NRA NORTH WEST 87

SEABURN SEWER SURVEY II

23-24 October 1991

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INTRODUCTION

Following the Seaburn Sewer Survey[1] carried out earlier this year during a neap tide, it was recommended that a similar exercise be conducted during a spring tide, where greater water movements are to be expected.

OBJECTIVE

The Seaburn Sewer Survey II was carried out during a spring tide in order to determine whether the discharge from the BNFL sewage treatment plant has a significant impact on the bacterial counts found at Seascale beach, thereby contributing to the failure of the beach to meet EC standards.

METHODOLOGY

The methodology together with the approach to the interpretation of results have been kept similar to the first Seaburn Sewer Survey [1] in order to facilitate the comparison between the sets of results. Appendix 1 lists some details relating to the Seaburn Survey II.

On October 23, the beach was sampled in order to determine Bacillus globigii background levels. Levels were expected to be equal to zero as the tracers had not yet been introduced into the environment.

On October 24 between 00:20 and 00:25, approximately 40 kg of Rhodamine B, together with one litre of B. globigii (10^{14} spores/l) were added to the Seaburn Sewer manhole. The manhole is located just downstream from the point where the sewage treatment plant effluent connects to the Seaburn Sewer system.

Samples for total coliforms and E. coli concentrations were taken at the manhole from 00:30 to 01:35. The Seaburn Sewer outfall at the confluence of the Calder/Ehen was also sampled at that time to determine the level of mixing between the two tracers and coliform levels. The Seascale beach was sampled from 06:00 to 23:00 for levels of coliforms and tracers. Figure 1 shows the location of the sampling sites.

RESULTS

All raw data can be found in Appendix 2.

While some variation in coliform levels were observed in the manhole, Figure 2, it can be assumed that the overall effluent quality is reasonably constant, see Table 1.

Table 1: Mean coliform levels at the manhole

	N	Mean	St.Dev.	St.Err.
Total coliforms	14	$12.5 * 10^4$	$1.9 * 10^4$	$5.1 * 10^3$
E. coli	14	$8.7 * 10^4$	$1.3 * 10^4$	$3.6 * 10^3$

N = number of samples
St.Dev. = Standard deviation
St.Err. = Standard error about the mean
Units = counts / 100 ml

At the outfall, located at the confluence of the rivers Calder and Ehen, the coliform concentrations were lower than observed at the manhole (Table 2), possibly a function of better mixing between the sewage and the cooling water flow.

Table 2: Coliform ratios between the manhole and the outfall at the confluence of the Calder/Ehen

	Manhole	Calder/Ehen	Dilution
Total coliforms	$12.5 * 10^4$	$8.5 * 10^4$	1.48 : 1
E. coli	$8.7 * 10^4$	$5.8 * 10^4$	1.50 : 1

Units = counts / 100 ml

Sampling at the outfall also revealed that the mixing between the tracers and coliform levels was not homogeneous, Figure 3. Therefore, it was not possible to determine the initial ratio B. globigii : E. coli necessary to predict the beach levels of E. coli originating from the Seaburn Sewer.

Rhodamine beach levels showed that the dye reached highest concentrations on Seascale beach 6 hours, and 18 hours after the release of the tracer into the manhole, Figure 4.

Errors in B. globigii concentrations were reported on three distinct occasions, which resulted in discarding all B. globigii data. These mistakes, probably due to laboratory contamination, were:

- Beach levels of B. globigii reaching 60 counts / 100 ml during the background run.

- The non exponential trend of B. globigii with time during the sampling of the outfall following the release of the tracers in the manhole, see Figure 2.

- High levels of B. globigii only reported at site 8.1, without the natural progression of the tracer along the coast, Figure 5.

CONCLUSIONS

1. The sample taken at the EC monitoring point on Seascale beach at 21:45 h on the 24th October failed the mandatory standards of the EC bathing directive:

	Observed	Standard
Total coliforms	16 000	10 000
E. coli	3 300	2 000

Units = counts / 100 ml

2. It is advised that the Seaburn Sewer Survey II should be repeated, with the following refinements:

- A boat should be located at the mouth of the estuary during the adding of the tracers into the manhole to better quantify the initial dilution between tracers and coliform levels.

- Because previous work [1] suggests that the tracers reach the shore on the successive tide following the release of the tracers, it is recommended that the survey be carried out in the summer months when the length of daylight is less limiting.

- Greater care in manipulating B. globigii samples.

SELECTED REFERENCES

1. Seaburn Sewer Survey - 05-07 August 1991. National Rivers Authority North West Region, Report MSP-004, September 1991.

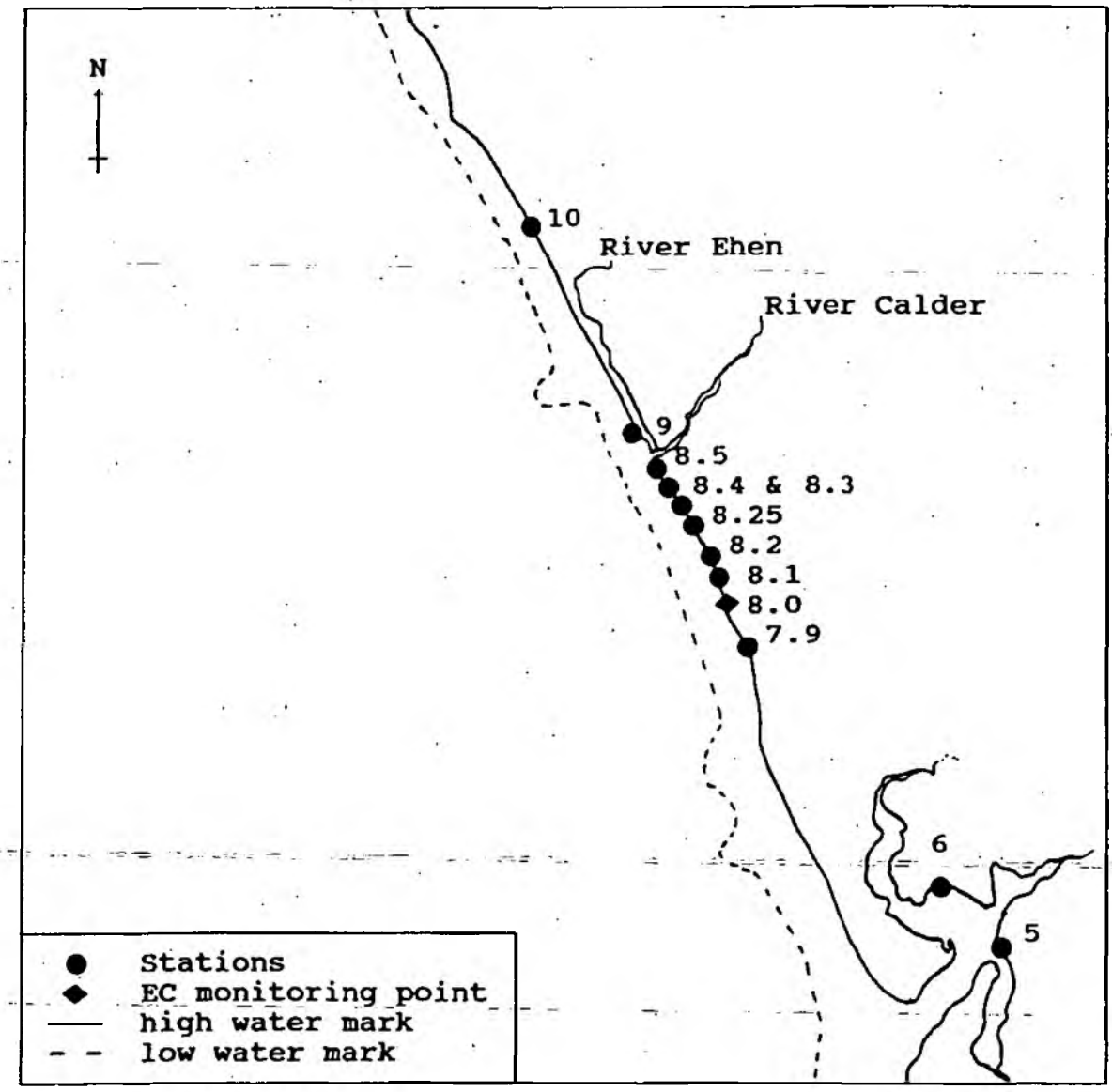


Figure 1: Sampling stations along the beach during the Seaburn Sewer Survey II, 23-24 October 1991

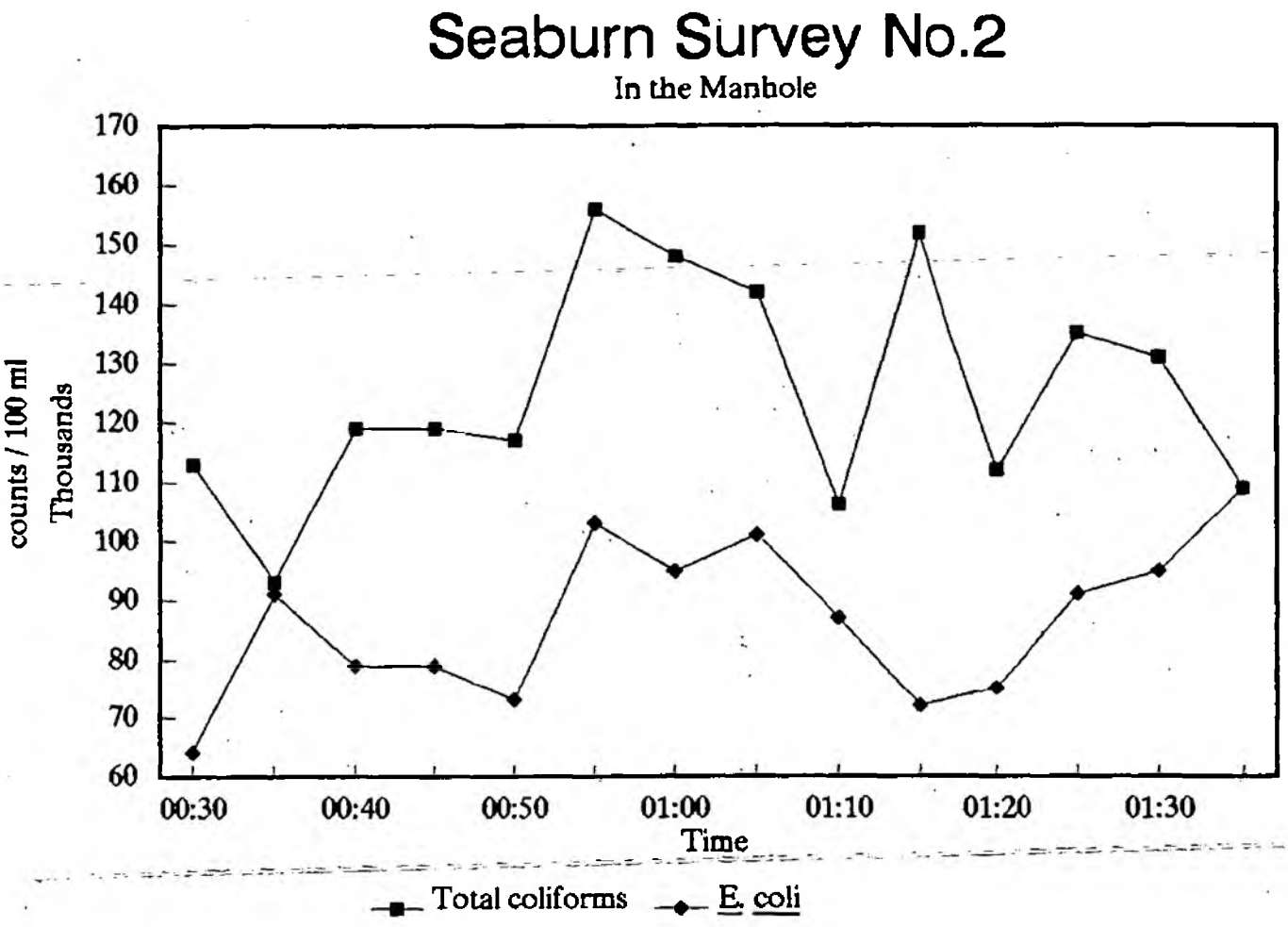


Figure 2: Seaburn effluent content at the manhole, following the release of the tracers

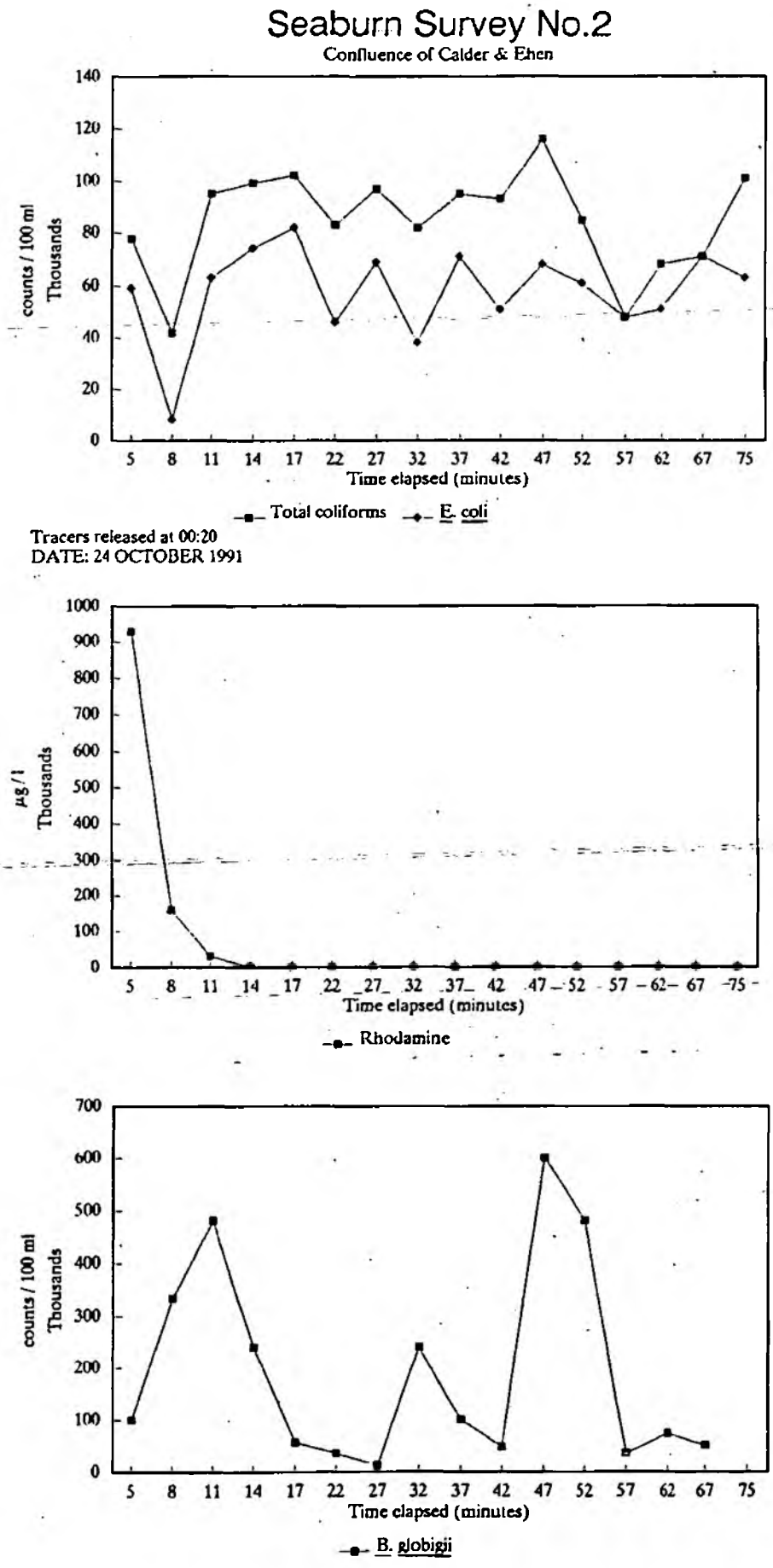
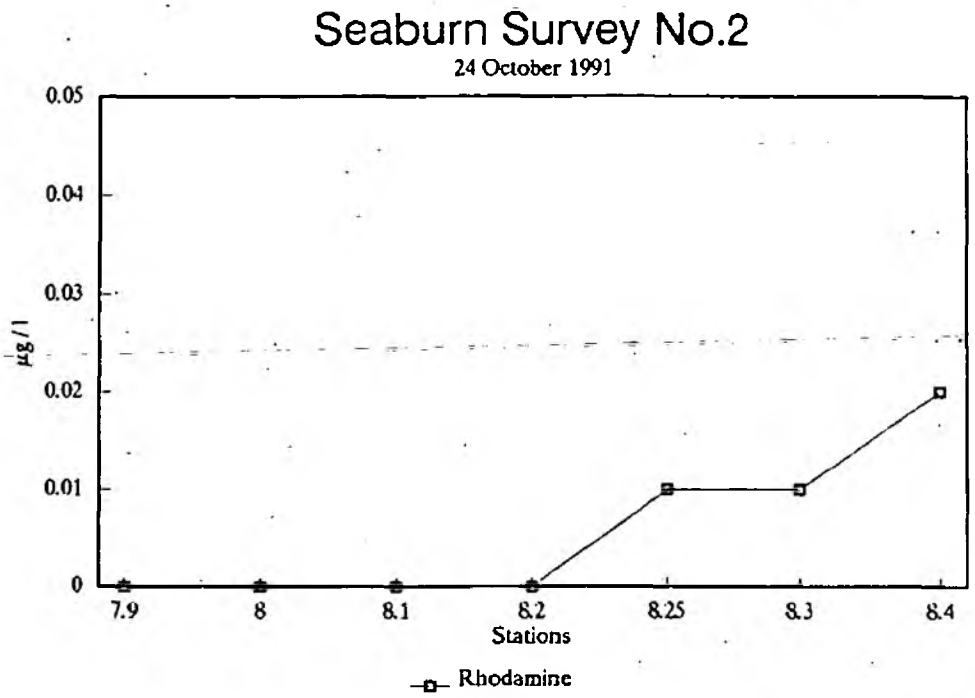


Figure 3: Samples taken at the Seaburn Sewer outfall, following the release of the tracers



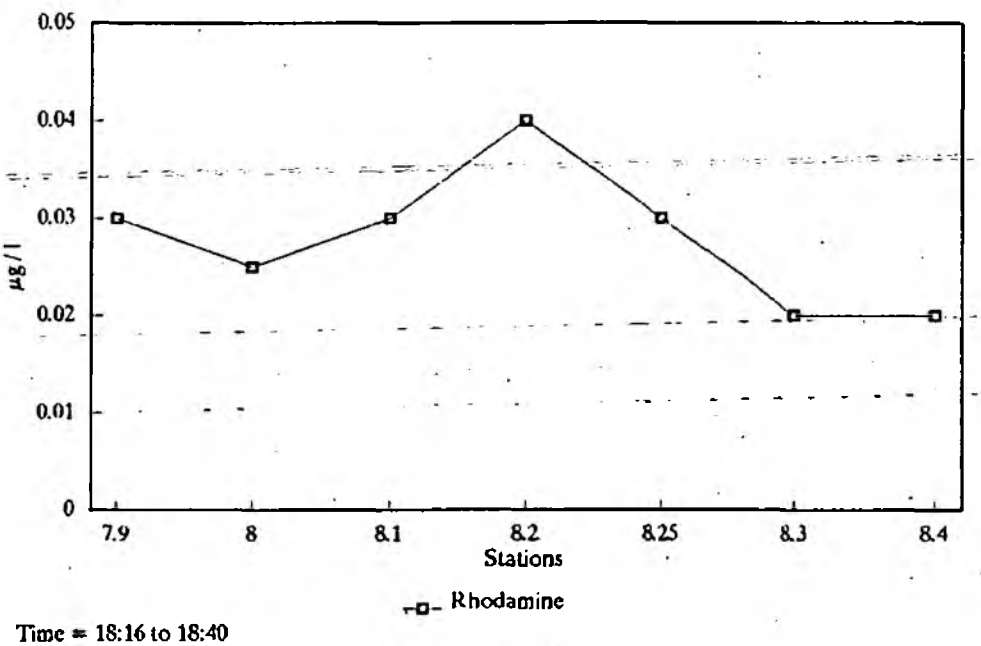


Figure 4: Example of Rhodamine levels along Seascale beach: about 18 h after the dye release into the manhole

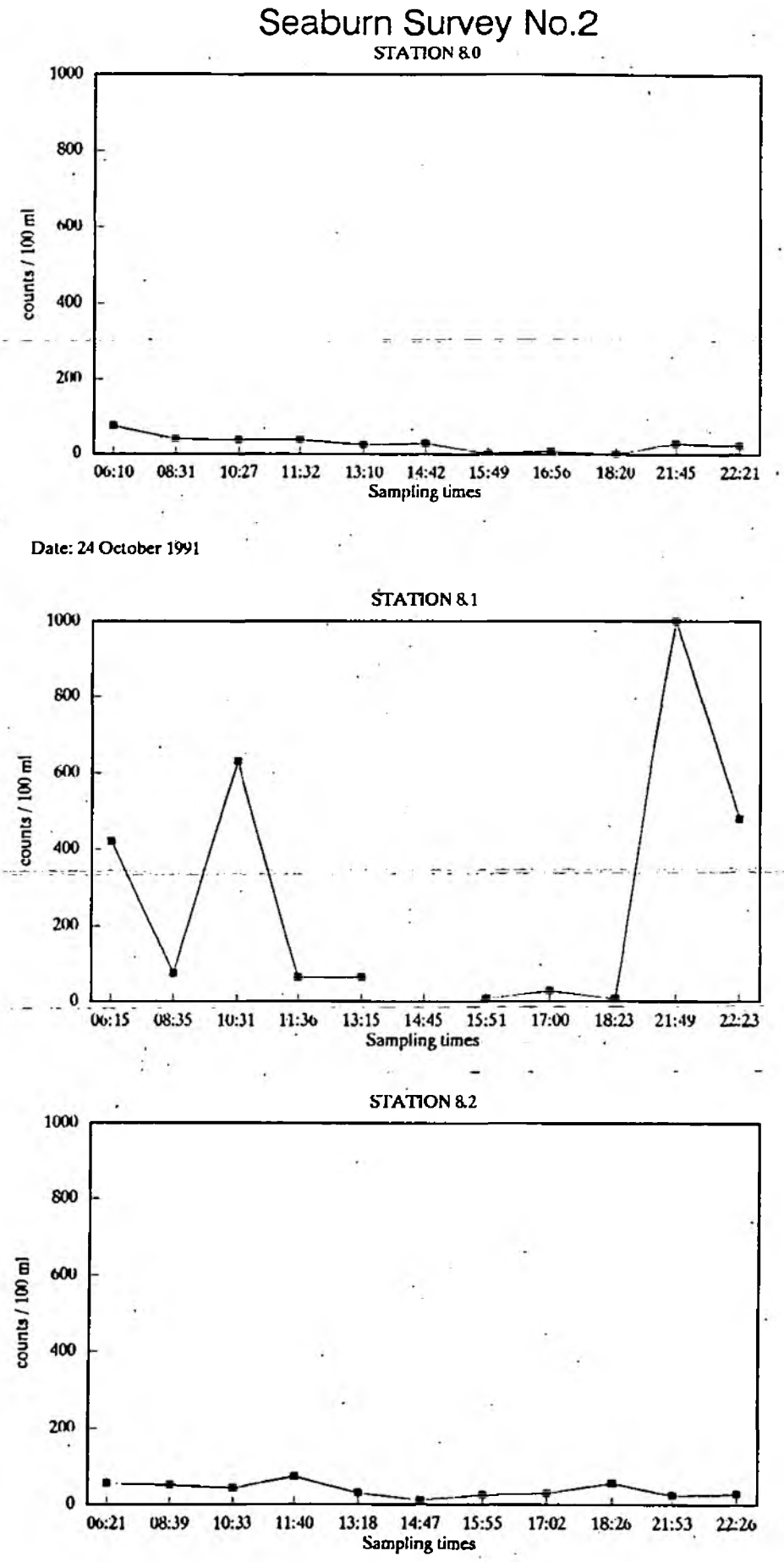


Figure 5: B. globigii concentrations with time, for three stations

APPENDIX 1

SURVEY DETAILS

High Water:

date	time	time
23-10-91	11:44	23:59
24-10-90	12:19	-
25-10-90	00:39	

Tidal Height:

date	(m)	(m)
23-10-91	9.3	9.6
24-10-90	9.5	-
25-10-90	9.7	

Flow in the sewer: 5.6 Ml/day

Flow in the plant:

At 00:30 (24-10-91)	26 l/sec
Average for the day	40 l/sec

Location of sites:

Station	Latitude	Longitude
5.0	54 21 20	03 24 50
6.0	54 21 70	03 25 50
7.9	54 23 20	03 29 20
8.0*	54 23 55	03 29 55
8.1	54 23 72	03 29 73
8.2	54 23 88	03 29 95
8.25	54 24 10	03 29 93
8.3	54 24 24	03 30 44
8.4	54 24 42	03 30 64
8.5	54 24 48	03 30 49
9.0	54 24 80	03 31 70
10.0	54 26 30	03 32 40

* EC monitoring point

APPENDIX 2

RAW DATA

KEY:

TOT.COL.	Total coliforms
RHODA.	Rhodamine B
STATIONS	Manhole = 101 to 114
	Calder/Ehen = 201 to 216
	Beach = 5.0 to 10.0

UNITS:

Total coliforms in counts / 100 ml

E. coli in counts / 100 ml

B. globigii in counts / 100 ml

Rhodamine in µg / l

ROW	STATION	DATE	Time	Tot.col.	E. coli	globigii	Rhoda.	
								45
								46
1	10.00	911023	17.00	*	*	31	*	47
2	8.20	911023	17.48	*	*	56	*	48
3	8.10	911023	17.45	*	*	43	*	49
4	8.00	911023	17.40	*	*	12	*	50
5	7.90	911023	17.36	*	*	48	*	51
6	5.00	911023	15.45	*	*	0	*	52
7	5.00	911024	11.45	20	20	0	0.000	53
8	5.00	911024	14.40	960	630	1	0.000	54
9	5.00	911024	21.50	18000	2300	15	0.000	55
10	6.00	911024	11.35	*	*	14	0.000	56
11	7.90	911024	6.00	910	660	150	0.210	57
12	7.90	911024	8.25	1130	650	210	0.010	58
13	7.90	911024	10.24	510	480	29	0.000	59
14	7.90	911024	14.40	1050	670	31	0.000	60
15	7.90	911024	15.41	390	330	24	0.000	61
16	7.90	911024	16.50	300	7	13	0.000	62
17	7.90	911024	18.16	3900	270	9	0.030	63
18	7.90	911024	21.40	1100	100	14	0.000	64
19	8.00	911024	6.10	1020	720	76	0.880	65
20	8.00	911024	8.31	810	710	41	0.020	66
21	8.00	911024	10.27	2100	1800	39	0.000	67
22	8.00	911024	11.32	2000	1500	39	0.000	68
23	8.00	911024	13.10	4200	1900	27	0.000	69
24	8.00	911024	14.42	2600	950	30	0.000	70
25	8.00	911024	15.49	1000	710	4	0.000	71
26	8.00	911024	16.56	1900	190	10	0.000	72
27	8.00	911024	18.20	1300	70	3	0.025	73
28	8.00	911024	21.45	16000	3300	30	0.000	74
29	8.00	911024	22.21	1500	120	25	0.000	75
30	8.10	911024	6.15	850	600	420	0.140	76
31	8.10	911024	8.35	670	590	74	0.010	77
32	8.10	911024	10.31	810	550	630	0.000	78
33	8.10	911024	11.36	2100	1900	63	0.000	79
34	8.10	911024	13.15	1300	740	63	0.000	80
35	8.10	911024	14.45	530	320	*	0.000	81
36	8.10	911024	15.51	1700	490	7	0.010	82
37	8.10	911024	17.00	1100	200	28	0.000	83
38	8.10	911024	18.23	1300	120	7	0.030	84
39	8.10	911024	21.49	600	120	1000	0.000	85
40	8.10	911024	22.23	700	260	480	0.005	86
41	8.20	911024	6.21	750	490	56	0.500	87
42	8.20	911024	8.39	710	460	52	0.000	88
43	8.20	911024	10.33	590	430	43	0.000	89
44	8.20	911024	11.40	870	840	73	0.000	90

8.20	911024	13.18	1300	830	30	0.000
8.20	911024	14.47	3600	810	11	0.000
8.20	911024	15.55	1100	630	27	0.000
8.20	911024	17.02	1100	600	30	0.000
8.20	911024	18.26	700	250	56	0.040
8.20	911024	21.53	300	300	25	0.000
8.20	911024	22.26	700	270	28	0.010
8.25	911024	8.45	710	680	0	0.000
8.25	911024	10.36	800	530	22	0.000
8.25	911024	11.44	530	490	57	0.000
8.25	911024	13.21	680	440	120	0.000
8.25	911024	14.50	610	390	58	0.000
8.25	911024	15.55	560	480	*	0.010
8.25	911024	17.11	900	430	47	0.010
8.25	911024	18.30	470	470	48	0.030
8.25	911024	21.56	1600	400	28	0.030
8.25	911024	22.30	370	180	5	0.005
8.30	911024	6.29	520	340	0	0.055
8.30	911024	8.49	530	530	27	0.025
8.30	911024	10.38	480	450	31	0.000
8.30	911024	11.46	510	510	20	0.000
8.30	911024	13.25	2300	2200	16	0.000
8.30	911024	14.53	670	350	23	0.010
8.30	911024	16.00	540	410	27	0.010
8.30	911024	17.15	400	350	80	0.010
8.30	911024	18.35	330	130	30	0.020
8.30	911024	21.58	1100	100	40	0.000
8.30	911024	22.33	400	90	42	0.000
8.40	911024	6.37	430	380	380	0.020
8.40	911024	8.55	530	340	600	0.090
8.40	911024	10.42	2400	2400	40	0.000
8.40	911024	11.49	580	460	25	0.000
8.40	911024	13.28	1700	570	23	0.000
8.40	911024	14.55	1700	570	52	0.010
8.40	911024	16.09	380	190	26	0.010
8.40	911024	17.21	900	80	30	0.020
8.40	911024	18.40	300	80	64	0.020
8.40	911024	22.04	310	130	35	0.030
8.40	911024	22.36	3500	2600	100	0.030
8.50	911024	6.54	4800	3800	2600	0.010
8.50	911024	9.07	880	600	780	0.080
8.50	911024	10.48	1800	630	1200	0.000
8.50	911024	11.52	390	220	170	0.500
8.50	911024	13.32	550	420	440	0.000
8.50	911024	15.00	8100	5800	2900	0.040
8.50	911024	17.35	21000	8300	1800	0.010

91	9.00	911024	10.45	880	670	240	0.000
92	9.00	911024	13.35	120	40	25	0.000
93	9.00	911024	15.05	80	70	20	0.000
94	10.00	911024	11.05	1050	990	0	0.000
95	10.00	911024	13.55	4700	1500	51	0.000
96	10.00	911024	15.30	2400	880	15	0.000
97	101.00	911024	0.30	113000	64000	*	*
98	102.00	911024	0.35	93000	91000	*	*
99	103.00	911024	0.40	119000	79000	*	*
100	104.00	911024	0.45	119000	79000	*	*
101	105.00	911024	0.50	117000	73000	*	*
102	106.00	911024	0.55	156000	103000	*	*
103	107.00	911024	1.00	148000	95000	*	*
104	108.00	911024	1.05	142000	101000	*	*
105	109.00	911024	1.10	106000	87000	*	*
106	110.00	911024	1.15	152000	72000	*	*
107	111.00	911024	1.20	112000	75000	*	*
108	112.00	911024	1.25	135000	91000	*	*
109	113.00	911024	1.30	131000	95000	*	*
110	114.00	911024	1.35	109000	109000	*	*
111	201.00	911024	0.25	78000	59000	100000	930000
112	202.00	911024	0.28	42000	82000	333333	160000
113	203.00	911024	0.31	95000	63000	480000	32000
114	204.00	911024	0.34	99000	74000	240000	1900
115	205.00	911024	0.37	102000	82000	56000	320.000
116	206.00	911024	0.42	83000	46000	36000	100.000
117	207.00	911024	0.47	97000	69000	12000	70.000
118	208.00	911024	0.52	82000	38000	240000	100.000
119	209.00	911024	0.57	95000	71000	100000	42.000
120	210.00	911024	1.02	93000	51000	48000	40.000
121	211.00	911024	1.07	116000	68000	600000	19.800
122	212.00	911024	1.12	85000	61000	480000	19.500
123	213.00	911024	1.17	48000	48000	36000	19.800
124	214.00	911024	1.22	68000	51000	74000	16.000
125	215.00	911024	1.27	71000	71000	50000	29.500
126	216.00	911024	1.35	101000	63000	*	12.000