride (mg/L)
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004



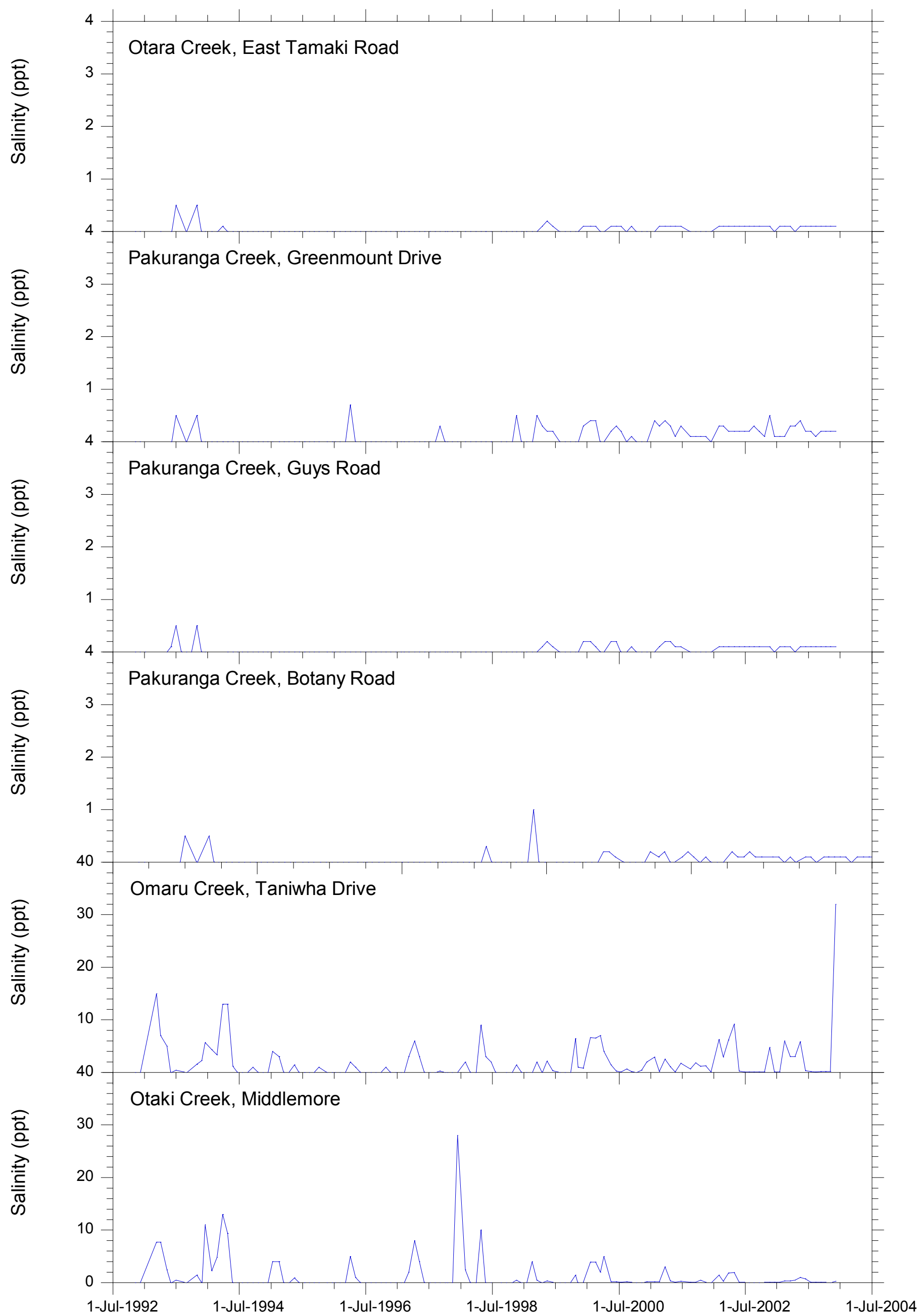
No 7 Buoy
Chloride (g/L)
30000
25000
20000
15000
10000
5000
Surface
5 metre depth
bottom depth
Panmure Bridge
Chloride (mg/L)
30000
25000
20000
15000
10000
5000
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

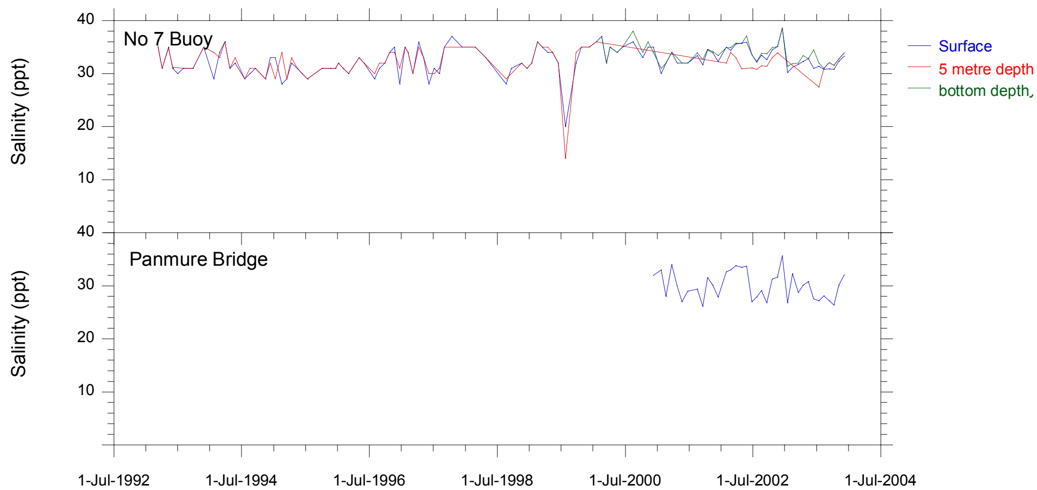
APPENDIX 26: TAMAKI ESTUARY – SALINITY

a) Salinity (ppt) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	0.1	0.1	0.1	0.1	0.1	0.1	30.2	31.4	26.8
14-Feb-03	0.1	0.1	0.1	0.1	6.0	0.4	31.2	31.9	32.3
18-Mar-03	0.1	0.3	0.1	0.1	3.0	0.4	31.8	32.0	28.7
15-Apr-03	0.0	0.3	0.0	0.1	3.0	0.5	32.3	33.4	30.1
15-May-03	0.1	0.4	0.1	0.1	5.8	1.0	32.8	32.8	30.8
13-Jun-03	0.1	0.2	0.1	0.2	0.4	0.7	31.0	34.5	27.6
14-Jul-03	0.1	0.2	0.1	0.1	0.2	0.1	31.4	32.0	27.2
11-Aug-03	0.1	0.1	0.1	0.0	0.1	0.1	30.8	31.0	28.1
10-Sep-03	0.1	0.2	0.1	0.1	0.2	0.1	30.9	32.1	27.2
08-Oct-03	0.1	0.2	0.1	0.1	0.2	0.1	30.8	31.6	26.4
06-Nov-03	0.1	0.2	0.1	0.1	0.2	0.0	32.3	32.7	30.1
05-Dec-03	0.1	0.2	0.1	0.1	32.0	0.3	33.3	33.9	32.1
Median	0.1	0.2	0.1	0.1	0.3	0.2	31.3	32.1	28.4
IQR/Median %	0	25	0	0	1111	163	5	3	11

b) The graphs on the following pages show salinity results for the period November 1992 to December 2003 (where data available).


Otara Creek, East Tamaki Road
Pakuranga Creek, Greenmount Drive
Pakuranga Creek, Guys Road
Pakuranga Creek, Botany Road
Omaru Creek, Taniwha Drive
Otaki Creek, Middlemore
Salinity (ppt)
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

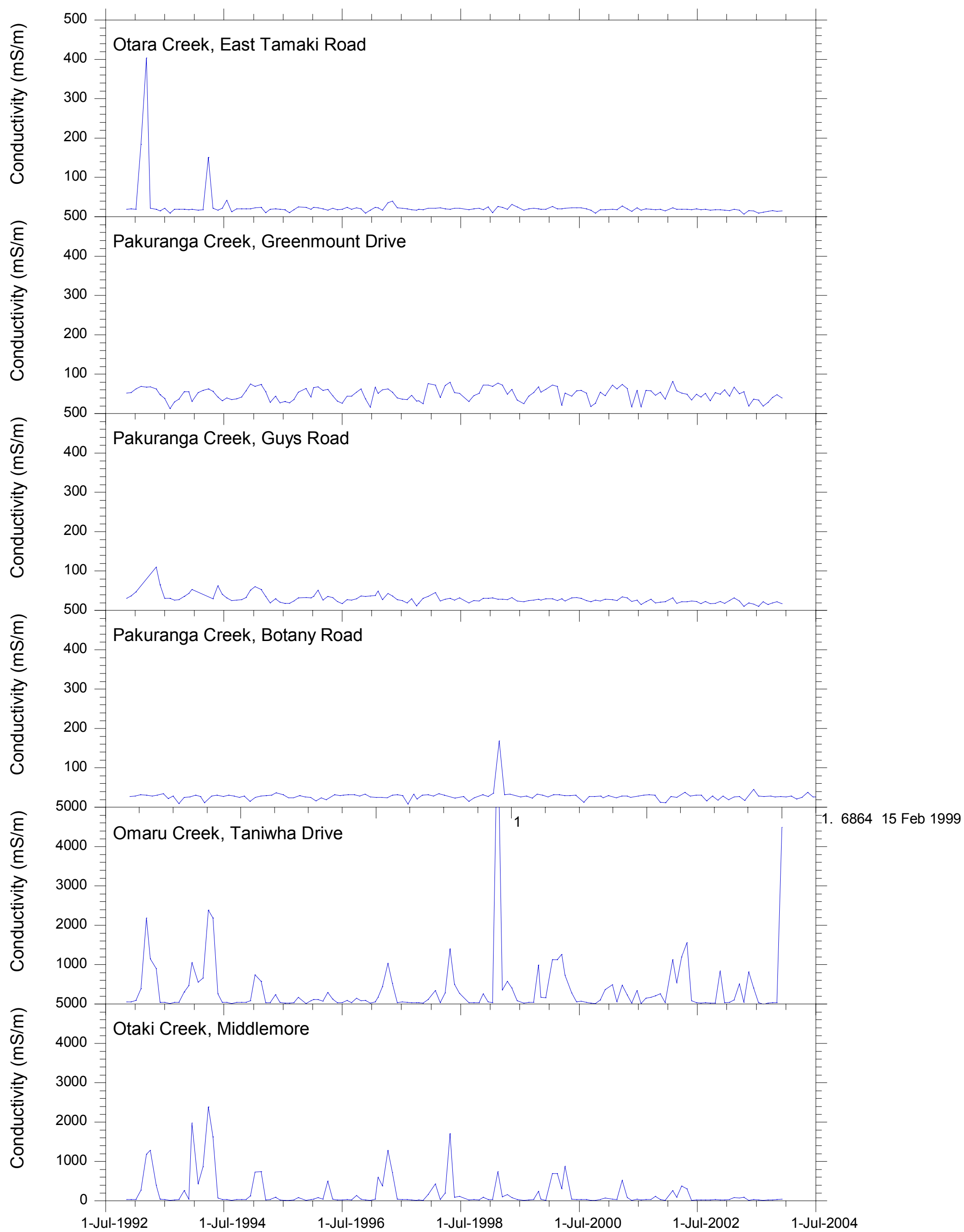

No 7 Buoy
Panmure Bridge
Salinity (ppt)
Salinity (ppt)
40
30
20
10
40
30
20
10
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004
Surface
5 metre depth
bottom depth

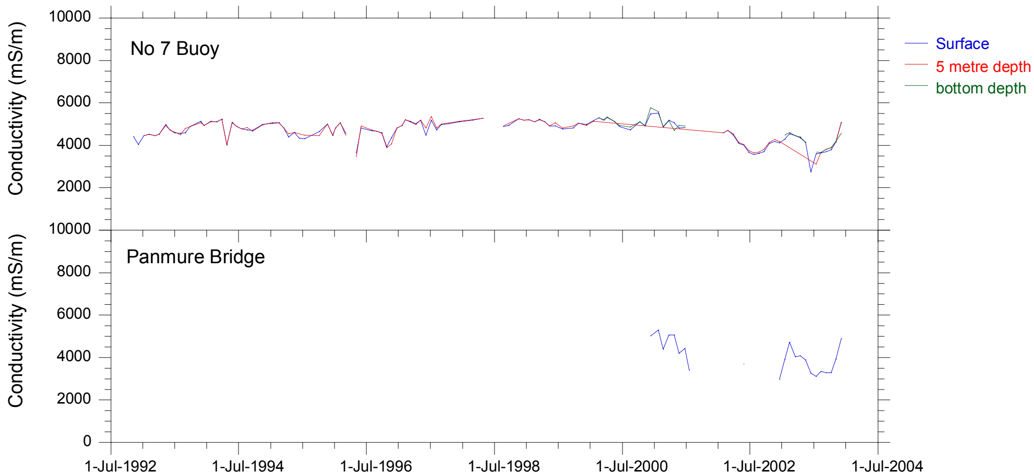
APPENDIX 27: TAMAKI ESTUARY – CONDUCTIVITY

a) Conductivity (mS/m) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	16.1	44.2	25.4	27.1	45.8	30.0	4294	4476	3922
14-Feb-03	19.7	67.0	31.5	30.9	101	76.7	4546	4618	4737
18-Mar-03	16.7	50.8	24.0	21.7	509	72.6	4451	4467	4054
15-Apr-03	7.2	55.7	10.5	28.1	48.6	94.6	4378	4402	4103
15-May-03	16.0	19.5	20.0	30.0	822	15.5	4148	4148	3887
13-Jun-03	15.5	36.1	16.4	27.9	405	33.4	2760		3271
14-Jul-03	9.6	34.6	10.9	23.0	36.0	23.0	3593	3685	3126
11-Aug-03	11.4	20.1	21.6	6.8	7.8	12.9	3636	3654	3338
10-Sep-03	14.4	29.1	14.5	23.5	28.5	21.6	3701	3818	3298
08-Oct-03	15.8	40.8	19.1	24.9	31.5	21.0	3788	3879	3300
06-Nov-03	13.8	48.0	21.1	23.8	29.8	41.0	4155	4194	3938
05-Dec-03	15.1	39.9	17.3	27.8	4492	48.8	5070	4570	4900
Median	15.3	40.3	19.5	26.0	47.2	31.7	4152	4194	3905
IQR/Median %	19	38	32	18	847	105	17	15	20

b) The graphs on the following pages show conductivity results for the period November 1992 to December 2003 (where data available).


Otara Creek, East Tamaki Road
Pakuranga Creek, Greenmount Drive
Pakuranga Creek, Guys Road
Pakuranga Creek, Botany Road
Omaru Creek, Taniwha Drive
Otaki Creek, Middlemore
Conductivity (mS/m)
1. 6864 15 Feb 1999
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004



No 7 Buoy
Panmure Bridge
Conductivity (mS/m)
Conductivity (mS/m)
10000
8000
6000
4000
2000
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004
Surface
5 metre depth
bottom depth

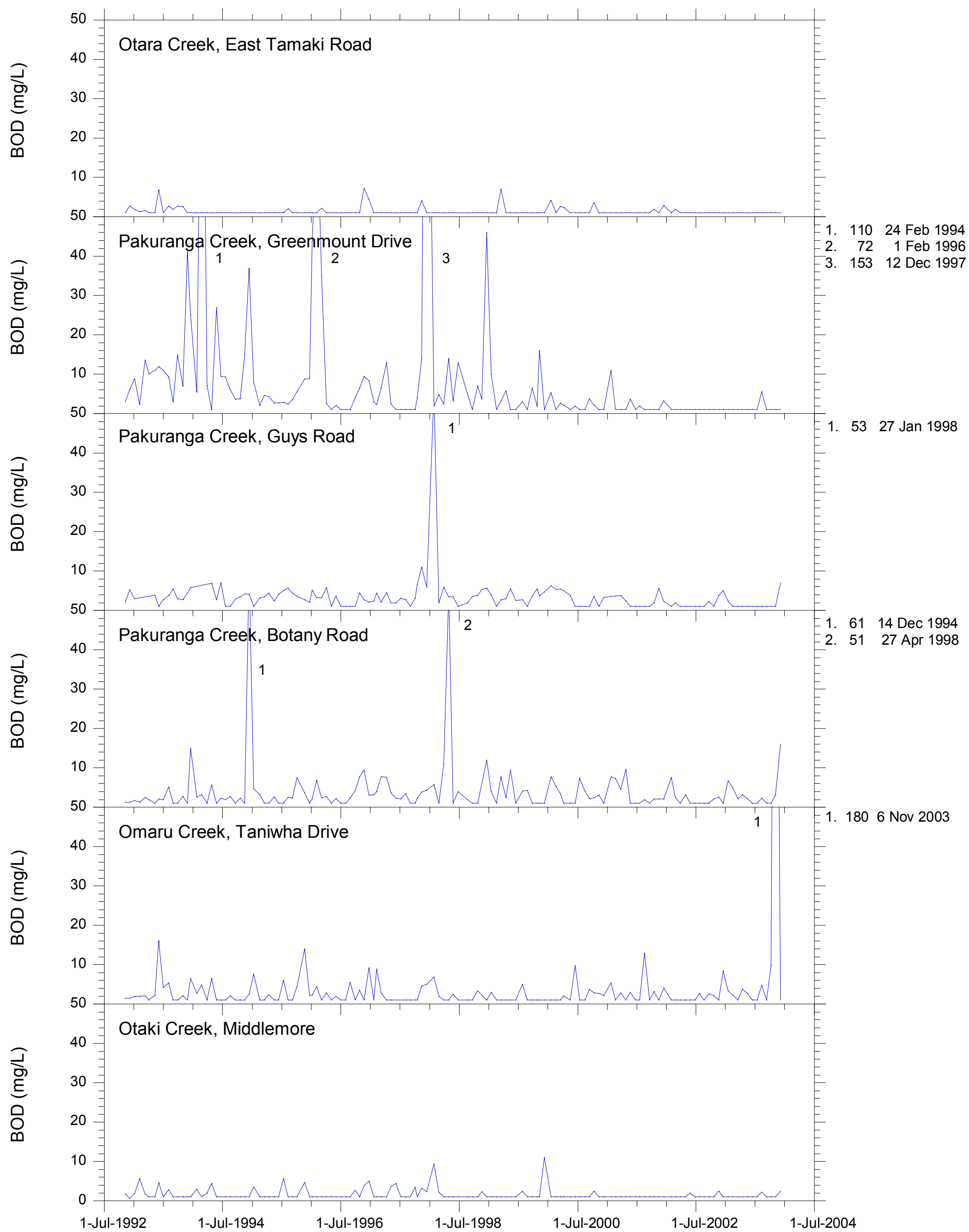
APPENDIX 28: TAMAKI ESTUARY – BIOCHEMICAL OXYGEN DEMAND

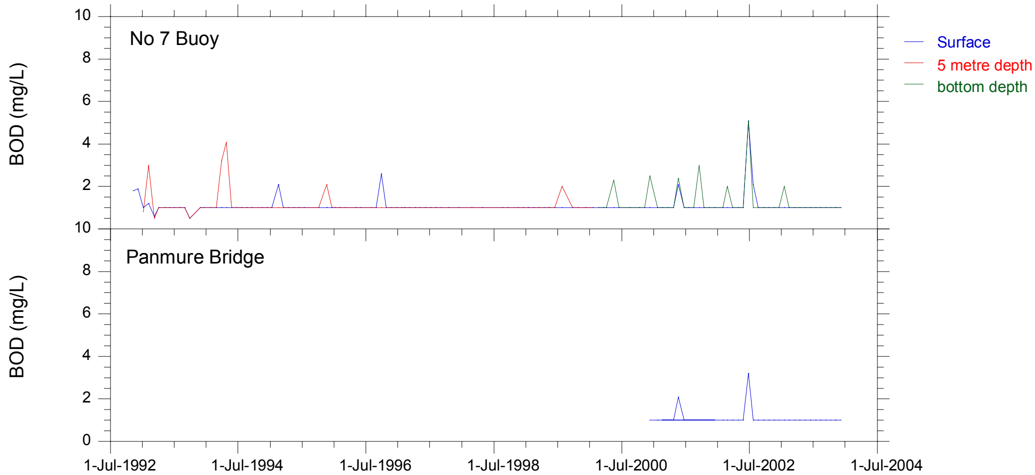
a) Biochemical oxygen demand (mg/L) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	<2	<2	2.4	6.7	3.3	<2	<2	2	<2
14-Feb-03	<2	<2	<2	5	2.3	<2	<2	<2	<2
18-Mar-03	<2	<2	<2	2.1	<2	<2	<2	<2	<2
15-Apr-03	<2	<2	<2	3.2	3.8	<2	<2	<2	<2
15-May-03	<2	<2	<2	2.2	2.7	<2	<2	<2	<2
13-Jun-03	<2	<2	<2	<2	<2	<2	<2	<2	<2
14-Jul-03	<2	<2	<2	<2	<2	<2	<2	<2	<2
11-Aug-03	<2	5.6	<2	2.3	4.8	2.2	<2	<2	<2
10-Sep-03	<2	<2	<2	<2	<2	<2	<2	<2	<2
08-Oct-03	<2	<2	<2	<2	9.8	<2	<2	<2	<2
06-Nov-03	<2	<2	<2	3.1	180	<2	<2	<2	<2
05-Dec-03	<2	<2	7	16	<2	2.5	<2	<2	<2
Median	1	1	1	2.3	2.5	1	1	1	1
IQR/Median %	0	0	0	118	122	0	0	0	0

b) The graphs on the following pages show BOD results for the period November 1992 to December 2003 (where data available).

Method detection limit is 2.0 mg/L. For summary statistics, a result of “<2.0” is taken to have the value 1.0


Otara Creek, East Tamaki Road
Pakuranga Creek, Greenmount Drive
1. 110 24 Feb 1994
2. 72 1 Feb 1996
3. 153 12 Dec 1997
Pakuranga Creek, Guys Road
1. 53 27 Jan 1998
Pakuranga Creek, Botany Road
1. 61 14 Dec 1994
2. 51 27 Apr 1998
Omaru Creek, Taniwha Drive
1. 180 6 Nov 2003
Otaki Creek, Middlemore
BOD (mg/L)
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004



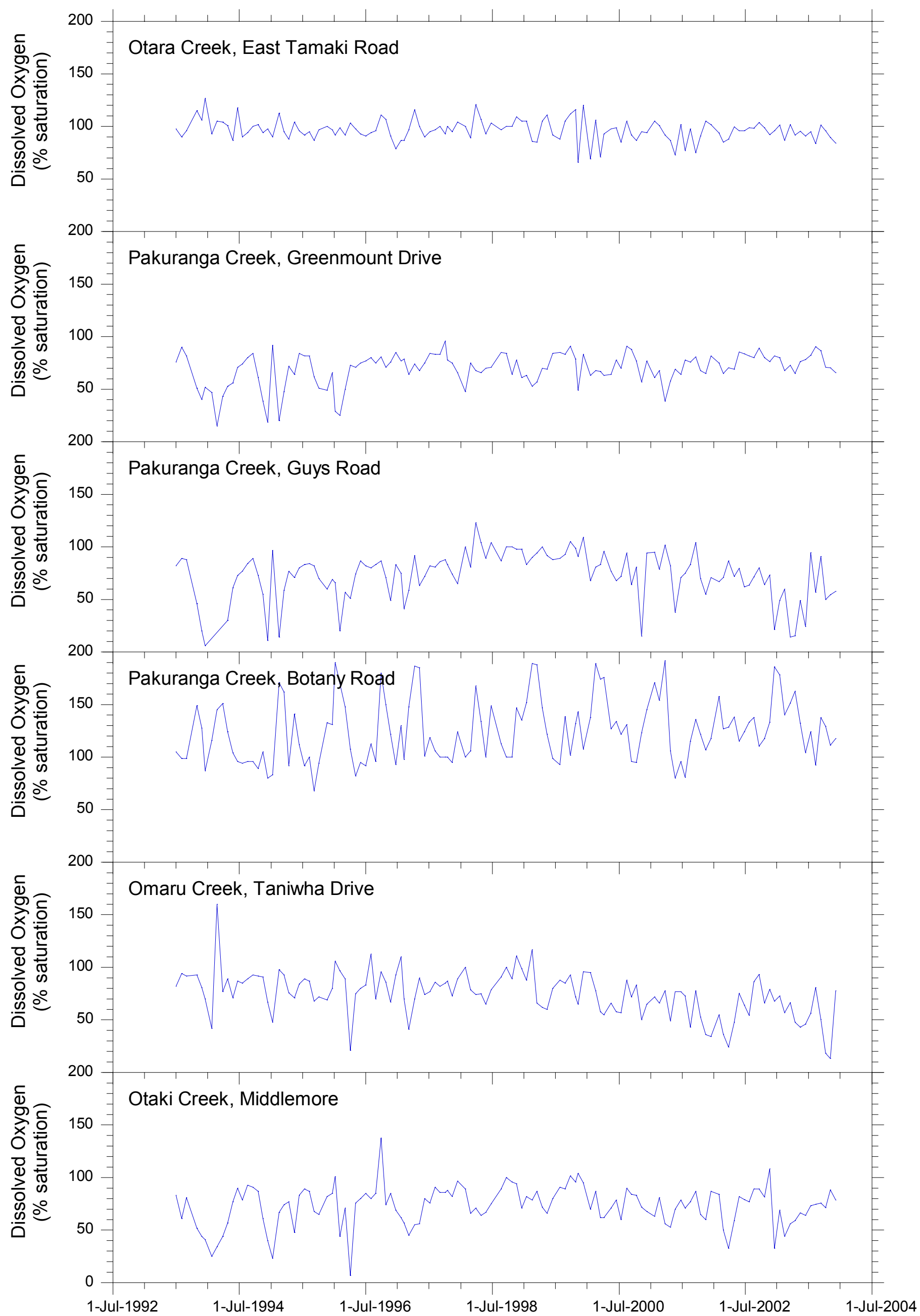
No 7 Buoy
Panmure Bridge
BOD (mg/L)
BOD (mg/L)
Surface
5 metre depth
bottom depth
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

APPENDIX 29: TAMAKI ESTUARY – DISSOLVED OXYGEN - % SATURATION

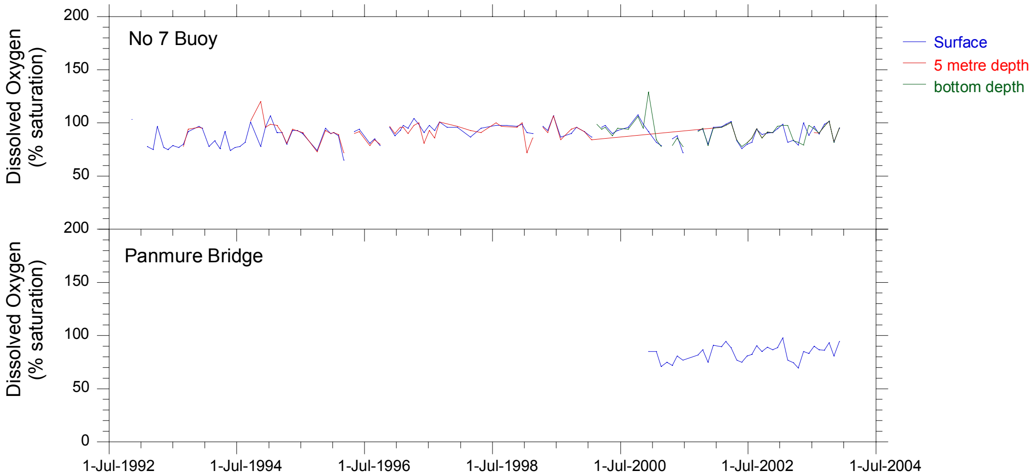
a) Dissolved oxygen (% saturation) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	101.4	79.9	49.1	178.3	72.6	69.2	98.8	97.6	97.8
14-Feb-03	87.0	68.0	60.0	140.0	57.0	44.0	82.0	97.6	77.0
18-Mar-03	101.8	72.6	14.0	151.5	66.4	55.8	83.8	83.0	74.4
15-Apr-03	91.9	64.9	15.7	162.7	48.0	59.1	79.1	82.1	69.6
15-May-03	95.7	76.2	49.2	132.1	43.4	66.6	100.1	79.3	85.0
13-Jun-03	90.9	78.5	24.0	104.1	45.9	64.2	88.1	98.0	83.3
14-Jul-03	95.3	82.3	94.5	124.1	56.5	73.2	96.9	94.8	90.0
11-Aug-03	83.9	90.7	57.1	92.4	81.1	74.5	89.5	90.3	87.0
10-Sep-03	101.5	86.7	91.2	137.9	50.3	76.0	98.8	96.8	86.5
08-Oct-03	95.8	70.8	50.0	129.1	18.2	71.5	101.6	102.0	93.3
06-Nov-03	89.5	70.6	54.4	111.7	13.4	88.3	82.5	82.1	80.9
05-Dec-03	84.1	66.2	58.0	118.0	77.9	78.9	95.3	95.4	94.5
Median	93.6	74.4	52.2	130.6	53.4	70.4	92.4	95.1	85.8
IQR/Median %	9	14	30	20	42	17	17	16	13

b) The graphs on the following pages show dissolved oxygen (% saturation) results for the period November 1992 to December 2003 (where data available).



Otara Creek, East Tamaki Road
Pakuranga Creek, Greenmount Drive
Pakuranga Creek, Guys Road
Pakuranga Creek, Botany Road
Omaru Creek, Taniwha Drive
Otaki Creek, Middlemore
Dissolved Oxygen (% saturation)
0
50
100
150
200
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

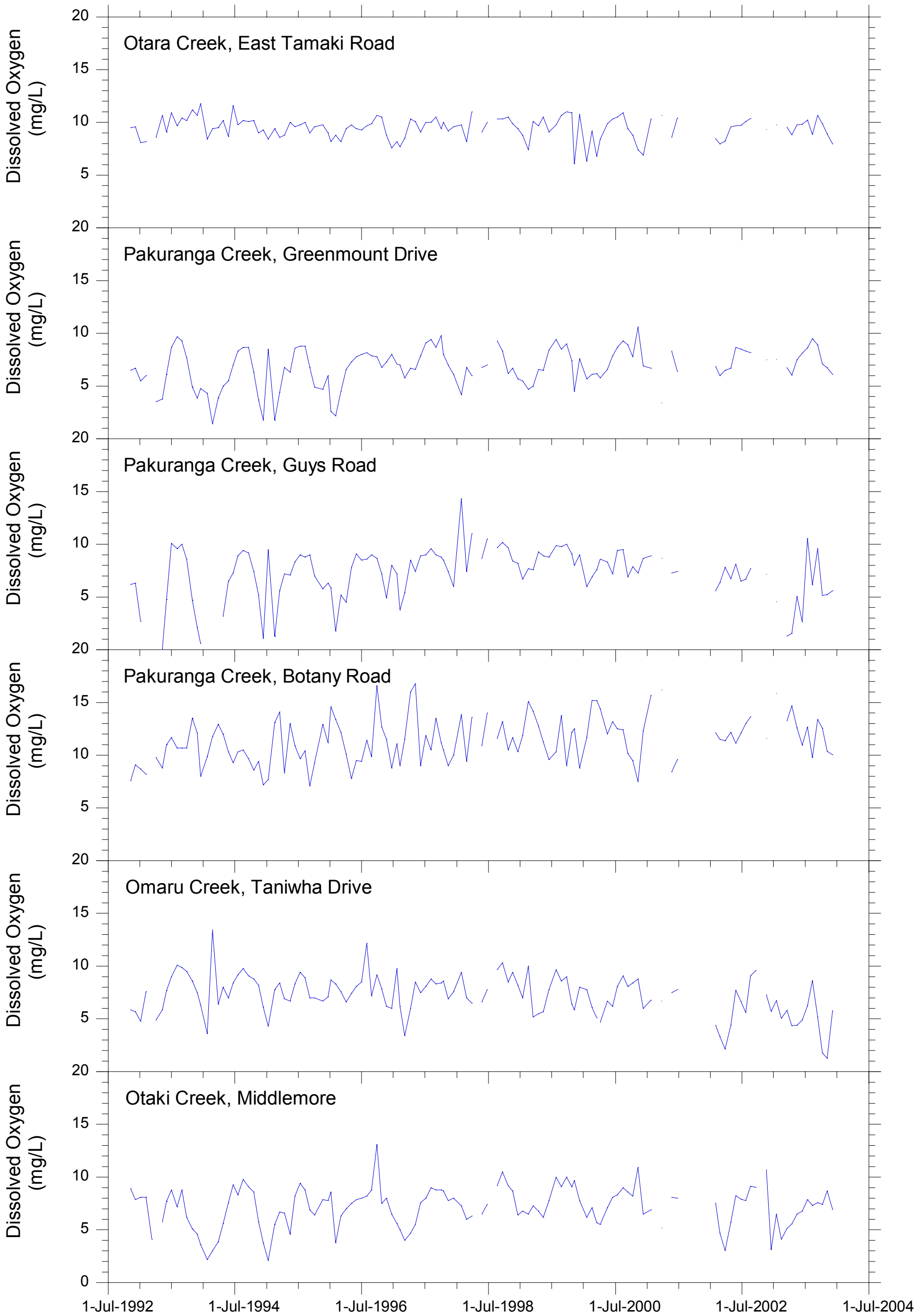

No 7 Buoy
Panmure Bridge
Dissolved Oxygen (% saturation)
Surface
5 metre depth
bottom depth
200
150
100
50
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

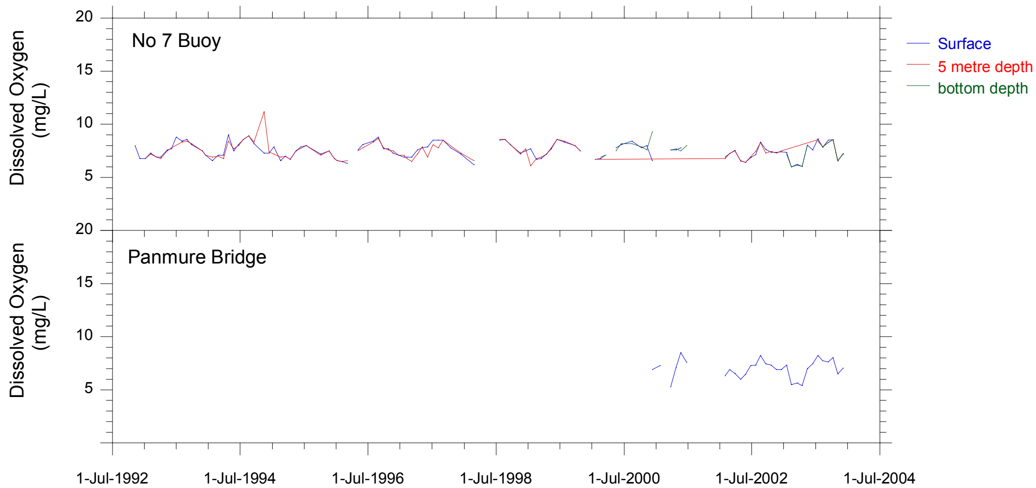
APPENDIX 30: TAMAKI ESTUARY – DISSOLVED OXYGEN – (mg/L)

a) Dissolved oxygen (mg/L) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	9.77	7.54	4.53	15.87	6.75	6.49	7.37	7.19	7.33
14-Feb-03					5.06	4.10	5.99	6.02	5.50
18-Mar-03	9.54	6.75	1.32	13.27	5.81	5.13	6.25	6.12	5.66
15-Apr-03	8.81	6.06	1.54	14.69	4.35	5.55	6.04	6.05	5.40
15-May-03	9.80	7.50	5.06	12.62	4.43	6.52	8.08	8.08	7.00
13-Jun-03	9.81	8.16	2.64	10.95	4.91	6.79	7.60		7.46
14-Jul-03	10.26	8.65	10.55	12.69	6.24	7.86	8.64	8.40	8.26
11-Aug-03	8.86	9.53	6.15	9.78	8.66	7.35	7.82	7.88	7.74
10-Sep-03	10.69	8.90	9.58	13.41	5.19	7.60	8.51	8.29	7.63
08-Oct-03	9.90	7.08	5.16	12.54	1.79	7.41	8.55	8.54	8.07
06-Nov-03	8.93	6.73	5.22	10.36	1.29	8.67	6.59	6.56	6.50
05-Dec-03	7.96	6.10	5.59	10.07	5.79	6.95	7.20	7.22	7.05
Median	9.77	7.50	5.16	12.62	5.13	6.87	7.49	7.22	7.19
IQR/Median %	10	22	44	21	29	18	22	26	19

b) The graphs on the following pages show dissolved oxygen results for the period November 1992 to December 2003 (where data available).


Otara Creek, East Tamaki Road
Pakuranga Creek, Greenmount Drive
Pakuranga Creek, Guys Road
Pakuranga Creek, Botany Road
Omaru Creek, Taniwha Drive
Otaki Creek, Middlemore
Dissolved Oxygen (mg/L)
0
5
10
15
20
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004



No 7 Buoy
Panmure Bridge
Dissolved Oxygen (mg/L)
20
15
10
5
Surface
5 metre depth
bottom depth
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

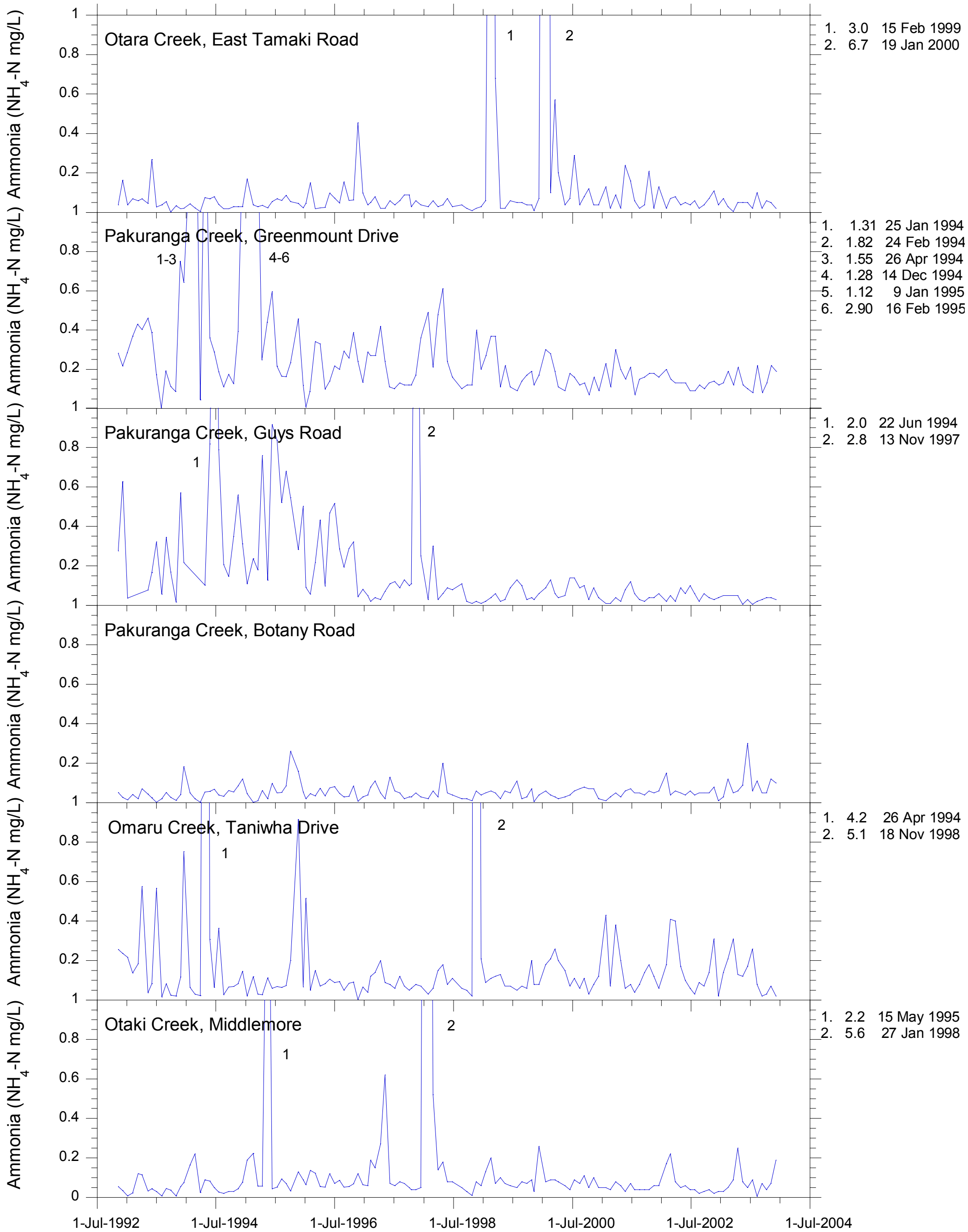
APPENDIX 31: TAMAKI ESTUARY – AMMONIA NITROGEN

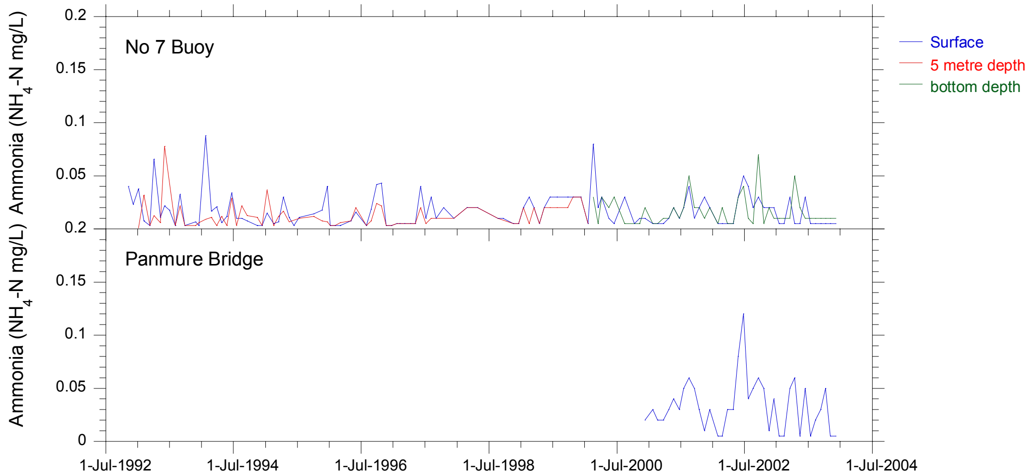
a) Ammonia nitrogen (mg/L) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	0.07	0.13	0.05	0.03	0.14	0.03	<0.01	<0.01	<0.01
14-Feb-03	0.03	0.19	0.05	0.12	0.21	0.05	<0.01	<0.01	<0.01
18-Mar-03	<0.01	0.12	0.05	0.05	0.31	0.09	0.03	<0.01	0.05
15-Apr-03	0.05	0.21	0.05	0.06	0.13	0.25	<0.01	0.05	0.06
15-May-03	0.05	0.12	<0.01	0.09	0.12	0.08	<0.01	0.02	<0.01
13-Jun-03	0.05	0.1	0.03	0.3	0.17	0.05	0.03	<0.01	0.05
14-Jul-03	0.02	0.08	<0.01	0.06	0.26	0.09	<0.01	<0.01	<0.01
11-Aug-03	0.1	0.22	0.02	0.11	0.08	<0.01	<0.01	<0.01	0.02
10-Sep-03	0.02	0.08	0.03	0.05	0.02	0.07	<0.01	<0.01	0.03
08-Oct-03	0.06	0.13	0.04	0.05	0.03	0.04	<0.01	<0.01	0.05
06-Nov-03	0.05	0.22	0.04	0.12	0.07	0.07	<0.01	<0.01	<0.01
05-Dec-03	0.02	0.19	0.03	0.1	0.02	0.19	<0.01	<0.01	<0.01
Median	0.05	0.13	0.04	0.08	0.13	0.07	0.01	0.01	0.01
IQR/Median %	65	62	64	83	96	61	0	0	360

b) The graphs on the following pages show ammonia nitrogen results for the period November 1992 to December 2003 (where data available).

Method detection limit is 0.01 mg/L. For summary statistics, a result of “<0.01” is taken to have the value 0.005


Otara Creek, East Tamaki Road
1. 3.0 15 Feb 1999
2. 6.7 19 Jan 2000
Pakuranga Creek, Greenmount Drive
1. 1.31 25 Jan 1994
2. 1.82 24 Feb 1994
3. 1.55 26 Apr 1994
4. 1.28 14 Dec 1994
5. 1.12 9 Jan 1995
6. 2.90 16 Feb 1995
Pakuranga Creek, Guys Road
1. 2.0 22 Jun 1994
2. 2.8 13 Nov 1997
Pakuranga Creek, Botany Road
Omaru Creek, Taniwha Drive
1. 4.2 26 Apr 1994
2. 5.1 18 Nov 1998
Otaki Creek, Middlemore
1. 2.2 15 May 1995
2. 5.6 27 Jan 1998
Ammonia (NH_4-N mg/L)
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004


No 7 Buoy
Panmure Bridge
Ammonia (NH4-N mg/L)
Ammonia (NH4-N mg/L)
0.2
0.15
0.1
0.05
0.2
0.15
0.1
0.05
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004
Surface
5 metre depth
bottom depth

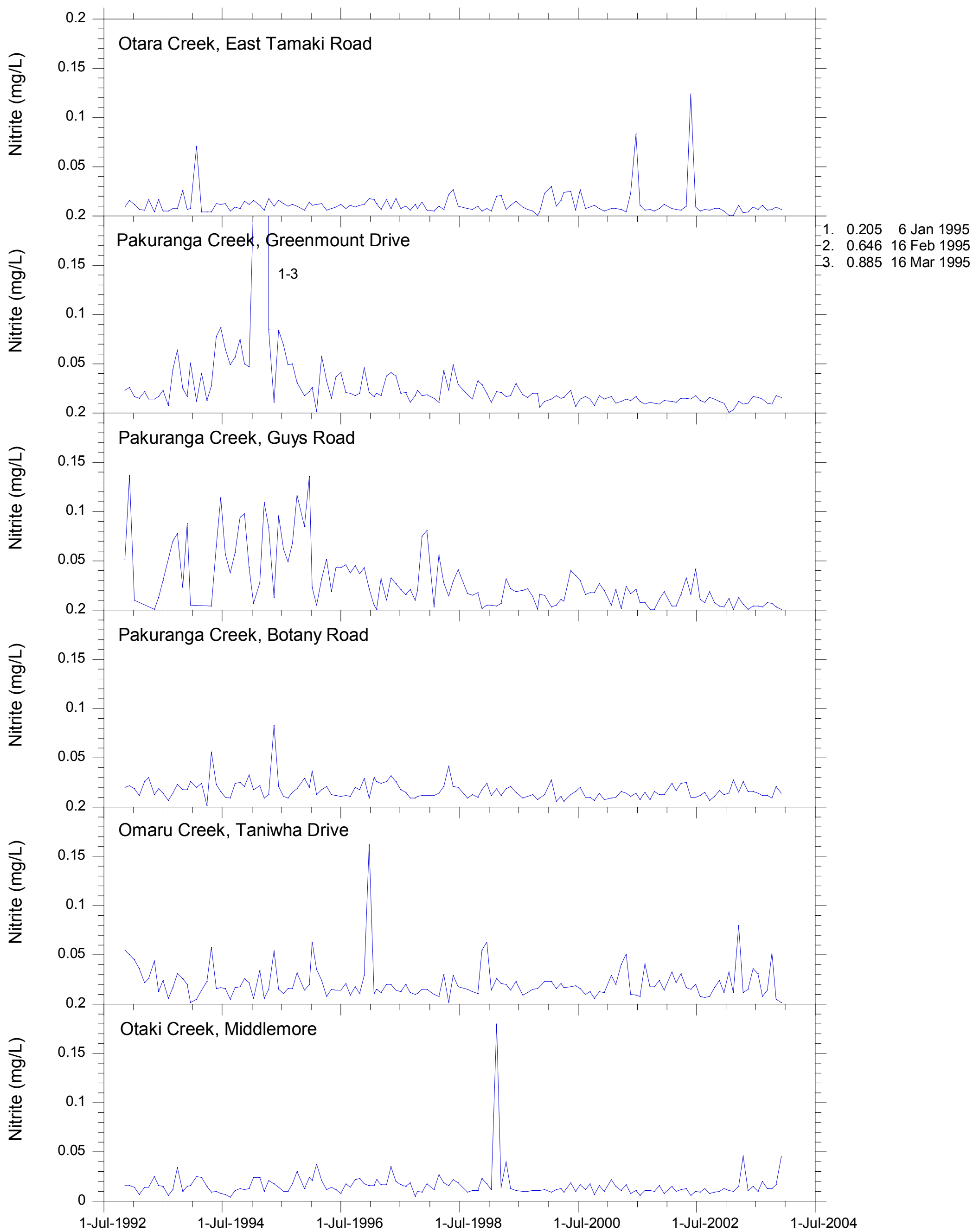
APPENDIX 32: TAMAKI ESTUARY – NITRITE NITROGEN

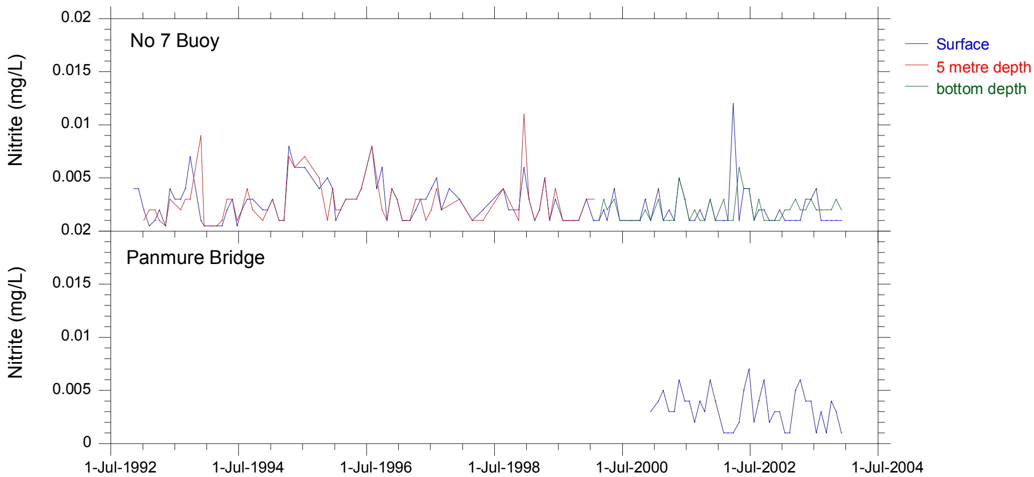
a) Nitrite nitrogen (mg/L) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	0.001	<0.002	<0.002	0.012	0.014	0.033	0.011	<0.002	<0.002
14-Feb-03	0.001	<0.002	0.003	<0.002	0.028	0.012	0.01	<0.002	<0.002
18-Mar-03	0.011	0.011	0.012	0.013	0.015	0.08	0.015	<0.002	0.003
15-Apr-03	0.003	0.003	0.009	0.006	0.026	0.012	0.046	<0.002	<0.002
15-May-03	0.004	0.004	0.01	<0.002	0.016	0.015	0.011	0.003	<0.002
13-Jun-03	0.009	0.009	0.017	0.004	0.016	0.036	0.015	0.003	0.003
14-Jul-03	0.007	0.007	0.016	0.004	0.014	0.031	0.01	0.004	<0.002
11-Aug-03	0.011	0.011	0.014	0.003	0.012	0.008	0.02	<0.002	<0.002
10-Sep-03	0.006	0.006	0.01	0.008	0.012	0.014	0.013	<0.002	<0.002
08-Oct-03	0.007	0.007	0.009	0.007	0.009	0.052	0.013	<0.002	<0.002
06-Nov-03	0.009	0.009	0.018	0.003	0.021	0.005	0.017	<0.002	0.003
05-Dec-03	0.007	0.007	0.016	<0.002	0.014	<0.002	0.045	<0.002	<0.002
Median	0.007	0.011	0.004	0.015	0.015	0.014	0.001	0.001	0.003
IQR/Median %	75	64	119	26	157	48	50	50	100

b) The graphs on the following pages show nitrite nitrogen results for the period November 1992 to December 2003 (where data available).

Method detection limit is 0.002 mg/L. For summary statistics, a result of "<0.002" is taken to have the value 0.001


Otara Creek, East Tamaki Road
Pakuranga Creek, Greenmount Drive
1-3
1. 0.205 6 Jan 1995
2. 0.646 16 Feb 1995
3. 0.885 16 Mar 1995
Pakuranga Creek, Guys Road
Pakuranga Creek, Botany Road
Omaru Creek, Taniwha Drive
Otaki Creek, Middlemore
Nitrite (mg/L)
0.2
0.15
0.1
0.05
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004


No 7 Buoy
Panmure Bridge
Nitrite (mg/L)
Nitrite (mg/L)
0.02
0.015
0.01
0.005
0.02
0.015
0.01
0.005
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004
Surface
5 metre depth
bottom depth

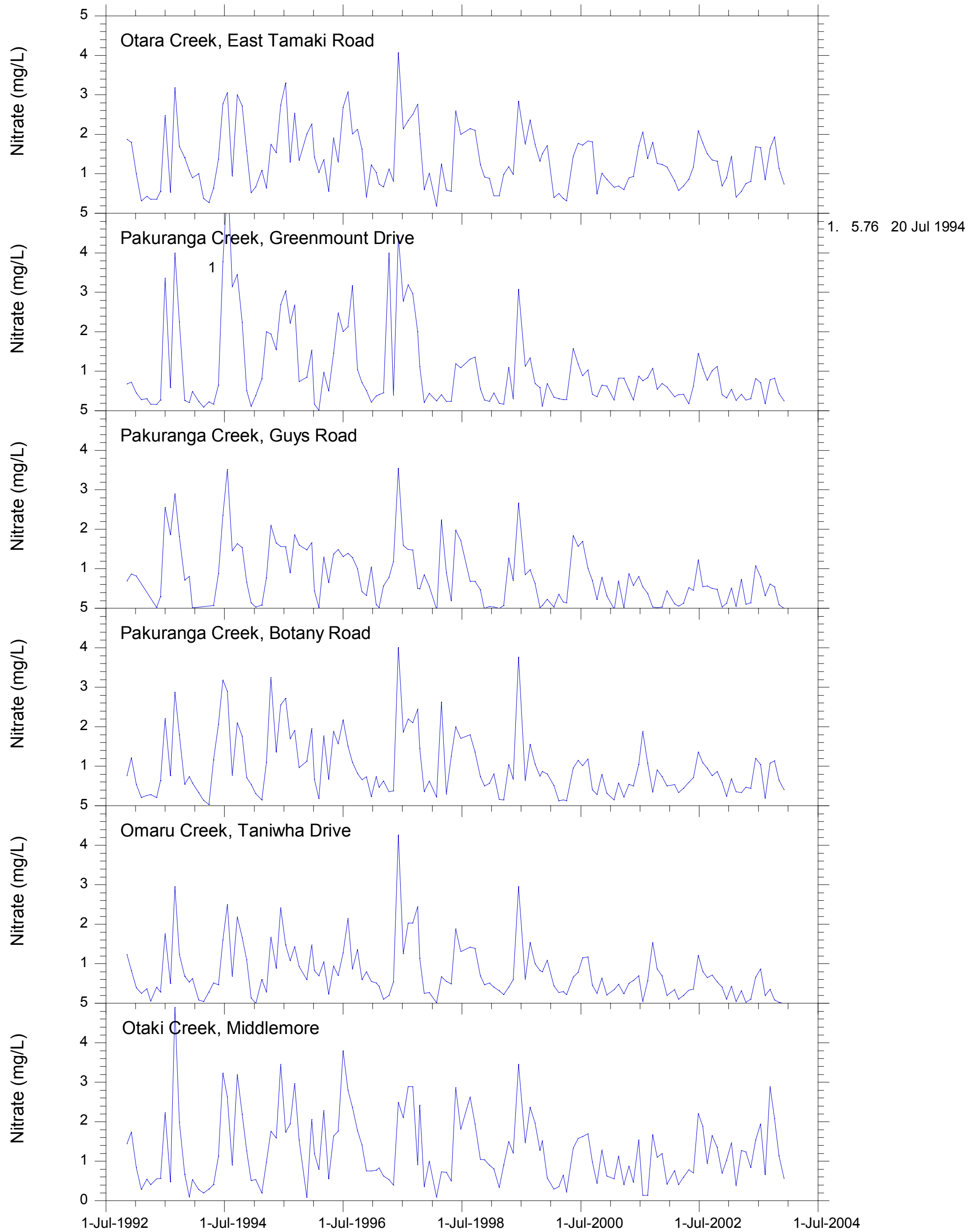
APPENDIX 33: TAMAKI ESTUARY – NITRATE NITROGEN

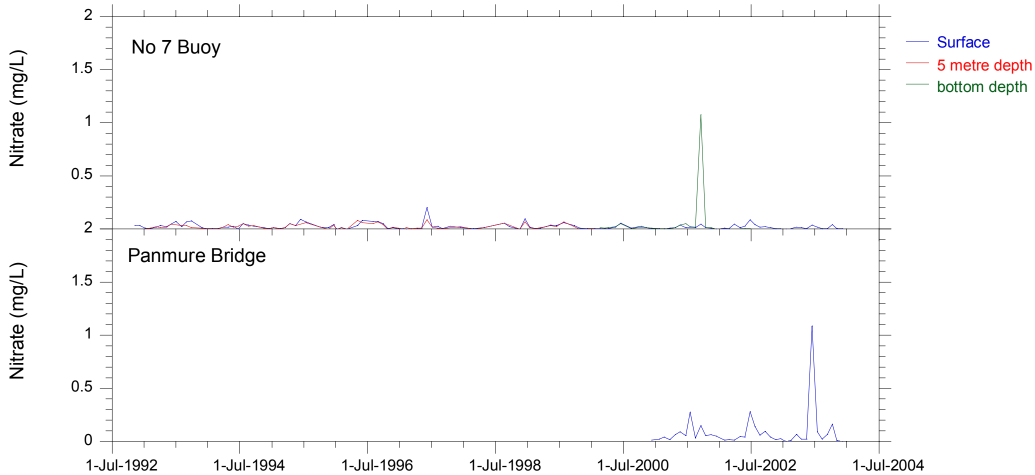
a) Nitrate nitrogen (mg/L) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	1.439	0.548	0.511	0.68	0.437	1.469	0.001	0.001	0.002
14-Feb-03	0.409	0.262	0.042	0.356	0.046	0.38	0.006	0.001	0.011
18-Mar-03	0.560	0.419	0.732	0.335	0.317	1.275	0.021	0.006	0.071
15-Apr-03	0.752	0.273	0.107	0.468	0.028	1.244	0.012	0.018	0.026
15-May-03	0.81	0.314	0.133	0.444	0.106	0.843	0.006	0.013	0.023
13-Jun-03	1.681	0.82	1.076	1.204	0.658	1.535	0.039	0.009	1.086
14-Jul-03	1.663	0.719	0.795	1.046	0.871	1.940	0.017	0.013	0.090
11-Aug-03	0.851	0.183	0.325	0.200	0.195	0.658	0.008	0.006	0.023
10-Sep-03	1.654	0.790	0.613	1.078	0.359	2.887	0.006	0.005	0.067
08-Oct-03	1.933	0.835	0.543	1.141	0.077	2.077	0.042	0.013	0.162
06-Nov-03	1.141	0.444	0.091	0.647	0.024	1.133	0.005	0.007	0.011
05-Dec-03	0.746	0.255	0.002	0.416	0.008	0.569	0.007	0.005	0.003
Median	0.996	0.432	0.418	0.558	0.151	1.260	0.008	0.007	0.025
IQR/Median %	91	108	129	117	224	67	160	123	264

b) The graphs on the following pages show nitrate nitrogen results for the period November 1992 to December 2003 (where data available).

NO_3-N is calculated from the difference between NNN and NO_2-N. Zero or negative results may be obtained and are recorded as zero.


Otara Creek, East Tamaki Road
Pakuranga Creek, Greenmount Drive
Pakuranga Creek, Guys Road
Pakuranga Creek, Botany Road
Omaru Creek, Taniwha Drive
Otaki Creek, Middlemore
Nitrate (mg/L)
1. 5.76 20 Jul 1994
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004



No 7 Buoy
Panmure Bridge
Nitrate (mg/L)
Nitrate (mg/L)
2
1.5
1
0.5
2
1.5
1
0.5
0
Surface
5 metre depth
bottom depth
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

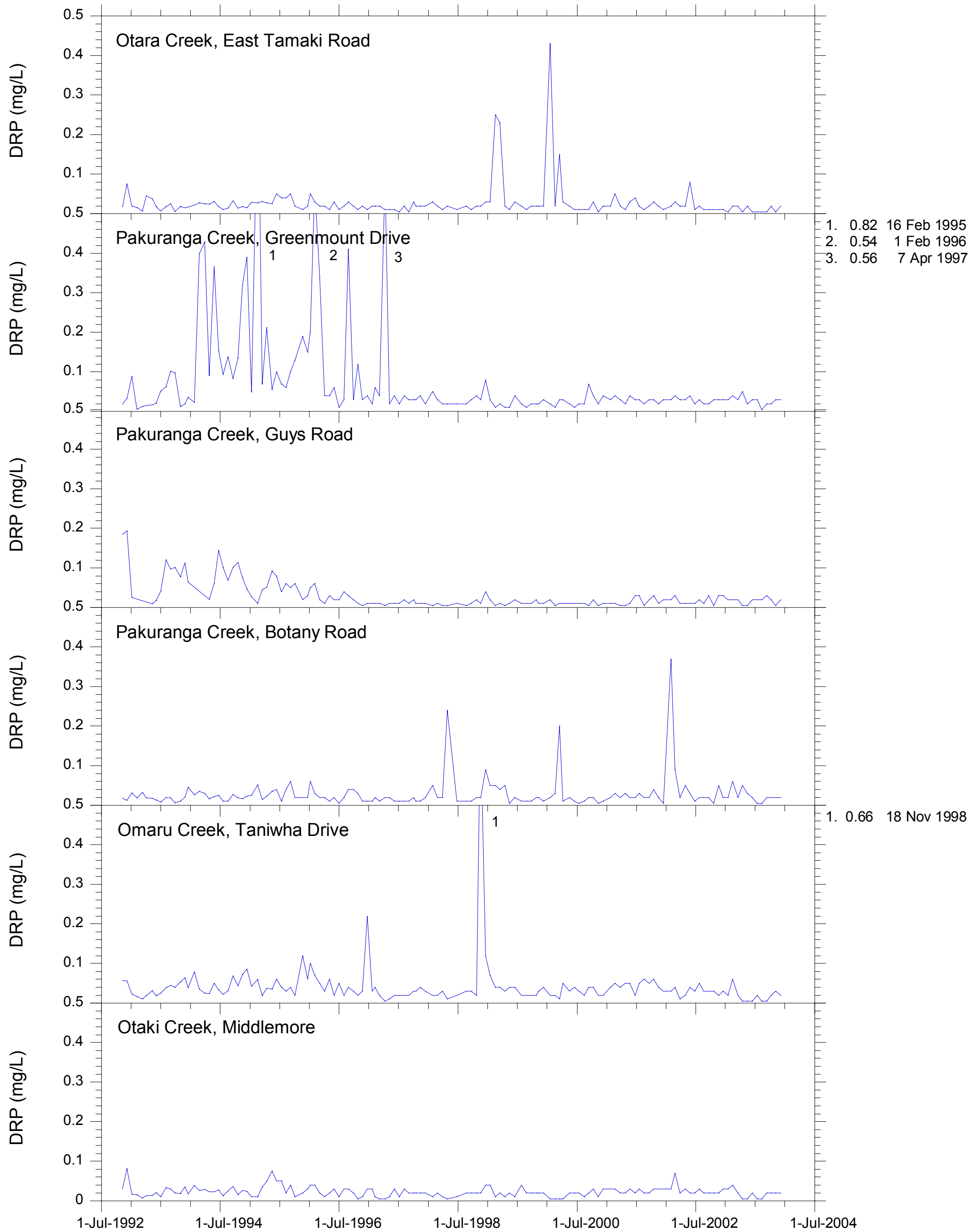
APPENDIX 34: TAMAKI ESTUARY – DISSOLVED REACTIVE PHOSPHORUS

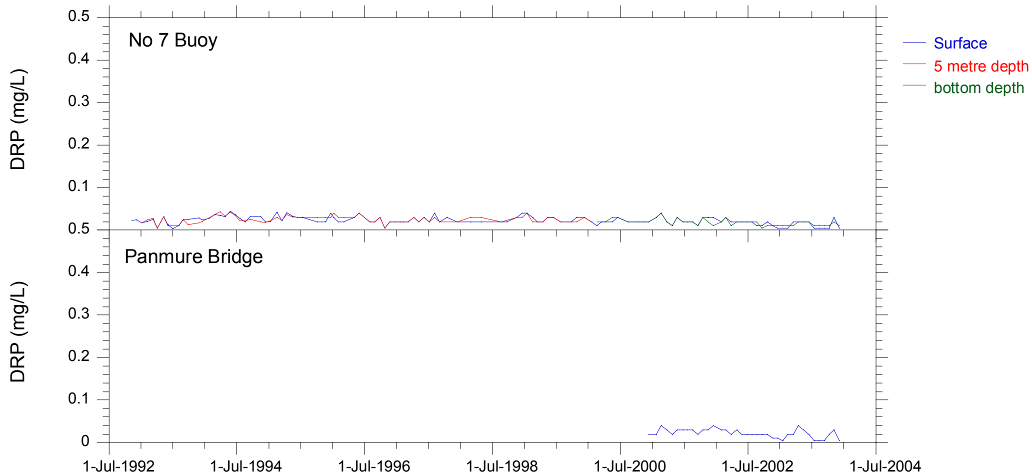
a) Dissolved reactive phosphorus (mg/L) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	<0.01	0.03	0.02	0.02	0.02	0.03	<0.01	<0.01	<0.01
14-Feb-03	0.02	0.04	0.02	0.06	0.06	0.04	<0.01	<0.01	0.02
18-Mar-03	0.02	0.03	0.02	0.02	0.02	0.02	0.02	<0.01	0.02
15-Apr-03	<0.01	0.05	<0.01	0.05	<0.01	<0.01	0.02	0.02	0.04
15-May-03	0.02	0.02	<0.01	0.03	<0.01	<0.01	0.02	0.02	0.03
13-Jun-03	<0.01	0.03	0.02	0.02	<0.01	0.02	0.02	0.02	0.02
14-Jul-03	<0.01	0.03	0.02	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
11-Aug-03	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
10-Sep-03	<0.01	0.02	0.03	0.02	<0.01	0.02	<0.01	<0.01	<0.01
08-Oct-03	0.02	0.02	0.02	0.02	0.02	0.02	<0.01	<0.01	0.02
06-Nov-03	<0.01	0.03	<0.01	0.02	0.03	0.02	0.03	0.02	0.03
05-Dec-03	0.02	0.03	0.02	0.02	0.02	0.02	<0.01	<0.01	<0.01
Median	0.005	0.030	0.020	0.020	0.020	0.020	0.005	0.005	0.020
IQR/Median %	300	33	19	13	75	75	300	300	88

b) The graphs on the following pages show dissolved reactive phosphorus results for the period November 1992 to December 2003 (where data available).

Method detection limit is 0.01 mg/L. For summary statistics, a result of “<0.01” is taken to have the value 0.005


Otara Creek, East Tamaki Road
Pakuranga Creek, Greenmount Drive
1. 0.82 16 Feb 1995
2. 0.54 1 Feb 1996
3. 0.56 7 Apr 1997
Pakuranga Creek, Guys Road
Pakuranga Creek, Botany Road
Omaru Creek, Taniwha Drive
1. 0.66 18 Nov 1998
Otaki Creek, Middlemore
DRP (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

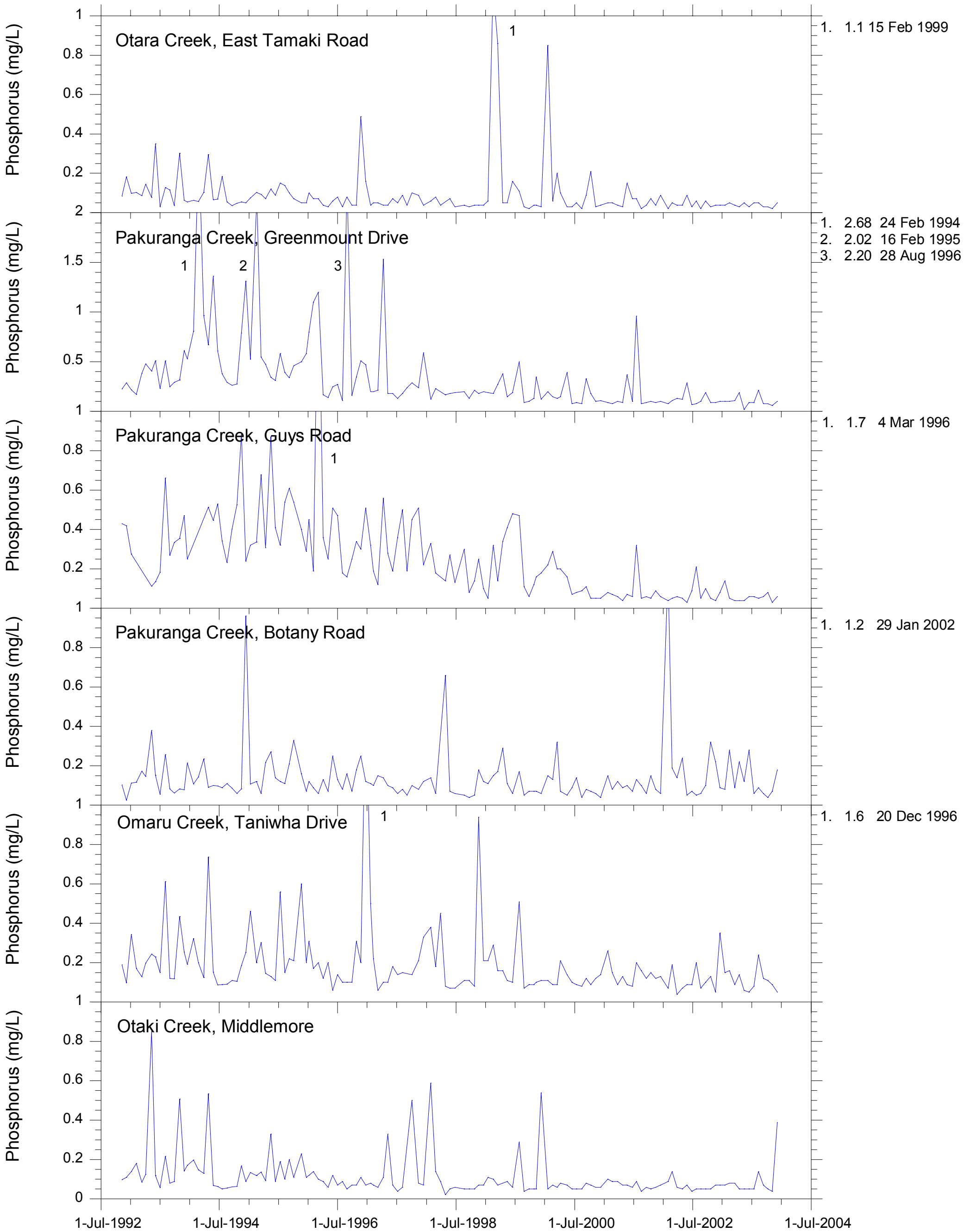

No 7 Buoy
Panmure Bridge
DRP (mg/L)
DRP (mg/L)
0.5
0.4
0.3
0.2
0.1
0.5
0.4
0.3
0.2
0.1
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004
Surface
5 metre depth
bottom depth

APPENDIX 35: TAMAKI ESTUARY – TOTAL PHOSPHORUS

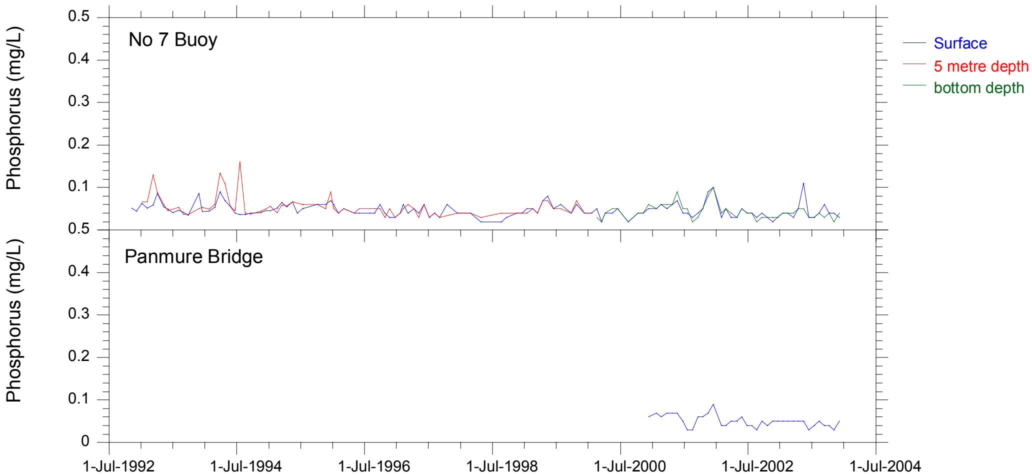
a)Total phosphorus (mg/L) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	0.04	0.10	0.14	0.08	0.15	0.07	0.04	0.04	0.05
14-Feb-03	0.05	0.10	0.05	0.28	0.16	0.08	0.04	0.04	0.05
18-Mar-03	0.04	0.11	0.04	0.09	0.09	0.08	0.03	0.04	0.05
15-Apr-03	0.03	0.19	0.04	0.22	0.14	0.05	0.05	0.05	0.05
15-May-03	0.05	0.02	0.04	0.12	0.06	0.05	0.11	0.05	0.05
13-Jun-03	0.03	0.09	0.06	0.28	0.05	0.05	0.03	0.03	0.03
14-Jul-03	0.05	0.09	0.06	0.06	0.08	0.05	0.03	0.03	0.04
11-Aug-03	0.05	0.21	0.05	0.09	0.24	0.14	0.04	0.04	0.05
10-Sep-03	0.03	0.08	0.06	0.06	0.12	0.07	0.06	0.03	0.04
08-Oct-03	0.03	0.08	0.08	0.04	0.11	0.05	0.04	0.04	0.04
06-Nov-03	0.02	0.06	0.03	0.07	0.09	0.04	0.04	0.02	0.03
05-Dec-03	0.05	0.10	0.06	0.18	0.05	0.39	0.03	0.04	0.05
Median	0.04	0.10	0.06	0.09	0.10	0.06	0.04	0.04	0.05
IQR/Median %	50	24	36	136	68	50	31	25	20

b) The graphs on the following pages show total phosphorus results for the period November 1992 to December 2003 (where data available).



Otara Creek, East Tamaki Road
1. 1.1 15 Feb 1999
Pakuranga Creek, Greenmount Drive
1. 2.68 24 Feb 1994
2. 2.02 16 Feb 1995
3. 2.20 28 Aug 1996
Pakuranga Creek, Guys Road
1. 1.7 4 Mar 1996
Pakuranga Creek, Botany Road
1. 1.2 29 Jan 2002
Omaru Creek, Taniwha Drive
1. 1.6 20 Dec 1996
Otaki Creek, Middlemore
Phosphorus (mg/L)
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004


No 7 Buoy
Panmure Bridge
Phosphorus (mg/L)
Phosphorus (mg/L)
Surface
5 metre depth
bottom depth
0.5
0.4
0.3
0.2
0.1
0.5
0.4
0.3
0.2
0.1
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

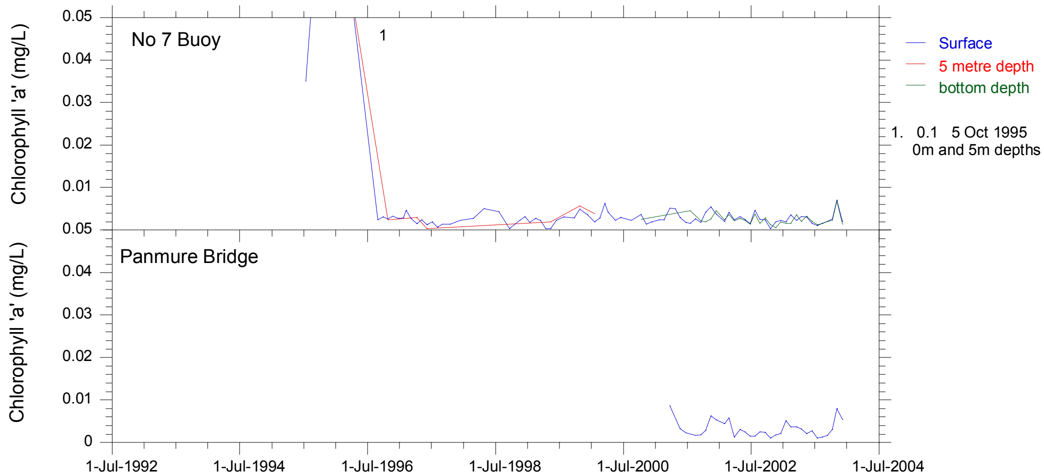
APPENDIX 36: TAMAKI ESTUARY – CHLOROPHYLL A

a) Chlorophyll *a* (mg/L) for the period January 2003 - December 2003

Date	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	0.0020	0.0016	0.0051
14-Feb-03	0.0035	0.0016	0.0037
18-Mar-03	0.0023	0.0035	0.0037
15-Apr-03	0.0032	0.0021	0.0032
15-May-03	0.0031	0.0033	0.0021
13-Jun-03	0.0016	0.0021	0.0027
14-Jul-03	0.0010	0.0012	0.0011
11-Aug-03	0.0016	0.0015	0.0013
10-Sep-03	0.0021	0.0021	0.0017
08-Oct-03	0.0026	0.0023	0.0031
06-Nov-03	0.0071	0.0068	0.0080
05-Dec-03	0.0021	0.0014	0.0055
Median	0.0022	0.0021	0.0032
IQR/Median %	56	46	65

b) The graphs on the following page show chlorophyll *a* results for the period November 1992 to December 2003 (where data available).

Note: Otara Creek (East Tamaki), Pakuranga Creek at Greenmount Dr., Pakuranga Creek at Guys Rd., Pakuranga Creek at Botany Rd., Omaru Creek, and Otaki Creek not analysed for chlorophyll *a*.



No 7 Buoy
Chlorophyll 'a' (mg/L)
0.05
0.04
0.03
0.02
0.01
1
Surface
5 metre depth
bottom depth
1. 0.1 5 Oct 1995
0m and 5m depths
Panmure Bridge
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

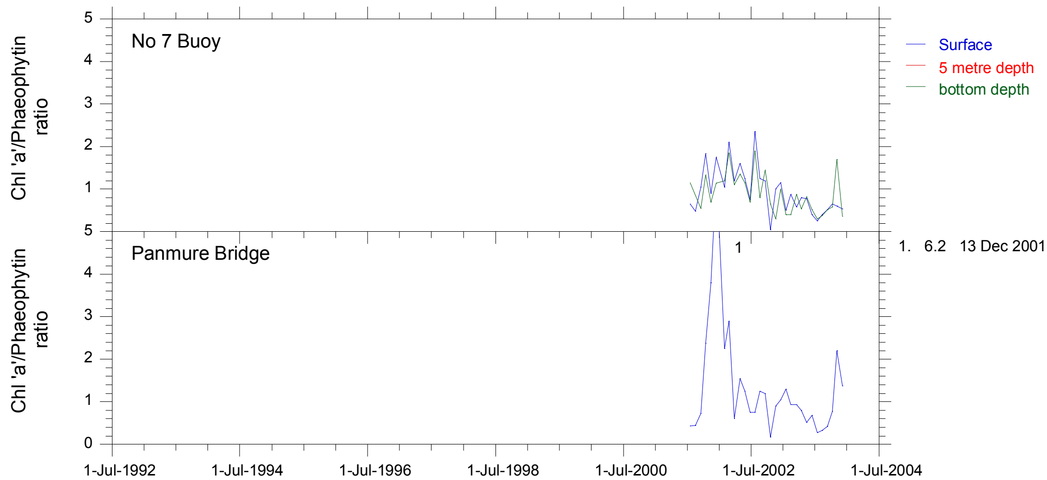
APPENDIX 37: TAMAKI ESTUARY – CHLOROPHYLL/PHAEOPHYTIN RATIO

a) Chlorophyll/phaeophytin ratio for the period January 2003 - December 2003

Date	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	0.5	0.4	1.3
14-Feb-03	0.88	0.4	0.93
18-Mar-03	0.58	0.88	0.93
15-Apr-03	0.8	0.53	0.8
15-May-03	0.78	0.82	0.52
13-Jun-03	0.4	0.52	0.68
14-Jul-03	0.25	0.3	0.28
11-Aug-03	0.4	0.38	0.33
10-Sep-03	0.52	0.52	0.42
08-Oct-03	0.65	0.58	0.78
06-Nov-03	0.6	1.7	2.2
05-Dec-03	0.53	0.35	1.38
Median	0.5550	0.5200	0.7900
IQR/Median %	37	47	67

b) The graphs on the following page show chlorophyll/phaeophytin ratio results for the period November 1992 to December 2003 (where data available).

Note: Otara Creek (East Tamaki), Pakuranga Creek at Greenmount Dr., Pakuranga Creek at Guys Rd., Pakuranga Creek at Botany Rd., Omaru Creek, and Otaki Creek not analysed for chlorophyll *a* and phaeophytin.



No 7 Buoy
Panmure Bridge
Chl 'a'/Phaeophytin ratio
Surface
5 metre depth
bottom depth
1. 6.2 13 Dec 2001
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

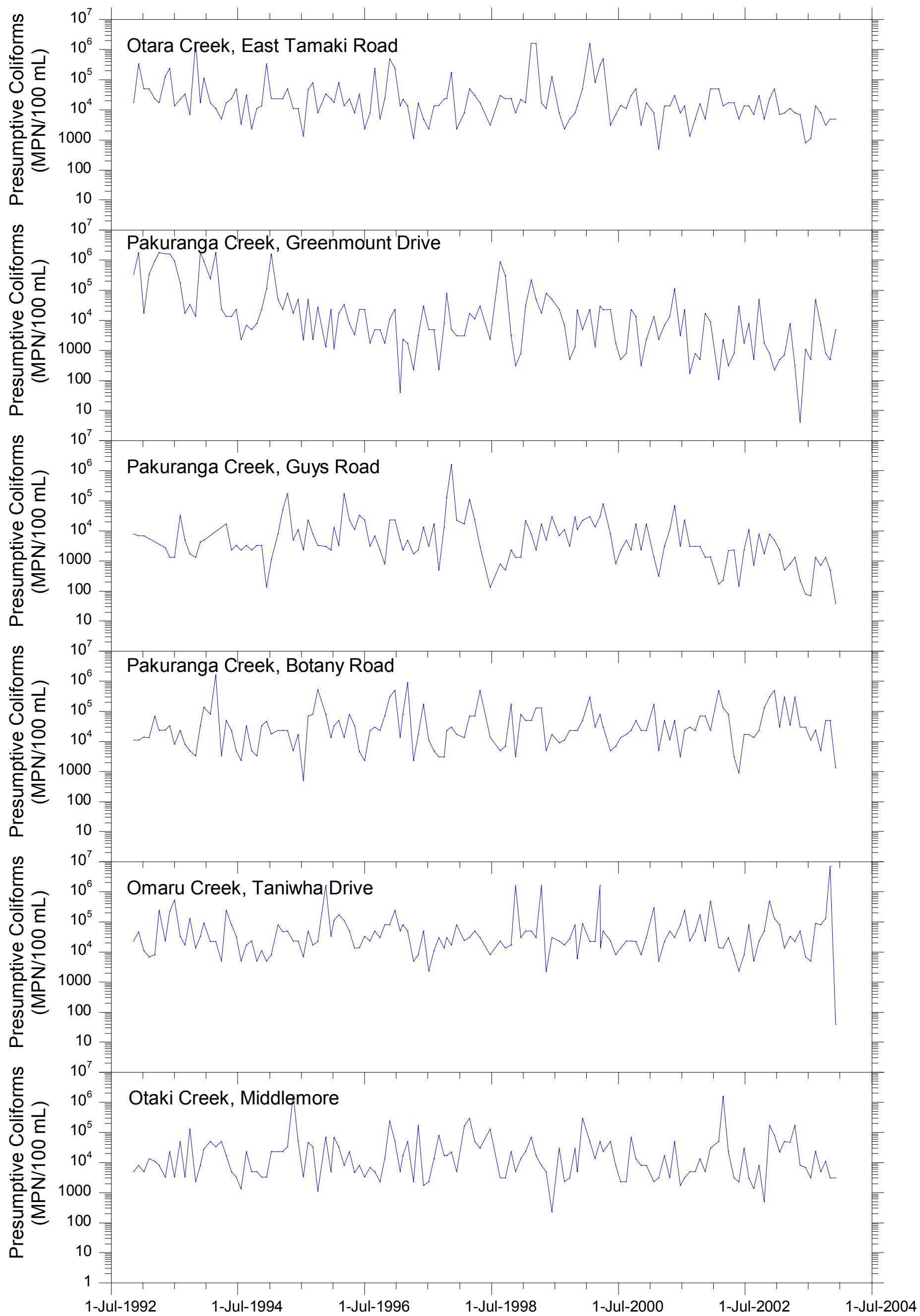
APPENDIX 38: TAMAKI ESTUARY – PRESUMPTIVE COLIFORMS

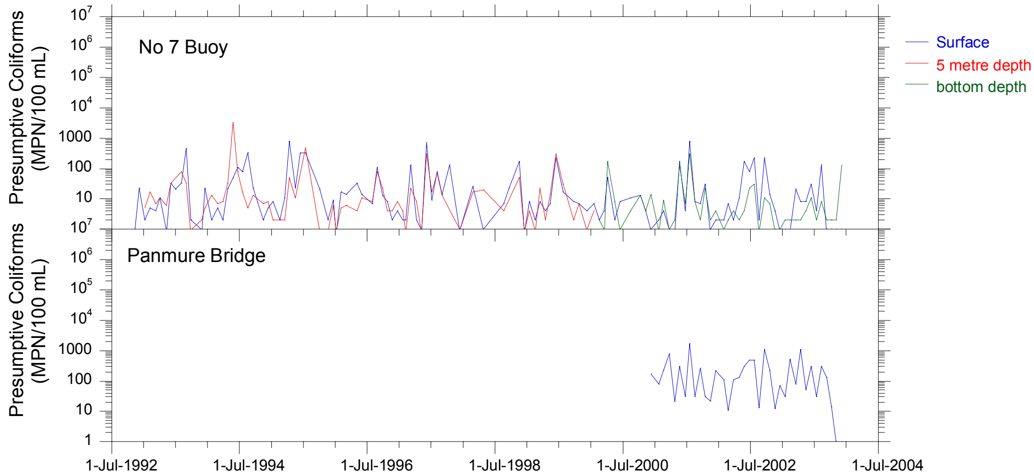
a) Presumptive coliforms (MPN/100mL) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	7000	500	2300	30000	80000	22000	<2	<2	30
14-Feb-03	8000	700	500	300000	13000	50000	<2	<2	520
18-Mar-03	11000	7900	790	35000	33000	46000	21	<2	79
15-Apr-03	8000	300	1300	300000	22000	170000	8	7	1100
15-May-03	7000	4	230	30000	50000	8000	8	11	50
13-Jun-03	800	1100	80	30000	7000	7000	30	21	300
14-Jul-03	1100	500	70	11000	5000	3000	4	<2	30
11-Aug-03	13000	50000	1300	24000	90000	24000	130	27	300
10-Sep-03	8000	7000	700	5000	80000	5000	<2	4	130
08-Oct-03	3000	800	1300	50000	130000	11000	<2	4	14
06-Nov-03	5000	500	500	50000	7000000	3000	<2	<2	<2
05-Dec-03	5000	5000	40	1300	40	3000	<2	130	<2
Median	7000	750	600	30000	41500	9500	3	4	65
IQR/Median %	50	667	185	98	171	263	410	288	425

b) The graphs on the following pages show presumptive coliform results for the period November 1992 to December 2003 (where data available).

Method detection limit is 2 MPN/100 mL. For summary statistics, a result of "<2" is taken to have the value 1.


Otara Creek, East Tamaki Road
Pakuranga Creek, Greenmount Drive
Pakuranga Creek, Guys Road
Pakuranga Creek, Botany Road
Omaru Creek, Taniwha Drive
Otaki Creek, Middlemore
Presumptive Coliforms (MPN/100 mL)
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004



No 7 Buoy
Panmure Bridge
Presumptive Coliforms (MPN/100 mL)
Presumptive Coliforms (MPN/100 mL)
Surface
5 metre depth
bottom depth
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

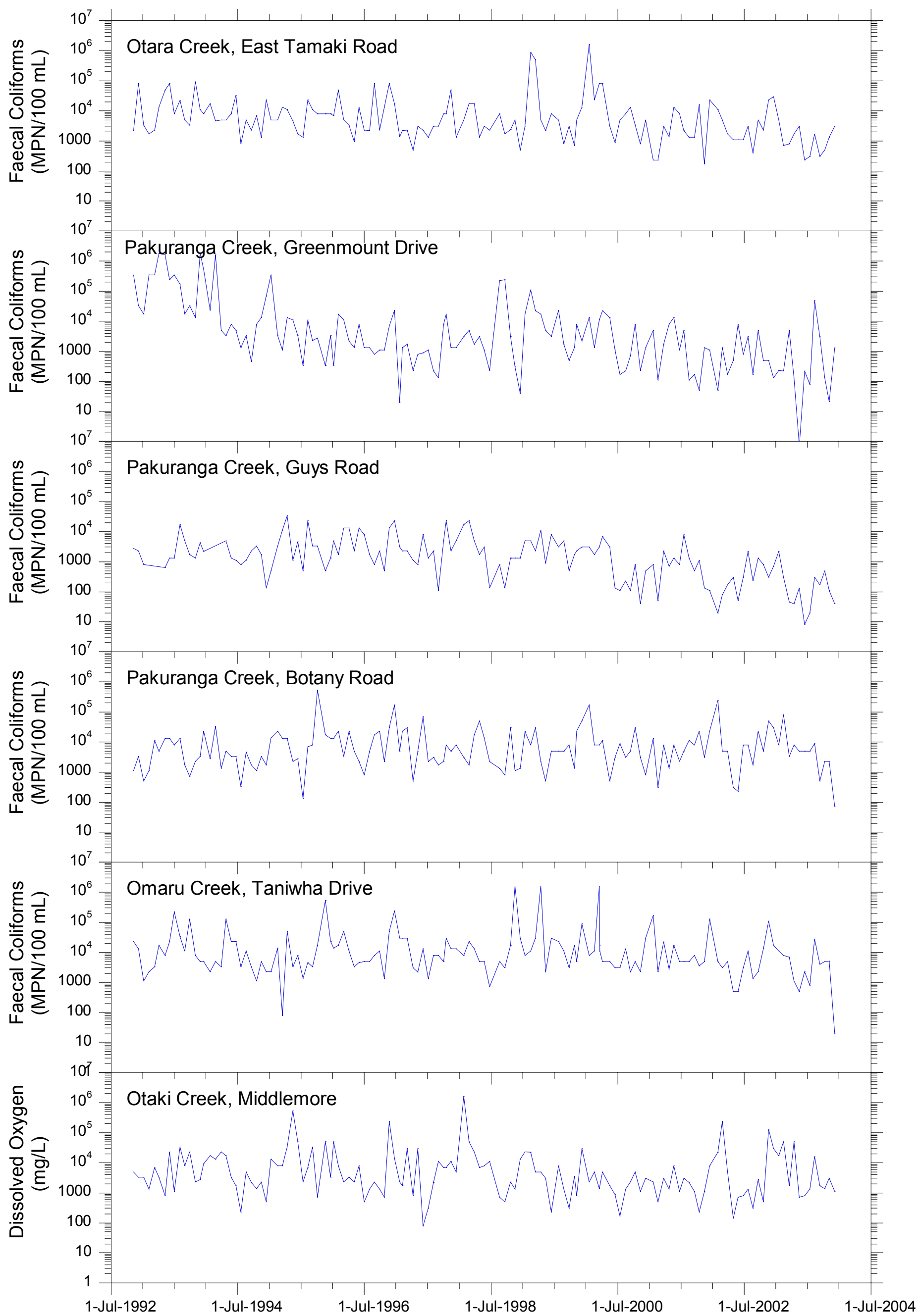
APPENDIX 39: TAMAKI ESTUARY – FAECAL COLIFORMS

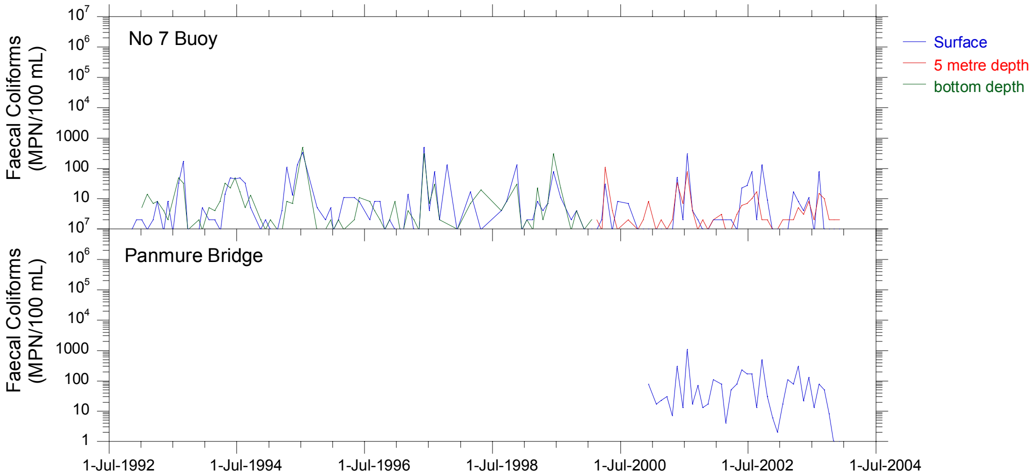
a) Faecal coliforms (MPN/100mL) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	5000	230	2200	8000	11000	17000	<2	<2	17
14-Feb-03	700	220	300	80000	8000	50000	<2	<2	110
18-Mar-03	790	4900	45	3300	7000	1700	17	<2	79
15-Apr-03	1700	130	40	8000	1100	50000	8	<2	300
15-May-03	3000	<2	130	5000	500	700	4	4	22
13-Jun-03	230	220	8	5000	2300	800	11	11	130
14-Jul-03	300	80	20	5000	800	1300	<2	<2	13
11-Aug-03	1700	50000	300	9000	28000	16000	80	8	80
10-Sep-03	300	3000	170	500	4000	1700	<2	<2	50
08-Oct-03	500	130	500	2300	5000	1400	<2	<2	8
06-Nov-03	1300	21	110	2200	5150	3000	<2	<2	<2
05-Dec-03	3000	1300	40	70	20	1100	<2	130	<2
Median	1045	220	120	5000	4500	1700	1	1	1
IQR/Median %	151	731	217	115	138	882	775	400	210

b) The graphs on the following pages show faecal coliform results for the period November 1992 to December 2003 (where data available).

Method detection limit is 2 MPN/100 mL. For summary statistics, a result of "<2" is taken to have the value 1.


Otara Creek, East Tamaki Road
Pakuranga Creek, Greenmount Drive
Pakuranga Creek, Guys Road
Pakuranga Creek, Botany Road
Omaru Creek, Taniwha Drive
Otaki Creek, Middlemore
Faecal Coliforms (MPN/100 mL)
Dissolved Oxygen (mg/L)
10^7
10^6
10^5
10^4
1000
100
10
1
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004



No 7 Buoy
Panmure Bridge
Faecal Coliforms (MPN/100 mL)
Surface
5 metre depth
bottom depth
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

APPENDIX 40: TAMAKI ESTUARY – ENTEROCOCCI

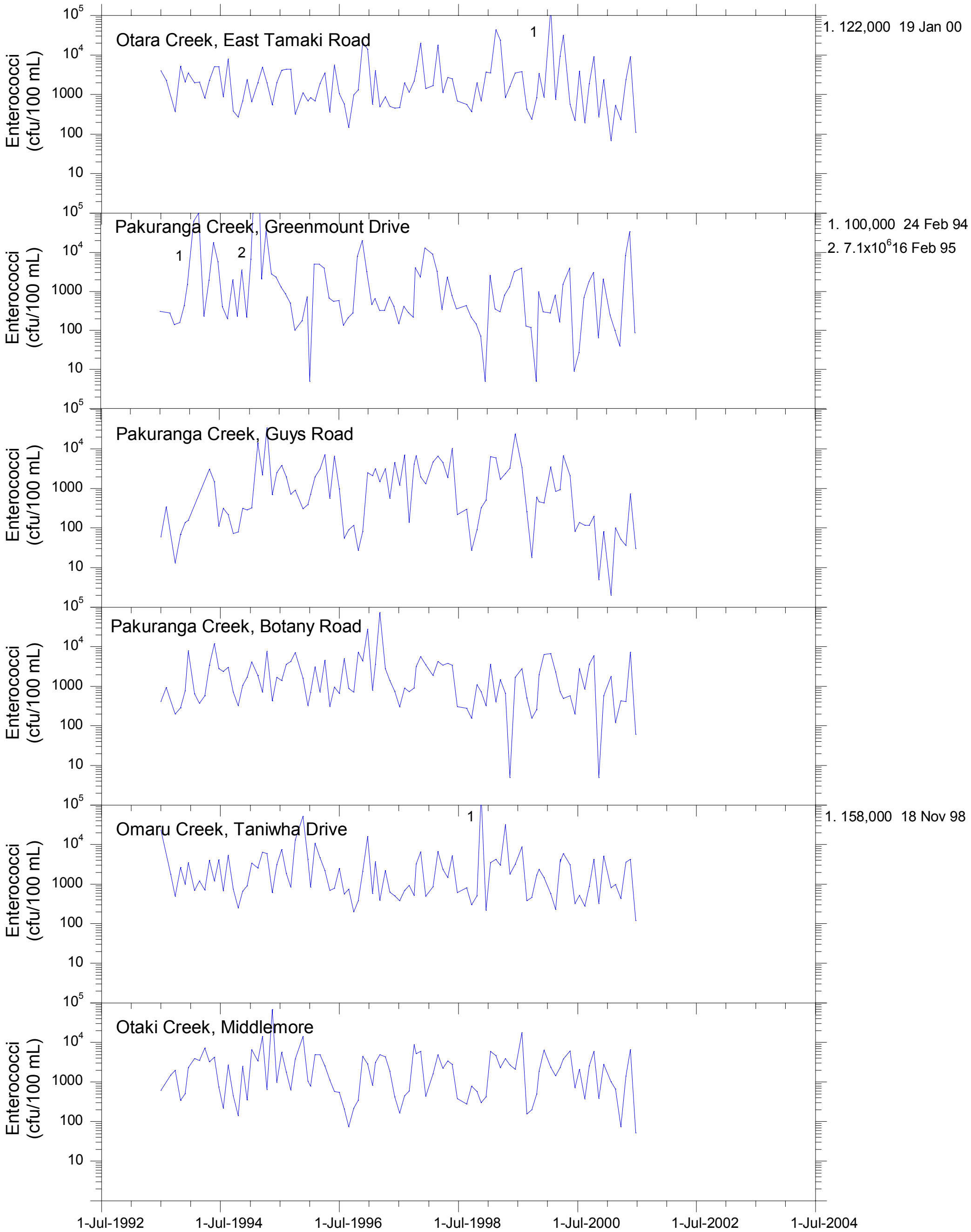
a) Enterococci (cfu/100mL) for the period January 2003 - December 2003

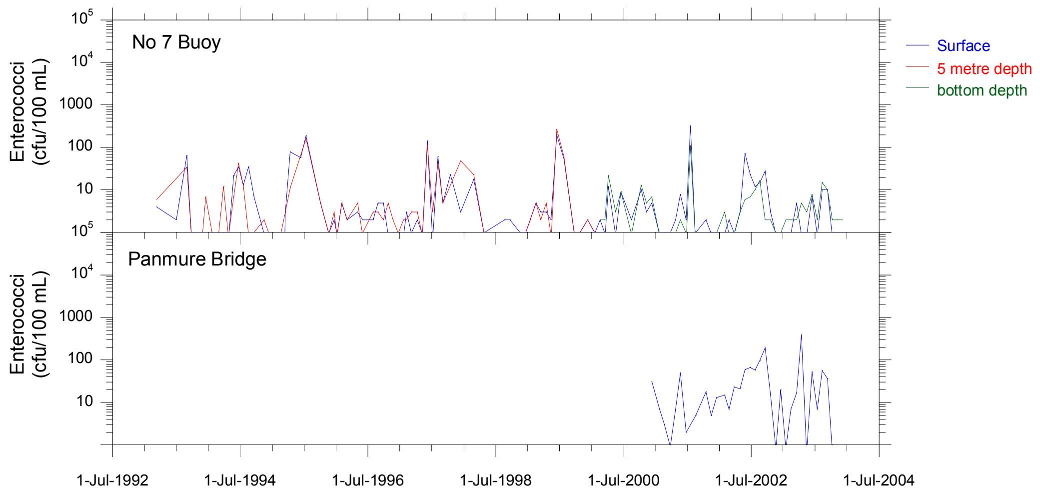
Date	No7 Buoy surface	No7 Buoy bottom	Panmure Bridge
15-Jan-03	<2	<2	<2
14-Feb-03	<2	<2	7
18-Mar-03	5	<2	17
15-Apr-03	<2	5	390
15-May-03	<2	3	<2
13-Jun-03	7	8	52
14-Jul-03	<2	<2	7
11-Aug-03	10	15	56
10-Sep-03	10	10	36
08-Oct-03	<2	<2	<2
06-Nov-03	<2	<2	<2
05-Dec-03	<2	<2	<2
Median	1	1	7
IQR/Median %	450	475	557

b) The graphs on the following pages show enterococci results for the period November 1992 to December 2003 (where data available).

Note: Otara Creek (East Tamaki), Pakuranga Creek at Greenmount Dr., Pakuranga Creek at Guys Rd., Pakuranga Creek at Botany Rd., Omaru Creek, and Otaki Creek not analysed for enterococci.

Method detection limit is 2 cfu/100 mL. For summary statistics, a result of “<2” is taken to have the value 1.


Otara Creek, East Tamaki Road
1. 122,000 19 Jan 00
Pakuranga Creek, Greenmount Drive
1. 100,000 24 Feb 94
2. 7.1x10^6 16 Feb 95
Pakuranga Creek, Guys Road
Pakuranga Creek, Botany Road
Omaru Creek, Taniwha Drive
1. 158,000 18 Nov 98
Otaki Creek, Middlemore
Enterococci (cfu/100 mL)
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004


No 7 Buoy
Panmure Bridge
Enterococci (cfu/100 mL)
10^5
10^4
1000
100
10
Surface
5 metre depth
bottom depth
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

APPENDIX 41: TAMAKI ESTUARY – E.COLI

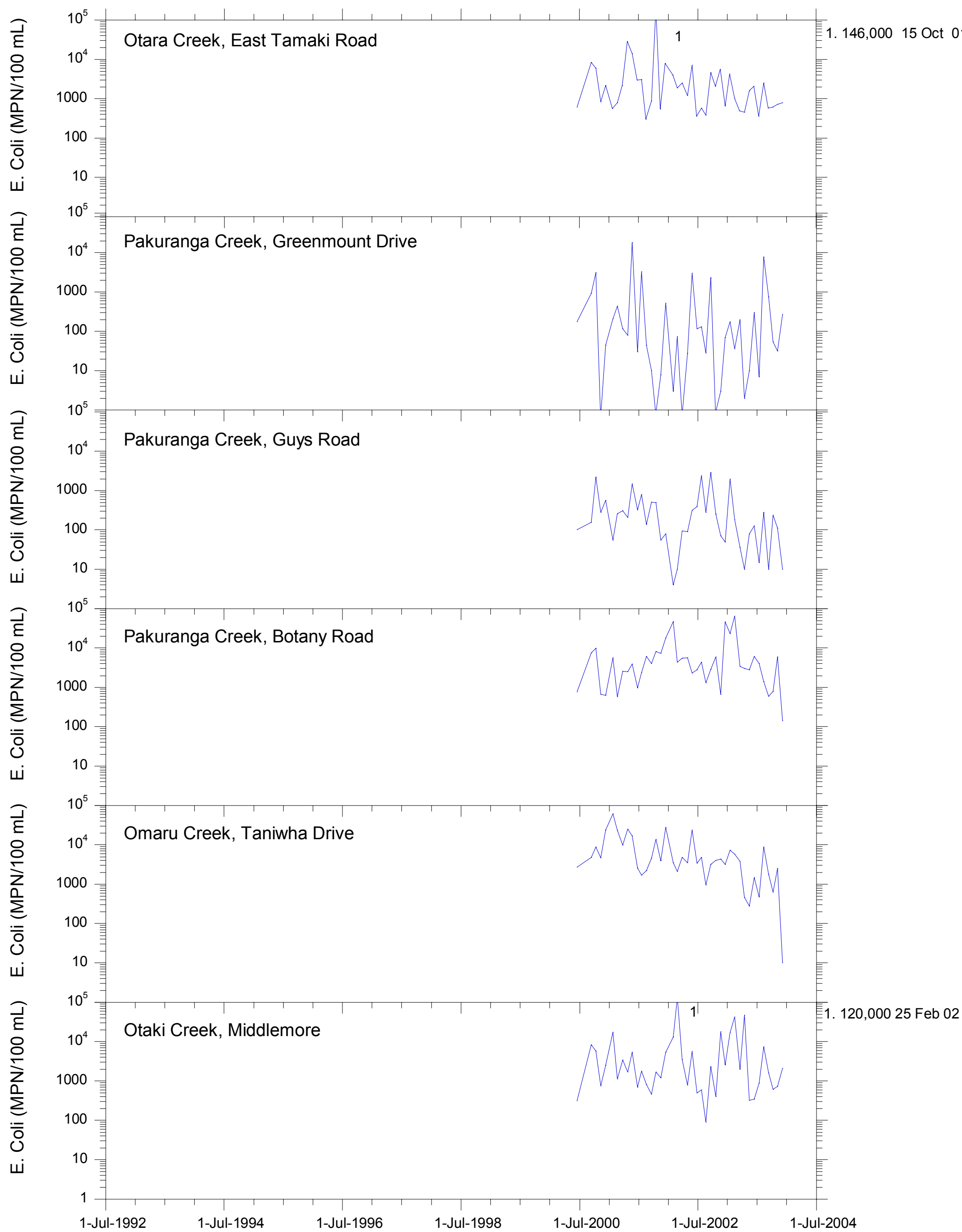
a) *E.Coli* (MPN/100mL) for the period January 2003 - December 2003

Date	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore
15-Jan-03	4200	173	2000	23000	7400	17000
14-Feb-03	1000	36	182	64000	5800	42000
18-Mar-03	500	200	36	3400	3800	2000
15-Apr-03	460	<2	10	3000	460	47000
15-May-03	1600	10	80	2800	280	330
13-Jun-03	2100	300	127	6100	1500	340
14-Jul-03	360	7	15	4000	470	890
11-Aug-03	2500	7800	280	1400	8900	7400
10-Sep-03	580	760	10	590	1800	1600
08-Oct-03	620	54	240	790	630	610
06-Nov-03	710	32	112	6000	2500	740
05-Dec-03	800	270	10	140	10	2100
Median	755	114	96	3200	1650	1800
IQR/Median %	154	221	190	149	232	505

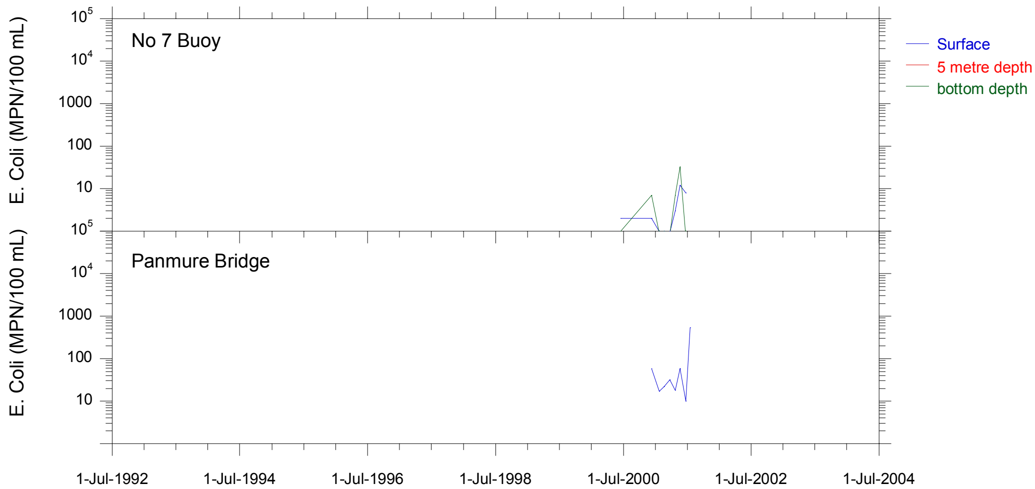
b) The graphs on the following pages show *e.coli* results for the period November 1992 to December 2003 (where data available).

Note: No.7 Buoy not analysed for *E. coli*.

Method detection limit is 2 MPN/100 mL. For summary statistics, a result of “<2” is taken to have the value 1.



E. Coli (MPN/100 mL)
Otara Creek, East Tamaki Road
1
1. 146,000 15 Oct 01
Pakuranga Creek, Greenmount Drive
Pakuranga Creek, Guys Road
Pakuranga Creek, Botany Road
Omaru Creek, Taniwha Drive
Otaki Creek, Middlemore
1
1. 120,000 25 Feb 02
1
10
100
1000
10^4
10^5
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

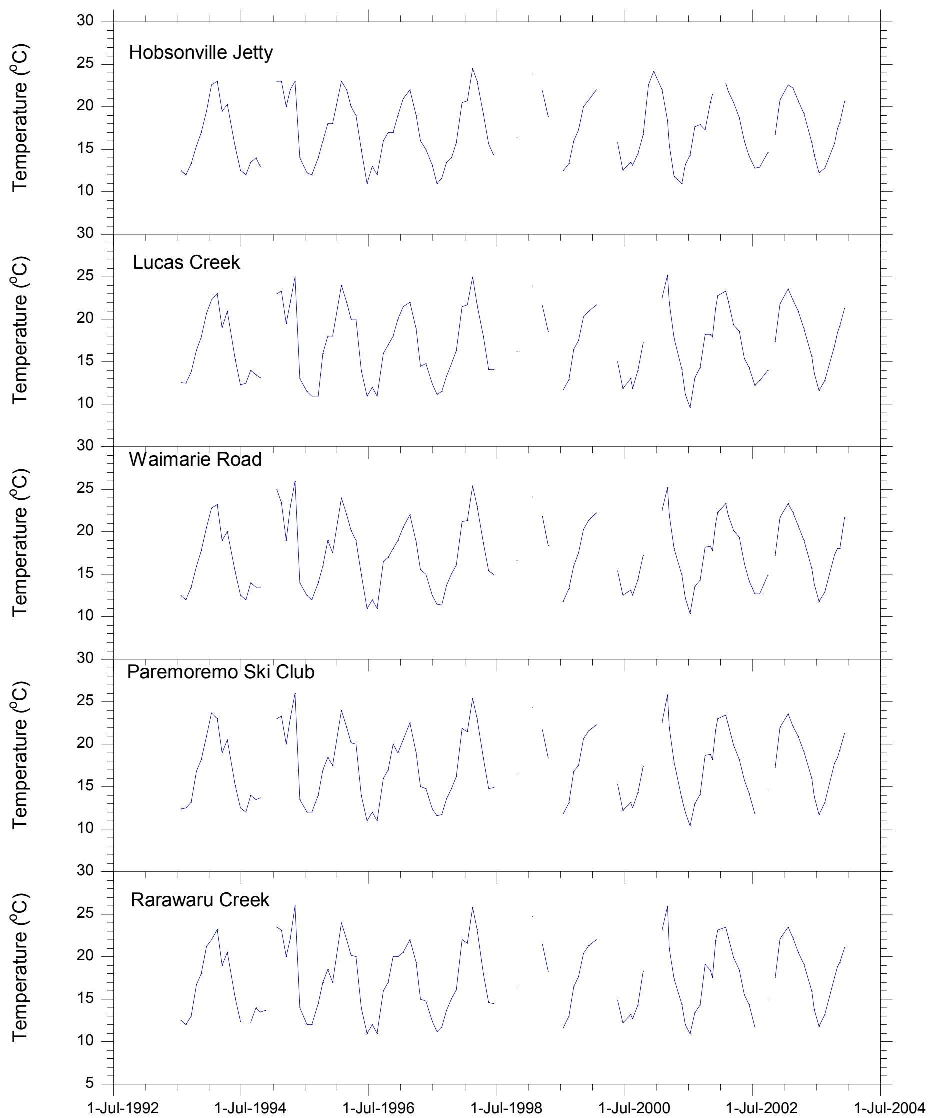

No 7 Buoy
Panmure Bridge
E. Coli (MPN/100 mL)
E. Coli (MPN/100 mL)
10^5
10^4
1000
100
10
10^5
10^4
1000
100
10
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004
Surface
5 metre depth
bottom depth

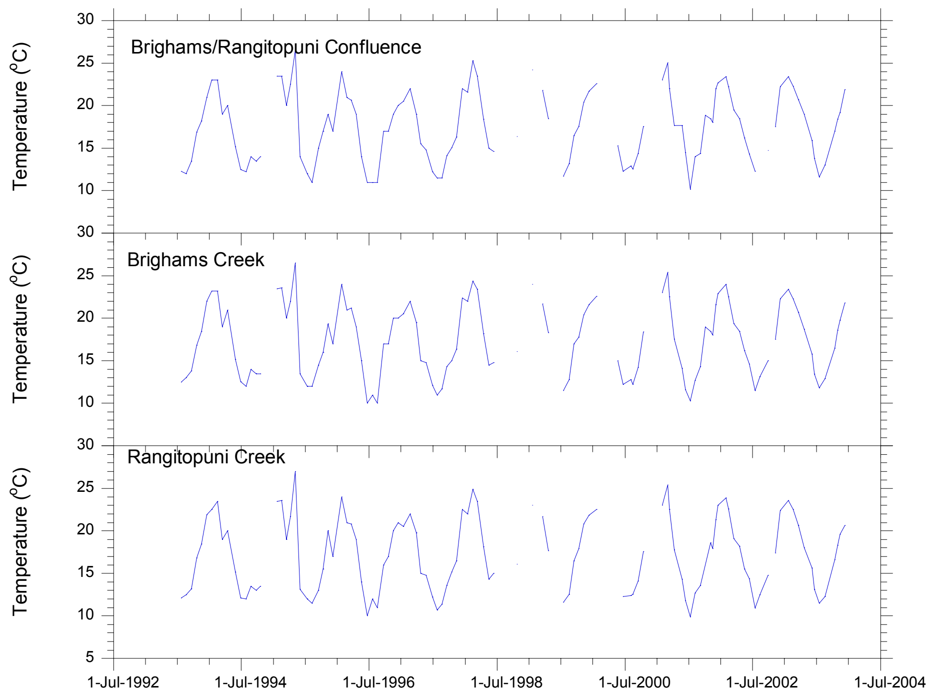
APPENDIX 42: UPPER WAITEMATA HARBOUR – TEMPERATURE

a) Temperature (°C) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	22.6	23.6	23.3	23.6	23.5	23.4	23.4	23.6
19-Feb-03	22.2	22.3	22.3	22.1	22.2	22.3	22.3	22.5
21-Mar-03	20.7	21.0	20.7	20.9	20.5	20.7	20.7	20.6
23-Apr-03	19.2		19.0	19.1	19.1	19.0	18.7	18.0
5-Jun-03	15.8	15.6	15.7	16.0	15.9	15.9	15.8	15.6
19-Jun-03	14.4	13.7	13.9	13.9	13.8	13.8	13.4	13.1
17-Jul-03	12.2	11.6	11.8	11.7	11.8	11.6	11.8	11.5
18-Aug-03	12.8	12.8	12.9	13.1	13.2	13.0	12.9	12.3
15-Oct-03	15.7	16.9	17.3	17.8	17.6	17.0	16.5	16.6
29-Oct-03	17.4	18.4	18.0	18.4	18.8	18.4	18.6	18.3
12-Nov-03	18.1	19.2	18.0	19.3	19.3	19.2	19.8	19.6
10-Dec-03	20.6	21.3	21.7	21.3	21.1	21.9	21.8	20.6
Median	17.8	18.7	18.0	18.8	19.0	18.7	18.7	18.2
IQR/Median %	30	32	32	29	28	30	31	31

b) The graphs on the following pages show temperature results for the period 1993 to December 2003 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Temperature (°C)
30
25
20
15
10
5
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

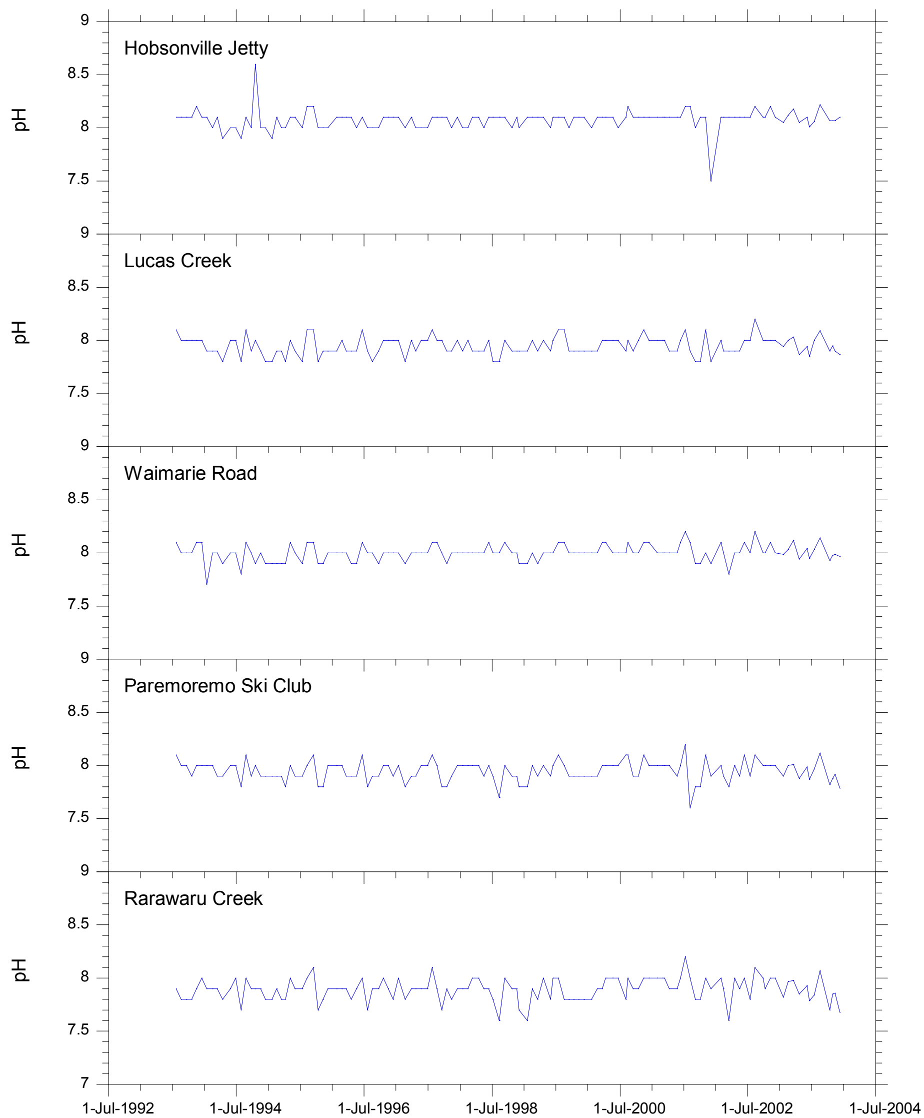

Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Temperature (°C)
Temperature (°C)
Temperature (°C)
30
25
20
15
10
5
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

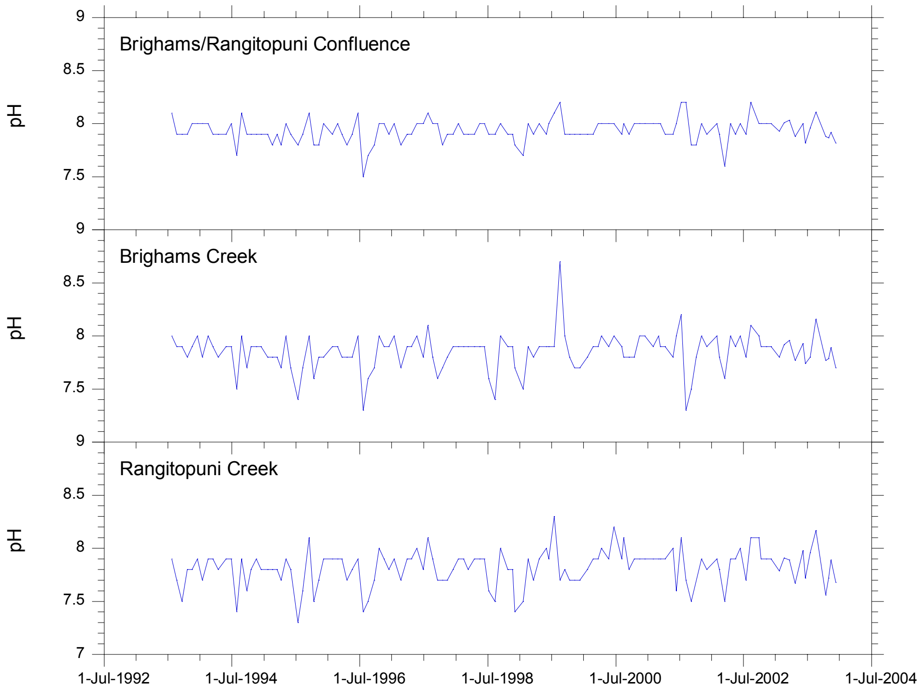
APPENDIX 43: UPPER WAITEMATA HARBOUR – pH

a) pH for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	8.05	7.94	7.99	7.90	7.82	7.93	7.80	7.79
19-Feb-03	8.12	8.00	8.03	8.00	7.97	8.01	7.92	7.91
21-Mar-03	8.18	8.03	8.12	8.01	7.98	8.03	7.96	7.89
23-Apr-03	8.05	7.87	7.94	7.88	7.85	7.88	7.77	7.67
5-Jun-03	8.10	7.94	8.04	7.99	7.93	8.00	7.93	7.98
19-Jun-03	8.01	7.85	7.95	7.87	7.79	7.82	7.74	7.72
17-Jul-03	8.06	8.00	8.03	7.97	7.84	7.96	7.80	7.96
18-Aug-03	8.22	8.09	8.14	8.12	8.07	8.11	8.16	8.17
15-Oct-03	8.07	7.90	7.93	7.82	7.70	7.88	7.77	7.56
29-Oct-03	8.07	7.95	7.98	7.88	7.85	7.87	7.79	7.72
12-Nov-03	8.07	7.90	7.99	7.92	7.86	7.92	7.89	7.89
10-Dec-03	8.10	7.87	7.97	7.79	7.68	7.82	7.70	7.68
Median	8.07	7.94	7.99	7.91	7.85	7.93	7.80	7.84
IQR/Median %	1	1	1	1	2	2	2	3

b) The graphs on the following pages show pH results for the period 1993 to December 2003 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
pH
9
8.5
8
7.5
7
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004



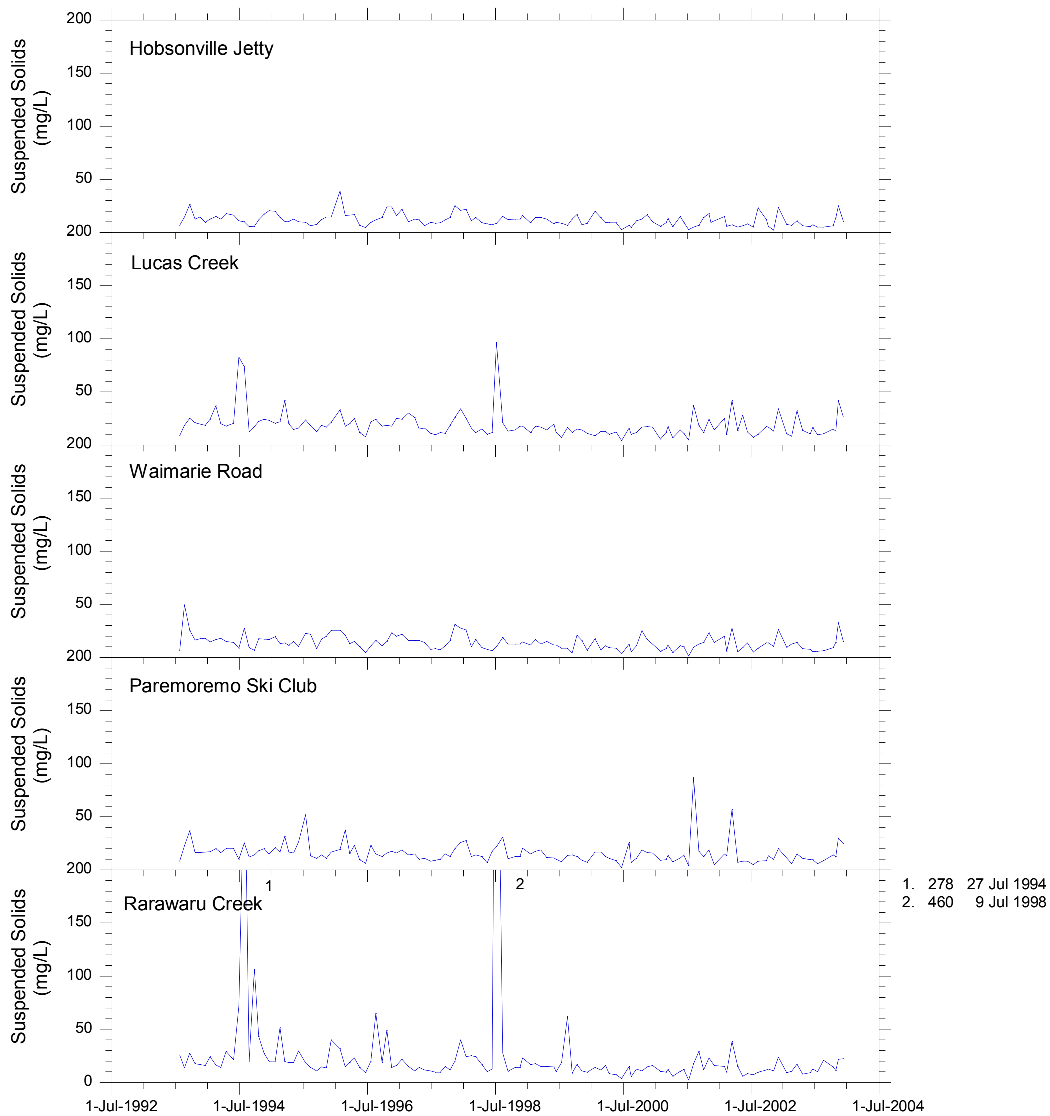
Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
pH
9
8.5
8
7.5
7
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

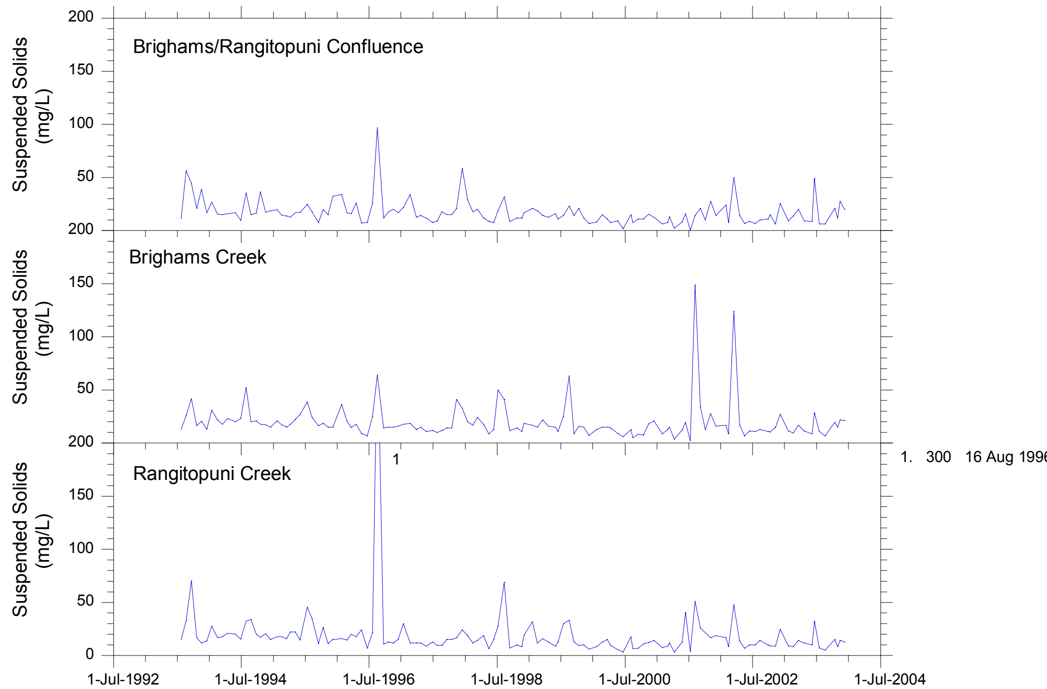
APPENDIX 44: UPPER WAITEMATA HARBOUR – SUSPENDED SOLIDS

a) Suspended solids (mg/L) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	7.9	10.5	9.6	11.3	9.3	9.4	11.5	9.3
19-Feb-03	6.9	8.3	12.7	5.8	10.5	13.6	9.7	8.3
21-Mar-03	10.8	32.2	13.9	15.1	17.2	20.1	16.8	14.2
23-Apr-03	6.6	13.6	8.4	10.8	7.9	9.2	11.4	11.8
5-Jun-03	5.3	10.5	7.9	9.5	9.3	8.7	8.9	10.1
19-Jun-03	7.4	16.6	5.7	9.5	12.8	49.2	28.9	32.3
17-Jul-03	5.2	9.8	6.2	6.1	10.2	6.5	10.8	7.6
18-Aug-03	4.9	10.5	6.5	8.5	21.1	6.4	6.7	5
15-Oct-03	6.4	15.2	9.4	13.9	14.7	21.1	19.4	15
29-Oct-03	13.6	13.1	14.1	12.7	11.6	12	15.1	8.2
12-Nov-03	25	41.9	33	30	22	28	22	14
10-Dec-03	10.5	26.3	14.9	24.6	22.4	19.4	21.2	13
Median	7.2	13.4	9.5	11.1	12.2	12.8	13.3	11.0
IQR/Median %	62	64	67	45	67	88	70	53

b) The graphs on the following pages show suspended solids results for the period 1993 to December 2003 (where data available


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Suspended Solids (mg/L)
200
150
100
50
0
1
2
1. 278 27 Jul 1994
2. 460 9 Jul 1998
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

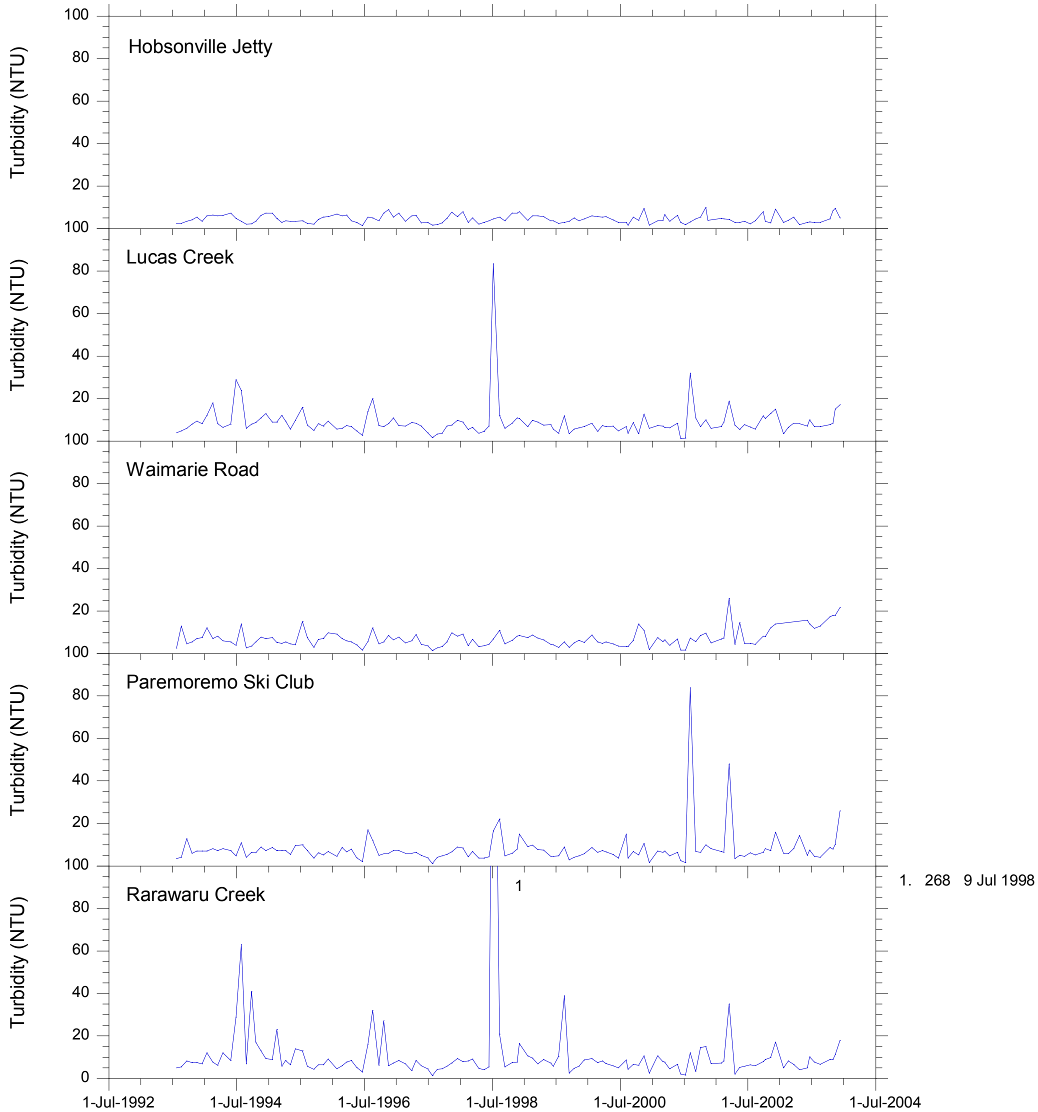

Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Suspended Solids (mg/L)
200
150
100
50
0
1
1. 300 16 Aug 1996
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

APPENDIX 45: UPPER WAITEMATA HARBOUR – TURBIDITY

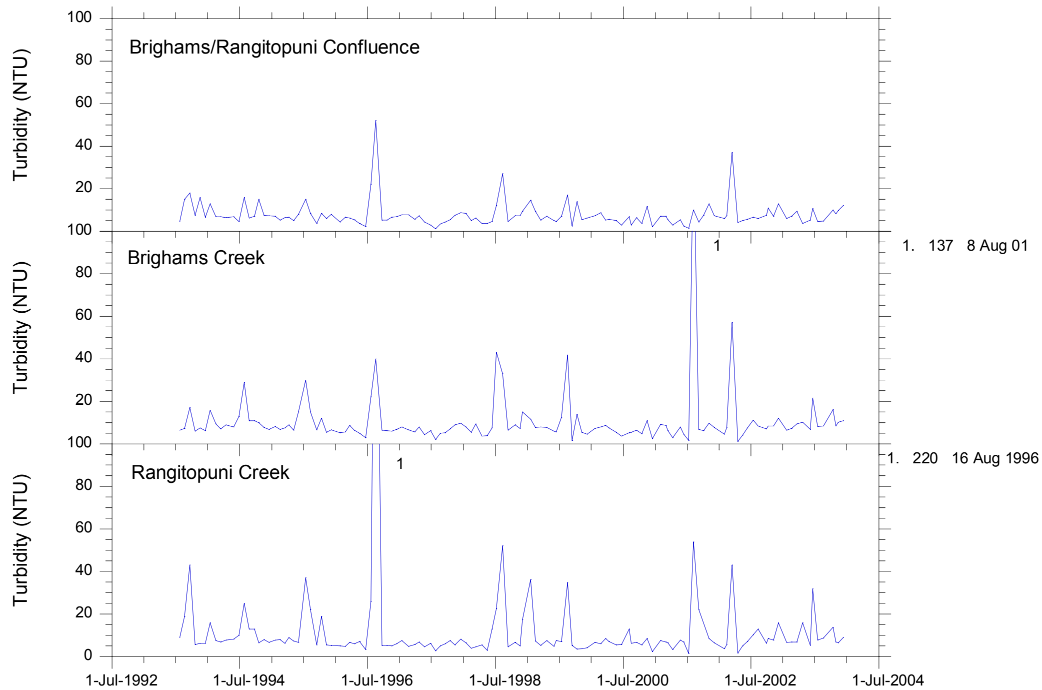
a) Turbidity (NTU) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	3.0	3.4	4.0	5.9	5.1	6.0	6.3	6.6
19-Feb-03	3.9	6.5	7.1	5.7	8.1	7.0	7.2	6.8
21-Mar-03	5.4	8.5	6.8	8.1	6.7	9.5	9.4	6.8
23-Apr-03	1.8	8.3	5.4	14.4	4.1	3.7	10.4	16.0
5-Jun-03	3.0	7.0	4.3	5.0	5.0	5.3	6.9	5.3
19-Jun-03	3.3	10.1	5.3	7.7	10.3	10.6	21.5	31.9
17-Jul-03	2.9	6.9	4.0	4.7	7.8	4.7	8.2	7.8
18-Aug-03	2.9	6.8	2.9	4.2	6.7	4.7	8.4	8.7
15-Oct-03	4.7	7.8	6.9	8.6	8.9	10.0	16.2	13.7
29-Oct-03	8.4	8.5	9.2	7.9	8.8	8.3	8.4	6.8
12-Nov-03	9.7	15.1	11.0	10.4	11.1	9.9	10.2	6.5
10-Dec-03	5.0	17.0	8.2	26.0	18.0	12.0	11.0	9.0
Median	3.6	8.0	6.1	7.8	7.9	7.7	8.9	7.3
IQR/Median %	59	26	52	46	37	62	30	47

b) The graphs on the following pages show turbidity results for the period 1993 to December 2003 (where data available).



Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Turbidity (NTU)
100
80
60
40
20
0
1
1. 268 9 Jul 1998
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

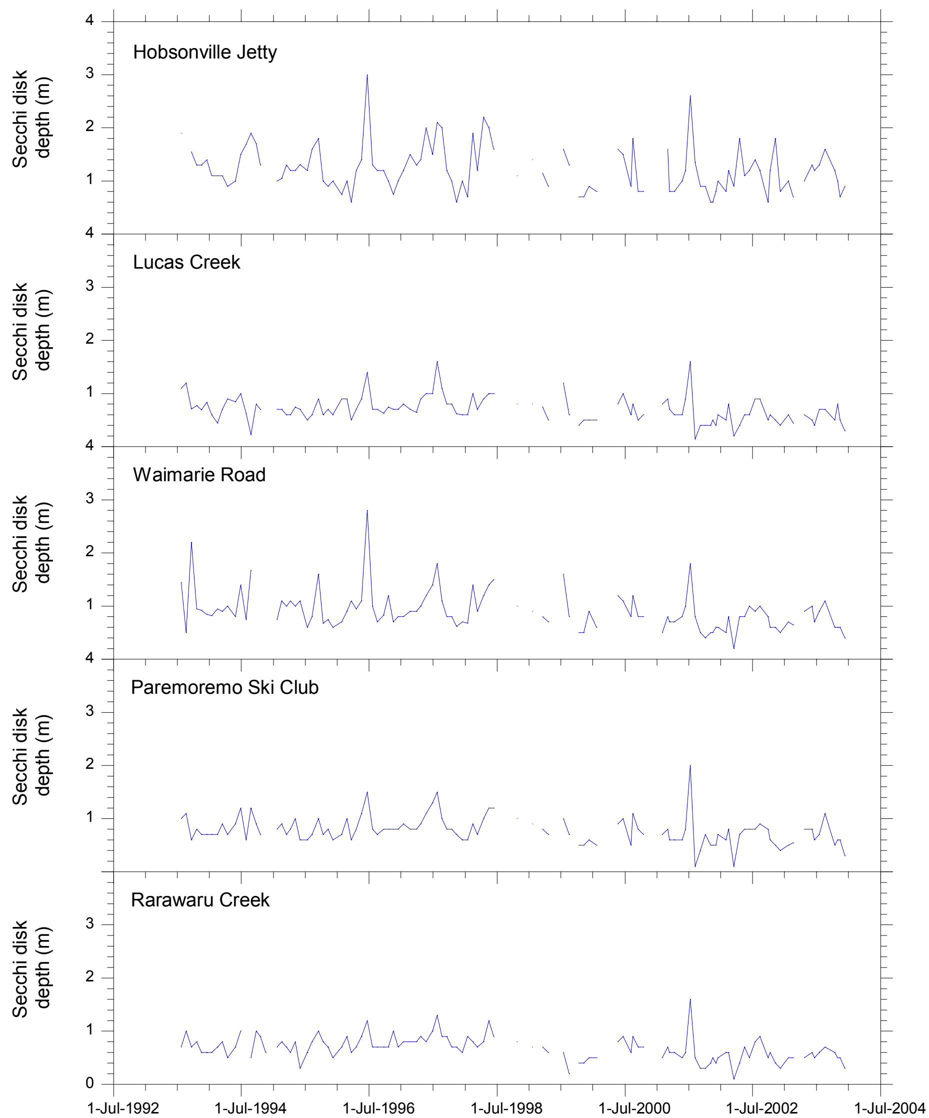

Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Turbidity (NTU)
100
80
60
40
20
0
1
1. 137 8 Aug 01
1. 220 16 Aug 1996
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

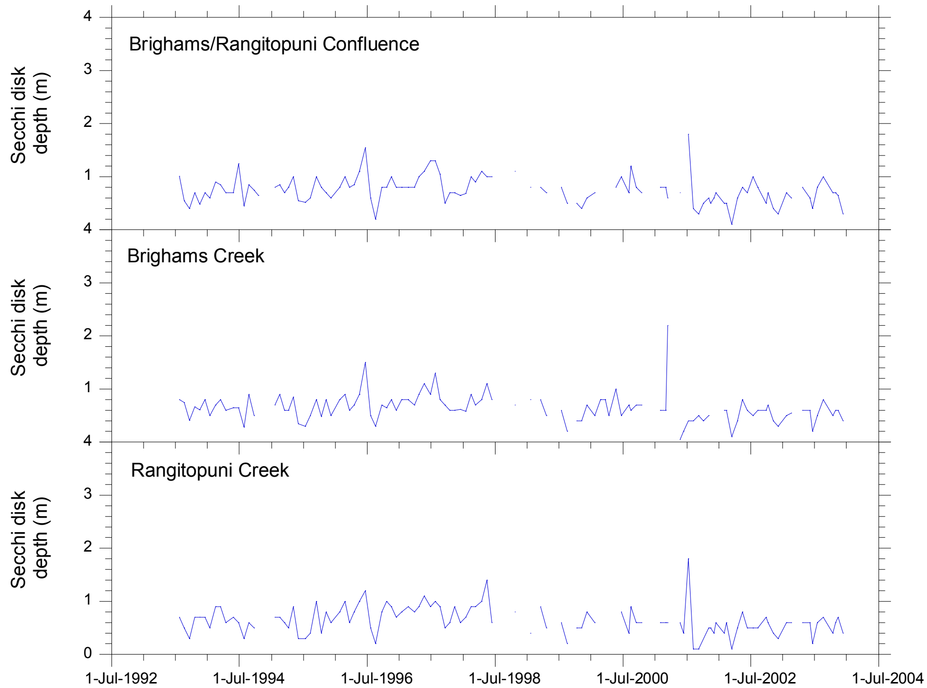
APPENDIX 46: UPPER WAITEMATA HARBOUR – SECCHI DEPTH

a) Secchi depth (m) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	1.0	0.6	0.7	0.5	0.5	0.7	0.5	0.6
19-Feb-03	0.7	0.5	0.7	0.6	0.5	0.6	0.6	0.6
21-Mar-03								
23-Apr-03	1.0	0.6	0.9	0.8	0.5	0.8	0.6	0.6
5-Jun-03	1.3	0.5	1.0	0.8	0.6	0.6	0.6	0.6
19-Jun-03	1.2	0.4	0.7	0.6	0.5	0.4	0.2	0.2
17-Jul-03	1.3	0.7	0.9	0.7	0.6	0.8	0.5	0.6
18-Aug-03	1.6	0.7	1.1	1.1	0.7	1.0	0.8	0.7
15-Oct-03	1.2	0.5	0.6	0.5	0.6	0.7	0.5	0.4
29-Oct-03	1.0	0.8	0.6	0.6	0.5	0.7	0.6	0.6
12-Nov-03	0.7	0.5	0.6	0.6	0.5	0.7	0.6	0.7
10-Dec-03	0.9	0.3	0.4	0.3	0.3	0.3	0.4	0.4
Median	1.0	0.5	0.7	0.6	0.5	0.7	0.6	0.6
IQR/Median %	30	35	43	38	20	21	18	17

b) The graphs on the following pages show Secchi disk depth results for the period 1993 to December 2003 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Secchi disk depth (m)
0
1
2
3
4
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

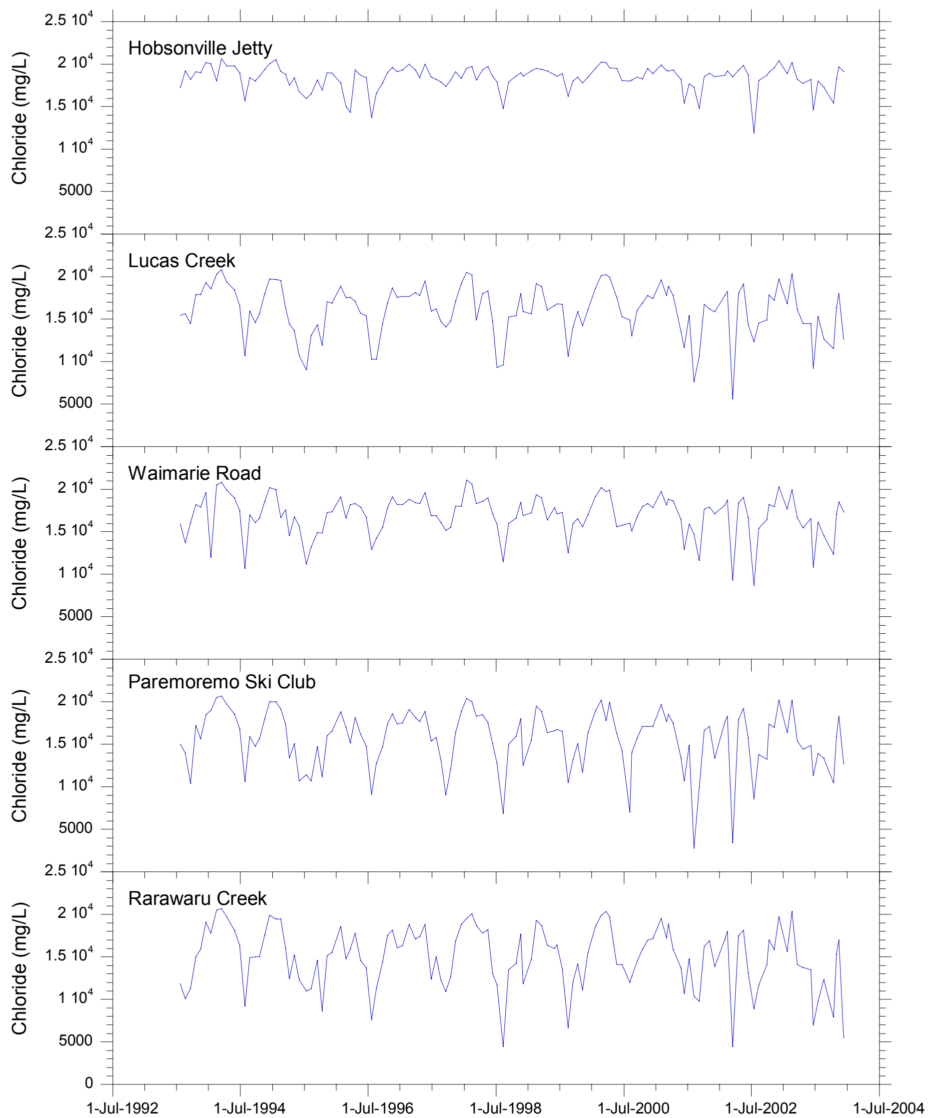

Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Secchi disk depth (m)
Secchi disk depth (m)
Secchi disk depth (m)
0
1
2
3
4
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

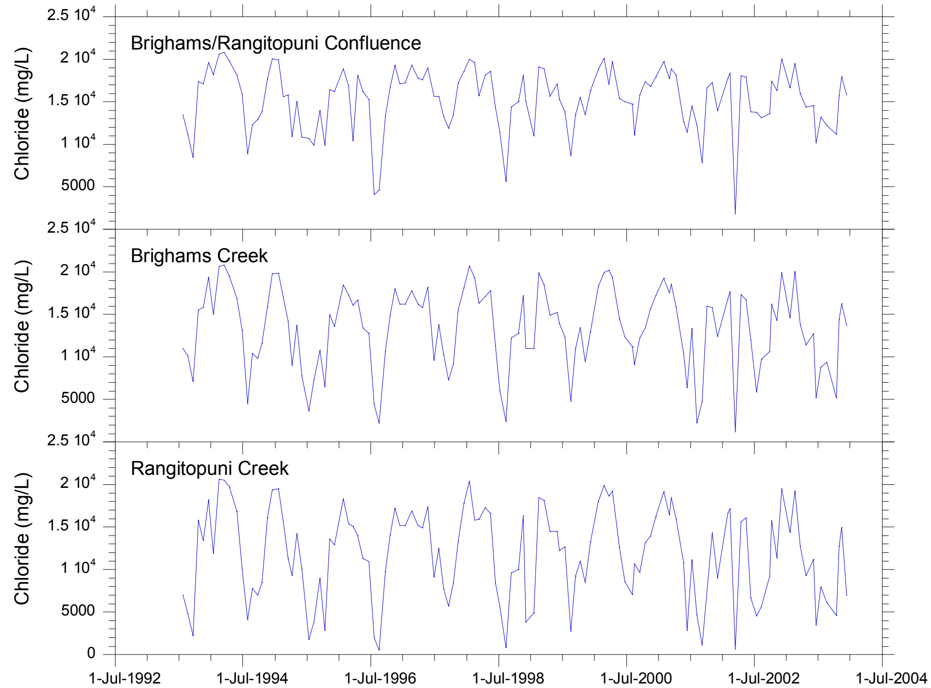
APPENDIX 47: UPPER WAITEMATA HARBOUR – CHLORIDE

a) Chloride (mg/L) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	18854	16827	17669	16404	15652	16640	14614	14369
19-Feb-03	20188	20361	19955	20196	20341	19472	20044	19290
21-Mar-03	18210	16125	16677	15395	14094	15966	13830	12740
23-Apr-03	17754	14510	15435	14448	13758	14388	11441	9252
5-Jun-03	18211	14488	16518	14870	13469	14539	12748	11200
19-Jun-03	14610	9197	10807	11327	6953	10182	5164	3494
17-Jul-03	18026	15332	16139	13954	9810	13220	8785	7984
18-Aug-03	17310	12650	14569	13335	12325	12201	9416	6116
15-Oct-03	15408	11545	12317	10441	7910	11181	5149	4599
29-Oct-03	18236	16370	17077	15981	15343	15706	14365	12783
12-Nov-03	19663	17998	18541	18324	16981	17970	16243	14971
10-Dec-03	19167	12650	17339	12738	5513	15786	13731	6924
Median	18211	14921	16598	14659	13614	15123	13240	10226
IQR/Median %	7	26	13	20	45	21	39	63

b) The graphs on the following pages show chloride results for the period 1993 to December 2003 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Chloride (mg/L)
2.5 10^4
2 10^4
1.5 10^4
1 10^4
5000
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004



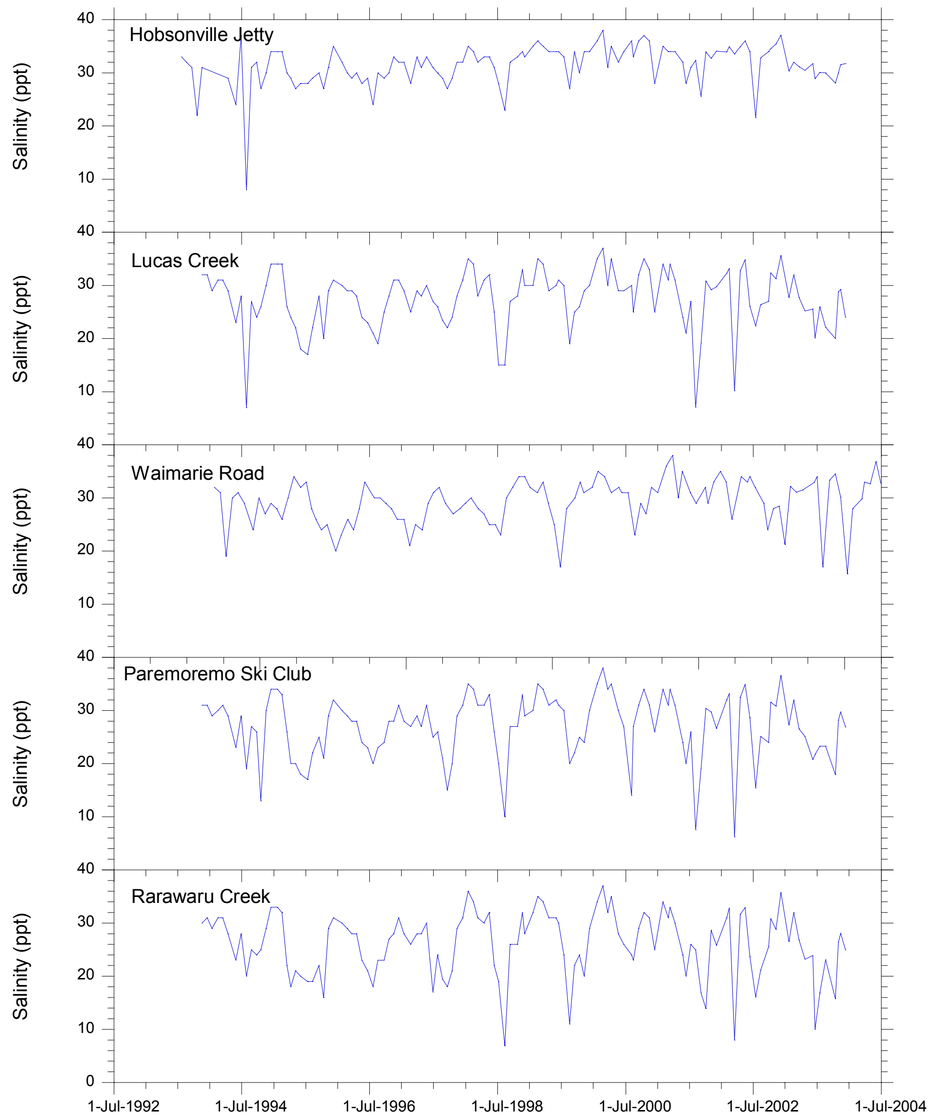
Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Chloride (mg/L)
2.5 10^4
2 10^4
1.5 10^4
1 10^4
5000
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

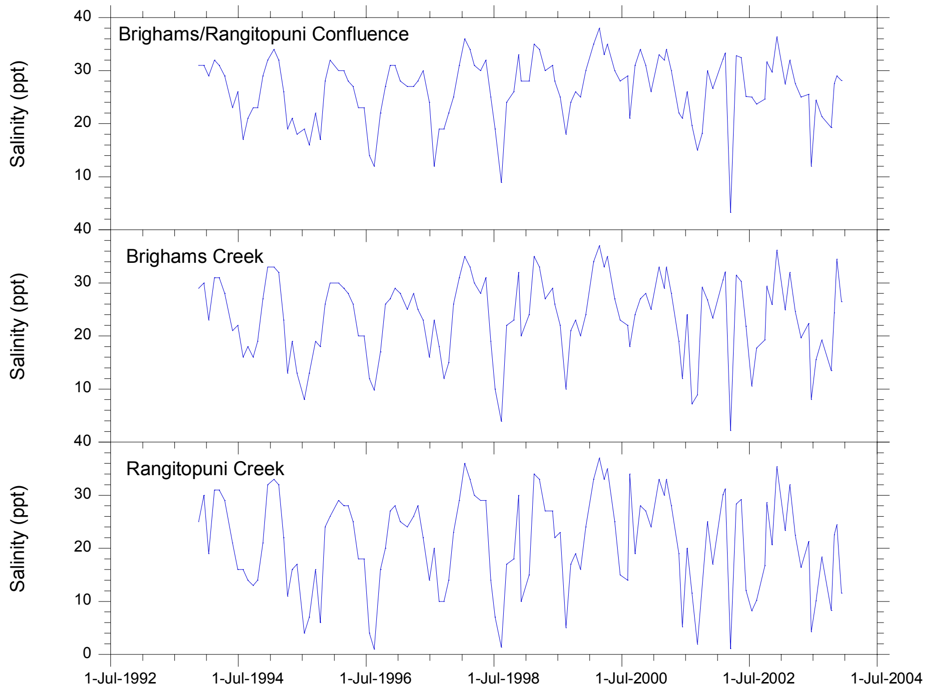
APPENDIX 48: UPPER WAITEMATA HARBOUR – SALINITY

a) Salinity (ppt) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	30.4	27.8	28.6	27.3	26.6	27.5	24.9	23.4
19-Feb-03	32	32	33	32	32	32	32	32
21-Mar-03	31.2	27.8	28.8	26.6	26.8	27.6	24.6	22.5
23-Apr-03	30.5	25.2	26.7	25.1	23.2	25	19.7	16.4
5-Jun-03	31.8	25.6	28.8	20.8	23.9	25.6	22.4	21.3
19-Jun-03	28.9	20.1	23.8	21.7	10	12	8	4.3
17-Jul-03	30.1	26	27.5	23.3	16.8	24.5	15.6	10.1
18-Aug-03	30	22.1	25.6	23.3	23.1	21.4	19.3	18.4
15-Oct-03	28.1	20	21.6	17.9	15.8	19.3	13.5	8.3
29-Oct-03	30	28.8	30	28.2	26.4	27.6	24.4	22.6
12-Nov-03	32	29	31	30	28	29	35	25
10-Dec-03	31.8	24	30.4	26.9	25	28.1	26.5	11.6
Median	30	26	29	26	24	27	23	20
IQR/Median %	5	18	13	18	21	15	30	58

b) The graphs on the following pages show salinity results for the period 1993 to December 2003 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Salinity (ppt)
40
30
20
10
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

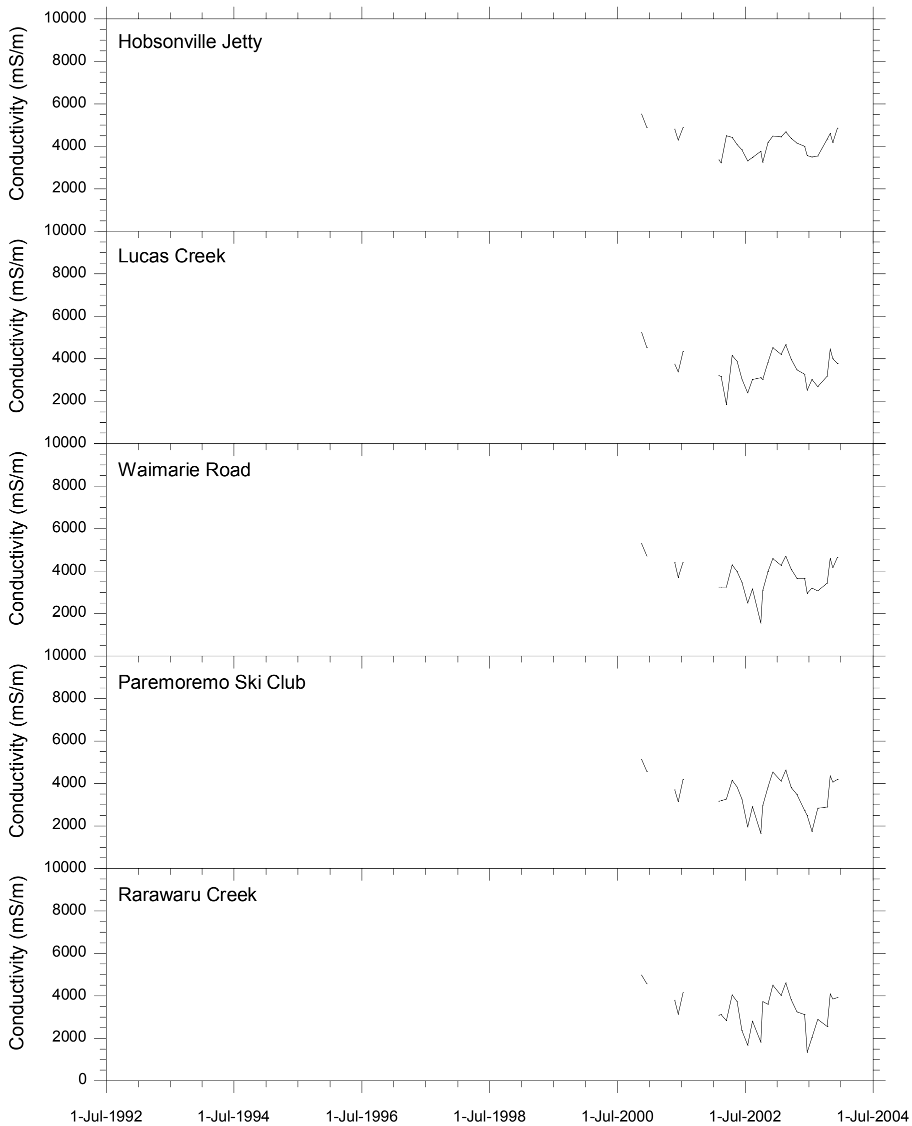

Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Salinity (ppt)
Salinity (ppt)
Salinity (ppt)
40
30
20
10
40
30
20
10
40
30
20
10
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

APPENDIX 49: UPPER WAITEMATA HARBOUR – CONDUCTIVITY

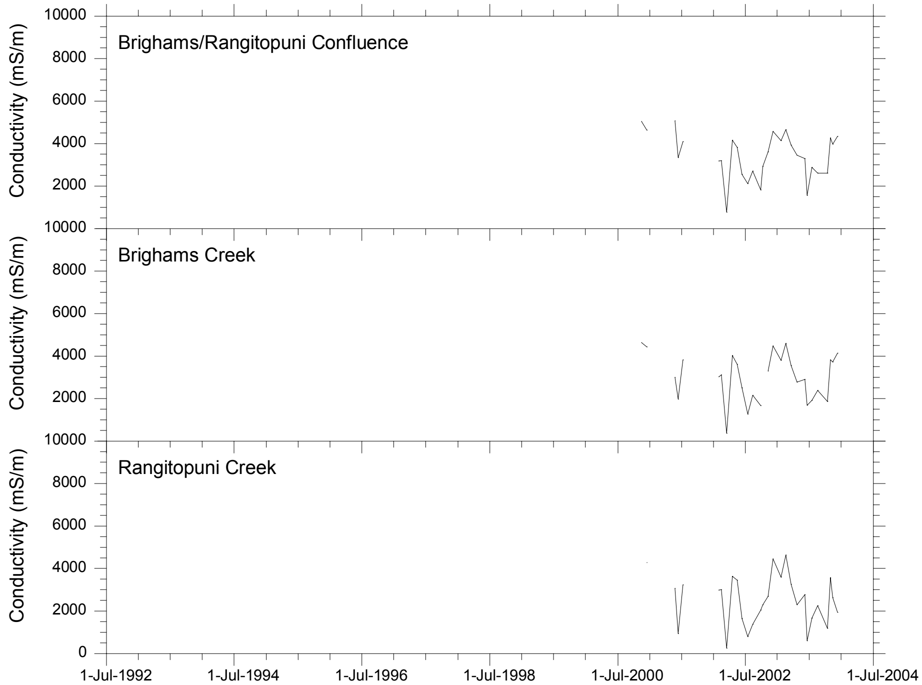
a) Conductivity (mS/m) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	4455	4201	4288	4130	4035	4143	3797	3600
19-Feb-03	4680	4672	4711	4640	4614	4660	4587	4640
21-Mar-03	4385	3983	4091	3820	3821	3926	3548	3256
23-Apr-03	4168	3484	3675	3483	3242	3467	2777	2306
5-Jun-03	4011	3288	3663	2739	3112	3304	2924	2783
19-Jun-03	3567	2525	2957	2501	1335	1580	1679	600
17-Jul-03	3508	3026	3206	1749	2056	2879	1907	1660
18-Aug-03	3554	2693	3082	2843	2877	2622	2382	2254
15-Oct-03	4352	3196	3432	2891	2573	2625	1876	1191
29-Oct-03	4616	4453	4613	4358	4107	4284	3829	3568
12-Nov-03	4195	4009	4151	4082	3875	3982	3724	2650
10-Dec-03	4861	3771	4677	4186	3912	4355	4137	1940
Median	4274	3628	3883	3652	3532	3697	3236	2478
IQR/Median %	14	25	26	36	32	37	48	59

b) The graphs on the following pages show conductivity results for the period 1993 to December 2003 (where data available).



Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Conductivity (mS/m)
0
2000
4000
6000
8000
10000
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004


Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Conductivity (mS/m)
Conductivity (mS/m)
Conductivity (mS/m)
10000
8000
6000
4000
2000
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

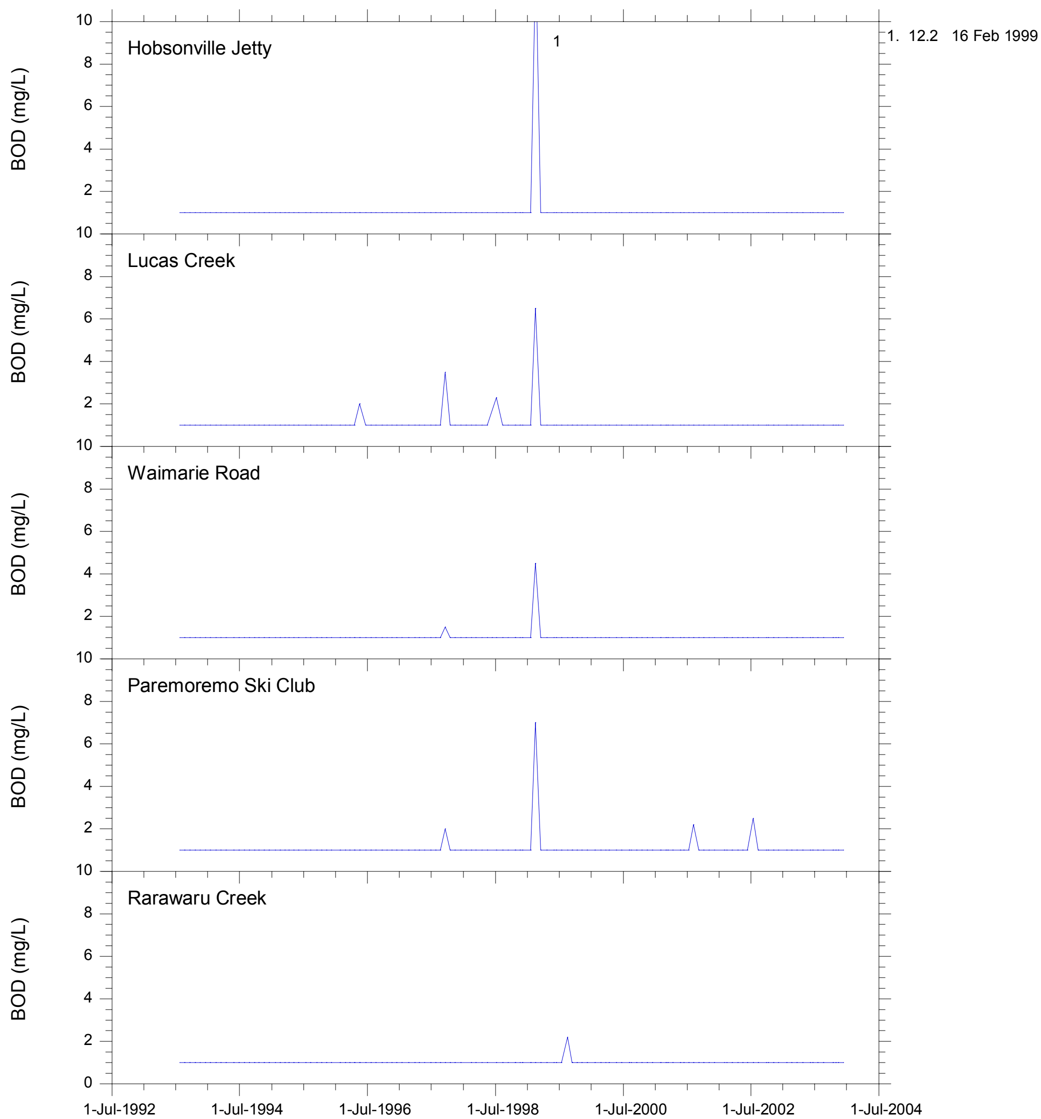
APPENDIX 50: UPPER WAITEMATA HARBOUR – BIOCHEMICAL OXYGEN DEMAND

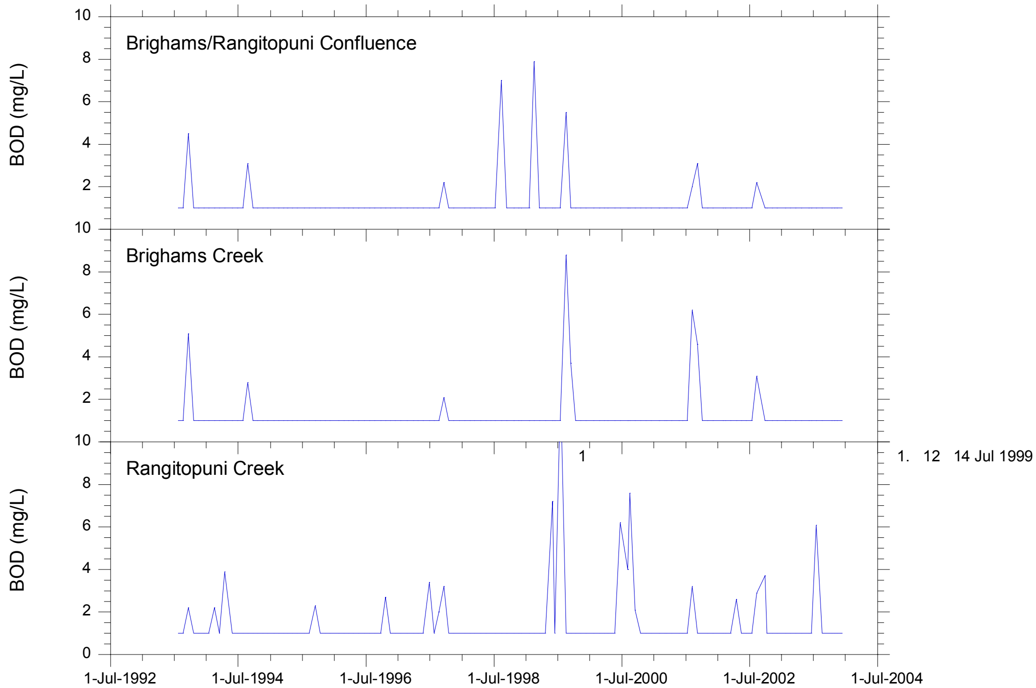
BOD (mg/L) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	<2	<2	<2	<2	<2	<2	<2	<2
19-Feb-03	<2	<2	<2	<2	<2	<2	<2	<2
21-Mar-03	<2	<2	<2	<2	<2	<2	<2	<2
23-Apr-03	<2	<2	<2	<2	<2	<2	<2	<2
5-Jun-03	<2	<2	<2	<2	<2	<2	<2	<2
19-Jun-03	<2	<2	<2	<2	<2	<2	<2	<2
17-Jul-03	<2	<2	<2	<2	<2	<2	<2	6.1
18-Aug-03	<2	<2	<2	<2	<2	<2	<2	<2
15-Oct-03	<2	<2	<2	<2	<2	<2	<2	<2
29-Oct-03	<2	<2	<2	<2	<2	<2	<2	<2
12-Nov-03	<2	<2	<2	<2	<2	<2	<2	<2
10-Dec-03	<2	<2	<2	<2	<2	<2	<2	<2
Median	1	1	1	1	1	1	1	1
IQR/Median %	0	0	0	0	0	0	0	0

b) The graphs on the following pages show BOD results for the period 1993 to December 2003 (where data available).

Method detection limit is 2.0 mg/L. For summary statistics, a result of "<2.0" is taken to have the value 1.0.


Hobsonville Jetty
1
1. 12.2 16 Feb 1999
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
BOD (mg/L)
0
2
4
6
8
10
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

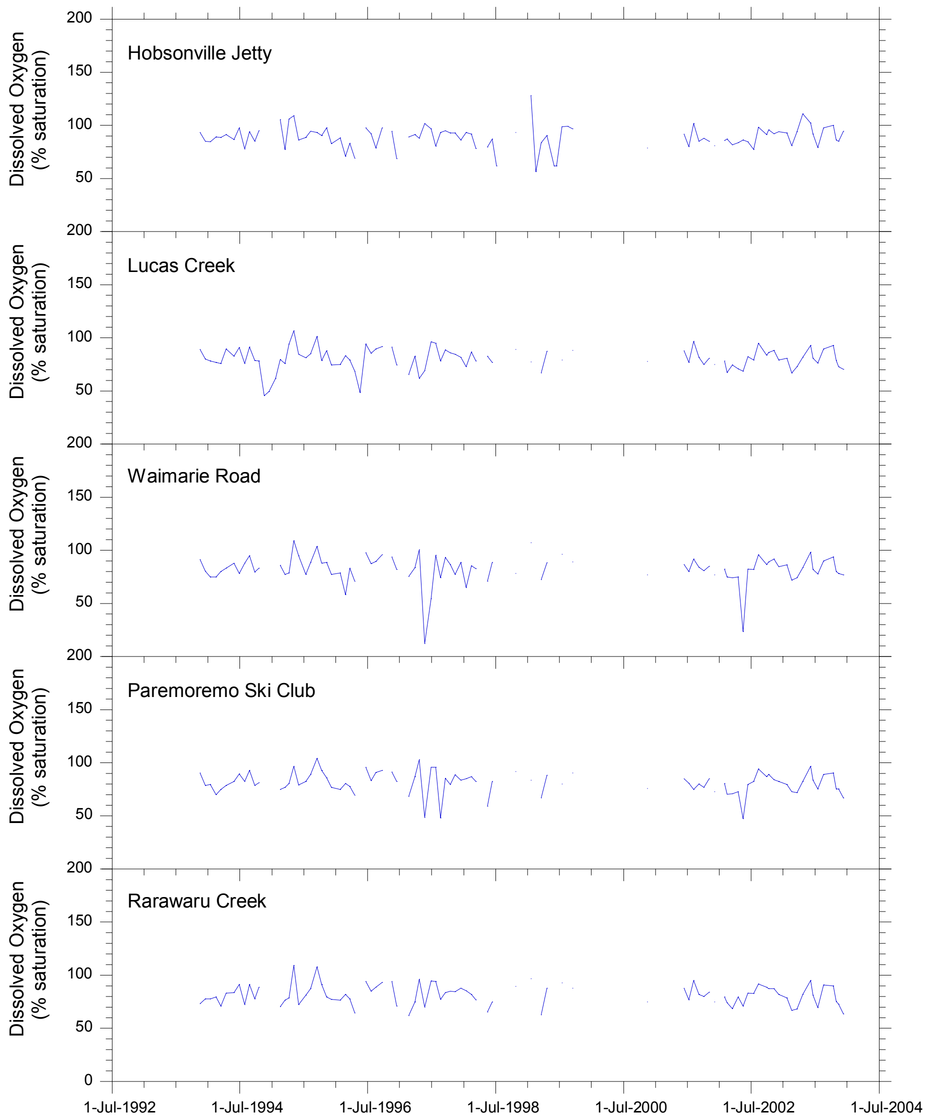

Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
BOD (mg/L)
BOD (mg/L)
BOD (mg/L)
0
2
4
6
8
10
1
1. 12 14 Jul 1999
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

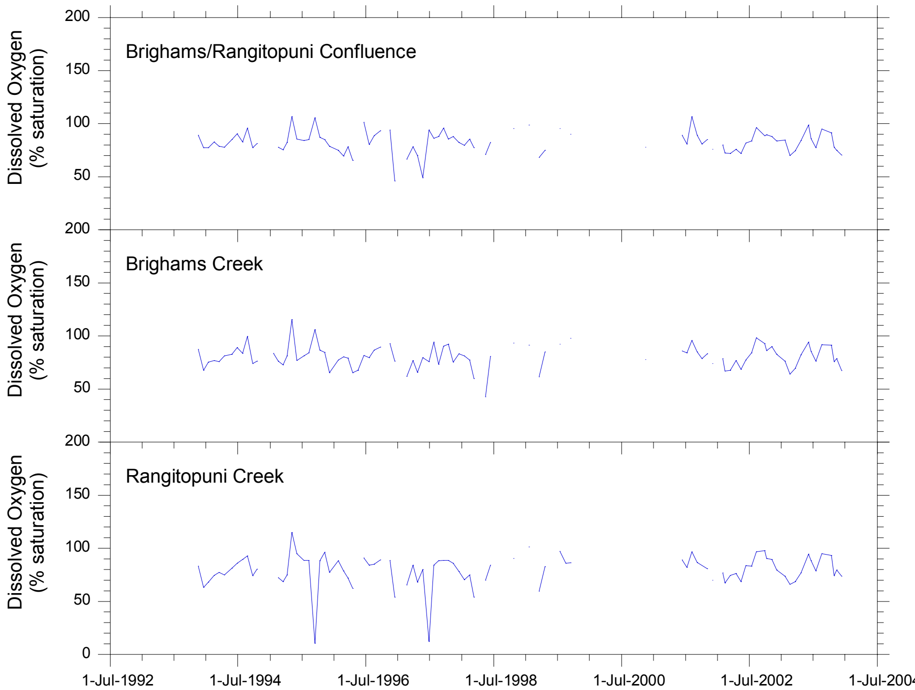
APPENDIX 51: UPPER WAITEMATA HARBOUR – DISSOLVED OXYGEN % SATURATION

a) Dissolved oxygen (% saturation) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	92.6	81.1	86.4	79.7	78.9	84.6	76.4	73.6
19-Feb-03	81.0	67.0	72.0	73.0	67.0	70.0	64.0	66.0
21-Mar-03	94.1	72.7	74.3	71.8	68.1	74.6	69.5	68.6
23-Apr-03	111	81.8	83.7	82.5	82.1	84.0	82.4	77.1
5-Jun-03	102.3	92.6	98.1	97.0	94.9	98.6	93.9	94.4
19-Jun-03	92.0	80.9	81.8	83.6	81.2	86.0	85.6	88.2
17-Jul-03	79.3	76.5	77.7	75.6	69.8	77.2	76.4	78.9
18-Aug-03	97.7	89.8	90.0	89.3	91	95.1	91.8	95.2
15-Oct-03	99.9	92.8	93.8	90.7	90.2	91.5	91.4	93.5
29-Oct-03	86.3	78.7	80.3	75.6	75.7	77.6	75.9	74.0
12-Nov-03	85.0	73.0	78.0	75.0	73.0	75.0	79.0	80.0
10-Dec-03	94.5	70.6	77.1	66.9	63.6	70.5	67.5	73.7
Median	93	80	81	78	77	81	78	78
IQR/Median %	13	14	12	13	19	15	16	20

b) The graphs on the following pages show dissolved oxygen (% saturation) results for the period 1993 to December 2003 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Dissolved Oxygen (% saturation)
200
150
100
50
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004



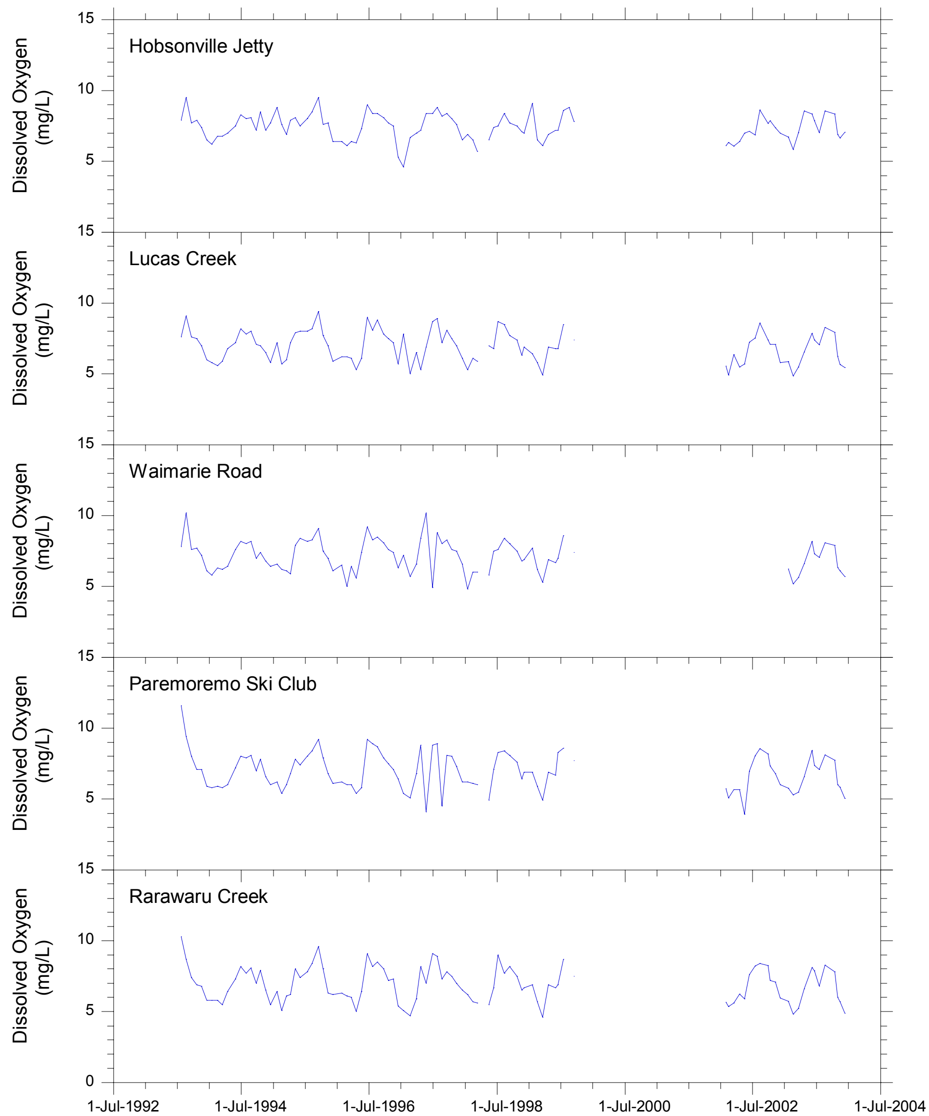
Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Dissolved Oxygen (% saturation)
200
150
100
50
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

APPENDIX 52: UPPER WAITEMATA HARBOUR – DISSOLVED OXYGEN mg/L

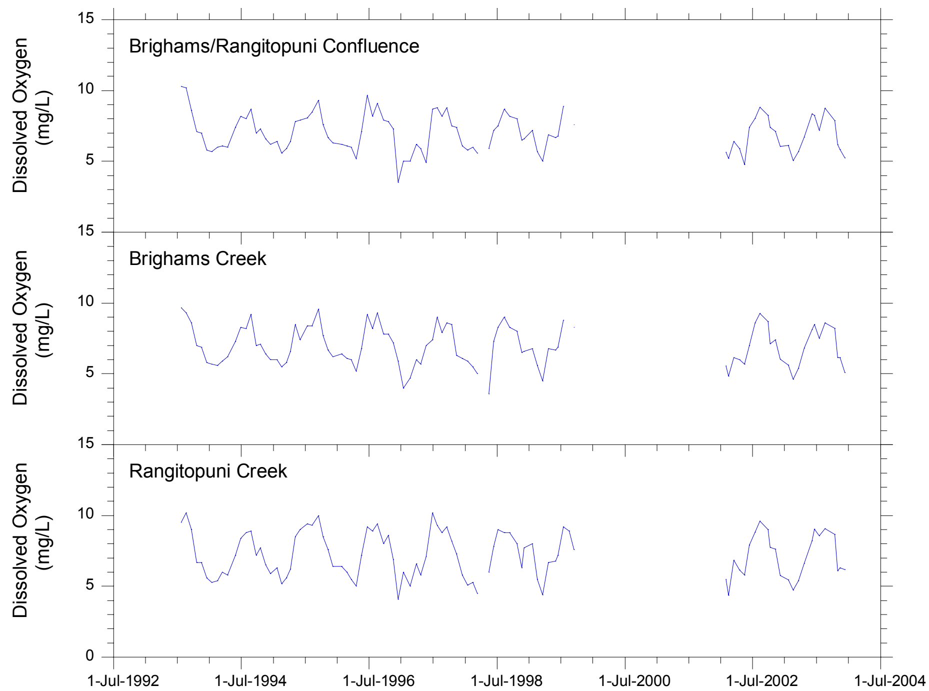
a) Dissolved oxygen (mg/L) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	6.72	5.87	6.25	5.78	5.75	6.15	5.63	5.46
19-Feb-03	5.84	4.84	5.19	5.28	4.82	5.06	4.62	4.75
21-Mar-03	7.02	5.5	5.63	5.49	5.23	5.69	5.39	5.4
23-Apr-03	8.55	6.55	6.63	6.59	6.62	6.72	6.84	6.61
5-Jun-03	8.35	7.89	8.17	8.44	8.11	8.35	8.12	8.24
19-Jun-03	7.87	7.40	7.29	7.36	7.89	8.26	8.49	9.03
17-Jul-03	7.04	7.06	7.07	7.08	6.77	7.19	7.50	8.55
18-Aug-03	8.57	8.27	8.10	8.12	8.27	8.78	8.60	9.08
15-Oct-03	8.35	7.97	7.92	7.75	7.83	7.86	8.22	8.67
29-Oct-03	6.90	6.23	6.35	6.00	6.02	6.17	6.14	6.09
12-Nov-03	6.65	5.67	6.09	5.83	5.70	5.83	6.15	6.30
10-Dec-03	7.05	5.45	5.68	5.06	4.89	5.25	5.08	6.19
Median	7.05	6.39	6.49	6.30	6.32	6.45	6.50	6.46
IQR/Median %	21	30	22	28	36	34	40	41

b) The graphs on the following pages show dissolved oxygen results for the period 1993 to December 2003 (where data available).



Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Dissolved Oxygen (mg/L)
15
10
5
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004


Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Dissolved Oxygen (mg/L)
15
10
5
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

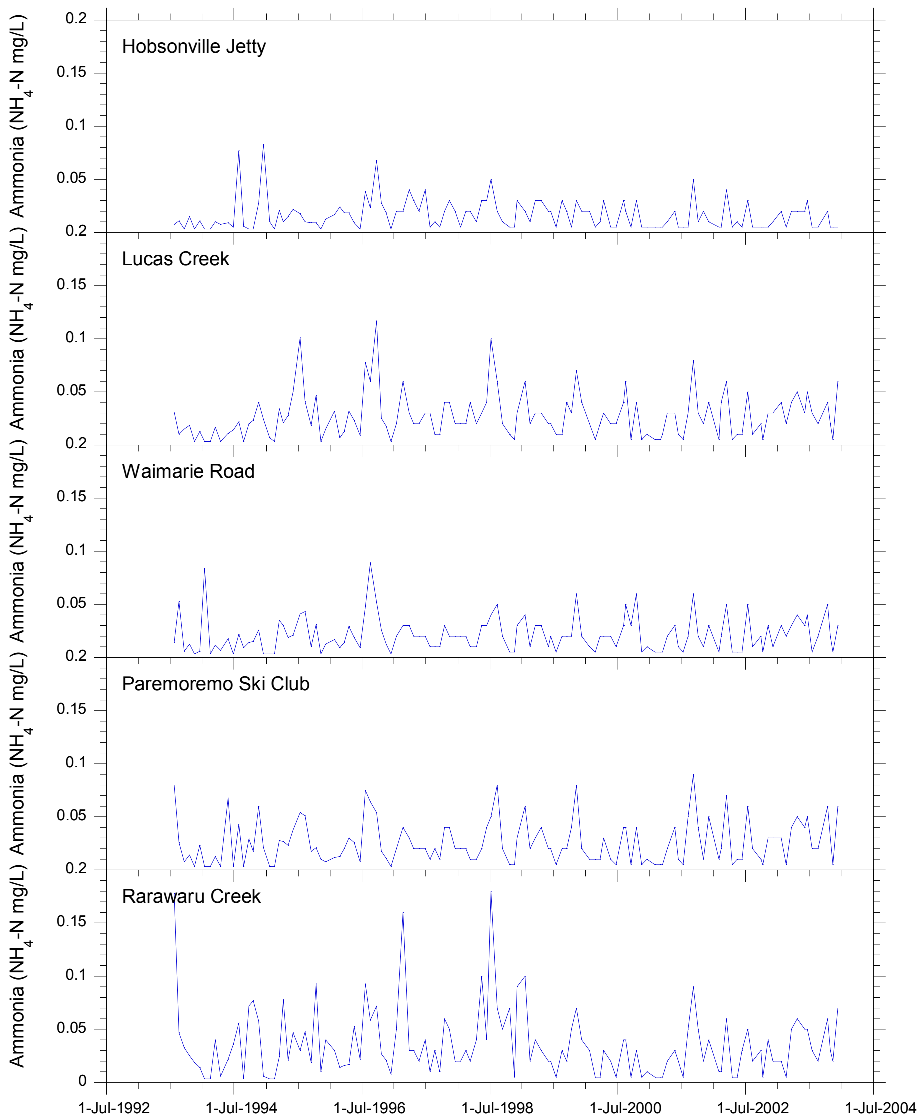
APPENDIX 53: UPPER WAITEMATA HARBOUR – AMMONIA NITROGEN

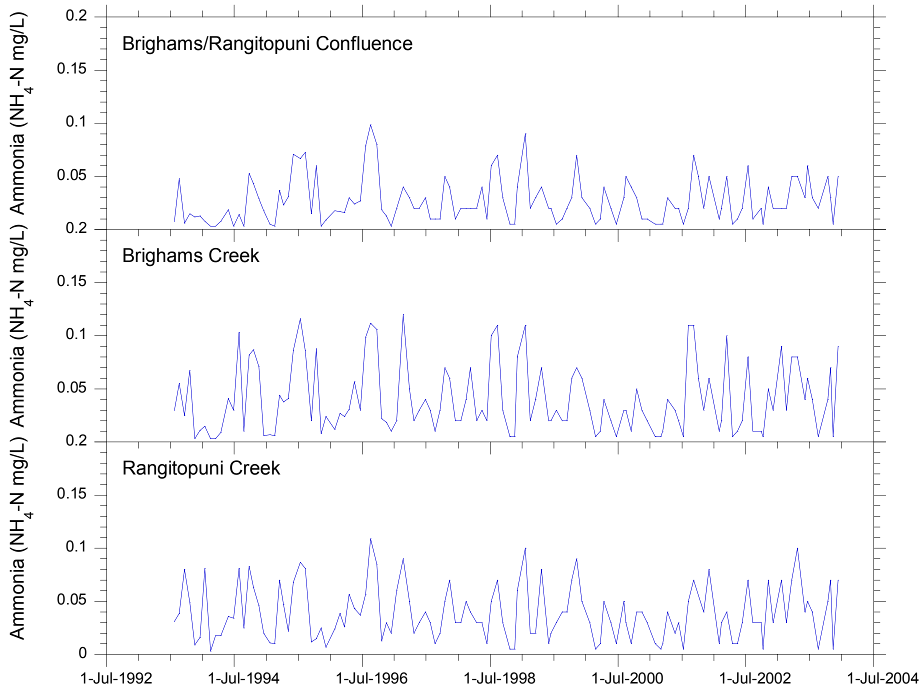
a) Ammonia nitrogen (mg/L) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	0.02	0.04	0.03	0.03	0.02	0.02	0.09	0.07
19-Feb-03	<0.01	0.02	0.02	<0.01	<0.01	0.02	0.03	0.03
21-Mar-03	0.02	0.04	0.03	0.04	0.05	0.05	0.08	0.07
23-Apr-03	0.02	0.05	0.04	0.05	0.06	0.05	0.08	0.1
5-Jun-03	0.02	0.03	0.03	0.04	0.05	0.03	0.04	0.04
19-Jun-03	0.03	0.05	0.04	0.05	0.05	0.06	0.06	0.05
17-Jul-03	<0.01	0.03	<0.01	0.02	0.03	0.03	0.04	0.04
18-Aug-03	<0.01	0.02	0.02	0.02	0.02	0.02	<0.01	<0.01
15-Oct-03	0.02	0.04	0.05	0.06	0.06	0.05	0.04	0.05
29-Oct-03	<0.01	0.02	0.02	0.03	0.03	0.03	0.07	0.07
12-Nov-03	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
10-Dec-03	<0.01	0.06	0.03	0.06	0.07	0.05	0.09	0.07
Median	0.01	0.04	0.03	0.04	0.04	0.03	0.05	0.05
IQR/Median %	120	64	42	86	81	100	85	65

b) The graphs on the following pages show ammonia nitrogen results for the period 1993 to December 2003 (where data available).

Method detection limit is 0.01 mg/L. For summary statistics, a result of "<0.01" is taken to have the value 0.005.


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Ammonia (NH_4-N mg/L)
0.2
0.15
0.1
0.05
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004


Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Ammonia (NH_4-N mg/L)
0.2
0.15
0.1
0.05
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

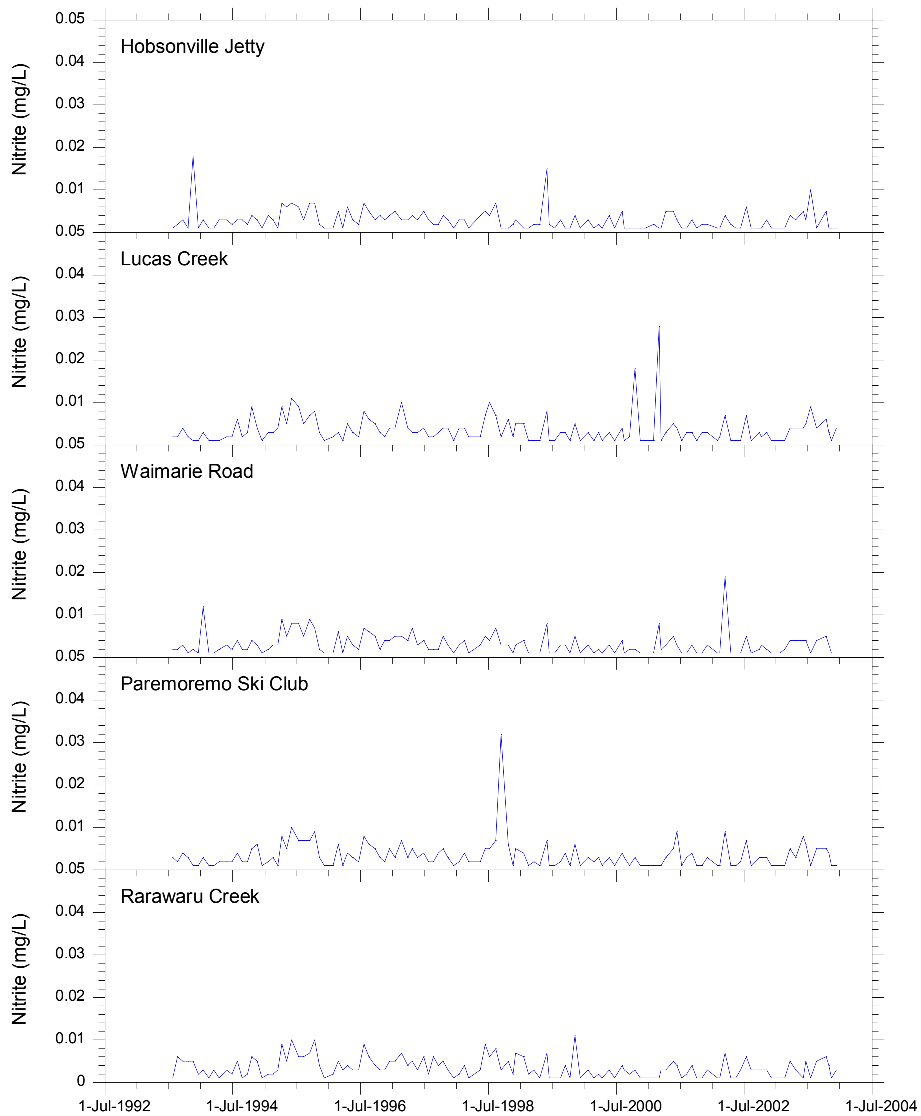
APPENDIX 54: UPPER WAITEMATA HARBOUR – NITRITE NITROGEN

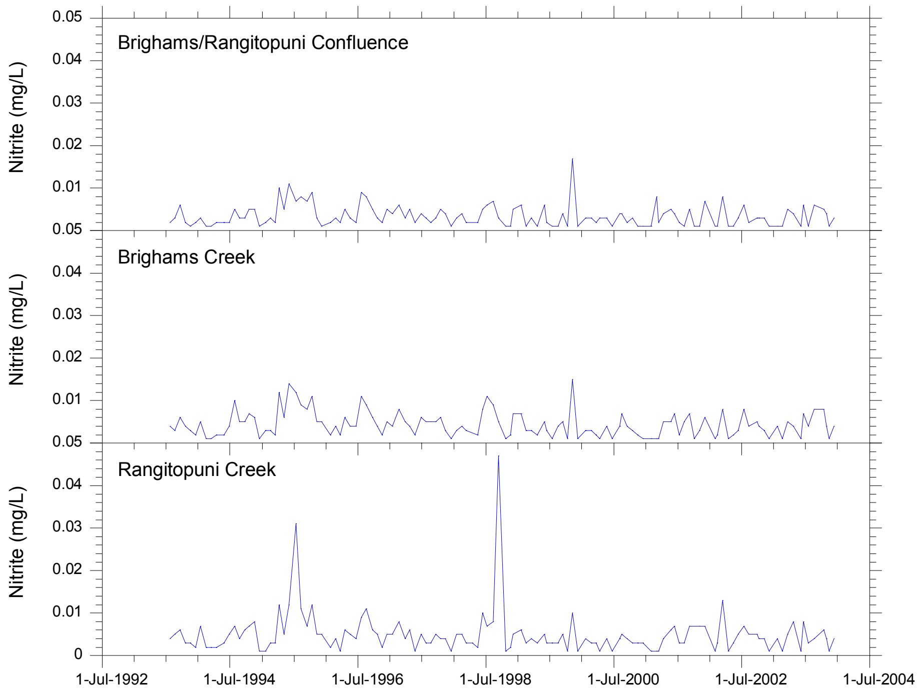
a) Nitrite nitrogen (mg/L) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	0.004
19-Feb-03	<0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002
21-Mar-03	0.004	0.004	0.004	0.005	0.005	0.005	0.005	0.005
23-Apr-03	0.003	0.004	0.004	0.003	0.003	0.004	0.004	0.008
5-Jun-03	0.005	0.004	0.004	0.008	<0.002	<0.002	<0.002	<0.002
19-Jun-03	0.003	0.005	0.004	0.006	0.005	0.006	0.007	0.008
17-Jul-03	0.01	0.009	<0.002	<0.002	<0.002	<0.002	0.004	0.003
18-Aug-03	<0.002	0.004	0.004	0.005	0.005	0.006	0.008	0.004
15-Oct-03	0.005	0.006	0.005	0.005	0.006	0.005	0.008	0.006
29-Oct-03	<0.002	0.003	0.003	0.004	0.004	0.004	0.004	0.004
12-Nov-03	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
10-Dec-03	<0.002	0.004	<0.002	<0.002	0.003	0.003	0.004	0.004
Median	0.002	0.004	0.004	0.004	0.003	0.004	0.004	0.004
IQR/Median %	163	44	86	114	133	114	56	69

b) The graphs on the following pages show nitrite nitrogen results for the period 1993 to December 2003 (where data available).

Method detection limit is 0.002 mg/L. For summary statistics, a result of "<0.002" is taken to have the value 0.001.


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Nitrite (mg/L)
0.05
0.04
0.03
0.02
0.01
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004


Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Nitrite (mg/L)
0.05
0.04
0.03
0.02
0.01
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

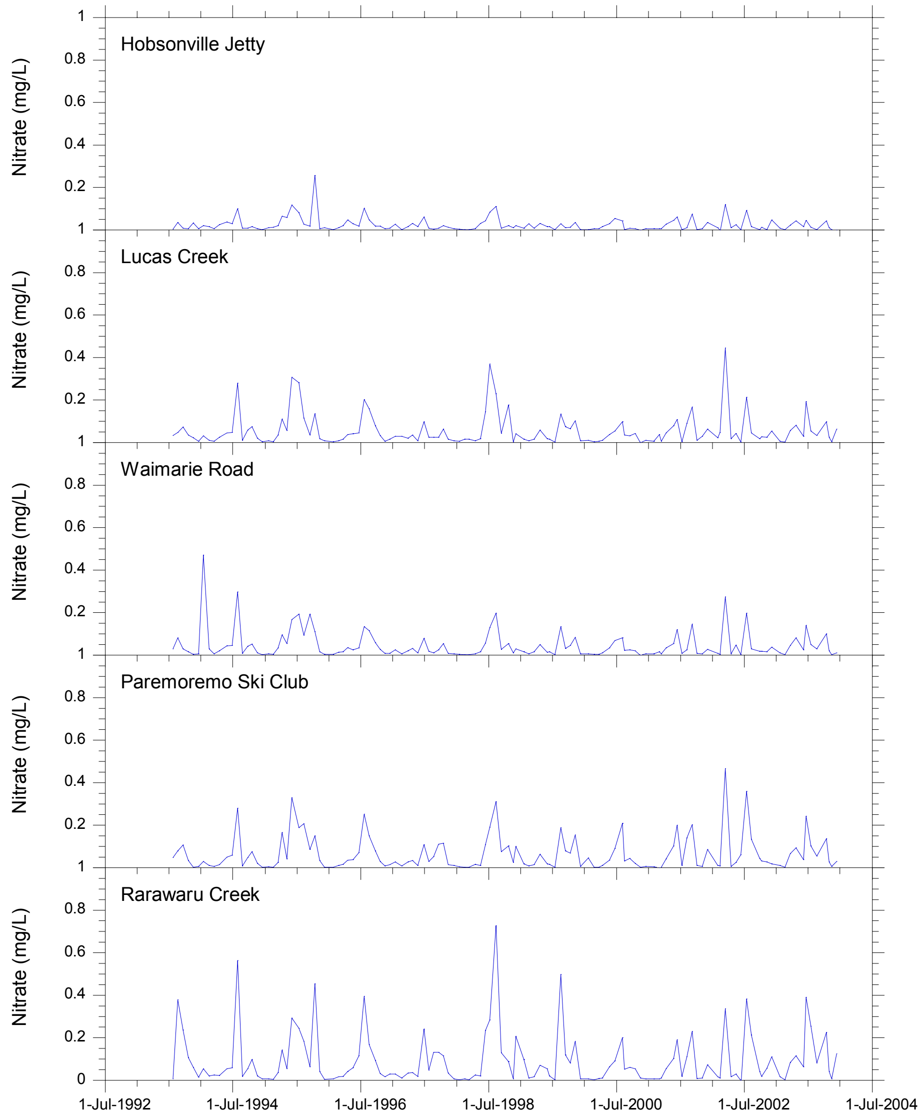
APPENDIX 55: UPPER WAITEMATA HARBOUR – NITRATE NITROGEN

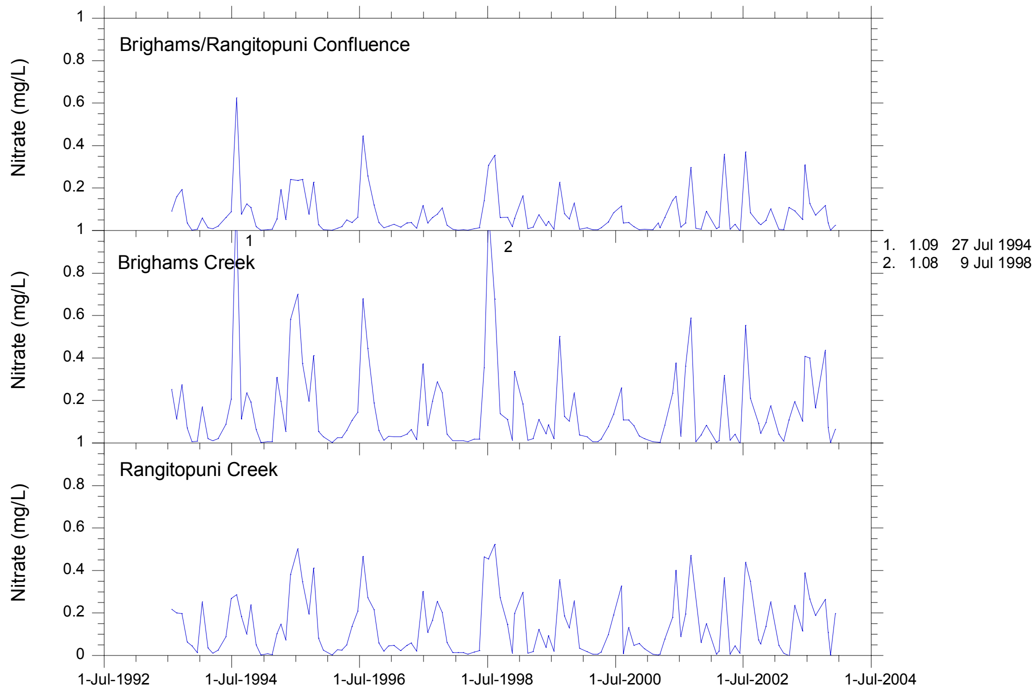
a) Nitrate nitrogen (mg/L) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	0.010	0.007	0.011	0.012	0.017	0.006	0.041	0.048
19-Feb-03	0.004	0.002	0.002	0.004	0.004	0.005	0.009	0.011
21-Mar-03	0.023	0.058	0.047	0.067	0.084	0.109	0.11	0.001
23-Apr-03	0.044	0.083	0.081	0.095	0.116	0.095	0.196	0.238
5-Jun-03	0.015	0.031	0.025	0.039	0.064	0.052	0.102	0.115
19-Jun-03	0.046	0.193	0.141	0.243	0.392	0.310	0.410	0.388
17-Jul-03	0.014	0.054	0.05	0.103	0.254	0.127	0.401	0.267
18-Aug-03	0.003	0.035	0.031	0.055	0.083	0.074	0.166	0.189
15-Oct-03	0.043	0.098	0.100	0.137	0.224	0.119	0.436	0.264
29-Oct-03	0.011	0.024	0.021	0.028	0.042	0.036	0.074	0.109
12-Nov-03	0.002	0.005	0.003	0.006	0.007	0.004	0.003	0.004
10-Dec-03	0	0.064	0.011	0.029	0.124	0.024	0.066	0.199
Median	0.013	0.045	0.028	0.047	0.084	0.063	0.106	0.152
IQR/Median %	194	110	167	155	136	146	177	135

b) The graphs on the following pages show nitrate nitrogen results for the period 1993 to December 2003 (where data available).

NO_3-N is calculated from the difference between NNN and NO_2-N. Zero or negative results may be obtained and are recorded as zero.


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Nitrate (mg/L)
1
0.8
0.6
0.4
0.2
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004


Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Nitrate (mg/L)
1
0.8
0.6
0.4
0.2
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004
1. 1.09 27 Jul 1994
2. 1.08 9 Jul 1998

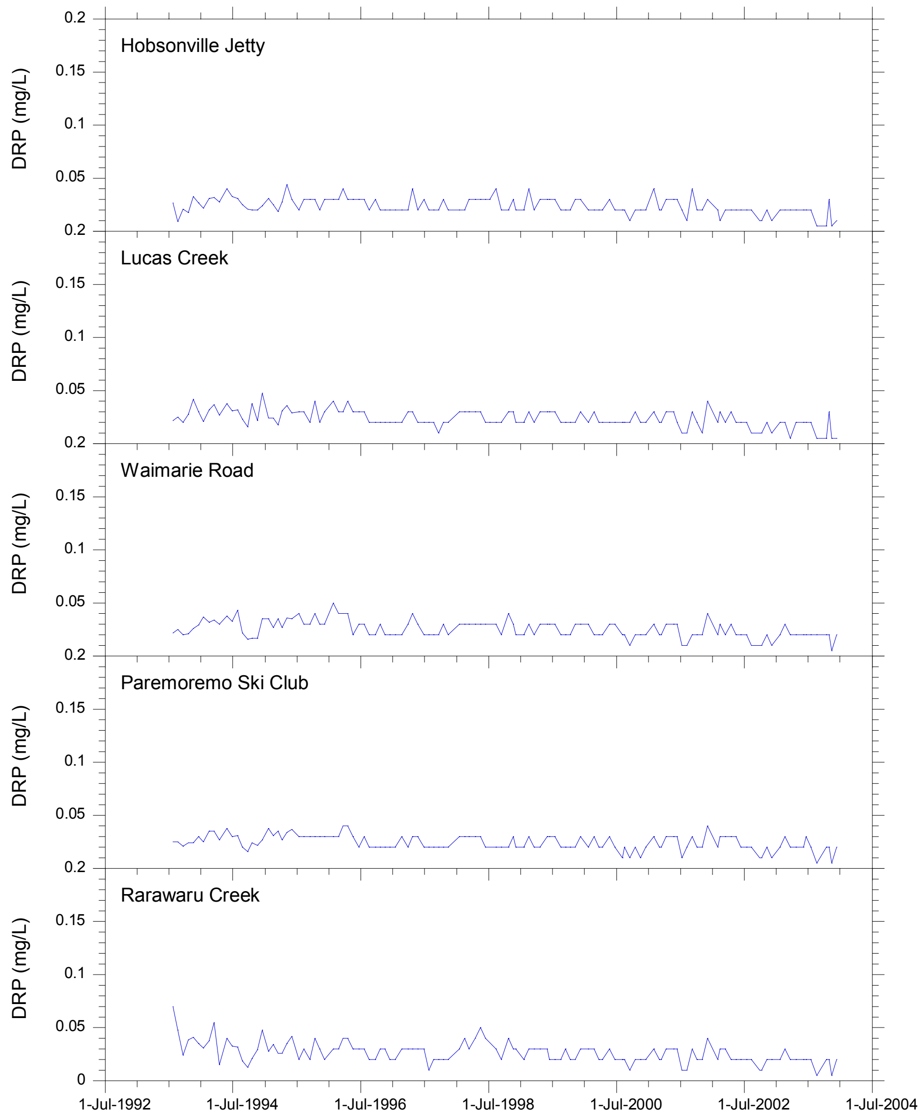
APPENDIX 56: UPPER WAITEMATA HARBOUR – DISSOLVED REACTIVE PHOSPHORUS

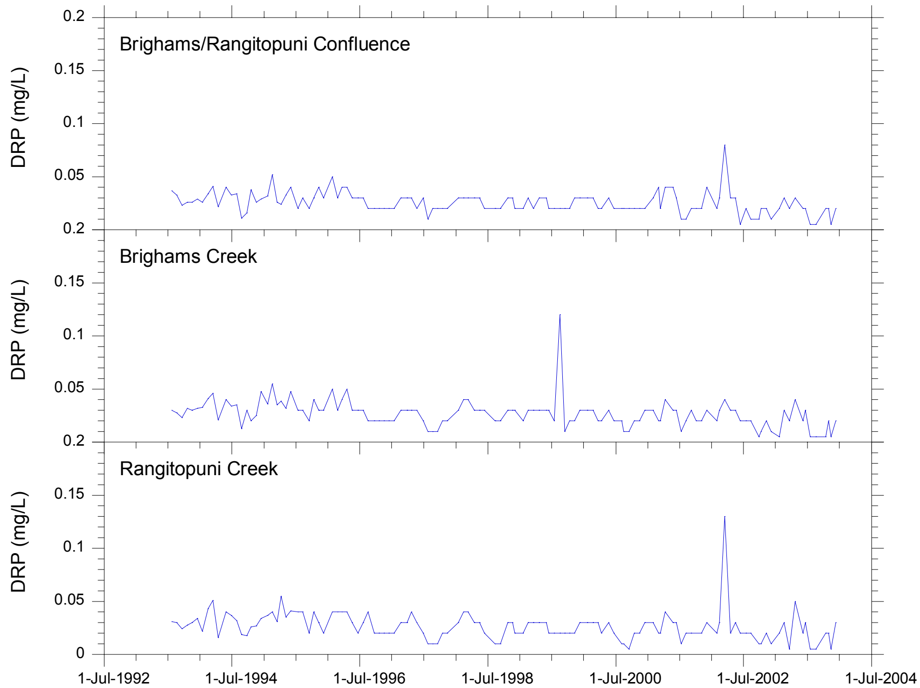
a) Dissolved reactive phosphorus (mg/L) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	0.02	0.02	0.02	0.02	0.02	0.02	<0.01	0.02
19-Feb-03	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03
21-Mar-03	0.02	<0.01	0.02	0.02	0.02	0.02	0.02	<0.01
23-Apr-03	0.02	0.02	0.02	0.02	0.02	0.03	0.04	0.05
5-Jun-03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
19-Jun-03	0.02	0.02	0.02	0.03	0.02	0.02	0.03	0.03
17-Jul-03	0.02	0.02	0.02	0.02	0.02	<0.01	<0.01	<0.01
18-Aug-03	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01
15-Oct-03	<0.01	<0.01	0.02	0.02	0.02	0.02	<0.01	0.02
29-Oct-03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02
12-Nov-03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
10-Dec-03	0.01	<0.01	0.02	0.02	0.02	0.02	0.02	0.03
Median	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
IQR/Median %	56	75	0	0	0	19	88	125

b) The graphs on the following pages show dissolved reactive phosphorus results for the period 1993 to December 2003 (where data available).

Method detection limit is 0.01 mg/L. For summary statistics, a result of "<0.01" is taken to have the value 0.005.


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
DRP (mg/L)
0.2
0.15
0.1
0.05
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

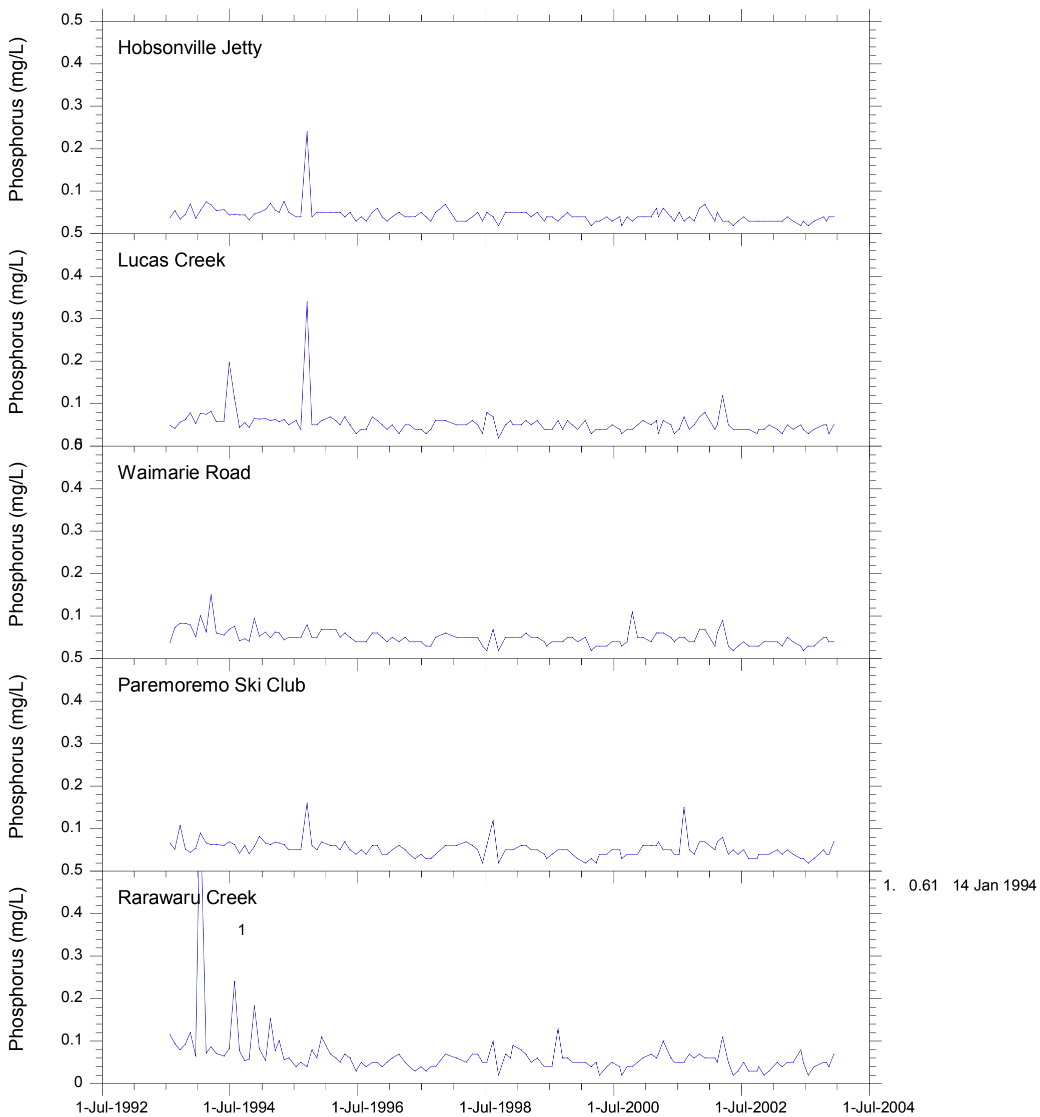

Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
DRP (mg/L)
DRP (mg/L)
DRP (mg/L)
0.2
0.15
0.1
0.05
0.2
0.15
0.1
0.05
0.2
0.15
0.1
0.05
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

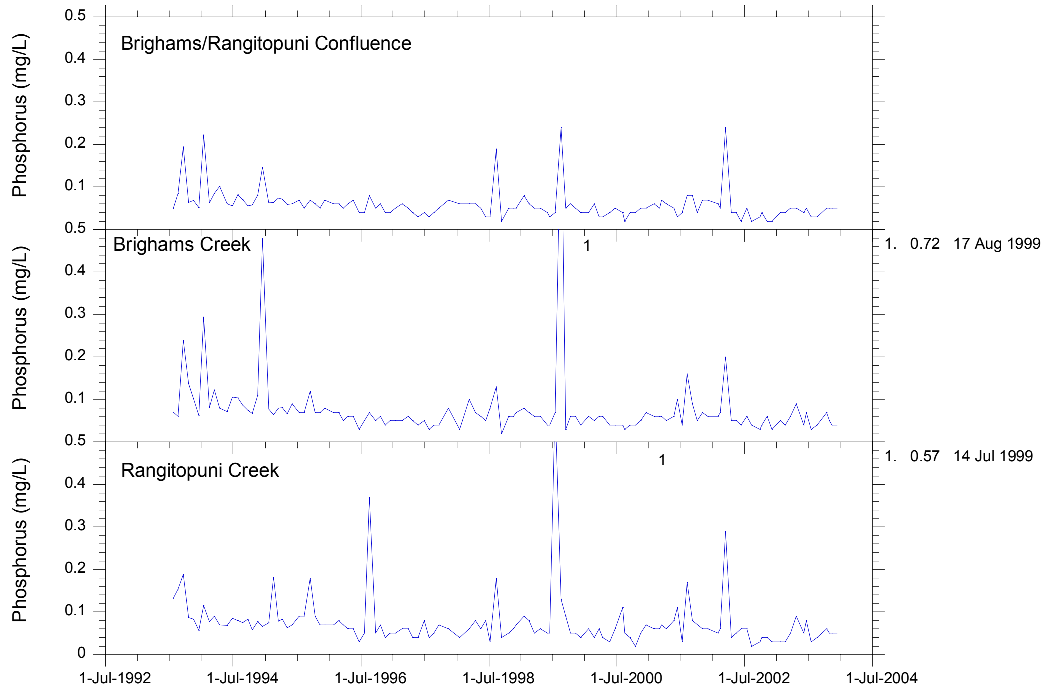
APPENDIX 57: UPPER WAITEMATA HARBOUR – TOTAL PHOSPHORUS

a) Total phosphorus (mg/L) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	0.03	0.04	0.04	0.05	0.05	0.04	0.05	0.03
19-Feb-03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.03
21-Mar-03	0.04	0.05	0.05	0.05	0.05	0.05	0.06	0.05
23-Apr-03	0.03	0.04	0.04	0.04	0.05	0.05	0.09	0.09
5-Jun-03	0.02	0.05	0.03	0.03	0.08	0.04	0.04	0.05
19-Jun-03	0.03	0.04	0.02	0.03	0.05	0.05	0.07	0.08
17-Jul-03	0.02	0.03	0.03	0.02	0.02	0.03	0.03	0.03
18-Aug-03	0.03	0.04	0.03	0.03	0.04	0.03	0.04	0.04
15-Oct-03	0.04	0.05	0.05	0.05	0.05	0.05	0.07	0.06
29-Oct-03	0.03	0.05	0.05	0.04	0.05	0.05	0.05	0.05
12-Nov-03	0.04	0.03	0.04	0.04	0.04	0.05	0.04	0.05
10-Dec-03	0.04	0.05	0.04	0.07	0.07	0.05	0.04	0.05
Median	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.05
IQR/Median %	33	31	31	50	20	20	50	30

b) The graphs on the following pages show total phosphorus results for the period 1993 to December 2003 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
1
Phosphorus (mg/L)
1. 0.61 14 Jan 1994
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

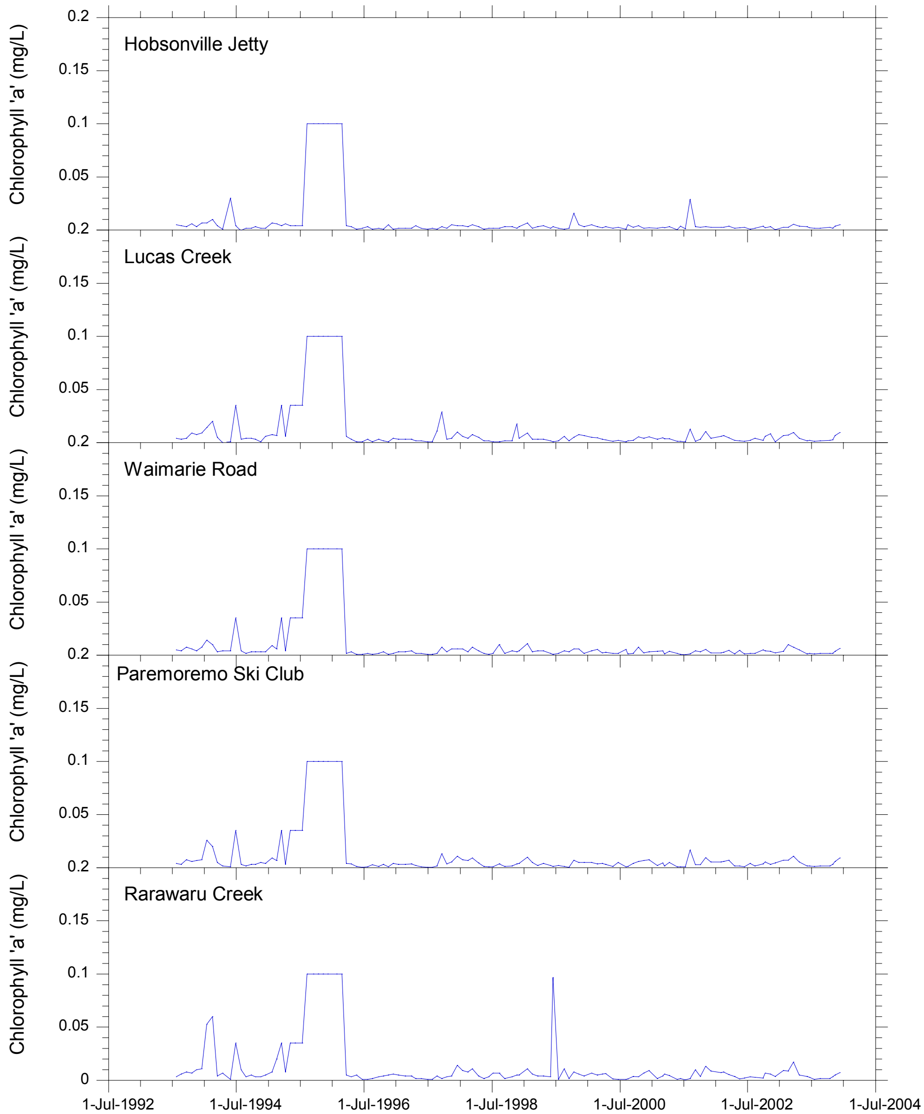

Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Phosphorus (mg/L)
1. 0.72 17 Aug 1999
1. 0.57 14 Jul 1999
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

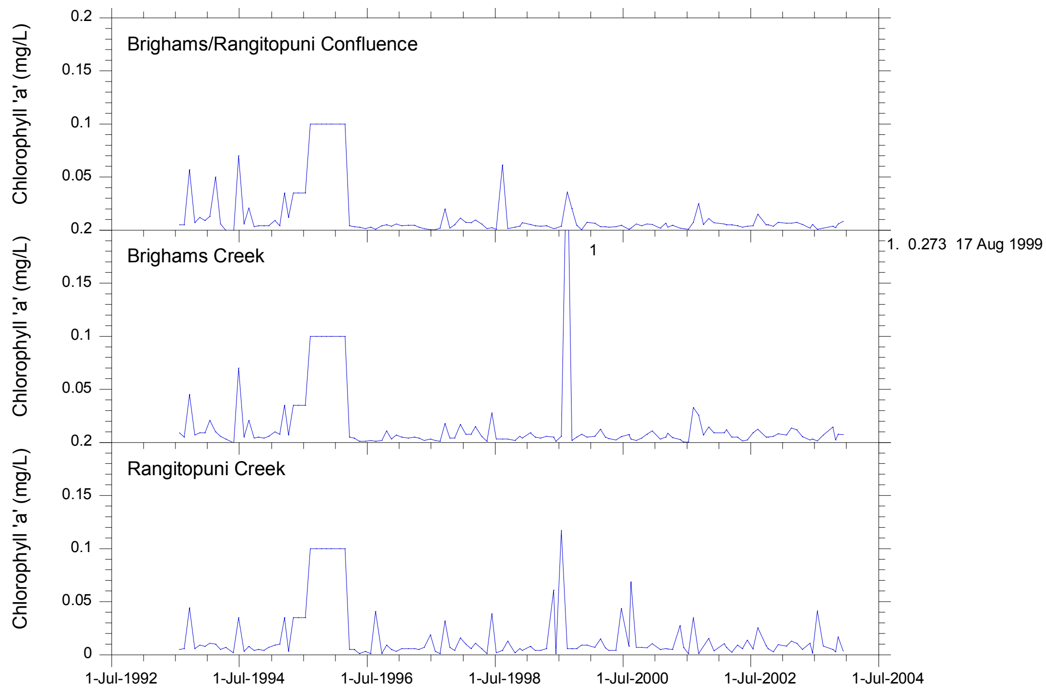
APPENDIX 58: UPPER WAITEMATA HARBOUR – CHLOROPHYLL a

a) Chlorophyll *a* (mg/L) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	0.0027	0.0067	0.0038	0.0074	0.0091	0.0065	0.0071	0.0082
19-Feb-03	0.0028	0.0075	0.0102	0.0073	0.0086	0.0066	0.0136	0.0127
21-Mar-03	0.0055	0.0098	0.0078	0.0111	0.0174	0.0075	0.0119	0.0112
23-Apr-03	0.0039	0.0042	0.0052	0.0054	0.0052	0.0054	0.0057	0.0051
5-Jun-03	0.0030	0.0018	0.0016	0.0018	0.0036	0.0018	0.0026	0.0109
19-Jun-03	0.0025	0.0024	0.0021	0.0021	0.0028	0.0055	0.0031	0.0016
17-Jul-03	0.0019	0.0016	0.0015	0.0013	0.0010	0.0009	0.0013	0.0416
18-Aug-03	0.0020	0.0019	0.0021	0.0018	0.0019	0.0020	0.0070	0.0081
15-Oct-03	0.0027	0.0024	0.0017	0.0019	0.0020	0.0038	0.0146	0.0049
29-Oct-03	0.0019	0.0029	0.0019	0.0031	0.0030	0.0026	0.0025	0.0027
12-Nov-03	0.0039	0.0068	0.0039	0.0059	0.0049	0.0062	0.0078	0.0168
10-Dec-03	0.0049	0.0096	0.0064	0.0090	0.0072	0.0083	0.0072	0.0036
Median	0.0028	0.0036	0.0030	0.0043	0.0043	0.0055	0.0071	0.0082
IQR/Median %	55	132	124	128	116	75	83	86

b) The graphs on the following pages show chlorophyll *a* results for the period 1993 to December 2003 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Chlorophyll 'a' (mg/L)
0.2
0.15
0.1
0.05
0
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004



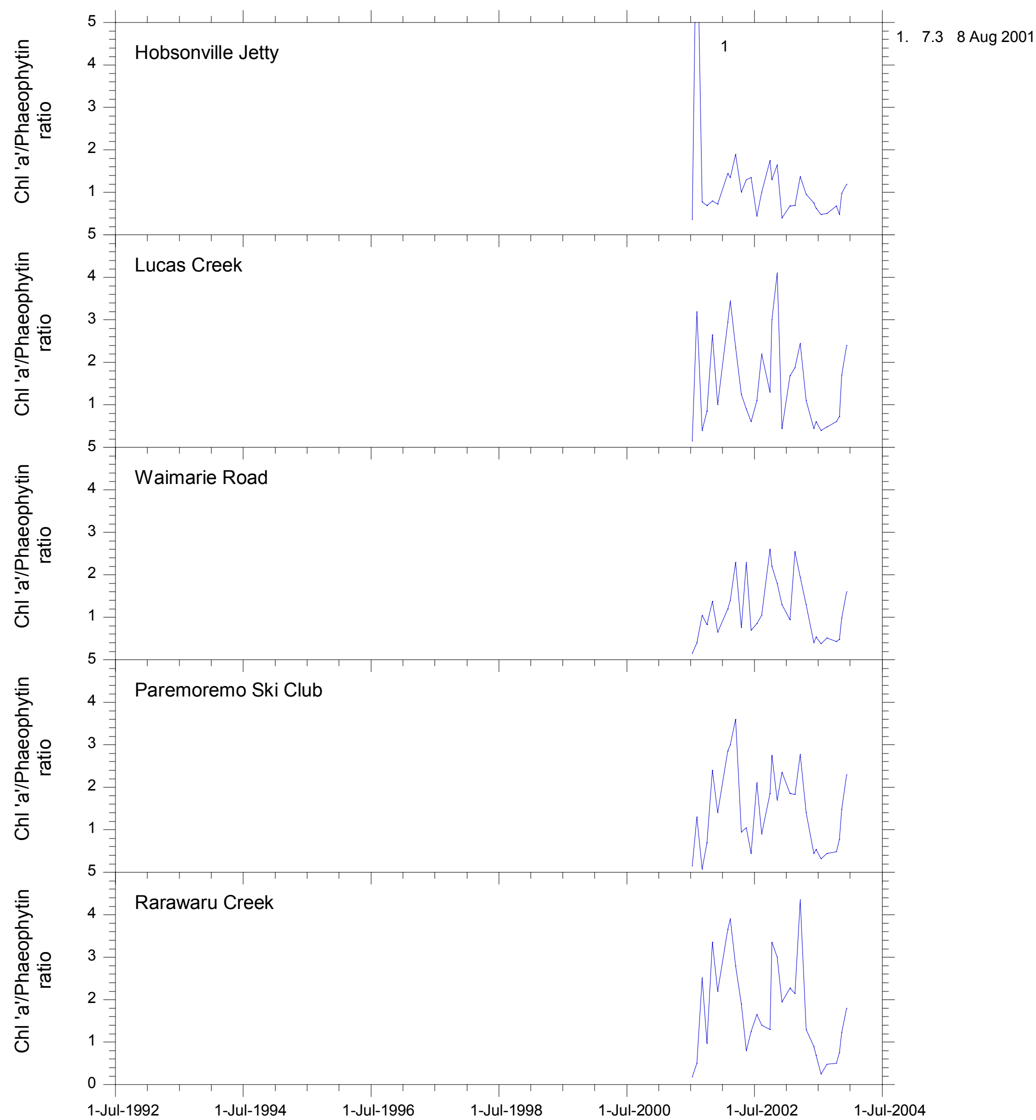
Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Chlorophyll 'a' (mg/L)
0.2
0.15
0.1
0.05
0
1
1. 0.273 17 Aug 1999
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

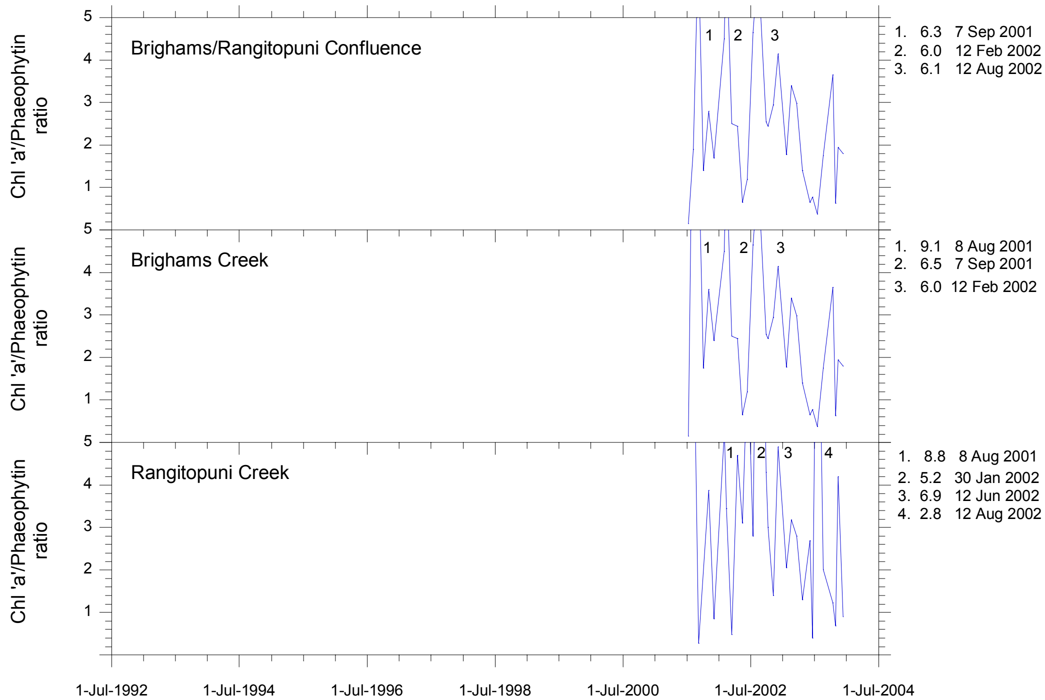
APPENDIX 59: UPPER WAITEMATA HARBOUR – CHLOROPHYLL/PHAEOPHYTIN RATIO

a) Chlorophyll/phaeophytin ratio for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	0.68	1.68	0.95	1.85	2.28	1.62	1.77	2.05
19-Feb-03	0.70	1.88	2.55	1.83	2.15	1.65	3.40	3.18
21-Mar-03	1.38	2.45	1.95	2.78	4.35	1.88	2.98	2.80
23-Apr-03	0.96	1.10	1.30	1.40	1.30	1.40	1.40	1.30
5-Jun-03	0.75	0.45	0.40	0.45	0.90	0.45	0.65	2.70
19-Jun-03	0.63	0.60	0.53	0.53	0.70	1.38	0.78	0.40
17-Jul-03	0.48	0.40	0.38	0.32	0.25	0.22	0.38	10.60
18-Aug-03	0.50	0.48	0.52	0.45	0.48	0.50	1.75	2.02
15-Oct-03	0.68	0.60	0.43	0.48	0.50	0.95	3.65	1.23
29-Oct-03	0.48	0.73	0.48	0.78	0.75	0.65	0.63	0.68
12-Nov-03	0.98	1.70	0.98	1.48	1.23	1.55	1.95	4.20
10-Dec-03	1.20	2.40	1.60	2.30	1.80	2.10	1.80	0.90
Median	0.69	0.92	0.74	1.09	1.07	1.39	1.76	2.04
IQR/Median %	53	128	123	125	116	73	83	86

b) The graphs on the following pages show total chlorophyll/phaeophytin ratio results for the period 1993 to December 2003 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Chl 'a'/Phaeophytin ratio
1
1. 7.3 8 Aug 2001
0
1
2
3
4
5
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004


Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Chl 'a'/Phaeophytin ratio
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004
1. 6.3 7 Sep 2001
2. 6.0 12 Feb 2002
3. 6.1 12 Aug 2002
1. 9.1 8 Aug 2001
2. 6.5 7 Sep 2001
3. 6.0 12 Feb 2002
1. 8.8 8 Aug 2001
2. 5.2 30 Jan 2002
3. 6.9 12 Jun 2002
4. 2.8 12 Aug 2002

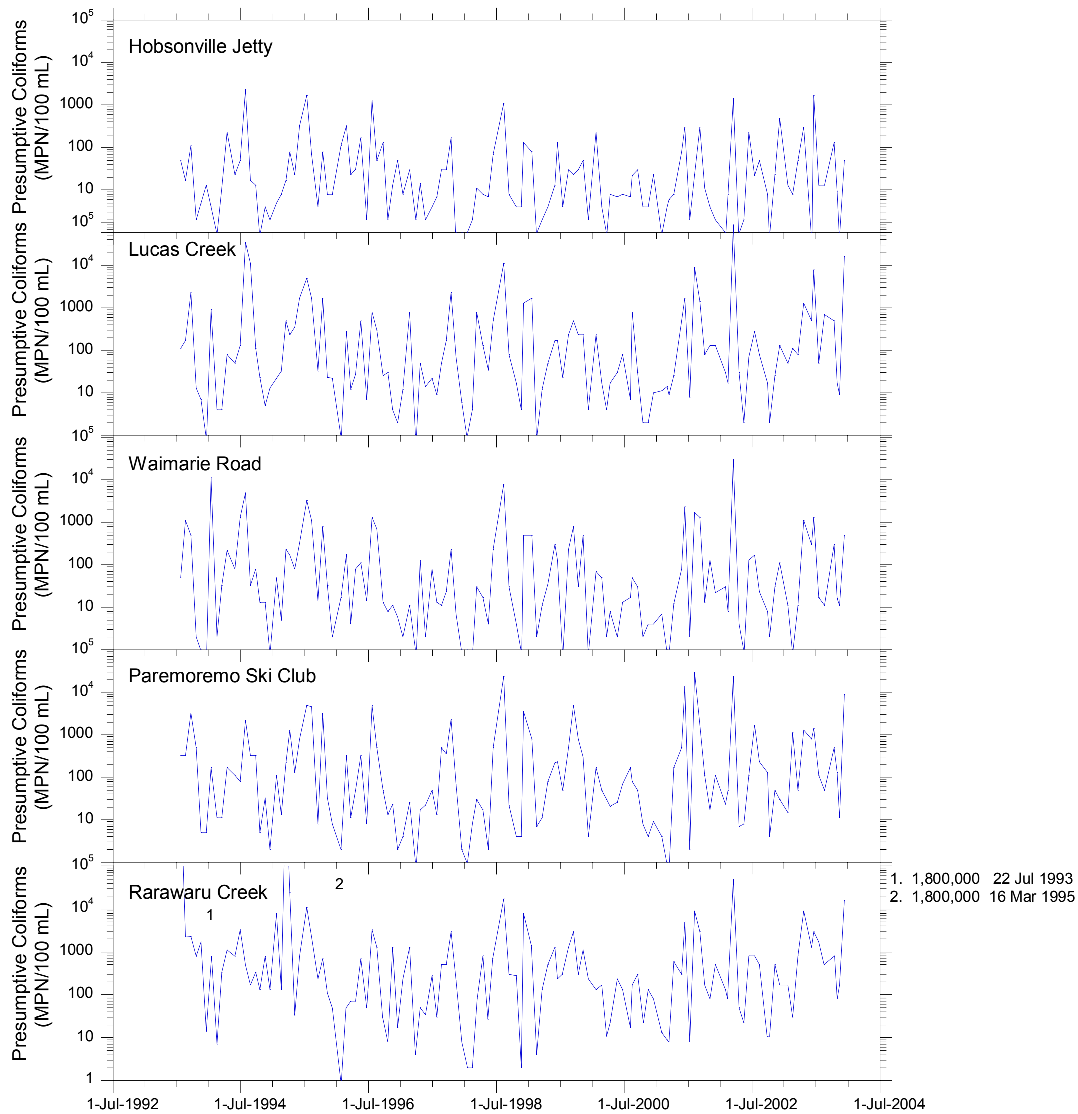
APPENDIX 60: UPPER WAITEMATA HARBOUR – PRESUMPTIVE COLIFORMS

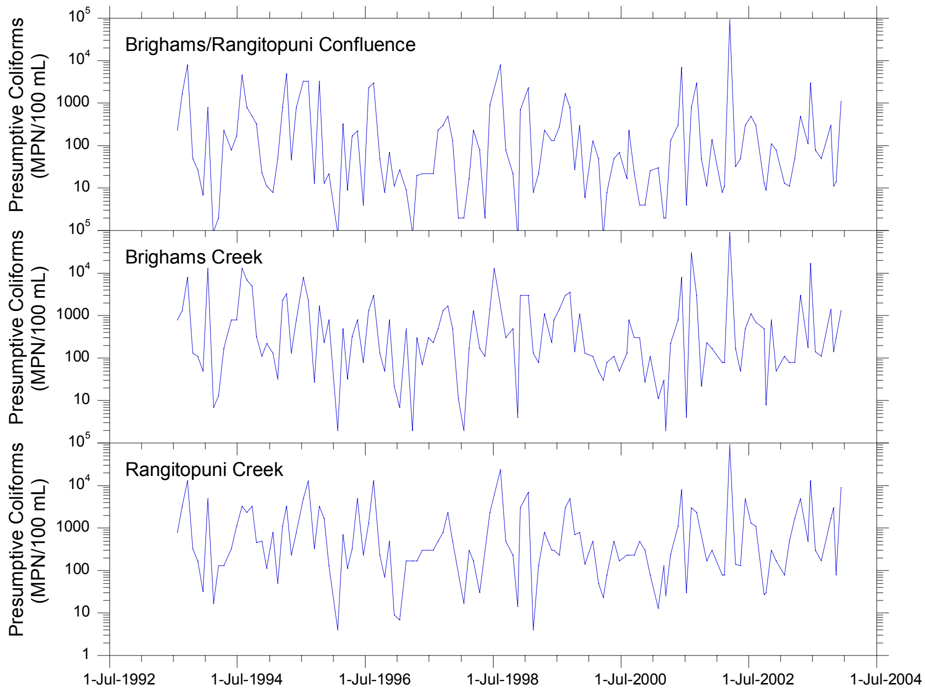
a) Presumptive coliforms (MPN/100mL) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	13	50	11	15	170	13	110	80
19-Feb-03	8	110	<2	1100	30	11	80	500
21-Mar-03	50	80	11	50	800	50	80	1700
23-Apr-03	300	1300	1100	1300	9000	500	3000	5000
5-Jun-03	<2	500	300	800	1300	110	180	500
19-Jun-03	1700	8000	1300	1400	3000	3000	17000	13000
17-Jul-03	13	50	17	110	1700	80	140	300
18-Aug-03	13	700	11	50	500	50	110	170
15-Oct-03	130	500	300	500	800	300	1400	1700
29-Oct-03	9	17	16	130	80	11	140	3000
12-Nov-03	<2	9	11	11	170	14	300	80
10-Dec-03	50	16000	500	9000	16000	1100	1300	9000
Median	13	305	17	315	800	65	160	1100
IQR/Median %	471	262	2055	349	232	517	759	294

b) The graphs on the following pages show presumptive coliform results for the period 1993 to December 2003 (where data available).

Method detection limit is 2 MPN/100 mL. For summary statistics, a result of "<2" is taken to have the value 1.


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Presumptive Coliforms (MPN/100 mL)
1
2
1. 1,800,000 22 Jul 1993
2. 1,800,000 16 Mar 1995
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004



Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Presumptive Coliforms (MPN/100 mL)
1
10
100
1000
10^4
10^5
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

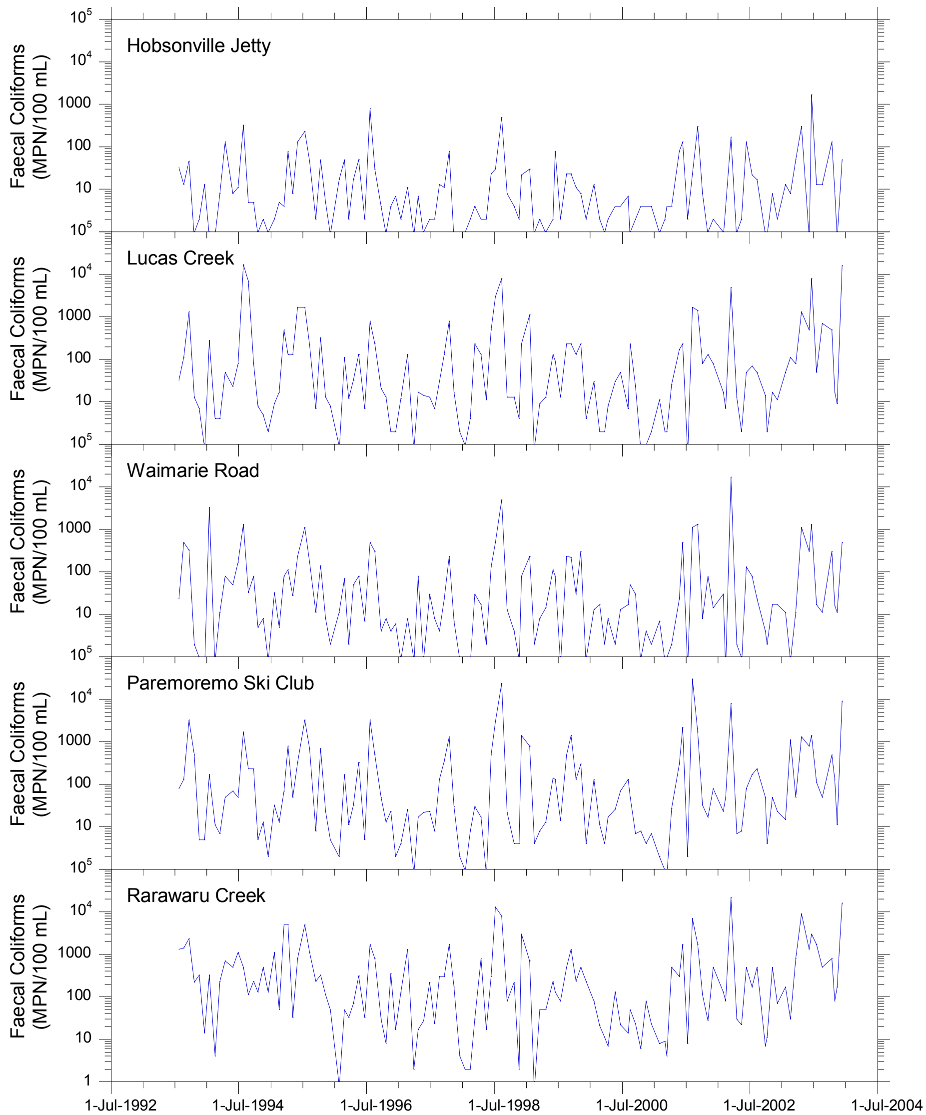
APPENDIX 61: UPPER WAITEMATA HARBOUR –FAECAL COLIFORMS

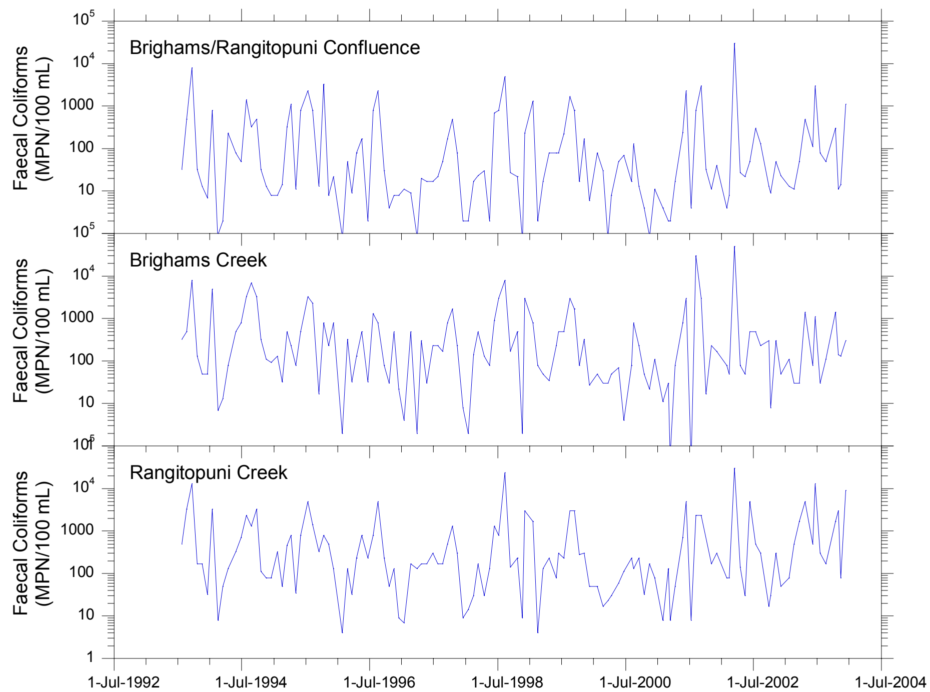
a) Faecal coliforms (MPN/100mL) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	<2	11	4	15	80	13	110	80
19-Feb-03	<2	50	<2	80	13	8	30	30
21-Mar-03	7	30	17	50	800	30	30	800
23-Apr-03	170	300	300	500	1100	500	1400	3000
5-Jun-03	<2	500	130	500	50	30	80	300
19-Jun-03	40	400	300	500	300	130	1100	1300
17-Jul-03	<2	50	11	30	1300	13	30	80
18-Aug-03	<2	80	11	13	130	17	110	80
15-Oct-03	130	170	300	300	800	300	1400	500
29-Oct-03	4	17	9	130	80	11	140	130
12-Nov-03	<2	4	<2	14	110	4	130	50
10-Dec-03	13	5000	140	9000	3000	110	300	3000
Median	3	65	14	105	215	24	120	215
IQR/Median %	750	459	1230	451	370	436	360	393

b) The graphs on the following pages show faecal coliform results for the period 1993 to December 2003 (where data available).

Method detection limit is 2 MPN/100 mL. For summary statistics, a result of "<2" is taken to have the value 1.


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Faecal Coliforms (MPN/100 mL)
10^5
10^4
1000
100
10
1
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004



Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Faecal Coliforms (MPN/100 mL)
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

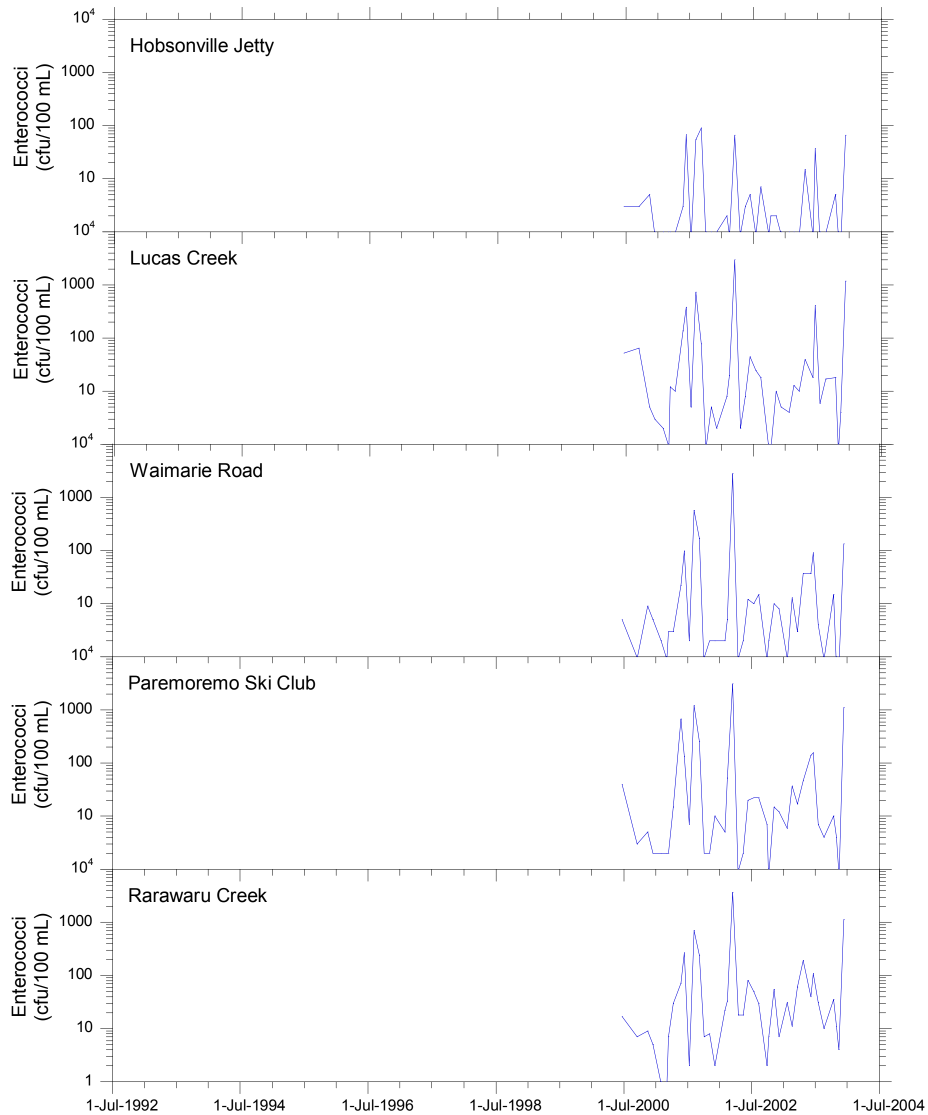
APPENDIX 62: UPPER WAITEMATA HARBOUR –ENTEROCOCCI

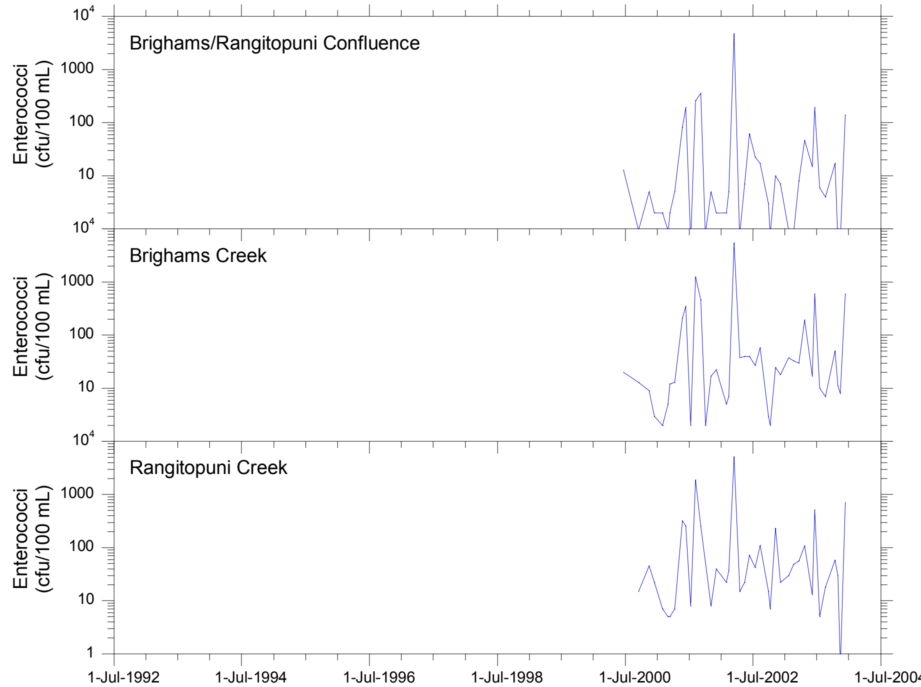
a) Enterococci (cfu/100mL) for the period January 2003 - December 2003

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
22-Jan-03	<2	4	<2	6	31	<2	38	30
19-Feb-03	<2	13	13	37	11	<2	33	48
21-Mar-03	<2	10	3	17	61	8	30	56
23-Apr-03	15	40	37	46	190	46	190	110
5-Jun-03	<2	18	37	140	40	15	17	13
19-Jun-03	37	410	90	156	110	190	610	510
17-Jul-03	<2	6	4	7	31	6	10	5
18-Aug-03	<2	17	<2	4	10	4	7	18
15-Oct-03	5	18	15	10	35	17	50	58
29-Oct-03	<2	<2	<2	4	11	<2	11	30
12-Nov-03	<2	4	<2	<2	4	<2	8	<2
10-Dec-03	66	1180	134	1100	1140	140	600	700
Median	1	15	9	14	33	7	32	39
IQR/Median %	650	120	424	474	189	332	236	139

b) The graphs on the following pages show enterococci results for the period 1993 to December 2003 (where data available).

Method detection limit is 2 cfu/100 mL. For summary statistics, a result of "<2" is taken to have the value 1.


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Enterococci (cfu/100 mL)
10^4
1000
100
10
1
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004



Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Enterococci (cfu/100 mL)
10^4
1000
100
10
1
1-Jul-1992
1-Jul-1994
1-Jul-1996
1-Jul-1998
1-Jul-2000
1-Jul-2002
1-Jul-2004

APPENDIX 63: DESCRIPTION OF WATER QUALITY VARIABLES

INTRODUCTION

The following section provides a summary of general information about the variables used in the water quality surveys including; what they measure, and relevance to water suitability for various uses.

Water Temperature

Water bodies generally show seasonal patterns in temperature that are correlated with air temperature. Heat transfer between the atmosphere and water surface primarily influences water temperatures of large water masses

Stream temperatures, in the absence of industrial discharges of heated water, are primarily regulated by the extent of riparian vegetation shading of the waterway. In catchments developed for urban uses or intensive agriculture, riparian vegetation has generally been removed to ameliorate flooding problems or maximise land use and as a result stream temperatures tend to be elevated.

Shallow coastal saline water temperatures are most commonly influenced by water passage on incoming tides over intertidal sediments that have been warmed by the sun, resulting in an increase in water temperature.

Elevated water temperature can influence aquatic biota in the following ways:

(i) Community structure in compromised waterways dominated by thermotolerant species that can survive fluctuations in temperature, particularly those experienced in summer.

(ii) An increase in water temperature results in a reduction in the dissolved oxygen carrying capacity of the water. This may be critical for sensitive organisms particularly where saturation levels are already reduced (see next section).

Dissolved Oxygen Saturation

Dissolved oxygen saturation (DO %sat) gives a direct measure for the assessment of a waterway's ability to support aquatic life and is therefore one of the more important water quality parameters measured in our surveys. However where low saturation levels occur there is often a multiplicity of possible causes.

DO (%sat) levels show natural fluctuations both diurnally (throughout the day) and seasonally. Diurnal changes are caused predominantly by the respiratory activities of aquatic biota, particularly plants. Seasonal variations are mainly follow changes in temperature, which is inversely related to oxygen solubility.

Dissolved oxygen levels around 5 mg/L are known to be stressful to sensitive aquatic biota. This concentration equates to a DO (%sat) of 40%-60% at the range of temperatures commonly found in Auckland waterways. If low DO (sat) levels persist for any extended period of time some organisms that cannot move away may die. Ultimately the diversity of aquatic biota may be reduced to those species tolerant of low DO (%sat).

Amelioration of low DO (%sat) levels can be achieved by a reduction of point and non-point source runoff by the modification of land use practices. Riparian vegetation has a role to play in filtering out diffuse sources of oxygen-demanding substances in rural and urban runoff, reducing temperatures and restricting in-stream plant growth by shading. Urbanised areas have the potential to reduce the input of oxygen demanding substances by utilising various stormwater treatment initiatives. In terms of point source inputs, ARC rural and industrial pollution abatement activities are designed to eliminate unauthorised discharges and control authorised discharges of contaminants to a level that can be assimilated by the water body concerned.

In catchments with agricultural development, substantial volumes of stream water are abstracted for irrigation purposes as, under current policy, up to 70% of the one in five year low flow is allocated in the Auckland Region. Consequently DO (%sat) levels may be further compromised by discharges of pollutants during the summer when the stream assimilation capacity is reduced by such abstractions.

Supersaturation of water is not unusual where aquatic plants in the form of macrophytes, periphyton or free-floating algae are abundant. During the hours of daylight the release of oxygen during photosynthesis augments the exchange of oxygen between the waterbody and the atmosphere. The negative side to the presence of these plants is the consumption of oxygen at night (i.e., by respiration), which can lead to serious oxygen depletion and subsequent effects on other biota. Depression in DO (%sat) levels caused by this phenomenon is usually greatest in the early hours of the morning.

Biochemical Oxygen Demand

Biochemical oxygen demand (BOD) is a measure of the amount of oxygen required to break down the organic matter in a set volume of water in a five-day period at 20 degrees Celsius. High BOD levels in water bodies indicate the presence of organic matter, which may exert an oxygen demand resulting in a reduced dissolved oxygen concentration and therefore a reduction of water quality. A yardstick for comparison is that waters with a BOD greater than 5 mg/L are considered polluted.

Measures available to reduce BOD input have been canvassed in the section on DO (%sat).

Conductivity

Conductivity is used to estimate the total dissolved solids (soluble salts) content of the water. The soluble salts concentration is an important consideration in relation to abstraction of water for horticultural use and in extreme situations the suitability of water for stock use.

Chloride

Chloride in these studies is used to indicate the relative proportions of seawater and freshwater in waters that have been sampled. This is in response to tides and indicates whether stream samples are reflecting catchment land use characteristics. The major natural source of chloride for freshwater streams is from groundwater, which in the Auckland Region ranges from 17-40 mg/L depending on the geology concerned. Seawater chloride is typically about 20,000 mg/L. High chloride levels are present in wind blown spray in coastal environments and in rural and urban wastewater. Thus, high chloride levels are often used to indicate the presence of other contaminants in freshwater aquatic systems.

The New Zealand Ministry of Health Department guideline value for chloride (recommended upper limit for the avoidance of taste and corrosion problems) in water used for human consumption is 250 mg/L (MoH, 2000).

pH

The pH is a measure of the hydrogen ion concentration and therefore indicates the acid or alkaline nature of the water. The pH range is from 0-14 and each unit represents a ten-fold change in hydrogen ion concentration. Natural freshwaters have a pH of around 7 although 6-9 is considered within the normal range. By comparison seawater is strongly buffered and even small pH changes are significant. The normal saline range is considerably narrower than freshwater from pH 7.8 to 8.3.

In the absence of contaminant discharges the major influence on pH levels is likely to be the photosynthetic activity of aquatic plants. This occurs when carbon dioxide is absorbed upsetting the carbon dioxide-bicarbonate equilibrium of the stream waters and elevating pH. This problem is most likely to occur in waterways with high nutrient levels and little overhanging vegetation to limit light levels and thereby in-stream plant growth.

pH does not have a directly toxic effect on aquatic biota although many species are not tolerant to wide fluctuations in pH. The principal influence of pH is on the toxicity or mobility of other contaminants present in the water column or sediments. In urbanised situations receiving water sediments may contain large amounts of heavy metals such as zinc, copper and lead from road stormwater runoff. Decreases in pH would tend to mobilise some of these bound contaminants. The toxicity of other contaminants such as ammonia, which is elevated in some rural waste discharges, generally increases with higher pH and temperature.

Chlorophyll a

Chlorophyll a level is a measure of the biomass in terms of photosynthetic algae (phytoplankton) abundance. Phytoplankton are microscopic plants which drift freely in the currents of streams and saline waters. They can determine the suitability of natural waters for a variety of uses. The Lake Managers Handbook (MWD 1987) states that in high concentrations phytoplankton can:

- decrease water clarity;
- alter the colour of the water;
- be toxic to stock and wildlife;
- form unsightly surface scums;
- produce unpleasant tastes and odours;
- alter the water pH;
- deplete oxygen through respiration and decay;
- clog water intake filters; and
- disrupt flocculation and chlorination processes in water treatment plants.

Chlorophyll a level is used in conjunction with total nitrogen and total phosphorus levels, to assess the trophic status of water bodies, particularly lakes.

Water Clarity

Public perception of water quality is often based on their observation of water quality or clarity, in that poor water clarity is aesthetically unpleasing, regardless of other water quality parameters. In the ARC baseline water quality monitoring programmes water clarity is expressed by measurements of turbidity, black disk transparency and Secchi disk depth. The critical measures of acceptable water clarity are: for recreational waters clarity greater than 1.6 metres as measured by the black disk technique, and for aesthetic purposes no significant change. A significant change is considered to be a 20% change in black disk reading.

Turbidity

Turbidity is a measure of the degree to which light is scattered in water by suspended particles and colloidal materials. Samples are analysed in the laboratory using a meter and the results are given as nephelometric turbidity units (NTU).

When turbidity levels are high light penetration is reduced, thereby limiting the ability of aquatic plants (algae and macrophytes) to photosynthesise (i.e., a reduction in the so-called euphotic depth). Organisms that are visually oriented may have difficulty locating and catching prey in turbid water and the fine suspended material that is characteristic of turbid water may detrimentally affect gill structures of aquatic organisms.

Black Disk Transparency

Black disk transparency is a measure of horizontal water clarity. The black disk reflects very little light and black disk transparency is the distance at which it becomes visible to an observer (using an underwater viewer). It is a good estimate of the distance that sighted animals can see horizontally under water.

Secchi Disk Depth

Secchi depth is a measurement of vertical optical water clarity, usually applied in deeper water bodies such as lakes, which is a function of light penetration. This defines the depth to where photosynthetic plants can survive and is known as the "euphotic depth". As a rough guide, the euphotic depth is taken as 2.5 times the Secchi depth. – The depth at which a quartered 200 mm diameter black and white disk becomes visible to an observer as it is raised through the water column.

Suspended Solids (also called non-filterable residue)

Suspended solids (SS) is a measurement of the suspended material in the water column, including plankton, non-living organic material, silica, clay and silt. High SS levels reduce light penetration and provide media for pollutants to attach to, resulting in a reduction in water quality for a variety of uses, such as horticulture, irrigation, stock water supply, and recreational and ecological functions. Under the appropriate conditions the suspended material can settle out as sediment thereby causing further problems, such as smothering of biota.

SS burdens to waterways can be reduced in a variety of ways depending on the type of land use concerned:

In rural catchments riparian zone management provided an effective filter for diffuse sources of SS and reduces streambed and bank scouring by dissipating the energy of floodwaters. Preventing stock access to stream beds and banks is a useful mitigation tool for reducing excessive SS.

In urban and industrial areas SS can be reduced through the implementation of storm water control measures. The period when land is being urbanised has the greatest potential to mobilise sediments to waterways. ARC Environment has produced urban earthworks guidelines to minimise SS runoff from exposed erodible soils.

Microbial Indicators

Microbial indicator organisms are typically used in water quality monitoring to provide a measure of faecal contamination and hence the sanitary quality of water resources. A number of different indicator organisms and monitoring strategies can be used depending on whether the purpose of sampling is simply to detect and quantify the level of contamination, or whether some measure or index of public health risk is required.

The indicator organisms used for water quality monitoring are generally bacteria that are present as normal inhabitants in the gut of healthy warm-blooded animals, including humans, and are shed in large numbers in faecal matter (at a rate of 10^6 – 10^9 per gram). They are not usually considered to present a risk to public health when present in natural waters (i.e., they are not generally disease causing or pathogenic when contacted through this route), but their presence is taken to indicate faecal contamination and hence the possibility that pathogenic micro organisms that are found in the gut may also be present.

It is necessary to use indicator organisms for routine monitoring purposes because there is such a wide variety of pathogens that may be present in faecal matter, that it is impossible to test for all of them at once. Detection of some pathogens, particularly viruses, is also expensive and time consuming. Also, the infective doses for many pathogens, particularly of viruses, are so low as to make routine measurement impracticable.

In New Zealand three bacterial indicator groups have been routinely used for water quality monitoring. These are the presumptive coliform, faecal coliform, and enterococci groups.

Coliforms or Presumptive Coliforms

The term coliform is used to describe a heterogeneous group of bacteria belonging to the family *Enterobacteriaceae*, which are characterised by their ability to ferment lactose with the production of acid and gas at 35°C. Included within this definition are members of the *Escherichia*, *Klebsiella*, *Enterobacter*, *Serratia*, and *Citrobacter* genera. While members of all of these genera are typically found in faecal material, only one, *Escherichia coli*, is truly faecal specific.

The results of coliform or presumptive coliform tests are often highly variable and do not necessarily indicate the degree of faecal contamination present in a waterway. This is because members of the coliform group are also found as natural inhabitants of soil and decaying vegetation, and therefore elevated levels in waters may be due to naturally occurring organisms. Nevertheless, the presumptive coliform test may provide useful information on the level and nature of contamination when used in association with other analyses such as the faecal coliform test.

Faecal Coliforms

Faecal coliforms represent a subset of the coliform group, differentiated by their ability to ferment lactose with the production of acid and gas at the elevated temperature of 44.5°C. This group is a more specific, but not unequivocal, indicator of faecal contamination than is the coliform group. For several decades faecal coliforms were the indicator organism of choice in NZ contact recreation water quality guidelines, but their use is now restricted to shellfish-gathering waters. Contact recreational water quality guidelines instead now use the organisms *e.coli* (for freshwaters) or enterococci (for marine waters) as indicator of choice for the presence of faecal contamination.

Despite this, the faecal coliform group is still considered appropriate for qualitative monitoring of faecal contamination in natural waters, and for assessment of long-term trends in water quality over time. It is in this context that the indicators are used in the baseline water quality studies, providing continuity of record across periods where indicator organism preferences have changed. However, it should be recognised that neither faecal coliforms nor *e.coli* provide the ability to distinguish human from non-human faecal contamination. Such an assessment must be made on the basis of subjective evaluation of likely sources and routes of contamination within the catchment.

For further information on this topic refer to "Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas", published by Ministry for the Environment and Ministry of Health, Wellington, in June 2003.

Enterococci

Members of the genus *Enterococcus* comprise another group of bacteria that are found in the gut of warm blooded animals and are commonly used as a health related indicators of saline recreational water quality. Enterococci analysis is typically carried out by the membrane filtration method using mE and EIA media (see APHA 1992). This method is selective for two species, *Ent. faecalis* and *Ent. faecium,* which are prominent in human faecal matter, although other faecal and non-faecal associated enterococci may also be detected using this method. Interpretation of results and assessment of public health risk therefore requires that consideration be given to the likely sources contaminants.

Nutrients

Nutrients are chemical compounds that are necessary for normal plant growth and are divided loosely into macro and micro-nutrients. Routine water quality monitoring records two groups of essential macro-nutrients.

The availability of readily assimilated forms of the nutrients nitrogen and phosphorus are commonly accepted as factors limiting aquatic plant growth. Anthropogenic activities increase the nutrient loading through the discharge of waste products, fertilisers and general storm-water runoff. Nutrient enrichment can result in a proliferation of algae and macrophytes in waterways, which potentially has a number of detrimental effects including:

(i) Choking waterways leading to reduced drainage capacity,

(ii) Loss of amenity values,

(iii) Physical habitat reduction,

(iv) Excessive fluctuations in dissolved oxygen and pH,

(v) Reduced suitability for stock watering or horticultural irrigation.

The adverse effects of elevated nitrate levels can be mitigated by the provision of riparian vegetation providing sufficient shading to preclude or minimise in-stream plant growth. Riparian vegetation also provides a mechanism for intercepting contaminants by filtering direct runoff and uptake of nitrate from the soil at the ground water interface. The proactive approach is to prevent or minimise the discharge of nutrient rich discharges into waterways. Nutrient levels entering waterways can be reduced by a number of land management options including;

(i) Limiting concentrations from point sources by consent conditions,

(ii) Requiring land application of wastes in a way that minimises subsequent input to streams,

(iii) Implementing land management techniques such as riparian zone protection to reduce diffuse input.

Ammonia

Ammoniacal nitrogen is a macro-nutrient but is considered in general water quality evaluations in terms of its toxicity to many aquatic animals.

Ammonia occurs in a number of waste products, which if discharged to the environment can result in elevated ammonia levels. Ammonia is reported as a combination of un-ionised ammonia (NH_3) and the ammonium ion (NH_4^+), at normal pH values the latter form predominates. Un-ionised ammonia is the more toxic form to aquatic life. The toxicity of ammonia is very dependent on water temperature, salinity and pH (USEPA, 1999). Regulatory agencies, such as the ARC Environment, have tended to rely on overseas criteria such as those promulgated by the USEPA. The ARC has commissioned studies on Auckland freshwater biota, which corroborate that USEPA criteria are appropriate (ARC 1992).

Ammonia toxicity for given pH and temperature combinations can be calculated using a mathematical equation. As a generalisation a chronic or long term exposure limit of 0.77 mg/L is appropriate for sensitive freshwater organisms under ambient conditions. In saline waters ammonia toxicity is influenced by salinity in addition to pH and temperature. The chronic exposure limit for sensitive saline organisms under ambient conditions is 2.3 mg/L.

Long term or chronic effects on biota include the limitation of species that can survive in the waterway to those tolerant of ammonia. In addition, sublethal effects, such as disruption of feeding patterns, removal of food sources, reduction of reproductive viability and restricted recruitment of juvenile organisms may be produced by long term exposure to ammonia, as documented by the USEPA.

In catchments with intensive farming practices ammonia rich wastewaters can come from several sources. Potential causes of diffuse input include rainfall on areas adjacent to waterways that have been recently grazed, spray irrigated with wastewater, or received applications of fertilisers such as ammonia urea. Rural point sources include race runoff, oxidation pond discharges, silage leachate, or raw wastes when disposal systems break down or are not used as intended.

Nitrite

Nitrite is the intermediate step in the conversion of ammonia to nitrate. It is usually short lived in the aquatic environment in the presence of oxygen and is therefore indicative of a source of nitrogenous waste in the immediate vicinity of the sampling site. It is intermediate in toxicity to ammonia and nitrate (USEPA, 1986).

Nitrate

Nitrate is the end product of the breakdown (oxidation) of ammonia through the intermediate step of nitrite by microbial decomposition. It is not particularly toxic to aquatic life (USEPA, 1986). Water for use as potable supply is limited to 10 mg/L on public health grounds.

Sources of nitrate in aquatic systems are similar to those discussed for ammonia. Nitrate is poorly bound to the soil and is therefore highly mobile. It is readily leached into local groundwater systems, particularly under high rainfall events. In winter, when ground conditions become saturated, the capacity of the soil to assimilate waste is reduced, resulting in elevated nitrate levels in runoff.

Nitrate is an important plant nutrient (which is generally non-limiting), which in conjunction with sufficient available phosphorus can lead to proliferation of aquatic plants (algae and macrophytes). Respiration of aquatic plants at night can lead to reductions in dissolved oxygen to the point that other aquatic organisms may become stressed or killed. Photosynthetic activity of aquatic plants also leads to elevated stream pH, which has an effect on the toxicity of other contaminants in the water such as ammonia.

Total Kjeldahl Nitrogen

Total Kjeldahl nitrogen (TKN) is a measure of the organic nitrogen plus ammonia concentration of a water sample. It includes such natural materials as proteins and peptides, nucleic acids and urea and numerous synthetic organic materials. It is used in this report to calculate the total nitrogen content of water samples.

Total Nitrogen

Total nitrogen is the combination of nitrate, nitrite and TKN, it is to estimate the "bioavailable" fraction of nitrogen in waterways. It is also used in conjunction with total phosphorus and chlorophyll *a* levels, to assess the trophic status of water bodies.

Total Phosphorus

Total phosphorus is a measure of all the phosphorus present in the sample and includes the soluble (bioavailable) fraction that is adsorbed onto sediment particles and present in the form of algae and other organic matter.

Dissolved Reactive Phosphorus (soluble reactive phosphorus)

Dissolved reactive phosphorus (DRP) is considered to be the bioavailable fraction of phosphorus and is an important as an indicator of water quality. It is frequently cited as the nutrient limiting the proliferation of algae and other aquatic plants in New Zealand waterways. Levels required to stimulate instream plant growth are reportedly as low as 0.01 mg/L (ANZECC, 2000).