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January – December 2002

Baseline water quality

Stream, lake and saline waters

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Baseline Water Quality Survey of the Auckland Region

Annual Report January – December 2002

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Executive Summary

The Auckland Regional Council and its antecedent organisations have been monitoring water quality as part of the Long Term Baseline (LTB) surveys since the mid-1980s. In this Annual Report, data from the LTB surveys are presented for 16 streams, 14 saline water sites in Manukau, Waitemata and Kaipara Harbours and the Hauraki Gulf, and seven lakes for the calendar year 2002 (January – December 2002). Time series graphs are included for the entire monitoring period of each site for which there is adequate quality assurance about the data; generally back to the early 1990's (streams and lakes) and late 1980's (saline). The previous Annual Report for the year 2001 is available as ARC Technical Publication TP190 (Wilcock and Kemp 2002). Detailed analysis of the data including assessments of condition, trends, and distribution are presented in a companion Summary Report produced approximately every five years, and most recently produced in 2000 available as ARC Technical Publication TP132 (Wilcock and Stroud 2000). Monitoring data from investigations of sites in Mahurangi Estuary, Upper Waitemata Harbour and Tamaki Estuary have been summarised for the period 1992-2002 in a companion document (TP208) to this report (Wilcock and Martin 2003). This report includes data on similar determinands collected at additional freshwater and saline sites.

1. INTRODUCTION

This report summarises water quality data collected as part of Long Term Baseline (LTB) surveys covering the period January – December 2002, carried out by the Environmental Management Division of the Auckland Regional Council. Aquatic resources surveyed include freshwater streams and lakes throughout the region and saline sites in the Kaipara, Manukau and Waitemata Harbours and the Hauraki Gulf. The principal aim of this report is to document water quality data over the specified year. This is the fourth in a series of annual reports describing the monitoring data for the 12-month period of the previous calendar year (in this instance, 2002). Every five years a comprehensive summary of the data is undertaken, as has been done previously (ARC 1995, Wilcock & Stroud 2000). An annual report of water quality survey data from Mahurangi Estuary, Upper Waitemata Harbour, and Tamaki Estuary for January – December 2002 is also available as a companion technical publication (Wilcock and Martin 2003).

The ARC undertakes monitoring programmes for the resources of the Auckland region as part of its statutory responsibilities under Sections 30 and 35 of the Resource Management Act (1991).

The principal aims of LTB water quality surveys are as follows:

1. Determine the temporal and spatial variability of selected water quality parameters at sites with different land-use influences through out the region;
2. Provide a baseline of water quality information from which the presence, direction and magnitude of trends can be determined.

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.

As in the last Annual Report (Wilcock & Kemp 2002), we have plotted time-series for water quality variables at all sites, so that they now cover the periods 1992 to 2002 for the freshwater and lake sites, and 1987-2002 for the saline sites. Data collected prior to this can be accessed through the references cited in ARC Technical Publication 132 (Wilcock & Stroud 2000), referred to throughout this report as TP132.

2. SAMPLING SITES AND SURVEY DETAILS

A team of field officers with an appropriately equipped vehicle collects all freshwater stream samples.

The ARC's saline LTB monitoring is carried out predominantly by helicopter instead of the more conventional boat method. The exception is the site at Shelly Beach in the Kaipara Harbour, which is accessed via a wharf. There are several advantages to gathering samples and data by helicopter, viz.:

1. Samples can be collected at approximately the same stage of the tide and within a narrow time frame;
2. The time for travel from collection to the laboratory is greatly reduced;
3. Sampling can be undertaken under more adverse weather conditions than is generally possible by small boat;
4. Substantial cost savings are involved in terms of equipment and staff resources.

LTB lake sites, except for Lake Pupuke, are also accessed by helicopter, although sampling is carried out from an inflatable boat once the helicopter has landed. Shore based sampling which took three to four days by a land-based team with a boat, can now be accomplished in six hours.

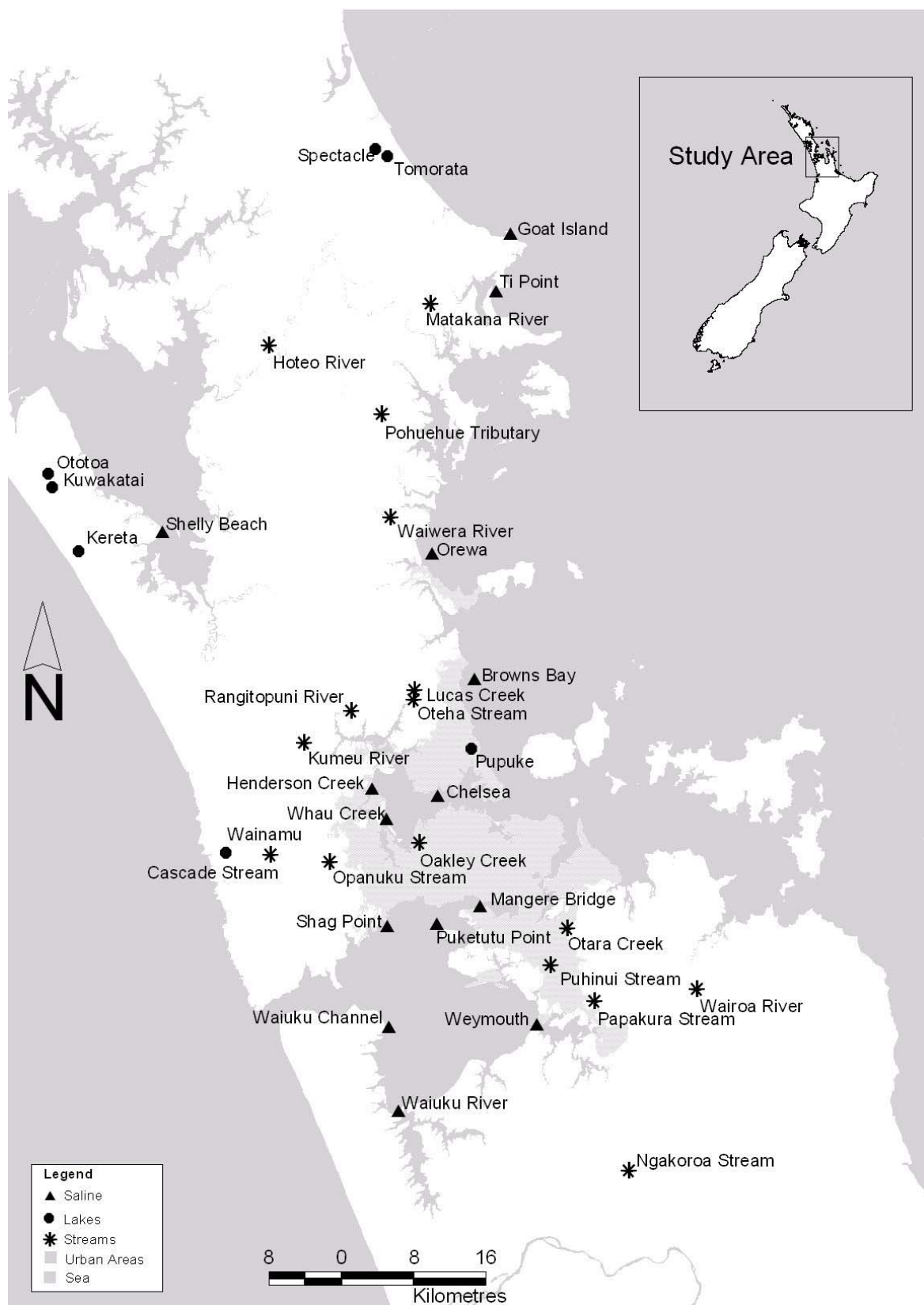


Figure 2.1: Location of freshwater, saline and lake monitoring sites.

2.1 Freshwater Streams Surveys

A total of sixteen freshwater sites representing notably different catchment development types, were sampled monthly for a range of water quality parameters.

The sites sampled are shown on a map of the region in Fig. 2.1 and are listed in Table 2.1 in alphabetical order, along with 1:50000 scale map references and complete monitoring periods.

Table 2.1 LTB freshwater sampling sites, map references and monitoring periods.

Stream (code)	Map reference (NZMS 260)	Sampling period
Cascade Stream (N9)	Q11: 461 781	26/06/86 – 3/12/02
Hoteo River (N5)	Q09: 456 343	24/06/86 – 3/12/02
Kumeu River (N8)	Q10: 497 905	26/06/86 – 3/12/02
Lucas Creek (N2)	R10: 618 962	3/08/93 – 3/12/02
Mahurangi River (N3)	R09: 583 296	24/06/86 – 3/12/02
Matakana River (N4)	R09: 636 387	6/12/86 – 3/12/02
Ngakoroa Stream (S5)	R12: 856 432	25/06/86 – 2/12/02
Oakley Stream (S1)	R11: 624 796	8/08/94 – 2/12/02
Opanuku Stream (S2)	R11: 526 773	26/06/86 – 2/12/02
Otara Stream (S3)	R11: 787 700	17/10/85 – 2/12/02
Oteha Stream (N1)	R10: 618 953	24/06/86 – 3/12/02
Papakura Stream (S4)	R11: 817 620	25/06/86 – 2/12/02
Puhinui Stream (S7)	R11: 768 660	2/02/94 – 2/12/02
Rangitopuni River (N7)	R10: 548 940	24/06/86 – 3/12/02
Wairoa River (S6)	S11: 931 634	25/06/86 – 2/12/02
Waiwera River (N6)	R10: 593 154	24/06/86 – 3/12/02

For ease of sampling the sites were split into two units based on logistical constraints, namely, northern and southern. The two sampling units were sampled on sequential days (whenever possible), with nine sites in the northern run and seven in the southern. Surface samples were taken at each site on the following days: 8 Jan; 5 Feb; 5 Mar; 3 Apr; 3 May; 4 Jun; 4 Jul; 5 Aug; 3 Sep; 30 Sep; 4 Nov and 3 Dec for the northern sites (N1-N9), and 10 Jan; 4 Feb; 7 Mar; 2 Apr; 1 May; 5 Jun; 3 Jul; 6 Aug; 5 Sep; 2 Oct; 5 Nov and 2 Dec for the southern sites (S1-S7).

Detailed descriptions of the sites that remained unchanged, including surrounding catchment uses and any known point sources influencing water quality, are given in technical publications TP28 (ARC 1993) and TP65 (ARC 1995), and in Table 2.2. Definitions for land use categories are given in Appendix 49.

Table 2.2: Land use in catchments of the LTB freshwater monitoring programme.

Site	Class name	Area (Hectares)	% Catchment
Cascades Stream - Confluence	INDIGENOUS_FOREST	270	100.0
	Total	270	100.0
Hoteo River - Grubbs	INDIGENOUS_FOREST	4011	15.0
	MINES_DUMPS	10	0.0
	PLANTED_FOREST	4809	18.0
	PRIM_PASTORAL	16648	62.3
	SHRUB	1172	4.4
	URBAN	61	0.2
	Total	26711	100.0
Kumeu River – Weza Lane	INDIGENOUS_FOREST	303	6.6
	PLANTED_FOREST	204	4.5
	PRIM_HORTICULTURAL	222	4.8
	PRIM_PASTORAL	3588	78.3
	SHRUB	219	4.8
	URBAN	20	0.4
	URBAN_OPEN_SPACE	25	0.5
	Total	4582	100.0
Lucas Creek - Gills Rd	INDIGENOUS_FOREST	18	3.0
	PLANTED_FOREST	3	0.4
	PRIM_PASTORAL	378	60.5
	SHRUB	86	13.7
	URBAN	140	22.4
	Total	625	100.0
Mahurangi River - Forest HQ	INDIGENOUS_FOREST	10	2.1
	PLANTED_FOREST	456	96.2
	PRIM_PASTORAL	5	1.0
	SHRUB	3	0.7
	Total	474	100.0
Matakana River - Wenzlick	INDIGENOUS_FOREST	358	25.5
	PLANTED_FOREST	208	14.8
	PRIM_PASTORAL	641	45.6
	SHRUB	199	14.2
	Total	1406	100.0

Site	Class name	Area (Hectares)	% Catchment
Ngakoroa Stream - Mill Rd	INDIGENOUS_FOREST	2	0.5
	PLANTED_FOREST	4	0.8
	PRIM_PASTORAL	431	95.1
	SHRUB	16	3.6
	Total	454	100.0
Oakley Creek	INDIGENOUS_FOREST	27	2.3
	URBAN	992	82.6
	URBAN_OPEN_SPACE	182	15.2
	Total	1201	100.0
Opanuku Stream - Candia Rd	INDIGENOUS_FOREST	1230	74.7
	PRIM_PASTORAL	280	17.0
	SHRUB	137	8.3
	URBAN	1	0.1
	Total	1647	100.0
Otara Stream - East Tamaki	INDIGENOUS_FOREST	42	2.4
	PLANTED_FOREST	21	1.2
	PRIM_PASTORAL	1581	90.6
	SHRUB	19	1.1
	URBAN	78	4.5
	URBAN_OPEN_SPACE	4	0.3
	Total	1746	100.0
Oteha Stream - Days Bridge	INDIGENOUS_FOREST	64	5.7
	PRIM_PASTORAL	66	5.8
	SHRUB	16	1.4
	URBAN	627	55.5
	URBAN_OPEN_SPACE	356	31.6
	Total	1128	100.0
Papakura Stream - Porchester Rd	INDIGENOUS_FOREST	291	6.2
	PLANTED_FOREST	119	2.5
	PRIM_HORTICULTURAL	41	0.9
	PRIM_PASTORAL	4004	85.5
	SHRUB	90	1.9
	URBAN	34	0.7
	URBAN_OPEN_SPACE	105	2.2
	Total	4685	100.0
Puhinui Stream - Ford	INDIGENOUS_FOREST	71	6.0

Site	Class name	Area (Hectares)	% Catchment
Rangitopuni River - Mill Flat Rd	PRIM_PASTORAL	625	52.3
	SHRUB	14	1.1
	URBAN	476	39.8
	URBAN_OPEN_SPACE	9	0.7
	Total	1195	100.0
	BARE_GROUND	22	0.3
	INDIGENOUS_FOREST	614	7.3
	MINES_DUMPS	52	0.6
	PLANTED_FOREST	1191	14.2
	PRIM_HORTICULTURAL	267	3.2
Wairoa River - Tourist Rd	PRIM_PASTORAL	5878	70.3
	SHRUB	306	3.7
	URBAN	10	0.1
	URBAN_OPEN_SPACE	24	0.3
	Total	8363	100.0
	INDIGENOUS_FOREST	2898	19.6
	PLANTED_FOREST	2393	16.1
	PRIM_PASTORAL	8481	57.2
	SHRUB	1048	7.1
	Total	14820	100.0
Waiwera River - Valley Springs	INDIGENOUS_FOREST	482	16.2
	PLANTED_FOREST	4	0.1
	PRIM_PASTORAL	1591	53.6
	SHRUB	893	30.1
	Total	2970	100.0

2.2 Saline Surveys

The sites referred to in this report (Fig. 2.1) are the same as those detailed in TP 132, with the exception of the following sites for which sampling has been discontinued: Kawau Bay, Mahurangi, Papakura Channel and Hobsonville. The water quality of these sites for the period July 1987 - December 2000 has been reviewed previously (Wilcock & Kemp 2001). The sites in sampling order were as follows:

Manukau Harbour

- 1) Weymouth
- 2) Waiuku River
- 3) Waiuku Channel

- 4) Puketutu Point
- 5) Mangere Bridge
- 6) Shag Point

East Coast and Waitemata Harbour

- 7) Goat Island
- 8) Ti Point
- 9) Orewa
- 10) Browns Bay
- 11) Chelsea
- 12) Henderson Creek
- 13) Whau Creek

Kaipara Harbour

- 14) Shelly Beach
-

Sites have been selected to best represent or integrate the influences of specific land uses on water quality.

Due to logistical constraints the saline LTB samples were collected on two separate days depending on the appropriate combination of tidal regime and time of day. The Manukau and Kaipara Harbours are collected concurrently, while the middle Waitemata Harbour and Hauraki Gulf are collectively sampled as a separate sampling run.

Vertical salinity readings were taken at each site to ensure that waters were fully mixed. A difference in salinity between top and bottom of greater than 2 parts per thousand was used as an indication of incomplete mixing. If incomplete mixing was detected samples were taken at the top and bottom of the water column for analysis and comparison.

The survey protocols adopted allow samples to be collected approximately 1–2.5 hours after high tide for the Kaipara Harbour, middle Waitemata Harbour and Hauraki Gulf sites and 2.5–4 hours for the Manukau Harbour.

Surveys were conducted at monthly intervals (with a few exceptions) over the periods shown in Table 2.3, which also lists alternate names that have been used for some sites, and map coordinates (eastings and northings) are also given.

Table 2.3: LTB saline monthly monitoring sites (codes), map references and monitoring periods.

Site (code)	Easting	Northing	Monitoring period
Mangere Bridge (SM05)	2668634	6472374	7/10/87 – 29/11/02
Puketutu Point (SM04)	2664289	6470427	7/10/87 – 31/10/02
Shag Point (Titirangi) (SM06)	2658790	6470166	7/10/87 – 29/11/02
Waiuku Channel (Grahams Beach) (SM03)	2659019	6459062	7/10/87 – 29/11/02
Papakura Channel*			7/10/87 – 10/06/99
Weymouth (SM01)	2675181	6459101	5/10/87 – 29/11/02
Waiuku River (Clarks Beach) (SM02)	2660023	6449792	5/10/87 – 29/11/02
Goat Island (SE01)	2670914	6546509	20/08/93 – 4/12/02
Ti Point (SE02)	2670783	6540222	19/03/91 – 4/12/02
Kawau Bay (Algies Beach)*	2667746	6529941	19/03/91 – 17/06/99
Mahurangi*	2665035	6521486	19/03/91 – 17/06/99
Orewa (SE05)	2663769	6511321	19/03/91 – 4/12/02
Browns Bay (SE06)	2668401	6497168	19/03/91 – 4/12/02
Chelsea (SE07)	2664122	6484305	19/03/91 – 4/12/02
Hobsonville*	2659770	6489031	19/03/91 – 17/06/99
Henderson Creek (SE09)	2657153	6485367	19/03/91 – 4/12/02
Whau Creek (SE10)	2658723	6482007	19/03/91 – 4/12/02
Shelly Beach (Kaipara Harbour) (KA1)	2634008	6513666	6/11/91 – 29/11/02

* Discontinued sites

2.3 Lake Surveys

Seven freshwater lakes from throughout the region were sampled quarterly for a range of parameters.

The general locations of the lakes sampled are shown in Fig. 2.1. Descriptions of all the lakes, except Pupuke, and maps showing greater detail of lake size, shape and surrounding land use have been presented in TP 89 (ARWB 1990). Information on Lake Pupuke has been presented in a number of ARC reports, the most recent being TP 93 (ARWB 1993). Locations of the lake sites and total monitoring periods used for time-series plots (Appendices 42-48) are listed in Table 2.4. A description of land use in each catchment is given in Table 2.5 (see Appendix 49 for definition of the terminology).

Table 2.4: LTB lake monitoring sites, map references and monitoring periods.

Site	Easting	Northing	Monitoring period
Tomarata	2658864	6555154	19/11/92 – 20/11/02
Spectacle	2657607	6555922	19/11/92 – 20/11/02
Ototoa	2621480	6520125	19/11/92 – 20/11/02
Kuwakatai	2621896	6518636	19/11/92 – 20/11/02
Kereta	2624825	6511571	19/11/92 – 20/11/02
Wainamu	2641049	6478309	19/11/92 – 20/11/02
Pupuke	2668158	6489781	19/11/92 – 25/11/02

Data reviewed in this report covers the four surveys made in February, June, August and November of 2002. Time-series for the monitoring periods given in Table 2.4 are shown in the Appendices. The lakes were sampled in the order given below.

- 1) Wainamu
- 2) Kereta
- 3) Kuwakatai
- 4) Ototoa
- 5) Spectacle
- 6) Tomarata
- 7) Pupuke

Previous findings have established that lake water quality can be adequately represented by depth profiles from a station located where the lake is deepest. In general, each profile comprised a surface sample and others taken at depth intervals of 5 or 10 m, with the exception of Lake Pupuke, for which samples were collected at 5, 25 and 50 m (ARC 1995, Gibbs et al. 1999). In 2002, surface and bottom samples were analysed for Lakes Wainamu, Tomarata, Spectacle and Kuwakatai, whereas Lake Ototoa was sampled at 10 m depth as well, while surface samples only were taken from Lake Kereta. Lake Pupuke was sampled at 5, 25 and 50 m depths.

Table 2.5: Landuse in catchments of the LTB lakes monitoring programme. Site codes and map coordinates (eastings and northings) are also given.

Site	Class name	Area (hectares)	%Catchment
Lake Kereta	INDIGENOUS_FOREST	107	15.2
	PLANTED_FOREST	113	16.1
	PRIM_PASTORAL	451	64.0
	SHRUB	33	4.7
	CATCHMENT TOTAL	704	100.0
	INLAND_WATER	26	
Lake Kuwakatai	INDIGENOUS_FOREST	21	4.9
	PRIM_PASTORAL	363	85.8
	SHRUB	39	9.3
	CATCHMENT TOTAL	423	100.0
	INLAND_WATER	33	
Lake Ototoa	INDIGENOUS_FOREST	158	36.2
	PLANTED_FOREST	95	21.7
	PRIM_PASTORAL	179	40.9
	SHRUB	5	1.2
	CATCHMENT TOTAL	437	100.0
	INLAND_WATER	125	
Lake Pupuke	URBAN	88	82.1
	URBAN_OPEN_SPACE	19	17.9
	CATCHMENT TOTAL	107	100.0
	INLAND_WATER	114	
Lake Spectacle	BARE_GROUND	3	0.4
	INDIGENOUS_FOREST	61	8.3
	PLANTED_FOREST	241	32.6
	PRIM_PASTORAL	430	58.3
	SHRUB	3	0.4
	CATCHMENT TOTAL	738	100.0
	INLAND_WATER	57	
Lake Tomarata	INDIGENOUS_FOREST	10	8.3
	PLANTED_FOREST	64	54.3
	PRIM_PASTORAL	44	37.3
	CATCHMENT TOTAL	117	100.0

Site	Class name	Area (hectares)	%Catchment
	INLAND_WATER	16	
	INLAND_WETLANDS	17	
Lake Wainamu	INDIGENOUS_FOREST	413	84.7
	PRIM_PASTORAL	17	3.4
	SHRUB	58	11.9
	CATCHMENT TOTAL	488	100.0
	INLAND_WATER	17	
	INLAND_WETLANDS	2	

Dissolved oxygen/temperature profiles were taken at 1 m intervals throughout the whole water column of all lakes except Lake Kereta.

The water quality of the lakes covering the period from spring 1992 to autumn 1998 has been reviewed recently (Gibbs et al. 1999) and is updated here by including all data up to November 2002.

3. METHODS AND DATA QUALITY ASSURANCE

The sampling protocols for the LTB surveys have changed little from those reported in various earlier ARC technical publications.

A standard list of physico-chemical parameters was monitored at each site on each sampling occasion. A core group of parameters was monitored irrespective of the resource under scrutiny, with key indicator parameters added as necessary.

A full list of the parameters used, what they measure, and likely sources and impacts on the environment, are summarised in Appendix 42 of TP132. It should be noted that because very low concentrations at or near the analytical detection limit were consistently found, nitrite-N (NO₂-N) was discontinued from the routine suite of LTB water quality variables starting from January 2002.

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 20th Edition" (APHA 1998).

4. STATISTICAL ANALYSIS AND DATA PRESENTATION

4.1 Freshwater and Saline sites

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.

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 2002. Where values are reported as being less than a detection limit, half that value is cited in the tables (e.g., < 2 mg/L for BOD is cited as 1.0 mg/L). Values exceeding some operational upper limit are nominally given this value in the tables (e.g., >16000 MPN/100 mL for presumptive coliform is cited as 16000 MPN/100mL). 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.

4.2 Lakes

Quarterly sampling data for all variables are tabulated for each lake, along with mean and median values for the period Feb – Nov 2002, in Appendices 42-48. Data for the entire monitoring period (Nov 1992 – Nov 2002) are plotted as time-series and tabulated with the 2002 data summaries. Dissolved oxygen and temperature depth profiles are also included in the appendices.

5. RESULTS AND DISCUSSION

5.1 Freshwater sites

For each sampling run (northern or southern) the same sequence and approximate timing of sampling was followed. In this way the temporal variability inherent in some parameters, such as dissolved oxygen, temperature and pH, was minimised for a particular site. To minimise the effects of variable weather the sampling runs for the nine northern and seven southern sites were made on sequential days.

5.1.1 Water clarity and suspended solids

Median values of black disk transparency, turbidity and SS at all sites were very similar to the long-term medians (Wilcock & Stroud 2000).

5.1.2 Temperature and pH

Temperatures were generally cooler by on average 1-2°C than for the previous year by, and by comparison with the long-term medians (Wilcock & Stroud, 2000). No values exceeded 22°C. pH values were unremarkable with no extreme values recorded.

5.1.3 DO and BOD

Dissolved oxygen (%saturation) values were generally about 8% higher than for 2001, but similar to the long-term medians at each site. Otara Stream again had the lowest recorded value (27.5% in February).

BOD values were similar to the long-term data with medians of 1 mg/L at all sites. The maximum values recorded were 4.8 mg/L (Otara, April) and 4.6 (Kumeu, September). All other values were ≤ 3 mg/L.

5.1.4 Faecal bacteria

Presumptive and faecal coliform results were generally similar to previous years. Faecal coliform values of 10,000 MPN/100 mL or more were recorded on five occasions.

5.1.5 Nutrients

The ANZECC & ARMCANZ (2000) total ammonia-N guideline for protection of 95% freshwater species is 0.9 mg/L at pH 8. Thirteen out of 192 values (7%) exceeded this value, but medians at all sites were 0.06 g m⁻³ or less.

Median nitrate levels are similar to the last two years and the long-term medians (1992-2000), with very low values in the native bush site (Cascades), elevated levels (1-4 g m⁻³) in the market garden stream (Ngakoroa) and winter maxima in the streams draining pasture.

Total and dissolved reactive phosphorus were generally low and similar to previous data for these streams. Medians were similar to the ANZECC & ARMCANZ (2000) trigger values for slightly disturbed lowland rivers, viz. 0.01 and 0.033 mg/L for TP and DRP, respectively.

5.1.6 Chloride and conductivity

Both variables had similar values to corresponding periods in previous years. An anomalous value of 9 mg/L was reported for Wairoa River in December (the median and IQR/median values are 16.4 mg/L and 4%, respectively, or approximately 16.4 ± 0.7 mg/L).

5.1.7 Metals

Soluble and total copper concentrations were mostly below 0.003 and 0.01 mg/L, respectively. Soluble Cu concentrations of 0.005 and 0.006 mg/L were recorded in Oakley Stream and are above the trigger level (2.5 µg/L) given in guidelines for the protection of 80% of aquatic life (ANZECC & ARMCANZ 1999). All but a few reported lead concentrations were 0.010 mg/L (10 µg/L). This value exceeds the trigger levels of 3.4 µg/L (95% level of protection) and 9.4 µg/L (80% level). Soluble Zn concentrations for Oakley, Oteha and Puhinui exceeded the trigger values of 8.0 µg/L (95% level of protection) and 31 µg/L (80% level).

5.2 Saline Sites

5.2.1 Water clarity and suspended solids

Suspended solids, turbidity and Secchi disk results were very similar to the previous year, with the exception of Mangere Bridge. All medians were similar to the long-term medians (Wilcock & Stroud, 2000). Shelly Beach continues to be the most turbid of the saline sites.

5.2.2 Temperature and pH

Values of pH and temperature were similar to previous years.

5.2.3 DO and BOD

BOD and DO data repeated previous patterns, showing the saline sites had very low levels of oxidisable organic matter and generally had well-oxygenated waters.

5.2.4 Nutrients and chlorophyll *a*

Marked reductions from previous years were evident for ammonia and nitrite nitrogen concentrations for the three sites nearest the Mangere Wastewater Treatment Plant (MWTP) (Mangere Bridge, Puketutu Point and Shag Point). Nitrite is a comparatively short-lived intermediate produced by the oxidation of ammonia to nitrate. Thus, nitrite is a useful indicator of recent or nearby sources of treated sewage effluent. Medians for the 2002, 2001 and 1992-2000 ammonia and nitrite-nitrogen data are shown in Fig. 5.1. Even allowing for the spread of data (as given by %IQR/median) the differences are meaningful and indicate a significant improvement in water quality following the changes in wastewater treatment at the MWTP. Nitrate-N, DRP and TP medians were also lower for 2002 than previous years, but the reductions were less marked (typically 70-100% of the 2001 values).

Chlorophyll *a* medians were higher at these three sites than in 2001. In other respects there was little difference between the 2001 and 2002 data.

5.2.5 Faecal bacteria

The faecal indicator bacteria show a similar pattern to the nutrients, with notable reductions in annual medians for presumptive coliform (6-70%) and faecal coliform (30-67%) at the Mangere Bridge, Puketutu Point and Shag Point sites. Enterococci concentrations were similar to previous years and annual medians were generally very low (1-11 cfu/100 mL).

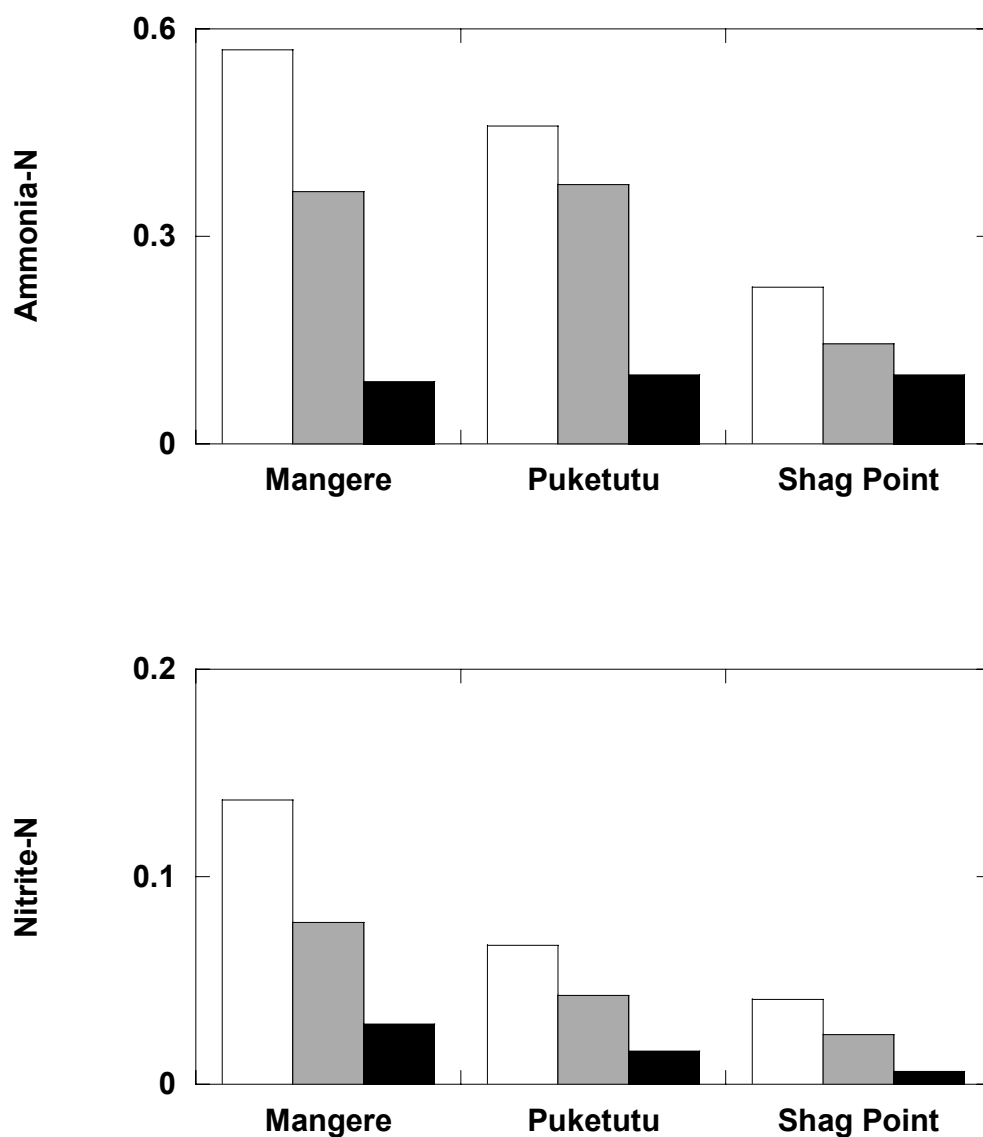


Figure 5.1: Ammonia and nitrite nitrogen median concentrations for Mangere Bridge, Puketutu Point and Shag Point (Titirangi), for the following periods: 1992-2000 (white), 2001 (cross-hatched) and 2002 (black).

5.2.6 Chloride and salinity

Chlorides and salinities were very similar to data measured in previous years, with 2002 annual medians within 2% of the 2001 values.

5.3 Lake Sites

5.3.1 Lake Kereta

Water quality variables were similar in magnitude to previous years. The lake is influenced by pastoral agriculture in its catchment and by a large population of swans (Gibbs et al. 1999). Measurements of temperature and DO were not recorded during 2002.

5.3.2 Lake Kuwakatai

Results for this agriculturally-affected lake were similar to past years. Surface water faecal bacteria levels were generally lower than for 2001, but bottom water concentrations were higher than the previous year. February and November depth profiles show that waters below 6-7 m were near anoxic, whereas in June all but the bottom 2 m was well oxygenated. The August profile showed uniform high DO concentrations at all depths.

5.3.3 Lake Ototoa

Lake Ototoa water quality results were similar to previous years. Stratification during February and November was evident in the DO and temperature data, and elevated $\text{NH}_4\text{-N}$ concentration in the bottom waters of the lake.

5.3.4 Lake Pupuke

Water quality in Lake Pupuke was similar to recent years. Depth profiles of DO, and temperature showed that the lake was stratified in February-November, but not in August. Concentrations of $\text{NH}_4\text{-N}$ in bottom waters (50 m) were elevated when stratification occurred.

5.3.5 Lake Spectacle

Lake Spectacle had a high faecal coliform concentration in June. Water quality was similar to other years. Depth profiles show that all but the bottom 1 m is well oxygenated, as has been observed in previous years.

5.2.6 Lake Tomarata

Lake Tomarata $\text{NH}_4\text{-N}$ and NO_2/NO_3 surface water concentrations were higher than for 2001, but chl_a levels were lower. Depth profiles again showed this lake to be well-oxygenated through most of the water column, year round.

5.3.7 Lake Wainamu

Water quality in Lake Wainamu during 2002 was similar to 2001, with occasionally elevated faecal coliform concentrations. Depth profiles show some stratification occurring in February, but the lake was uniformly well oxygenated for most of the year.

6. CONCLUSIONS

Water quality data collected from long-term monitoring of 16 freshwater sites, 14 saline sites and 7 lakes has been reviewed for the year Jan – Dec 2002. The data is of good quality and is very similar to data collected in recent years from these sites with the notable exception that there has been a marked improvement in water quality in the Manukau Harbour near the MWTP. This is almost certainly a result of improved quality of effluent discharged from the wastewater treatment plant.

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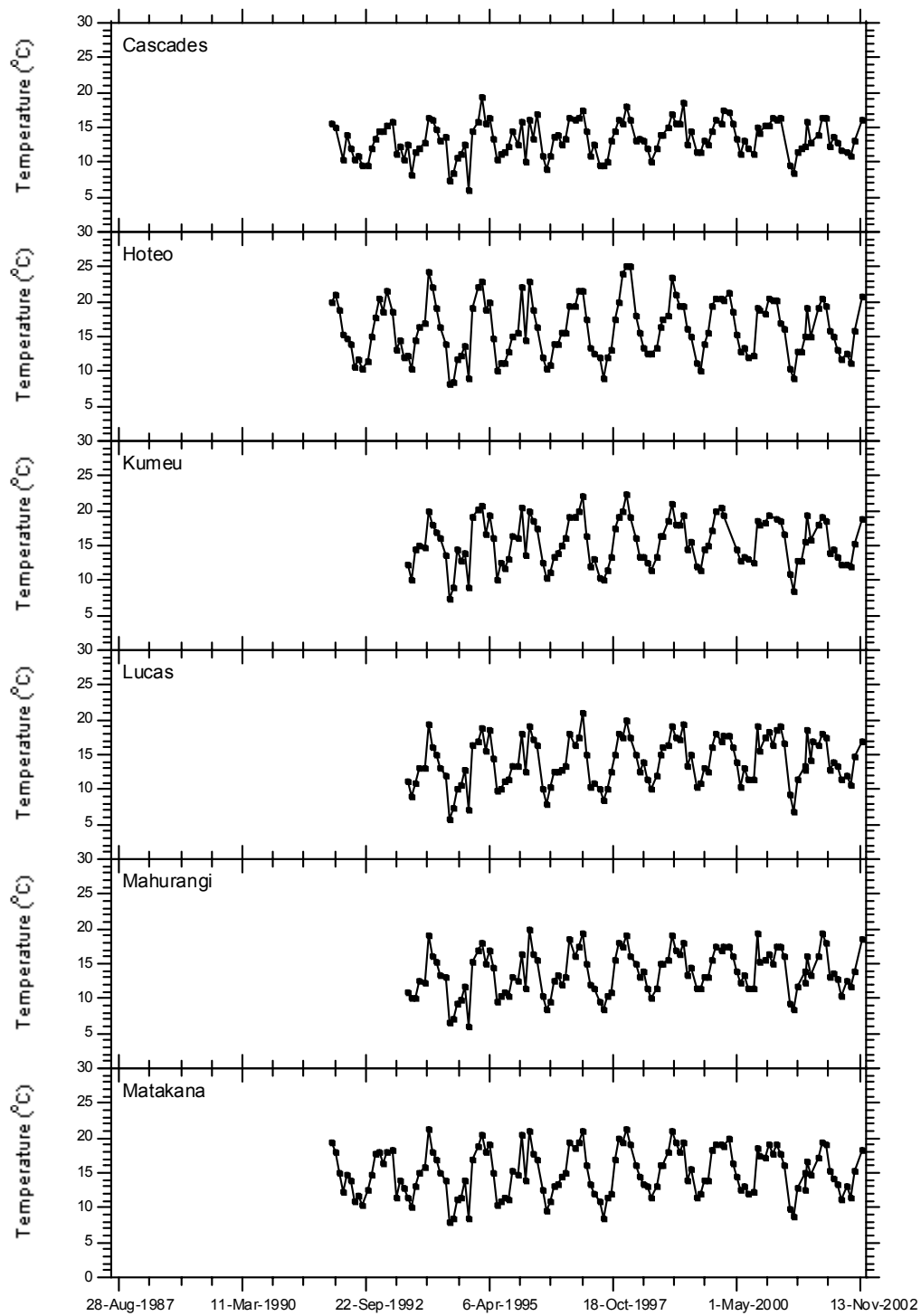
APPENDIX 1: FRESHWATER – TEMPERATURE

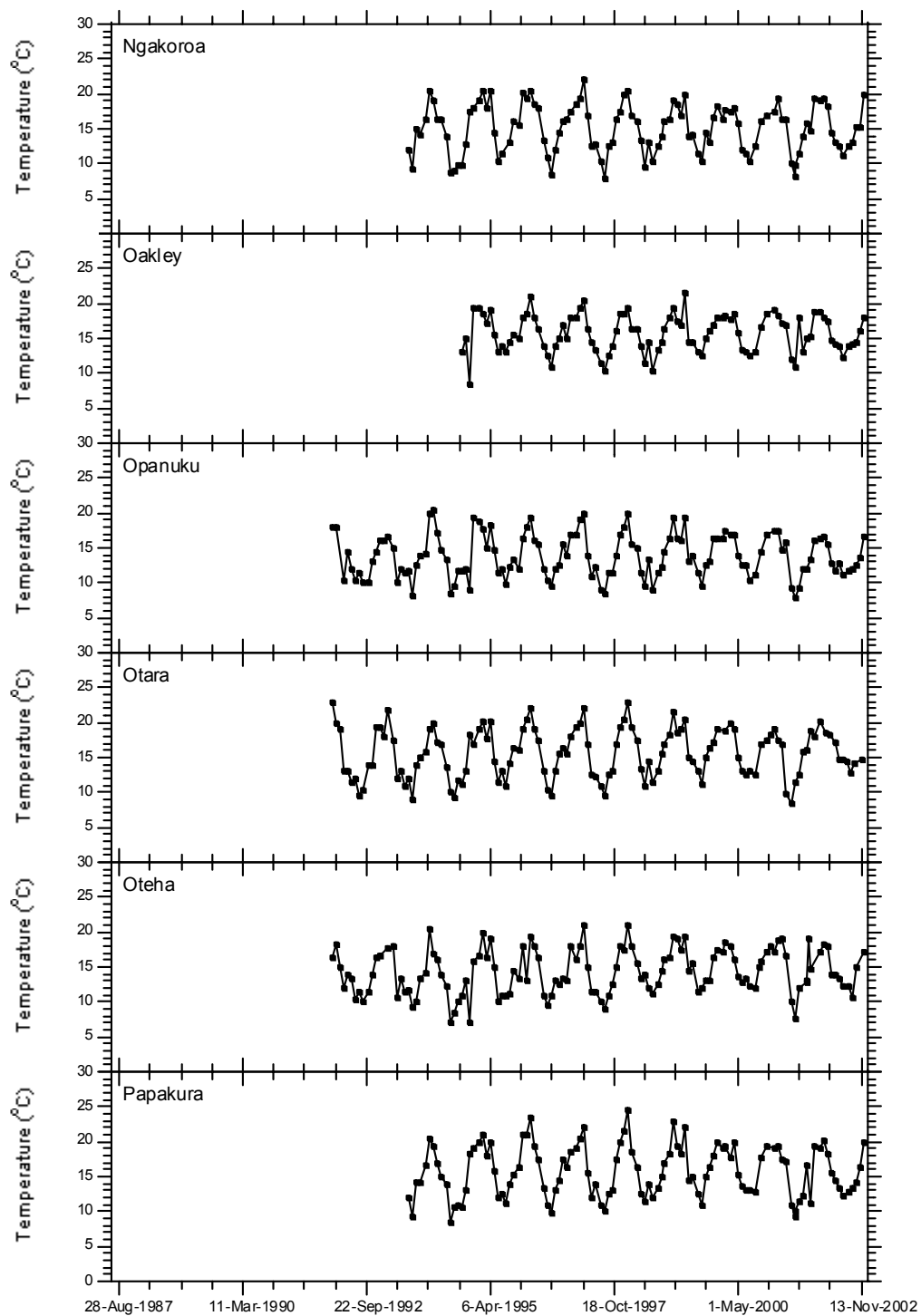
a) Temperature (°C) during January 2002 to December 2002

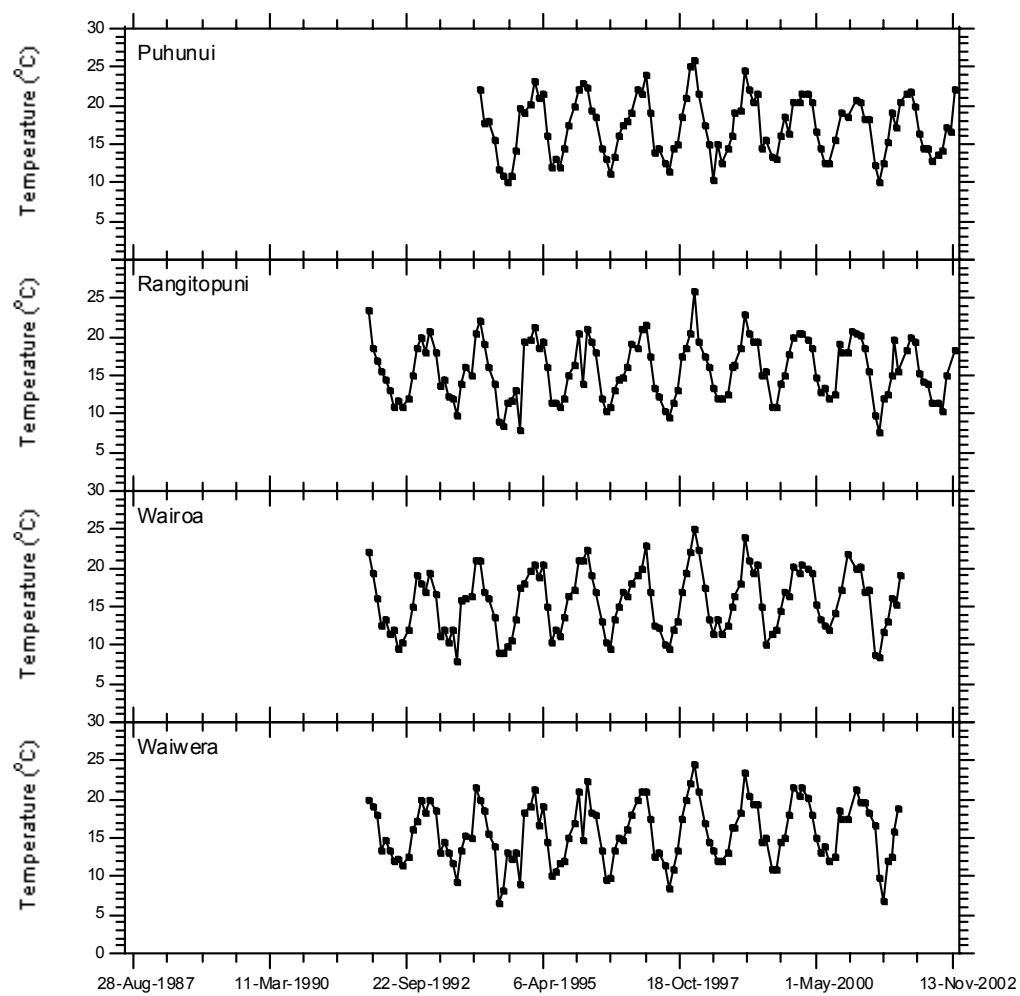
Date	Cascades	Hoteo	Kumeu	Lucas	Mahurangi	Matakana	Ngakoroa	Oakley	Opanuku	Otara	Oteha	Papakura	Puhinui	Rangitopuni	Wairoa	Waiwera
8-Jan-2002	13.8	19.2	17.9	16.4	16.2	17.3	19.1	18.7	16.3	20.3	17.1	19.0		18.4	18.6	17.4
5-Feb-2002	16.3	20.6	19.0	18.1	19.4	19.5	19.4	18.1	16.7	18.6	18.2	20.3	21.8	20.0		20.4
5-Mar-2002	16.5	19.4	18.5	17.6	17.9	19.0	18.3	17.5	15.6	18.4	18.0	18.2	20.0	19.3		18.5
3-Apr-2002	12.2	15.8	13.8	12.9	13.1	15.2	14.5	14.7	12.7	17.2	14.0	15.6	16.4	15.2		14.4
3-May-2002	13.6	14.9	14.5	14.0	13.7	14.2	13.2	14.2	11.8	14.8	14.0	14.4	14.5	14.2		14.1
4-Jun-2002	12.8	13.1	13.4	13.3	12.8	13.3	12.6	14.0	12.8	14.7	13.5	13.3	14.4	13.9		13.6
4-Jul-2002	11.7	11.8	12.2	11.6	10.5	11.3	11.1	12.2	11.3	14.4	12.2	12.2	12.8	11.6		11.4
5-Aug-2002	11.4	12.5	12.4	11.9	12.5	13.0	12.5	14.0	11.8	12.9	12.3	12.7	13.7	11.6		12.2
3-Sep-2002	10.8	11.3	12.1	10.6	11.7	11.4	13.0	14.2	12.0	14.3	10.7	13.3	14.3	10.5		11.7
30-Sep-2002	13.2	15.7	15.3	14.7	14.0	15.3	15.2	14.4	12.5		15.1	14.2	17.3	15.1		15.5
4-Nov-2002							15.4	16.0	13.6	14.8		16.3	16.6			
3-Dec-2002	16.2	20.8	18.7	17.0	18.6	18.4	20.0	18.1	16.6		17.1	20.0	22.1	18.3		21.0
Median	12.8	14.9	13.8	13.3	13.1	14.2	13.2	14.2	12.5	14.8	14.0	14.2	14.5	14.2		14.1
IQR/median %	14.8	22.1	21.0	21.1	11.5	16.2	19.7	4.9	8.0	21.2	20.0	16.2	20.7	25.4		23.4

NB: The dates given are for sites N1-N9. Sites S1-S7 were measured on 10-Jan, 4-Feb, 7-Mar, 2-Apr, 1-May, 5-Jun, 3-Jul, 6-Aug, 5-Sep, 2-Oct, 5-Nov and 2-Dec.

b) The graphs on the following pages show temperature measurements from January 1992 to December 2002 (where data available).







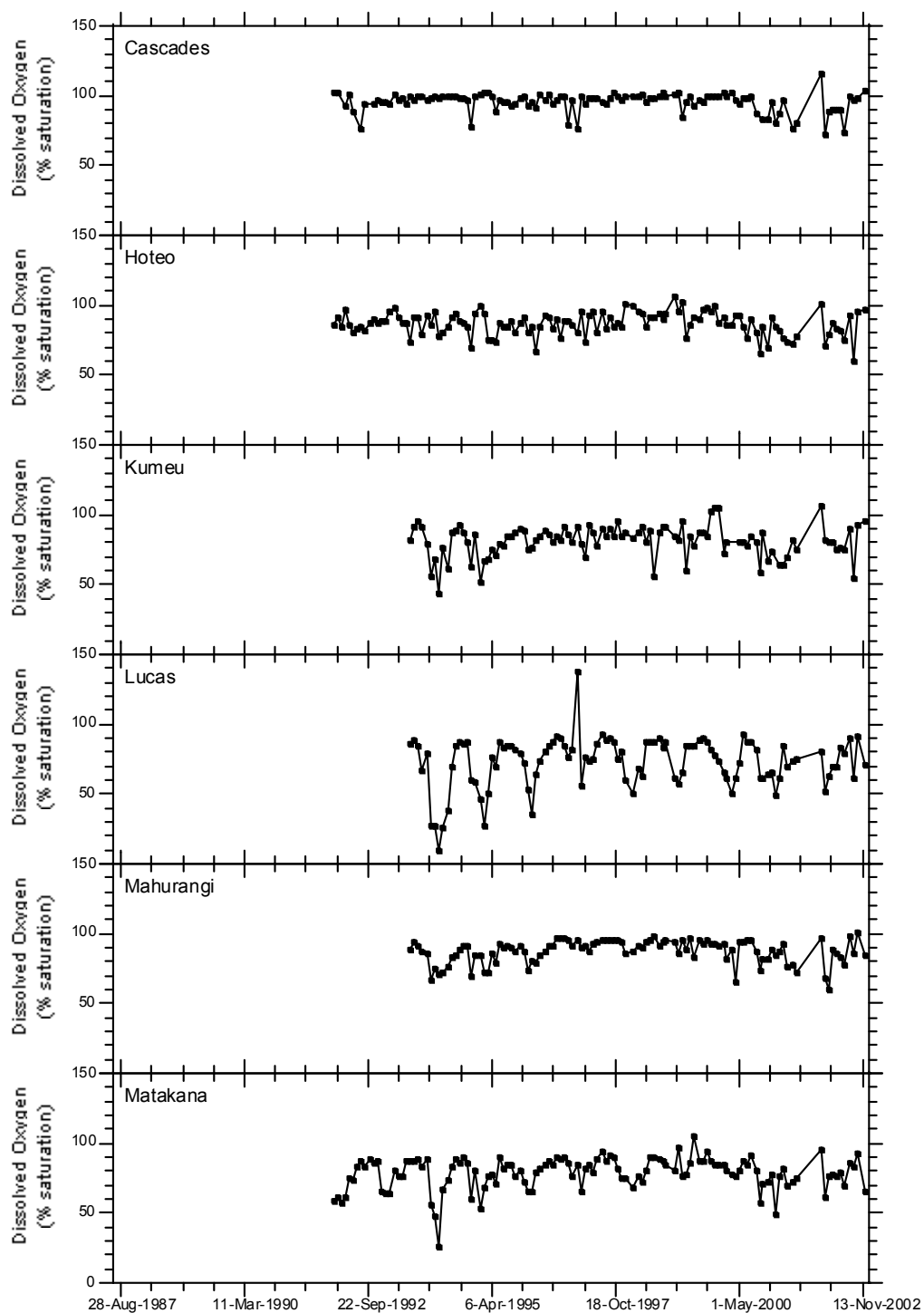
APPENDIX 2: FRESHWATER – DISSOLVED OXYGEN % SATURATION

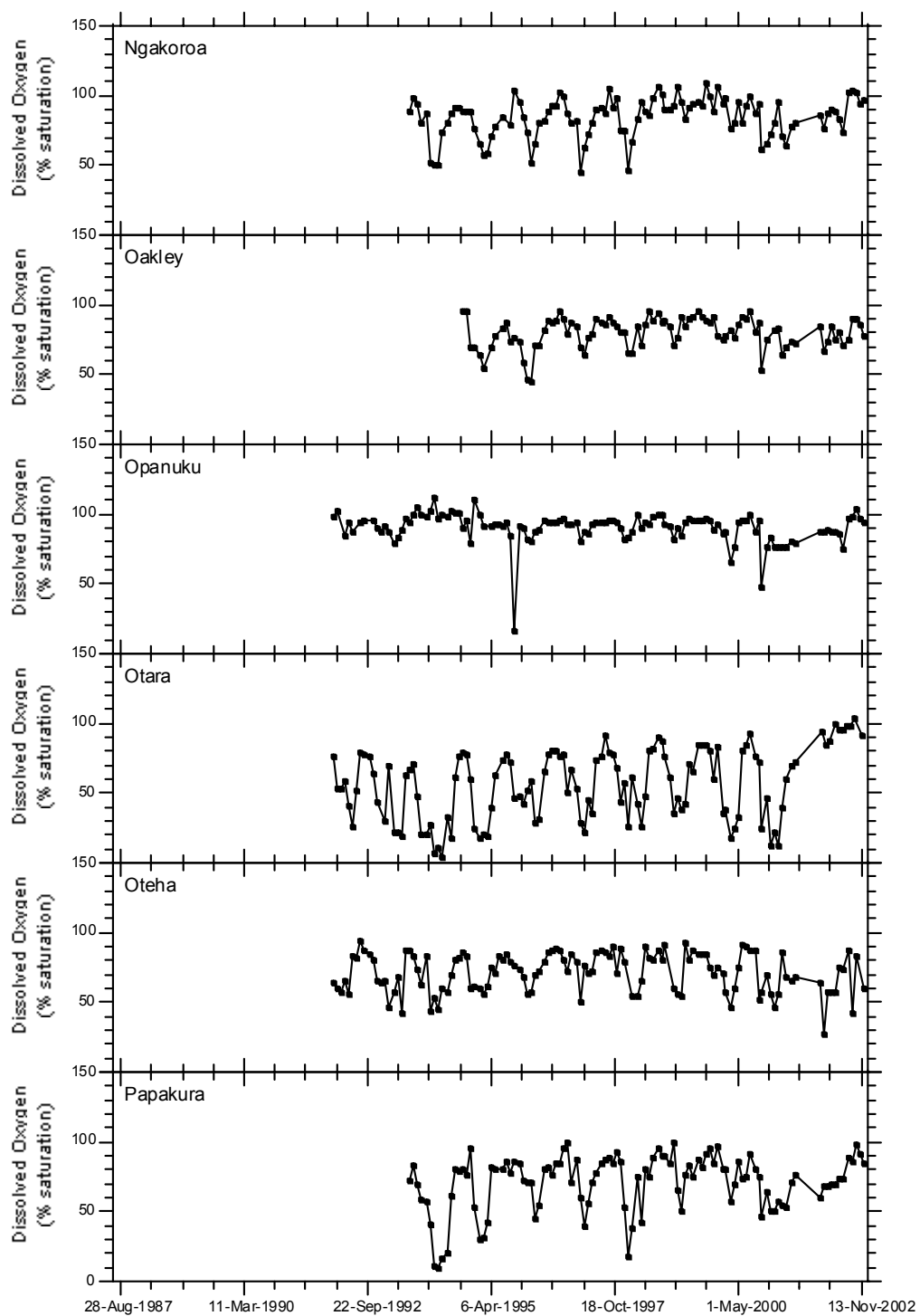
a) Dissolved oxygen (% saturation) during January 2002 to December 2002

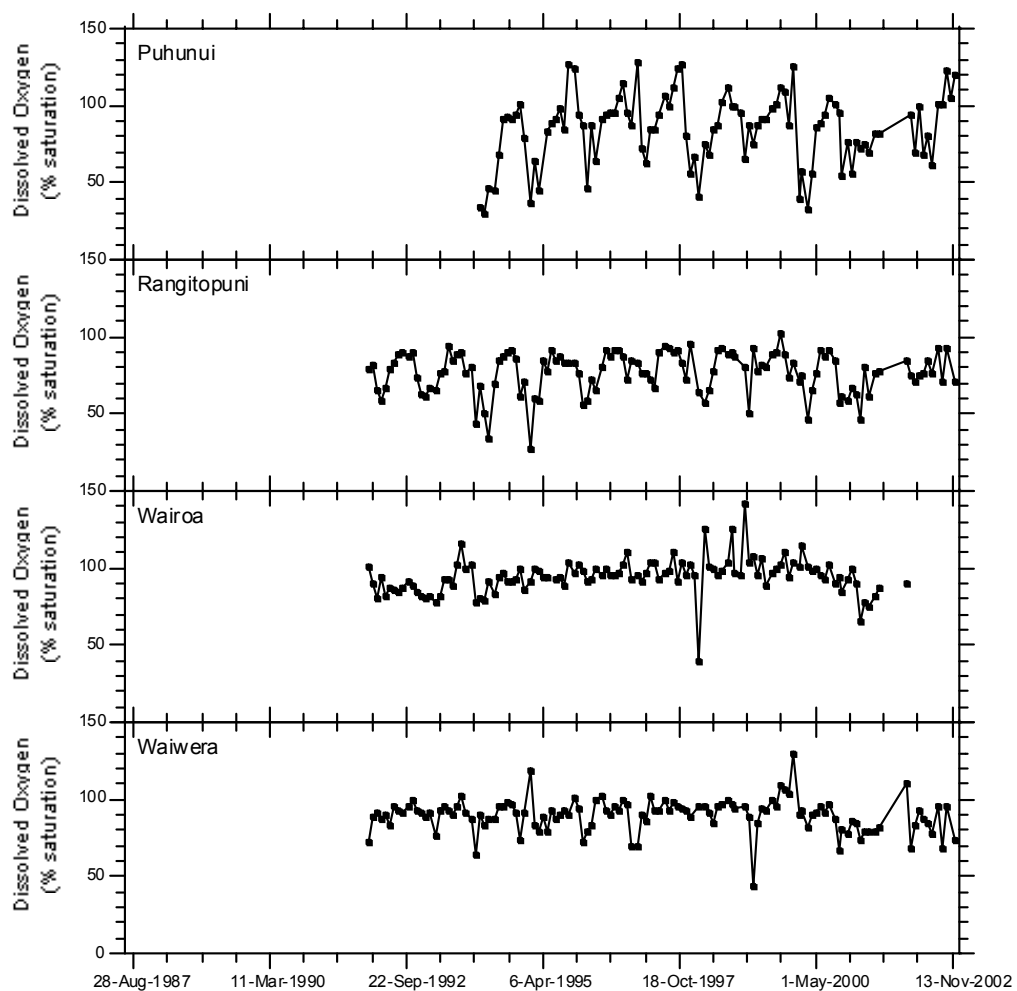
Date	Cascades	Hoteo	Kumeu	Lucas	Mahurangi	Matakana	Ngakoroa	Oakley	Opanuku	Otara	Oteha	Papakura	Puhinui	Rangitopuni	Wairoa	Waiwera
8-Jan-2002	116.3	101.2	105.8	80.5	97.4	96.1	86.4	84.7	88.0	66.2	64.6	59.8	101.2	84.8	89.7	110.9
5-Feb-2002		71.3	82.3	51.7	68.0	61.4	76.3	66.5	87.6	32.2	27.1	68.3	94.0	75.3	94.1	68.8
5-Mar-2002	88.7	79.6	80.5	62.3	59.8	76.1	87.3	74.0	89.1	27.5	56.8	67.6	69.5	70.4	86.9	83.0
3-Apr-2002	90.1	87.0	80.1	69.5	88.4	77.2	90.5	84.2	88.0	49.4	58.0	69.3	99.6	74.8	96.5	92.6
3-May-2002	90.2	83.3	75.6	69.7	85.6	77.0	88.9	74.9	87.9	46.2	57.7	70.2	68.8	76.4	89.2	86.9
4-Jun-2002	90.3	81.9	75.8	82.7	82.7	79.5	83.1	80.5	86.3	69.5	74.8	73.1	80.4	84.5	92.5	84.8
4-Jul-2002	73.2	75.7	75.3	78.6	78.0	69.3	74.0	70.8	75.3	71.7	73.8	73.9	61.7	76.5	76.5	77.9
5-Aug-2002	99.5	92.4	90.3	90.7	98.7	85.9	101.9	74.5	97.0	83.4	87.6	89.1	100.8	92.7	101.1	95.5
3-Sep-2002	97.3	60.0	54.4	62.0	85.6	83.1	103.2	90.5	97.9	85.6	42.0	86.4	100.7	71.2	97	68.6
30-Sep-2002	98.9	96.0	92.9	92.0	101.4	92.5	102.4	90.5	103.4	96.6	83.9	97.7	122.6	92.9	98.5	95.7
4-Nov-2002							93.6	86.5	96.6	67.8		91.0	105.4		97.4	
3-Dec-2002	103.1	96.8	95.3	70.5	84.1	65.5	97.0	77.3	93.6	49.8	60.6	84.4	120.4	71.0	106.1	74.3
Median	90.3	82.6	80.3	74.2	85.6	78.4	88.1	77.7	88.0	67.9	61.3	71.7	96.8	76.5	93.3	85.9
IQR/median %	9.7	17.4	15.8	24.3	18.7	11.3	17.2	13.4	8.4	49.3	28.6	20.6	29.5	12.8	8.1	18.2

NB: The dates given are for sites N1-N9. Sites S1-S7 were measured on 10-Jan, 4-Feb, 7-Mar, 2-Apr, 1-May, 5-Jun, 3-Jul, 6-Aug, 5-Sep, 2-Oct, 5-Nov and 2-Dec.

b) The graphs on the following pages show dissolved oxygen (% saturation) measurements from January 1992 to December 2002 (where data available).







APPENDIX 3: FRESHWATER – BIOCHEMICAL OXYGEN DEMAND

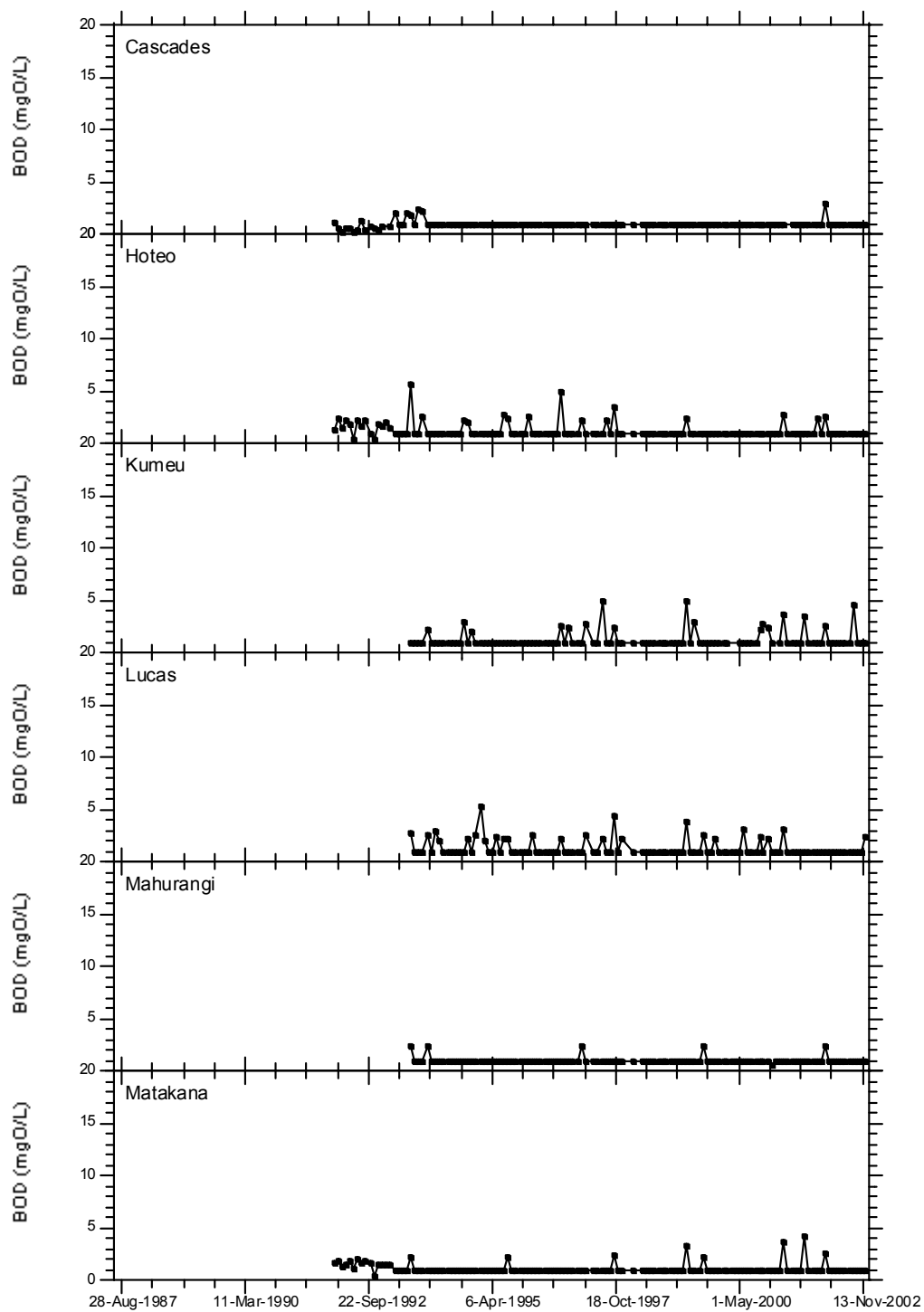
(Note that $\text{g/m}^3 = \text{g m}^{-3} = \text{mg/L}$)

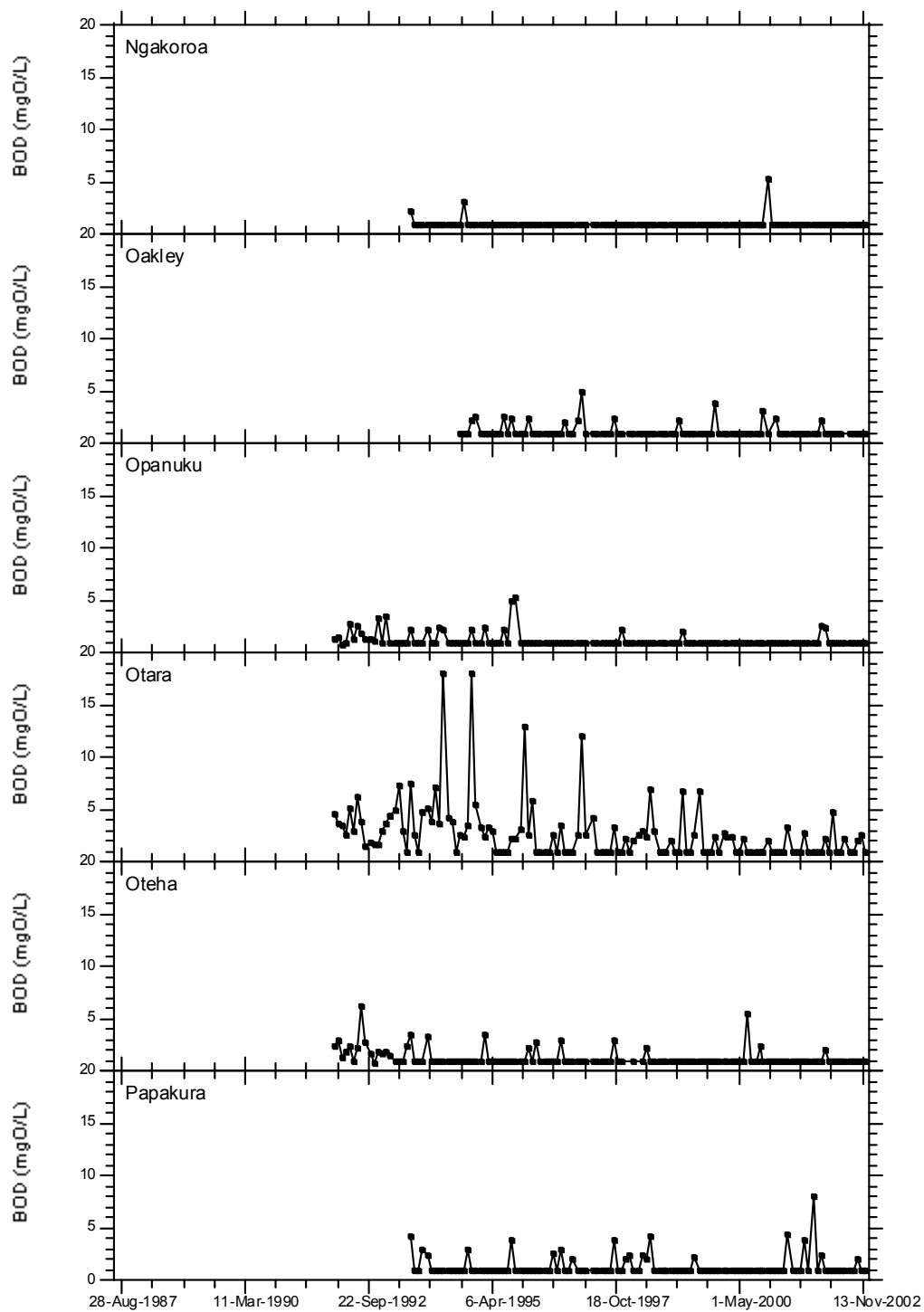
a) Biochemical oxygen demand (mg/L) during January 2002 to December 2002

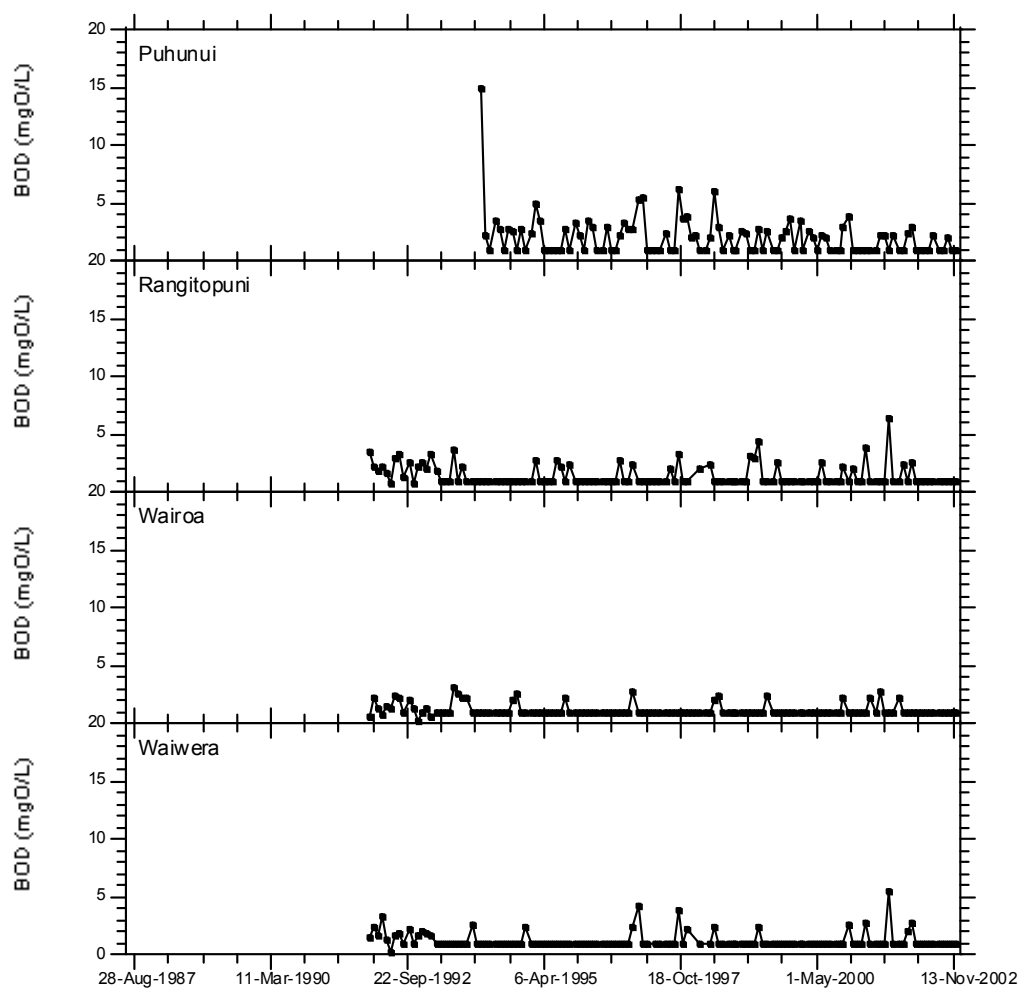
Date	Cascades	Hoteo	Kumeu	Lucas	Mahurangi	Matakana	Ngakoroa	Oakley	Opanuku	Otara	Oteha	Papakura	Puhinui	Rangitopuni	Wairoa	Waiwera
8-Jan-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.1	2.6	1.0	1.0	2.4	2.3	1.0	1.0	2.0
5-Feb-2002	3.0	2.6	2.5	1.0	2.3	2.6	1.0	1.0	2.4	2.1	2.0	1.0	2.9	2.5	1.0	2.7
5-Mar-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3-Apr-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	4.8	1.0	1.0	1.0	1.0	1.0	1.0
3-May-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4-Jun-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4-Jul-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0	2.2	1.0	1.0	2.2	1.0	1.0	1.0
5-Aug-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3-Sep-2002	1.0	1.0	4.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.6
30-Sep-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	1.0	2.0	2.0	1.0	1.0	1.0
4-Nov-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.5	1.0	1.0	1.0	1.0	1.0	1.0
3-Dec-2002	1.0	1.0	1.0	2.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Median	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
IQR/median %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	112.5	0.0	0.0	105.0	0.0	0.0	25.0

NB: The dates given are for sites N1-N9. Sites S1-S7 were measured on 10-Jan, 4-Feb, 7-Mar, 2-Apr, 1-May, 5-Jun, 3-Jul, 6-Aug, 5-Sep, 2-Oct, 5-Nov and 2-Dec.

b) The graphs on the following pages show BOD measurements from January 1992 to December 2002 (where data available).







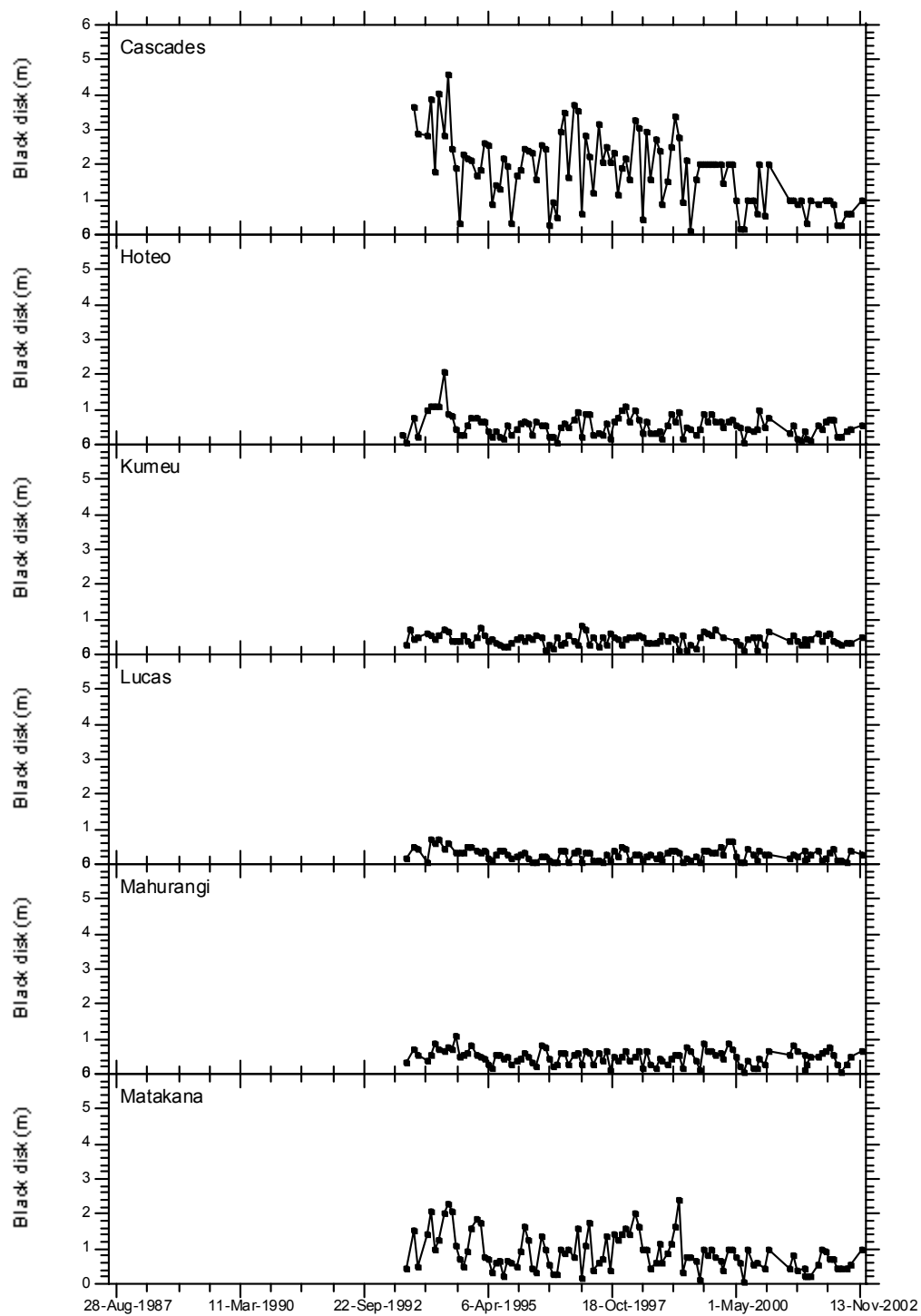
APPENDIX 4: FRESHWATER – BLACK DISK TRANSPARENCY

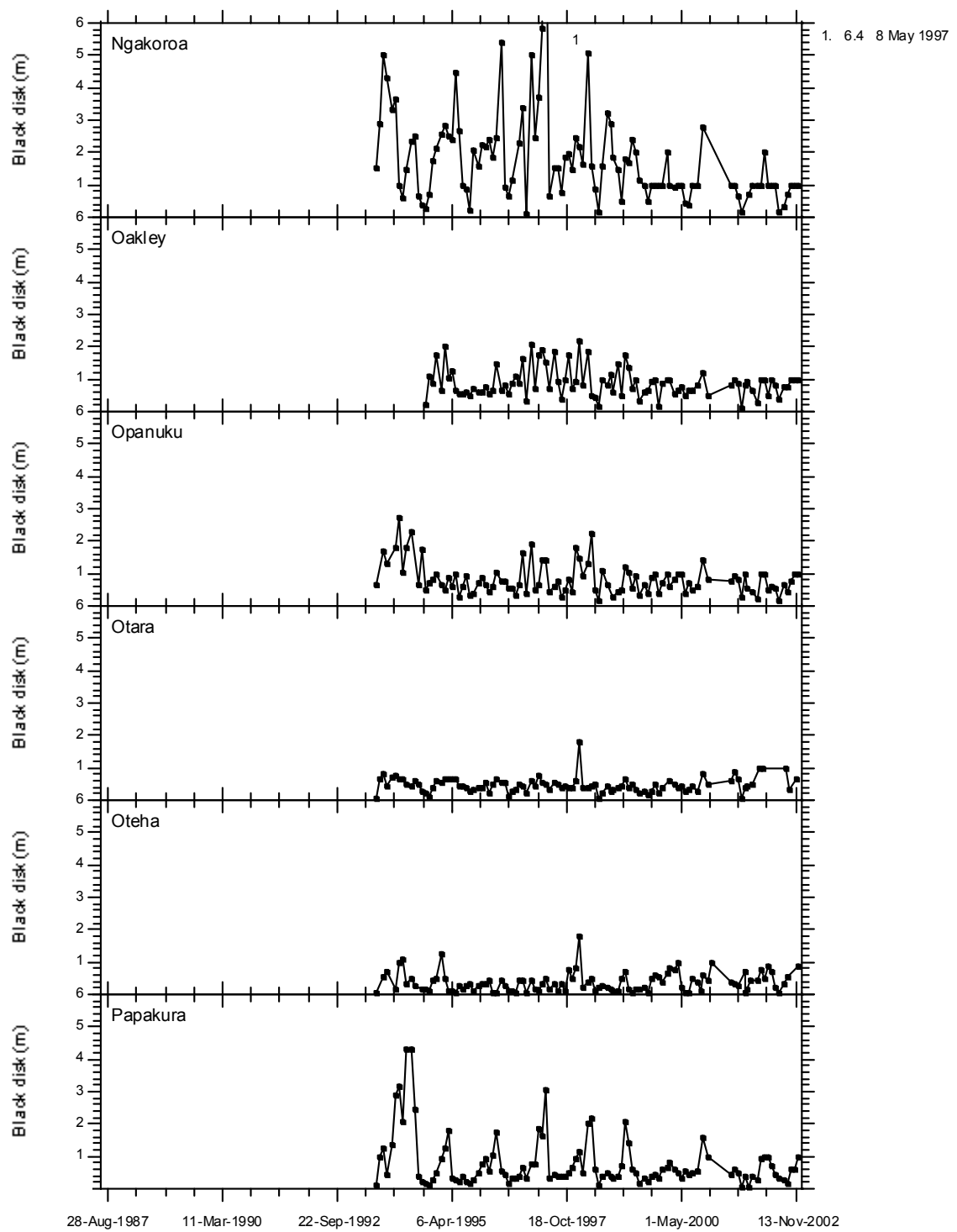
a) Black disk transparency (m) during January 2002 to December 2002

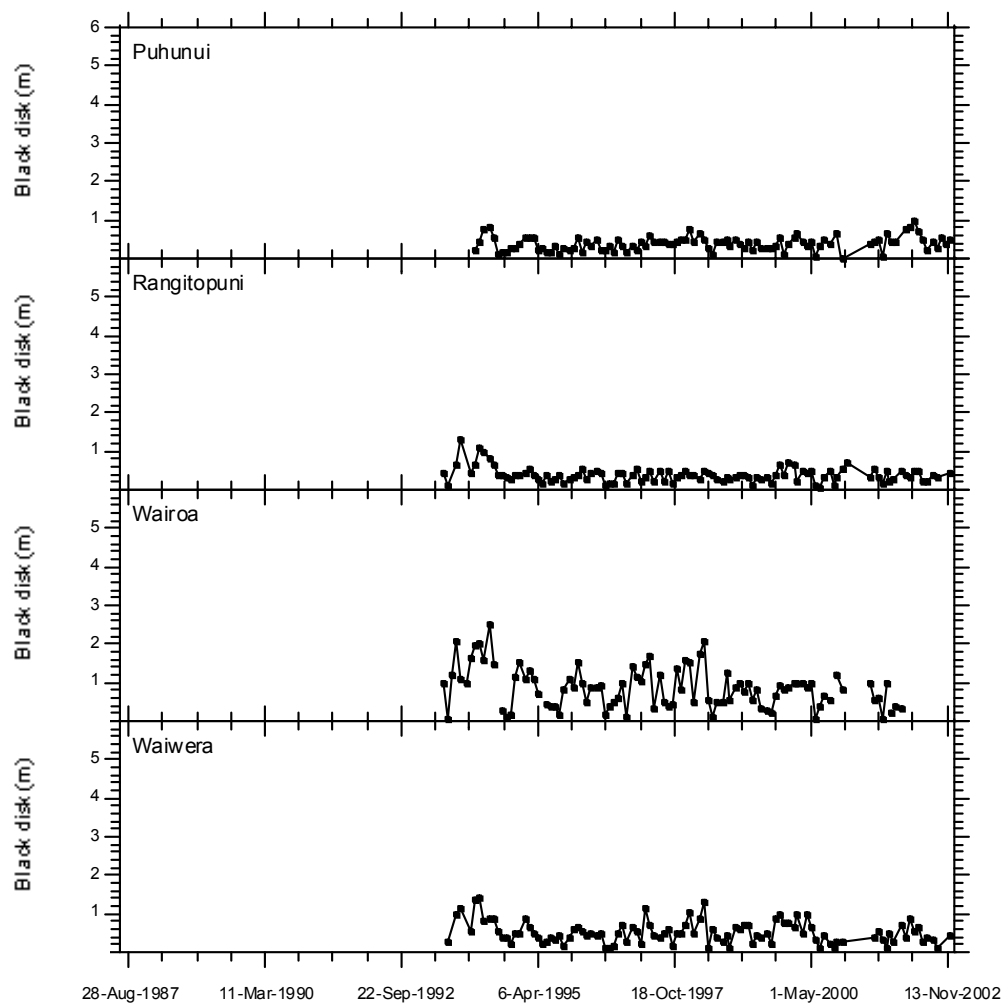
Date	Cascades	Hoteo	Kumeu	Lucas	Mahurangi	Matakana	Ngakoroa	Oakley	Opanuku	Otara	Oteha	Papakura	Puhinui	Rangitopuni	Wairoa	Waiwera
8-Jan-2002	0.85	0.56	0.61	0.36	0.51	0.55	1.00	0.28	0.24	1.00	0.45	0.26	0.42	0.48	0.34	0.73
5-Feb-2002		0.43	0.40	0.10	0.62	1	1.00	0.50	1.00	1.00	0.75	0.92	0.77	0.36	0.70	0.41
5-Mar-2002	1.00	0.63	0.55	0.15	0.64	0.92	2.00	1.00	1.00		0.52	1.00	0.83	0.34	0.45	0.85
3-Apr-2002	1.00	0.72	0.60	0.31	0.77	0.7	1.00	0.49	0.52		0.85	1.00	1.00	0.52	0.40	0.56
3-May-2002	0.90	0.70	0.38	0.43	0.53	0.7	1.00	1.00	0.62		0.70	0.72	0.70	0.47	0.10	0.65
4-Jun-2002	0.25	0.20	0.31	0.12	0.3	0.46	1.00	0.80	0.53		0.23	0.45	0.47	0.20	1.00	0.30
4-Jul-2002	0.29	0.20	0.26	0.12	0.04	0.43	0.16	0.36	0.14		0.06	0.34	0.23	0.24	0.18	0.39
5-Aug-2002	0.62	0.39	0.32	0.05	0.28	0.42	0.34	0.78	0.68	0.50	0.33	0.28	0.43	0.38	0.18	0.31
3-Sep-2002	0.58	0.42	0.31	0.41	0.52	0.53	0.35	0.74	0.42	0.33	0.55	0.18	0.27	0.32	0.05	0.10
30-Sep-2002							1.00	1.00	0.76			0.61	0.54		0.45	
4-Nov-2002							1.00	1.00	1.00	0.63		0.62	0.41		0.16	
3-Dec-2002	1.00	0.54	0.48	0.30	0.65	1.00	1.00	1.00	1.00		0.85	1.00	0.25	0.42	0.40	0.46
Median	0.85	0.49	0.39	0.23	0.53	0.63	1.00	0.79	0.65	0.63	0.54	0.62	0.45	0.37	0.37	0.44
IQR/median %	49.4	44.3	56.4	101.1	53.8	62.0	16.3	63.6	77.7	79.4	70.6	100.0	76.1	35.8	74.3	68.4

NB: The dates given are for sites N1-N9. Sites S1, S4-7 were measured on 10-Jan, 4-Feb, 7-Mar, 2-Apr, 1-May, 5-Jun, 3-Jul, 6-Aug, 5-Sep, 2-Oct, 5-Nov and 2-Dec. Opanuku (S2) and Otara (S3) were measured on 29-Jan, 25-Feb, 27-Mar, 30-Apr, 27-May, 25-Jun, 24-Jul, 21-Aug, 20-Sep, 18 Nov and 17-Dec. Values entered on field sheets as 1+ are given a value of 1.00.

b) The graphs on the following pages show black disk transparency measurements from January 1992 to December 2002 (where data available).







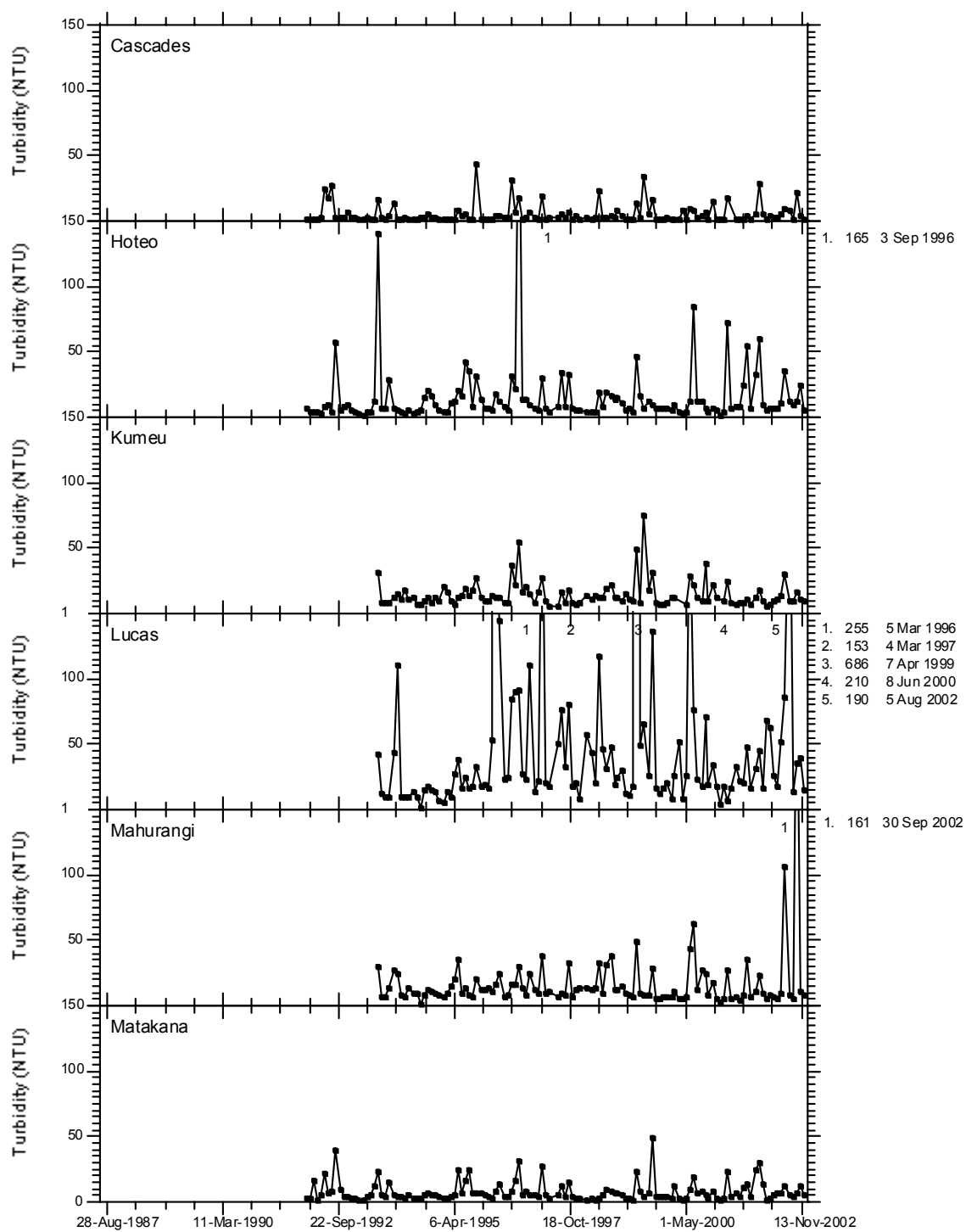
APPENDIX 5: FRESHWATER – TURBIDITY

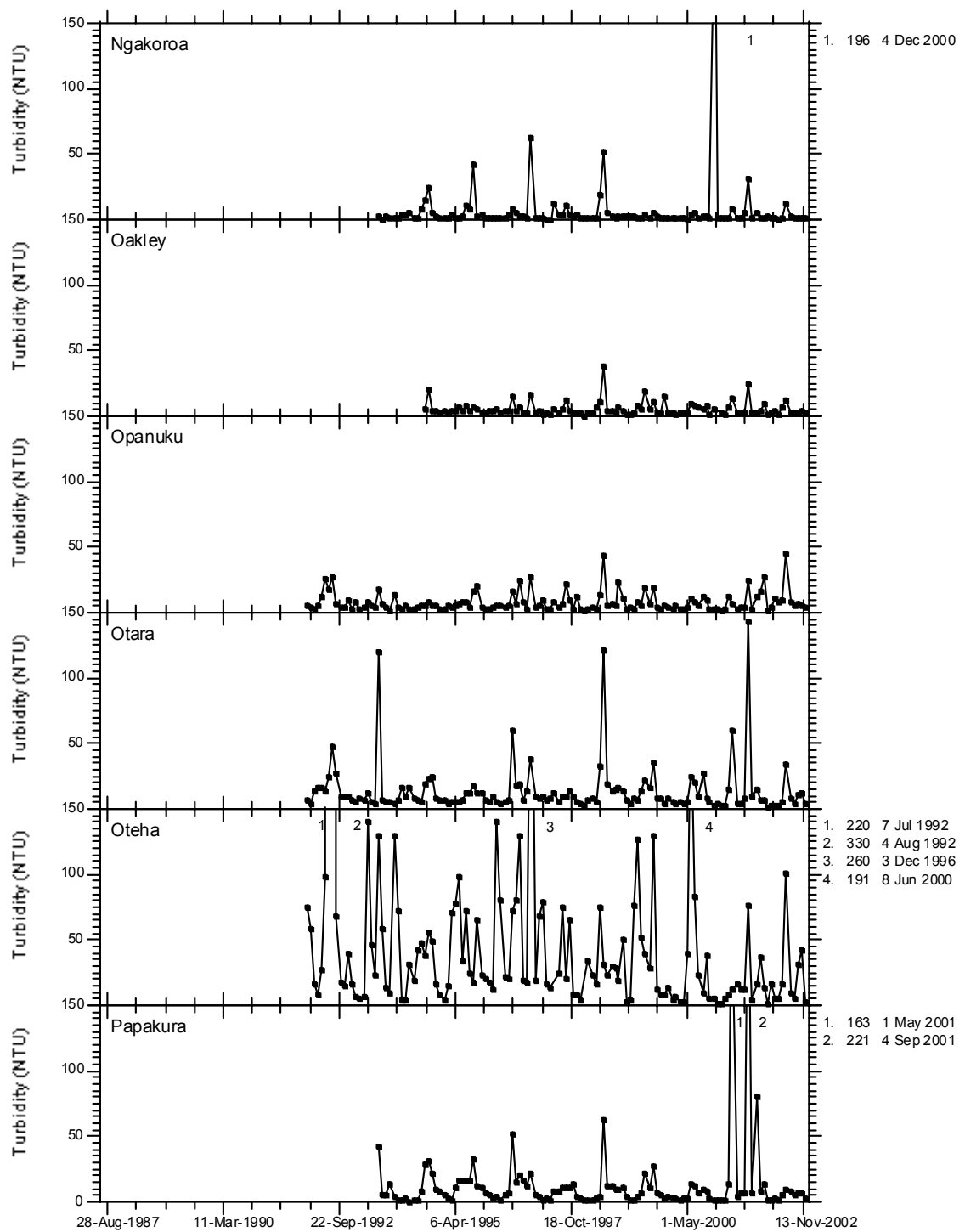
a) Turbidity (NTU) during January 2002 to December 2002

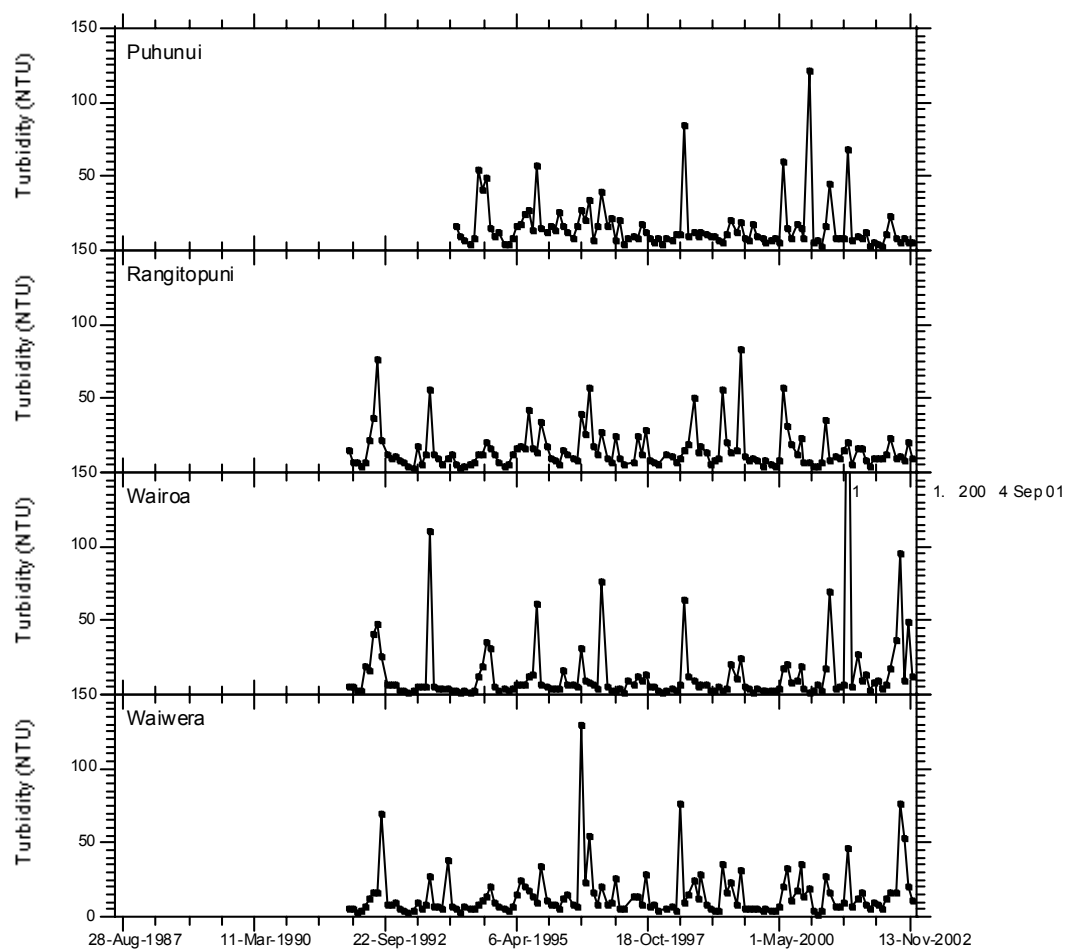
Date	Cascades	Hoteo	Kumeu	Lucas	Mahurangi	Matakana	Ngakoroa	Oakley	Opanuku	Otara	Oteha	Papakura	Puhinui	Rangitopuni	Wairoa	Waiwera
8-Jan-2002	14.0	1.5	10.0	27.0	7.1	14.0	14.0	13.0	8.4	14.0	8.3	14.0	1.5	10.0	27.0	7.1
5-Feb-2002	1.5	2.7	1.3	1.8	1.1	1.7	1.3	3.2	4.7	2.8	5.7	1.5	2.7	1.3	1.8	1.1
5-Mar-2002	3.1	1.3	2.9	4.3	3.0	16.0	2.0	5.1	10.0	7.6	10.0	3.1	1.3	2.9	4.3	3.0
3-Apr-2002	5.8	1.5	3.9	11.0	3.4	5.3	2.5	4.0	10.0	10.0	8.9	5.8	1.5	3.9	11.0	3.4
3-May-2002	6.3	0.5	1.6	8.0	2.4	4.8	1.3	2.5	9.2	4.1	6.1	6.3	0.5	1.6	8.0	2.4
4-Jun-2002	7.0	1.2	6.4	9.9	5.9	17.0	5.0	11.5	13.0	6.8	12.0	7.0	1.2	6.4	9.9	5.9
4-Jul-2002	12.2	12.4	12.9	45.5	33.9	101.0	9.7	23.9	22.8	18.3	16.0	12.2	12.4	12.9	45.5	33.9
5-Aug-2002	5.1	3.1	2.3	7.9	8.4	10.0	8.6	8.9	9.5	37.0	16.0	5.1	3.1	2.3	7.9	8.4
3-Sep-2002	4.0	0.9	2.2	5.9	4.3	5.0	5.6	5.3	10.7	95.0	76.9	4.0	0.9	2.2	5.9	4.3
30-Sep-2002	6.4	1.1	2.4	6.4	10.5	31.3	6.4	7.6	7.9	9.8	52.7	6.4	1.1	2.4	6.4	10.5
4-Nov-2002	12.0	1.7	3.7	5.2	12.1	43.0	6.4	5.6	21.0	49.1	21.0	12.0	1.7	3.7	5.2	12.1
3-Dec-2002	4.9	1.5	2.5	3.7	4.3	3.3	3.2	5.8	9.9	12.5	11.0	4.9	1.5	2.5	3.7	4.3
Median	6.0	1.5	2.7	7.2	5.1	12.0	5.3	5.7	10.0	11.3	11.5	6.0	1.5	2.7	7.2	5.1
IQR/median %	59.2	49.7	83.5	72.1	110.2	130.3	86.2	82.5	23.1	138.4	73.9	59.2	49.7	83.5	72.1	110.2

NB: The dates given are for sites N1-N9. Sites S1-S7 were measured on 10-Jan, 4-Feb, 7-Mar, 2-Apr, 1-May, 5-Jun, 3-Jul, 6-Aug, 5-Sep, 2-Oct, 5-Nov and 2-Dec.

b) The graphs on the following pages show turbidity measurements from January 1992 to December 2002 (where data available).







APPENDIX 6: FRESHWATER – SUSPENDED SOLIDS

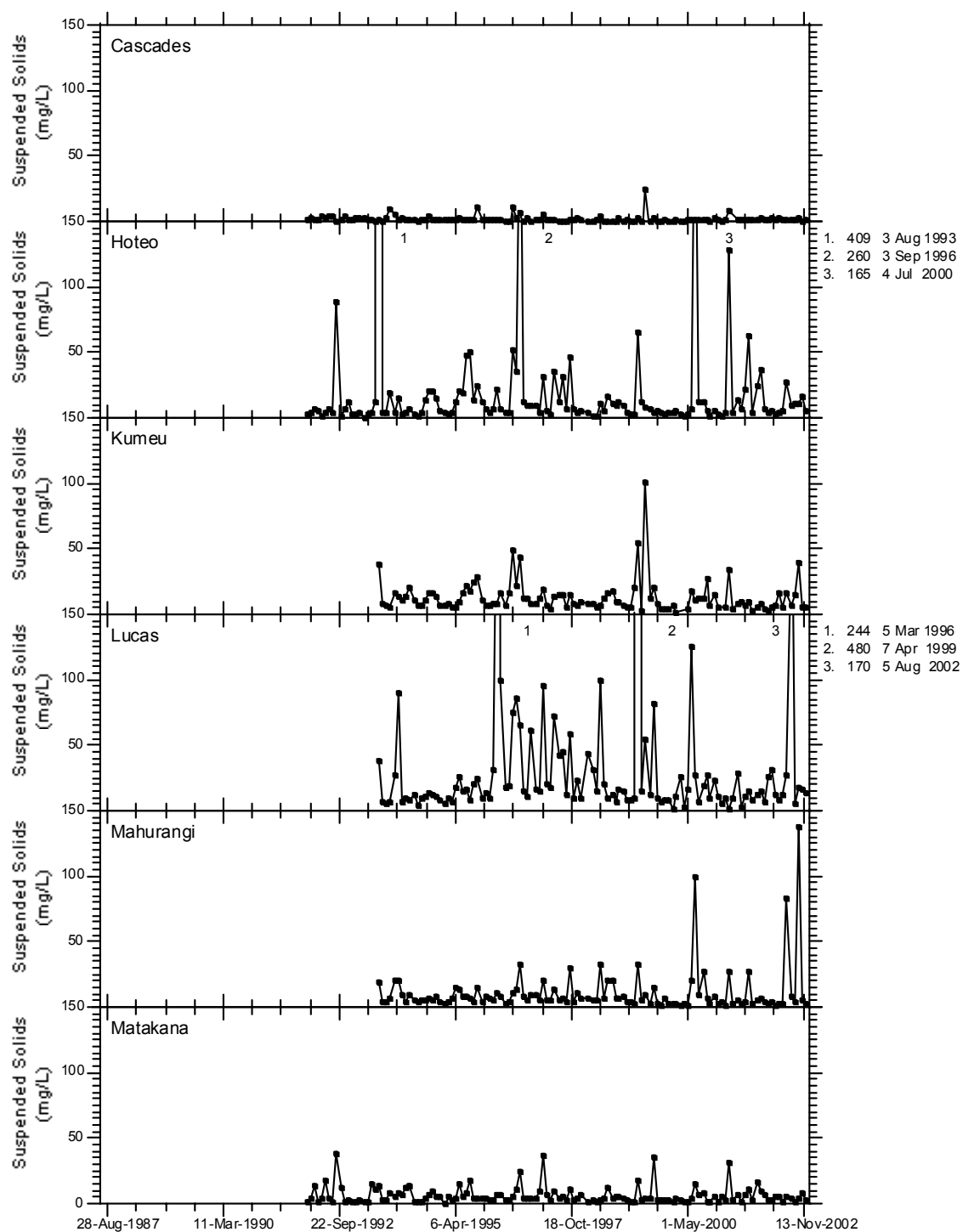
(Note that $\text{g/m}^3 = \text{g m}^{-3} = \text{mg/L}$)

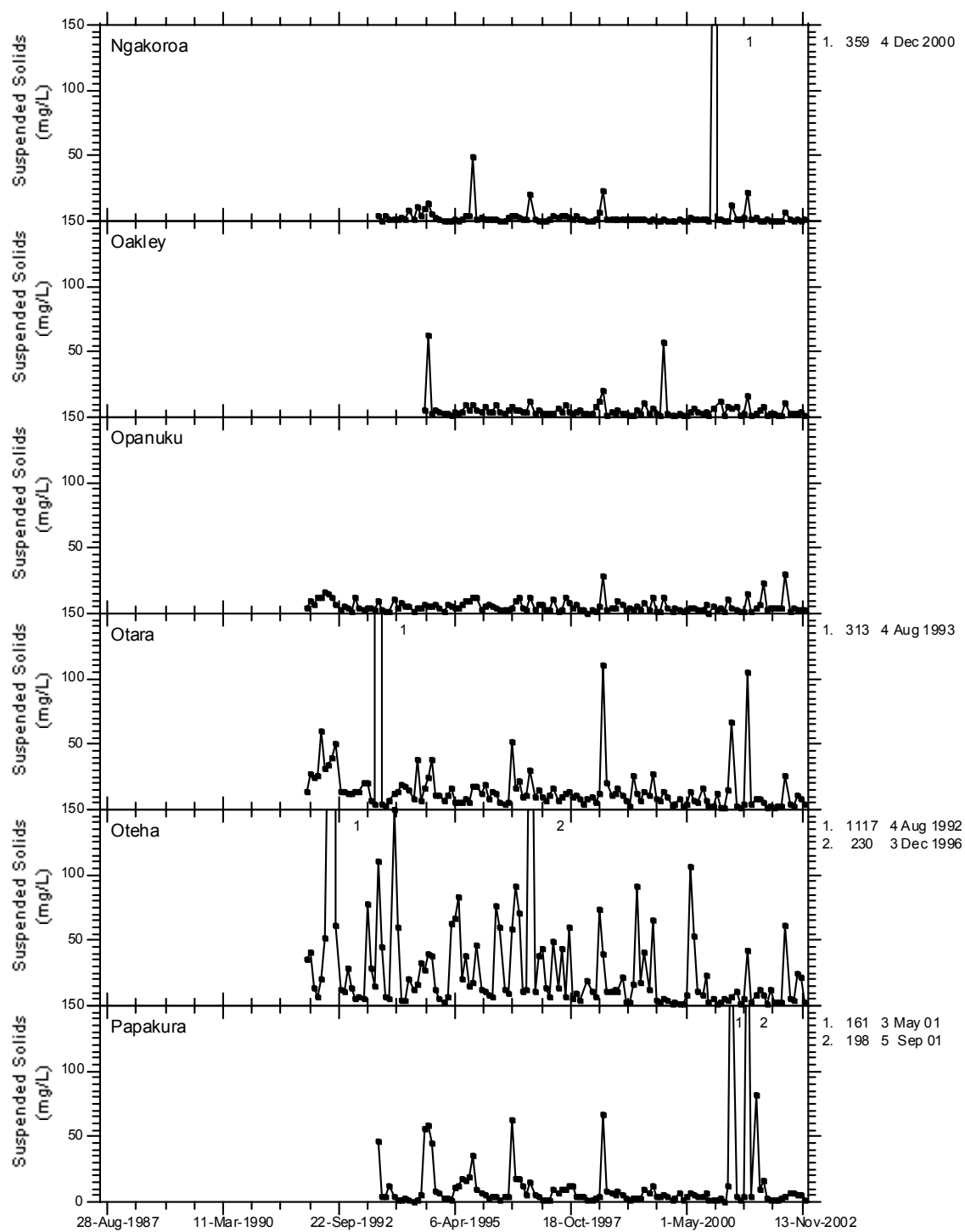
a) Suspended solids (mg/L) during January 2002 to December 2002

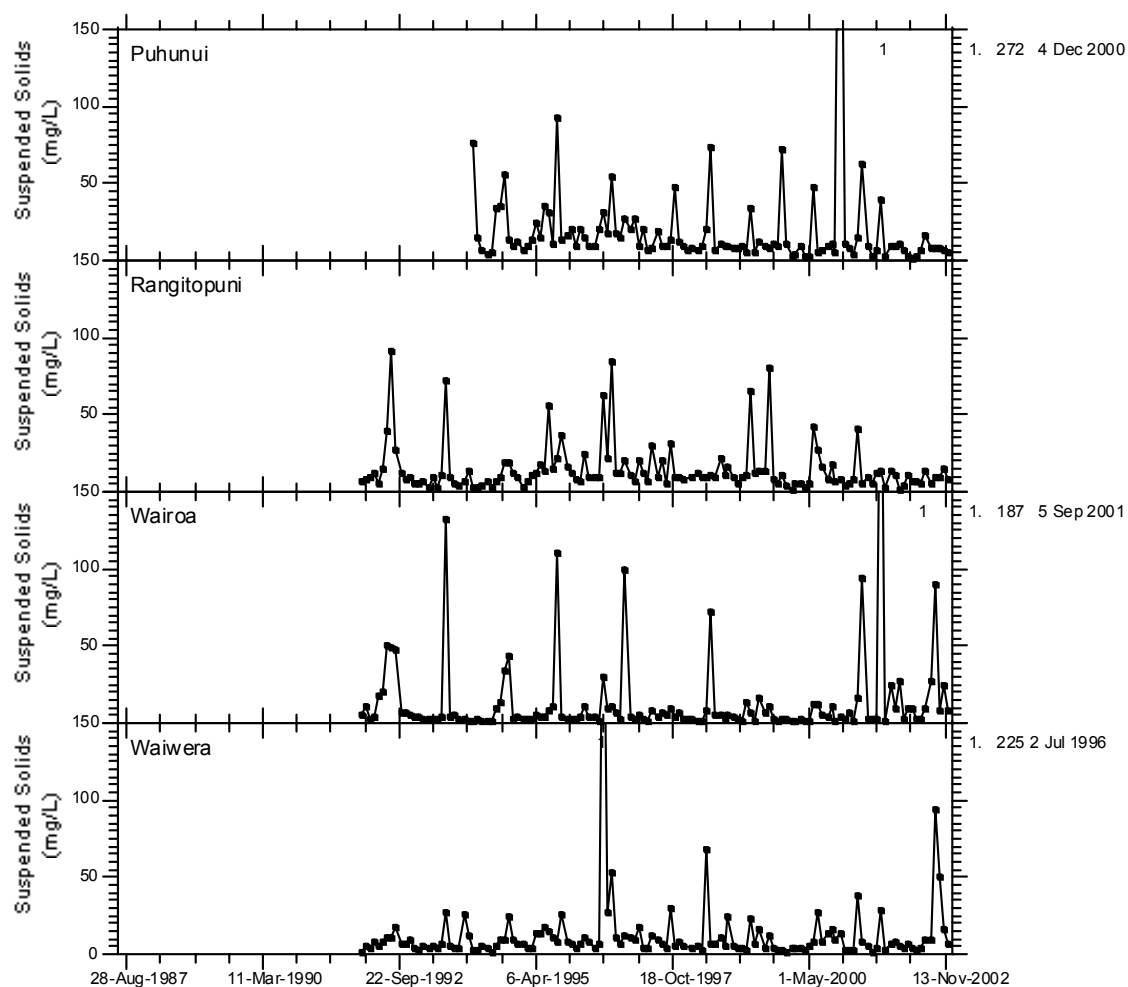
Date	Cascades	Hoteo	Kumeu	Lucas	Mahurangi	Matakana	Ngakoroa	Oakley	Opanuku	Otara	Oteha	Papakura	Puhinui	Rangitopuni	Wairoa	Waiwera
8-Jan-2002	1.4	6.7	3.8	6.7	4.1	6.7	0.5	8.7	23.0	5.4	8.9	17.0	11.0	1.3	27.0	4.9
5-Feb-2002	1.5	3.6	3.4	26.0	2.4	2.3	1.6	0.9	2.4	1.8	1.9	2.2	6.5	4.1	2.7	4.2
5-Mar-2002	2.4	5.3	5.2	31.4	4.8	3.3	0.4	2.7	4.2	2.4	11.7	2.0	3.3	11.2	9.0	6.9
3-Apr-2002	1.8	2.5	7.5	12.0	2.1	5.5	0.4	2.9	3.8	2.1	3.0	1.5	1.5	7.0	9.2	3.7
3-May-2002	2.3	3.5	16.3	8.6	2.2	6.1	0.1	2.0	3.5	2.6	2.3	1.5	2.8	7.1	3.1	3.1
4-Jun-2002	1.0	5.6	6.1	12.0	3.3	1.0	0.5	1.7	3.9	2.7	3.3	2.9	7.1	5.8	2.6	4.6
4-Jul-2002	0.8	27.0	16.4	27.6	83.0	5.9	6.4	10.6	30.5	25.8	61.8	4.4	16.6	13.2	10.0	9.3
5-Aug-2002	0.8	10.0	6.6	170.0	8.9	4.0	1.7	2.6	2.1	4.4	5.0	6.3	7.6	5.1	27.0	9.9
3-Sep-2002	1.1	11.0	15.0	5.1	3.6	1.9	0.6	2.8	3.9	3.2	3.6	6.3	8.1	9.7	89.4	94.0
30-Sep-2002	2.6	11.3	39.0	18.1	138.0	4.3	1.2	2.6	2.8	11.6	25.0	6.0	8.6	9.7	7.8	51.0
4-Nov-2002	0.6	16.8	5.9	16.8	5.9	8.2	0.5	4.3	3.1	8.7	21.7	5.5	6.6	15.5	24.5	16.3
3-Dec-2002	1.3	6.1	5.0	13.1	3.4	3.0	1.0	1.3	2.5	4.2	2.8	2.0	4.9	8.3	8.0	6.2
Median	1.4	6.4	6.4	15.0	3.9	4.2	0.6	2.7	3.7	3.7	4.3	3.7	6.9	7.7	9.1	6.6
IQR/median %	72.2	96.9	160.2	102.0	92.9	75.3	150.0	50.0	34.2	99.3	261.6	111.6	54.4	57.8	203.3	106.9

NB: The dates given are for sites N1-N9. Sites S1-S7 were measured on 10-Jan, 4-Feb, 7-Mar, 2-Apr, 1-May, 5-Jun, 3-Jul, 6-Aug, 5-Sep, 2-Oct, 5-Nov and 2-Dec.

b) The graphs on the following pages show suspended solids measurements from January 1992 to December 2002 (where data available).







APPENDIX 7: FRESHWATER – PRESUMPTIVE COLIFORMS

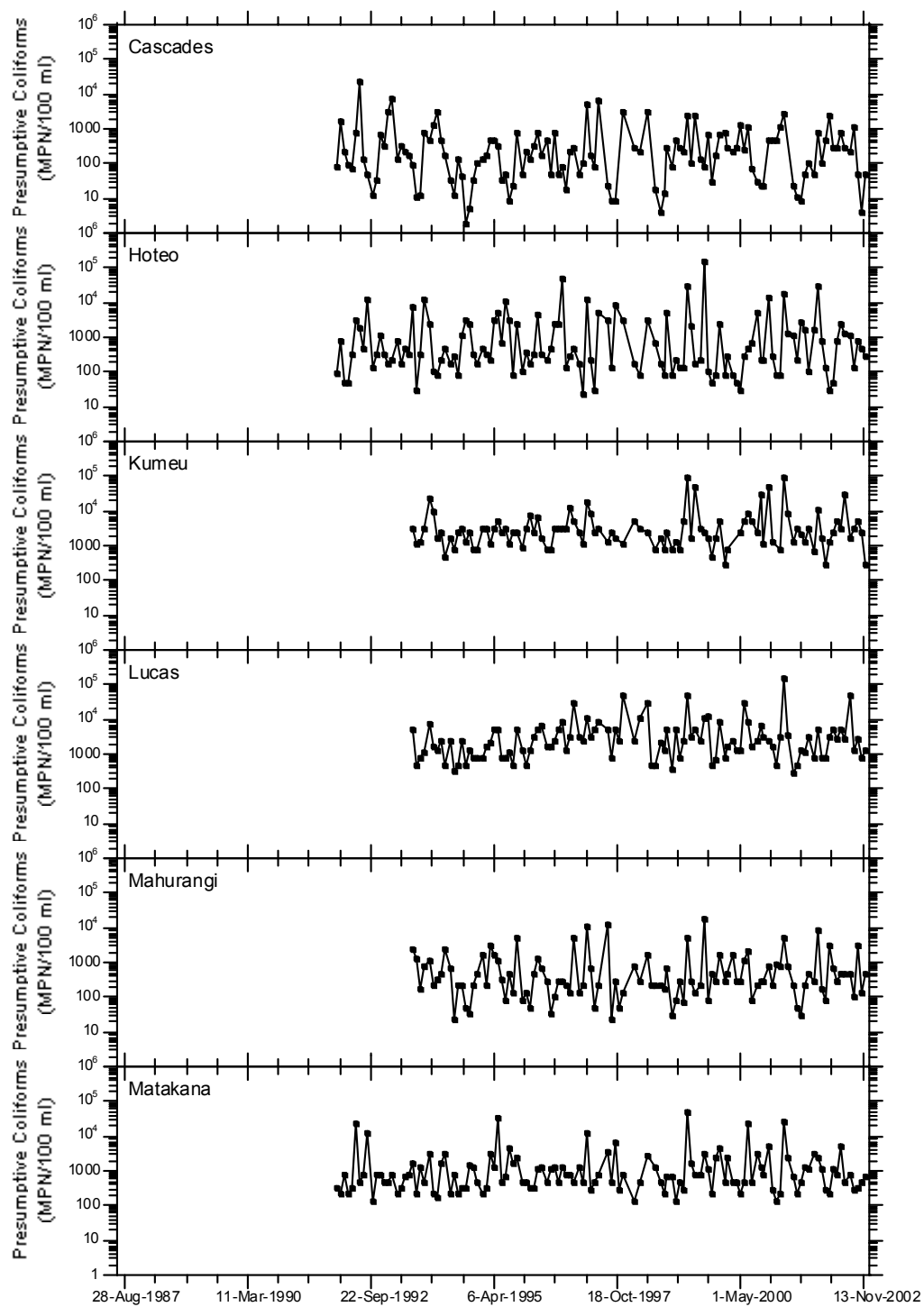
(Note that $\text{g/m}^3 = \text{g m}^{-3} = \text{mg/L}$)

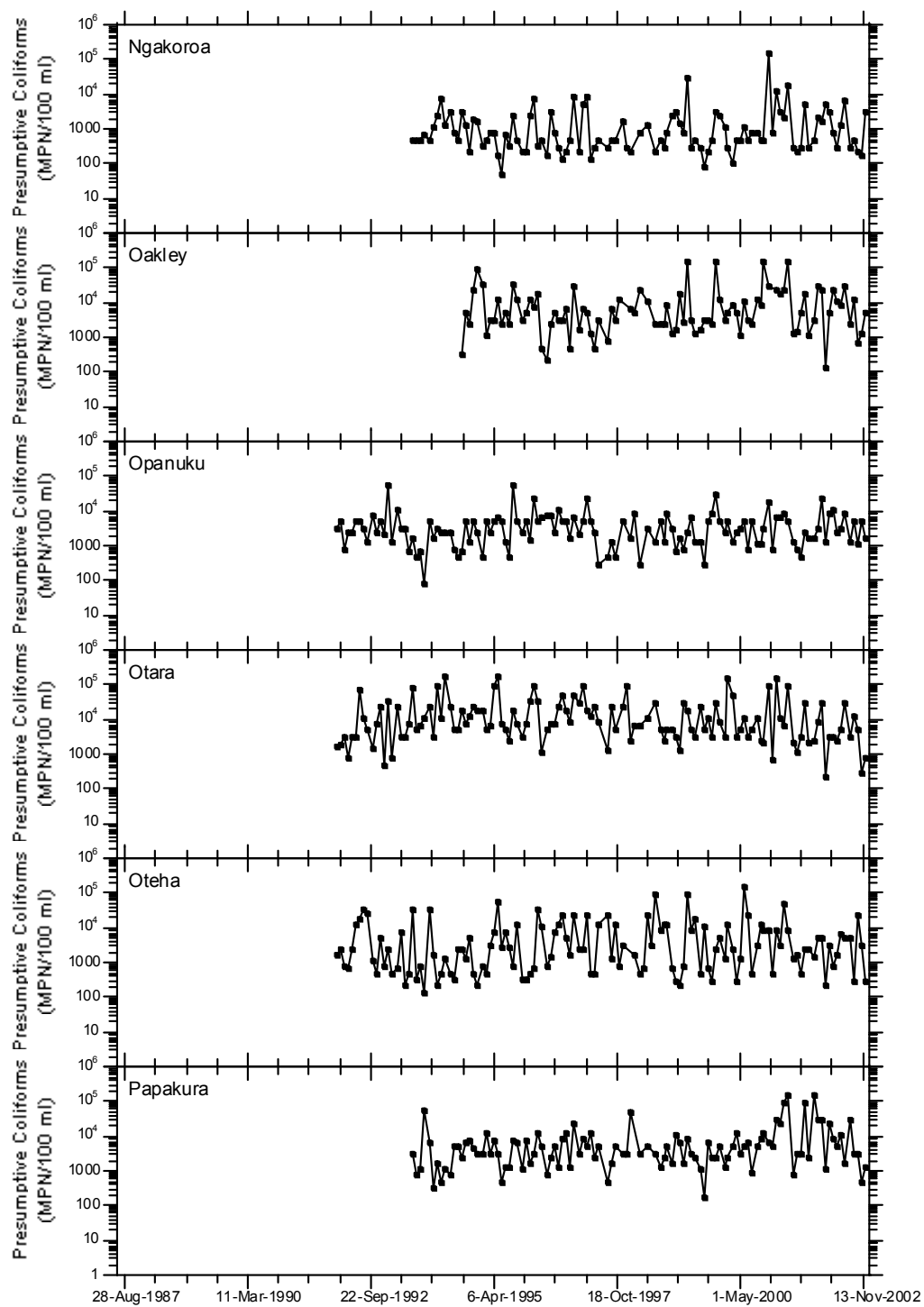
a) Presumptive coliforms (MPN/100 mL) during January 2002 to December 2002

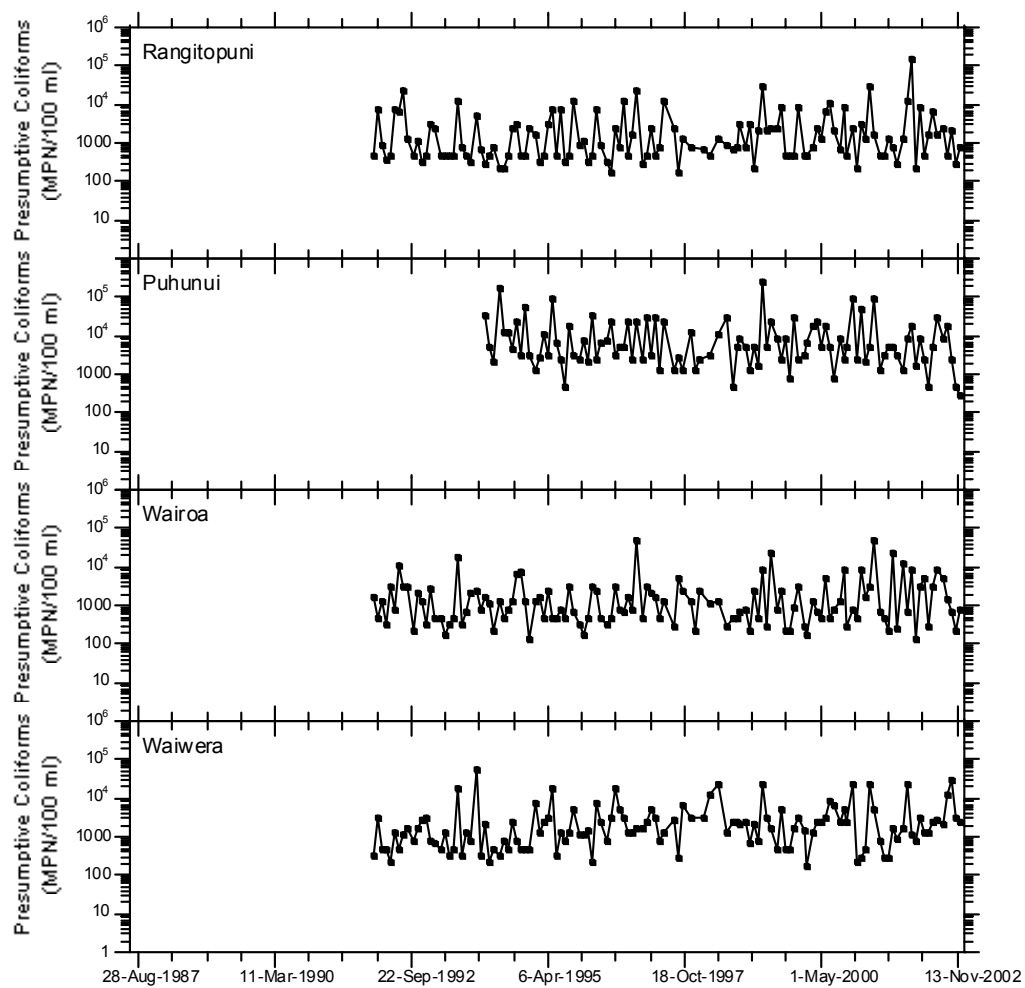
Date	Cascades	Hoteo	Kumeu	Lucas	Mahurangi	Matakana	Ngakoroa	Oakley	Opanuku	Otara	Oteha	Papakura	Puhinui	Rangitopuni	Wairoa	Waiwera
8-Jan-2002	110	800	1700	800	170	1100	1600	22000	24000	30000	5000	30000	17000	>160000	9000	1100
5-Feb-2002	500	130	300	800	80	300	5000	130	1300	230	230	1100	1700	220	130	800
5-Mar-2002	2300	30	1300	3000	3000	220	3000	5000	8000	3000	3000	24000	8000	8000	3000	3000
3-Apr-2002	300	50	2300	5000	700	1100	800	24000	11000	3000	800	9000	2300	500	5000	1300
3-May-2002	300	800	5000	2800	300	800	300	11000	2300	2300	1700	5000	500	1700	300	1300
4-Jun-2002	800	2300	3000	5000	500	5000	1300	8000	3000	5000	7000	11000	5000	7000	3000	2300
4-Jul-2002	300	1300	30000	2800	500	500	7000	30000	8000	30000	5000	1700	30000	1700	8000	2800
5-Aug-2002	230	1100	1700	50000	500	800	300	2300	1300	3000	5000	30000	8000	2300	5000	2200
3-Sep-2002	1100	140	3000	1300	110	300	500	13000	5000	13000	300	3000	17000	500	1400	13000
30-Sep-2002	50	800	5000	2900	3000	320	230	700	1100	5000	24000	3000	2300	2200	700	30000
4-Nov-2002	4	500	2300	800	130	500	170	1300	5000	300	3000	500	500	300	230	3000
3-Dec-2002	50	300	300	1300	500	700	3000	5000	1700	800	300	1300	300	800	800	2300
Median	300	650	2300	2800	500	600	1050	6500	4000	3000	3000	4000	3650	1700	2200	2300
IQR/median %	160	113	83	83	78	93	257	203	160	169	144	316	242	103	200	74

NB: The dates given are for sites N1-N9. Sites S1-S7 were measured on 10-Jan, 4-Feb, 7-Mar, 2-Apr, 1-May, 5-Jun, 3-Jul, 6-Aug, 5-Sep, 2-Oct, 5-Nov and 2-Dec.

b) The graphs on the following pages show presumptive coliform measurements from January 1992 to December 2002 (where data available).







APPENDIX 8: FRESHWATER – FAECAL COLIFORMS

a) Faecal coliforms (MPN/100 mL) during January 2002 to December 2002

Date	Cascades	Hoteo	Kumeu	Lucas	Mahurangi	Matakana	Ngakoroa	Oakley	Opanuku	Otara	Oteha	Papakura	Puhinui	Rangitopuni	Wairoa	Waiwera
8-Jan-2002	110	500	500	50	50	500	1600	5000	5000	7000	500	2200	5000	130	5000	700
5-Feb-2002	170	130	300	800	50	130	5000	80	500	130	130	800	1300	220	80	800
5-Mar-2002	1300	23	300	1300	300	70	280	2300	5000	280	280	8000	900	500	130	700
3-Apr-2002	50	30	1300	500	110	500	300	3000	2300	3000	500	7000	300	300	1700	800
3-May-2002	130	500	1400	1700	27	300	110	800	2300	800	170	3000	500	300	170	800
4-Jun-2002	220	80	500	700	230	220	1300	700	800	800	1400	11000	800	1100	1100	1300
4-Jul-2002	300	500	2800	500	130	300	220	13000	3000	17000	3000	1300	3000	500	800	1400
5-Aug-2002	22	110	1300	500	230	300	300	2300	800	500	1700	30000	3000	2300	800	300
3-Sep-2002	6	90	3000	300	110	170	500	8000	2200	350	300	3000	1100	300	500	13000
30-Sep-2002	50	500	5000	800	500	260	230	500	700	800	2800	3000	1300	300	500	30000
4-Nov-2002	4	500	500	500	130	300	110	1300	5000	170	350	500	300	300	230	3000
3-Dec-2002	50	23	300	350	300	700	3000	5000	1100	230	300	1300	300	800	800	2300
Median	80	120	900	500	130	300	300	2300	2250	650	425	3000	1000	300	650	1050
IQR/median %	174	360	144	68	117	48	383	184	120	167	278	198	128	92	102	162

NB: The dates given are for sites N1-N9. Sites S1-S7 were measured on 10-Jan, 4-Feb, 7-Mar, 2-Apr, 1-May, 5-Jun, 3-Jul, 6-Aug, 5-Sep, 2-Oct, 5-Nov and 2-Dec.

b) The graphs on the following pages show faecal coliform measurements from January 1992 to December 2002 (where data available).

