BATHING WATER QUALITY MONITORING PROGRAMME 2003

Report on physico-chemical monitoring

Environment Protection Directorate

Malta Environment and Planning Authority

INTRODUCTION:

As a Contracting Party to the Barcelona Convention, Malta is bound to carry out testing of bathing waters during the designated bathing season, namely mid-May to mid-October, of every year. As an acceding country to the European Union, Malta will soon be bound to implement and comply with the Bathing Water Directive (CD 76/160/EEC). The Directive has been transposed as L.N. 380 of 2003 and is yet to enter into force. This legislation lists a number of parameters (both microbiological and physico-chemical) that must be monitored and complied with.

The bathing water monitoring program is carried out jointly between the Department of Public Health within the Ministry of Health (who carries out monitoring of microbiological parameters) and the Environment Protection Directorate within the Malta Environment and Planning Authority (who carries out monitoring of physico-chemical parameters).

The present report contains results of tests that have been carried out on samples gathered around the Maltese Islands during the official bathing season. The Malta National Laboratory (MNL) carried out all the laboratory analysis mentioned in the document.

FREQENCY AND METHODOLGY OF SAMPLE COLLECTION

Authorised Environmental Protection Inspectors carried out the sampling during the bathing season of 2003. The bathing water samples were collected between the 19th of May and the 15th October 2003. The site selection and grouping of the different coastal areas was the same one utilized by the Public Health Department, whereby the Maltese Islands were divided into 4 coastal zones:

Coastal Zone A	**Malta South**
Coastal Zone B	**Sliema**
Coastal Zone C	**Malta North**
Coastal Zone D	**Gozo and Comino**

The Coastal Zones consist of a total of 87 sites with a corresponding code out of which 43 had been designated as sampling points for physicochemical monitoring. Sampling was carried out once every fortnight at the selected sites and in accordance with the sampling protocols outlined in the WHO and MED POL.

The samples were collected from the sites during early morning from a depth of 0.3m and placed within autoclaved bottles. On certain occasions when the weather was rough, samples were not collected. There was one instance during the whole season where a sample was lost due to an accidentally broken bottle. The samples were tested for pH and Dissolved Oxygen on site. On some occasions, the Dissolved Oxygen probe was not functioning and results were not obtained.

The samples collected from 43 sites were analysed by MNL for the following parameters; detection limits as provided by MNL Co. Ltd., are listed on the right. (pH and Dissolved Oxygen measurement were taken by MEPA inspectors on site).

Parameter	Unit	Detection Limit
Colour	-	
Odour	-	
Mineral Oils	mg/l	1.400
Surface-active substances	mg/l	0.020
Phenols	mg/l	0.050
Ammonia	mg/l	0.260
Nitrogen Kjeldahl	mg/l	1.000
Heavy Metals - Arsenic	mg/l	0.235
Heavy Metals - Cadmium	mg/l	0.011
Heavy Metals - Chromium	mg/l	0.043
Heavy Metals - Lead	mg/l	0.212
Heavy Metals - Mercury	mg/l	0.081
Cyanides	mg/l	0.030
Nitrate N - A & B Coastal Zones	mg/l	0.260
Nitrate N - C & D Coastal Zones	mg/l	1.000
Phosphate P	mg/l	0.010

Table 1. Detection Limit Values per Parameter Tested at MNL

For some parameters, the legal notice sets both guideline and mandatory values. Guideline values are stricter than mandatory and are represented either as specific values or limits of variation.

The parameters that have both Guideline and Mandatory values are Mineral Oils, Surface-Active Substances, Transparency and Phenols. The parameters that have only Guideline values are Dissolved Oxygen and Tarry Residues, while the parameters that only have Mandatory values are pH and Colour. The parameters that neither have Guideline nor Mandatory values are Ammonia, Nitrogen Kjeldahl, Heavy Metals Cyanides, Nitrates and Phosphates.

Transparency, Tarry Residues and Pesticides were not tested for in this case.

SAMPLE ANALYSIS

Coastal Zone sites that have been selected for sampling are listed below. The corresponding names of the Coastal Zones can be found in Annex I. Samples were tested for pH, Dissolved Oxygen, Kjeldahl N, Ammonia N, Nitrate N and Phosphate P in all the 43 Coastal Zones.

Coastal Zone A	A3	A5	A7	A8	A9	A11	A12	A13	A15	A16	A17			
Coastal Zone B	B1A	B3	B4	B5	B6	B9	B11	B12	B13					
Coastal Zone C	C1	C3	C5	C6	C7	C9	C13	C17	C19	C20A	C23	C26	C28	C30	C32
Coastal Zone D	D2	D6	D7	D9	D10	D13	D15	D17						

Table 2. Samples Tested for Physicochemical Parameters

As regards Oil and Grease, Anionic Surfactants, Phenols, Heavy Metals (namely arsenic, cadmium, chromium, lead, and mercury) and Cyanides, these parameters were analysed only in the 10 samples highlighted in the table above. These samples were chosen for the full complement of tests based on their being more influenced by land-based sources of pollution.

RESULTS – THEIR GRAPHICAL REPRESENTATION AND ANALYSIS

Averages of the values of the sample points for the four coastal zones were taken per day. The results were plotted in the graphs below. Two sets were composed:

1. Average Variation per Site
2. Average Temporal Variation per Site

The first set of variations attempted to compare the averages between sites to seek a correlation and to find out whether patters were reflected in neighbouring or all the surrounding sites. The averages are listed in Table 2 in temporal sequence. General comments on the tabulated results are given below together with further discussion of the graphs themselves.

Date	Coastal Zone	pH	DO	Oil & Grease mg/l	Anionic Surfactants mg/l	Ammonia N mg/l	Kjeldahl N mg/l	Nitrates mg/l	Phosphates mg/l
19-May-03	**A Coastal Zone**	N/A	N/A	4.78	0.09	0.39	3.26	0.36	0.01
21-May-03	**B Coastal Zone**	7.82	62	1.40	0.08	0.26	5.54	0.26	0.01
26-May-03	**C Coastal Zone**	7.79	70	1.97	0.18	0.50	1.24	3.95	0.02
28-May-03	**D Coastal Zone**	7.89	69	1.40	0.08	0.26	1.00	1.00	0.03
02-Jun-03	**A Coastal Zone**	7.86	74	2.18	0.13	0.26	1.72	0.70	2.53
04-Jun-03	**B Coastal Zone**	7.89	72	1.80	0.10	0.26	1.58	0.26	0.02
09-Jun-03	**C Coastal Zone**	7.72	62	1.40	0.06	0.28	1.86	2.40	0.40
11-Jun-03	**D Coastal Zone**	7.86	58	4.55	0.02	0.26	1.98	2.49	0.03
16-Jun-03	**A Coastal Zone**	7.70	83	3.35	0.17	0.26	2.15	0.67	0.01
18-Jun-03	**B Coastal Zone**	7.71	61	1.70	0.20	0.26	1.84	0.26	0.02
23-Jun-03	**C Coastal Zone**	7.89	N/A	2.93	0.13	0.26	1.47	1.75	0.01
***25-Jun-03**	**D Coastal Zone**	7.65	N/A	N/A	N/A	N/A	N/A	N/A	N/A
30-Jun-03	**A Coastal Zone**	7.75	83	4.50	0.07	0.26	1.64	0.78	0.01
02-Jul-03	**B Coastal Zone**	7.85	41	1.40	0.06	0.38	3.07	0.26	0.01
07-Jul-03	**C Coastal Zone**	7.77	N/A	1.73	0.14	0.28	1.99	1.44	0.02
09-Jul-03	**D Coastal Zone**	7.83	N/A	1.40	0.22	0.92	1.79	1.43	0.01
14-Jul-03	**A Coastal Zone**	7.99	50	4.18	0.12	0.33	1.24	0.33	0.01
16-Jul-03	**B Coastal Zone**	7.71	48	1.40	0.07	0.50	1.70	0.43	0.02
21-Jul-03	**C Coastal Zone**	7.86	63	4.27	0.13	0.26	1.09	1.00	0.01
23-Jul-03	**D Coastal Zone**	7.87	55	1.40	0.25	0.26	1.00	1.00	0.01
28-Jul-03	**A Coastal Zone**	7.93	N/A	4.08	0.23	0.26	1.22	0.57	0.01
30-Jul-03	**B Coastal Zone**	7.81	58	13.60	0.12	0.97	1.09	0.38	0.01
04-Aug-03	**C Coastal Zone**	7.93	58	3.73	0.20	0.26	1.00	1.28	0.01
06-Aug-03	**D Coastal Zone**	8.05	57	1.40	0.20	0.35	1.00	1.00	0.01
18-Aug-03	**A Coastal Zone**	N/A	50	1.80	0.17	0.26	1.00	0.26	0.02
20-Aug-03	**B Coastal Zone**	N/A	N/A	1.40	0.30	0.26	1.00	0.26	0.01
25-Aug-03	**C Coastal Zone**	7.86	N/A	5.10	0.18	0.31	1.00	1.00	0.01
27-Aug-03	**D Coastal Zone**	7.92	71	1.40	0.17	0.26	1.00	1.00	0.01
01-Sep-03	**A Coastal Zone**	7.90	63	2.98	0.14	0.26	1.00	0.26	0.01
03-Sep-03	**B Coastal Zone**	7.90	69	6.70	0.40	0.27	2.68	0.27	0.01
09-Sep-03	**C Coastal Zone**	7.99	67	1.40	0.14	0.26	1.19	1.00	0.02
10-Sep-03	**D Coastal Zone**	7.90	76	1.80	0.14	0.28	1.09	1.24	0.02
16-Sep-03	**A Coastal Zone**	7.78	65	3.33	0.16	0.26	2.59	0.26	0.01
17-Sep-03	**B Coastal Zone**	7.95	85	2.90	0.13	0.26	1.47	0.26	0.02
22-Sep-03	**C Coastal Zone**	7.94	69	1.40	0.39	0.26	1.00	2.19	0.01
24-Sep-03	**D Coastal Zone**	8.05	76	1.40	0.17	0.26	1.00	1.90	0.01
29-Sep-03	**A Coastal Zone**	7.93	78	1.40	0.15	0.26	1.15	0.26	0.02
01-Oct-03	**B Coastal Zone**	7.91	71	4.00	0.22	0.26	2.02	0.26	0.01
06-Oct-03	**C Coastal Zone**	7.97	83	1.60	0.15	0.26	1.03	1.00	0.02
08-Oct-03	**D Coastal Zone**	7.98	69	1.40	0.15	0.26	1.64	1.00	0.05
13-Oct-03	**A Coastal Zone**	8.00	80	5.05	0.08	0.26	1.50	0.26	0.02
14-Oct-03	**B Coastal Zone**	7.98	71	N/A	N/A	0.27	1.40	0.27	0.02

Table 3. Averages of the parameters measured for each Coastal Zone on each sampling date

*No available results

1. pH

The values of pH vary between 7.2 and 8.4 thus lying well in between the specified range of 6 – 9.

- Coastal Zone A - Kept a narrow range of 7.5 – 8.1
- Coastal Zone B - The pH varied between 7.38 and 8.22.
- Coastal Zone C – Ranged from pH 7.4 – 8.1
- Coastal Zone D - Had the largest variation between 7.2 and 8.4. There were instances where the pH was recorded with a 0.6 difference (D15 – Ramla, Xaghra side - 25th June), but the pH value was still within range.

2. Colour

All samples were generally colour-free. There was an instance where the water was murky in mid-September. This followed a heavy rainstorm on September the 15th, and thus the instance can be explained. Another indication of colour was recorded on the 4th of August at C32, though this was not present in any other sample. No reason could be given for this

3. Olfactory

No odour was detected during the bathing season in the samples taken except for site A13 on the 19th May and 14th July where a slight smell of diesel was identified.

4. Mineral & Oils (Oil & Grease) – Detection Limit 1.40mg/l

The results for the different locations varied greatly in the different Coastal Zones.

- Coastal Zone A - Oil and Grease varied between approximately 1.5 and 11.5mg. The sites with the largest values for oil & grease are in fact site A5 and site A9. The values were 11.40mg/l on the 13th October and 10.00 mg/l on the 19th May respectively.
- Coastal Zone B - The values for site B1 as the only Coastal Zone B representative were usually below 7mg/l, though there was one instance when the value was 13.6mg/l on the 30th July 2003.
- Coastal Zone C - Most of the values varied between 1.5mg/l and 8.25mg/l, except for one instance in C19 whereby the value was 12.50mg/l on the 25th August.

- Coastal Zone D – has the lowest values between 1.5mg/l and 5mg/l. On most occasions the values were below 2mg/l. The peak values of 4mg/l and 5.5mg/l found in the sites D17 and D13 respectively occurred on the same day, being the 11th of June.

Oil & Grease (graph below) showed a number of variations in levels during the bathing season of 2003. There were peaks in Coastal Zone B (Sliema Area) on the 30th July and the 3rd September.

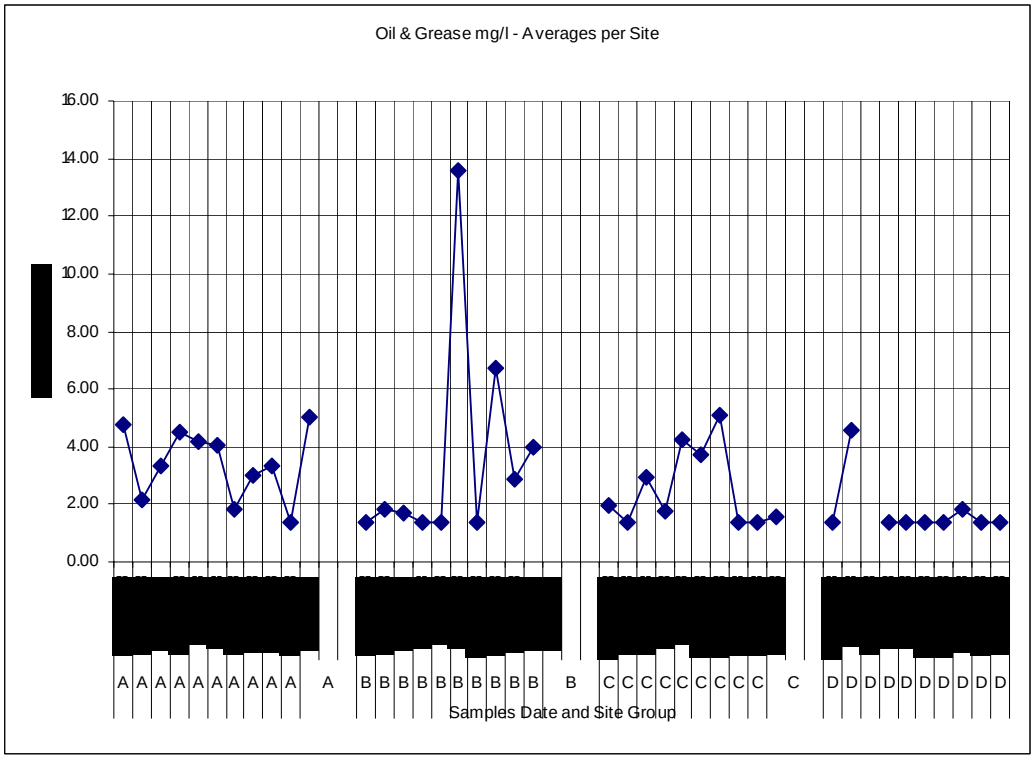


Figure 1. Average Oil & Grease mg/l Values per Site

5. Surface-Active Substances – Detection Limit 0.02mg/l

The values of surface-active substances varied between 0.02mg/l – 0.54mg/l.

- Coastal Zone A - Two peaks at the A5 and site A9 were recorded.
- Coastal Zone B - Most values were below 0.2mg/l. One value was recorded as 0.4mg/l on the 3rd September.
- Coastal Zone C - Had values generally below 0.3mg/l. One value was recorded at 0.54mg/l on the 22nd September, which was the highest value recorded in all the sites.
- Coastal Zone D - Site values varied between 0.02 and 0.25mg/l and were the lowest set of values recorded.

Anionic Surfactants (graph below) fluctuated regularly, though there was a peak on the 3rd September (same as oil & grease) in Coastal Zone B. A second peak occurred on the 22nd September, though this occurred in Coastal Zone C.

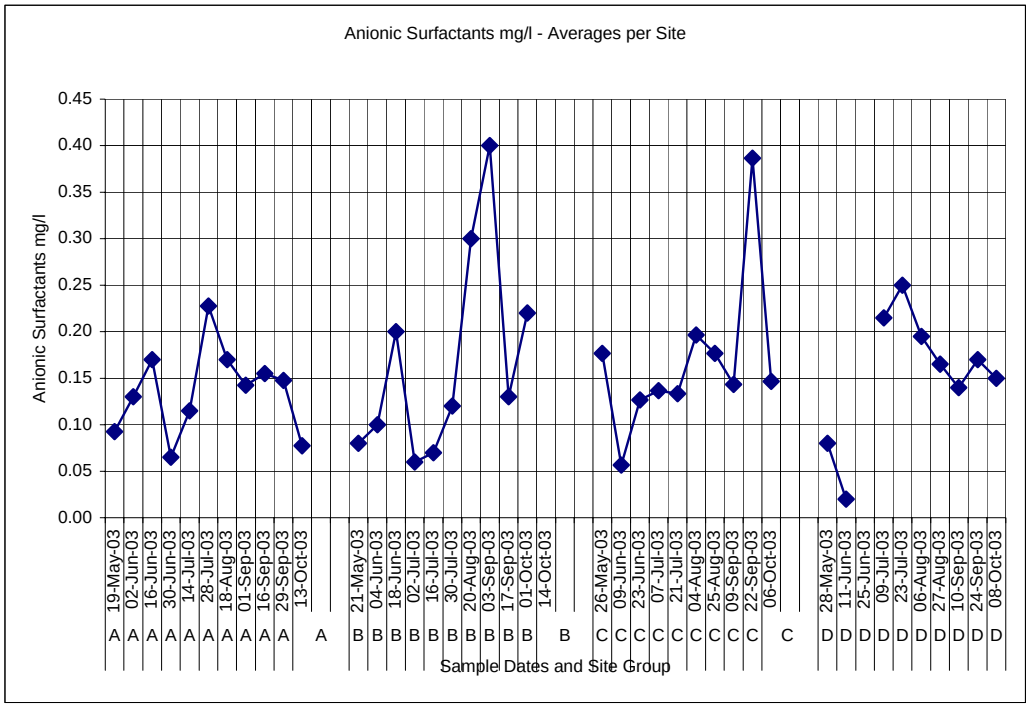


Figure 2. Average Anionic Surfactants mg/l Values per Site

6. Phenols –Detection Limit 0.05mg/l

The phenol values were all below detection limit.

7. Dissolved Oxygen - % Sat. Dissolved Oxygen

Testing for dissolved oxygen carried out on-site using a DO probe. This is not as specified in the Bathing Water Directive (76/160/EEC). The values for dissolved oxygen largely varied between 16 and 131. In some cases the DO meter was not functioning well, and it is most likely that this accounts for the sudden high peaks of DO. This occurred in Coastal Zones C, D and A respectively on the 23rd, 25th and 30th June.

- Coastal Zone A – Excluding the 30th June, when there was a possible erroneous reading of DO, the levels were recorded between 30% and 100%.
- Coastal Zone B – Values varied between 16% and 92%.

- Coastal Zone C – Values for this site, excluding those of the 23rd June, varied between 40%–100%.
- Coastal Zone D – Values for the site, excluding those of the 25th June, varied between 25%-90%.

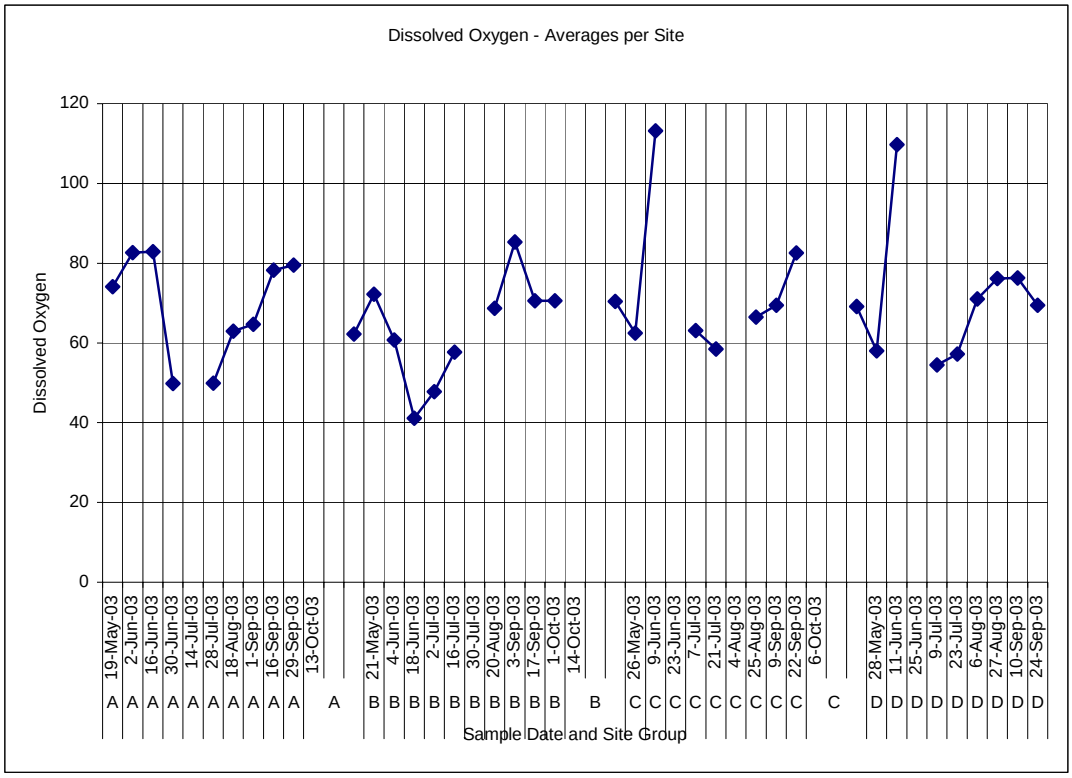


Figure 3. Average Dissolved Oxygen Values per Site

Dissolved Oxygen had rather low values throughout all Coastal Zones. This can be partially explained through the fact that DO was measured in very shallow waters in sometimes highly enclosed areas. The temperature of the water was relatively high, especially in very shallow waters, and this again decreases the dissolution of oxygen.

8. Ammonia N – Detection Limit 0.26mg/l

The values of ammonia N varied between 0.26mg/l and 3.9mg/l. Most of the values in all the Coastal Zones varied from 0.26mg/l to 1.5mg/l. A few localized outliers were present.

- Coastal Zone A – Levels in this Coastal Zone were usually below 0.75mg/l. One peak value in A3 was recorded at 1.7mg/l on the 19th May.

- Coastal Zone B – Most values were below detection limit. Some peaks were recorded in the B1 site and B6 site at values of around 1.4mg/l on the 2nd July and the 30th July respectively.
- Coastal Zone C – Most values were below 0.75mg/l throughout the season. In one instance the value for ammonia N reached 3.85mg/l on the 26th May at site C1.
- Coastal Zone D – Generally the values were below detection limit. Peaks were recorded on 3 instances on the 9th July at D7, D15 and D17. The values were: for D17 - 2.74mg/l, for D15 – 1.88mg/l and for D7 – 1.44mg/l. The second minor instance occurred on the 6th August in site D2 when levels increased from below a detection limit to 1.00mg/l.

9. Kjeldahl N – Detection Limit 1.00mg/l

The values for Kjeldahl N fluctuate for all sites, the least fluctuation occurring in the D Coastal Zone. Values were generally below 4mg/l, but there were instances where the amount was surpassed.

- In Coastal Zone A, the values fluctuated and kept below the value of 6mg/l.
- In Coastal Zone B, there was a similar fluctuation, although there were peaks on the 21st May in around half the sites.
- In Coastal Zone C, the values were all below 5mg/l. and there were slight peaks in some instances.
- In Coastal Zone D, the values were all below 4mg/l.

10. Phosphates – Detection Limit 0.01mg/l

Generally phosphates were below detection limit in all sites except for some instances.

- Coastal Zone A – Mostly values were below detection limit but high peaks were recorded on the 2nd June in all the A sites except A16 and A17.
- Coastal Zone B – Values were all below detection limit.
- Coastal Zone C – All values were below detection limit but a peak was noted on the 9th June at site C5 site.
- Coastal Zone D – All values were below detection limit.

11. Nitrates – Detection Limit Varies 0.26mg/l or 1.00mg/l

The nitrate levels in the coastal zones never exceeded 8mg/l.

- Coastal Zone A - There were peaks between June and July, the most prominent being in A5 with a peak at 4.79mg/l on the 16th June. Another major peak occurred on the 30th June in A3 with the highest value of Coastal Zone A with 5.09mg/l
- Coastal Zone B - The values never exceeded 1mg/l.
- Coastal Zone C, the values fluctuated heavily between the detection limit and 8mg/l. Peaks were recorded several times during the season, the highest record was on the 26th May in the C30 site, with a value of 7.88mg/l
- Coastal Zone D – The values for Coastal Zone D coincided with values in Coastal Zone C, such as the peaks on the 11th June, 9th July and 24th September.

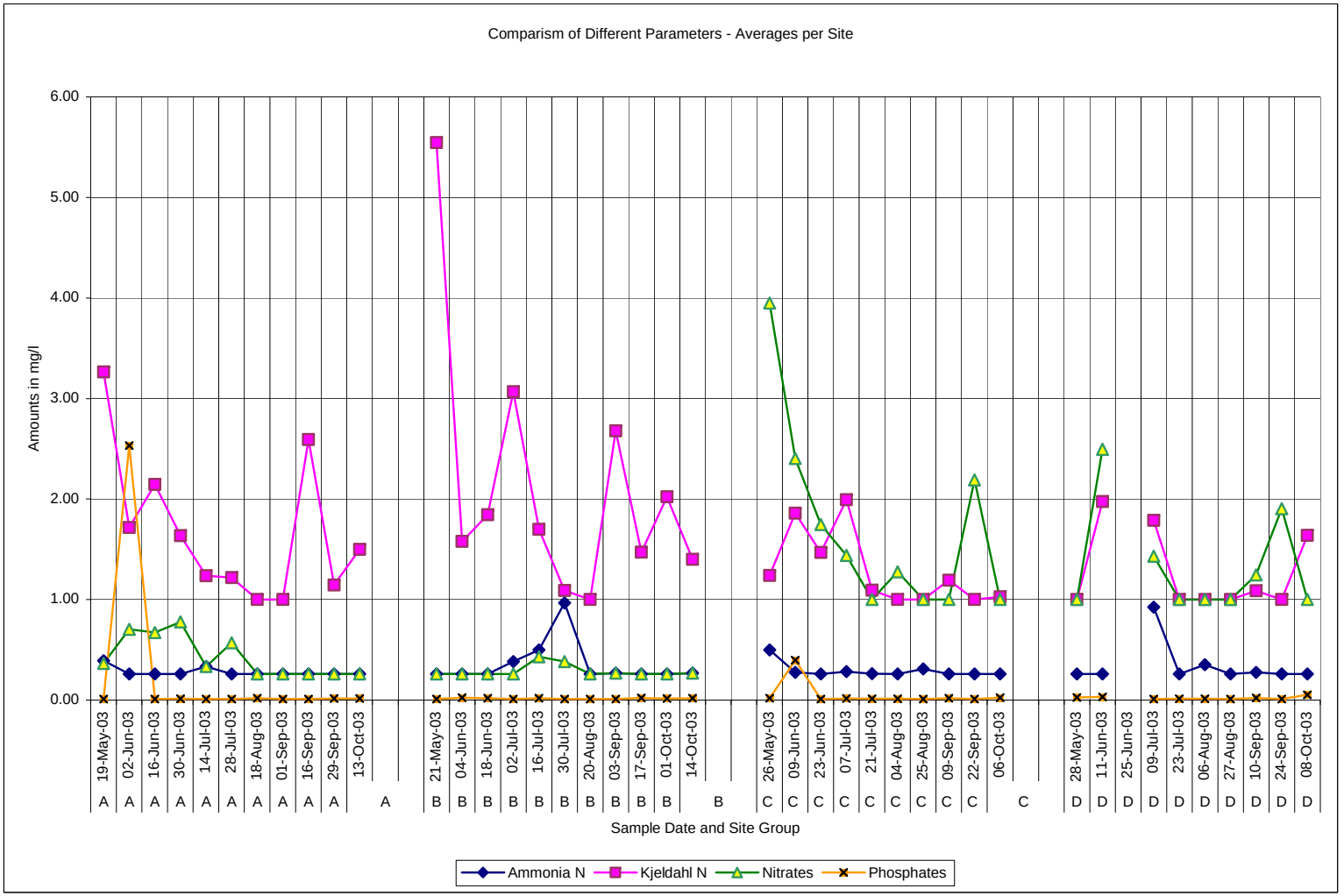


Figure 4. Average Parameter Variation mg/l Values per Site and Sample Date

A temporal average variation graph is plotted below and it can be noticed that some parameters fluctuated together. While phosphates remained low, with occasional peaks, the remaining three parameters (Kjeldahl N, Nitrate N and Ammonia N) reached higher values. Kjeldahl N and Nitrates in general peaked together. Ammonia peaked a few times with nitrate values, but was generally consistent in value.

Analysis of averages of Ammonia N, Kjeldahl N, Nitrates and Phosphates shows that peaks were prominent in May between the 19th and the 26th in all the Coastal Zones. Ammonia levels were quite low in all sites, never exceeding a value of 1 mg/l. Kjeldahl N values were high in Coastal Zone B and low in Coastal Zone D. Apparently the values varied consistently from Zone to Zone, this would be more visible in a temporal average graph where the Zones are sequenced according to sample date.

Nitrates were consistent within each Coastal Zone. The highest values were in Coastal Zone C (Malta North). There is a significant difference between Kjeldahl N and Nitrate values. Phosphates were rather low, either equal or a slightly larger to the detection limit. On one occasion in Coastal Zone A, there was a significant peak on 2nd June already mentioned in previous section.

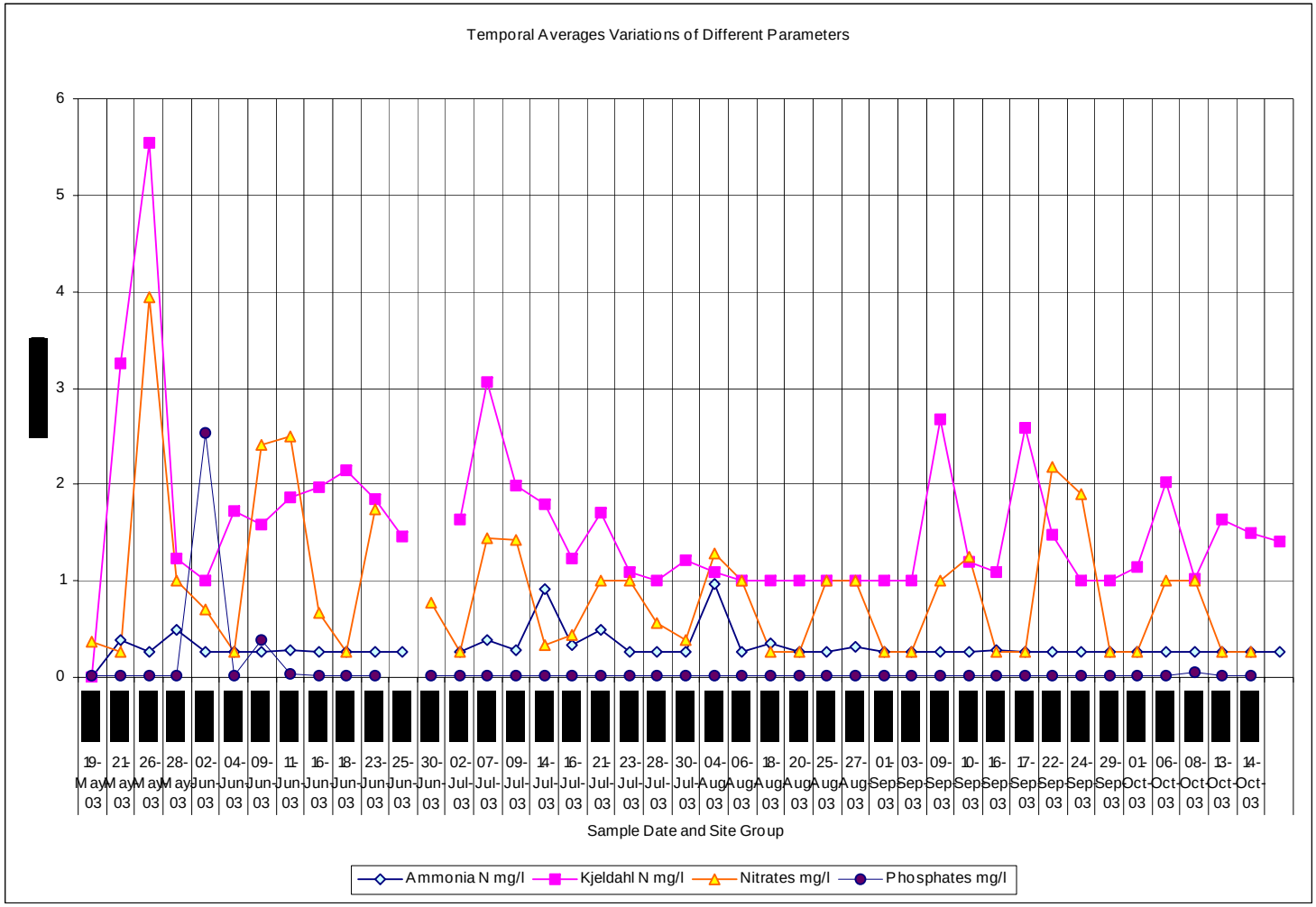


Figure 5. Average Parameter Variation mg/l Values per Site and Sample Date

12. Heavy Metals

As regards the level of Heavy Metals, generally values were below detection limit with the following exceptions:

Arsenic - All below detection limit

Cadmium - All below detection limit except:

- A9 (0.012mg/l on 30.6.03)

Chromium - All below detection limit

Lead - All below detection limit except

- A9 (0.250 mg/l on 30.6.03)
- A11 (0.262 mg/l on 30.6.03)

Mercury - All below detection limit except

- A9 (0.012mg/l on 30.6.03)

Cyanides

All results were below detection limit except C30 with a value of 0.08mg/l on the 9th June 2003.

DISCUSSION AND CONCLUSIONS

Marine physico-chemical characteristics partly reflect aquatic conditions caused by terrestrial influences occur during the year as a result of anthropogenic activities. Nonetheless they also reflect natural cycles and baseline changes. Interpretation of results is thus not always a clear cause-and-effect mechanism, due to this duality. Different natural characteristics and anthropogenic influences affect different water quality parameters.

Malta monitors bathing water during the official bathing season, when there are increased pressures on the coastal environment. Around 1.2 million tourists visit Malta in any one year, with a particular concentration of tourists arriving during the summer months.

Other increased pressures during the bathing season are linked to pleasure boating and numerous water sports. The increased tourist population is known to increase the burden on the sewerage collection system. This results in a number of occasions were sewage overflows to the sea around the coast, which are both a health hazard and a nuisance to the local population and tourists alike.

Another major difficulty in interpreting these results arises from the fact that there is practically nothing to which one can compare the results obtained. In contrast to the microbiological parameters, CD76/160/EEC gives little, if any, indication of guidance and/or mandatory values for physico-chemical parameters. It is also difficult to identify those bathing sites which can be classified a *reference* bathing site.

Suggested improvements for future bathing water monitoring programs therefore are:

1. Record of daily weather to be kept in conjunction with results, with special reference to rainfall, wind strength and wind direction.
2. Detection limits for some parameters need to be lower than they are at present.
3. Analyses of parameters must be carried out in accordance with the methodologies of the bathing water regulations.
4. Selection of a few (perhaps three) sites that are clean but are not bathing sites for monitoring of some physico-chemical parameters for comparison to the results obtained for the bathing sites, in the absence of formal guidance through the bathing water regulations.

Annex I

Full List of Coastal Zones

Day	Site	Code	Analysis
Wk. 1 Day 1	Ghar Lapsi	A17	**
	Wied iz-Zurrieq	A16	**
	B'Bugia: Pretty Bay	A13	**
		A14	*
		A15	**
	B'Bugia: St George's Bay	A10	**
		A11	*
		A12	**
	Marsaxlokk Bay	A09	**
	St Thomas Bay	A07	**
		A08	**
	Marsascala Bay	A03	**
		A04	*
		A05	**
		A06	*

Wk. 1 Day 2	Sliema	B10	*
		B11	**
		B12	**
		B13	**
		B14	*
		B15	*
	Balluta Bay	B08	*
		B09	**
	Spinola Bay	B06	**
		B07	*
	St George's Bay	B03	**
		B04	**
		B05	**
	Pembroke	B01	*

		B02	*
	Qalet Marku	B 01a	**

Date	Site	Code	Analysis
Wk.2 Day 1	Qawra	C28	**
		C29	*
		C30	**
		C31	*
	Salini	C32	**
	Bugibba	C25	*
		C26	**
		C27	*
	St Paul's Bay	C18	*
		C19	**
		C20	*
		C20a	**
		C21	*
		C22	*
		C23	**
		C24	*
	Golden Bay	C04	*
		C05	**
	Ghajn Tuffieha	C02	*
		C03	**
	Anchor Bay	C06	**
	Gnejna Bay	C01	**
	Mistra Bay	C16	*
		C17	**
	Mellieha Bay	C11	*
		C12	*
		C13	**
		C14	*
		C15	*
	Armier	C09	*
	Little Armier	C10	*
	Cirkewwa	C07	**
		C08	*

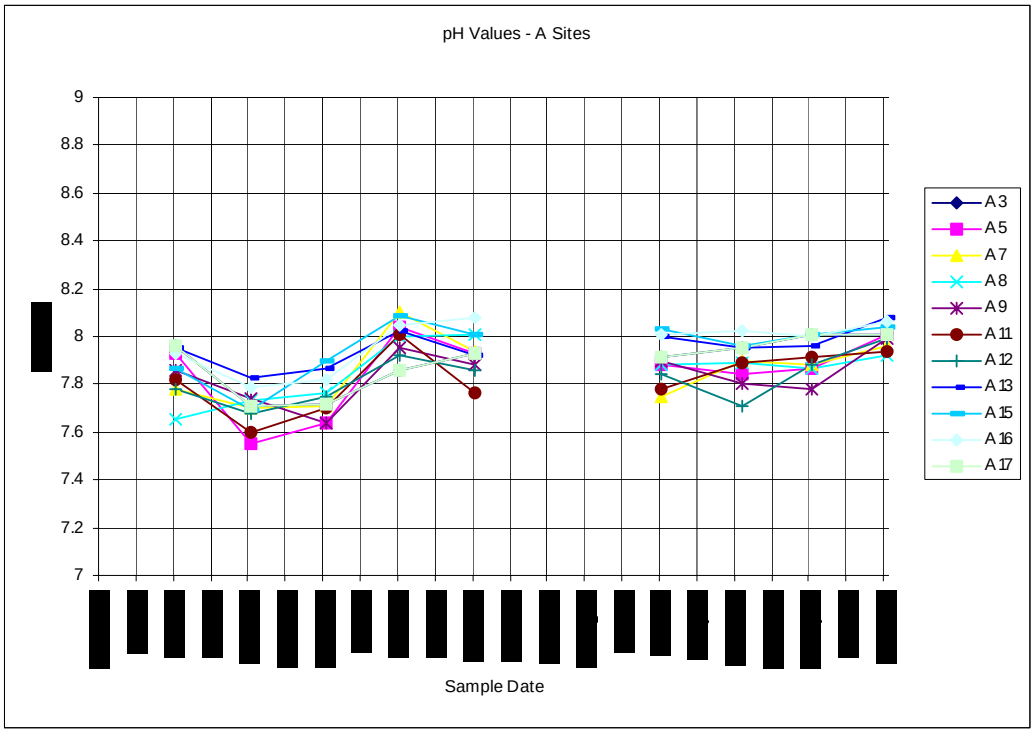
Day	Site	Code	Analysis
Wk. 2 Day 2	Comino	D21	*
		D22	*
		D23	*
	Southern Gozo	D01	*
		D02	*
		D03	*
	Xlendi	D04	*
		D05	**
		D06	*
		D07	**
	Dwejra	D08	*
	Hondoq ir-Rummien	D19	*
	Zewwieqa Bay	D20	*
	Marsalforn Bay	D09	*
		D10	*
		D11	*
		D12	*
		D13	**
		D14	*
	Ramla Bay	D15	*
		D16	*
	San Blas	D17	**
		D18	*

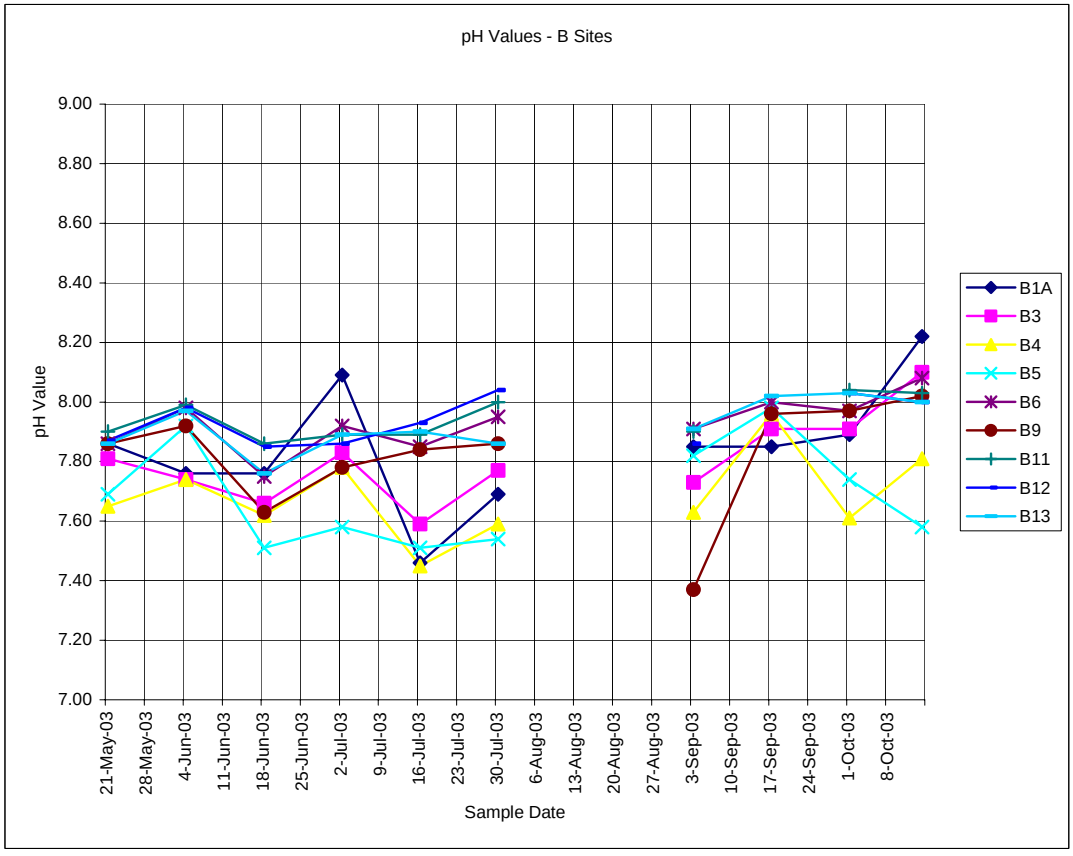
Key:

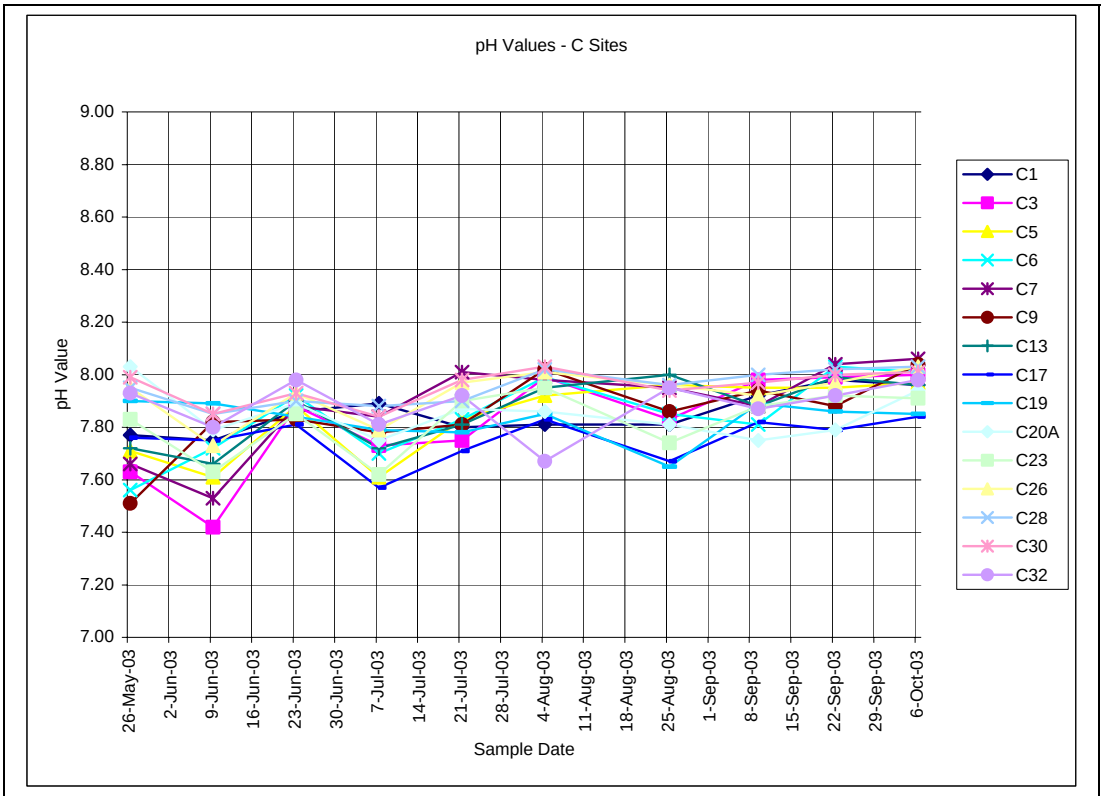
- * Analysis by the Department of Public Health only
- ** Analysis by the Department of Public Health and by the Environment Protection Directorate.

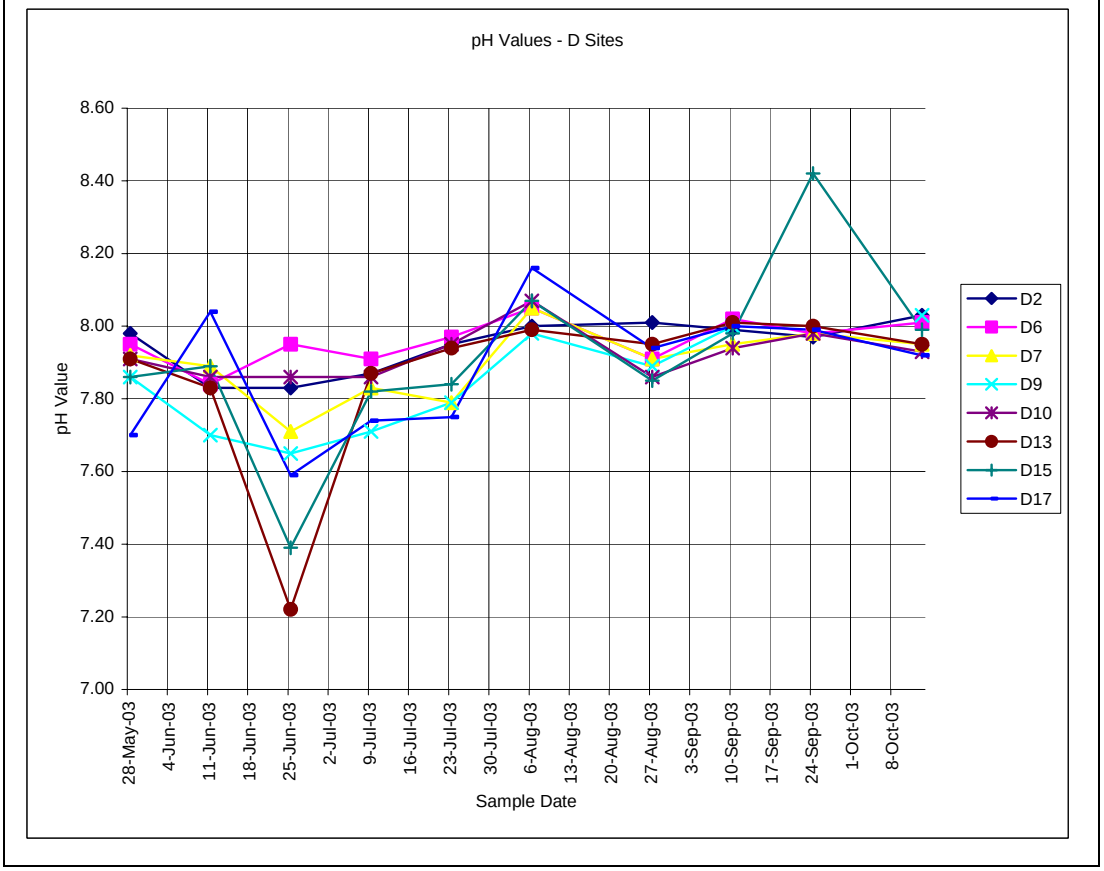
Annex II

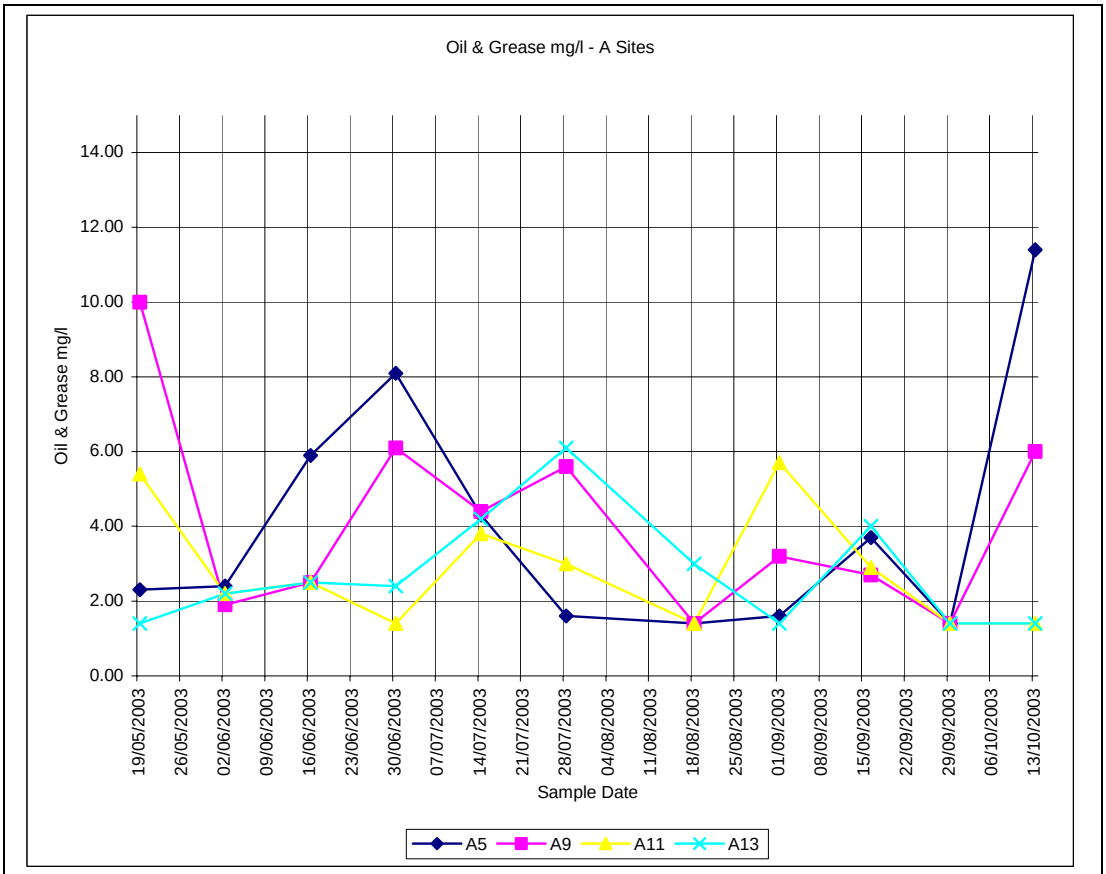
Graphical Illustration of Results Obtained

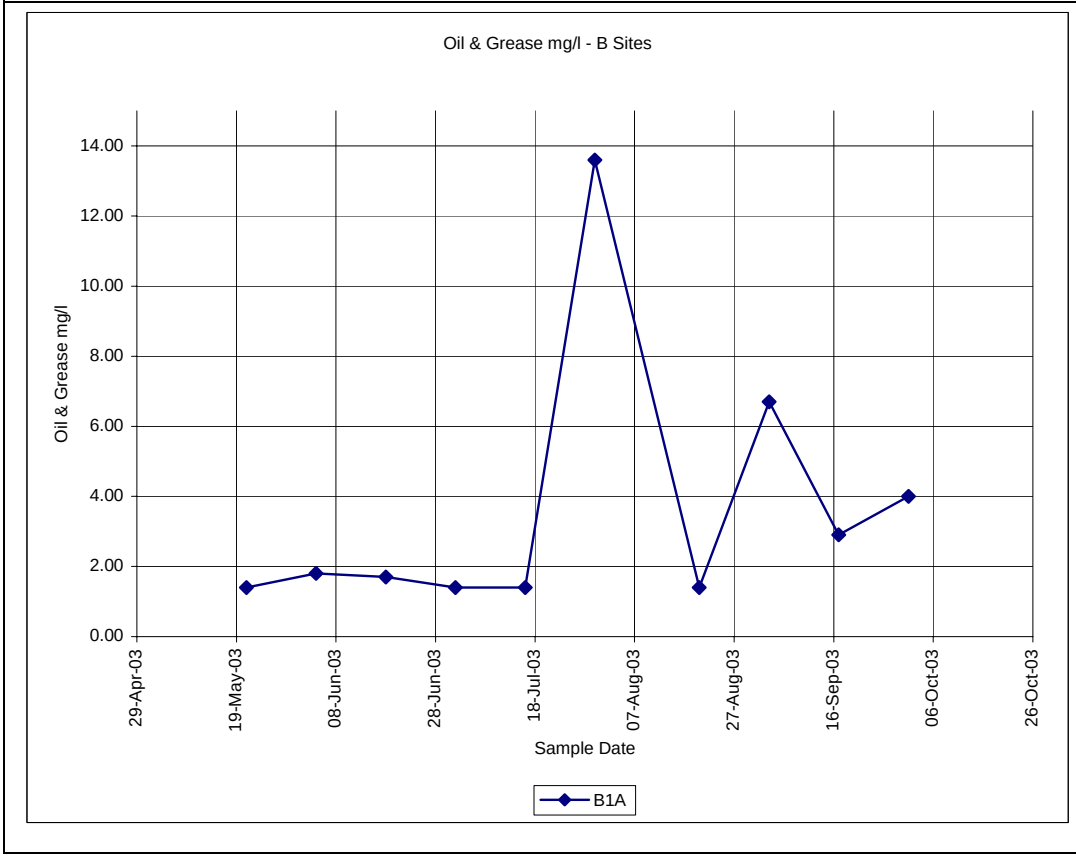

pH Values - A Sites
9
8.8
8.6
8.4
8.2
8
7.8
7.6
7.4
7.2
7
A3
A5
A7
A8
A9
A11
A12
A13
A15
A16
A17
Sample Date

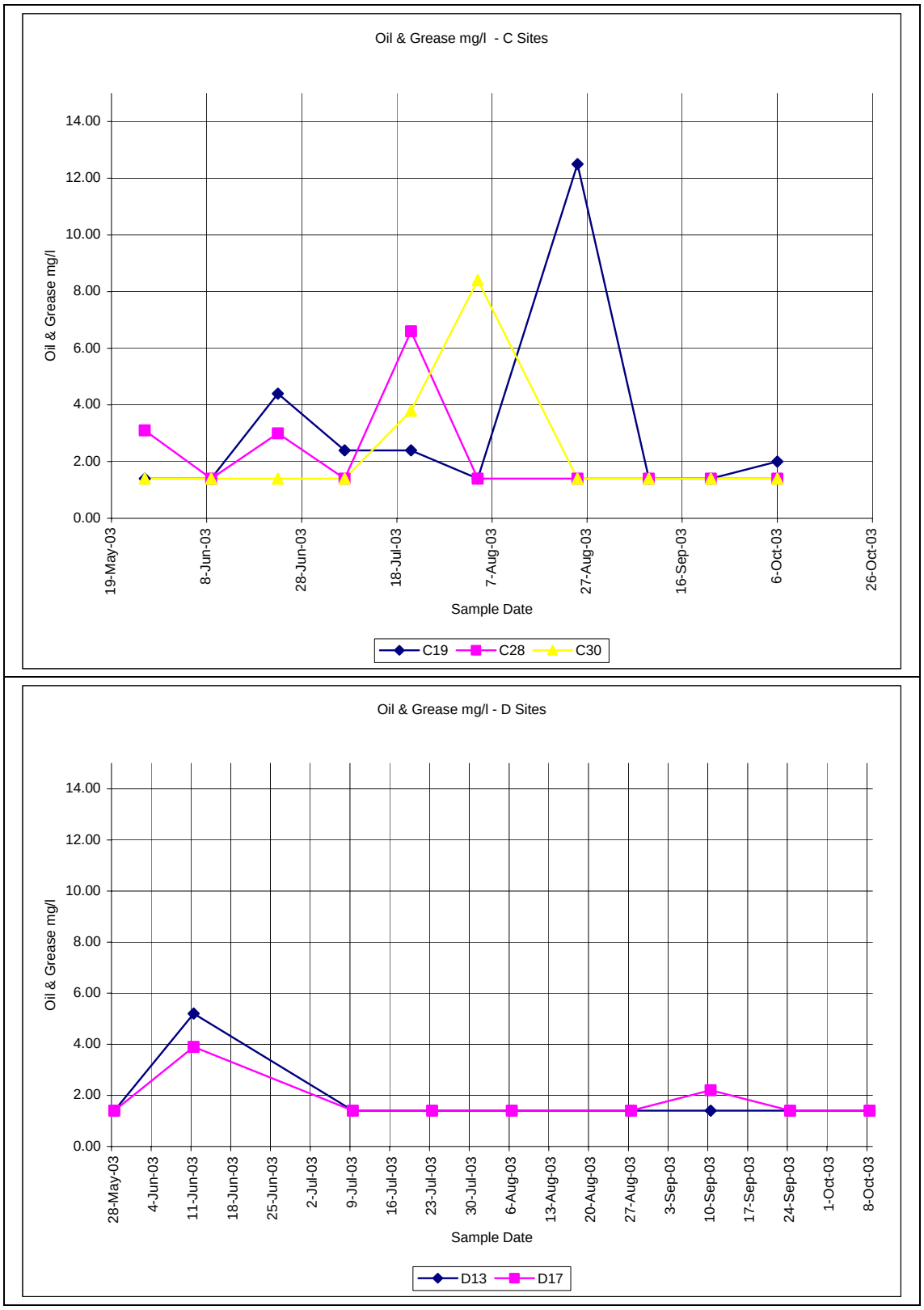

pH Values - B Sites
9.00
8.80
8.60
8.40
8.20
8.00
7.80
7.60
7.40
7.20
7.00
pH Value
21-May-03
28-May-03
4-Jun-03
11-Jun-03
18-Jun-03
25-Jun-03
2-Jul-03
9-Jul-03
16-Jul-03
23-Jul-03
30-Jul-03
6-Aug-03
13-Aug-03
20-Aug-03
27-Aug-03
3-Sep-03
10-Sep-03
17-Sep-03
24-Sep-03
1-Oct-03
8-Oct-03
Sample Date
B1A
B3
B4
B5
B6
B9
B11
B12
B13

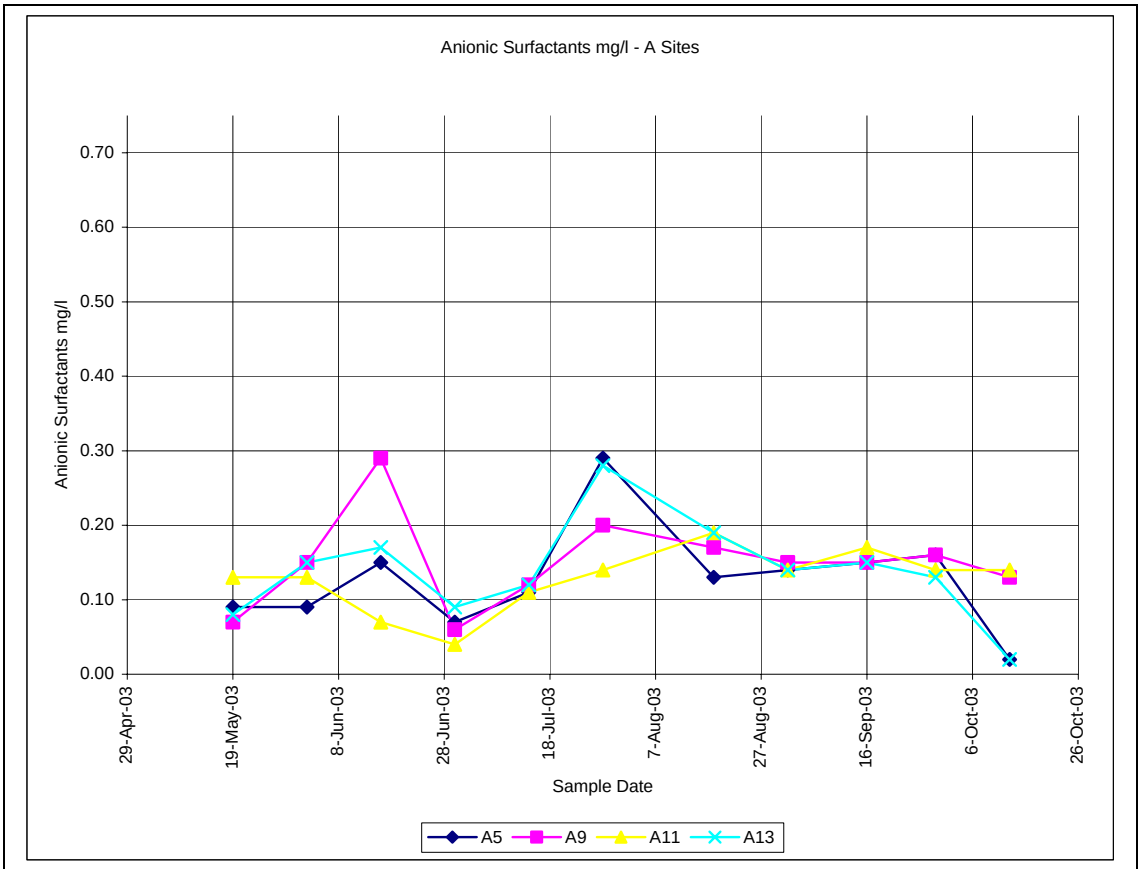

pH Values - C Sites
pH Value
9.00
8.80
8.60
8.40
8.20
8.00
7.80
7.60
7.40
7.20
7.00
26-May-03
2-Jun-03
9-Jun-03
16-Jun-03
23-Jun-03
30-Jun-03
7-Jul-03
14-Jul-03
21-Jul-03
28-Jul-03
4-Aug-03
11-Aug-03
18-Aug-03
25-Aug-03
1-Sep-03
8-Sep-03
15-Sep-03
22-Sep-03
29-Sep-03
6-Oct-03
Sample Date
C1
C3
C5
C6
C7
C9
C13
C17
C19
C20A
C23
C26
C28
C30
C32

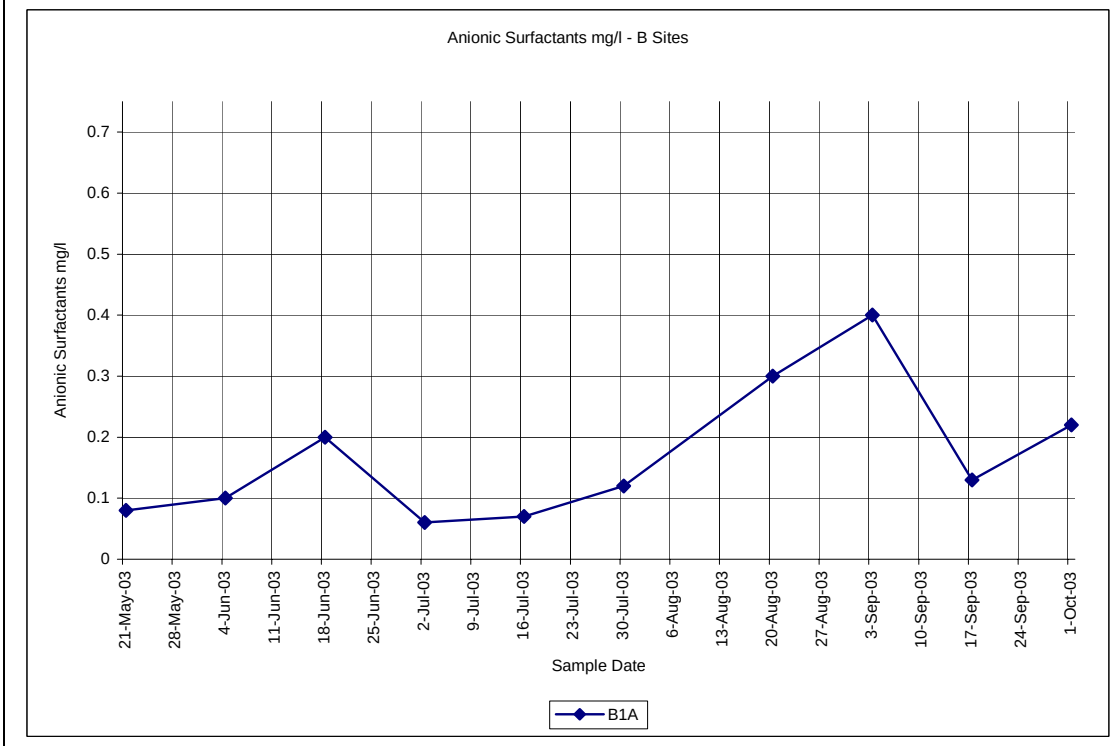

pH Values - D Sites
pH Value
8.60
8.40
8.20
8.00
7.80
7.60
7.40
7.20
7.00
28-May-03
4-Jun-03
11-Jun-03
18-Jun-03
25-Jun-03
2-Jul-03
9-Jul-03
16-Jul-03
23-Jul-03
30-Jul-03
6-Aug-03
13-Aug-03
20-Aug-03
27-Aug-03
3-Sep-03
10-Sep-03
17-Sep-03
24-Sep-03
1-Oct-03
8-Oct-03
Sample Date
D2
D6
D7
D9
D10
D13
D15
D17


Oil & Grease mg/l - A Sites
Oil & Grease mg/l
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
19/05/2003
26/05/2003
02/06/2003
09/06/2003
16/06/2003
23/06/2003
30/06/2003
07/07/2003
14/07/2003
21/07/2003
28/07/2003
04/08/2003
11/08/2003
18/08/2003
25/08/2003
01/09/2003
08/09/2003
15/09/2003
22/09/2003
29/09/2003
06/10/2003
13/10/2003
Sample Date
A5
A9
A11
A13

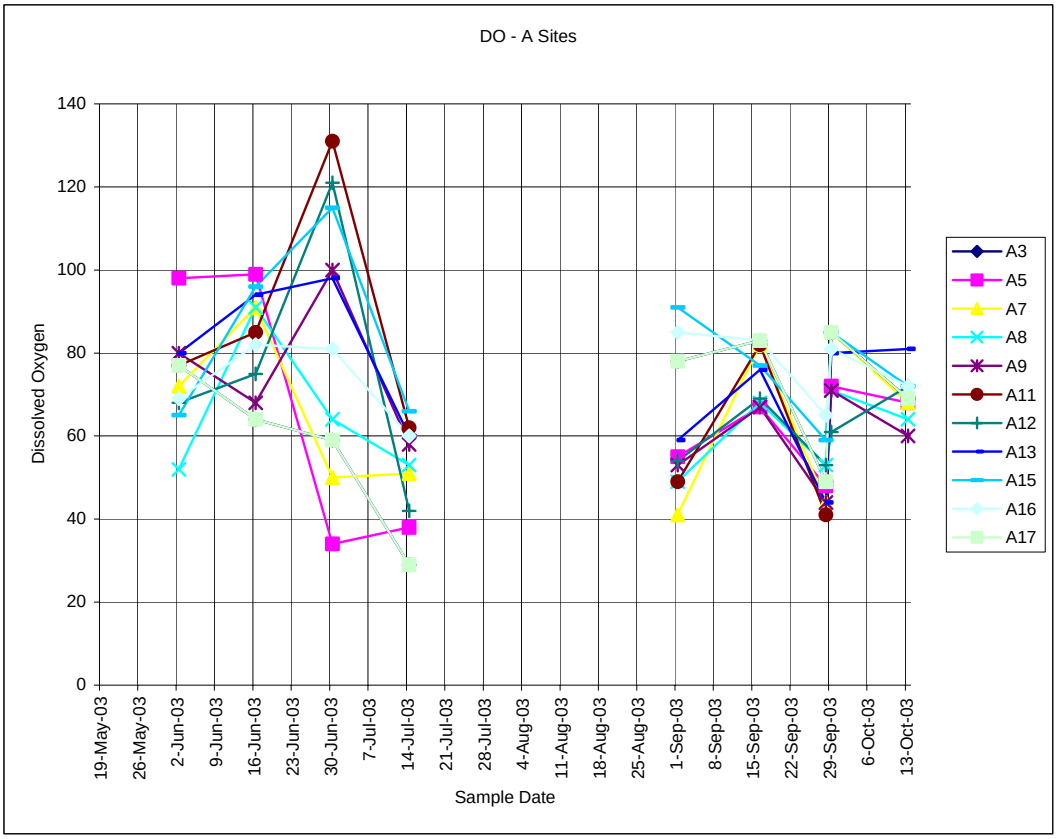

Oil & Grease mg/l - B Sites
Oil & Grease mg/l
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
29-Apr-03
19-May-03
08-Jun-03
28-Jun-03
18-Jul-03
07-Aug-03
27-Aug-03
16-Sep-03
06-Oct-03
26-Oct-03
Sample Date
B1A

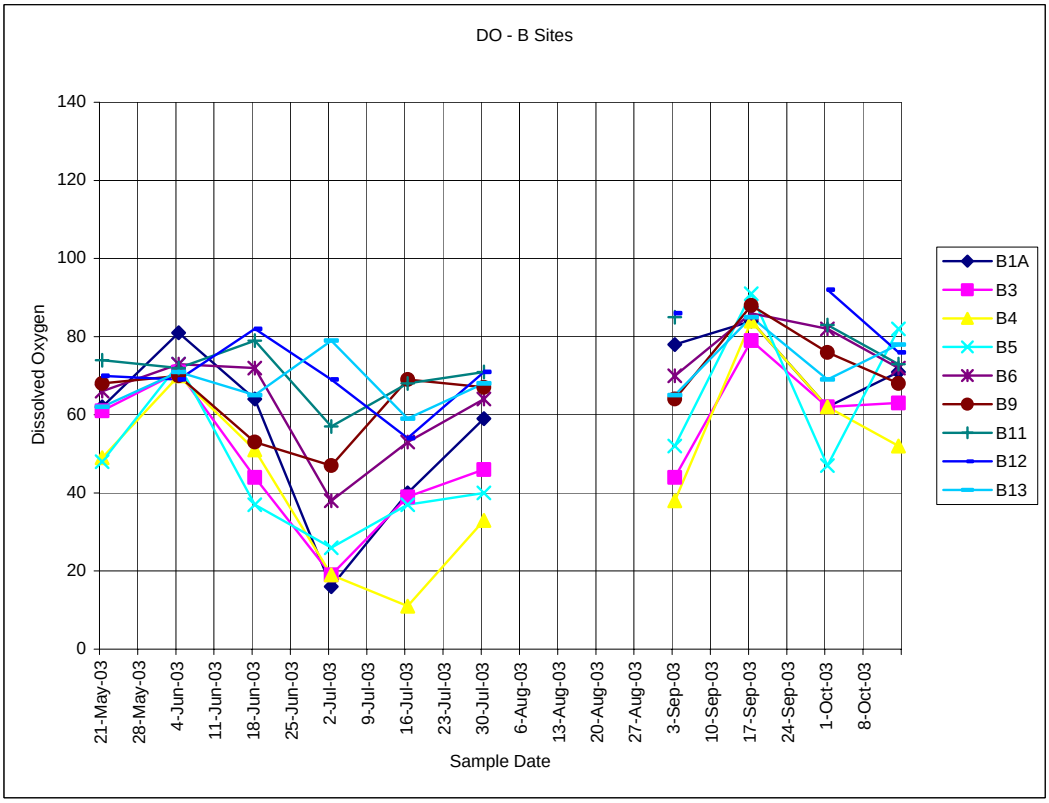

Oil & Grease mg/l - C Sites
Oil & Grease mg/l
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
19-May-03
8-Jun-03
28-Jun-03
18-Jul-03
7-Aug-03
27-Aug-03
16-Sep-03
6-Oct-03
26-Oct-03
Sample Date
C19
C28
C30
Oil & Grease mg/l - D Sites
Oil & Grease mg/l
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
28-May-03
4-Jun-03
11-Jun-03
18-Jun-03
25-Jun-03
2-Jul-03
9-Jul-03
16-Jul-03
23-Jul-03
30-Jul-03
6-Aug-03
13-Aug-03
20-Aug-03
27-Aug-03
3-Sep-03
10-Sep-03
17-Sep-03
24-Sep-03
1-Oct-03
8-Oct-03
Sample Date
D13
D17

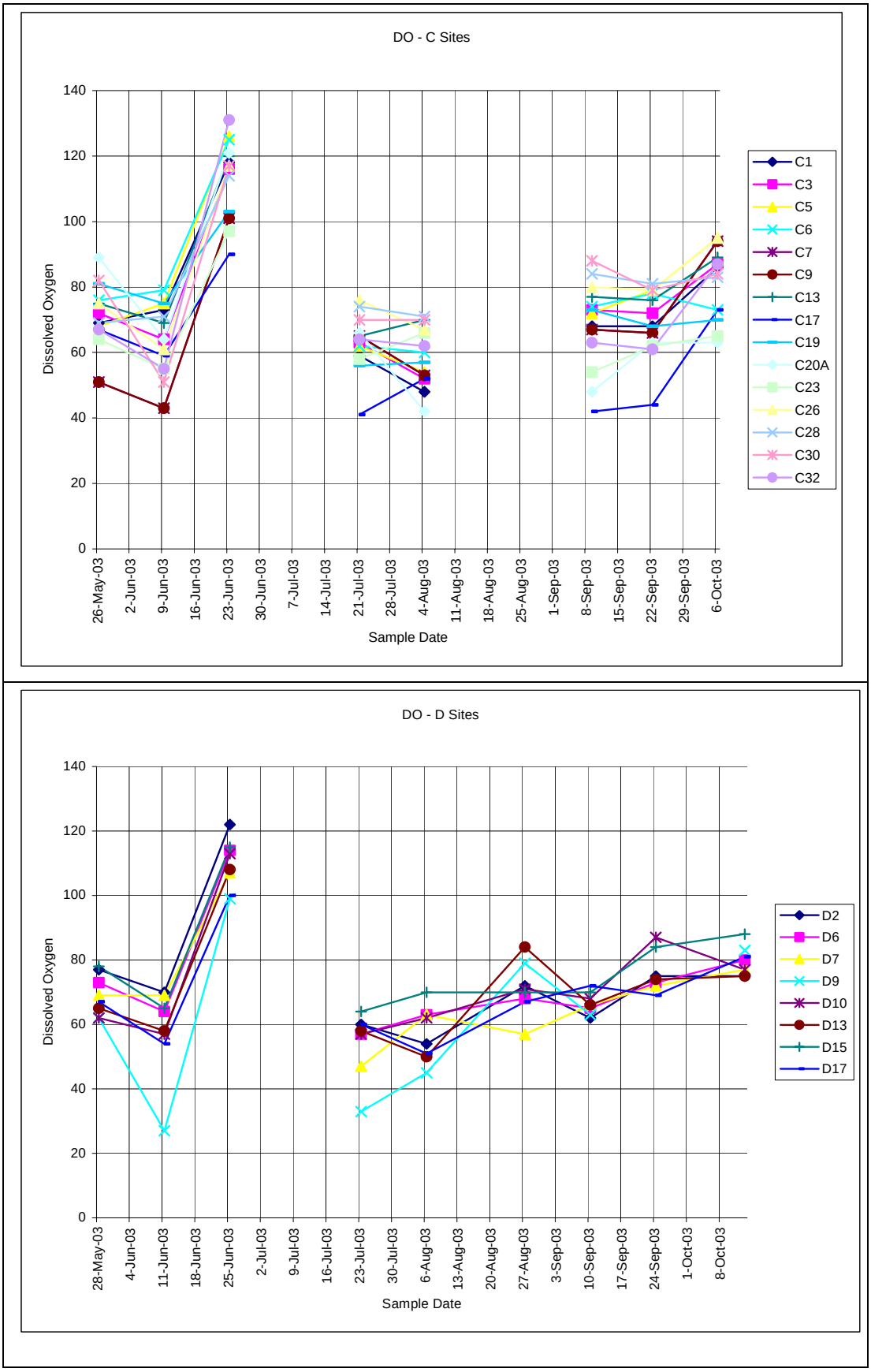

Anionic Surfactants mg/l - A Sites
Anionic Surfactants mg/l
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
29-Apr-03
19-May-03
8-Jun-03
28-Jun-03
18-Jul-03
7-Aug-03
27-Aug-03
16-Sep-03
6-Oct-03
26-Oct-03
Sample Date
A5
A9
A11
A13

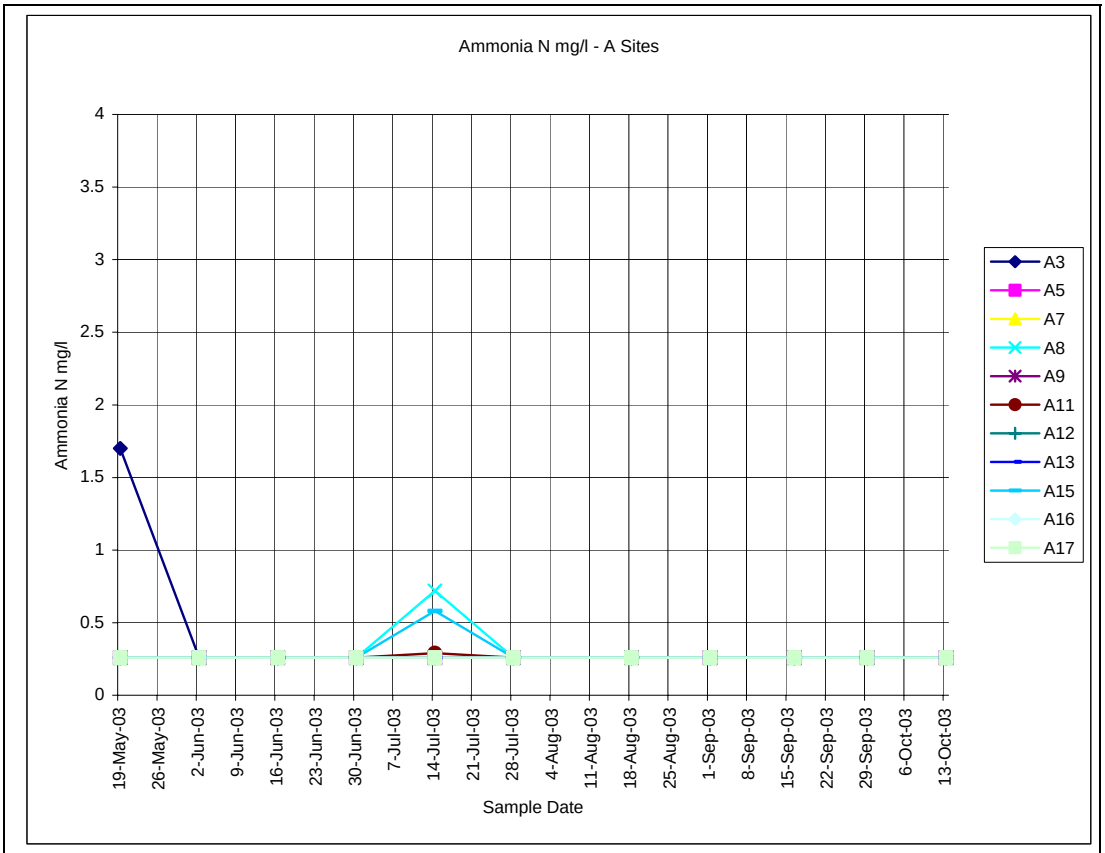

Anionic Surfactants mg/l - B Sites
Anionic Surfactants mg/l
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
21-May-03
28-May-03
4-Jun-03
11-Jun-03
18-Jun-03
25-Jun-03
2-Jul-03
9-Jul-03
16-Jul-03
23-Jul-03
30-Jul-03
6-Aug-03
13-Aug-03
20-Aug-03
27-Aug-03
3-Sep-03
10-Sep-03
17-Sep-03
24-Sep-03
1-Oct-03
Sample Date
B1A

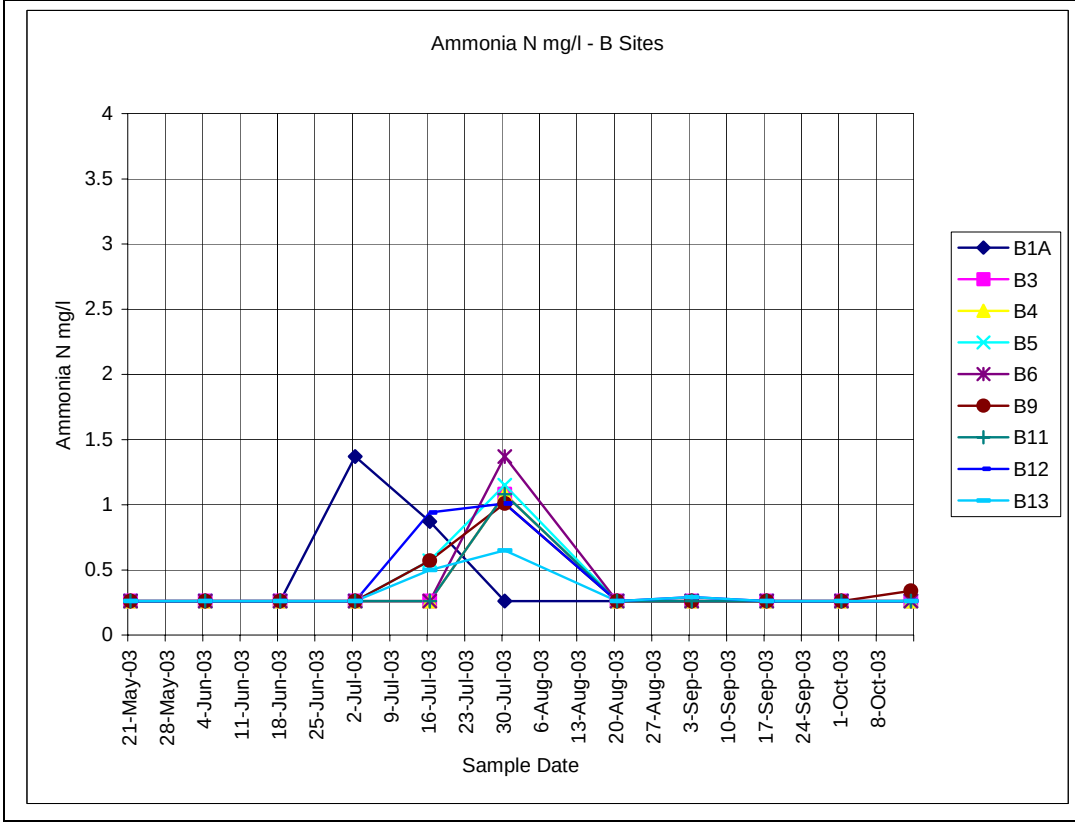

Anionic Surfactants mg/l - C Sites
Anionic Surfactants mg/l
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
26-May-03
2-Jun-03
9-Jun-03
16-Jun-03
23-Jun-03
30-Jun-03
7-Jul-03
14-Jul-03
21-Jul-03
28-Jul-03
4-Aug-03
11-Aug-03
18-Aug-03
25-Aug-03
1-Sep-03
8-Sep-03
15-Sep-03
22-Sep-03
29-Sep-03
6-Oct-03
Sample Date
C19
C28
C30
Anionic Surfactants mg/l - D Sites
Anionic Surfactants mg/l
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
28-May-03
4-Jun-03
11-Jun-03
18-Jun-03
25-Jun-03
2-Jul-03
9-Jul-03
16-Jul-03
23-Jul-03
30-Jul-03
6-Aug-03
13-Aug-03
20-Aug-03
27-Aug-03
3-Sep-03
10-Sep-03
17-Sep-03
24-Sep-03
1-Oct-03
8-Oct-03
Sample Date
D13
D17

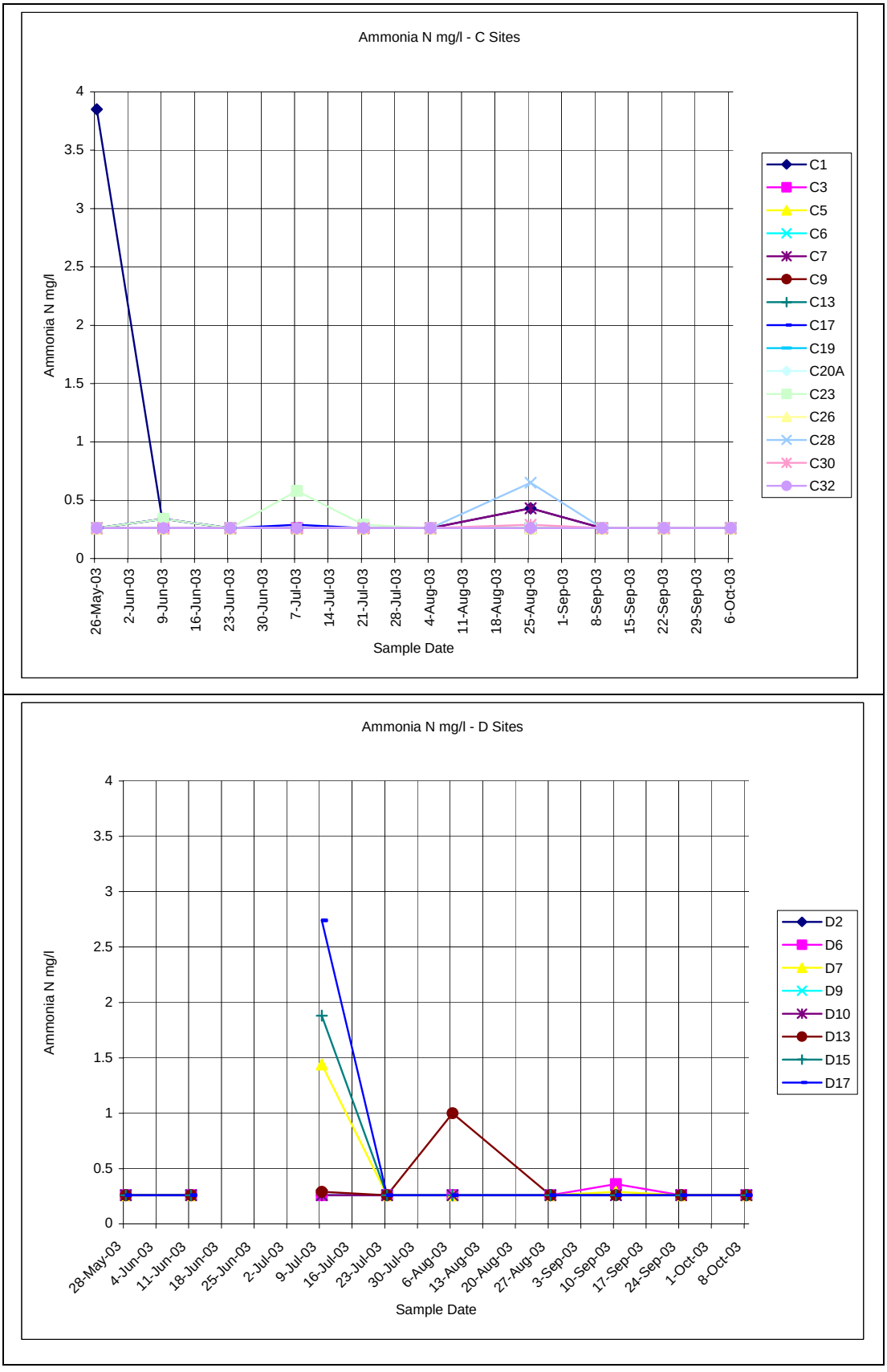

DO - A Sites
Dissolved Oxygen
Sample Date
A3
A5
A7
A8
A9
A11
A12
A13
A15
A16
A17

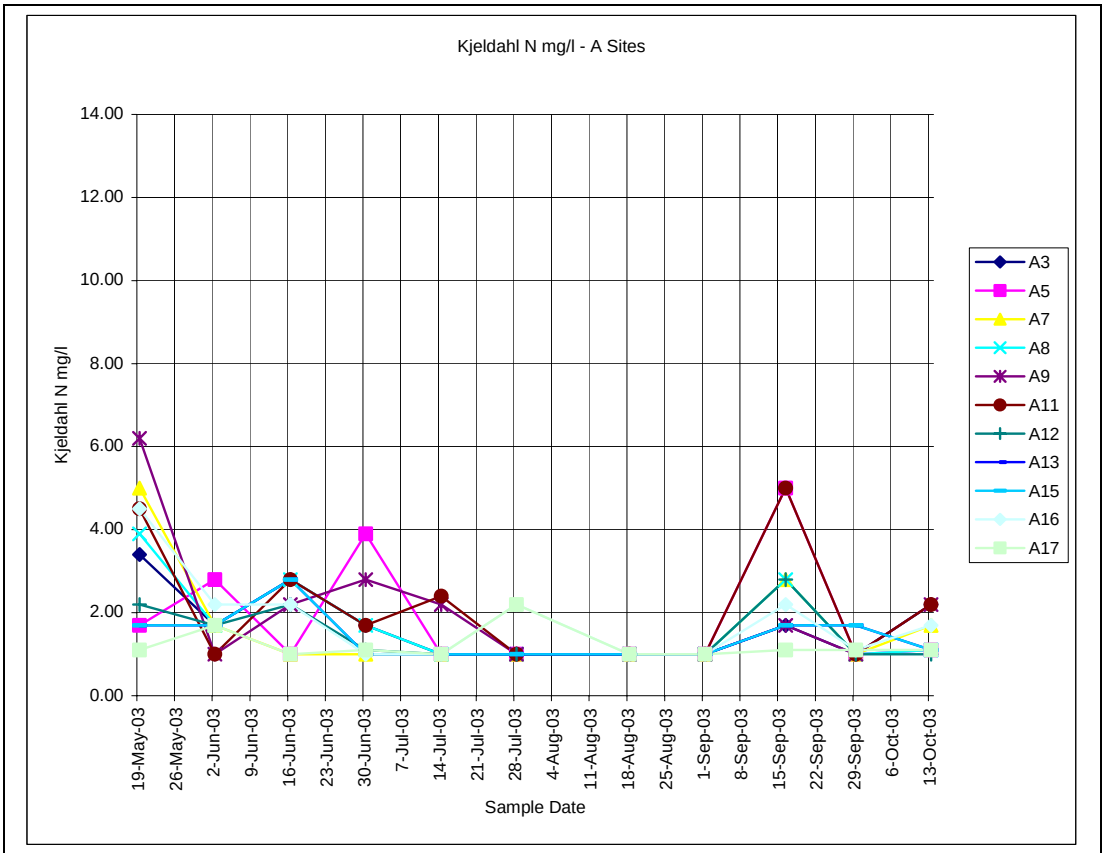

DO - B Sites
Dissolved Oxygen
Sample Date
B1A
B3
B4
B5
B6
B9
B11
B12
B13

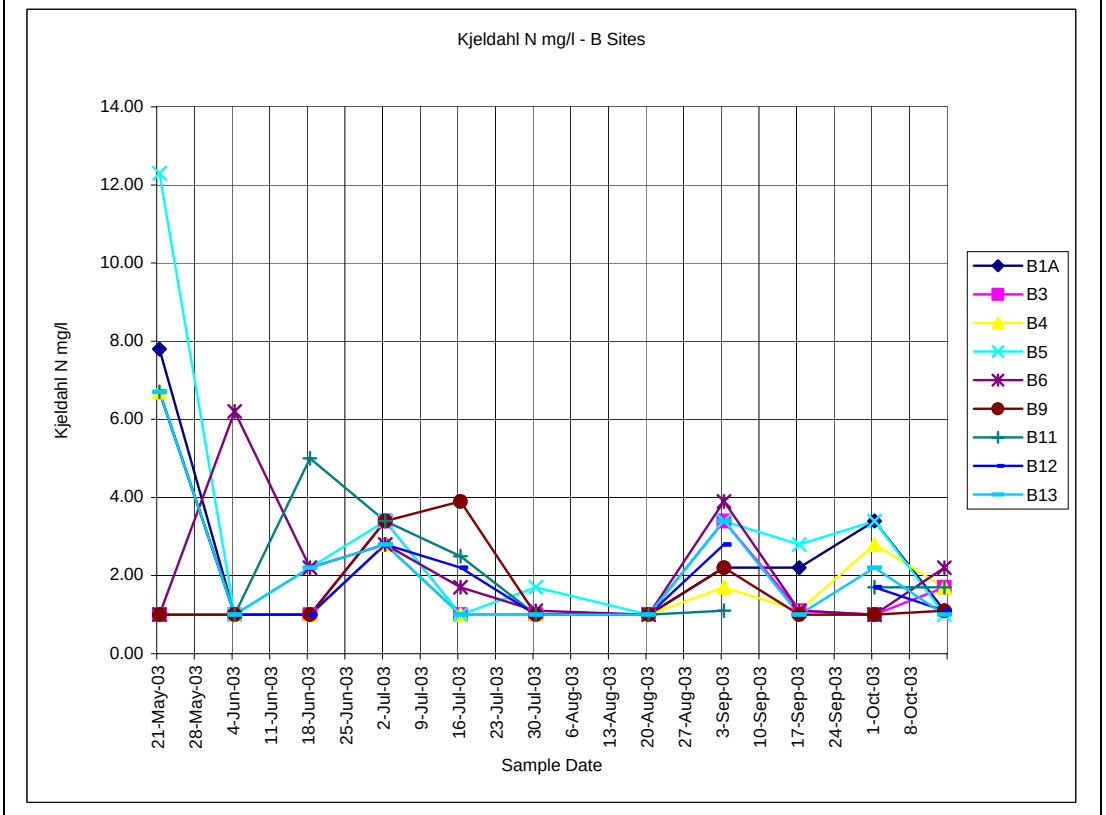

DO - C Sites
Dissolved Oxygen
Sample Date
0
20
40
60
80
100
120
140
26-May-03
2-Jun-03
9-Jun-03
16-Jun-03
23-Jun-03
30-Jun-03
7-Jul-03
14-Jul-03
21-Jul-03
28-Jul-03
4-Aug-03
11-Aug-03
18-Aug-03
25-Aug-03
1-Sep-03
8-Sep-03
15-Sep-03
22-Sep-03
29-Sep-03
6-Oct-03
C1
C3
C5
C6
C7
C9
C13
C17
C19
C20A
C23
C26
C28
C30
C32
DO - D Sites
Dissolved Oxygen
Sample Date
0
20
40
60
80
100
120
140
28-May-03
4-Jun-03
11-Jun-03
18-Jun-03
25-Jun-03
2-Jul-03
9-Jul-03
16-Jul-03
23-Jul-03
30-Jul-03
6-Aug-03
13-Aug-03
20-Aug-03
27-Aug-03
3-Sep-03
10-Sep-03
17-Sep-03
24-Sep-03
1-Oct-03
8-Oct-03
D2
D6
D7
D9
D10
D13
D15
D17

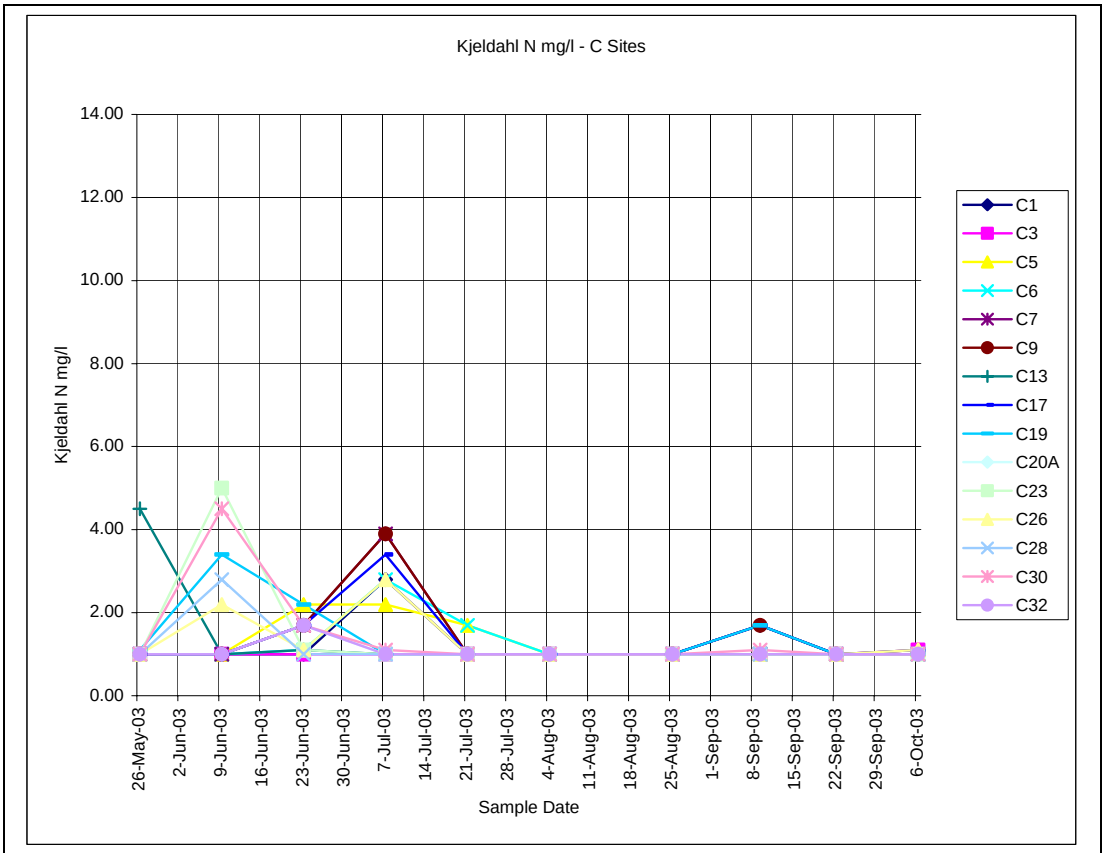

Ammonia N mg/l - A Sites
Ammonia N mg/l
Sample Date
A3
A5
A7
A8
A9
A11
A12
A13
A15
A16
A17

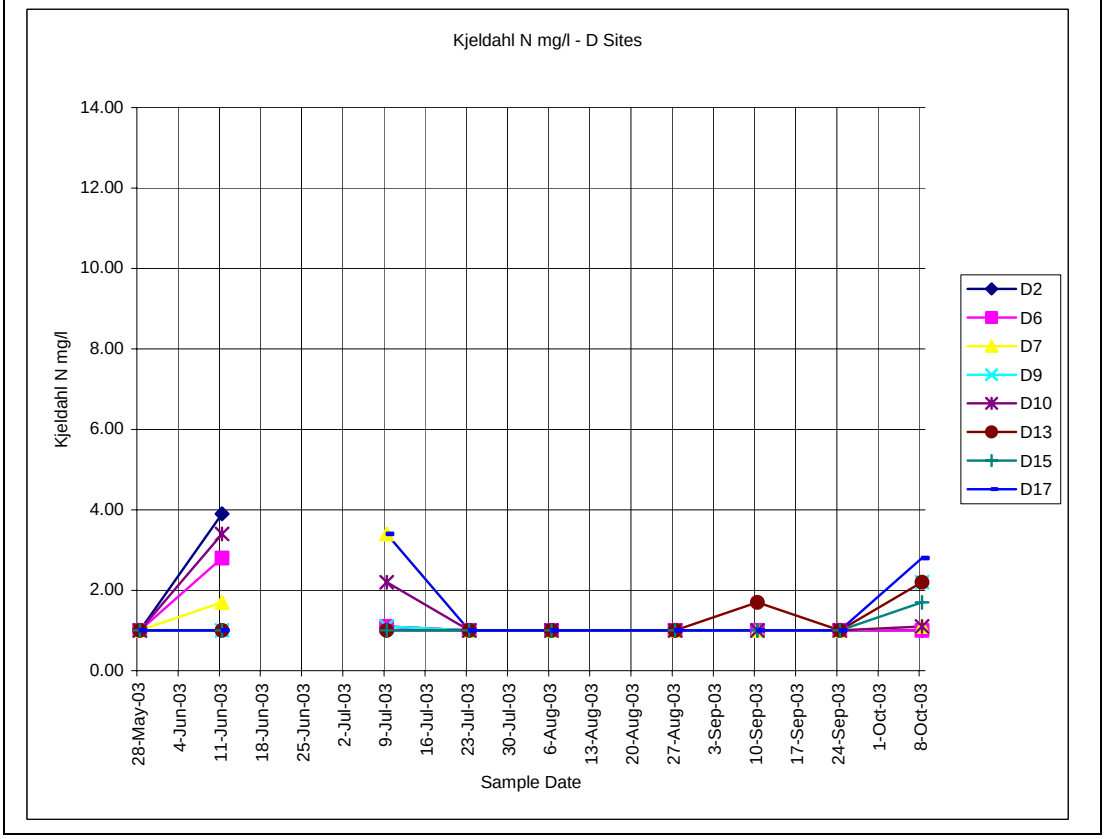

Ammonia N mg/l - B Sites
Ammonia N mg/l
Sample Date
B1A
B3
B4
B5
B6
B9
B11
B12
B13

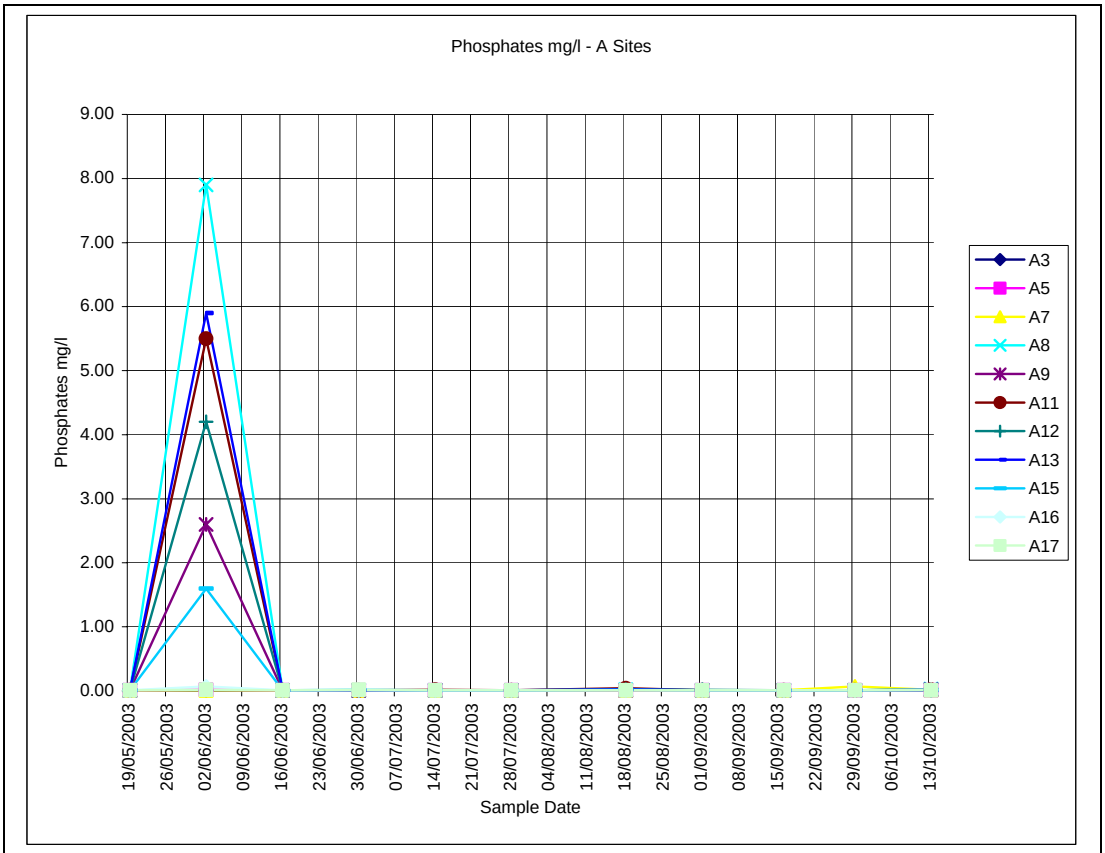

Ammonia N mg/l - C Sites
Ammonia N mg/l
Sample Date
0
0.5
1
1.5
2
2.5
3
3.5
4
26-May-03
2-Jun-03
9-Jun-03
16-Jun-03
23-Jun-03
30-Jun-03
7-Jul-03
14-Jul-03
21-Jul-03
28-Jul-03
4-Aug-03
11-Aug-03
18-Aug-03
25-Aug-03
1-Sep-03
8-Sep-03
15-Sep-03
22-Sep-03
29-Sep-03
6-Oct-03
C1
C3
C5
C6
C7
C9
C13
C17
C19
C20A
C23
C26
C28
C30
C32
Ammonia N mg/l - D Sites
Ammonia N mg/l
Sample Date
0
0.5
1
1.5
2
2.5
3
3.5
4
28-May-03
4-Jun-03
11-Jun-03
18-Jun-03
25-Jun-03
2-Jul-03
9-Jul-03
16-Jul-03
23-Jul-03
30-Jul-03
6-Aug-03
13-Aug-03
20-Aug-03
27-Aug-03
3-Sep-03
10-Sep-03
17-Sep-03
24-Sep-03
1-Oct-03
8-Oct-03
D2
D6
D7
D9
D10
D13
D15
D17

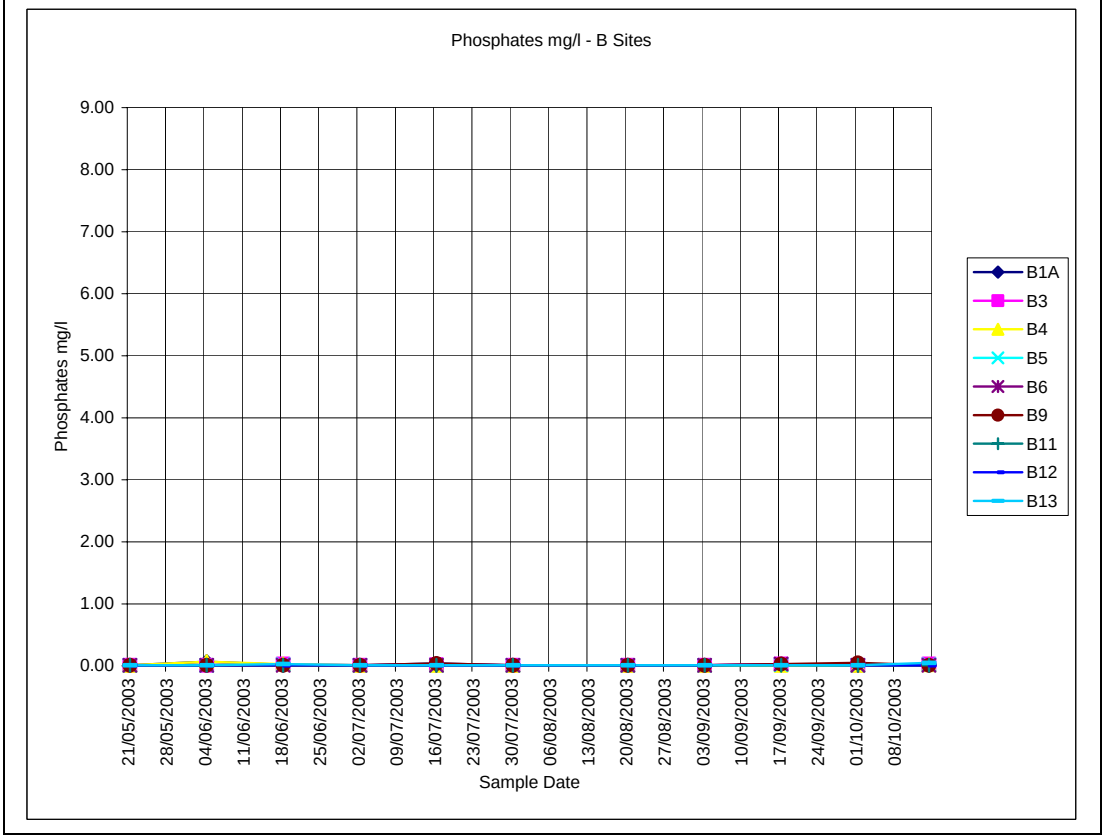

Kjeldahl N mg/l - A Sites
Kjeldahl N mg/l
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
19-May-03
26-May-03
2-Jun-03
9-Jun-03
16-Jun-03
23-Jun-03
30-Jun-03
7-Jul-03
14-Jul-03
21-Jul-03
28-Jul-03
4-Aug-03
11-Aug-03
18-Aug-03
25-Aug-03
1-Sep-03
8-Sep-03
15-Sep-03
22-Sep-03
29-Sep-03
6-Oct-03
13-Oct-03
Sample Date
A3
A5
A7
A8
A9
A11
A12
A13
A15
A16
A17

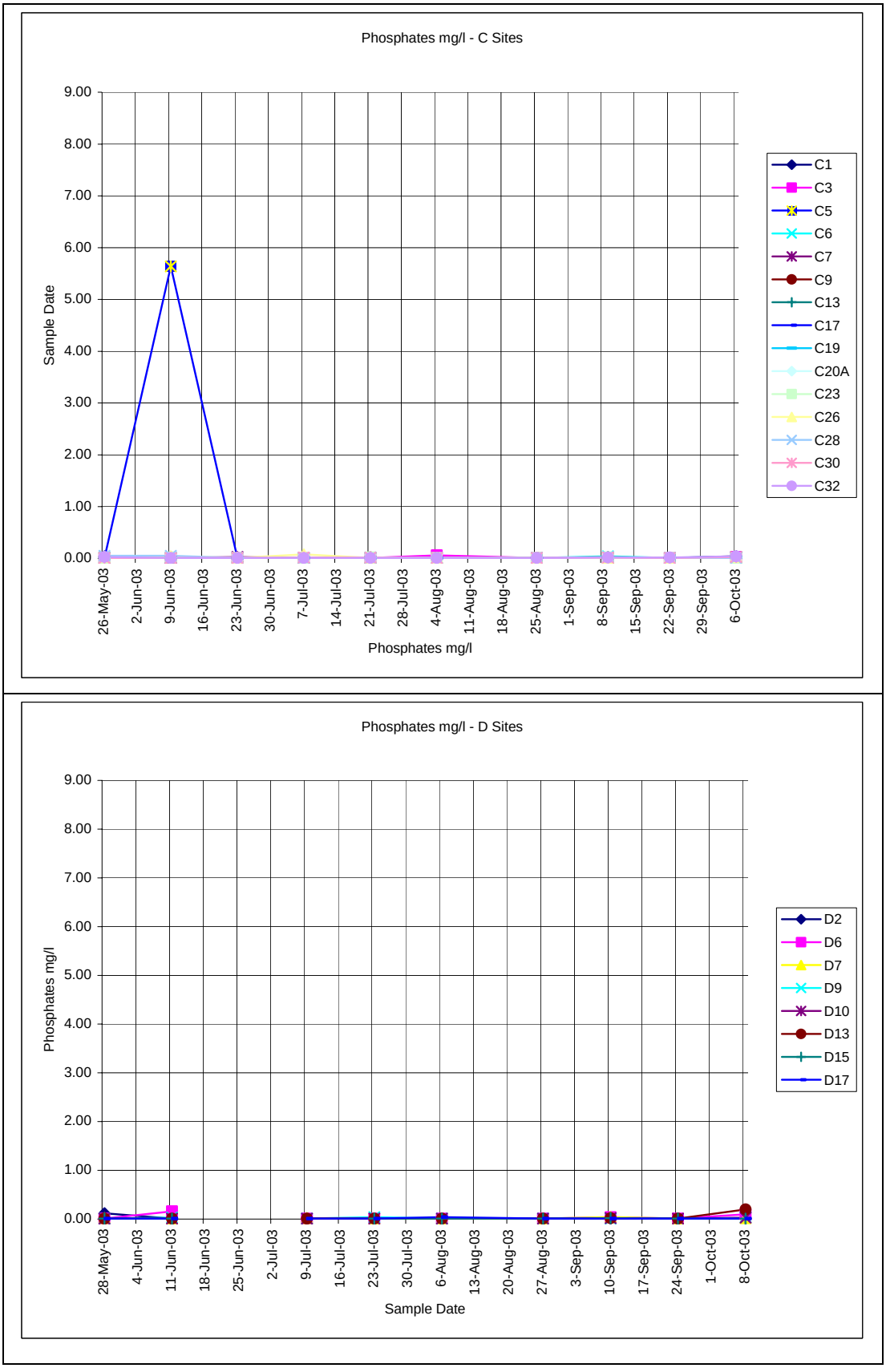

Kjeldahl N mg/l - B Sites
Kjeldahl N mg/l
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
21-May-03
28-May-03
4-Jun-03
11-Jun-03
18-Jun-03
25-Jun-03
2-Jul-03
9-Jul-03
16-Jul-03
23-Jul-03
30-Jul-03
6-Aug-03
13-Aug-03
20-Aug-03
27-Aug-03
3-Sep-03
10-Sep-03
17-Sep-03
24-Sep-03
1-Oct-03
8-Oct-03
Sample Date
B1A
B3
B4
B5
B6
B9
B11
B12
B13

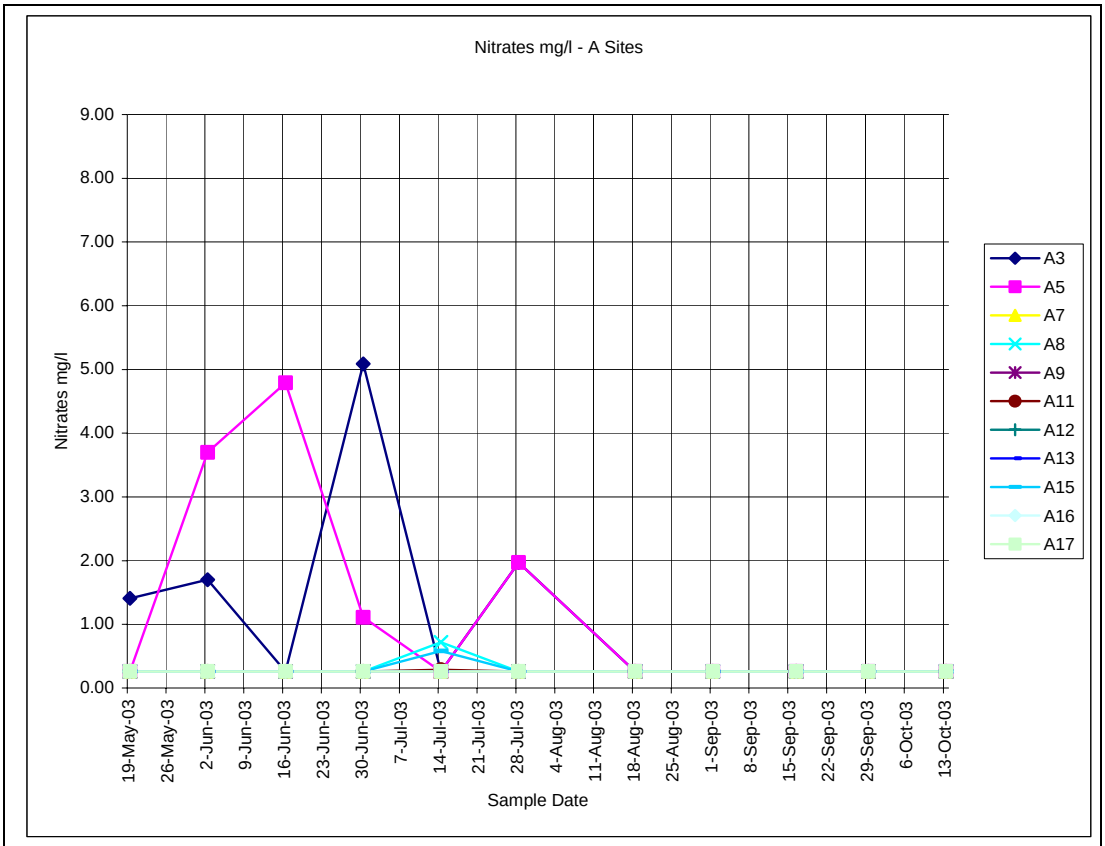

Kjeldahl N mg/l - C Sites
Kjeldahl N mg/l
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
26-May-03
2-Jun-03
9-Jun-03
16-Jun-03
23-Jun-03
30-Jun-03
7-Jul-03
14-Jul-03
21-Jul-03
28-Jul-03
4-Aug-03
11-Aug-03
18-Aug-03
25-Aug-03
1-Sep-03
8-Sep-03
15-Sep-03
22-Sep-03
29-Sep-03
6-Oct-03
Sample Date
C1
C3
C5
C6
C7
C9
C13
C17
C19
C20A
C23
C26
C28
C30
C32

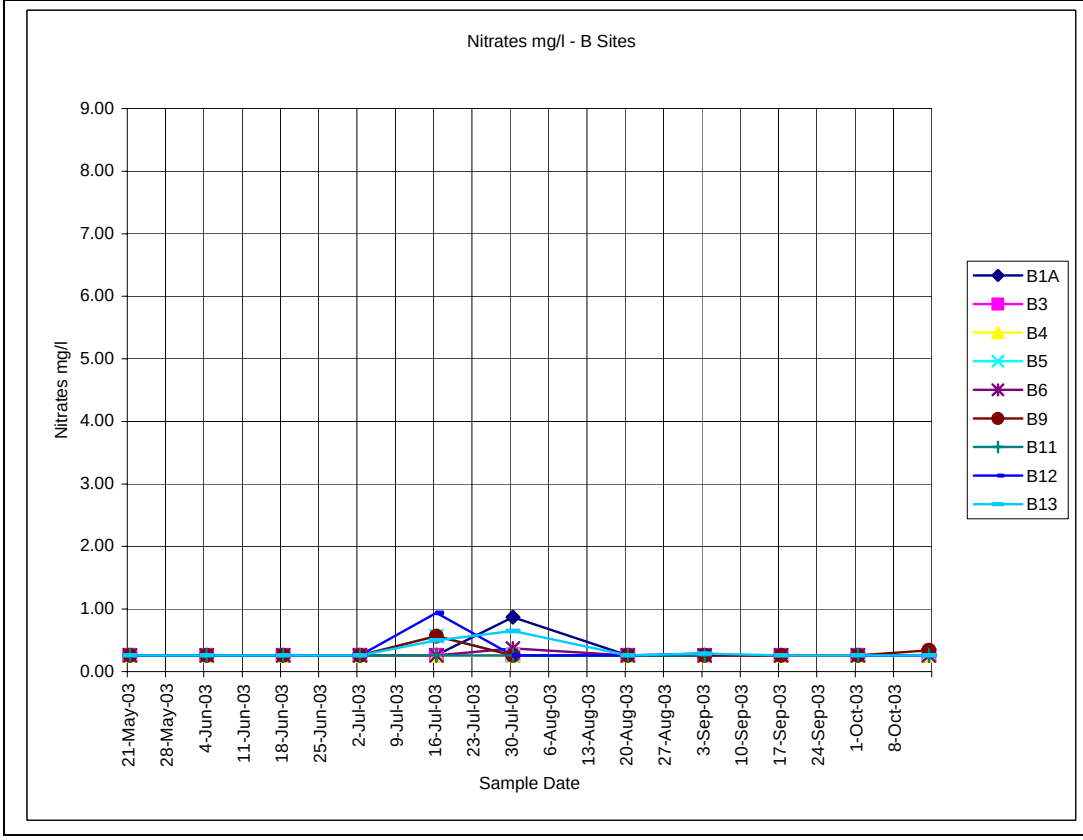

Kjeldahl N mg/l - D Sites
Kjeldahl N mg/l
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
28-May-03
4-Jun-03
11-Jun-03
18-Jun-03
25-Jun-03
2-Jul-03
9-Jul-03
16-Jul-03
23-Jul-03
30-Jul-03
6-Aug-03
13-Aug-03
20-Aug-03
27-Aug-03
3-Sep-03
10-Sep-03
17-Sep-03
24-Sep-03
1-Oct-03
8-Oct-03
Sample Date
D2
D6
D7
D9
D10
D13
D15
D17

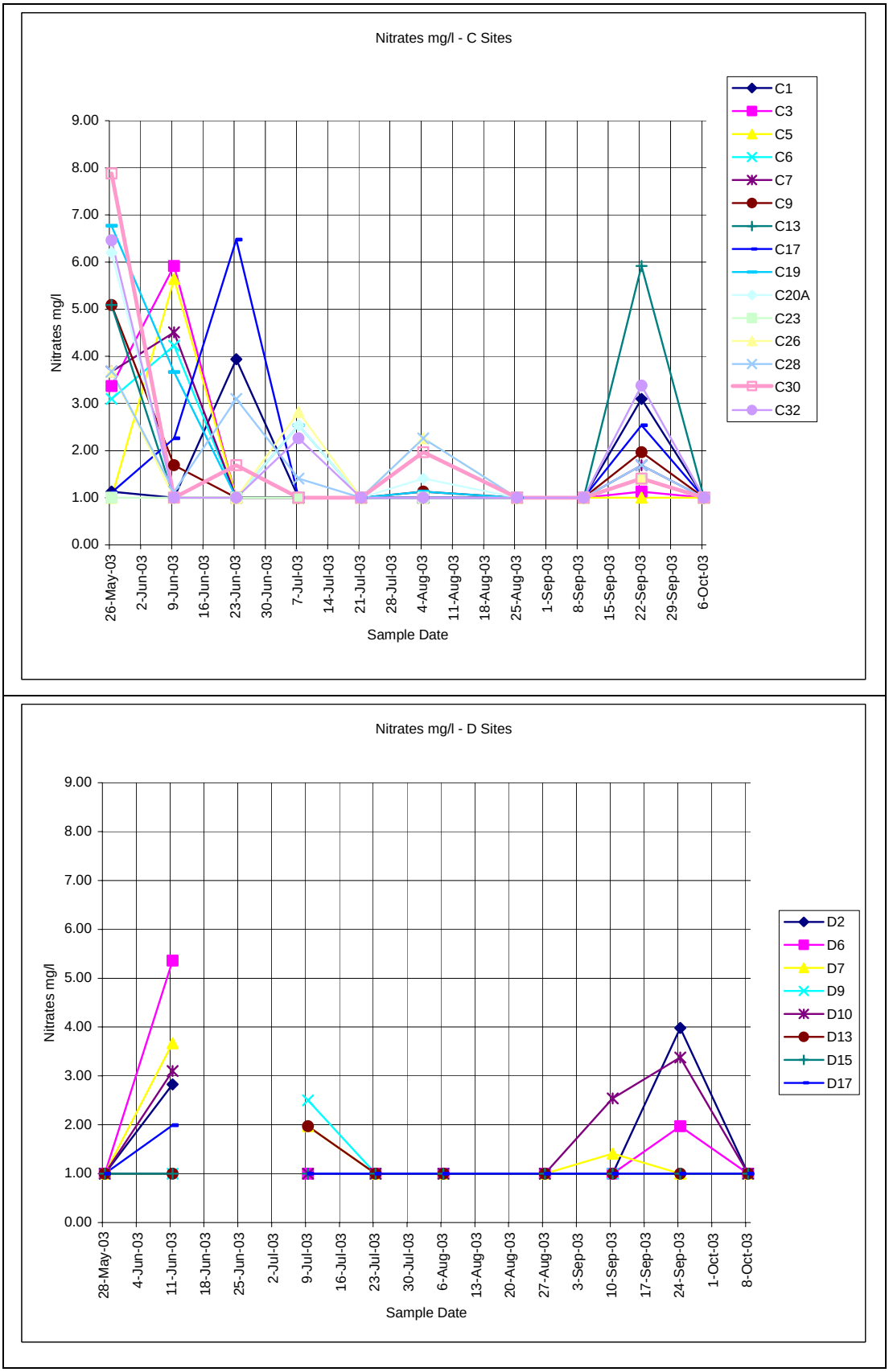

Phosphates mg/l - A Sites
Phosphates mg/l
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
19/05/2003
26/05/2003
02/06/2003
09/06/2003
16/06/2003
23/06/2003
30/06/2003
07/07/2003
14/07/2003
21/07/2003
28/07/2003
04/08/2003
11/08/2003
18/08/2003
25/08/2003
01/09/2003
08/09/2003
15/09/2003
22/09/2003
29/09/2003
06/10/2003
13/10/2003
Sample Date
A3
A5
A7
A8
A9
A11
A12
A13
A15
A16
A17


Phosphates mg/l - B Sites
Phosphates mg/l
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
21/05/2003
28/05/2003
04/06/2003
11/06/2003
18/06/2003
25/06/2003
02/07/2003
09/07/2003
16/07/2003
23/07/2003
30/07/2003
06/08/2003
13/08/2003
20/08/2003
27/08/2003
03/09/2003
10/09/2003
17/09/2003
24/09/2003
01/10/2003
08/10/2003
Sample Date
B1A
B3
B4
B5
B6
B9
B11
B12
B13


Phosphates mg/l - C Sites
Sample Date
Phosphates mg/l
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
26-May-03
2-Jun-03
9-Jun-03
16-Jun-03
23-Jun-03
30-Jun-03
7-Jul-03
14-Jul-03
21-Jul-03
28-Jul-03
4-Aug-03
11-Aug-03
18-Aug-03
25-Aug-03
1-Sep-03
8-Sep-03
15-Sep-03
22-Sep-03
29-Sep-03
6-Oct-03
C1
C3
C5
C6
C7
C9
C13
C17
C19
C20A
C23
C26
C28
C30
C32
Phosphates mg/l - D Sites
Phosphates mg/l
Sample Date
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
28-May-03
4-Jun-03
11-Jun-03
18-Jun-03
25-Jun-03
2-Jul-03
9-Jul-03
16-Jul-03
23-Jul-03
30-Jul-03
6-Aug-03
13-Aug-03
20-Aug-03
27-Aug-03
3-Sep-03
10-Sep-03
17-Sep-03
24-Sep-03
1-Oct-03
8-Oct-03
D2
D6
D7
D9
D10
D13
D15
D17


Nitrates mg/l - A Sites
Nitrates mg/l
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
19-May-03
26-May-03
2-Jun-03
9-Jun-03
16-Jun-03
23-Jun-03
30-Jun-03
7-Jul-03
14-Jul-03
21-Jul-03
28-Jul-03
4-Aug-03
11-Aug-03
18-Aug-03
25-Aug-03
1-Sep-03
8-Sep-03
15-Sep-03
22-Sep-03
29-Sep-03
6-Oct-03
13-Oct-03
Sample Date
A3
A5
A7
A8
A9
A11
A12
A13
A15
A16
A17


Nitrates mg/l - B Sites
Nitrates mg/l
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
21-May-03
28-May-03
4-Jun-03
11-Jun-03
18-Jun-03
25-Jun-03
2-Jul-03
9-Jul-03
16-Jul-03
23-Jul-03
30-Jul-03
6-Aug-03
13-Aug-03
20-Aug-03
27-Aug-03
3-Sep-03
10-Sep-03
17-Sep-03
24-Sep-03
1-Oct-03
8-Oct-03
Sample Date
B1A
B3
B4
B5
B6
B9
B11
B12
B13


Nitrates mg/l - C Sites
Nitrates mg/l
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
26-May-03
2-Jun-03
9-Jun-03
16-Jun-03
23-Jun-03
30-Jun-03
7-Jul-03
14-Jul-03
21-Jul-03
28-Jul-03
4-Aug-03
11-Aug-03
18-Aug-03
25-Aug-03
1-Sep-03
8-Sep-03
15-Sep-03
22-Sep-03
29-Sep-03
6-Oct-03
Sample Date
C1
C3
C5
C6
C7
C9
C13
C17
C19
C20A
C23
C26
C28
C30
C32
Nitrates mg/l - D Sites
Nitrates mg/l
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
28-May-03
4-Jun-03
11-Jun-03
18-Jun-03
25-Jun-03
2-Jul-03
9-Jul-03
16-Jul-03
23-Jul-03
30-Jul-03
6-Aug-03
13-Aug-03
20-Aug-03
27-Aug-03
3-Sep-03
10-Sep-03
17-Sep-03
24-Sep-03
1-Oct-03
8-Oct-03
Sample Date
D2
D6
D7
D9
D10
D13
D15
D17

Bathing Water Monitoring Program 2003:

Coordinator:

Ms. Ramona Scerri, Environment Protection Officer, EPD.

Environment Inspectors:

Mr. Anthony Aquilina
Ms. Elysia Borg
Mr. Carmel Camilleri
Ms. Lorna Mallia
Ms. Marlene Vella

Analyses carried out by:

Malta National Laboratory Co. Ltd.

Report compiled by:

Ms. Gabrielle Galea, Environment Protection Officer, EPD.
Ms. Ramona Scerri, Environment Protection Officer, EPD.