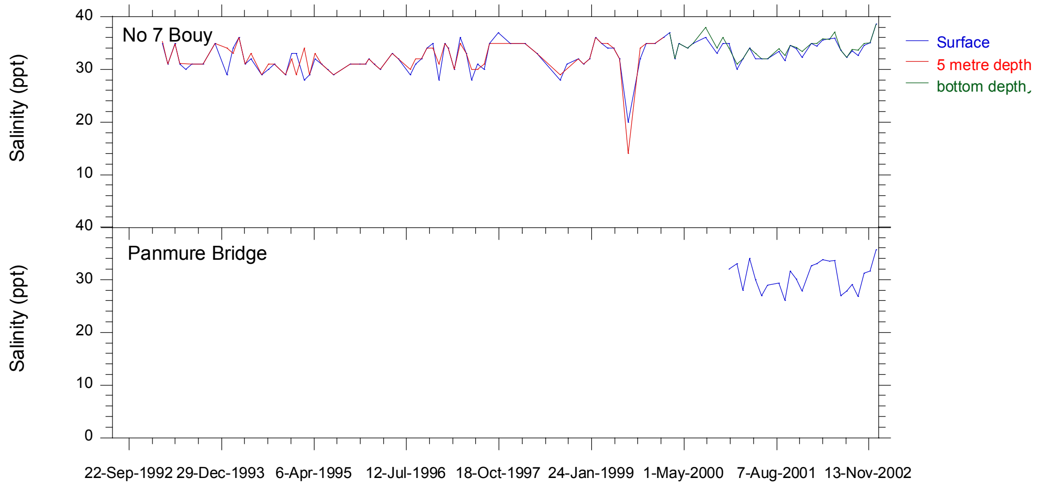
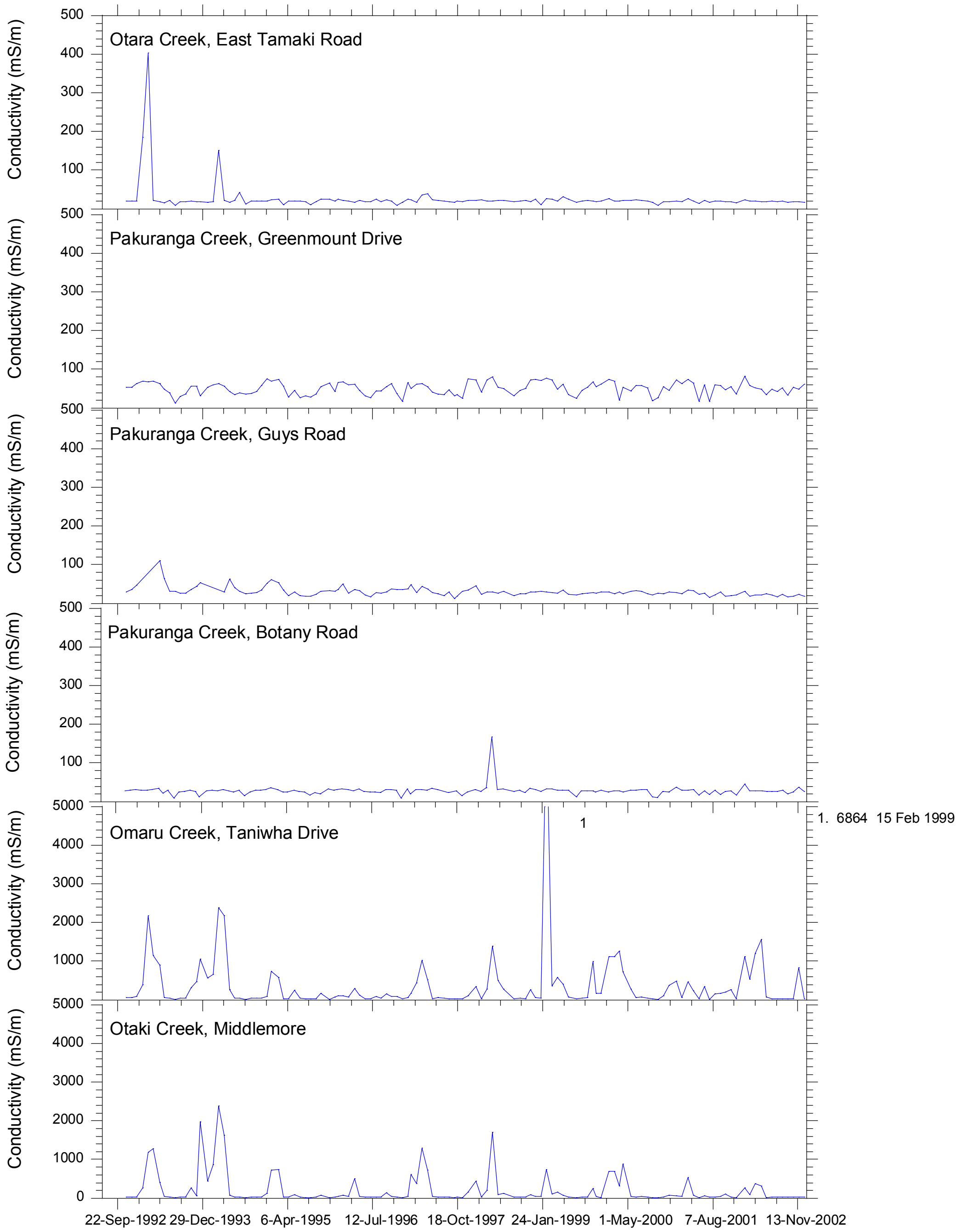

No 7 Bouy
Panmure Bridge
Salinity (ppt)
Salinity (ppt)
40
30
20
10
40
30
20
10
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002
Surface
5 metre depth
bottom depth

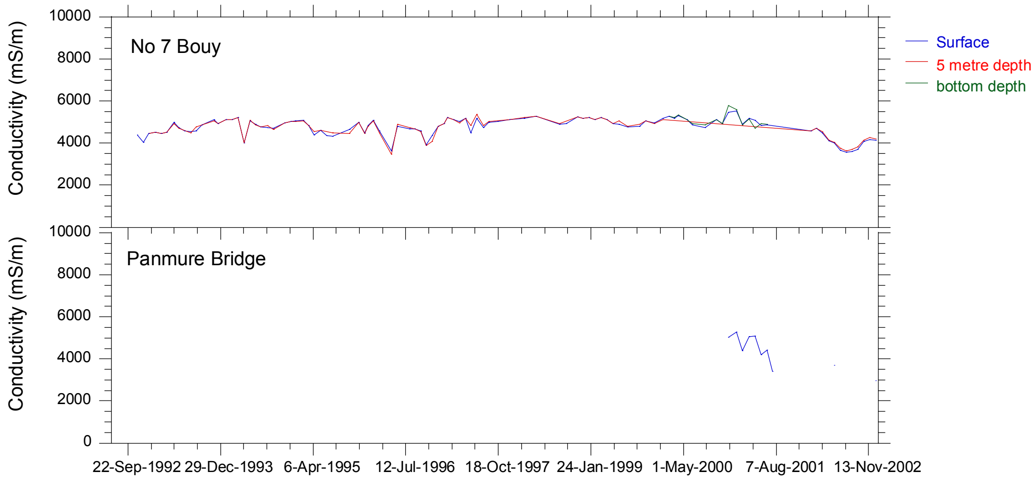
APPENDIX 27: TAMAKI ESTUARY – CONDUCTIVITY

a) Conductivity (mS/m) during January 2002 - December 2002

	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No. 7 Buoy surface	No. 7 Buoy bottom	Panmure Bridge
29-Jan-2002	22.9	81.9	31.6	46.0	1125	268	4600	4600	
25-Feb-2002	20.2	58.2	17.9	28.7	530	89.2	4700	4700	
27-Mar-2002	19.5	52.2	21.4	27.6	1193	382	4500	4550	
30-Apr-2002	19.1	49.5	22.1	28.6	1560	308	4105	4146	
27-May-2002	18.6	34.2	24.0	26.1	78.5	20.4	4027	4051	3700
25-Jun-2002	20.4	49.5	22.7	27.1	34.6	26.3	3661	3745	
24-Jul-2002	18.4	42.8	16.6	25.8	25.8	26.5	3585	3652	
21-Aug-2002	20.1	51.6	23.1	29.1	34.8	21.8	3611	3681	
20-Sep-2002	17.6	32.8	17.4	20.4	22.4	23.1	3698	3821	
18-Oct-2002	18.9	53.8	18.7	25.3	27.7	31.2	4083	4140	
18-Nov-2002	17.9	49.1	23.5	38.0	840	24.6	4182	4268	
17-Dec-2002	16.9	60.7	19.0	25.7	31.9	28.7	4126	4198	2970
Median	19.0	50.6	21.8	27.4	56.7	27.6	4094	4143	3335
IQR/Median %	10	15	22	11	1554	397	14	13	11

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


Otara Creek, East Tamaki Road
Pakuranga Creek, Greenmount Drive
Pakuranga Creek, Guys Road
Pakuranga Creek, Botany Road
Omaru Creek, Taniwha Drive
1
1. 6864 15 Feb 1999
Otaki Creek, Middlemore
Conductivity (mS/m)
500
400
300
200
100
5000
4000
3000
2000
1000
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002


No 7 Bouy
Panmure Bridge
Conductivity (mS/m)
Conductivity (mS/m)
10000
8000
6000
4000
2000
0
Surface
5 metre depth
bottom depth
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

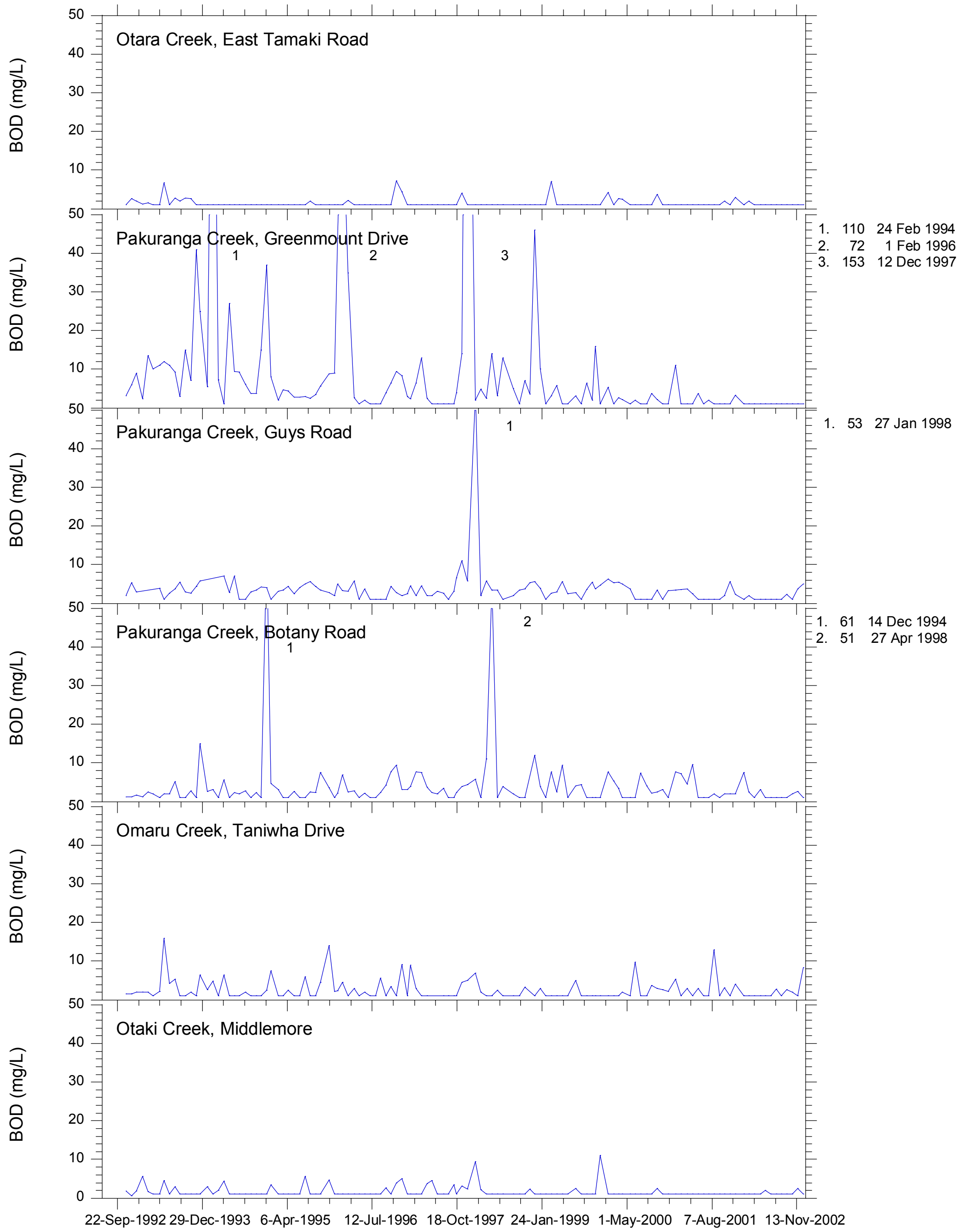
APPENDIX 28: TAMAKI ESTUARY – BIOCHEMICAL OXYGEN DEMAND

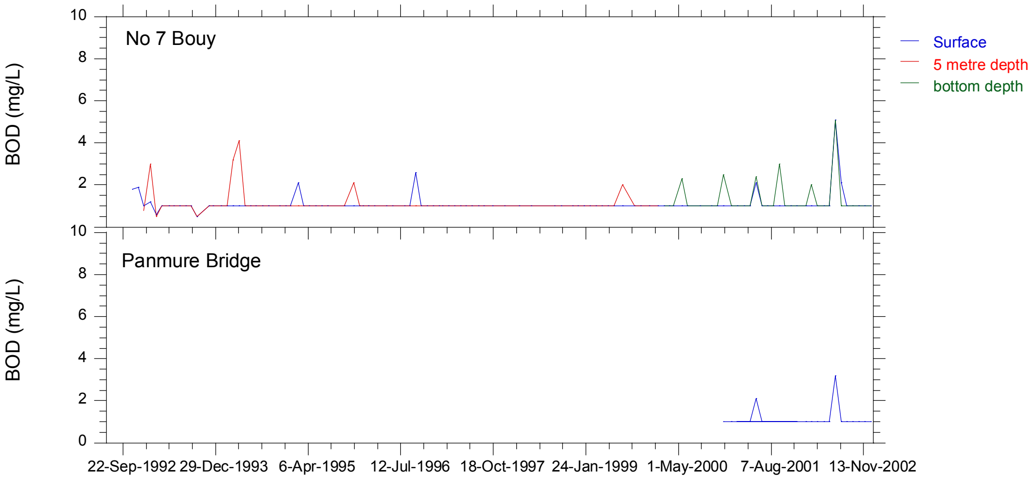
a) Biochemical oxygen demand (mg/L) during January 2002 - December 2002

	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No. 7 Buoy surface	No. 7 Buoy bottom	Panmure Bridge
29-Jan-2002	1.0	1.0	1.0	7.5	1.0	1.0	1.0	1.0	1.0
25-Feb-2002	2.0	1.0	2.0	2.5	1.0	1.0	1.0	2.0	1.0
27-Mar-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
30-Apr-2002	1.0	1.0	1.0	3.2	1.0	1.0	1.0	1.0	1.0
27-May-2002	1.0	1.0	1.0	1.0	1.0	2.0	1.0	1.0	1.0
25-Jun-2002	1.0	1.0	1.0	1.0	1.0	1.0	5.1	5.1	3.2
24-Jul-2002	1.0	1.0	1.0	1.0	2.8	1.0	2.1	1.0	1.0
21-Aug-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
20-Sep-2002	1.0	1.0	2.3	1.0	2.6	1.0	1.0	1.0	1.0
18-Oct-2002	1.0	1.0	1.0	2.1	2.1	1.0	1.0	1.0	1.0
18-Nov-2002	1.0	1.0	3.8	2.6	1.0	2.5	1.0	1.0	1.0
17-Dec-2002	1.0	1.0	5.0	1.0	8.4	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
IQR/Median %	0	0	108	153	123	0	0	0	0

NB: Data reported as < 2 mg/L is given a value of 1 mg/L in this table.

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


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
Otaki Creek, Middlemore
BOD (mg/L)
0
10
20
30
40
50
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

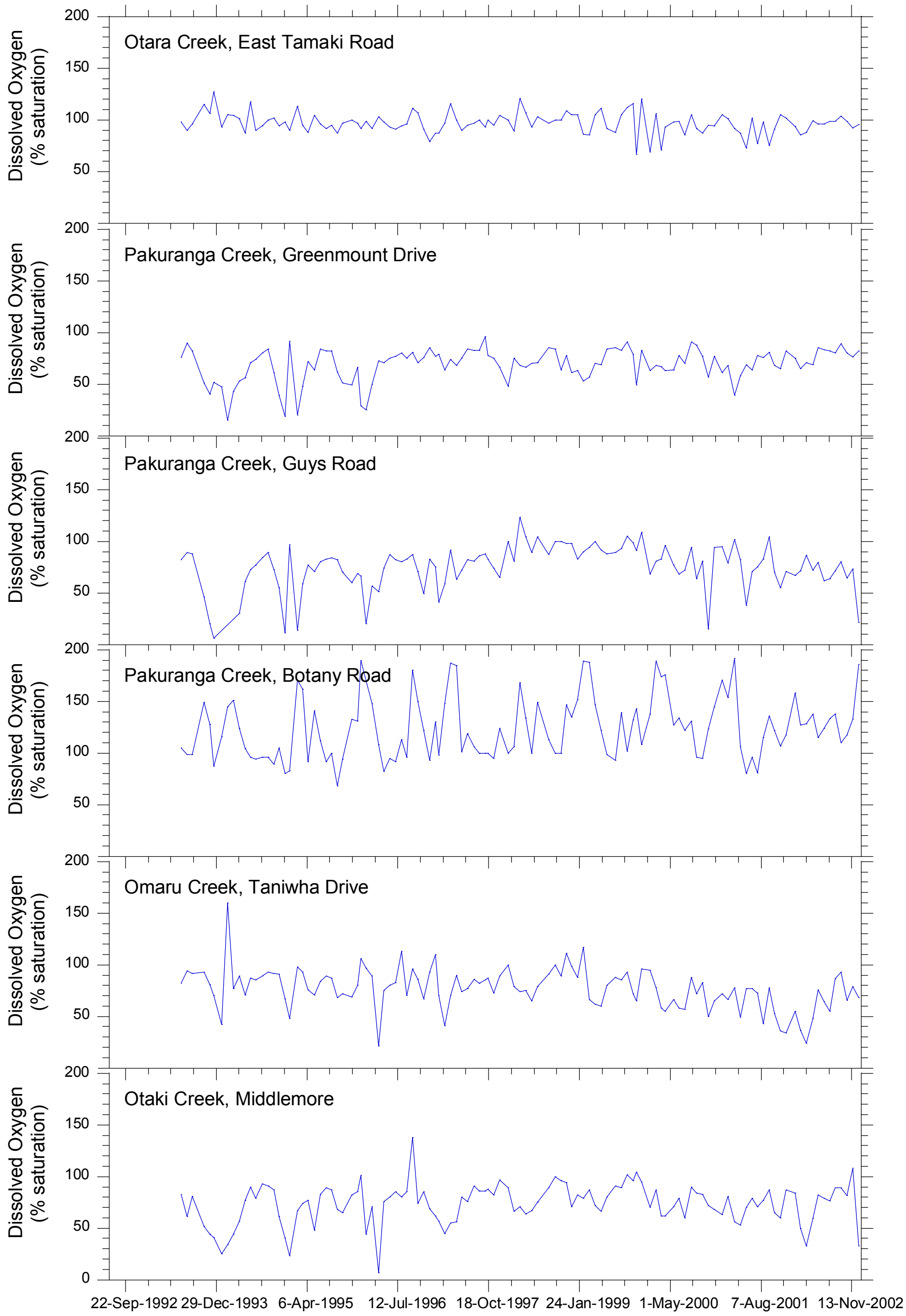

No 7 Bouy
Panmure Bridge
BOD (mg/L)
BOD (mg/L)
Surface
5 metre depth
bottom depth
10
8
6
4
2
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

APPENDIX 29: TAMAKI ESTUARY – DISSOLVED OXYGEN % SATURATION

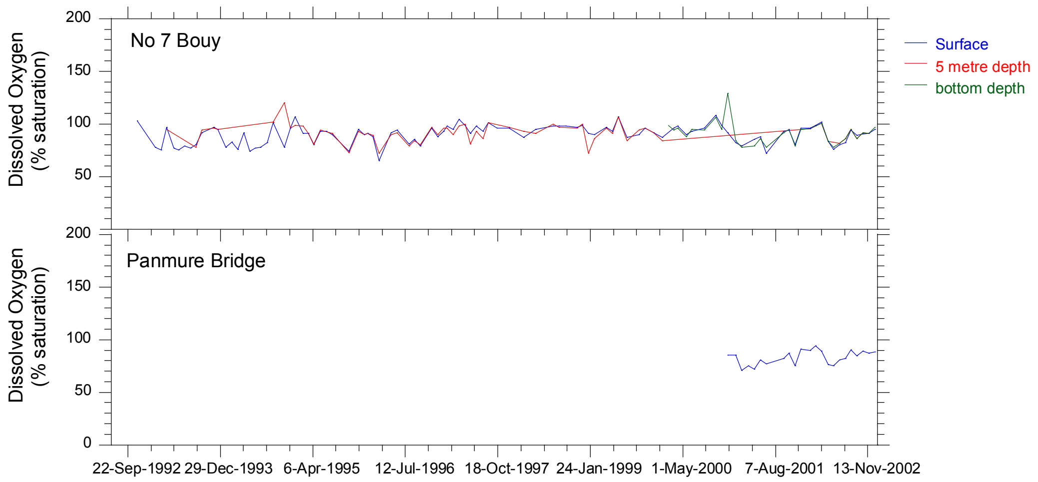
a) Dissolved oxygen (% saturation) during January 2002 - December 2002

	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No. 7 Buoy surface	No. 7 Buoy bottom	Panmure Bridge
29-Jan-2002	93.7	75.2	67.1	157.9	54.9	84.2	96.2	95.8	89.5
25-Feb-2002	85.0	65.1	71.2	127.0	36.5	50.1	99.0	98.0	94.4
27-Mar-2002	87.7	70.6	86.9	128.6	24.0	32.7	101.5	100.5	88.9
30-Apr-2002	99.4	69.1	72.0	138.1	48.0	59.1	83.2	83.8	76.7
27-May-2002	95.9	85.6	79.4	115.1	75.6	82.0	76.1	77.6	75.3
25-Jun-2002	96.1	83.7	61.9	124.0	64.4	79.1	80.1	81.4	80.9
24-Jul-2002	98.9	82.0	63.5	133.3	54.6	76.7	81.9	85.8	82.2
21-Aug-2002	98.4	80.2	71.6	138.0	86.4	89.3	94.3	94.8	90.6
20-Sep-2002	103.8	89.2	80.0	110.4	93.1	89.0	89.0	86.1	84.9
18-Oct-2002	98.8	80.1	64.4	117.9	65.9	81.4	90.5	91.7	89.0
18-Nov-2002	92.1	76.3	73.1	133.2	79.1	108.1	90.8	90.8	87.0
17-Dec-2002	95.8	81.9	21.5	186.2	68.0	32.7	94.7	96.7	88.7
Median	96.0	80.2	71.4	130.9	65.2	80.3	91	91	88
IQR/Median %	6	10	15	12	36	36	13	12	8

b) The graphs on the following pages show dissolved oxygen (% saturation) measurements from 1992 to December 2002 (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)
200
150
100
50
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

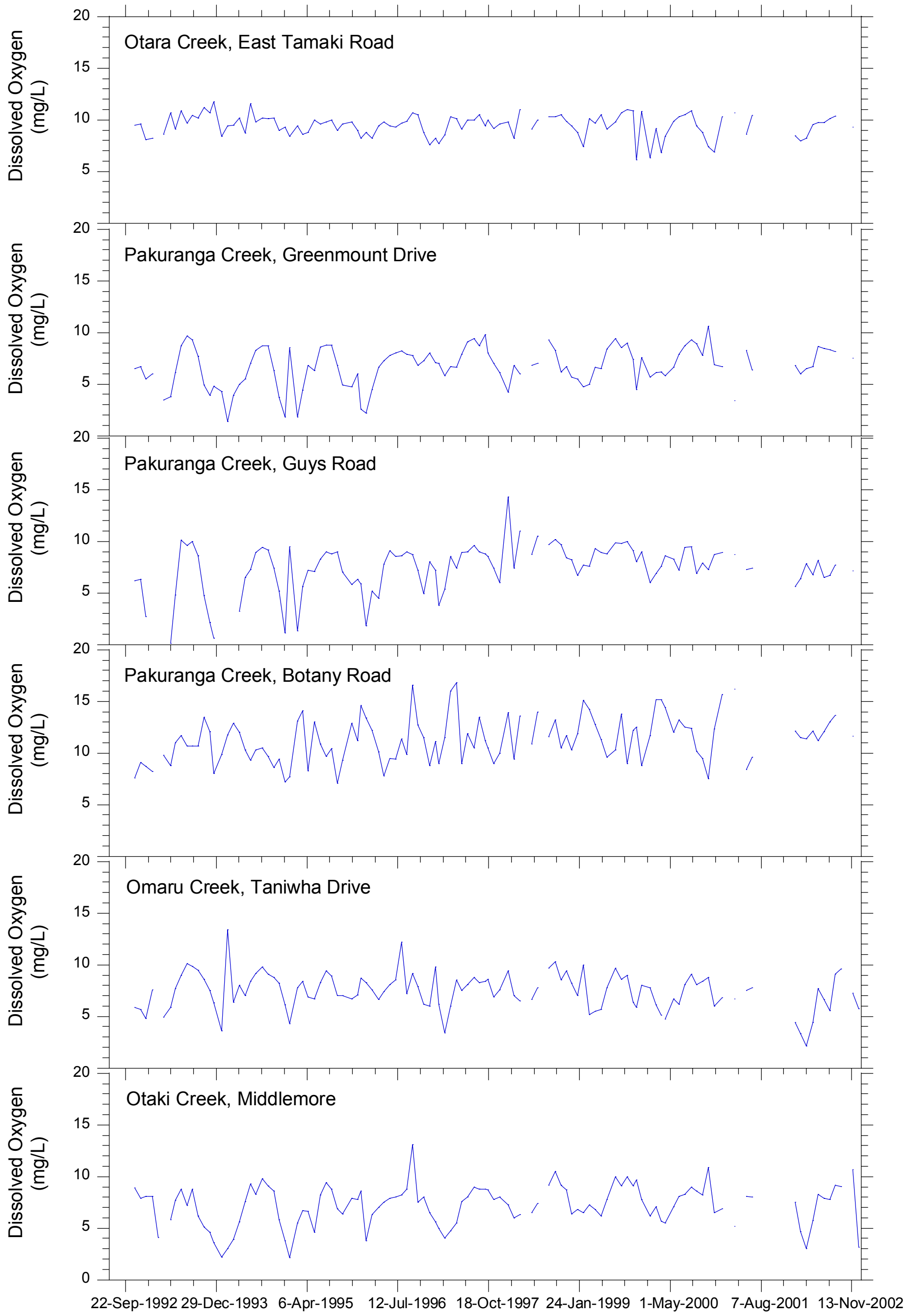

200
150
100
50
Dissolved Oxygen
(% saturation)
No 7 Bouy
Surface
5 metre depth
bottom depth
200
150
100
50
0
Dissolved Oxygen
(% saturation)
Panmure Bridge
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

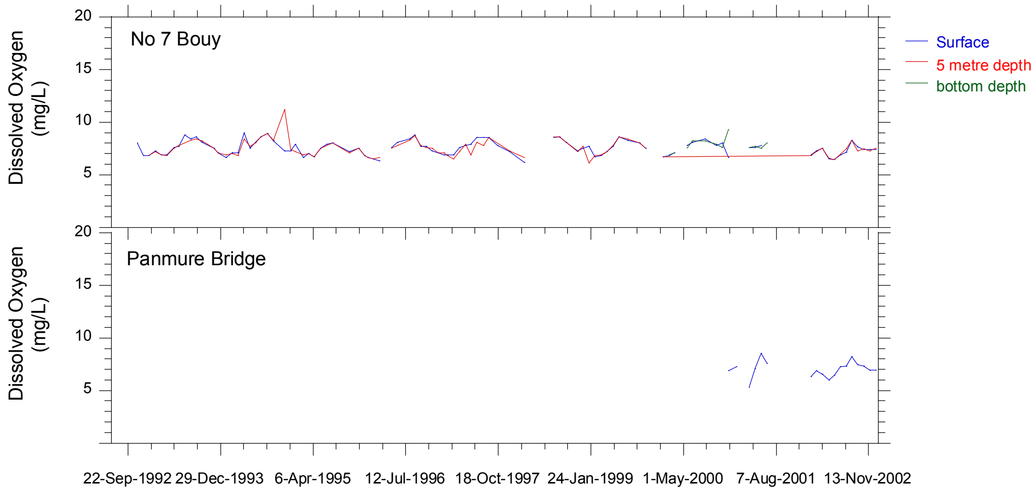
APPENDIX 30: TAMAKI ESTUARY – DISSOLVED OXYGEN (mg/L)

a) Dissolved oxygen (mg/L) during January 2002 - December 2002

	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No. 7 Buoy surface	No. 7 Buoy bottom	Panmure Bridge
29-Jan-2002	8.46	6.85	5.60	12.15	4.44	7.54		6.80	6.30
25-Feb-2002	7.94	6.02	6.37	11.49	3.32	4.68		7.22	6.91
27-Mar-2002	8.24	6.52	7.82	11.36	2.12	3.03		7.51	6.56
30-Apr-2002	9.58	6.69	6.75	12.17	4.43	5.75		6.58	6.00
27-May-2002	9.71	8.67	8.14	11.16	7.72	8.25		6.42	6.45
25-Jun-2002	9.74	8.49	6.50	12.09	6.65	7.91		6.96	7.27
24-Jul-2002	10.11	8.34	6.67	13.00	5.58	7.78		7.46	7.33
21-Aug-2002	10.38	8.17	7.69	13.64	9.09	9.17		8.29	8.23
20-Sep-2002					9.60	9.03		7.28	7.48
18-Oct-2002								7.44	7.31
18-Nov-2002	9.32	7.49	7.17	11.61	7.28	10.69		7.27	6.94
17-Dec-2002					5.74	3.16		7.52	6.93
Median	9.58	7.49	6.75	12.09	5.74	7.78		7.28	6.94
IQR/Median %	13	22	18	6	53	44		8	11

b) The graphs on the following pages show dissolved oxygen measurements from 1992 to December 2002 (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
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002



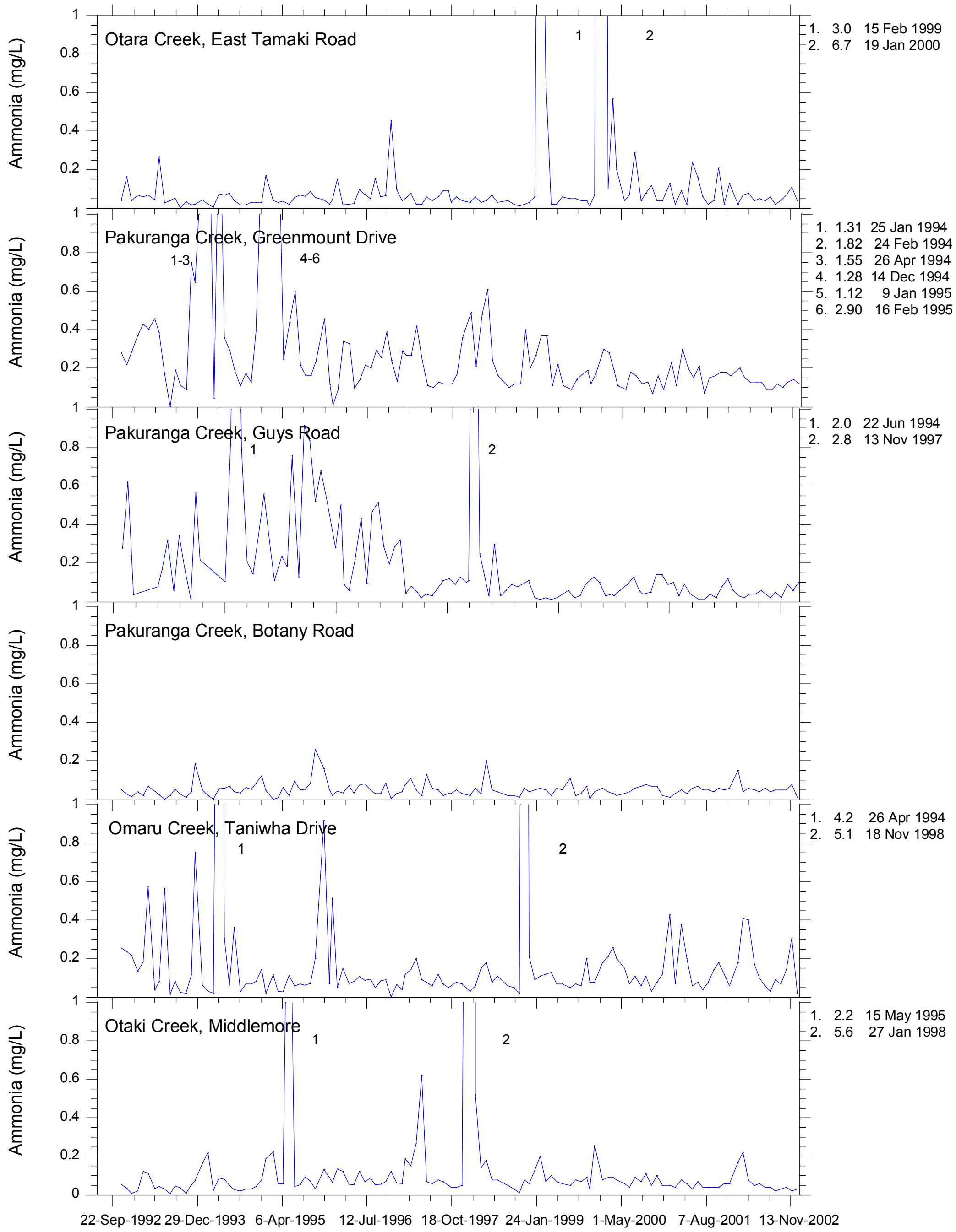
No 7 Bouy
Panmure Bridge
Dissolved Oxygen (mg/L)
Dissolved Oxygen (mg/L)
20
15
10
5
20
15
10
5
Surface
5 metre depth
bottom depth
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

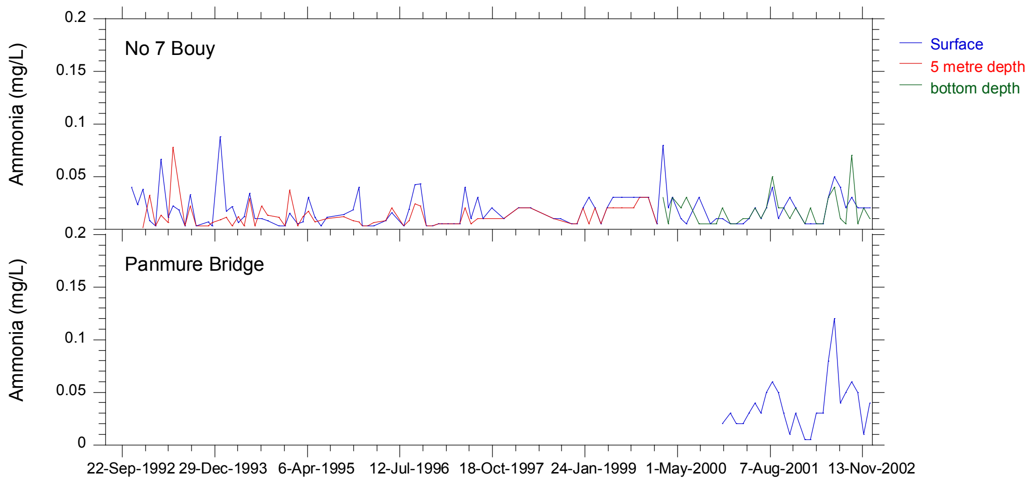
APPENDIX 31: TAMAKI ESTUARY – AMMONIA NITROGEN

a) Ammonia nitrogen (mg/L) during January 2002 - December 2002

	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No. 7 Buoy surface	No. 7 Buoy bottom	Panmure Bridge
29-Jan-2002	0.02	0.2	0.02	0.15	0.18	0.17	0.005	0.005	0.005
25-Feb-2002	0.07	0.15	0.05	0.04	0.41	0.22	0.005	0.02	0.005
27-Mar-2002	0.08	0.13	0.02	0.06	0.4	0.08	0.005	0.005	0.03
30-Apr-2002	0.04	0.13	0.09	0.05	0.17	0.05	0.005	0.005	0.03
27-May-2002	0.05	0.13	0.06	0.04	0.1	0.06	0.03	0.03	0.08
25-Jun-2002	0.04	0.09	0.1	0.06	0.06	0.04	0.05	0.04	0.12
24-Jul-2002	0.06	0.09	0.06	0.04	0.03	0.04	0.04	0.01	0.04
21-Aug-2002	0.02	0.12	0.02	0.05	0.09	0.02	0.02	0.005	0.05
20-Sep-2002	0.04	0.1	0.06	0.05	0.07	0.03	0.03	0.07	0.06
18-Oct-2002	0.07	0.13	0.04	0.05	0.14	0.04	0.02	0.005	0.05
18-Nov-2002	0.11	0.14	0.03	0.08	0.31	0.02	0.02	0.02	0.01
17-Dec-2002	0.04	0.12	0.04	0.01	0.02	0.03	0.02	0.01	0.04
Median	0.045	0.130	0.045	0.050	0.120	0.040	0.020	0.010	0.040
IQR/Median %	67	13	72	40	121	88	125	175	69

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


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 (mg/L)
22-Sep-1992 29-Dec-1993 6-Apr-1995 12-Jul-1996 18-Oct-1997 24-Jan-1999 1-May-2000 7-Aug-2001 13-Nov-2002



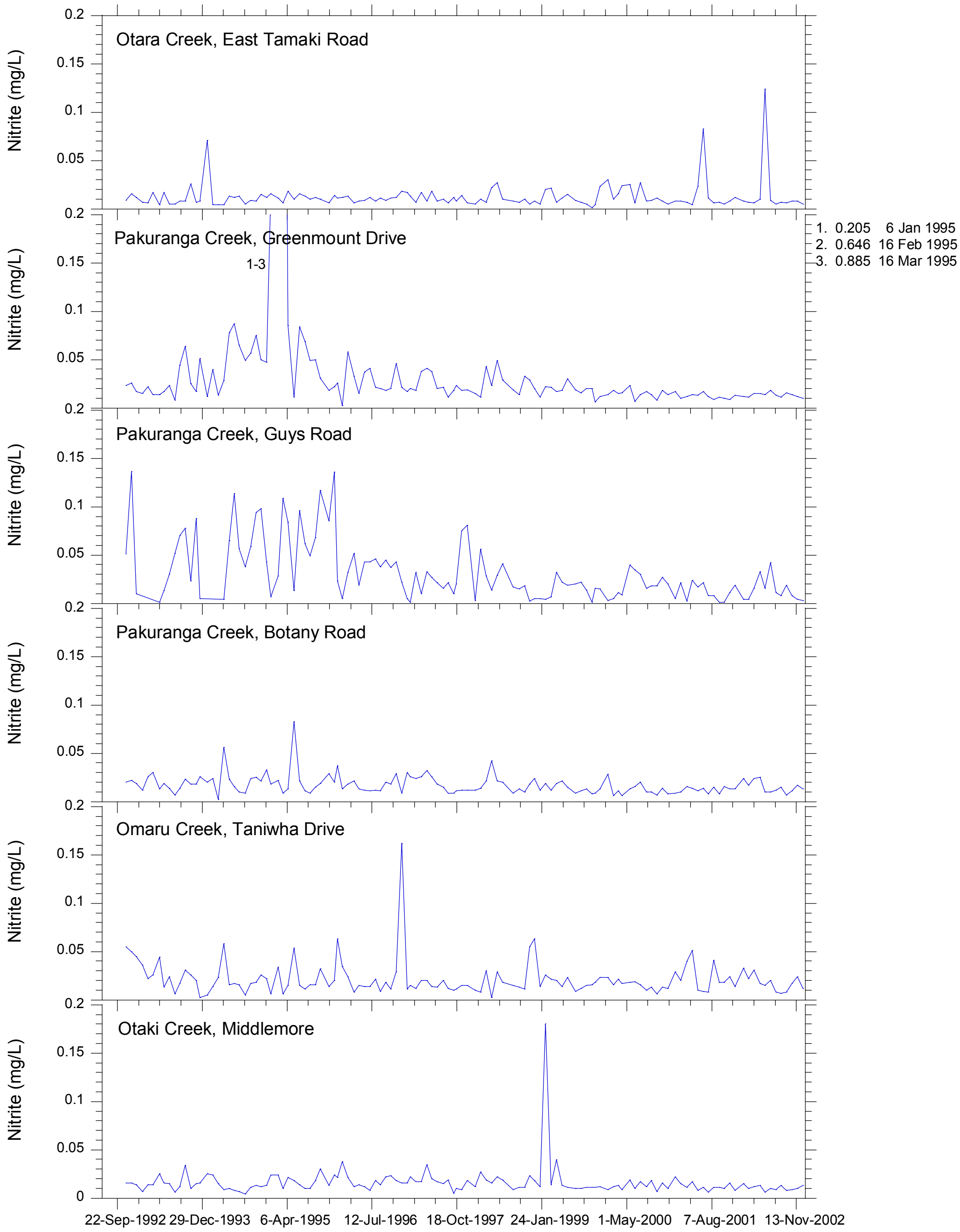
No 7 Bouy
Panmure Bridge
Ammonia (mg/L)
Ammonia (mg/L)
0.2
0.15
0.1
0.05
0.2
0.15
0.1
0.05
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002
Surface
5 metre depth
bottom depth

APPENDIX 32: TAMAKI ESTUARY – NITRITE NITROGEN

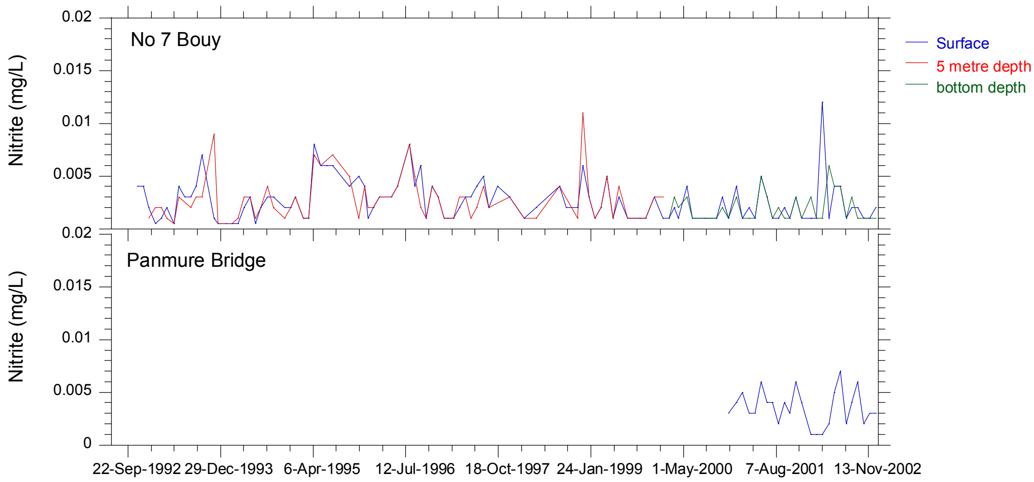
a) Nitrite nitrogen (mg/L) during January 2002 - December 2002

	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No. 7 Buoy surface	No. 7 Buoy bottom	Panmure Bridge
29-Jan-2002	0.008	0.012	0.004	0.024	0.033	0.015	0.001	0.003	0.001
25-Feb-2002	0.007	0.011	0.004	0.017	0.022	0.010	0.001	0.001	0.001
27-Mar-2002	0.006	0.015	0.016	0.024	0.031	0.012	0.012	0.001	0.001
30-Apr-2002	0.010	0.015	0.033	0.025	0.017	0.013	0.001	0.006	0.002
27-May-2002	0.124	0.014	0.016	0.010	0.015	0.006	0.004	0.004	0.005
25-Jun-2002	0.009	0.018	0.042	0.010	0.020	0.010	0.004	0.004	0.007
24-Jul-2002	0.005	0.013	0.011	0.012	0.008	0.009	0.001	0.001	0.002
21-Aug-2002	0.007	0.011	0.008	0.015	0.007	0.013	0.002	0.003	0.004
20-Sep-2002	0.006	0.016	0.019	0.007	0.008	0.008	0.002	0.001	0.006
18-Oct-2002	0.008	0.014	0.008	0.011	0.017	0.009	0.001	0.001	0.002
18-Nov-2002	0.008	0.012	0.004	0.017	0.024	0.010	0.001	0.001	0.003
17-Dec-2002	0.005	0.010	0.003	0.013	0.012	0.013	0.002	0.001	0.003
Median	0.008	0.014	0.010	0.014	0.017	0.010	0.002	0.001	0.003
IQR/Median %	30	24	134	57	68	40	100	225	100

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



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
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

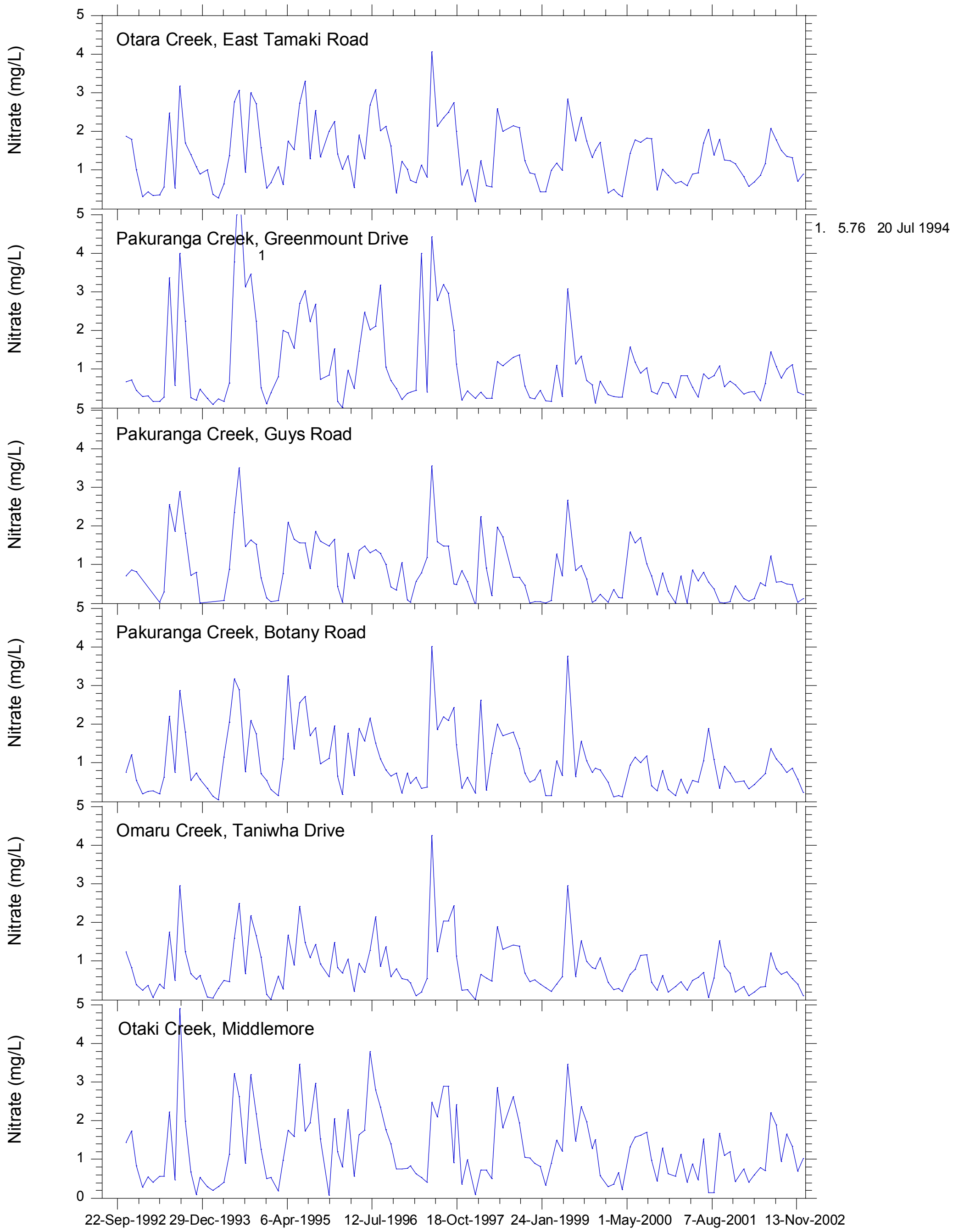

No 7 Bouy
Panmure Bridge
Nitrite (mg/L)
Nitrite (mg/L)
0.02
0.015
0.01
0.005
0
Surface
5 metre depth
bottom depth
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

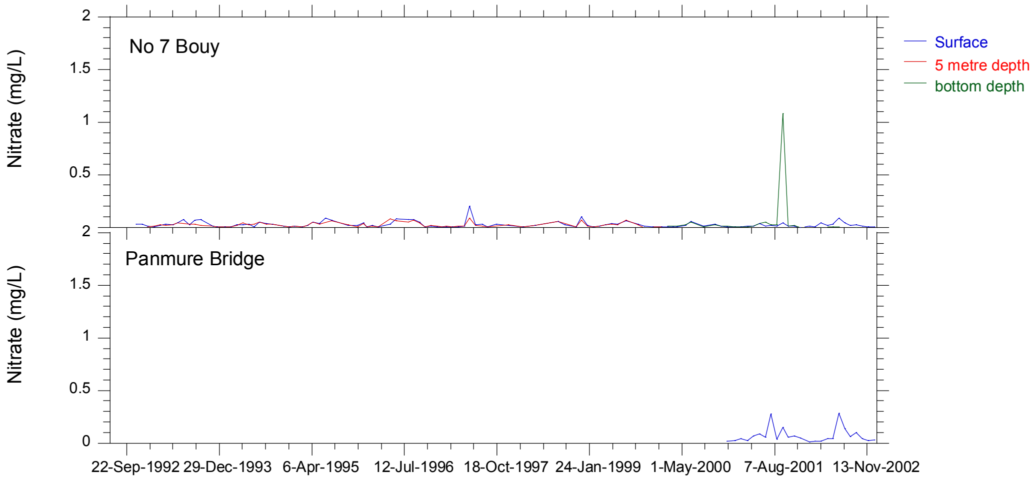
APPENDIX 33: TAMAKI ESTUARY – NITRATE NITROGEN

a) Nitrate nitrogen (mg/L) during January 2002 - December 2002

	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No. 7 Buoy surface	No. 7 Buoy bottom	Panmure Bridge
29-Jan-2002	0.829	0.353	0.118	0.531	0.339	0.760	0.008	0.001	0.011
25-Feb-2002	0.575	0.407	0.058	0.334	0.111	0.409	0.007	0.011	0.016
27-Mar-2002	0.691	0.419	0.132	0.442	0.199	0.599	0.046	0.004	0.014
30-Apr-2002	0.869	0.179	0.527	0.594	0.329	0.782	0.015	0.020	0.045
27-May-2002	1.166	0.625	0.451	0.720	0.348	0.705	0.028	0.020	0.041
25-Jun-2002	2.091	1.452	1.228	1.370	1.220	2.210	0.085	0.071	0.284
24-Jul-2002	1.785	1.077	0.542	1.098	0.809	1.891	0.041	0.035	0.140
21-Aug-2002	1.513	0.777	0.570	0.959	0.655	0.949	0.018	0.016	0.062
20-Sep-2002	1.354	1.014	0.505	0.763	0.722	1.652	0.026	0.014	0.098
18-Oct-2002	1.322	1.126	0.480	0.866	0.546	1.351	0.012	0.006	0.041
18-Nov-2002	0.699	0.407	0.034	0.587	0.413	0.696	0.006	0.006	0.020
17-Dec-2002	0.900	0.338	0.120	0.238	0.100	1.027	0.007	0.004	0.028
Median	1.033	0.522	0.466	0.657	0.381	0.866	0.017	0.013	0.041
IQR/Median %	58	122	88	58	99	84	142	116	127

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


Otara Creek, East Tamaki Road
Pakuranga Creek, Greenmount Drive
1. 5.76 20 Jul 1994
Pakuranga Creek, Guys Road
Pakuranga Creek, Botany Road
Omaru Creek, Taniwha Drive
Otaki Creek, Middlemore
Nitrate (mg/L)
22-Sep-1992 29-Dec-1993 6-Apr-1995 12-Jul-1996 18-Oct-1997 24-Jan-1999 1-May-2000 7-Aug-2001 13-Nov-2002



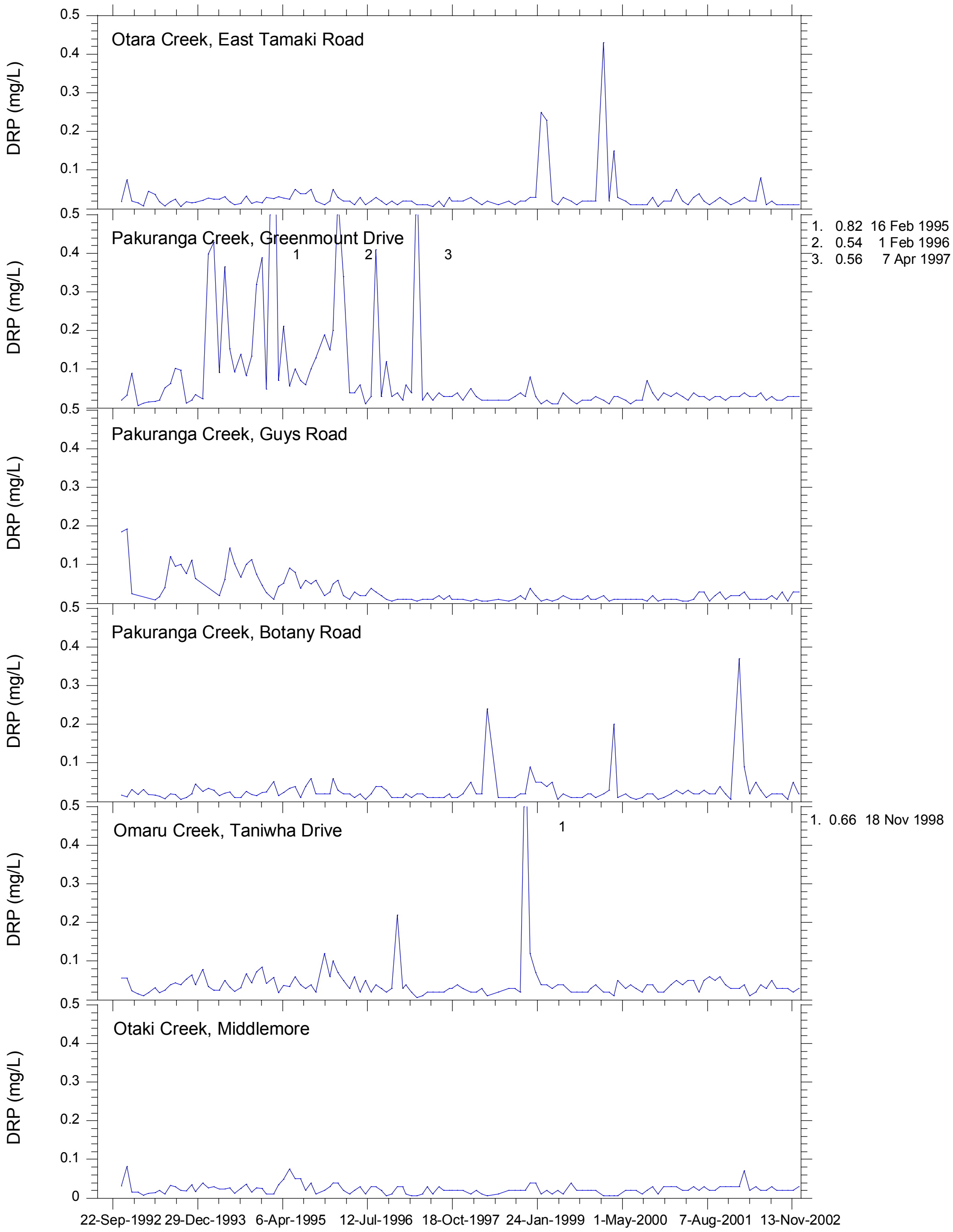
No 7 Bouy
Panmure Bridge
Nitrate (mg/L)
Nitrate (mg/L)
Surface
5 metre depth
bottom depth
2
1.5
1
0.5
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

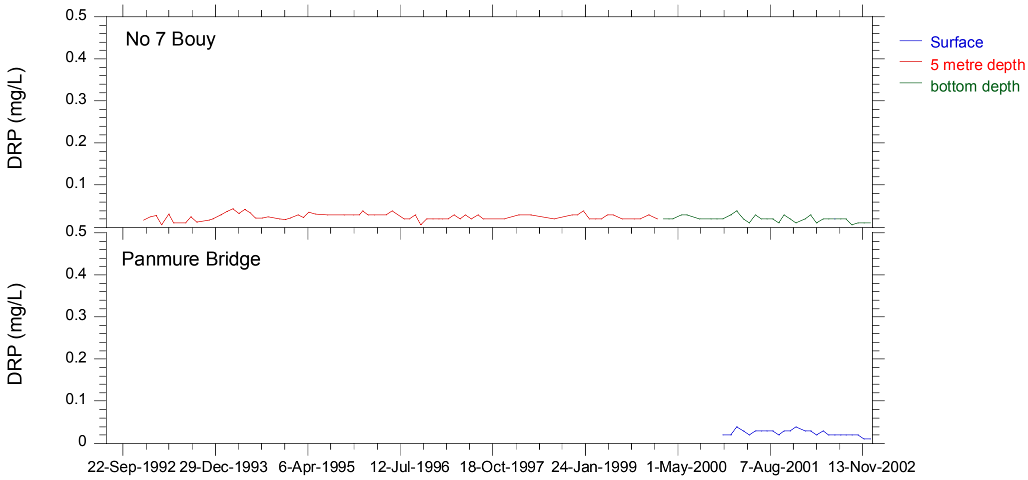
APPENDIX 34: TAMAKI ESTUARY – DISSOLVED REACTIVE PHOSPHORUS

a) Dissolved reactive phosphorus (mg/L) during January 2002 - December 2002

	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No. 7 Buoy surface	No. 7 Buoy bottom	Panmure Bridge
29-Jan-2002	0.02	0.03	0.02	0.37	0.03	0.03	0.02	0.02	0.03
25-Feb-2002	0.03	0.04	0.03	0.09	0.04	0.07	0.03	0.03	0.03
27-Mar-2002	0.02	0.03	0.01	0.02	0.01	0.02	0.02	0.01	0.02
30-Apr-2002	0.02	0.03	0.01	0.05	0.02	0.03	0.02	0.02	0.03
27-May-2002	0.08	0.04	0.01	0.03	0.04	0.02	0.02	0.02	0.02
25-Jun-2002	0.01	0.02	0.01	0.01	0.03	0.02	0.02	0.02	0.02
24-Jul-2002	0.02	0.03	0.02	0.02	0.05	0.03	0.02	0.02	0.02
21-Aug-2002	0.01	0.02	0.01	0.02	0.03	0.02	0.01	0.02	0.02
20-Sep-2002	0.01	0.02	0.03	0.02	0.03	0.02	0.01	0.005	0.02
18-Oct-2002	0.01	0.03	0.005	0.005	0.03	0.02	0.02	0.01	0.02
18-Nov-2002	0.01	0.03	0.03	0.05	0.02	0.02	0.01	0.01	0.01
17-Dec-2002	0.01	0.03	0.03	0.02	0.03	0.03	0.005	0.01	0.01
Median	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.02	0.02
IQR/Median %	67	8	133	150	17	50	50	50	13

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


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)
22-Sep-1992 29-Dec-1993 6-Apr-1995 12-Jul-1996 18-Oct-1997 24-Jan-1999 1-May-2000 7-Aug-2001 13-Nov-2002

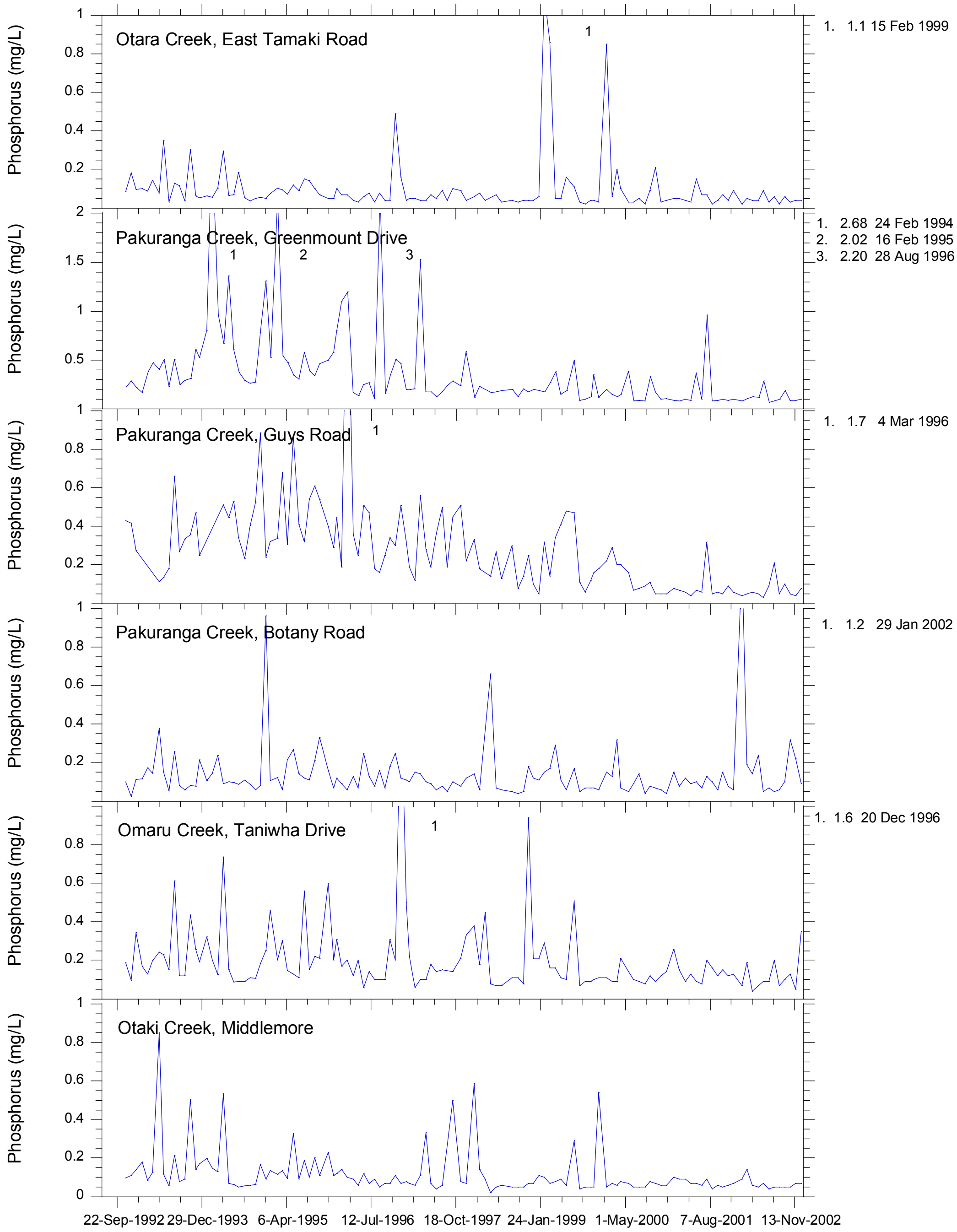

No 7 Bouy
Panmure Bridge
DRP (mg/L)
DRP (mg/L)
0.5
0.4
0.3
0.2
0.1
0
Surface
5 metre depth
bottom depth
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

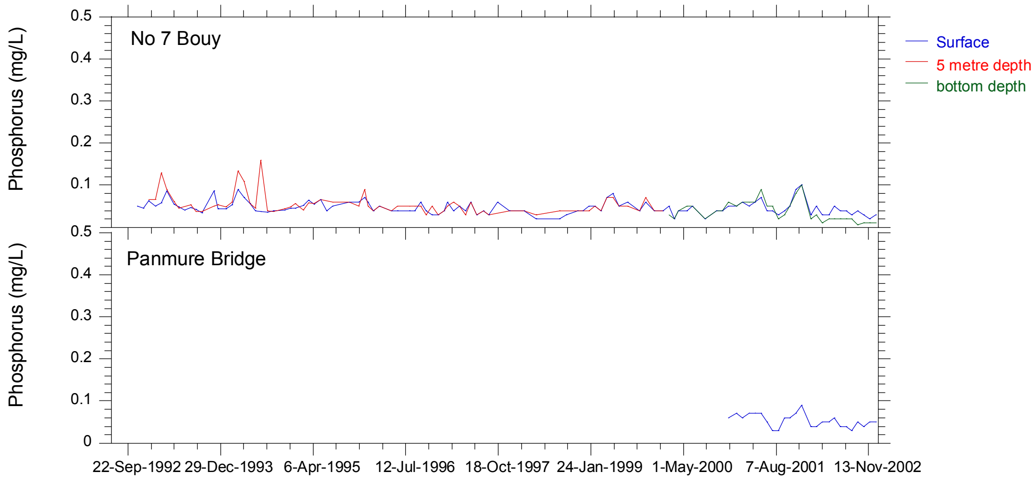
APPENDIX 35: TAMAKI ESTUARY – TOTAL PHOSPHORUS

a) Total phosphorus (mg/L) during January 2002 - December 2002

	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No. 7 Buoy surface	No. 7 Buoy bottom	Panmure Bridge
29-Jan-2002	0.02	0.08	0.04	1.2	0.07	0.09	0.03	0.04	0.04
25-Feb-2002	0.05	0.11	0.05	0.19	0.19	0.14	0.05	0.05	0.04
27-Mar-2002	0.04	0.13	0.06	0.14	0.04	0.06	0.03	0.04	0.05
30-Apr-2002	0.04	0.12	0.05	0.24	0.07	0.05	0.03	0.03	0.05
27-May-2002	0.09	0.29	0.03	0.05	0.09	0.07	0.05	0.05	0.06
25-Jun-2002	0.03	0.07	0.09	0.07	0.09	0.04	0.04	0.04	0.04
24-Jul-2002	0.06	0.08	0.21	0.05	0.20	0.05	0.04	0.04	0.04
21-Aug-2002	0.02	0.10	0.05	0.06	0.07	0.05	0.03	0.02	0.03
20-Sep-2002	0.06	0.19	0.10	0.10	0.10	0.05	0.04	0.03	0.05
18-Oct-2002	0.03	0.09	0.05	0.32	0.13	0.05	0.03	0.03	0.04
18-Nov-2002	0.04	0.09	0.04	0.22	0.05	0.07	0.02	0.03	0.05
17-Dec-2002	0.04	0.10	0.08	0.09	0.35	0.07	0.03	0.03	0.05
Median	0.04	0.10	0.05	0.12	0.09	0.06	0.03	0.04	0.05
IQR/Median %	56	35	70	131	83	36	33	29	22

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


Otara Creek, East Tamaki Road
1
1. 1.1 15 Feb 1999
Pakuranga Creek, Greenmount Drive
1
2
3
1. 2.68 24 Feb 1994
2. 2.02 16 Feb 1995
3. 2.20 28 Aug 1996
Pakuranga Creek, Guys Road
1
1. 1.7 4 Mar 1996
Pakuranga Creek, Botany Road
1. 1.2 29 Jan 2002
Omaru Creek, Taniwha Drive
1
1. 1.6 20 Dec 1996
Otaki Creek, Middlemore
Phosphorus (mg/L)
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002



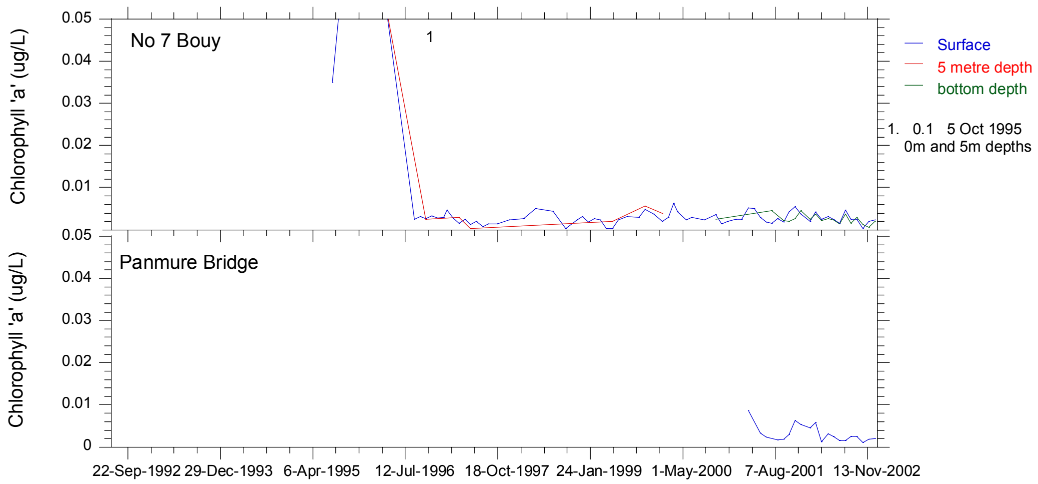
No 7 Bouy
Panmure Bridge
Phosphorus (mg/L)
Phosphorus (mg/L)
0.5
0.4
0.3
0.2
0.1
0.5
0.4
0.3
0.2
0.1
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002
Surface
5 metre depth
bottom depth

APPENDIX 36: TAMAKI ESTUARY – CHLOROPHYLL *a*

a) Chlorophyll *a* (mg/L) during January 2002 - December 2002

	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No. 7 Buoy surface	No. 7 Buoy bottom	Panmure Bridge
29-Jan-2002							0.0021	0.0024	0.0045
25-Feb-2002							0.0042	0.0037	0.0058
27-Mar-2002							0.0024	0.0022	0.0012
30-Apr-2002							0.0032	0.0027	0.0031
27-May-2002							0.0025	0.0023	0.0025
25-Jun-2002							0.0015	0.0014	0.0015
24-Jul-2002							0.0047	0.0038	0.0015
21-Aug-2002							0.0025	0.0016	0.0025
20-Sep-2002							0.0024	0.0029	0.0024
18-Oct-2002							0.0003	0.0013	0.0010
18-Nov-2002							0.0020	0.0006	0.0018
17-Dec-2002							0.0023	0.0020	0.0021
Median							0.0024	0.0023	0.0023
IQR/Median %							25	53	51

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



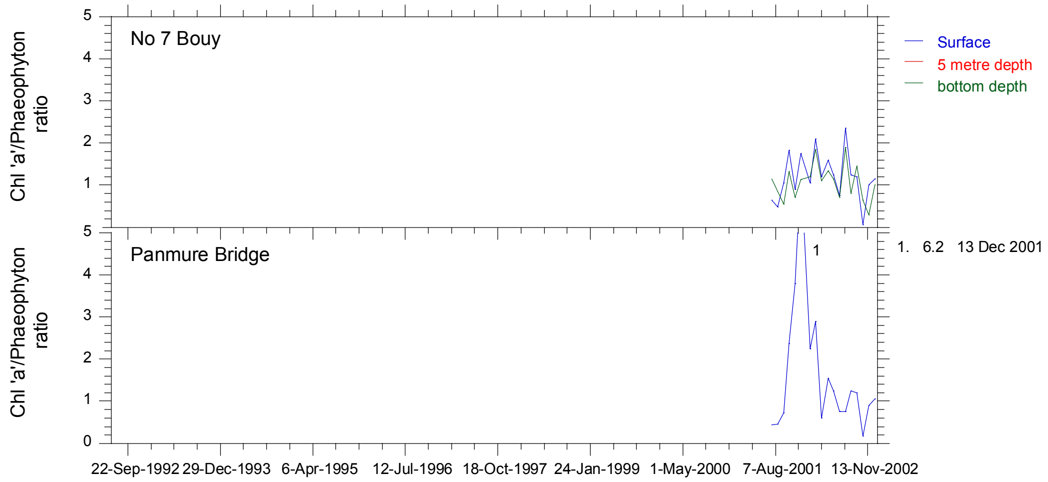
Chlorophyll 'a' (ug/L)
0.05
0.04
0.03
0.02
0.01
No 7 Bouy
1
Surface
5 metre depth
bottom depth
1. 0.1 5 Oct 1995
0m and 5m depths
Panmure Bridge
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

APPENDIX 37: TAMAKI ESTUARY – CHLOROPHYLL/PHAEOPHYTON RATIO

a) Chlorophyll/phaeophyton ratio during January 2002 - December 2002

	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No. 7 Buoy surface	No. 7 Buoy bottom	Panmure Bridge
29-Jan-2002							0.53	0.60	1.13
25-Feb-2002							1.05	0.92	1.45
27-Mar-2002							0.60	0.55	0.30
30-Apr-2002							0.80	0.68	0.78
27-May-2002							0.63	0.58	0.61
25-Jun-2002							0.38	0.35	0.38
24-Jul-2002							1.18	0.95	0.38
21-Aug-2002							0.60	0.40	0.60
20-Sep-2002							0.60	0.73	0.60
18-Oct-2002							0.10	0.30	0.20
18-Nov-2002							0.50	0.15	0.45
17-Dec-2002							0.60	0.50	0.50
Median							0.60	0.57	0.55
IQR/Median %							25	54	50

b) The graphs on the following pages show chlorophyll/phaeophyton ratio measurements from 1992 to December 2002 (where data available).



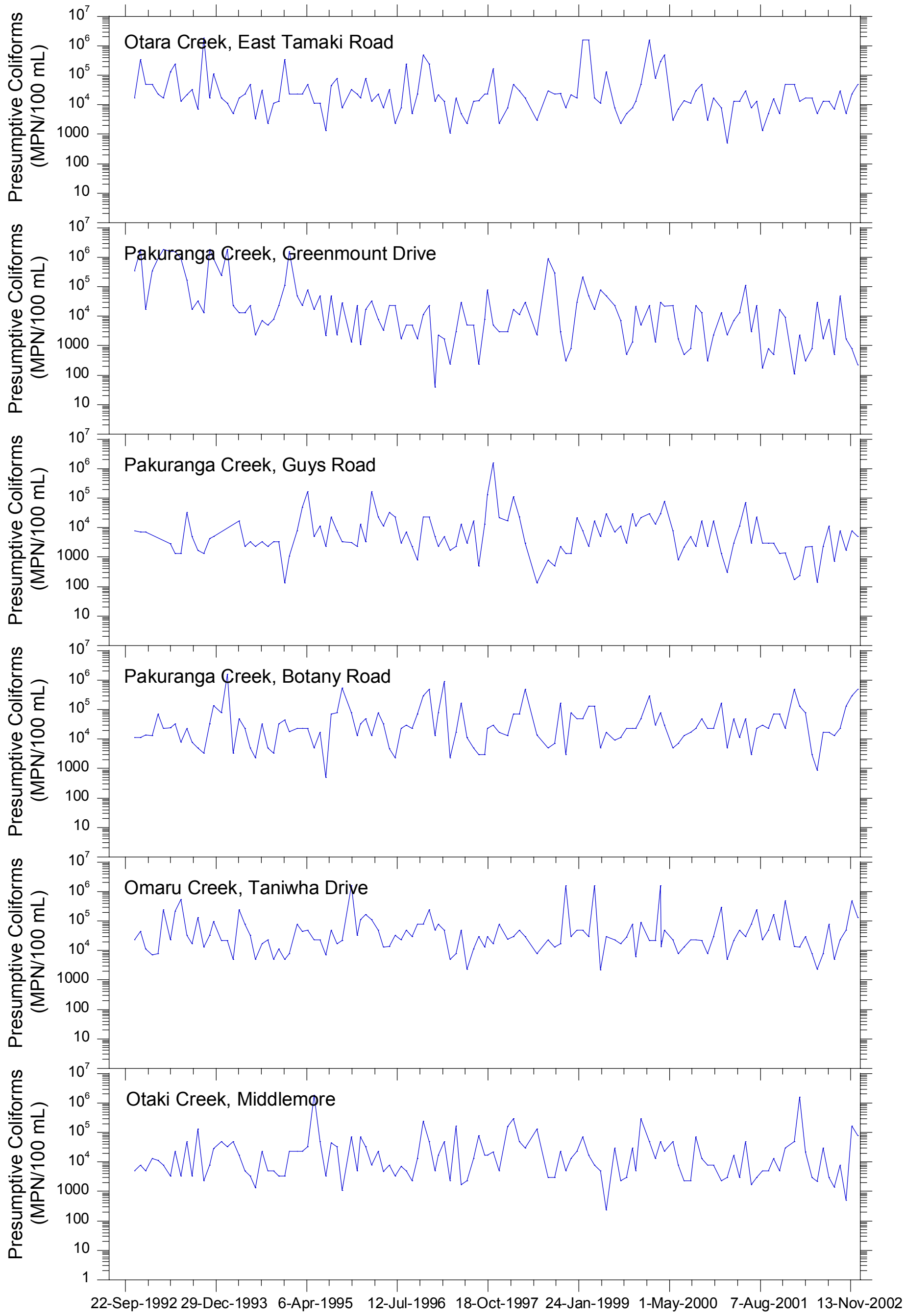
No 7 Bouy
Panmure Bridge
Chl 'a'/Phaeophyton ratio
Chl 'a'/Phaeophyton ratio
Surface
5 metre depth
bottom depth
1
1. 6.2 13 Dec 2001
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

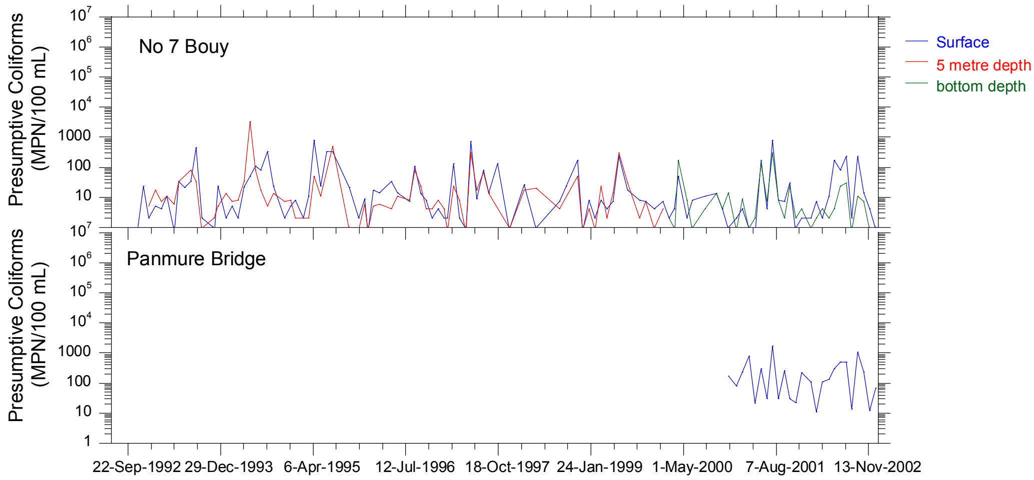
APPENDIX 38: TAMAKI ESTUARY – PRESUMPTIVE COLIFORM

a) Presumptive coliform (MPN/100 mL) during January 2002 - December 2002

	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No. 7 Buoy surface	No. 7 Buoy bottom	Panmure Bridge
29-Jan-2002	50000	110	170	500000	14000	50000	2	1	110
25-Feb-2002	13000	2300	230	130000	13000	1600000	7	30	11
27-Mar-2002	17000	300	2200	80000	30000	22000	2	8	110
30-Apr-2002	17000	800	2300	3000	8000	3000	11	4	130
27-May-2002	5000	30000	140	900	2300	2200	170	110	300
25-Jun-2002	13000	1700	2300	17000	8000	30000	80	30	500
24-Jul-2002	13000	8000	11000	17000	80000	3000	230	50	500
21-Aug-2002	7000	500	700	13000	5000	1400	2	1	13
20-Sep-2002	30000	50000	8000	23000	23000	8000	230	50	1100
18-Oct-2002	5000	1700	1700	130000	50000	500	14	11	230
18-Nov-2002	23000	800	8000	300000	500000	170000	4	4	12
17-Dec-2002	50000	220	5000	500000	130000	80000	1	4	70
Median	15000	1250	2250	51500	18500	15000	9	10	120
IQR/Median %	88	262	230	304	268	365	1117	326	245

b) The graphs on the following pages show presumptive coliform measurements from 1992 to December 2002 (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
Presumptive Coliforms (MPN/100 mL)
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

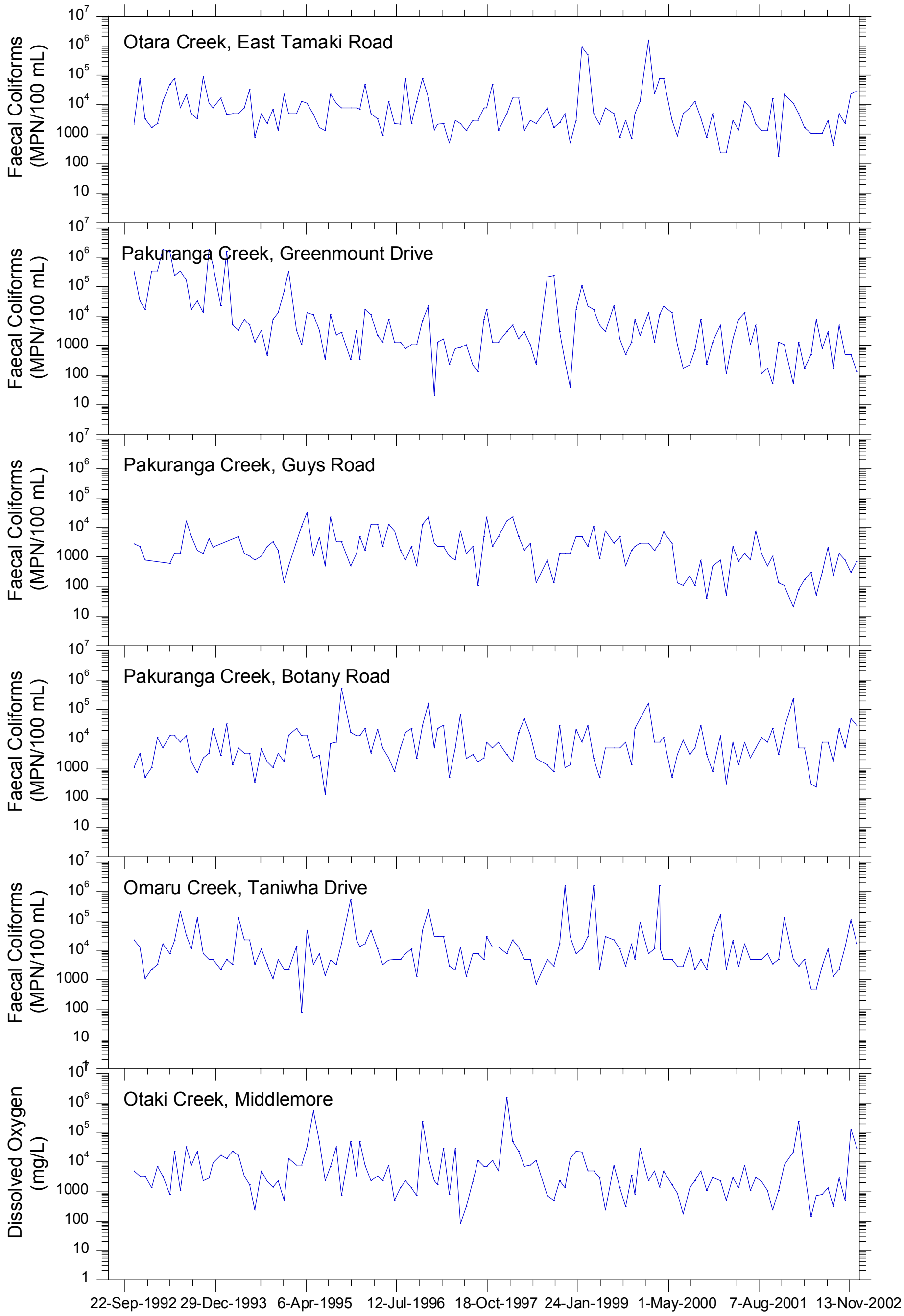

No 7 Bouy
Panmure Bridge
Presumptive Coliforms (MPN/100 mL)
Surface
5 metre depth
bottom depth
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

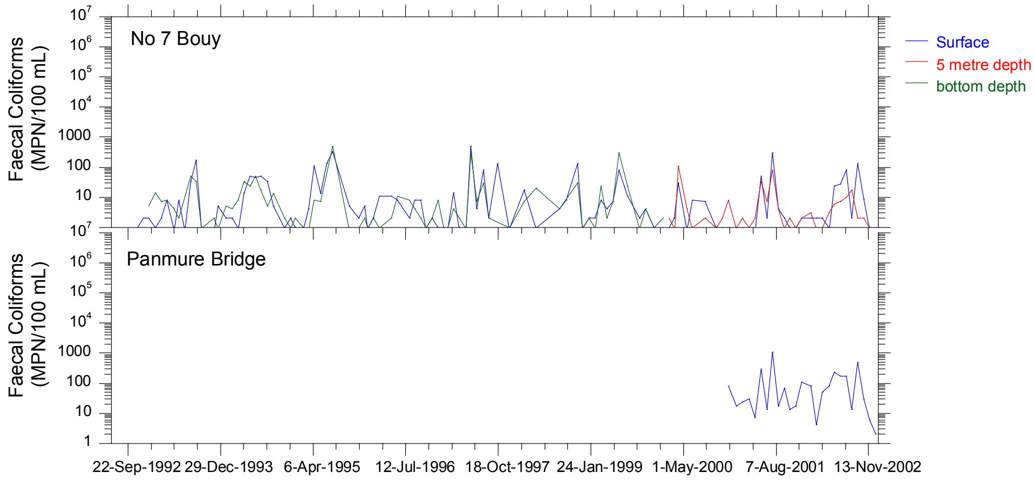
APPENDIX 39: TAMAKI ESTUARY – FAECAL COLIFORM

a) Faecal coliform (MPN/100 mL) during January 2002 - December 2002

	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No. 7 Buoy surface	No. 7 Buoy bottom	Panmure Bridge
29-Jan-2002	11000	50	20	240000	5000	22000	2	1	80
25-Feb-2002	5000	1300	80	5000	3000	240000	2	2	4
27-Mar-2002	1700	170	170	5000	5000	5000	2	4	50
30-Apr-2002	1100	500	300	300	500	140	1	2	80
27-May-2002	1100	8000	50	230	500	700	23	4	230
25-Jun-2002	1100	800	300	8000	3000	800	27	23	170
24-Jul-2002	3000	3000	2200	8000	11000	1300	80	30	170
21-Aug-2002	400	170	230	1700	1300	300	2	1	13
20-Sep-2002	5000	5000	1300	23000	2300	2800	130	11	500
18-Oct-2002	2300	500	800	5000	13000	500	9	7	30
18-Nov-2002	23000	500	300	50000	110000	130000	1	1	6
17-Dec-2002	30000	130	700	30000	17000	30000	1	1	2
Median	2650	500	300	6500	4000	2050	2	3	65
IQR/Median %	204	311	193	317	236	1139	1113	233	244

b) The graphs on the following pages show faecal coliform measurements from 1992 to December 2002 (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
Faecal Coliforms (MPN/100 mL)
Dissolved Oxygen (mg/L)
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

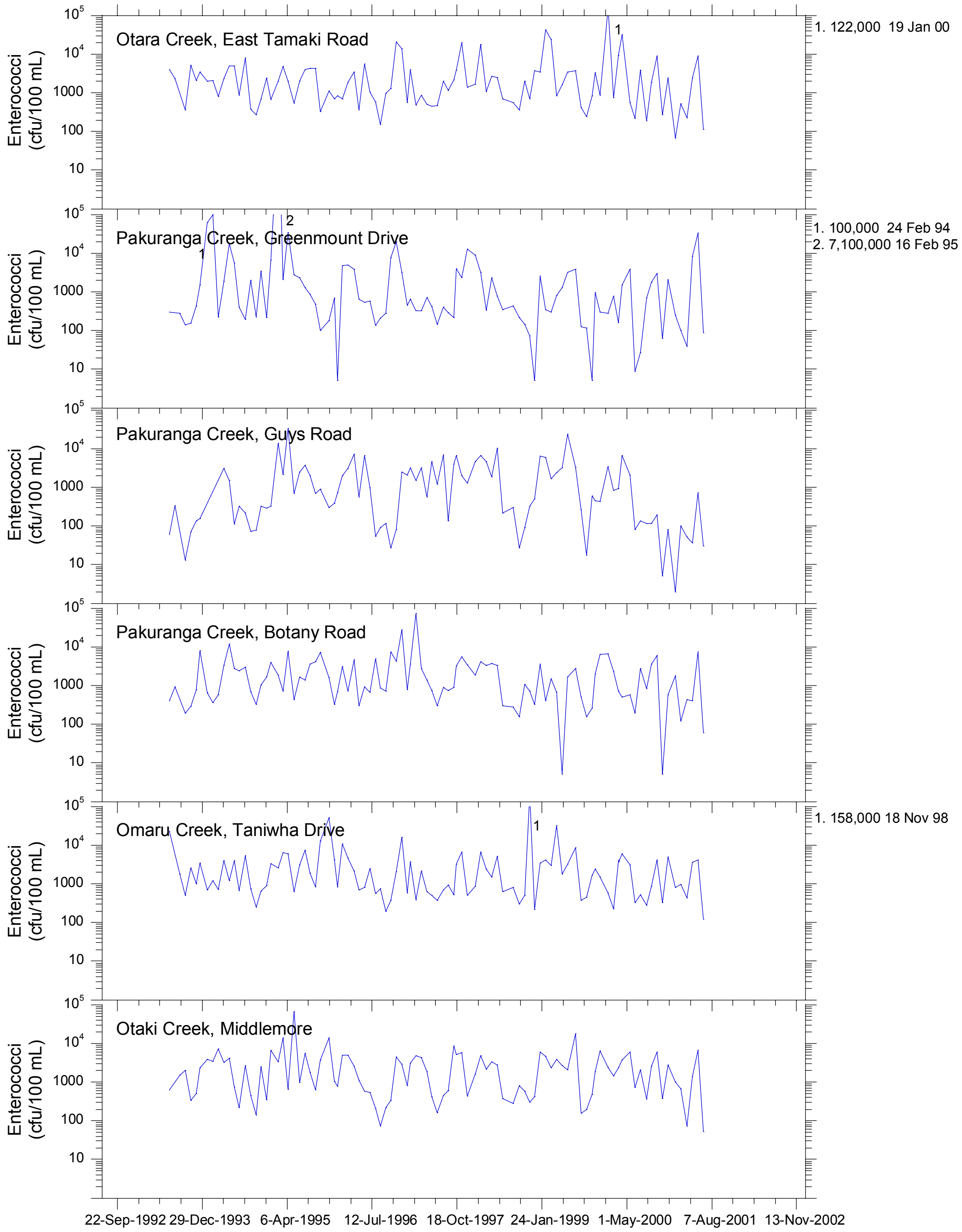

No 7 Bouy
Panmure Bridge
Faecal Coliforms (MPN/100 mL)
Surface
5 metre depth
bottom depth
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

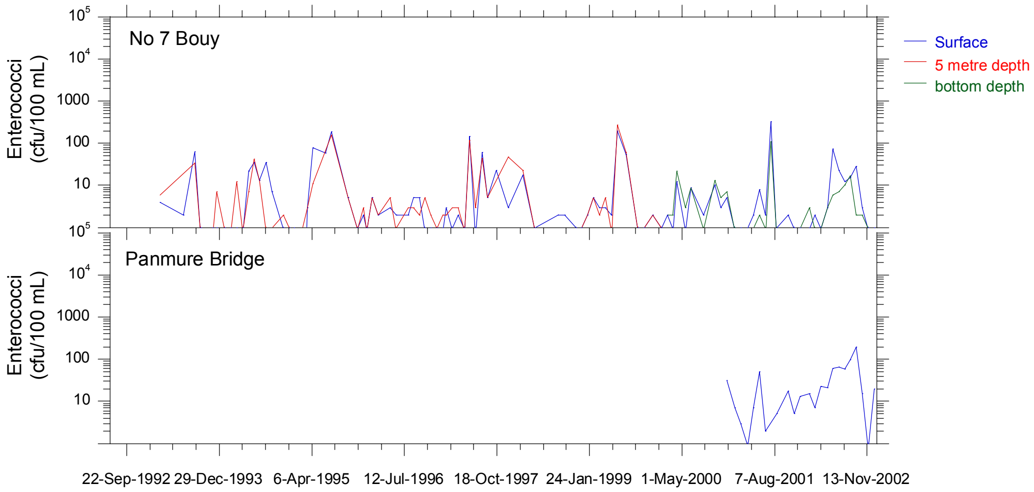
APPENDIX 40: TAMAKI ESTUARY – ENTEROCOCCI

a) Enterococci (cfu/100 mL) during January 2002 - December 2002

	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No. 7 Buoy surface	No. 7 Buoy bottom	Panmure Bridge
29-Jan-2002							1	3	15
25-Feb-2002							2	1	7
27-Mar-2002							1	1	23
30-Apr-2002							3	3	21
27-May-2002							74	6	60
25-Jun-2002							23	7	66
24-Jul-2002							12	10	58
21-Aug-2002							15	17	98
20-Sep-2002							28	2	194
18-Oct-2002							3	2	15
18-Nov-2002							1	1	1
17-Dec-2002							1	1	20
Median							3	3	22
IQR/Median %							533	210	211

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


Otara Creek, East Tamaki Road
1. 122,000 19 Jan 00
Pakuranga Creek, Greenmount Drive
1. 100,000 24 Feb 94
2. 7,100,000 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)
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

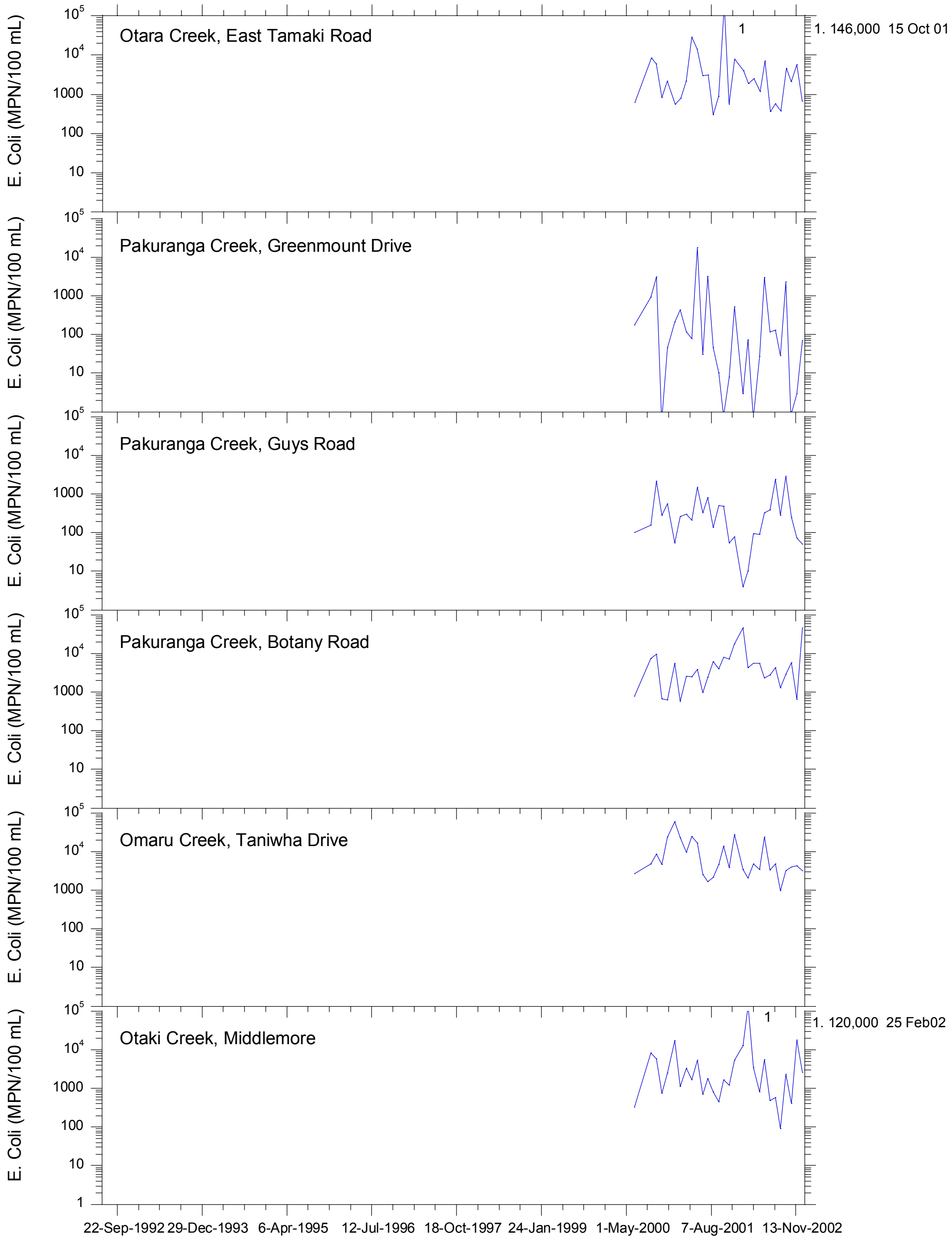

No 7 Bouy
Panmure Bridge
Enterococci (cfu/100 mL)
Surface
5 metre depth
bottom depth
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

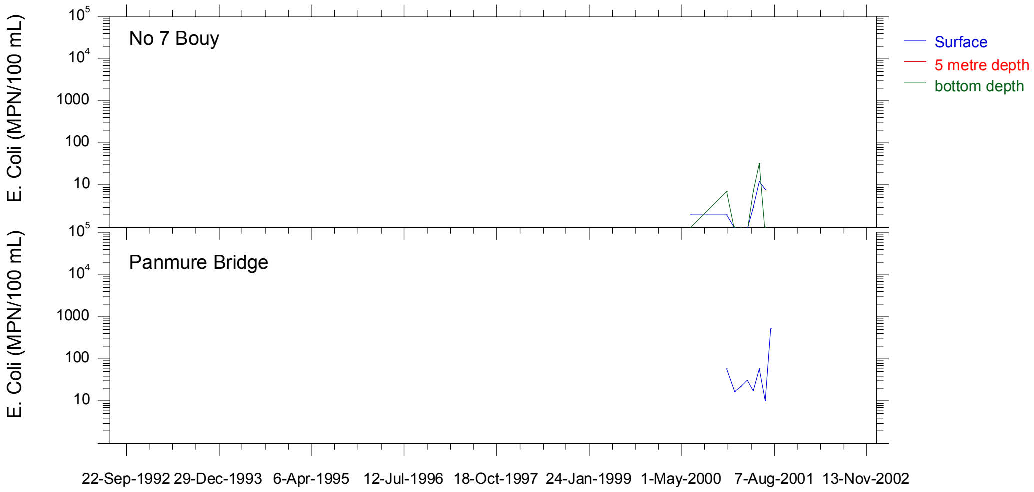
APPENDIX 41: TAMAKI ESTUARY – *E. coli*

a) *E. coli* (MPN/100 mL) during January 2002 - December 2002

	Otara Creek East Tamaki	Pakuranga Ck Greenmount	Pakuranga Ck Guys	Pakuranga Ck Botany	Omaru Creek Taniwha	Otaki Creek Middlemore	No. 7 Buoy surface	No. 7 Buoy bottom	Panmure Bridge
29-Jan-2002	4000	3	4	47000	3500	13000			
25-Feb-2002	1900	74	10	4400	2100	120000			
27-Mar-2002	2500	<2	96	5500	4800	3500			
30-Apr-2002	1190	27	90	5700	3500	800			
27-May-2002	7100	3000	320	2300	24000	5700			
25-Jun-2002	360	118	390	2800	3400	490			
24-Jul-2002	580	130	2400	4400	4800	590			
21-Aug-2002	380	28	280	1300	960	91			
20-Sep-2002	4600	2300	2900	2900	3200	2300			
18-Oct-2002	2100	<2	250	5900	4000	400			
18-Nov-2002	5700	3	72	660	4300	18000			
17-Dec-2002	670	70	50	46000	3200	2600			
Median	2000	72	173	4400	3500	2450			
IQR/Median %	175	139	157	70	35	284			

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


Otara Creek, East Tamaki Road
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. 120,000 25 Feb02
E. Coli (MPN/100 mL)
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002



No 7 Bouy
Panmure Bridge
E. Coli (MPN/100 mL)
E. Coli (MPN/100 mL)
10^5
10^4
1000
100
10
Surface
5 metre depth
bottom depth
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

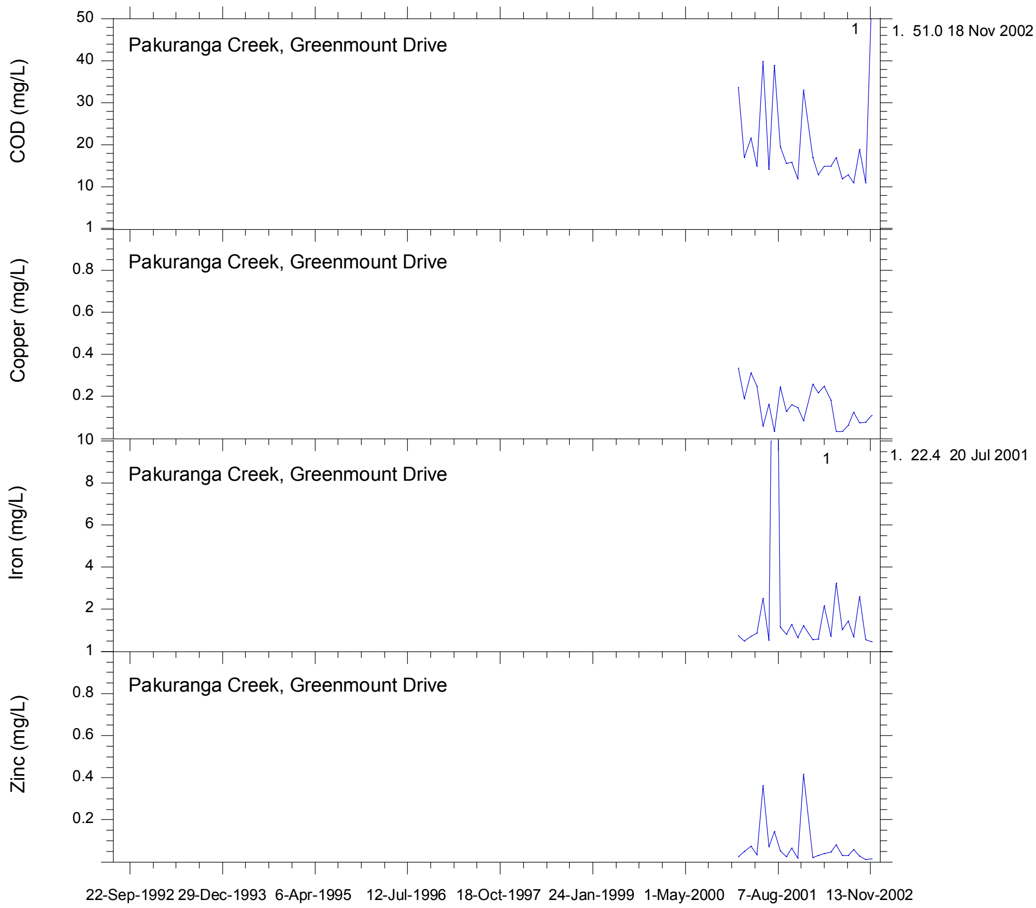
APPENDIX 42: TAMAKI ESTUARY – PAKURANGA CREEK – GREENMOUNT DRIVE

COD and Total Copper, Iron and Zinc Results

a) Results (mg/L) during January 2002 - December 2002

	COD	Total Copper	Total Iron	Total Zinc
29-Jan-2002	17	0.259	0.562	0.022
25-Feb-2002	13	0.219	0.598	0.029
27-Mar-2002	15	0.248	2.160	0.040
30-Apr-2002	15	0.182	0.724	0.046
27-May-2002	17	0.035	3.240	0.083
25-Jun-2002	12	0.035	1.030	0.029
24-Jul-2002	13	0.064	1.460	0.029
21-Aug-2002	11	0.126	0.683	0.058
20-Sep-2002	19	0.076	2.630	0.028
18-Oct-2002	11	0.080	0.553	0.012
18-Nov-2002	51	0.109	0.459	0.016
17-Dec-2002				
Median	15	0.109	0.724	0.029
IQR/Median %	30	120	170	62

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

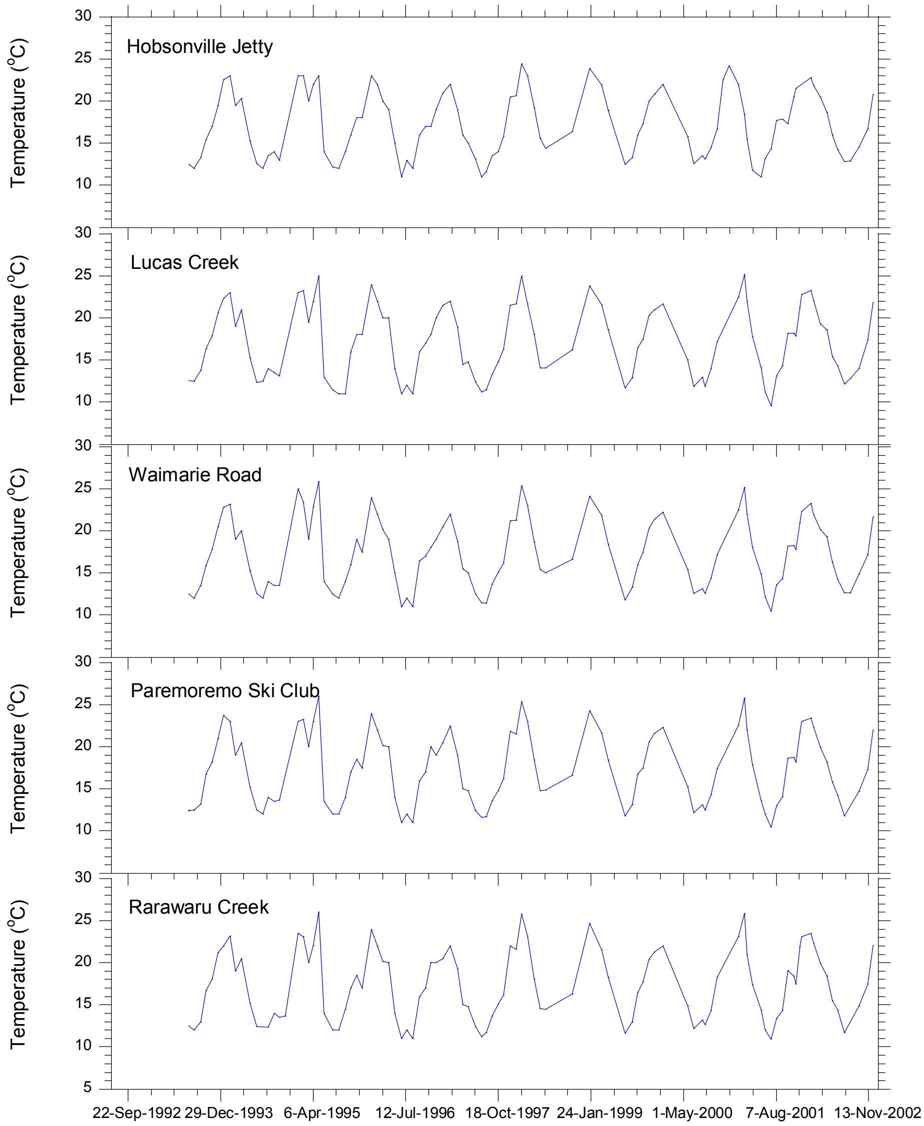

Pakuranga Creek, Greenmount Drive
COD (mg/L)
1. 51.0 18 Nov 2002
Copper (mg/L)
Iron (mg/L)
1. 22.4 20 Jul 2001
Zinc (mg/L)
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

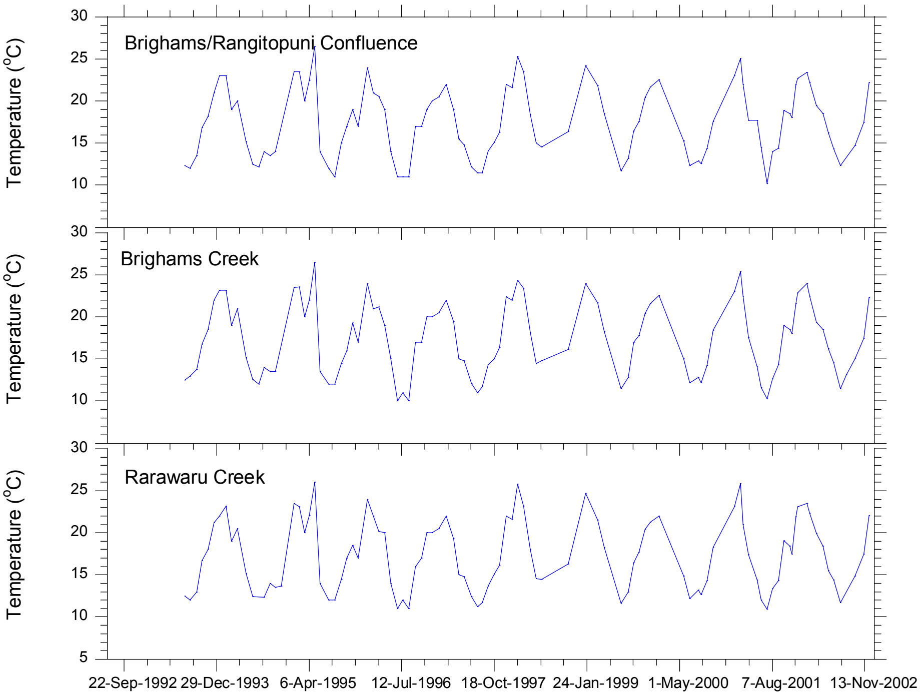
APPENDIX 43: UPPER WAITEMATA HARBOUR – TEMPERATURE

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

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	22.8	23.3	23.3	23.4	23.5	23.4	24.0	23.9
12-Feb-2002	21.8	22.1	21.9	22.3	22.3	22.2	22.5	22.6
15-Mar-2002	20.5	19.3	20.2	19.9	19.9	19.5	19.4	19.1
17-Apr-2002	18.7	18.6	19.3		18.4	18.5	18.5	18.2
16-May-2002				18.2				
12-Jun-2002	14.2	14.3	14.2	14.2	14.4	14.3	14.6	14.4
16-Jul-2002	12.8	12.2	12.7	11.8	11.7	12.3	11.5	10.9
12-Aug-2002	12.9	12.8	12.7				13.1	12.5
26-Sep-2002	14.6	14	14.9	14.7	14.9	14.7	15.0	14.8
9-Oct-2002		-	-	-	17.5	17.5		
7-Nov-2002	16.7	17.4	17.2	17.3	22.1	22.2	17.5	17.4
6-Dec-2002	20.8	21.8	21.7	22.0			22.3	22.4
Median	17.7	18.0	18.3	18.2	18.4	18.5	18.0	17.8
IQR/Median %	36	39	38	40	39	41	38	40

b) The graphs on the following pages show temperature measurements from 1993 to December 2002 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Temperature (°C)
30
25
20
15
10
5
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002



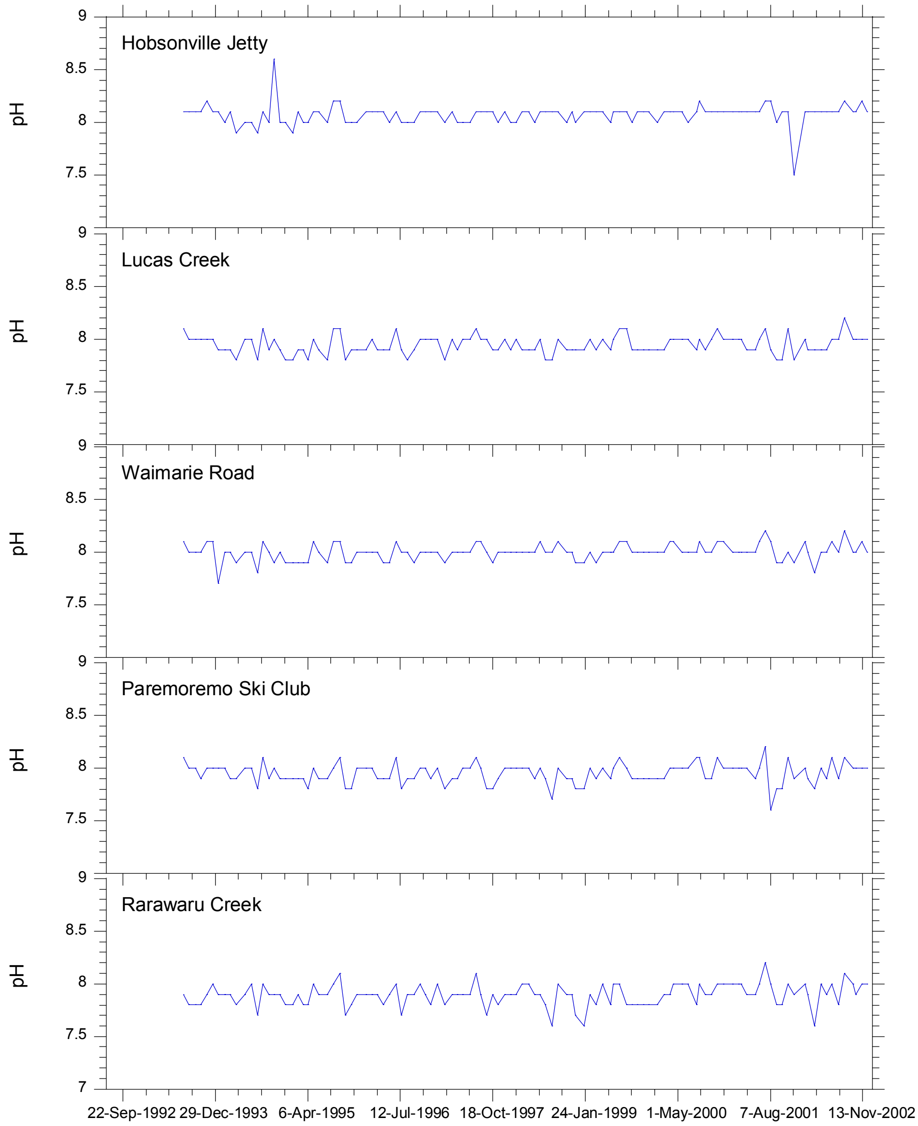
Brighams/Rangitopuni Confluence
Brighams Creek
Rarawaru Creek
Temperature (°C)
30
25
20
15
10
5
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

APPENDIX 44: UPPER WAITEMATA HARBOUR – pH

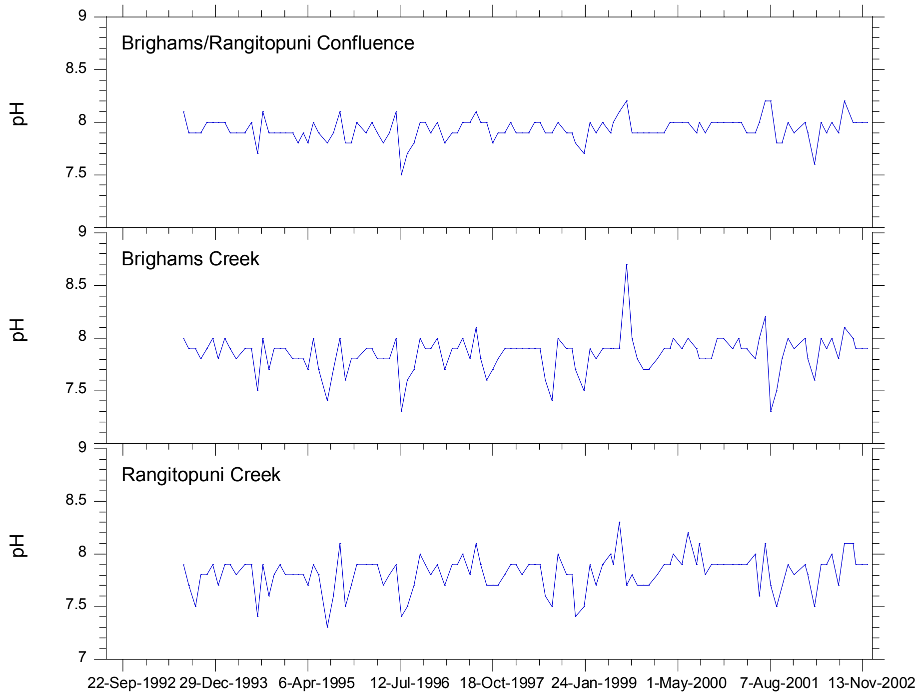
a) pH (units) during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	8.1	8.0	8.1	8.0	8.0	8.0	8.0	7.9
12-Feb-2002	8.1	7.9	8.0	7.9	7.9	7.9	7.8	7.8
15-Mar-2002	8.1	7.9	7.8	7.8	7.6	7.6	7.6	7.5
17-Apr-2002	8.1	7.9	8.0	8.0	8.0	8.0	8.0	7.9
16-May-2002	8.1	7.9	8.0	7.9	7.9	7.9	7.9	7.9
12-Jun-2002	8.1	8.0	8.1	8.1	8.0	8.0	8.0	8.0
16-Jul-2002	8.1	8.0	8.0	7.9	7.8	7.9	7.8	7.7
12-Aug-2002	8.2	8.2	8.2	8.1	8.1	8.2	8.1	8.1
26-Sep-2002	8.1	8.0	8.0	8.0	8.0	8.0	8.0	8.1
9-Oct-2002	8.1	8.0	8.0	8.0	7.9	8.0	7.9	7.9
7-Nov-2002	8.2	8.0	8.1	8.0	8.0	8.0	7.9	7.9
6-Dec-2002	8.1	8.0	8.0	8.0	8.0	8.0	7.9	7.9
Median	8.1	8.0	8.0	8.0	8.0	8.0	7.9	7.9
IQR/Median %	0	1	1	1	1	1	2	1

b) The graphs on the following pages show pH measurements from 1993 to December 2002 (where data available).



Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
pH
9
8.5
8
7.5
7
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002



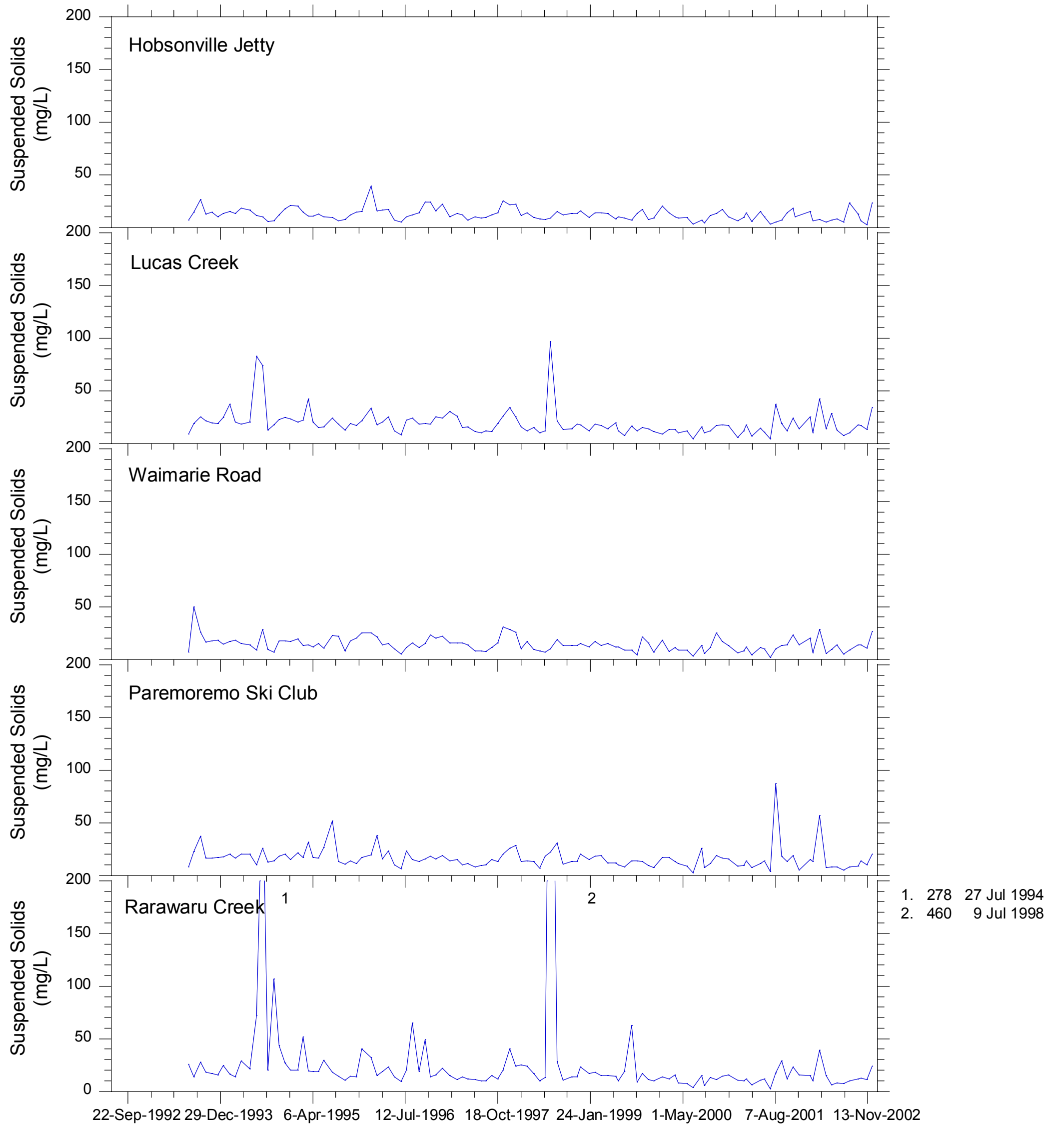
Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
pH
9
8.5
8
7.5
7
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

APPENDIX 45: UPPER WAITEMATA HARBOUR – SUSPENDED SOLIDS

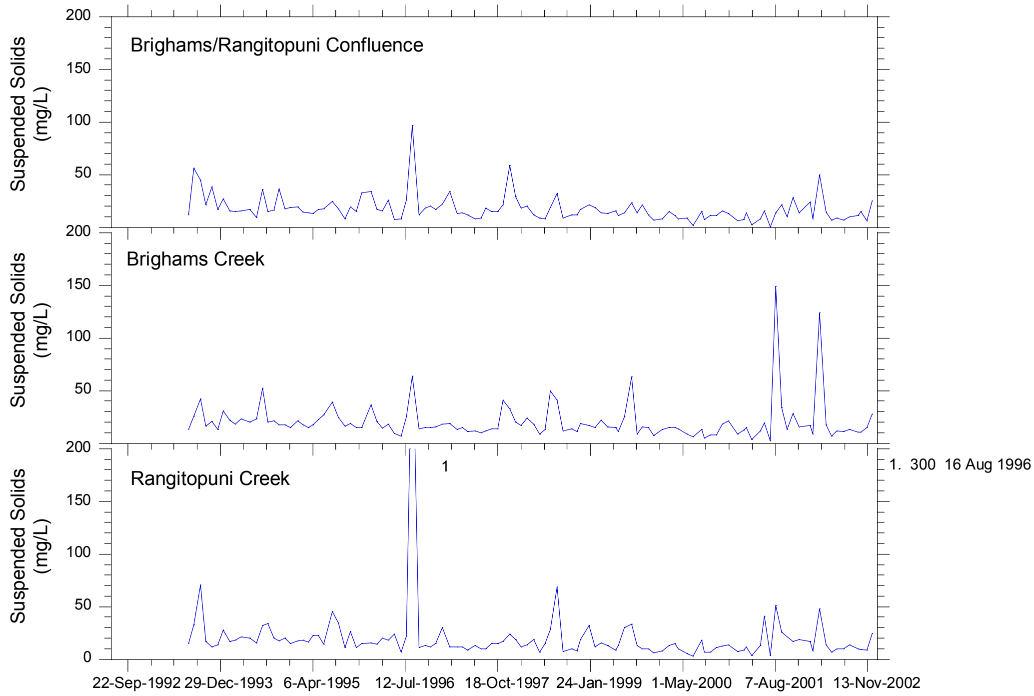
a) Suspended solids (mg/L) during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	15.0	25.0	20.0	15.0	15.0	24.0	17.0	17.0
12-Feb-2002	6.1	9.8	6.1	13.2	9.8	8.0	8.7	8.3
15-Mar-2002	7.4	42.0	28.0	57.0	39.0	50.0	124.0	48.0
17-Apr-2002	5.1	13.6	5.7	7.6	15.3	14.2	17.5	13.7
16-May-2002	6.5	28.2	9.4	8.3	6.0	6.9	6.9	6.9
12-Jun-2002	8.4	12.3	13.7	8.1	8.1	8.9	11.6	10.2
16-Jul-2002	4.8	7.6	4.9	5.0	7.3	6.9	11.0	10.1
12-Aug-2002	23.0	10.0	8.8	8.3	9.6	10.0	13.0	14.0
26-Sep-2002	12.4	17.2	13.8	8.7	11.8	11.2	10.8	10.1
9-Oct-2002	5.9	16.8	13.6	13.5	12.6	15.0	10.6	9.2
7-Nov-2002	2.3	13.1	10.6	10.1	11.0	6.3	14.8	8.9
6-Dec-2002	23.5	34.2	26.3	19.9	23.9	25.4	27.6	24.7
Median	7.0	15.2	12.1	9.4	11.4	10.6	12.3	10.2
IQR/Median %	106	93	60	60	51	90	52	55

b) The graphs on the following pages show suspended solids measurements from 1993 to December 2002 (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
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002



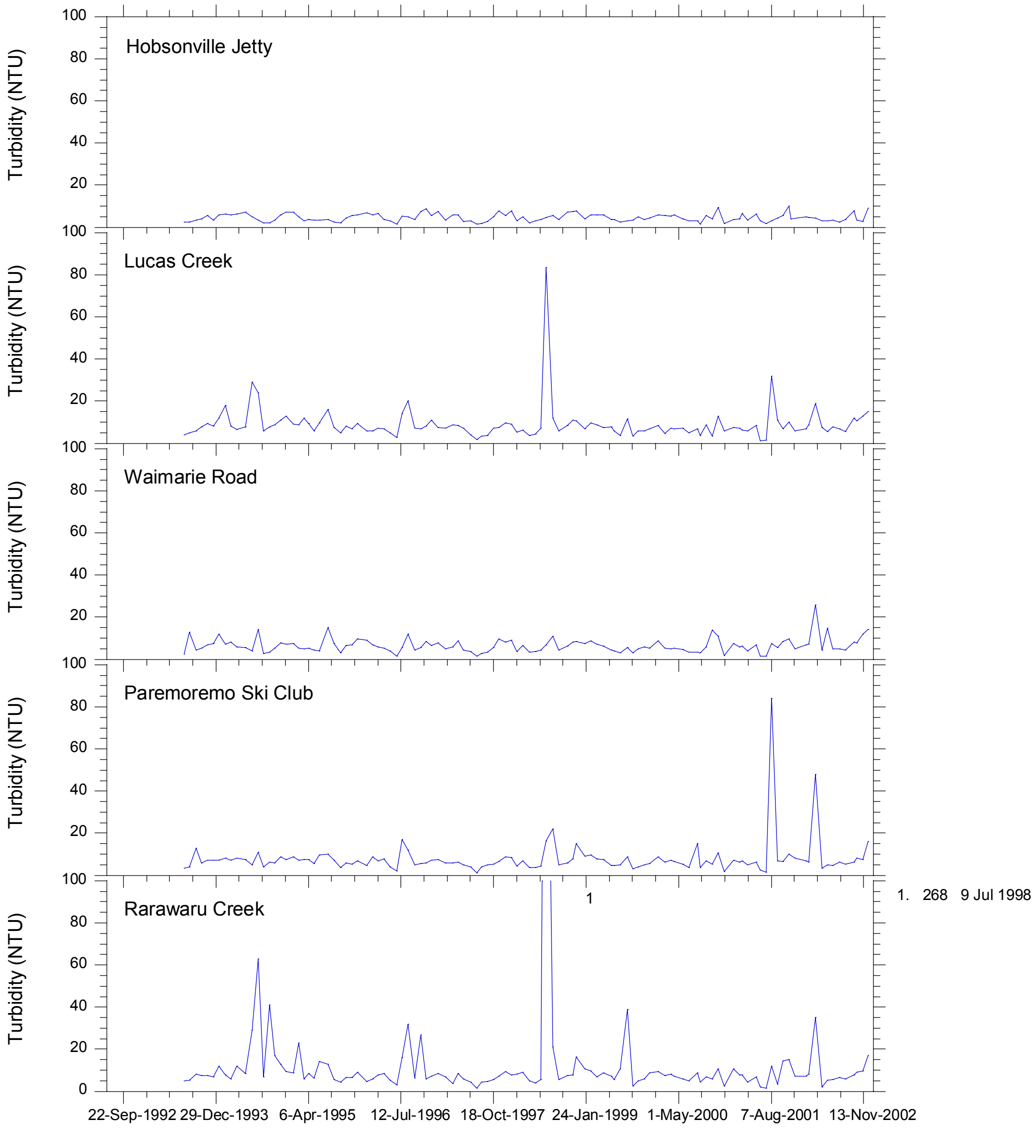
Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Suspended Solids (mg/L)
200
150
100
50
0
1
1. 300 16 Aug 1996
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

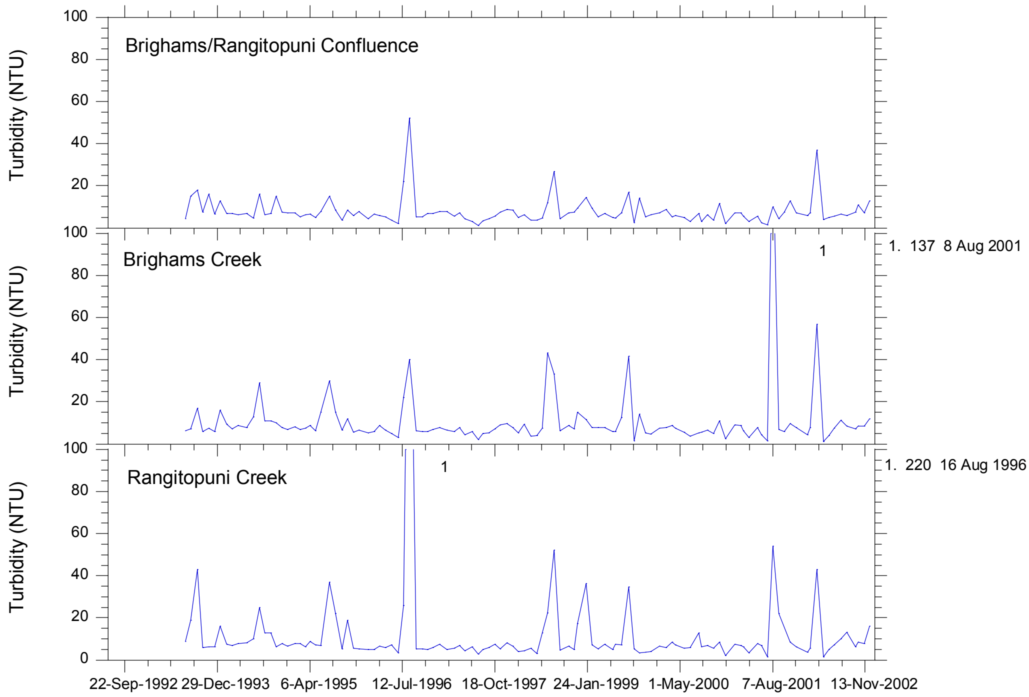
APPENDIX 46: UPPER WAITEMATA HARBOUR – TURBIDITY

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

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	4.8	6.8	6.8	6.8	7.3	6.0	4.5	3.6
12-Feb-2002	4.6	8.9	7.2	6.3	8.2	7.2	7.8	5.7
15-Mar-2002	4.3	19.0	26.0	48.0	35.0	37.0	57.0	43.0
17-Apr-2002	2.9	7.5	4.4	3.4	2.2	4.2	1.2	1.5
16-May-2002	3.1	5.6	14.7	5.0	5.3	5.0	4.2	5.0
12-Jun-2002	3.3	7.8	4.9	4.6	5.6	5.8	7.6	7.2
16-Jul-2002	2.4	6.7	4.8	6.1	6.5	6.7	11.3	10.2
12-Aug-2002	3.6	5.7	4.4	5.1	6.0	5.9	8.5	13.1
26-Sep-2002	8.0	11.9	8.3	6.3	7.9	7.6	7.1	6.2
9-Oct-2002	3.5	10.6	8.0	8.3	9.0	11.0	8.4	8.5
7-Nov-2002	2.8	13.0	12.0	7.4	9.7	7.1	8.4	7.8
6-Dec-2002	9.1	15.0	14.0	16.0	17.0	13.0	12.0	16.0
Median	3.5	8.4	7.6	6.3	7.6	6.9	8.1	7.5
IQR/Median %	46	65	100	40	43	37	34	72

b) The graphs on the following pages show turbidity measurements from 1993 to December 2002 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rararawu Creek
Turbidity (NTU)
0
20
40
60
80
100
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002
1
1. 268 9 Jul 1998



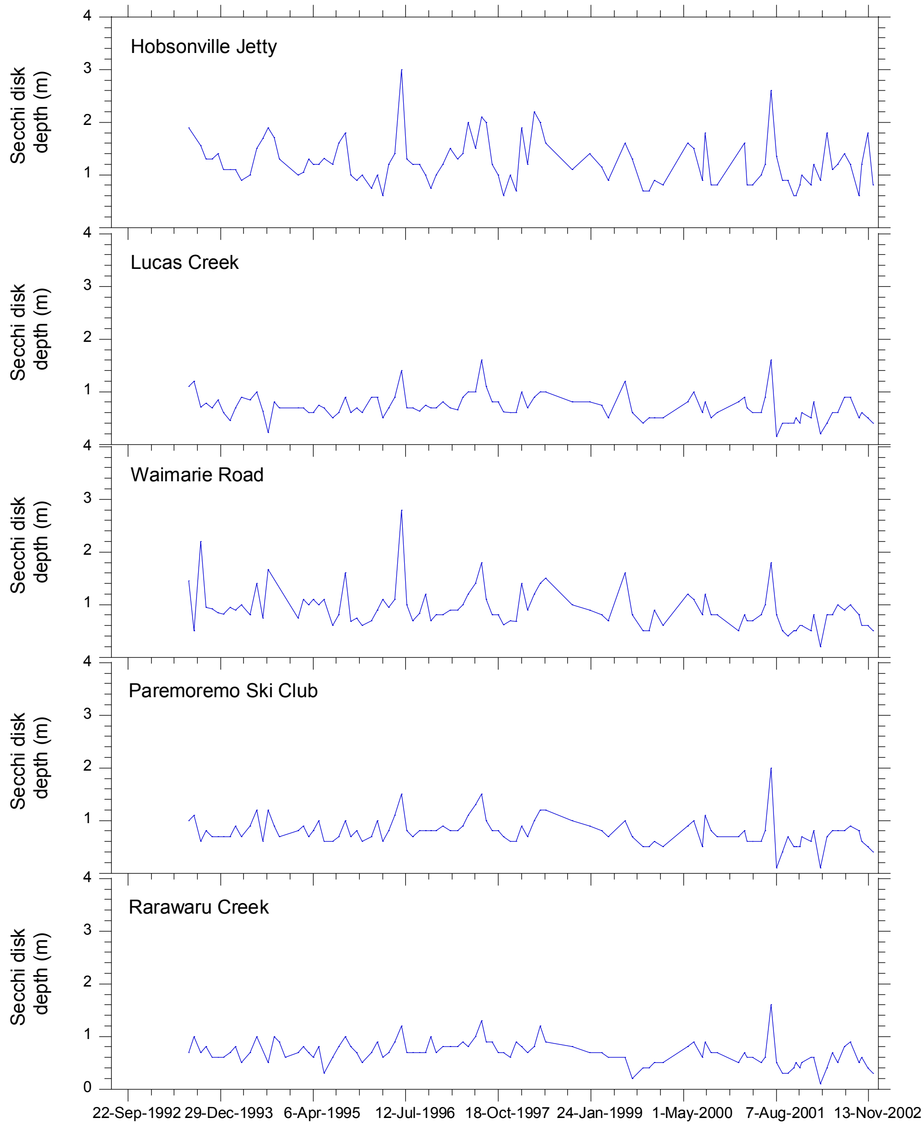
Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Turbidity (NTU)
Turbidity (NTU)
Turbidity (NTU)
100
80
60
40
20
0
1
1. 137 8 Aug 2001
1. 220 16 Aug 1996
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

APPENDIX 47: UPPER WAITEMATA HARBOUR – SECCHI DEPTH

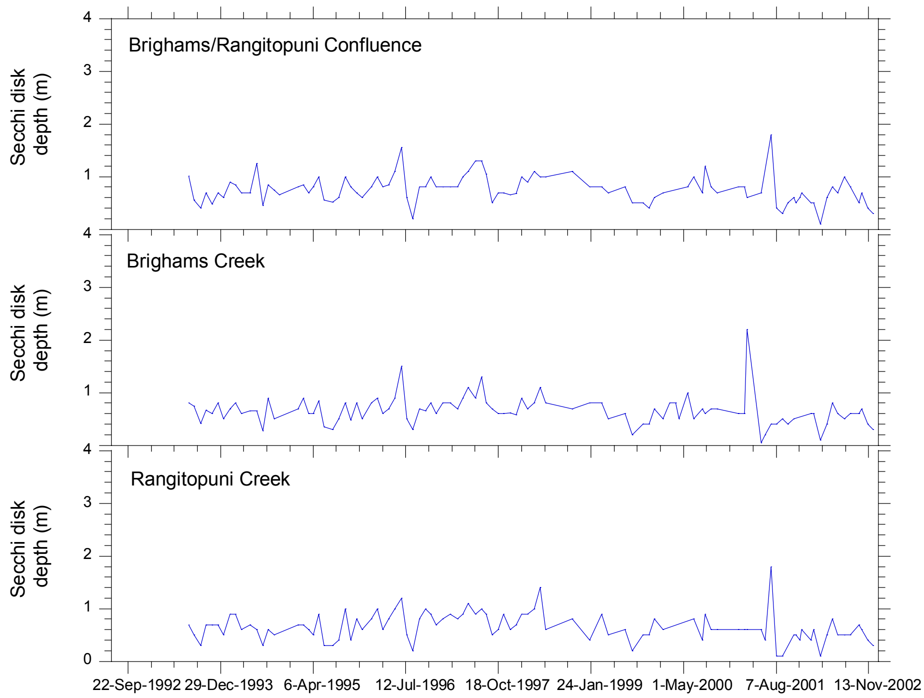
a) Secchi depth (m) during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	0.8	0.5	0.5	0.6	0.6	0.5	0.6	0.4
12-Feb-2002	1.2	0.8	0.8	0.8	0.6	0.5	0.6	0.6
15-Mar-2002	0.9	0.2	0.2	0.1	0.1	0.1	0.1	0.1
17-Apr-2002	1.8	0.4	0.8	0.7	0.4	0.6	0.4	0.5
16-May-2002	1.1	0.6	0.8	0.8	0.7	0.8	0.8	0.8
12-Jun-2002	1.2	0.6	1.0	0.8	0.5	0.7	0.6	0.5
16-Jul-2002	1.4	0.9	0.9	0.8	0.8	1.0	0.5	0.5
12-Aug-2002	1.2	0.9	1.0	0.9	0.9	0.8	0.6	0.5
26-Sep-2002	0.6	0.5	0.8	0.8	0.5	0.5	0.6	0.7
9-Oct-2002	1.2	0.6	0.6	0.6	0.6	0.7	0.7	0.6
7-Nov-2002	1.8	0.5	0.6	0.5	0.4	0.4	0.4	0.4
6-Dec-2002	0.8	0.4	0.5	0.4	0.3	0.3	0.3	0.3
Median	1.2	0.6	0.8	0.8	0.6	0.6	0.6	0.5
IQR/Median %	31	32	31	30	41	45	33	40

b) The graphs on the following pages show Secchi depth measurements from 1993 to December 2002 (where data available).



Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Secchi disk depth (m)
0
1
2
3
4
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

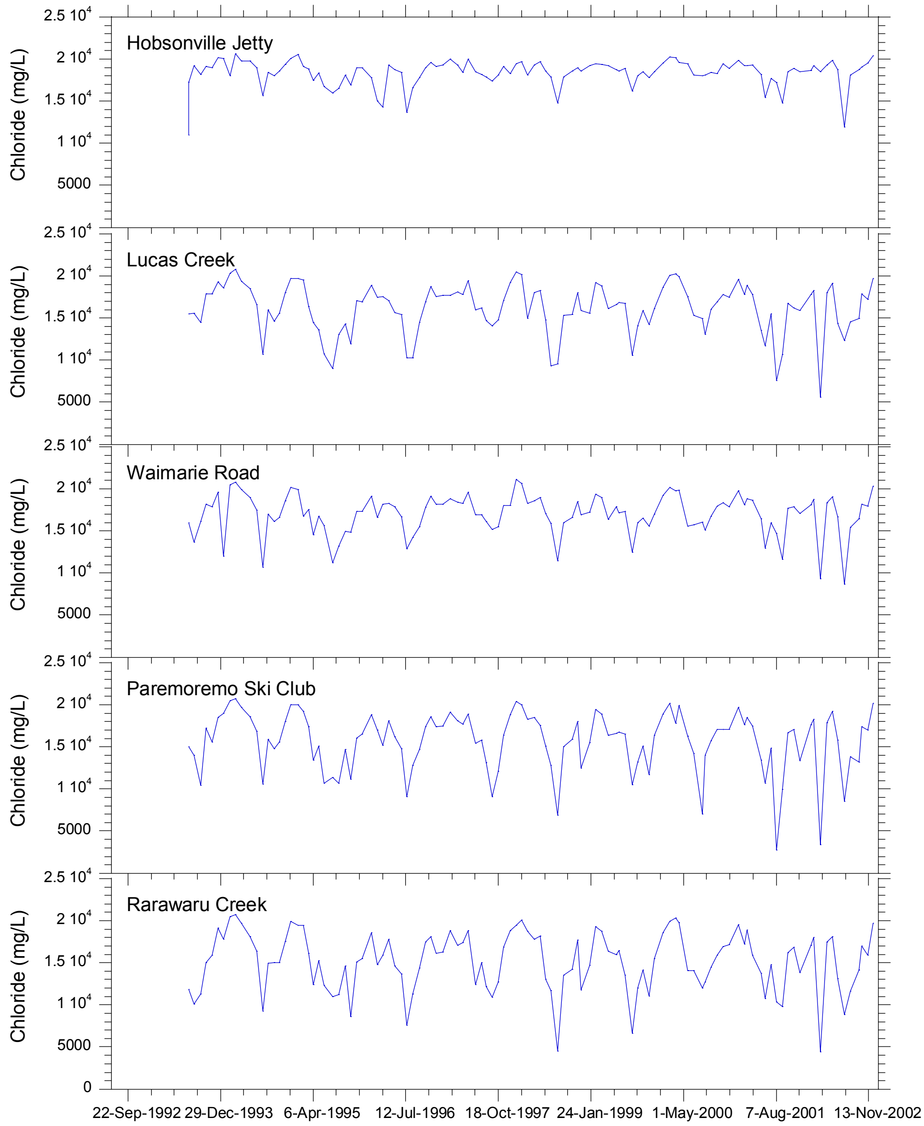

Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Secchi disk depth (m)
0
1
2
3
4
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

APPENDIX 48: UPPER WAITEMATA HARBOUR – CHLORIDE

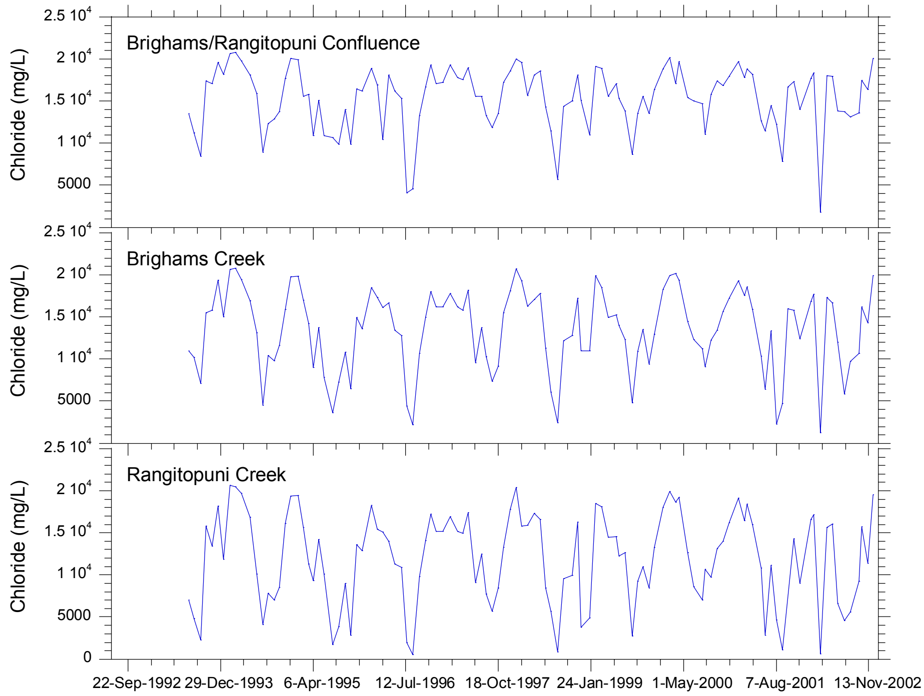
a) Chloride (mg/L) during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	18678	17811	18110	17617	17083	17729	16852	16596
12-Feb-2002	19229	18283	18763	18289	18051	18377	17686	17182
15-Mar-2002	18514	5608	9350	3423	4427	1807	1207	608
17-Apr-2002	19257	18036	18387	17901	17471	18062	17339	15643
16-May-2002	19826	19157	19052	19226	18108	17915	16697	16072
12-Jun-2002	18744	14372	16663	15773	13127	13836	11988	6657
16-Jul-2002	11906	12348	8709	8567	8847	13761	5834	4545
12-Aug-2002	18086	14541	15408	13817	11636	13126	9729	5609
26-Sep-2002	18727	14903	16442	13239	14123	13567	10655	9216
9-Oct-2002	19048	17844	18175	17403	17000	17448	16180	15744
7-Nov-2002	19564	17249	17960	16985	15871	16342	14284	11347
6-Dec-2002	20424	19695	20301	20170	19717	20042	19927	19514
Median	18896	17530	18035	17194	16436	16895	15232	13495
IQR/Median %	4	21	13	25	30	25	43	73

b) The graphs on the following pages show chloride measurements from 1993 to December 2002 (where data available).



Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Chloride (mg/L)
2.5 10⁴
2 10⁴
1.5 10⁴
1 10⁴
5000
0
22-Sep-1992 29-Dec-1993 6-Apr-1995 12-Jul-1996 18-Oct-1997 24-Jan-1999 1-May-2000 7-Aug-2001 13-Nov-2002

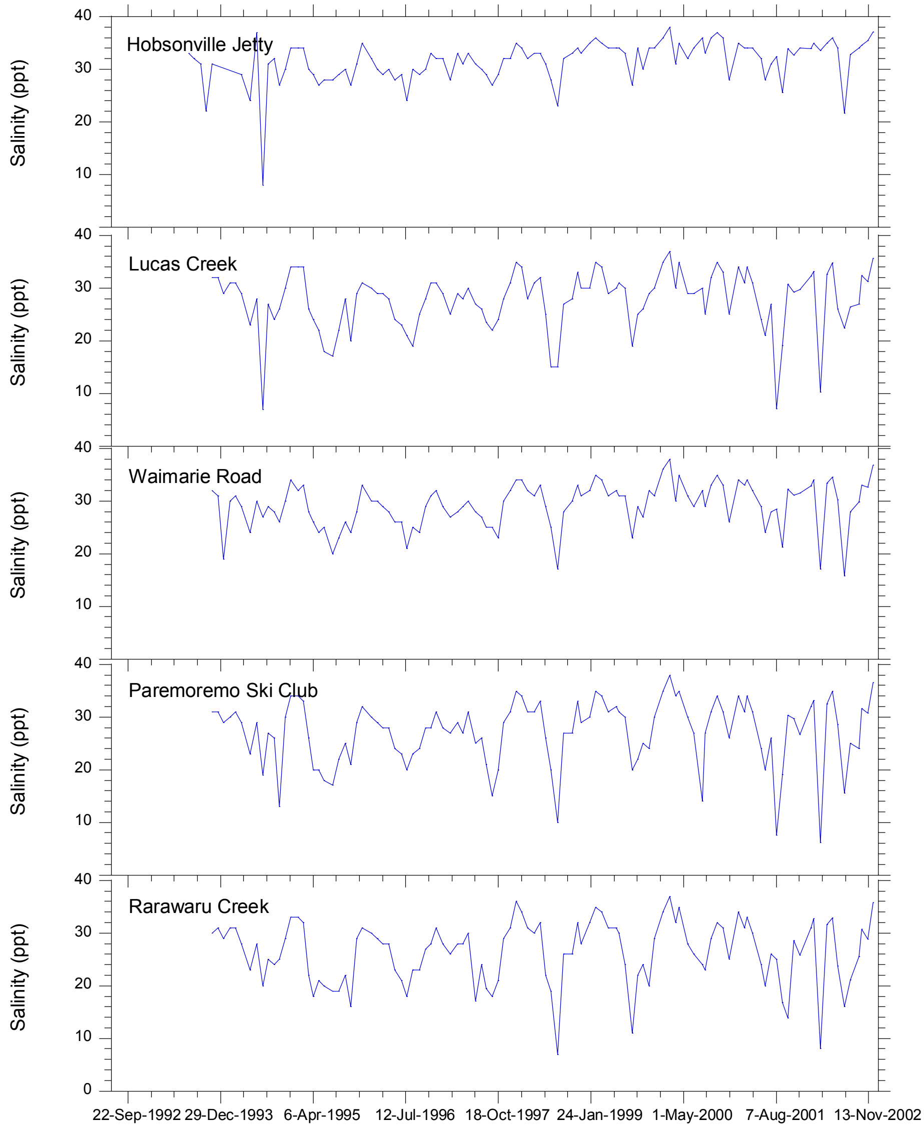

Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Chloride (mg/L)
2.5 10^4
2 10^4
1.5 10^4
1 10^4
5000
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

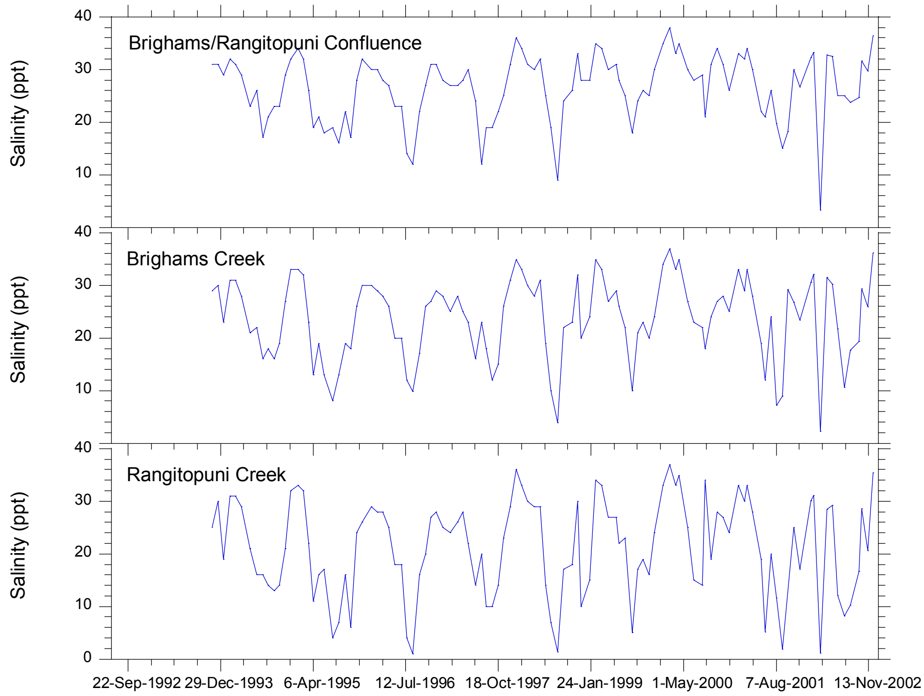
APPENDIX 49: UPPER WAITEMATA HARBOUR – SALINITY

a) Salinity (ppt) during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	33.9	32.3	32.9	32.0	31.0	32.2	30.6	30.1
12-Feb-2002	34.9	33.2	34.0	33.2	32.8	33.3	32.1	31.2
15-Mar-2002	33.6	10.2	17.0	6.2	8.0	3.3	2.2	1.1
17-Apr-2002	34.9	32.7	33.4	32.5	31.7	32.8	31.5	28.4
16-May-2002	36.0	34.8	34.6	34.9	32.9	32.5	30.3	29.2
12-Jun-2002	34.0	26.1	30.2	28.6	23.8	25.1	21.8	12.1
16-Jul-2002	21.6	22.4	15.8	15.5	16.1	25.0	10.6	8.2
12-Aug-2002	32.8	26.4	28.0	25.1	21.1	23.8	17.7	10.2
26-Sep-2002	34.0	27.0	29.8	24.0	25.6	24.6	19.3	16.7
9-Oct-2002	34.6	32.4	33.0	31.6	30.8	31.7	29.4	28.6
7-Nov-2002	35.5	31.3	32.6	30.8	28.8	29.7	25.9	20.6
6-Dec-2002	37.1	35.7	36.8	36.6	35.8	36.4	36.2	35.4
Median	34.3	31.8	32.8	31.2	29.8	30.7	27.7	24.5
IQR/Median %	4	20	13	25	30	25	43	73

b) The graphs on the following pages show salinity measurements from 1993 to December 2002 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Salinity (ppt)
0
10
20
30
40
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

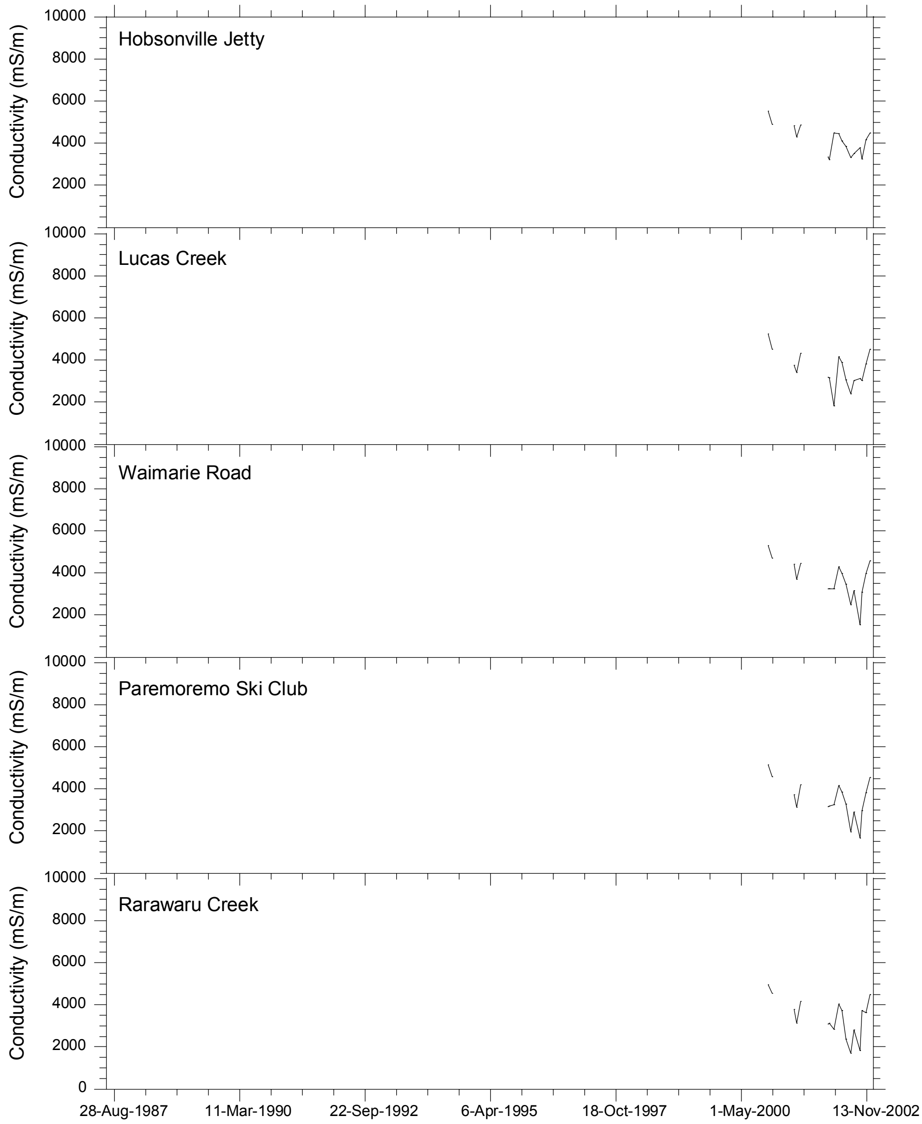

Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Salinity (ppt)
Salinity (ppt)
Salinity (ppt)
40
30
20
10
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

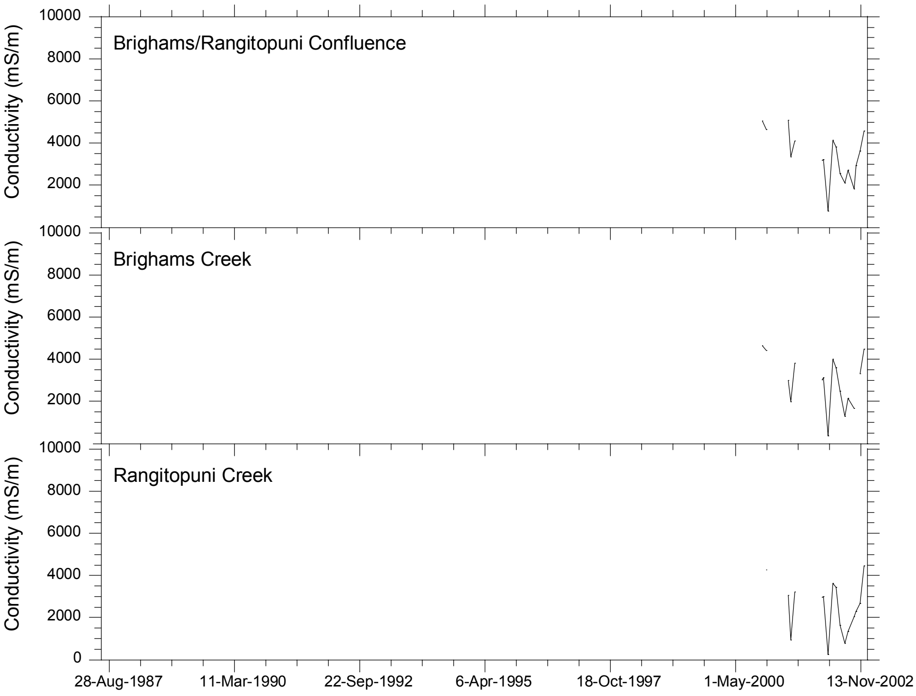
APPENDIX 50: UPPER WAITEMATA HARBOUR – CONDUCTIVITY

a) Conductivity (mS/m) during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	3360	3200	3260	3170	3090	3190	3040	2970
12-Feb-2002	3230	3150	3250	3190	3130	3210	3110	3000
15-Mar-2002	4500	1840	3240	3270	2840	781	370	260
17-Apr-2002	4440	4160	4300	4170	4050	4150	4020	3640
16-May-2002	4100	3880	3990	3850	3740	3830	3610	3450
12-Jun-2002	3850	3050	3480	3280	2380	2540	2500	1650
16-Jul-2002	3330	2390	2500	1960	1690	2110	1280	800
12-Aug-2002	3490	3030	3170	2910	2810	2710	2150	1370
26-Sep-2002	3780	3110	1540	1670	1810	1810	1660	2050
9-Oct-2002	3260	3030	3090	2960	3740	2950		2310
7-Nov-2002	4180	3840	3970	3840	3620	3620	3300	2690
6-Dec-2002	4480	4530	4590	4540	4500	4580	4490	4450
Median	3815	3130	3255	3230	3110	3070	3040	2500
IQR/Median %	23	26	25	28	33	40	51	61

b) The graphs on the following pages show conductivity measurements from 1993 to December 2002 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Conductivity (mS/m)
10000
8000
6000
4000
2000
0
28-Aug-1987
11-Mar-1990
22-Sep-1992
6-Apr-1995
18-Oct-1997
1-May-2000
13-Nov-2002

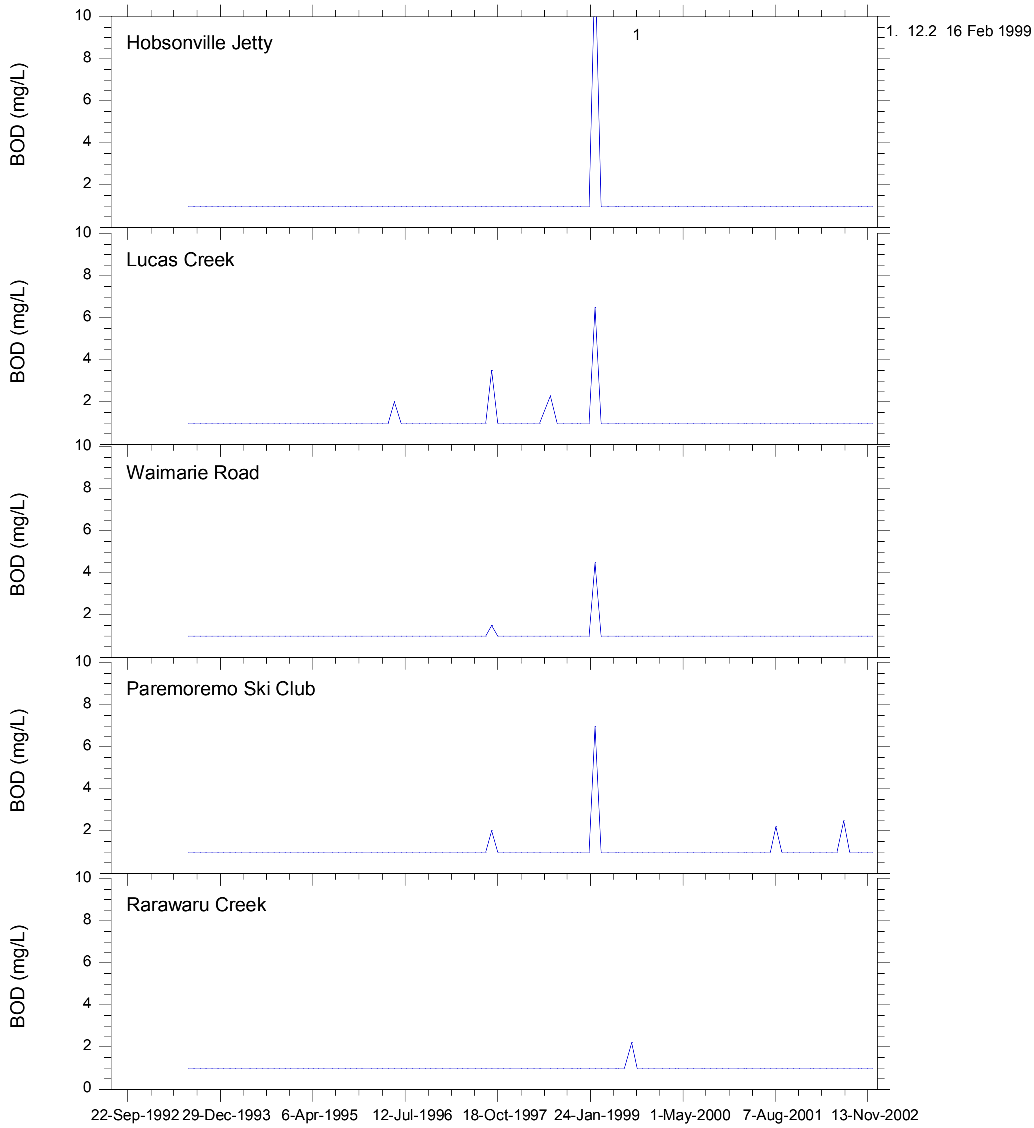

Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Conductivity (mS/m)
10000
8000
6000
4000
2000
0
28-Aug-1987
11-Mar-1990
22-Sep-1992
6-Apr-1995
18-Oct-1997
1-May-2000
13-Nov-2002

APPENDIX 51: UPPER WAITEMATA HARBOUR – BIOCHEMICAL OXYGEN DEMAND

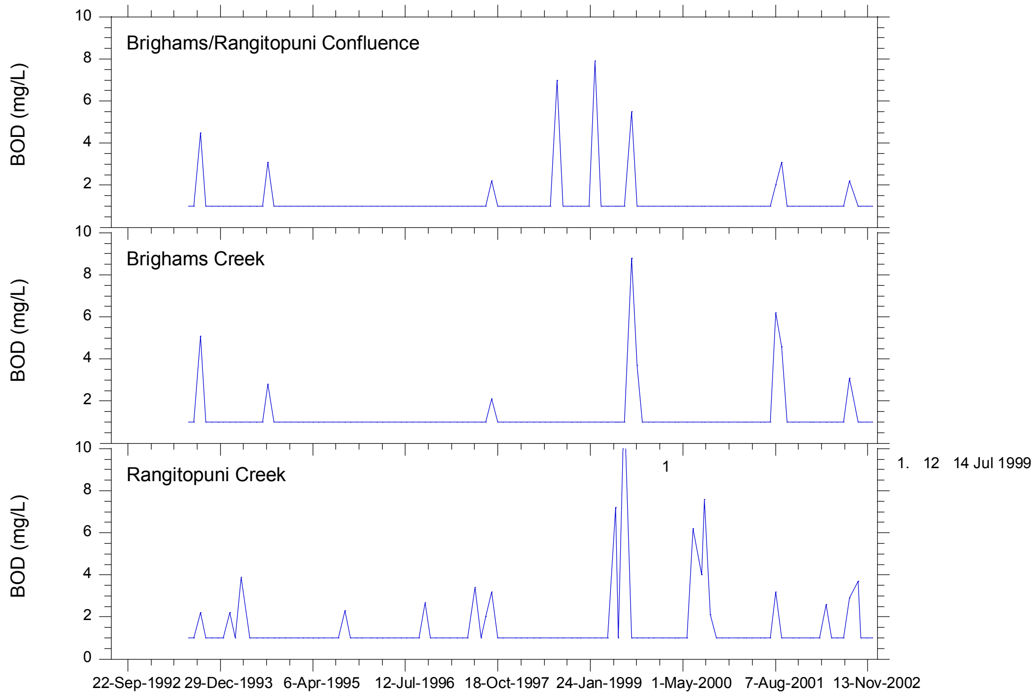
a) Biochemical oxygen demand (mg/L) during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
12-Feb-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
15-Mar-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
17-Apr-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.6
16-May-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
12-Jun-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
16-Jul-2002	1.0	1.0	1.0	2.5	1.0	1.0	1.0	1.0
12-Aug-2002	1.0	1.0	1.0	1.0	1.0	2.2	3.1	2.9
26-Sep-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	3.7
9-Oct-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7-Nov-2002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6-Dec-2002	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
IQR/Median %	0	0	0	0	0	0	0	40

NB: The reported detection limit is 2.0 mg/L. All data reported as <2.0 mg/L have been given a value of 1.0 mg/L.
b) The graphs on the following pages show BOD measurements from 1993 to December 2002 (where data available).



Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
BOD (mg/L)
1. 12.2 16 Feb 1999
22-Sep-1992 29-Dec-1993 6-Apr-1995 12-Jul-1996 18-Oct-1997 24-Jan-1999 1-May-2000 7-Aug-2001 13-Nov-2002



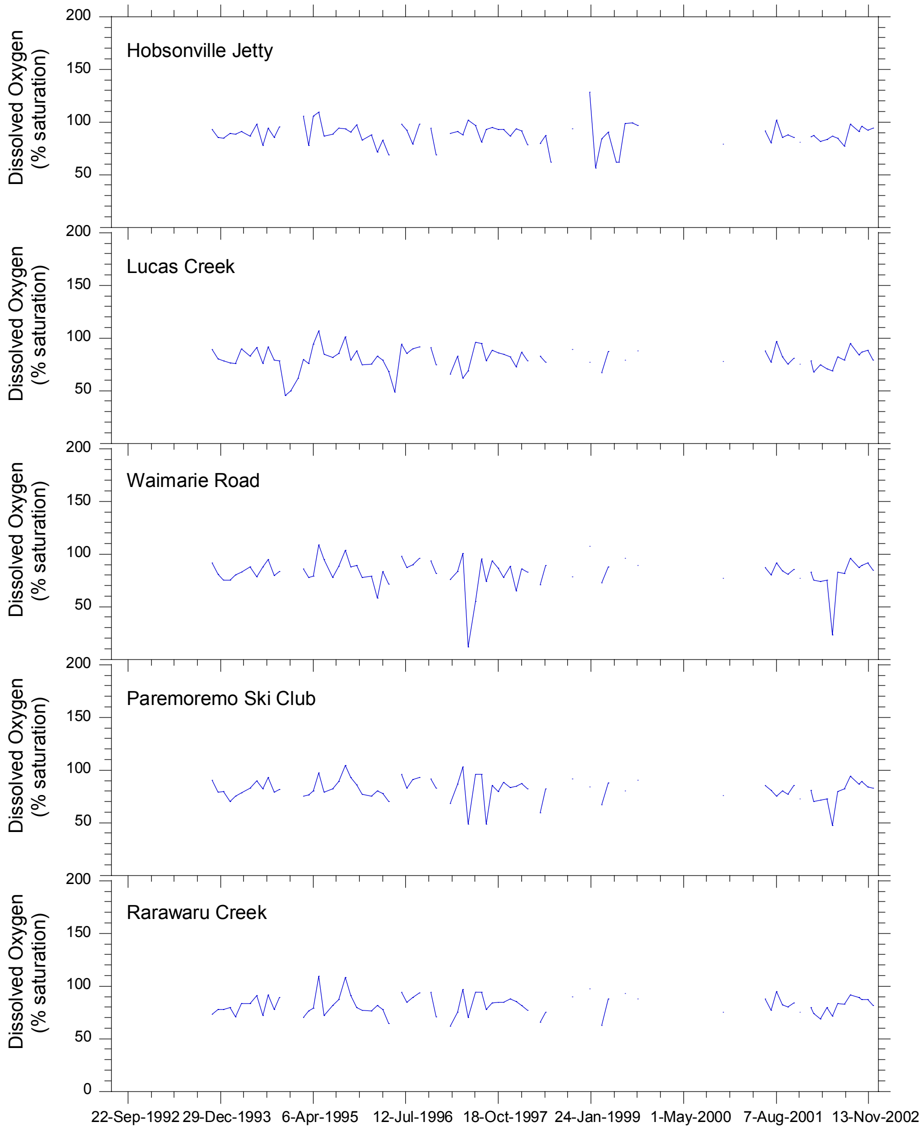
Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
BOD (mg/L)
1
1. 12 14 Jul 1999
22-Sep-1992 29-Dec-1993 6-Apr-1995 12-Jul-1996 18-Oct-1997 24-Jan-1999 1-May-2000 7-Aug-2001 13-Nov-2002

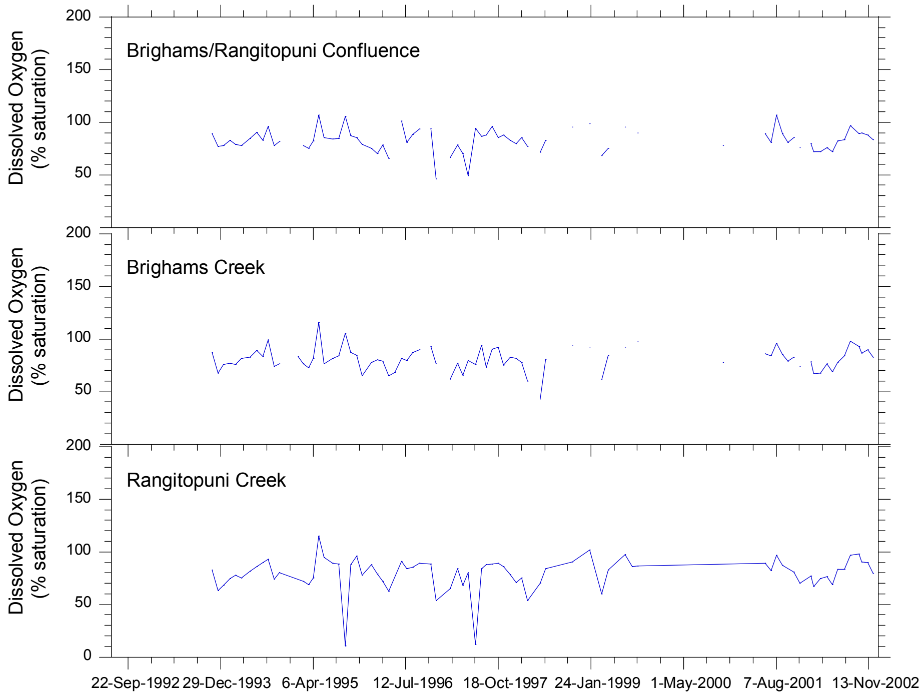
APPENDIX 52: UPPER WAITEMATA HARBOUR – DISSOLVED OXYGEN % SATURATION

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

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	85.9	78.3	82.6	80.7	79.6	79.9	78.6	77.1
12-Feb-2002	87.2	67.6	75.1	70.4	73.9	72.1	67.0	67.2
15-Mar-2002	81.7	74.6	74.0	71.2	68.8	71.9	67.8	74.8
17-Apr-2002	83.8	70.8	75.1	73.0	79.6	76.0	76.7	76.6
16-May-2002	86.3	68.8	23.6	47.5	71.2	71.9	68.7	68.8
12-Jun-2002	84.7	82.3	82.5	79.8	83.4	82.0	77.4	83.8
16-Jul-2002	77.2	79.3	81.7	82.3	82.9	83.8	84.0	83.2
12-Aug-2002	98.2	94.9	96.0	93.9	91.9	96.4	98.3	96.7
26-Sep-2002	91.3	83.9	87.1	86.9	88.9	88.9	92.7	97.8
9-Oct-2002	96.1	86.4	89.4	89.1	87.4	89.8	86.4	90.4
7-Nov-2002	92.2	88.3	91.9	84.4	87.3	87.7	90.0	89.7
6-Dec-2002	94.1	79.3	84.6	82.6	81.8	83.8	82.9	79.4
Median	86.8	79.3	82.6	81.5	82.4	82.9	80.8	81.3
IQR/Median %	9	14	15	15	11	16	16	17

b) The graphs on the following pages show dissolved oxygen (% saturation) measurements from 1993 to December 2002 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Dissolved Oxygen (% saturation)
200
150
100
50
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

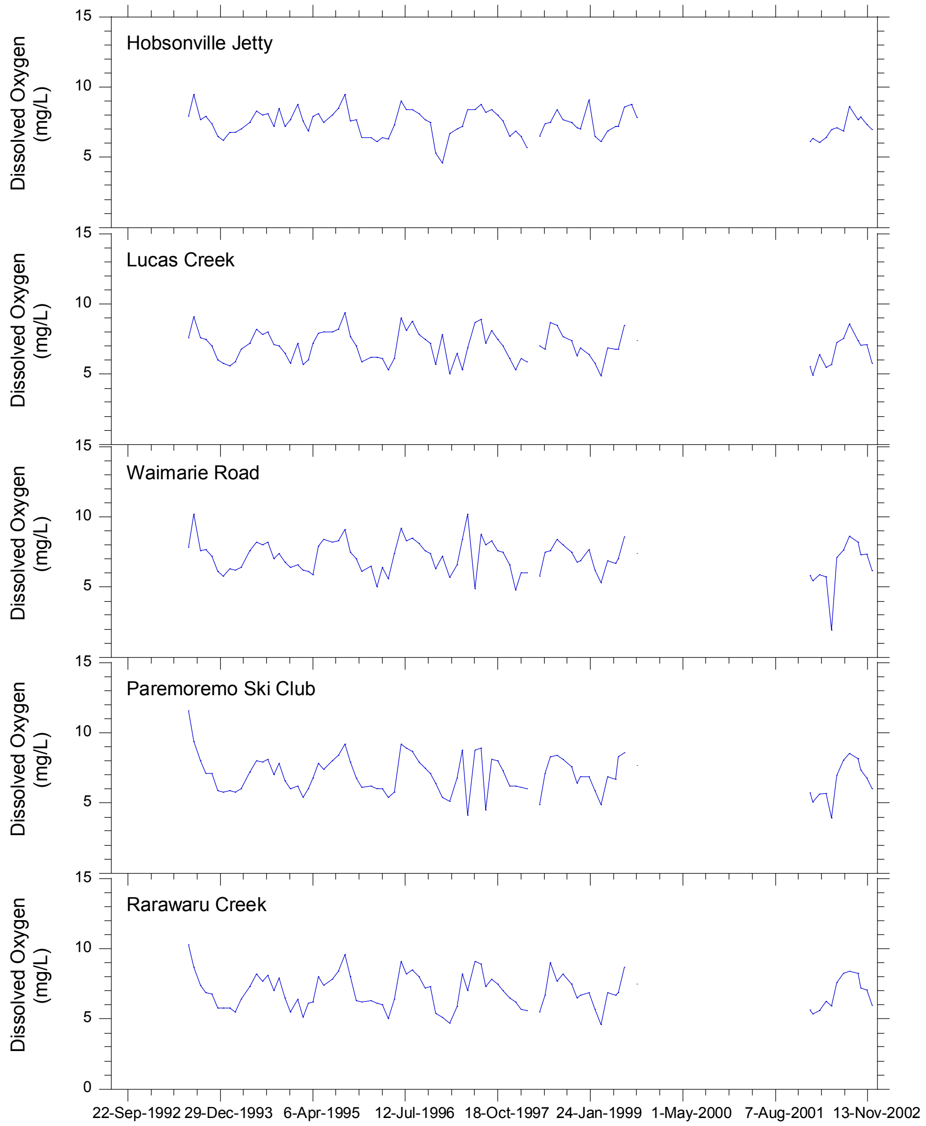

Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Dissolved Oxygen (% saturation)
200
150
100
50
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

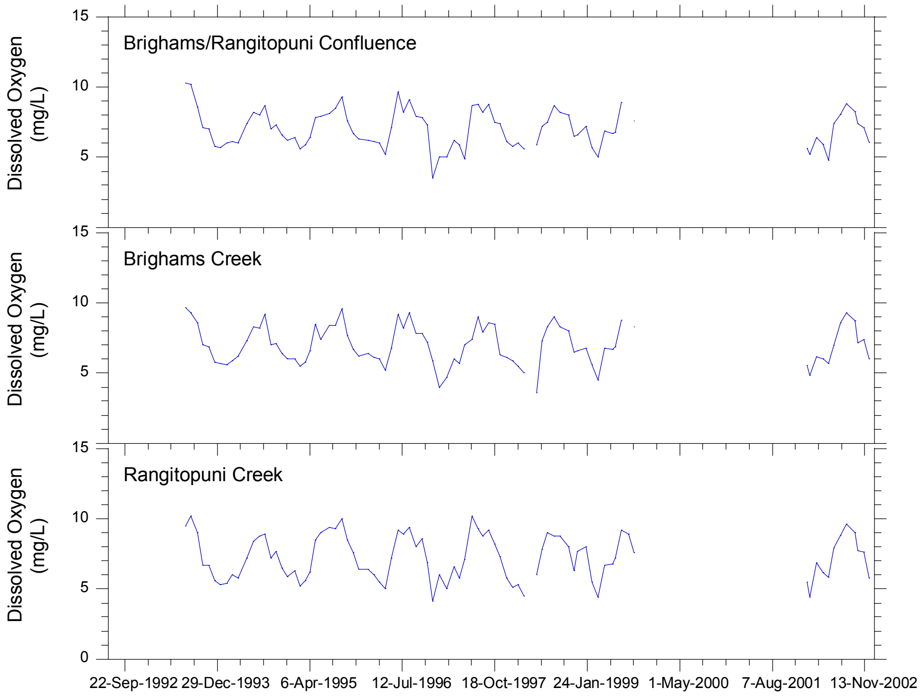
APPENDIX 53: UPPER WAITEMATA HARBOUR – DISSOLVED OXYGEN mg/L

a) Dissolved oxygen (mg/L) during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	6.09	5.55	5.84	5.73	5.66	5.66	5.56	5.49
12-Feb-2002	6.35	4.92	5.44	5.09	5.35	5.21	4.84	4.38
15-Mar-2002	6.08	6.39	5.86	5.66	5.58	6.41	6.16	6.86
17-Apr-2002	6.42	5.50	5.74	5.67	6.24	5.92	6.02	6.15
16-May-2002	6.99	5.69	1.92	3.91	5.92	4.79	5.70	5.81
12-Jun-2002	7.14	7.25	7.11	6.95	7.60	7.42	6.99	7.92
16-Jul-2002	6.87	7.53	7.62	8.05	8.24	8.06	8.58	8.84
12-Aug-2002	8.63	8.58	8.62	8.55	8.40	8.85	9.28	9.62
26-Sep-2002	7.69	7.40	8.21	8.18	8.25	8.25	8.71	8.99
9-Oct-2002	7.87	7.09	7.31	7.34	7.20	7.40	7.15	7.74
7-Nov-2002	7.37	7.11	7.37	6.80	7.09	7.12	7.42	7.64
6-Dec-2002	6.99	5.80	6.18	6.01	5.96	6.08	6.03	5.78
Median	6.99	6.74	6.65	6.41	6.67	6.77	6.58	7.25
IQR/Median %	15	24	24	29	29	25	27	32

b) The graphs on the following pages show dissolved oxygen (mg/L) measurements from 1993 to December 2002 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Dissolved Oxygen (mg/L)
0
5
10
15
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002



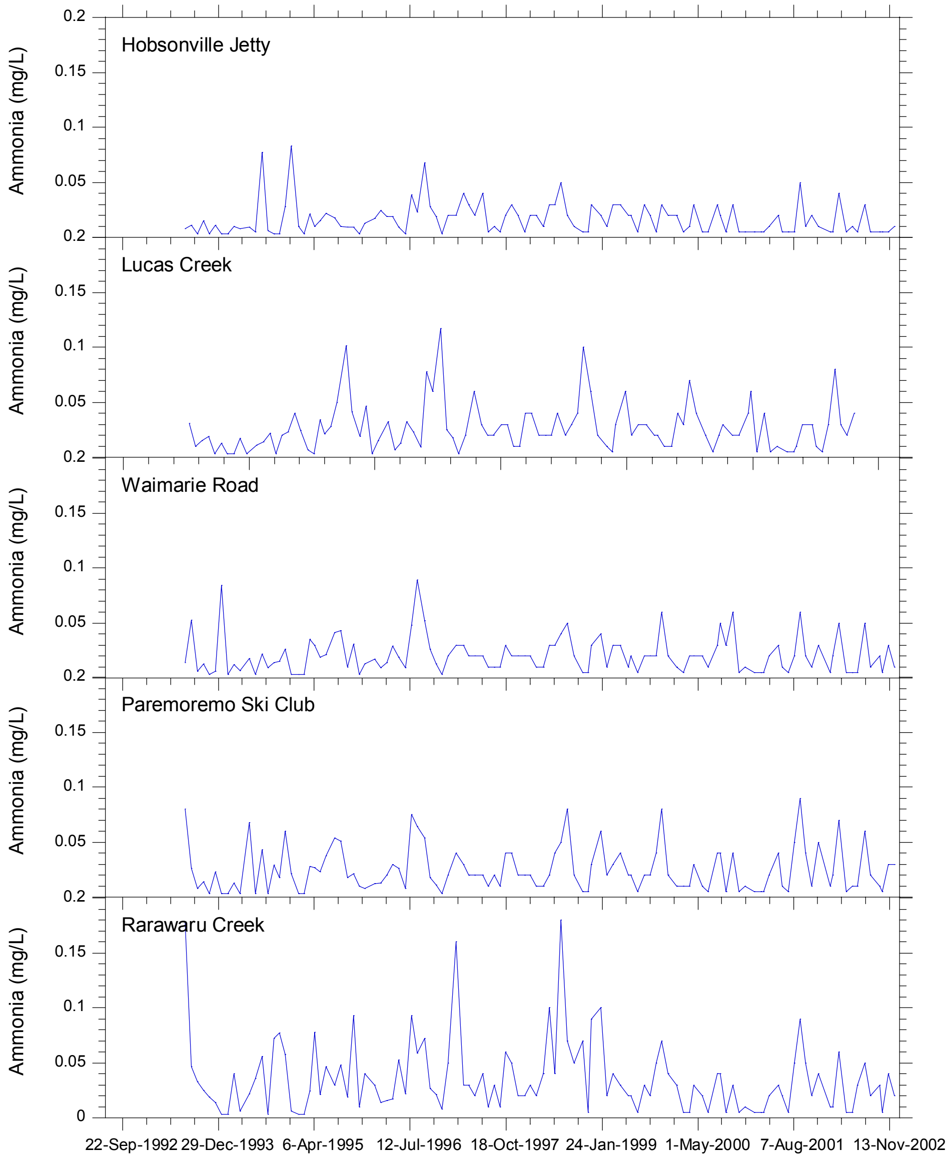
Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Dissolved Oxygen (mg/L)
Dissolved Oxygen (mg/L)
Dissolved Oxygen (mg/L)
15
10
5
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

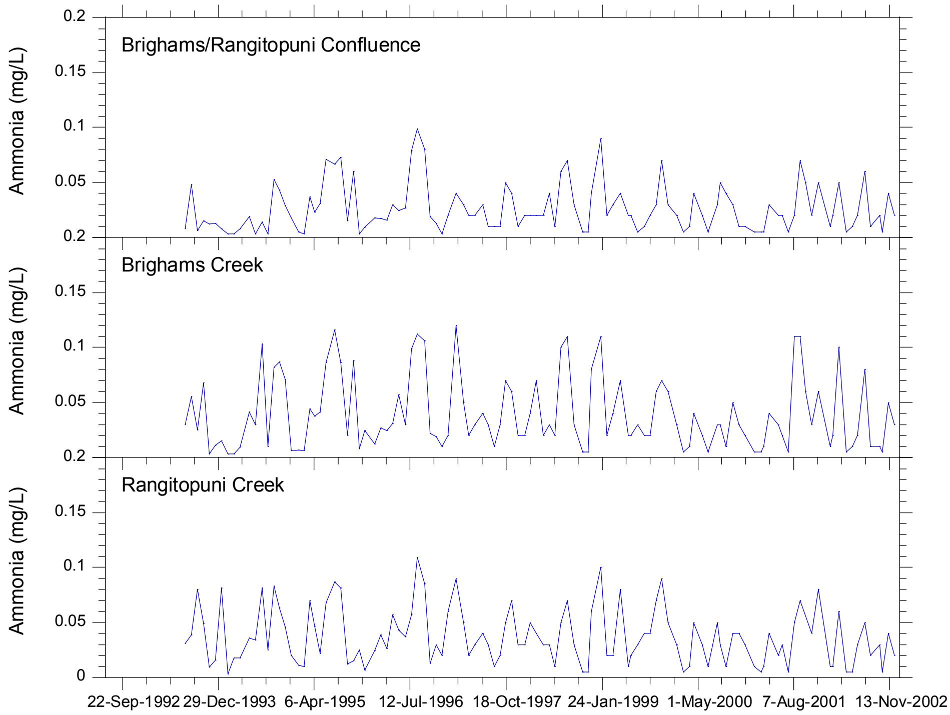
APPENDIX 54: UPPER WAITEMATA HARBOUR – AMMONIA NITROGEN

a) Ammonia nitrogen (mg/L) during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	0.005	0.005	0.005	0.01	0.01	0.01	0.01	0.01
12-Feb-2002	0.005	0.04	0.02	0.02	0.01	0.02	0.02	0.03
15-Mar-2002	0.04	0.06	0.05	0.07	0.06	0.05	0.1	0.04
17-Apr-2002	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.01
16-May-2002	0.01	0.01	0.005	0.01	0.005	0.01	0.01	0.01
12-Jun-2002	0.005	0.01	0.005	0.01	0.03	0.02	0.02	0.03
16-Jul-2002	0.03	0.05	0.05	0.06	0.05	0.06	0.08	0.07
12-Aug-2002	0.005	0.01	0.01	0.02	0.02	0.01	0.01	0.03
26-Sep-2002	0.005	0.02	0.02	0.01	0.03	0.02	0.01	0.03
9-Oct-2002	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
7-Nov-2002	0.005	0.03	0.03	0.03	0.04	0.04	0.05	0.07
6-Dec-2002	0.01	0.03	0.01	0.03	0.02	0.02	0.03	0.03
Median	0.005	0.015	0.010	0.015	0.020	0.020	0.015	0.030
IQR/Median %	100	158	175	133	119	75	167	75

b) The graphs on the following pages show ammonia nitrogen measurements from 1993 to December 2002 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Ammonia (mg/L)
0.2
0.15
0.1
0.05
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002



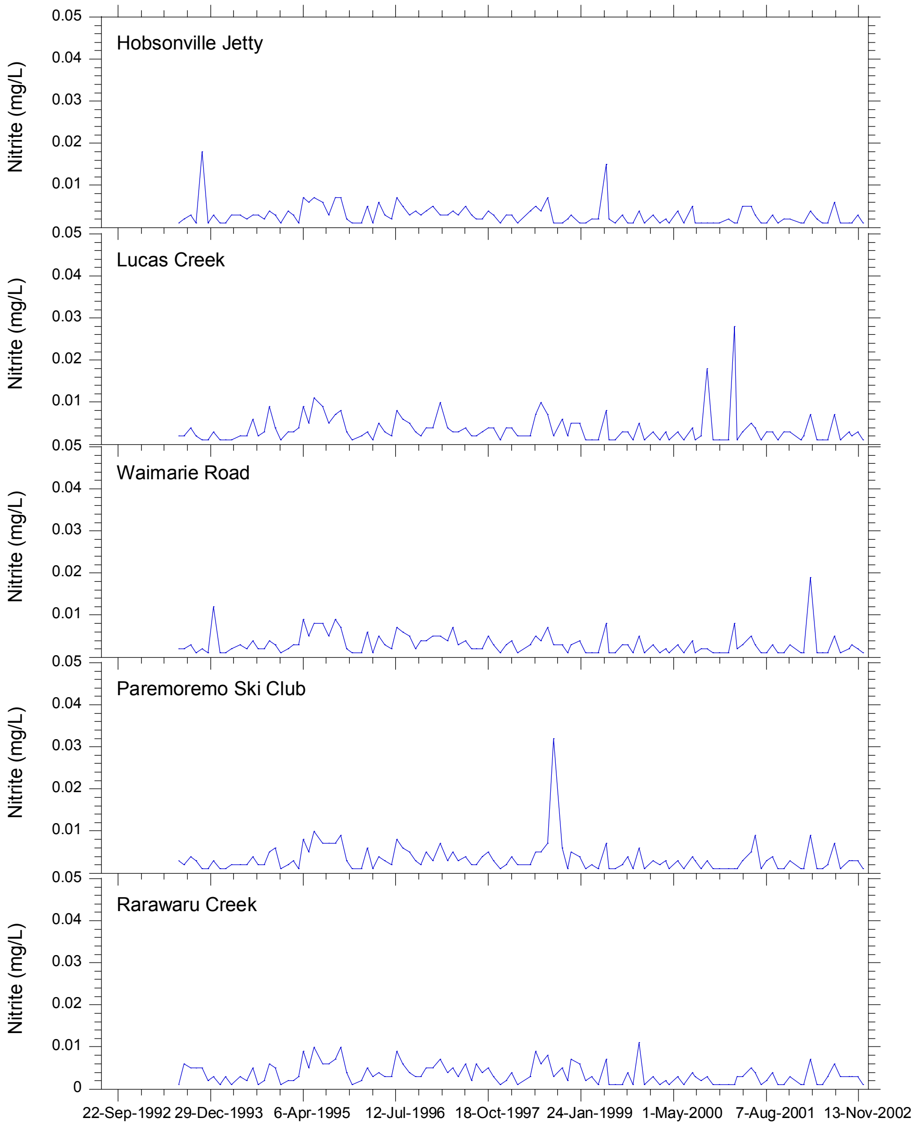
Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Ammonia (mg/L)
0.2
0.15
0.1
0.05
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

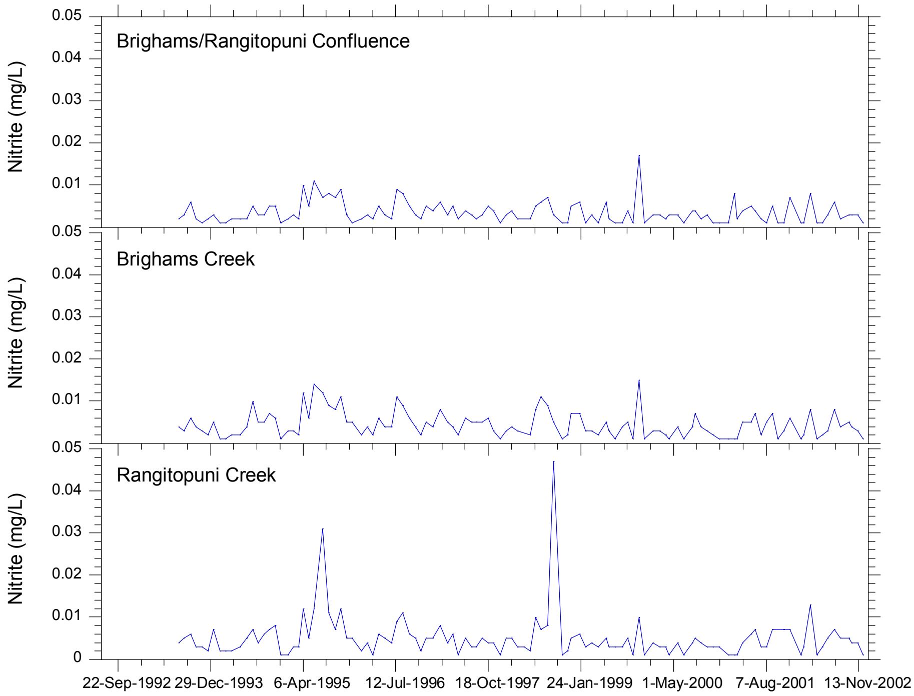
APPENDIX 55: UPPER WAITEMATA HARBOUR – NITRITE NITROGEN

a) Nitrite nitrogen (mg/L) during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
12-Feb-2002	0.001	0.002	0.001	0.001	0.001	0.001	0.002	0.003
15-Mar-2002	0.004	0.007	0.019	0.009	0.007	0.008	0.008	0.013
17-Apr-2002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001
16-May-2002	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.003
12-Jun-2002	0.001	0.001	0.001	0.002	0.003	0.003	0.003	0.005
16-Jul-2002	0.006	0.007	0.005	0.007	0.006	0.006	0.008	0.007
12-Aug-2002	0.001	0.001	0.001	0.001	0.003	0.002	0.004	0.005
26-Sep-2002	0.001	0.003	0.002	0.003	0.003	0.003	0.005	0.005
9-Oct-2002	0.001	0.002	0.003	0.003	0.003	0.003	0.004	0.004
7-Nov-2002	0.003	0.003	0.002	0.003	0.003	0.003	0.003	0.004
6-Dec-2002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Median	0.001	0.002	0.001	0.002	0.003	0.003	0.003	0.004
IQR/Median %	125	133	125	133	67	80	83	63

b) The graphs on the following pages show nitrite nitrogen measurements from 1993 to December 2002 (where data available).


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
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

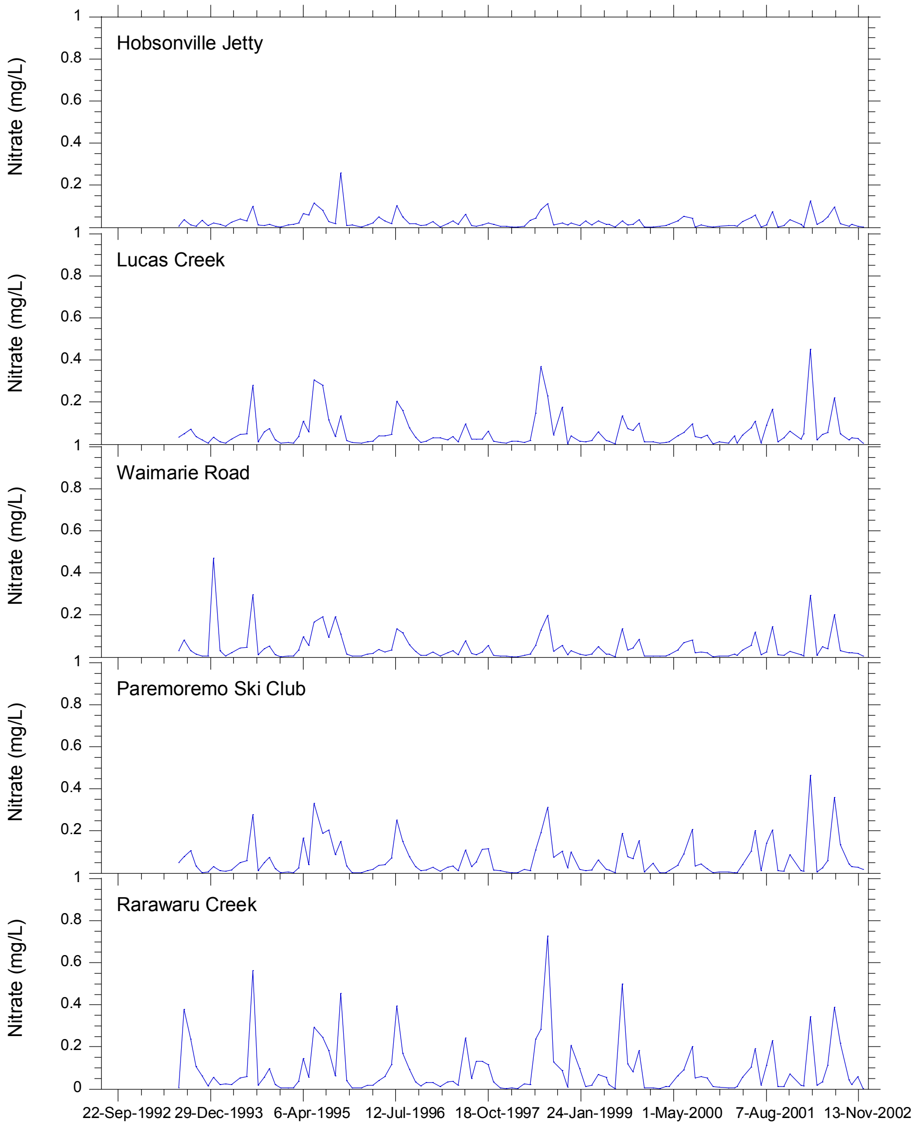

Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Nitrite (mg/L)
Nitrite (mg/L)
Nitrite (mg/L)
0.05
0.04
0.03
0.02
0.01
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

APPENDIX 56: UPPER WAITEMATA HARBOUR – NITRATE NITROGEN

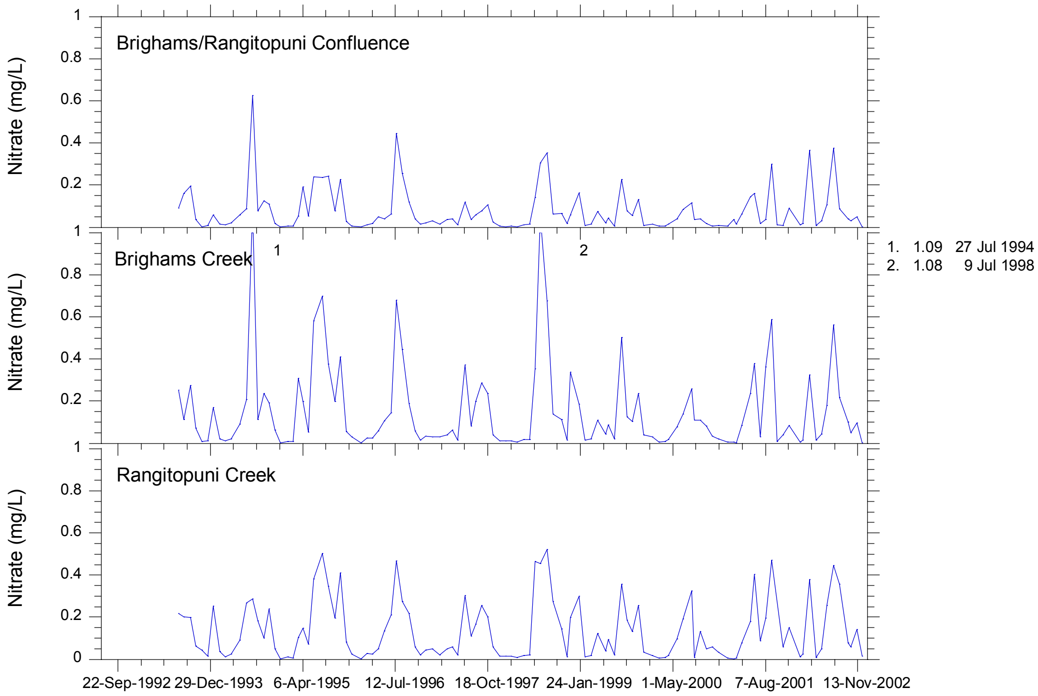
a) Nitrate nitrogen (mg/L) during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	0.015	0.025	0.012	0.011	0.019	0.012	0.007	0.010
12-Feb-2002	0.001	0.051	0.007	0.009	0.015	0.017	0.014	0.025
15-Mar-2002	0.126	0.453	0.295	0.466	0.344	0.367	0.327	0.380
17-Apr-2002	0.014	0.021	0.009	0.007	0.018	0.009	0.016	0.008
16-May-2002	0.028	0.046	0.050	0.024	0.033	0.032	0.043	0.050
12-Jun-2002	0.050	0.057	0.042	0.061	0.114	0.105	0.179	0.257
16-Jul-2002	0.099	0.221	0.203	0.360	0.388	0.377	0.564	0.446
12-Aug-2002	0.017	0.048	0.032	0.134	0.217	0.086	0.217	0.356
26-Sep-2002	0.005	0.022	0.020	0.044	0.045	0.041	0.100	0.079
9-Oct-2002	0.016	0.029	0.022	0.032	0.022	0.030	0.051	0.058
7-Nov-2002	0.006	0.028	0.019	0.028	0.060	0.051	0.099	0.142
6-Dec-2002	0.004	0.005	0.005	0.018	0.003	0.003	0.001	0.014
Median	0.016	0.038	0.021	0.030	0.039	0.037	0.075	0.069
IQR/Median %	179	75	156	210	310	205	231	379

b) The graphs on the following pages show nitrate nitrogen measurements from 1993 to December 2002 (where data available).



Note: Total nitrite plus nitrate plotted from Jan 2002.



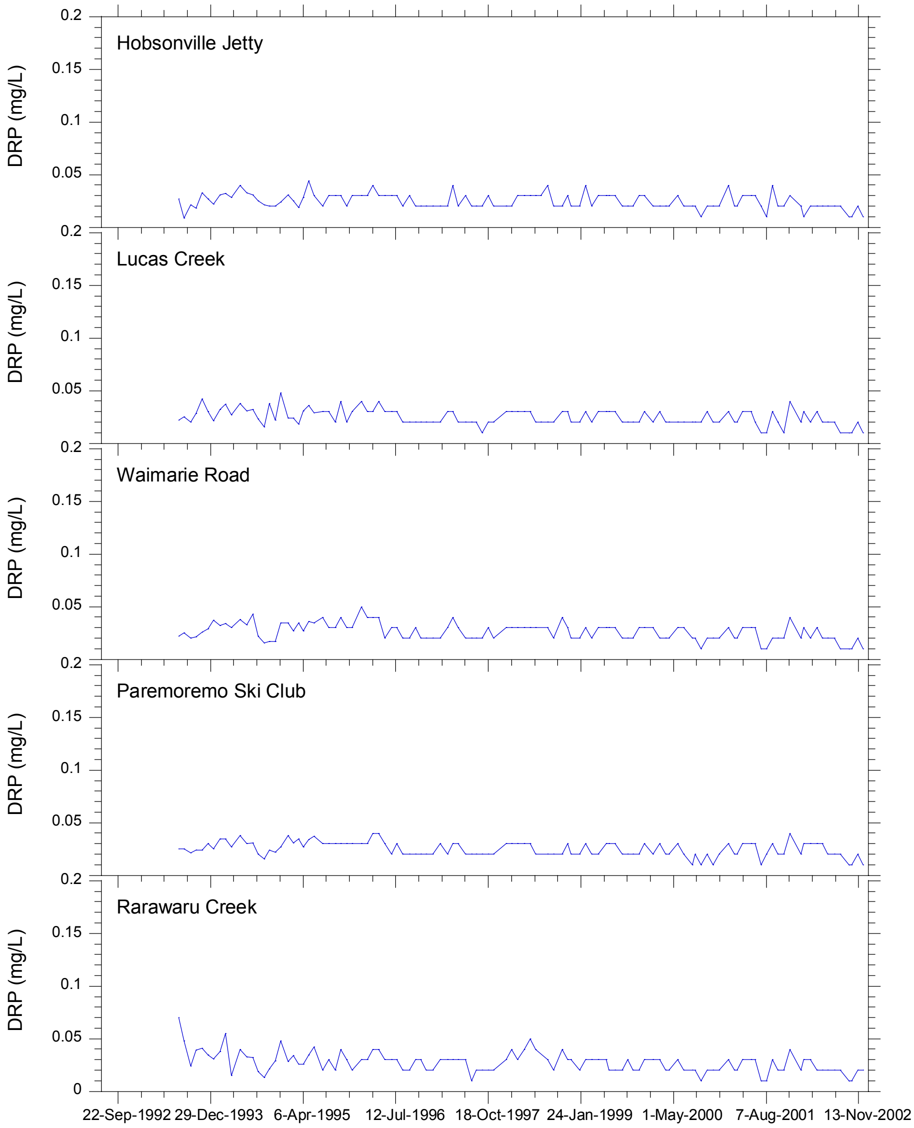
Note: Total nitrite plus nitrate plotted from Jan 2002.

APPENDIX 57: UPPER WAITEMATA HARBOUR – DISSOLVED REACTIVE PHOSPHORUS

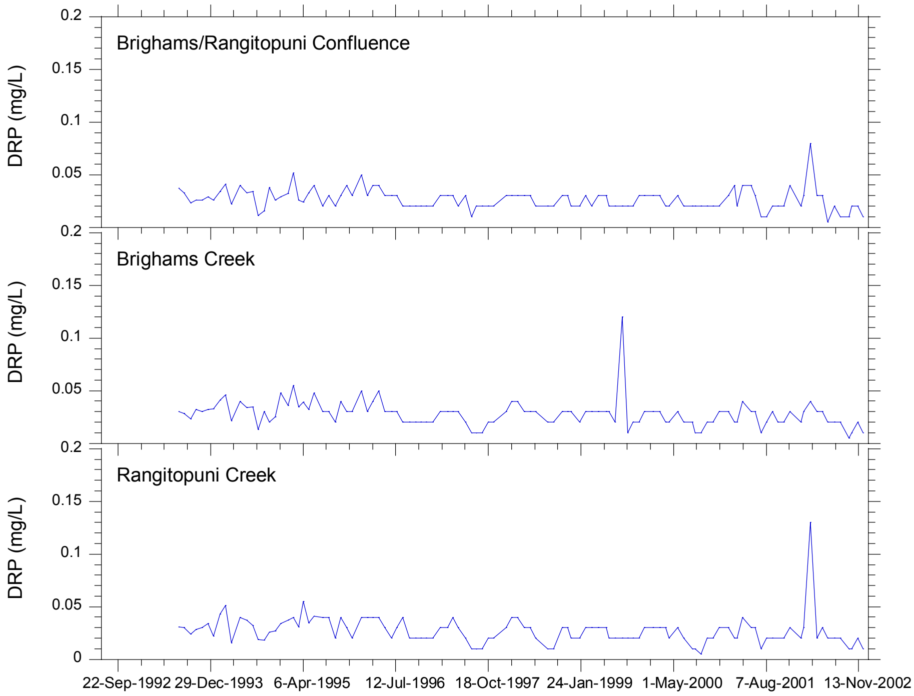
a) Dissolved reactive phosphorus (mg/L) during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
12-Feb-2002	0.01	0.03	0.03	0.03	0.03	0.03	0.03	0.03
15-Mar-2002	0.02	0.02	0.02	0.03	0.03	0.08	0.04	0.13
17-Apr-2002	0.02	0.03	0.03	0.03	0.02	0.03	0.03	0.02
16-May-2002	0.02	0.02	0.02	0.03	0.02	0.03	0.03	0.03
12-Jun-2002	0.02	0.02	0.02	0.02	0.02	0.005	0.02	0.02
16-Jul-2002	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
12-Aug-2002	0.02	0.01	0.01	0.02	0.02	0.01	0.02	0.02
26-Sep-2002	0.01	0.01	0.01	0.01	0.01	0.01	0.005	0.005
9-Oct-2002	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
7-Nov-2002	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
6-Dec-2002	0.005	0.01	0.01	0.01	0.02	0.01	0.01	0.01
Median	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
IQR/Median %	50	50	50	63	0	100	63	25

b) The graphs on the following pages show dissolved reactive phosphorus measurements from 1993 to December 2002 (where data available).



Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
DRP (mg/L)
0.2
0.15
0.1
0.05
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

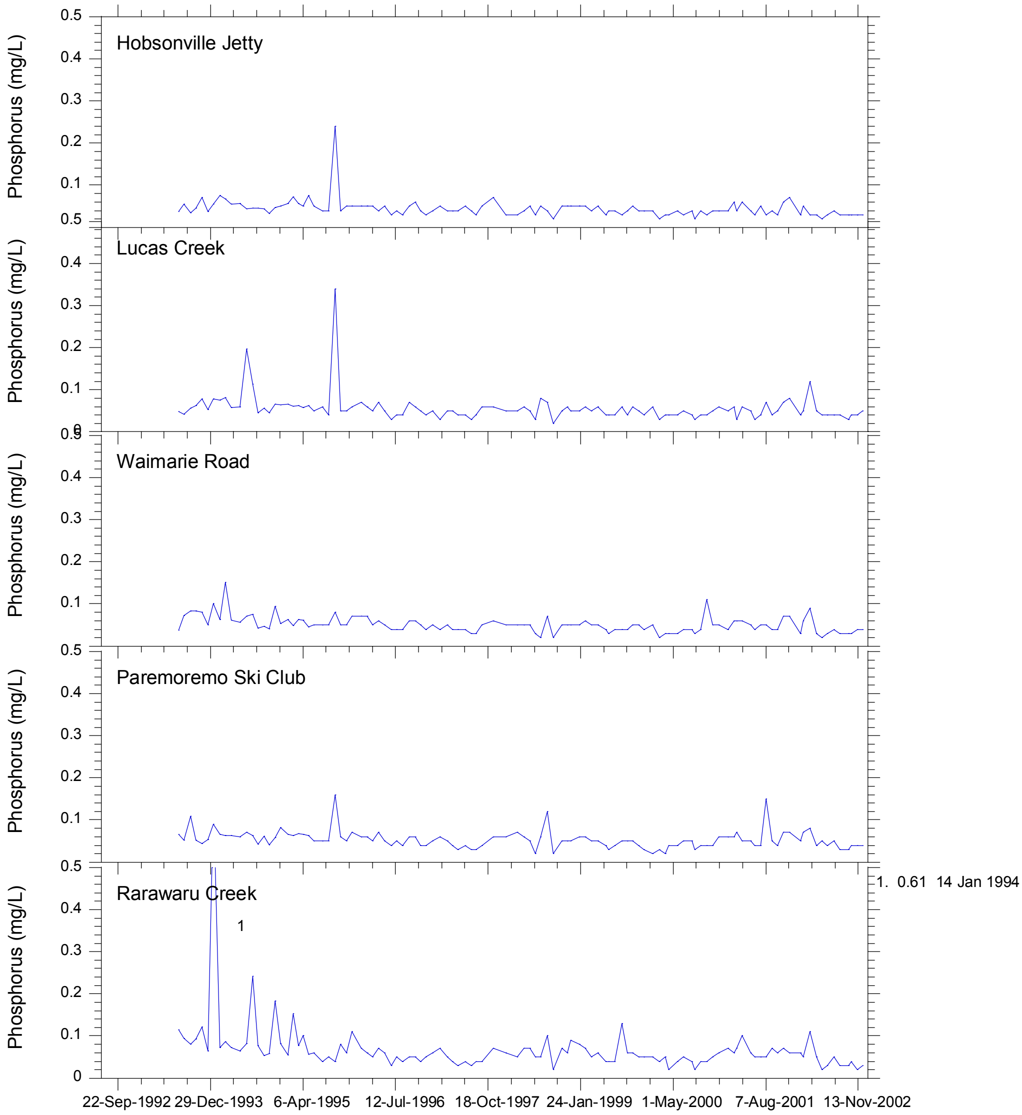

Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
DRP (mg/L)
0.2
0.15
0.1
0.05
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

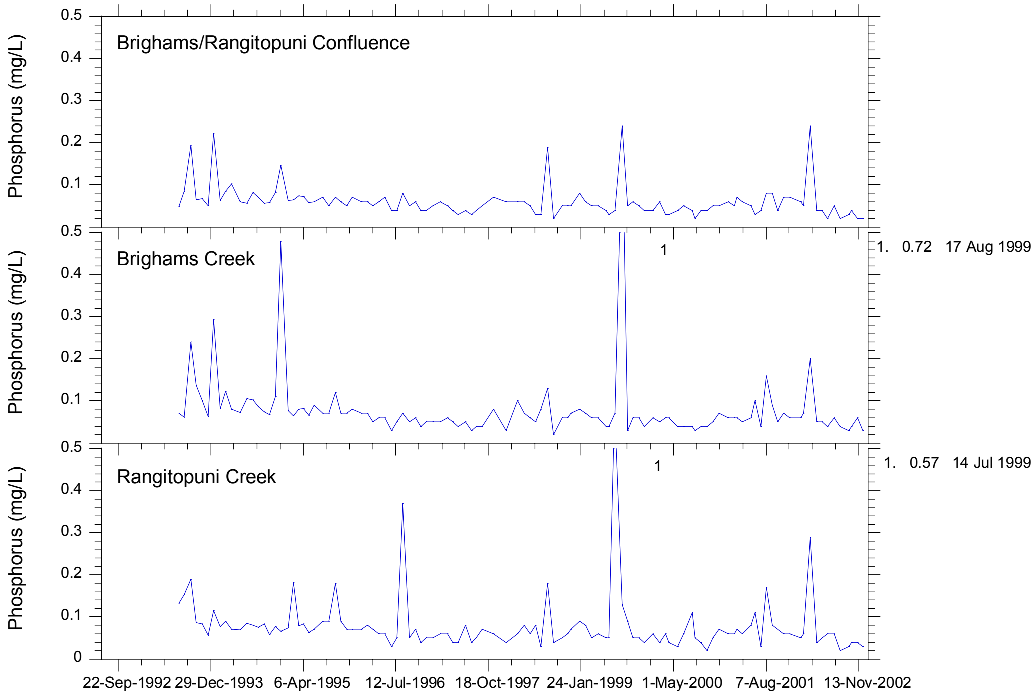
APPENDIX 58: UPPER WAITEMATA HARBOUR – TOTAL PHOSPHORUS

a) Total phosphorus (mg/L) during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	0.03	0.04	0.03	0.05	0.05	0.06	0.06	0.05
12-Feb-2002	0.05	0.05	0.06	0.07	0.06	0.05	0.07	0.06
15-Mar-2002	0.03	0.12	0.09	0.08	0.29	0.24	0.20	0.29
17-Apr-2002	0.03	0.05	0.03	0.04	0.04	0.04	0.05	0.04
16-May-2002	0.02	0.04	0.02	0.05	0.05	0.04	0.05	0.05
12-Jun-2002	0.03	0.04	0.03	0.04	0.06	0.02	0.04	0.06
16-Jul-2002	0.04	0.04	0.04	0.05	0.06	0.05	0.06	0.06
12-Aug-2002	0.03	0.04	0.03	0.03	0.02	0.02	0.04	0.02
26-Sep-2002	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
9-Oct-2002	0.03	0.04	0.03	0.04	0.04	0.04	0.04	0.04
7-Nov-2002	0.03	0.04	0.04	0.04	0.04	0.02	0.06	0.04
6-Dec-2002	0.03	0.05	0.04	0.04	0.03	0.02	0.03	0.03
Median	0.03	0.04	0.03	0.04	0.05	0.04	0.05	0.05
IQR/Median %	0	25	33	25	50	75	40	50

b) The graphs on the following pages show total phosphorus measurements from 1993 to December 2002 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Phosphorus (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
1. 0.61 14 Jan 1994
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002



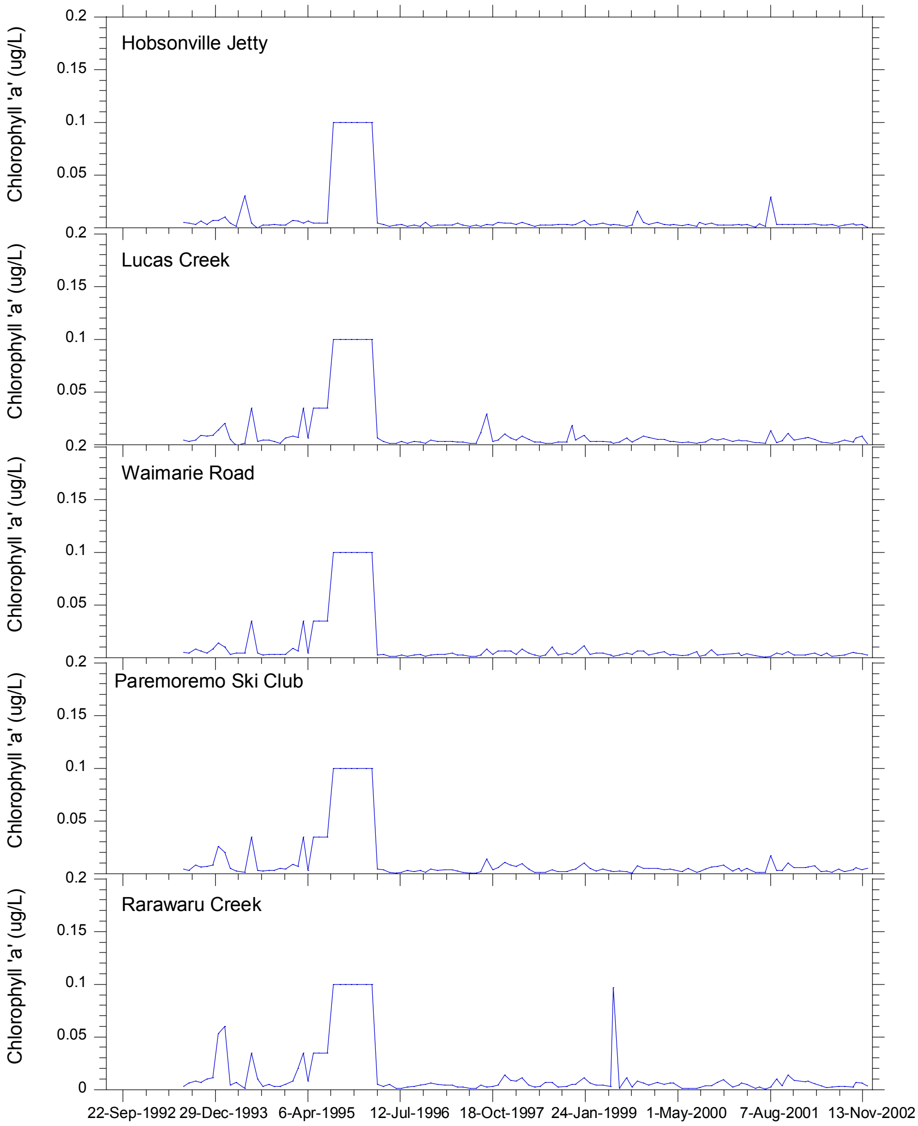
Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Phosphorus (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
1. 0.72 17 Aug 1999
1. 0.57 14 Jul 1999
22-Sep-1992 29-Dec-1993 6-Apr-1995 12-Jul-1996 18-Oct-1997 24-Jan-1999 1-May-2000 7-Aug-2001 13-Nov-2002

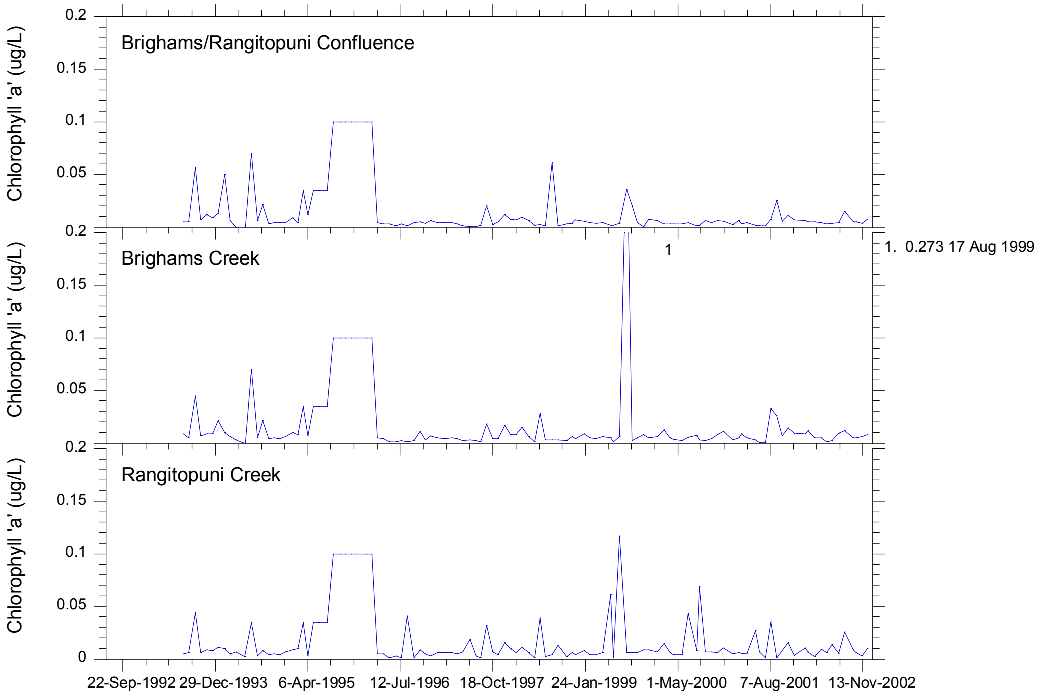
APPENDIX 59: UPPER WAITEMATA HARBOUR – CHLOROPHYLL *a*

a) Chlorophyll *a* (mg/L) during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	0.0029	0.0059	0.0024	0.0057	0.0073	0.0060	0.0090	0.0103
12-Feb-2002	0.0027	0.0069	0.0028	0.0060	0.0078	0.0049	0.0119	0.0069
15-Mar-2002	0.0038	0.0047	0.0046	0.0072	0.0056	0.0049	0.0050	0.0024
17-Apr-2002	0.0020	0.0025	0.0015	0.0019	0.0038	0.0043	0.0049	0.0094
16-May-2002	0.0026	0.0018	0.0046	0.0021	0.0016	0.0028	0.0013	0.0062
12-Jun-2002	0.0027	0.0012	0.0014	0.0009	0.0025	0.0035	0.0024	0.0137
16-Jul-2002	0.0009	0.0022	0.0017	0.0042	0.0033	0.0043	0.0093	0.0056
12-Aug-2002	0.0020	0.0044	0.0021	0.0018	0.0028	0.0150	0.0122	0.0256
26-Sep-2002	0.0035	0.0026	0.0052	0.0037	0.0026	0.0050	0.0051	0.0086
9-Oct-2002	0.0026	0.0060	0.0044	0.0055	0.0067	0.0052	0.0049	0.0060
7-Nov-2002	0.0033	0.0082	0.0036	0.0034	0.0060	0.0036	0.0059	0.0028
6-Dec-2002	0.0008	0.0009	0.0026	0.0047	0.0039	0.0072	0.0083	0.0098
Median	0.0027	0.0035	0.0027	0.0040	0.0039	0.0049	0.0055	0.0078
IQR/Median %	38	109	91	89	89	26	76	52

b) The graphs on the following pages show total chlorophyll *a* measurements from 1993 to December 2002 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Chlorophyll 'a' (ug/L)
0.2
0.15
0.1
0.05
0
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002


Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Chlorophyll 'a' (ug/L)
0
0.05
0.1
0.15
0.2
1
1. 0.273 17 Aug 1999
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

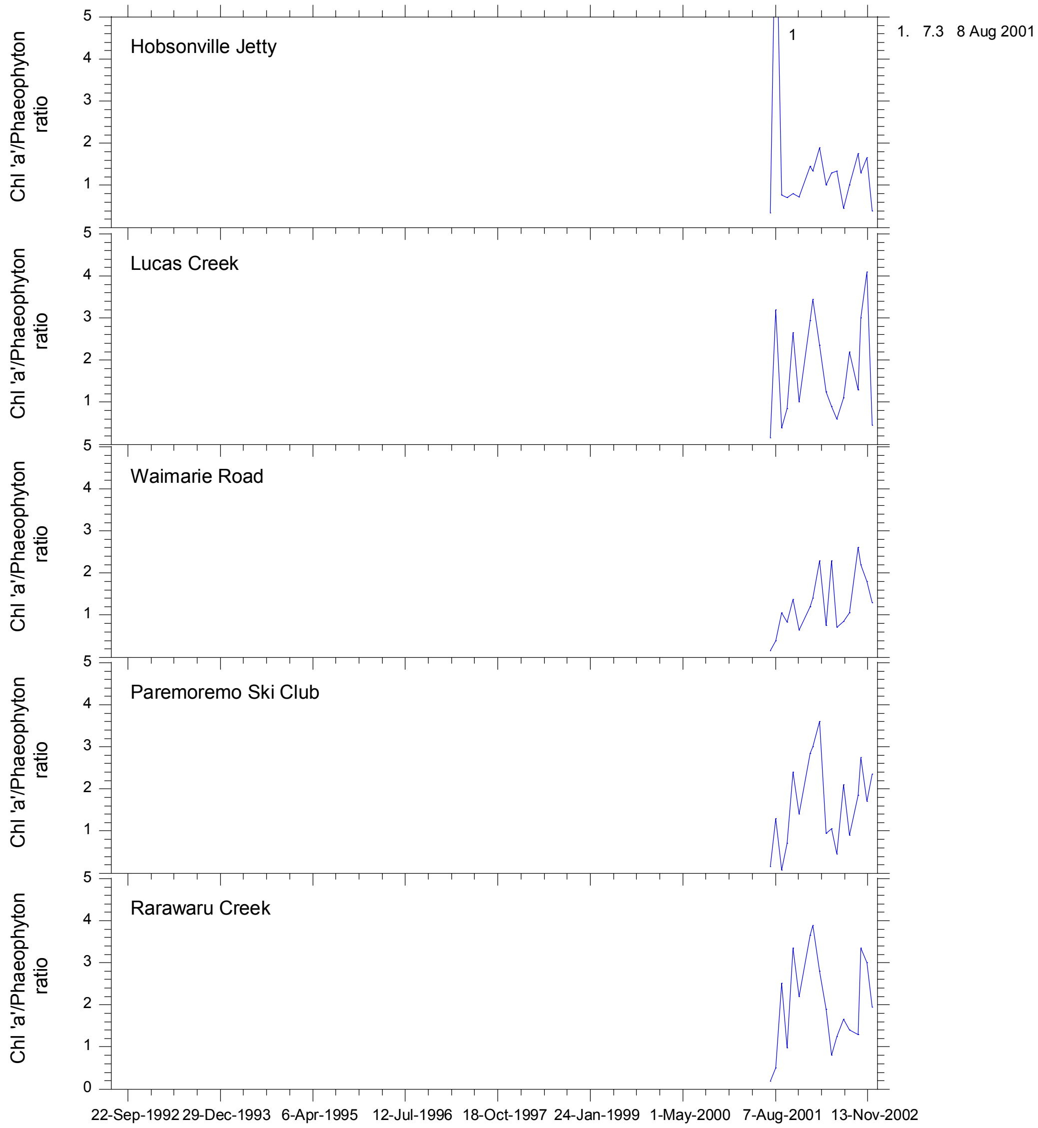
APPENDIX 60: UPPER WAITEMATA HARBOUR – CHLOROPHYLL/PHAEOPHYTON RATIO

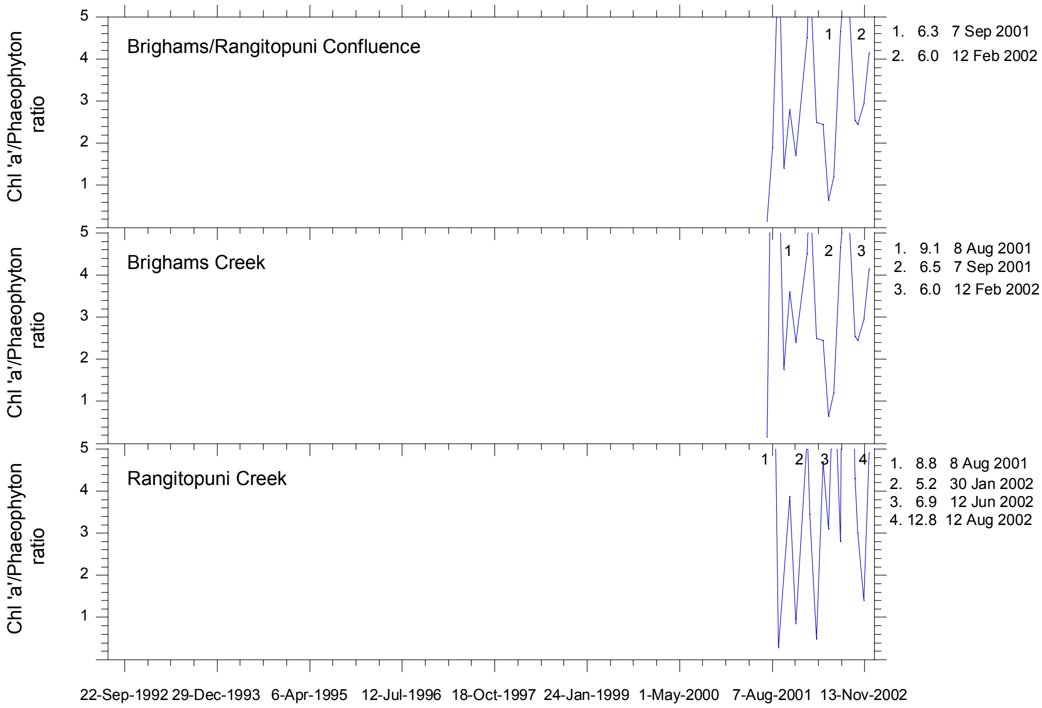
a) Chlorophyll/phaeophyton ratio during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	0.72	1.48	0.60	1.42	1.82	1.50	2.25	2.58
12-Feb-2002	0.68	1.72	0.70	1.50	1.95	1.22	2.98	1.72
15-Mar-2002	0.95	1.18	1.15	1.80	1.40	1.22	1.25	0.48
17-Apr-2002	0.50	0.63	0.38	0.48	0.95	1.10	1.20	2.40
16-May-2002	0.65	0.45	1.15	0.52	0.40	0.70	0.32	1.55
12-Jun-2002	0.68	0.30	0.35	0.23	0.63	0.88	0.60	3.43
16-Jul-2002	0.22	0.55	0.42	1.05	0.82	1.08	0.32	1.40
12-Aug-2002	0.50	1.10	0.53	0.45	0.70	3.75	3.05	6.40
26-Sep-2002	0.65	1.50	1.10	1.38	1.68	1.30	1.23	1.50
9-Oct-2002	0.88	0.65	1.30	0.93	0.65	1.25	1.28	2.15
7-Nov-2002	0.80	2.10	0.90	0.90	1.50	0.90	1.50	0.70
6-Dec-2002	0.20	0.20	0.70	1.20	1.00	1.80	2.10	2.50
Median	0.67	0.88	0.70	0.99	0.98	1.22	1.27	1.94
IQR/Median %	36	110	87	89	88	26	86	54

NB: Values reported as greater than a nominal value are given that value in this table (e.g., >1.0 is given a value of 1.0)

b) The graphs on the following pages show total chlorophyll/phaeophyton ratio measurements from 1993 to December 2002 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Chl 'a'/Phaeophyton ratio
1. 7.3 8 Aug 2001
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002



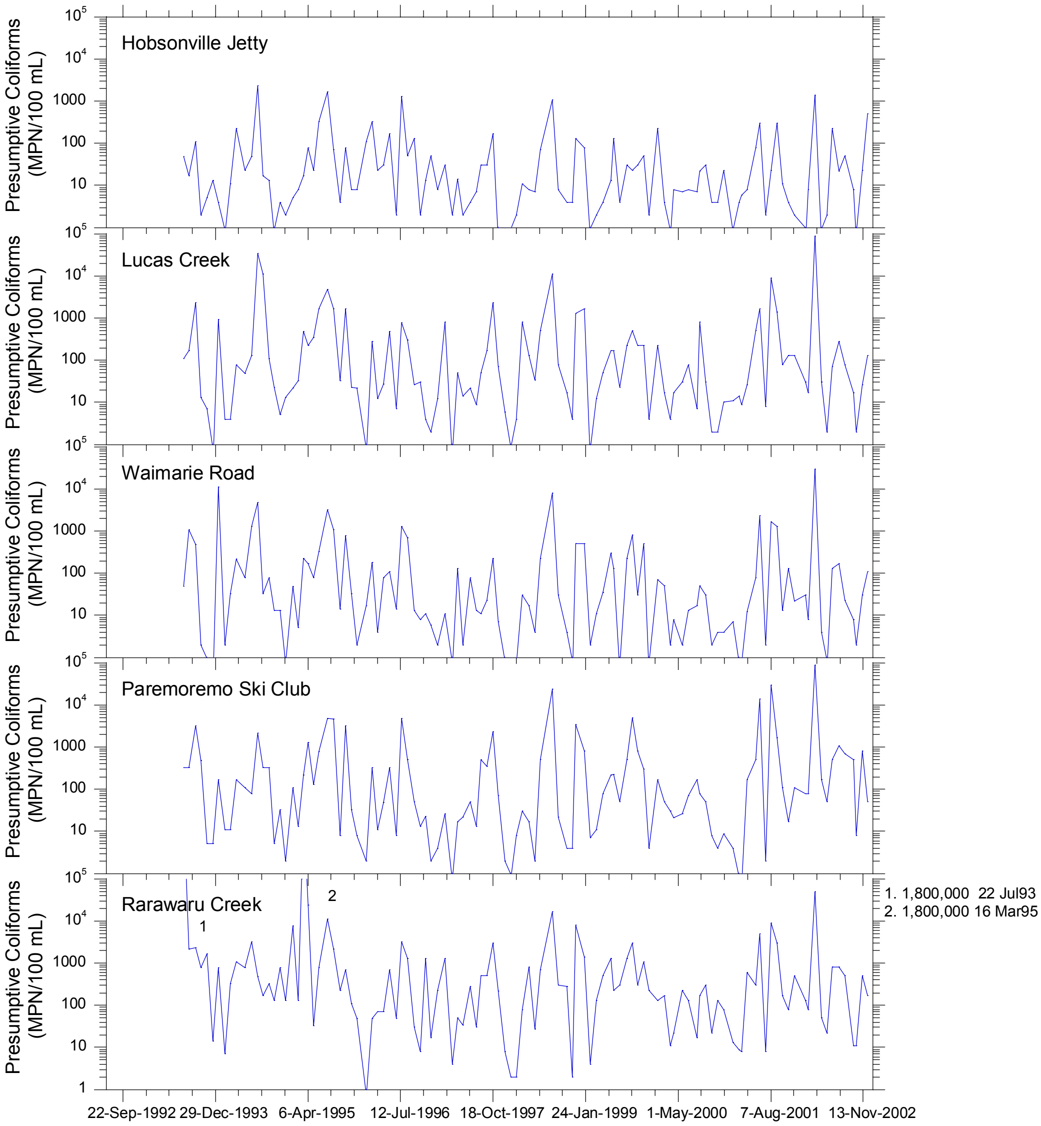
Chl 'a'/Phaeophyton ratio
Brighams/Rangitopuni Confluence
1. 6.3 7 Sep 2001
2. 6.0 12 Feb 2002
Brighams Creek
1. 9.1 8 Aug 2001
2. 6.5 7 Sep 2001
3. 6.0 12 Feb 2002
Rangitopuni Creek
1. 8.8 8 Aug 2001
2. 5.2 30 Jan 2002
3. 6.9 12 Jun 2002
4. 12.8 12 Aug 2002
22-Sep-1992 29-Dec-1993 6-Apr-1995 12-Jul-1996 18-Oct-1997 24-Jan-1999 1-May-2000 7-Aug-2001 13-Nov-2002

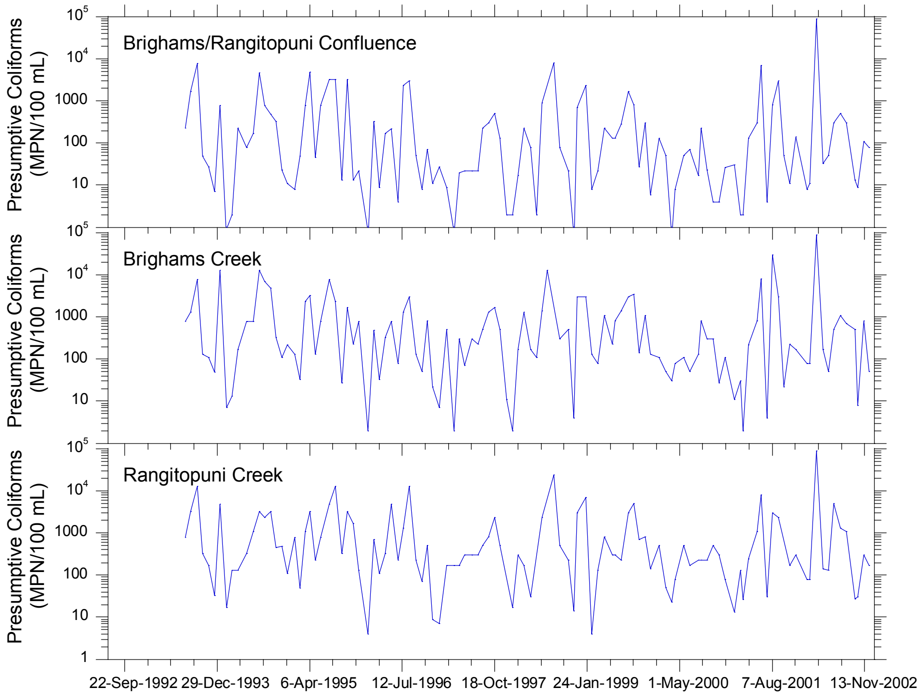
APPENDIX 61: UPPER WAITEMATA HARBOUR – PRESUMPTIVE COLIFORM

a) Presumptive coliform (MPN/100 mL) during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	1	30	30	23	130	8	80	80
12-Feb-2002	8	17	8	50	80	11	80	80
15-Mar-2002	1400	90000	30000	24000	50000	90000	90000	90000
17-Apr-2002	1	30	4	7	50	33	170	140
16-May-2002	2	2	1	8	22	50	50	130
12-Jun-2002	230	70	130	110	800	300	500	5000
16-Jul-2002	22	280	170	1700	800	500	1100	1300
12-Aug-2002	50	80	23	230	500	300	700	1100
26-Sep-2002	8	17	8	130	11	13	500	27
9-Oct-2002	1	2	2	4	11	9	8	30
7-Nov-2002	23	26	30	50	500	110	800	300
6-Dec-2002	500	130	110	30	170	80	50	170
Median	15	30	27	50	150	65	335	155
IQR/Median %	622	252	408	272	355	442	195	690

b) The graphs on the following pages show presumptive coliform measurements from 1993 to December 2002 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Presumptive Coliforms (MPN/100 mL)
10^5
10^4
1000
100
10
1
1
2
1. 1,800,000 22 Jul93
2. 1,800,000 16 Mar95
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002



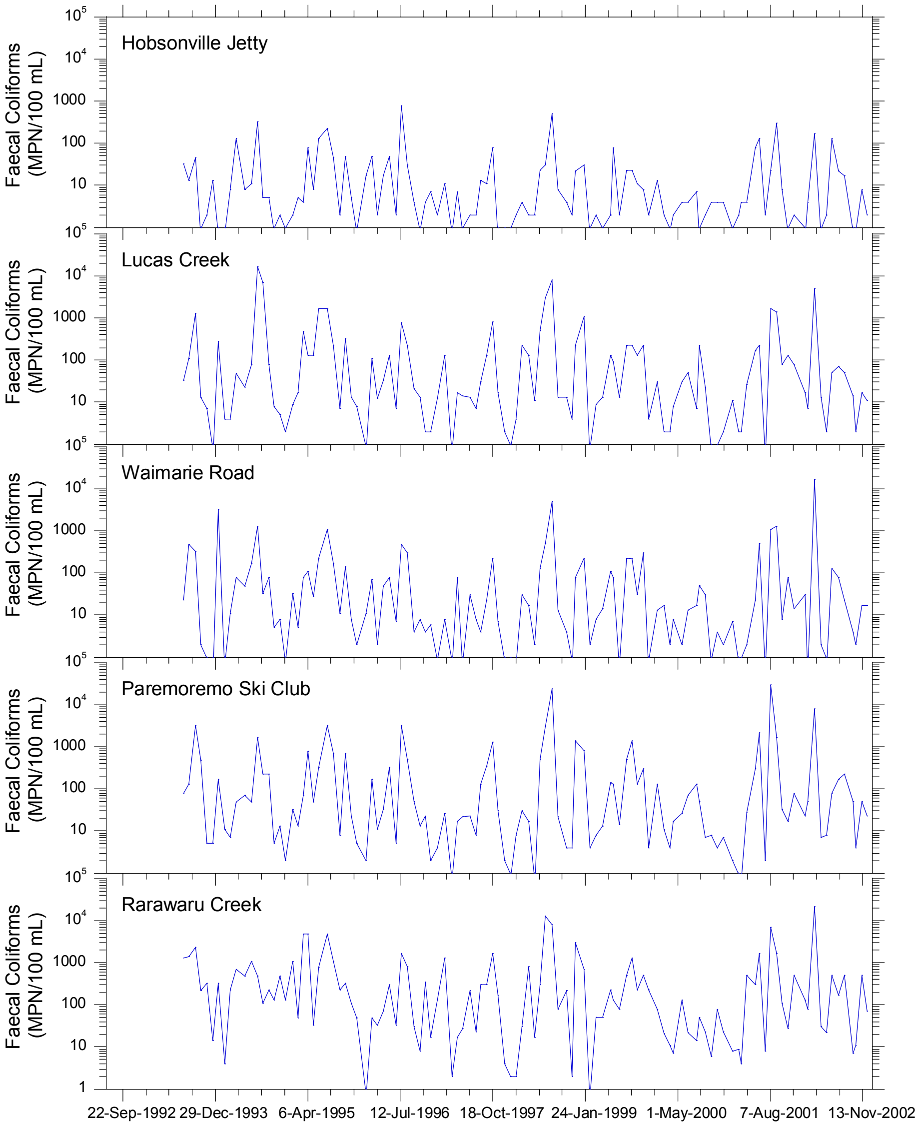
Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Presumptive Coliforms (MPN/100 mL)
10^5
10^4
1000
100
10
1
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

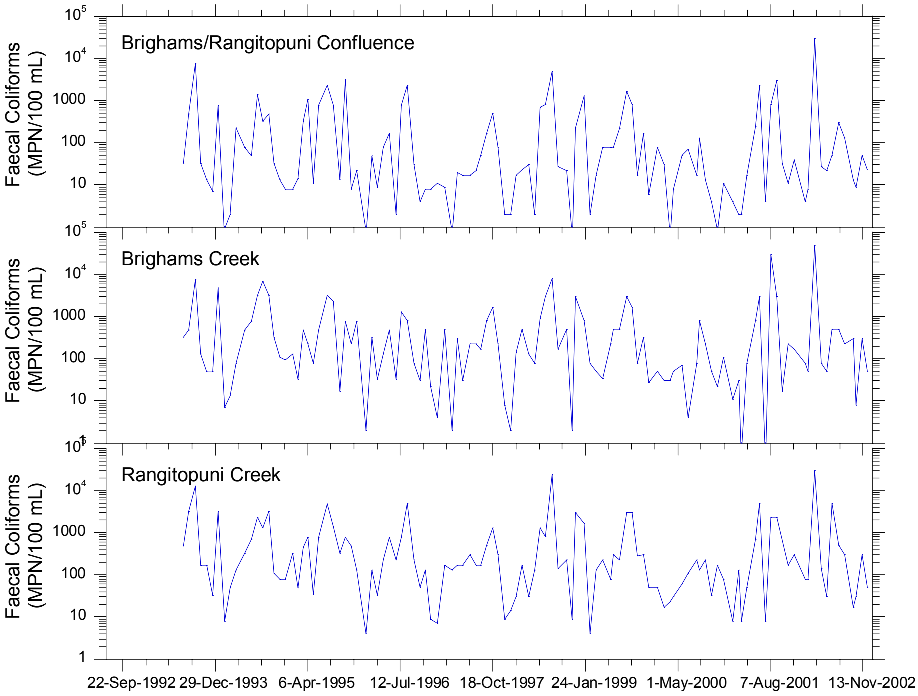
APPENDIX 62: UPPER WAITEMATA HARBOUR – FAECAL COLIFORM

a) Faecal coliform (MPN/100 mL) during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	1	17	30	23	130	4	80	80
12-Feb-2002	4	7	1	50	80	8	50	80
15-Mar-2002	170	5000	17000	8000	22000	30000	50000	30000
17-Apr-2002	1	13	2	7	30	27	80	140
16-May-2002	2	2	1	8	22	22	50	30
12-Jun-2002	130	50	130	80	500	50	500	5000
16-Jul-2002	22	70	80	170	170	300	500	500
12-Aug-2002	17	50	23	230	500	130	230	300
26-Sep-2002	1	14	4	50	7	13	300	17
9-Oct-2002	1	2	2	4	11	9	8	30
7-Nov-2002	8	17	17	50	500	50	300	300
6-Dec-2002	2	11	17	23	70	23	50	50
Median	3	16	17	50	105	25	155	110
IQR/Median %	575	258	238	167	450	232	194	277

b) The graphs on the following pages show faecal coliform measurements from 1993 to December 2002 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Faecal Coliforms (MPN/100 mL)
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

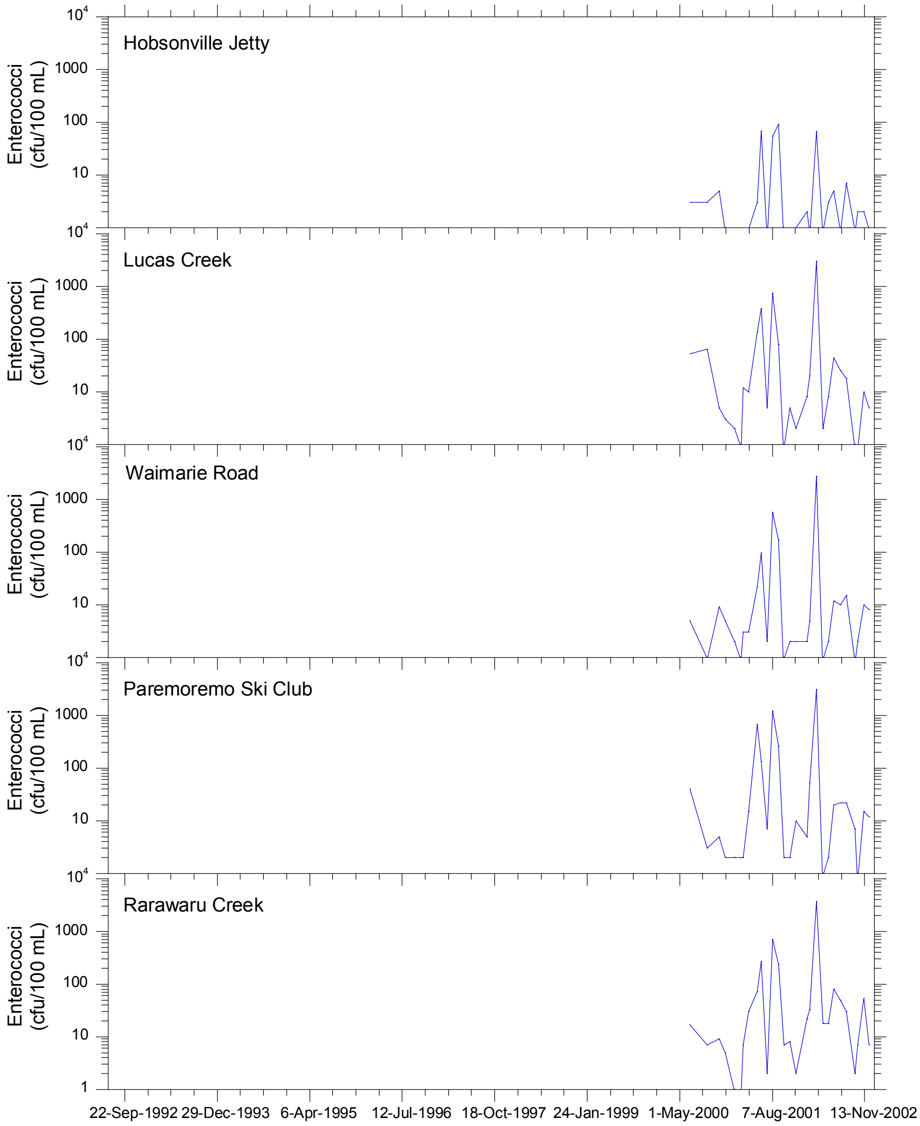

Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Faecal Coliforms (MPN/100 mL)
1
10
100
1000
10^4
10^5
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

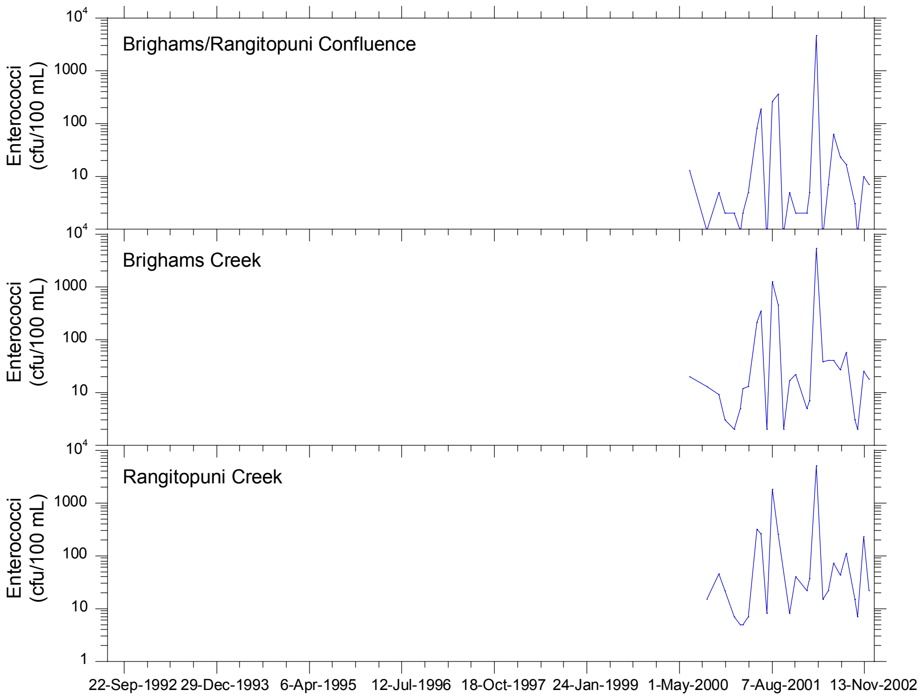
APPENDIX 63: UPPER WAITEMATA HARBOUR – ENTEROCOCCI

a) Enterococci (cfu/100 mL) during January 2002 - December 2002

	Hobsonville Jetty	Lucas Creek	Waimarie Road	Paremoremo Ski Club	Rarawaru Creek	Brighams/Rangitopuni confluence	Brighams Creek	Rangitopuni Creek
30-Jan-2002	2	8	2	5	22	2	5	22
12-Feb-2002	1	20	5	52	33	5	7	37
15-Mar-2002	66	3000	2800	3100	3700	4700	5400	5100
17-Apr-2002	1	2	1	1	18	1	38	15
16-May-2002	3	8	2	2	18	7	40	22
12-Jun-2002	5	44	12	20	82	62	40	72
16-Jul-2002	1	25	10	22	50	23	27	42
12-Aug-2002	7	18	15	22	30	17	58	112
26-Sep-2002	1	1	1	7	2	3	3	15
9-Oct-2002	2	1	2	1	7	1	2	7
7-Nov-2002	2	10	10	15	54	10	25	230
6-Dec-2002	1	5	8	12	7	7	18	22
Median	2	9	7	14	26	7	26	30
IQR/Median %	125	189	131	131	138	225	129	209

b) The graphs on the following pages show enterococci measurements from 1993 to December 2002 (where data available).


Hobsonville Jetty
Lucas Creek
Waimarie Road
Paremoremo Ski Club
Rarawaru Creek
Enterococci (cfu/100 mL)
10^4
1000
100
10
1
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002


Brighams/Rangitopuni Confluence
Brighams Creek
Rangitopuni Creek
Enterococci (cfu/100 mL)
10^4
1000
100
10
1
22-Sep-1992
29-Dec-1993
6-Apr-1995
12-Jul-1996
18-Oct-1997
24-Jan-1999
1-May-2000
7-Aug-2001
13-Nov-2002

APPENDIX 64: 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 that are differentiated by their ability to ferment lactose with the production of acid and gas at the elevated temperature of 44.5°C. This group are more specific indicators of faecal contamination than the coliform group, although the functional definition still includes some organisms that are natural inhabitants of soil and decaying vegetation. The use of the term "faecal" in the group description is therefore somewhat misleading, and has lead to the use of the term "thermotolerant coliforms" as an alternative group name.

Faecal coliforms have historically been the indicator of choice for assessment of the sanitary quality of natural waters and have formed the basis of the previous microbiological guidelines for recreation and shellfish growing waters. However, studies undertaken on behalf of the United States Environmental Protection Agency (USEPA) comparing indicator levels with health effects have indicated that enterococci (see later) provide a much better index of health risk than faecal coliforms. The USEPA have subsequently developed enterococci guidelines for health risk monitoring of recreational water quality in the USA. These guidelines have been used to form the basis of New Zealand's provisional guidelines for recreational water quality monitoring. For further information on this topic refer to the "Recreational Water Quality Guidelines" published by Ministry for the Environment and Ministry of Health, Wellington, November 1999.

However, despite this the faecal coliform group is still considered appropriate for qualitative monitoring of faecal contamination in natural waters, and for assessment of long terms trends in water quality over time. It is in this context that the indicators are used in the baseline water quality studies. The only major impediment to this use is the inability to discriminate between contamination of human and non-human origin. Such assessments must be made on the basis of subjective evaluation of likely sources and routes of contamination within the catchment.

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. faecalils* 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.

Ammonia toxicity for given pH and temperature combination 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, 1985).

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, 1985). 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).