

**ENVIRONMENTAL DEPARTMENT
CORNWALL AREA**



NRA

FINAL DRAFT REPORT

**ST COLUMB MAJOR STW UV
DISINFECTION SURVEY
1994**

September 1995

INV/95/006

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ST COLUMB MAJOR STW UV DISINFECTION SURVEY - 1994

1. INTRODUCTION

1.1. Background

Non-compliance at Mawgan Porth EC bathing water was recorded in 1986, 1987, 1989, 1990, 1991 and 1993. The River Menalhyl flows out onto Mawgan Porth beach and is considered the major source for bathing water non-compliance. St Columb Major STW final effluent is the major discharge within the Menalhyl catchment although previous work has shown diffuse sources within the catchment may be as important. Because of bathing water failure South West Water Services Ltd (SWWSL) installed ultra violet (UV) disinfection to the final effluent during the summer of 1994 for a trial period. All sites are shown in figure 1.

St Columb Major STW final effluent has always been considered a factor in Mawgan Porth bathing beach failure. Therefore, it was requested (by Tidal Waters Quality) to assess the effect of the UV disinfection on bacteriological quality of the River Menalhyl.

1.2. Objective

To assess the effectiveness of UV disinfection of St Columb Major STW final effluent on bacteriological quality of the River Menalhyl at Mawgan Porth.

2. METHODS

Following discussions with Tidal Waters Quality and SWWSL a survey was drawn up to assess the following:

- * bacteriological quality of the River Menalhyl catchment with and without UV disinfection of St Columb Major STW final effluent
- * flow measurements of final effluent, River Menalhyl and River Gluvian
- * the effect of UV disinfection on sanitary quality of the River Menalhyl downstream of St Columb Major STW final effluent

It was deemed necessary to collect twenty-four hours of data before and after UV switch off. Allowing for time of travel at the downstream sites this entailed a survey of sixty hours duration. Stable low-flow conditions were required for the survey.

A bacteriophage viral tracer was dosed into the final effluent channel at UV switch off. This was used to measure the actual time of travel to the downstream sites to enable the impact of the UV switch off to be followed. Time series plots were calculated by using the time of travel to shift the data, so that the same body of water can be referred to at each of the corresponding sampling points. This allows the degree of bacterial die off to be assessed.

The STW discharge flow was measured using a continuously logging ultrasonic flow gauge. River flows were measured at the River Menalhyl upstream STW, River Menalhyl at ford and River Gluvian at road bridge. Spot measurements were taken using conventional techniques on

five occasions at each site (see appendix 2). All other flow readings were calculated from these spot measurements by using a best fit line graph or calculation.

Hourly rainfall data was obtained from the two nearest sites north and south of the River Menalhyl to give an indication of rainfall on site during the survey. Data is shown in appendix 5.

Detailed schedules for the survey are contained in appendix 1. Sampling sites are shown in figure 1.

3. RESULTS

The survey was carried out from the 19 to 21 October 1994. The sampling site at Mawgan Porth was relocated (see figure 1) after the first two samples. This was because the site was being influenced by high tides.

Bacteriological and flow data are shown in appendices 2 and 3. Sanitary data is shown in appendix 4. Rainfall data during the survey is shown in appendix 5.

Bacteriological time series plots expressed per 100 ml are shown in figures 2 to 4. Bacteriological time series plots expressed per second are shown in figures 5 to 10. Time series plots were calculated by shifting the data in relation to the time of travel.

4. DISCUSSION

At the start of the survey an overflow from the balancing tank for the sand filters appeared to discharge direct to the final effluent channel bypassing the UV disinfection and final effluent sampling point. This is not illegal (A. Blewett pers. comm.) but the current NRA sampling point will not sample the full impact of St Columb Major STW. The balancing tank was reset at the start of the survey and no further overflow was observed during the survey.

Time of travel along the River Menalhyl from St Columb Major STW was ten hours to the ford and twelve hours to Mawgan Porth (see appendix 2). This gives an average speed of approximately 500 metres per hour (0.14 metres per second) to both sites. This is much as expected for this type of river taking into account the flow conditions and the morphology of the catchment (K. Barker pers. comm.).

Bacterial concentrations and loadings in the final effluent increased by approximately four orders of magnitude following UV switch off. In the River Menalhyl immediately downstream of the final effluent the increase was approximately two orders of magnitude. There was good agreement between calculated and actual bacterial concentrations and loadings for the downstream site.

Bacterial concentrations and loadings in the River Menalhyl at the ford and Mawgan Porth suggested no more than a slight trend upwards much less than an order of magnitude. This indicated a substantial die off of bacteria between the final effluent discharge point and Mawgan Porth. Thus, the effect of UV disinfection on bacterial concentrations and loadings at Mawgan Porth was likely to have been minimal.

The survey was planned to be undertaken in dry weather and low flow. However, rainfall immediately before and towards the end of the survey (see appendix 5) caused some variation

in flow (see appendix 3). Storm overflows throughout the catchment were inspected at regular intervals during the survey, but operation of the overflows was not observed. Therefore, the increasing bacterial concentrations and loadings at the start and end of the survey were most likely to have been due to general catchment runoff. The effect of this on bacterial concentrations and loadings was more marked than the UV switch off, with over an order of magnitude increase in the River Menalhyl at Mawgan Porth.

Biochemical oxygen demand (BOD) of the final effluent increased slightly because of UV switch off. This was reflected in a slight increase in BOD in the River Menalhyl immediately downstream. The increase in BOD would be expected due to the much greater biological activity of an effluent without UV disinfection. None of the other sanitary determinands analysed for showed any obvious change because of UV switch off.

5. CONCLUSIONS

1. UV switch off resulted in a substantial increase in bacterial concentrations in St Columb STW final effluent and the River Menalhyl immediately downstream.
2. UV switch off resulted in a slight upward trend in bacterial concentrations in the River Menalhyl at the ford and Mawgan Porth. The effect of rain during the survey resulted in a much more noticeable increase.
3. The overflow from the balancing tank at St Columb STW bypasses the current final effluent monitoring point.

6. ACTIONS

1. A review of bacteriological data to identify requirements for further work.

Action - Tidal Waters Quality

2. St Columb Major STW final effluent monitoring point to be moved to the flow measurement flume to rectify problem of overflow from balancing tank.

Action - Senior Water Quality Officer (West)

Figure 1. River Menalhyl catchment, discharges and sampling points

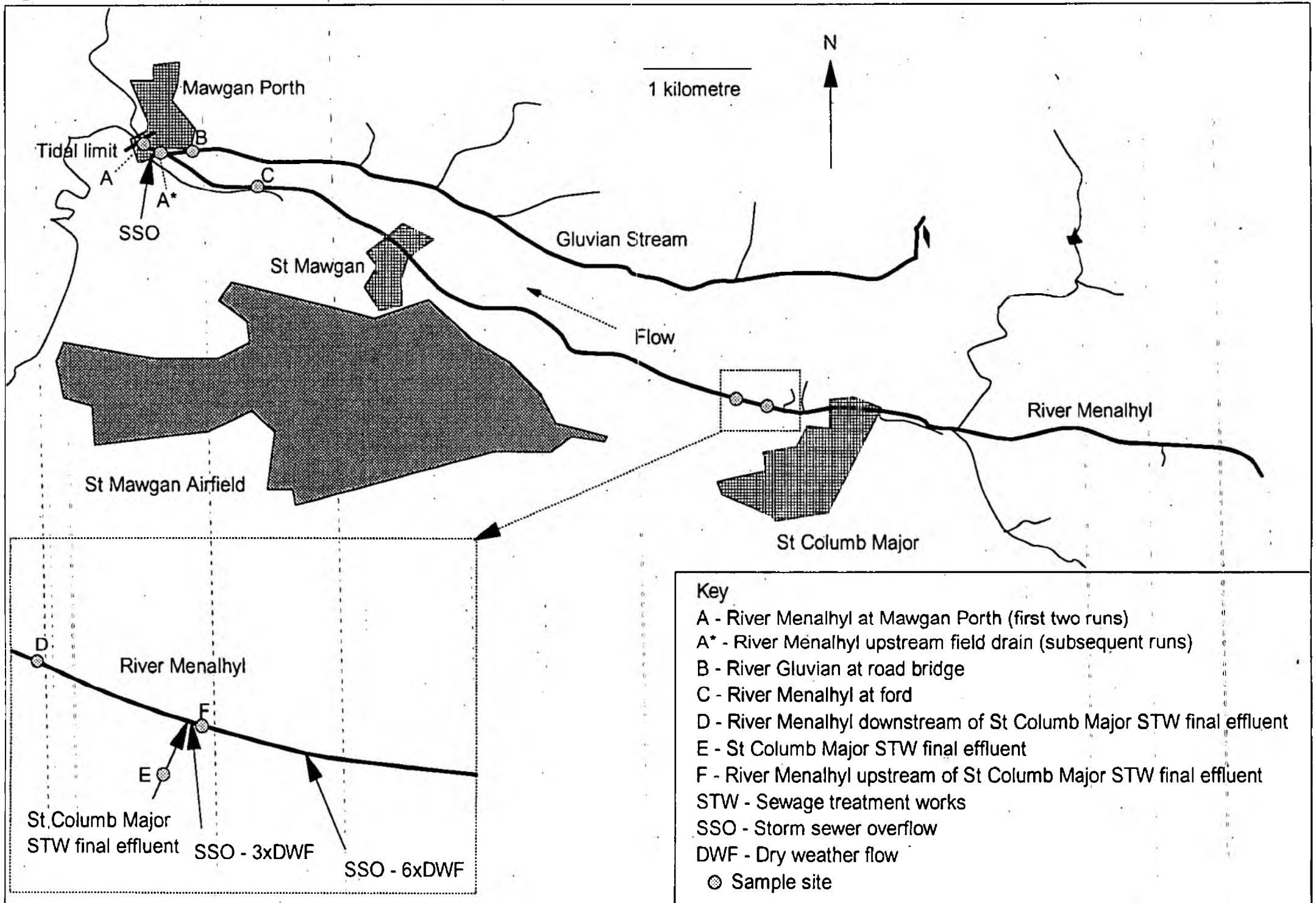


Figure 2. Total coliforms per 100 ml - time series plot

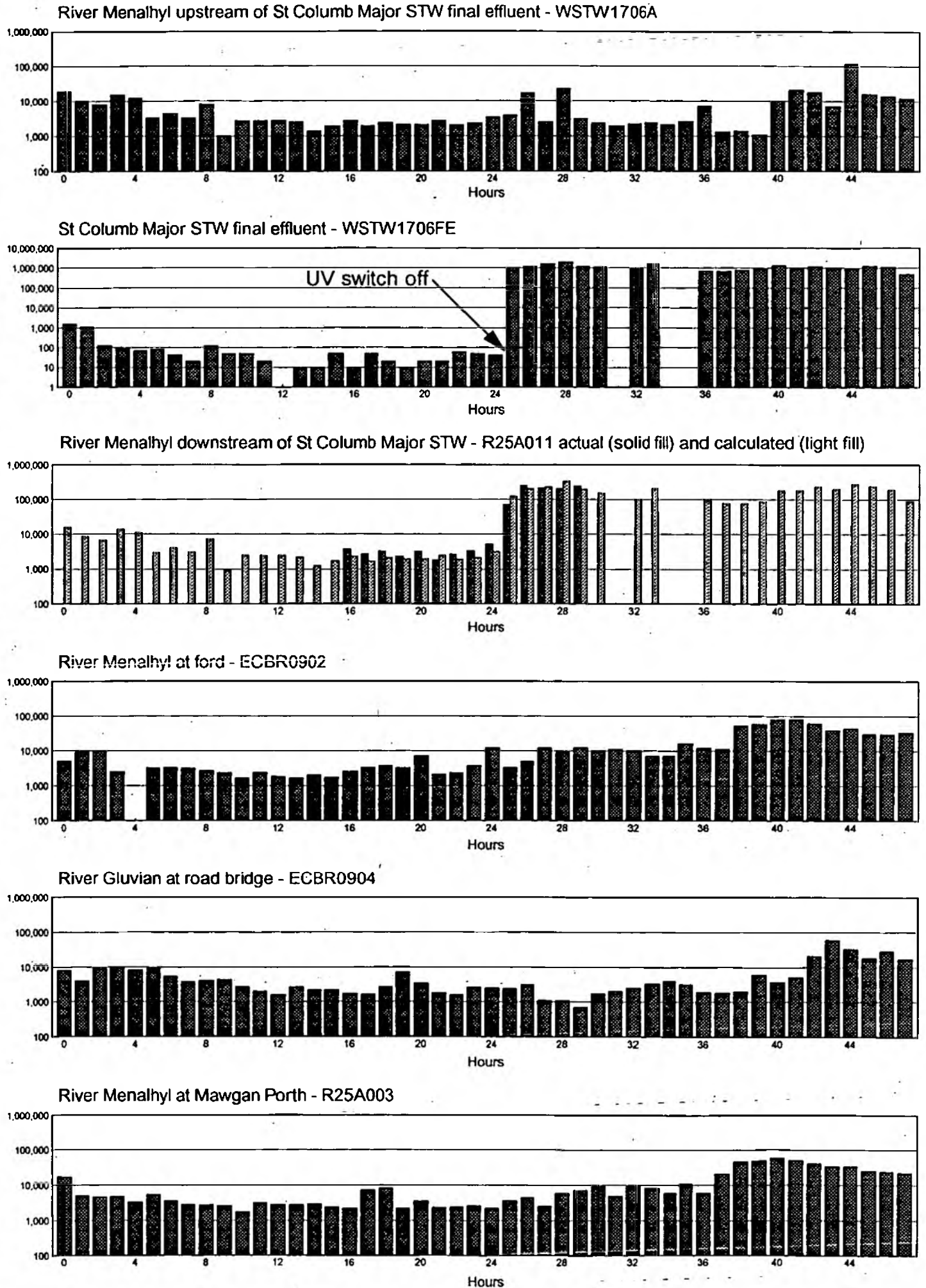


Figure 3. Faecal coliforms per 100 ml - time series plot

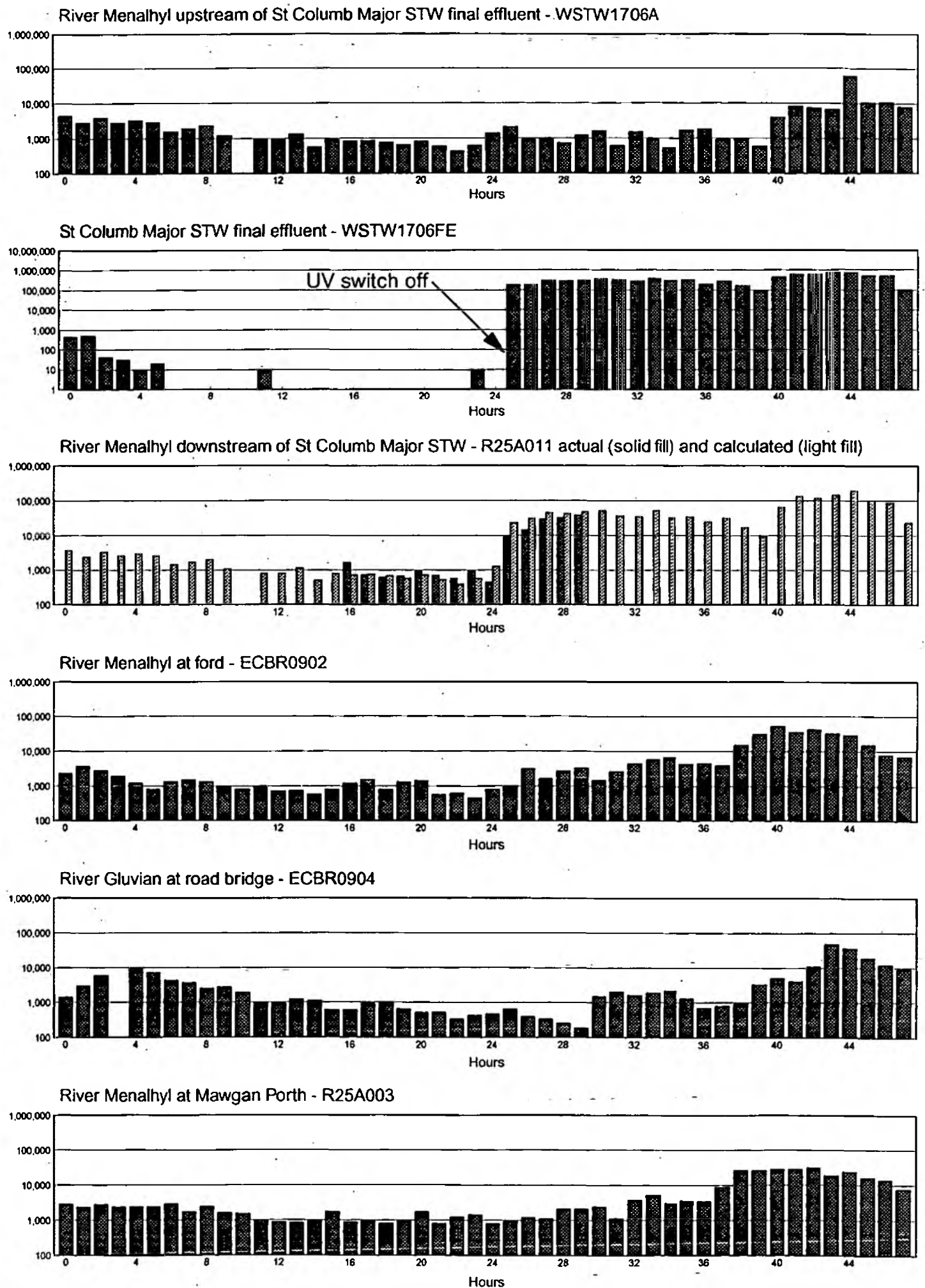
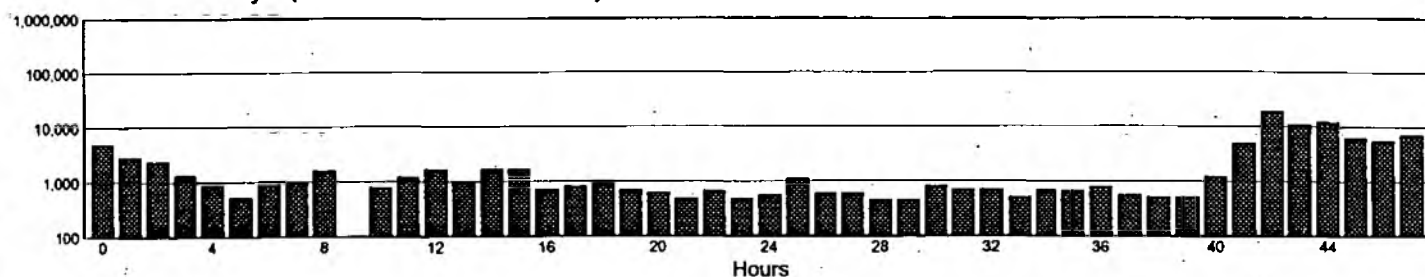
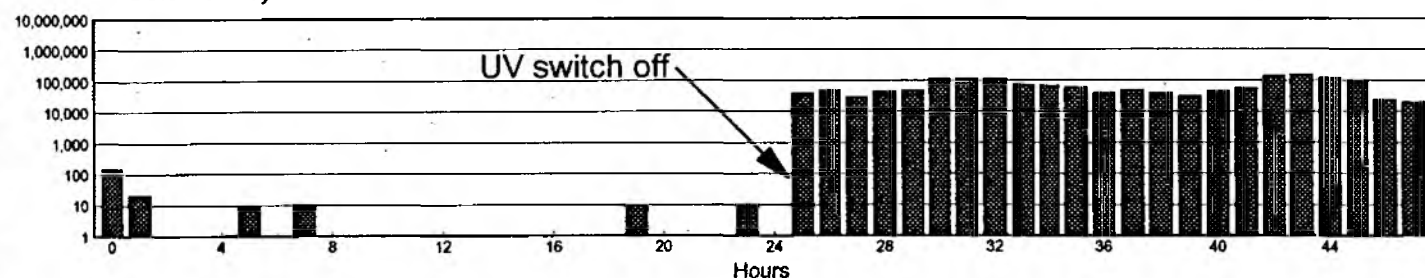


Figure 4. Faecal streptococci per 100 ml - time series plot

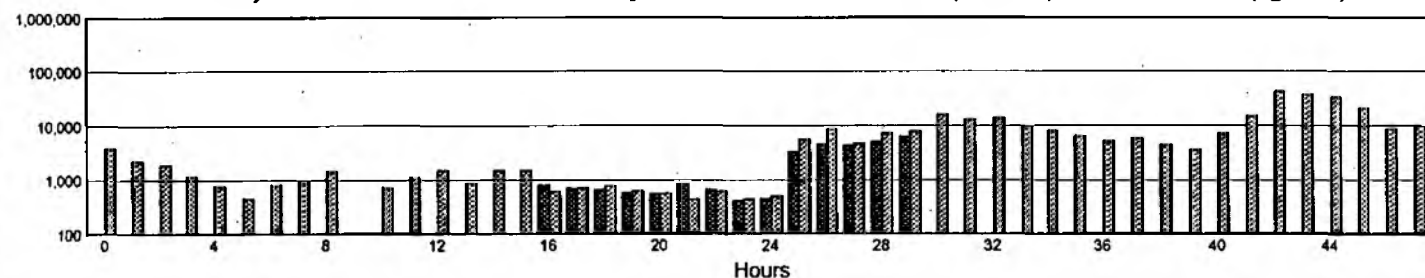
River Menalhyl upstream of St Columb Major STW final effluent - WSTW1706A



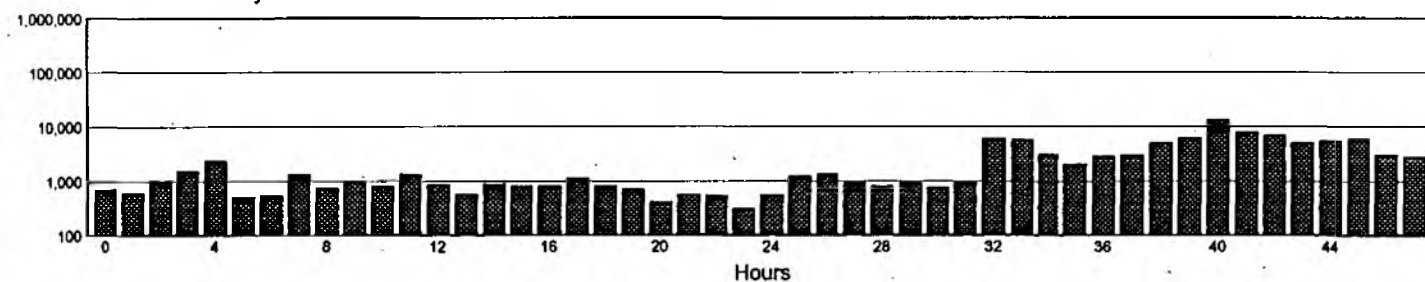
St Columb Major STW final effluent - WSTW1706FE



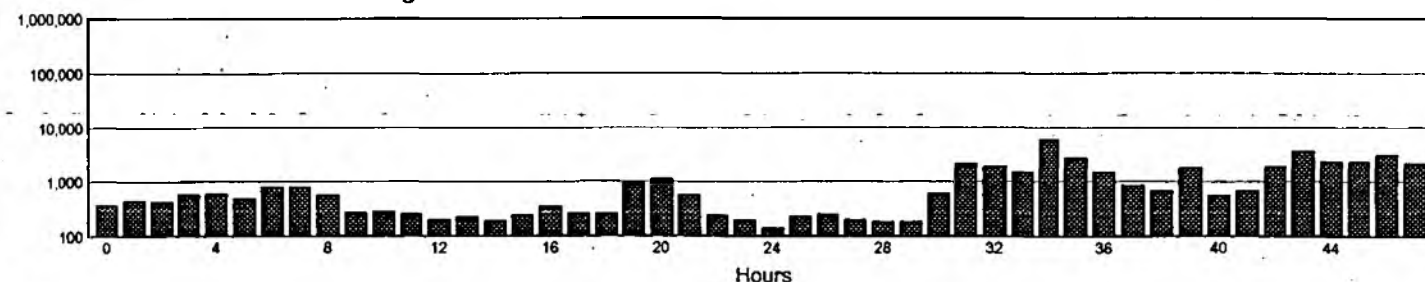
River Menalhyl downstream of St Columb Major STW - R25A011 actual (solid fill) and calculated (light fill)



River Menalhyl at ford - ECBR0902



River Gluvian at road bridge - ECBR0904



River Menalhyl at Mawgan Porth - R25A003

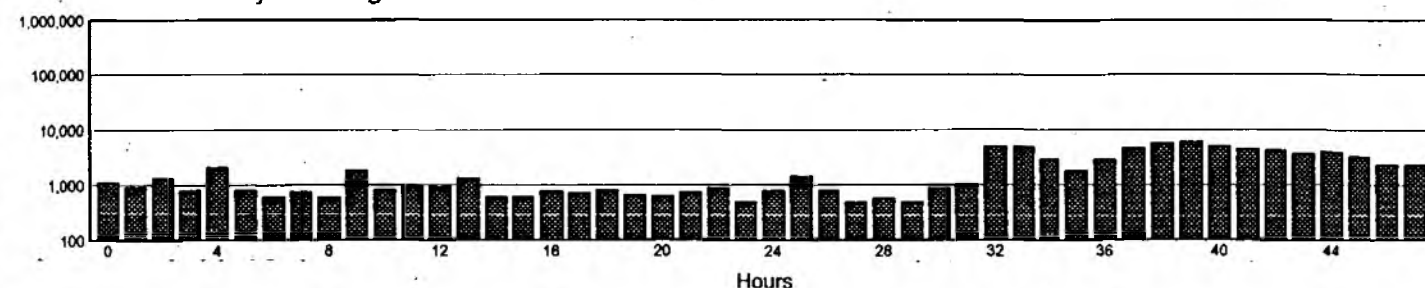
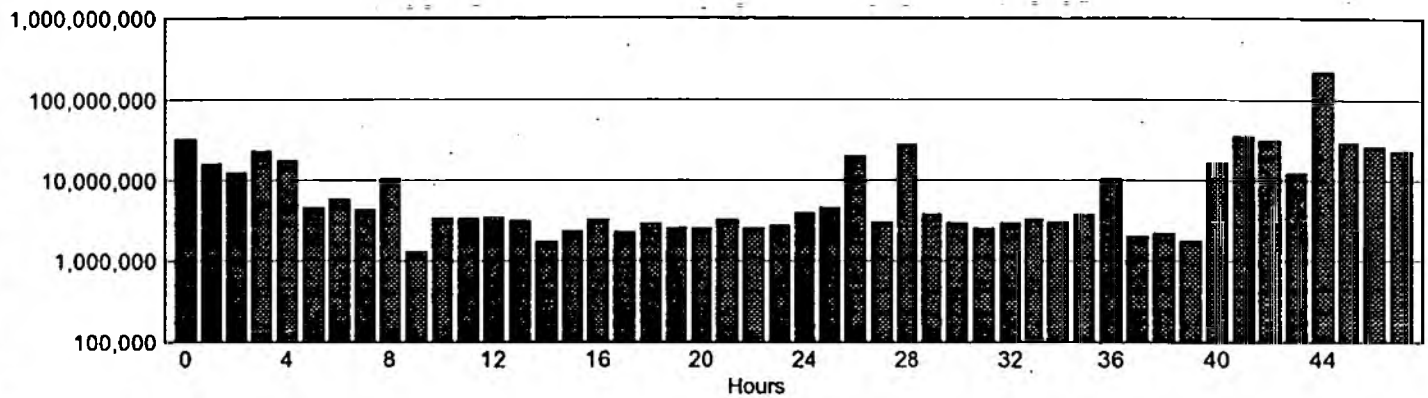
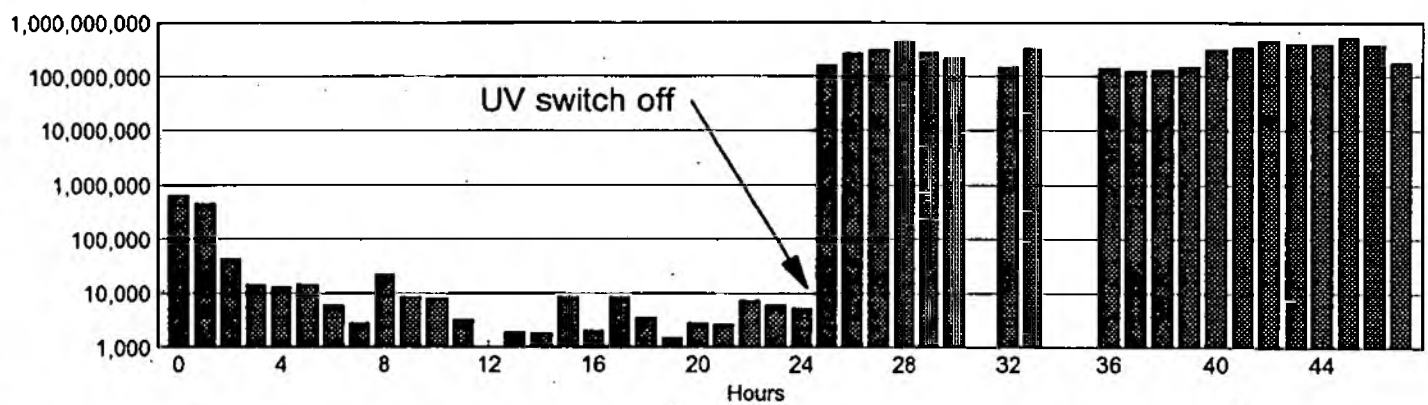


Figure 5. Total coliforms per second - time series plot

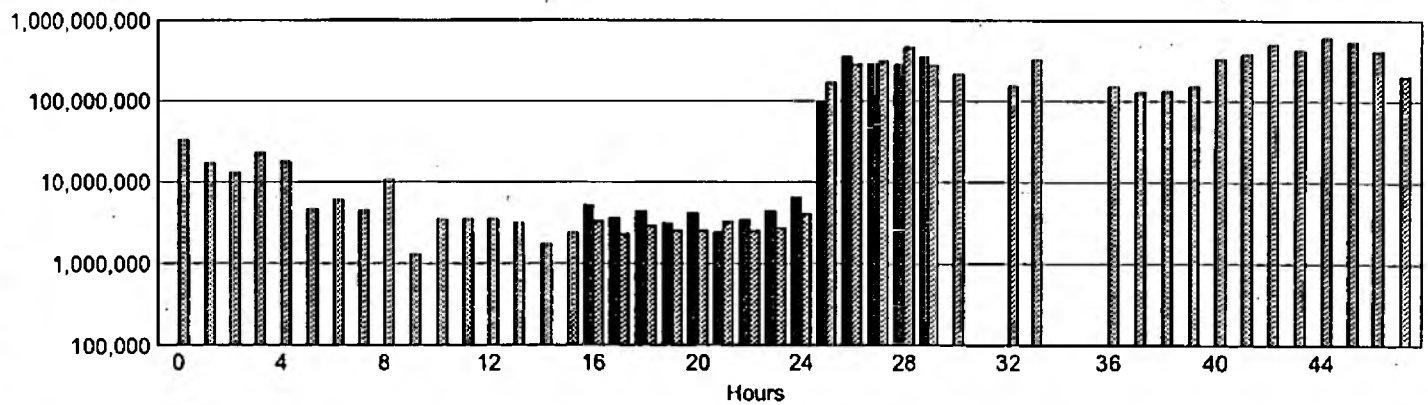
River Menalhyl upstream of St Columb Major STW final effluent - WSTW1706A



St Columb Major STW final effluent - WSTW1706FE



River Menalhyl downstream of St Columb Major STW - R25A011 actual (solid fill) and calculated (light fill)



River Menalhyl at ford - ECBR0902

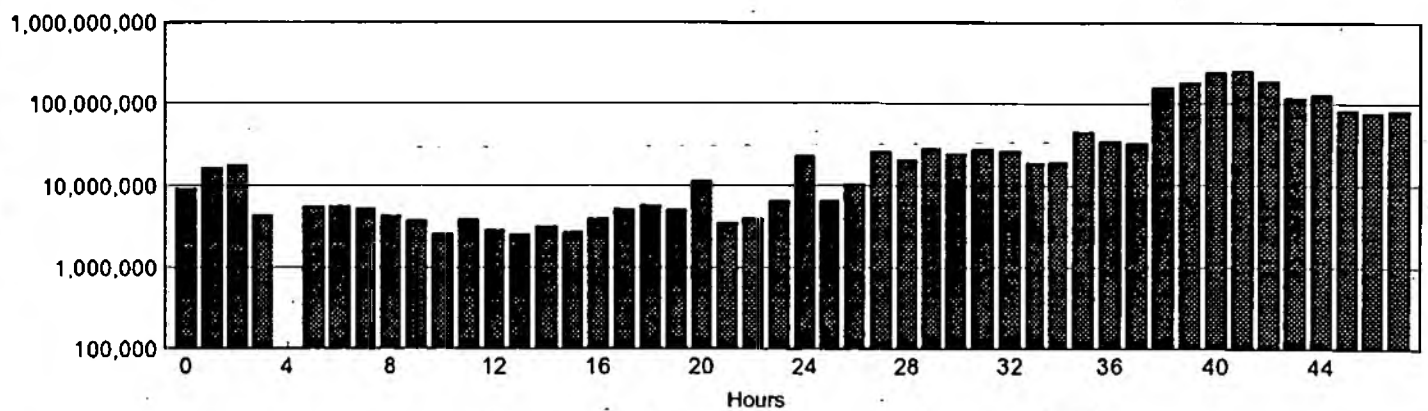
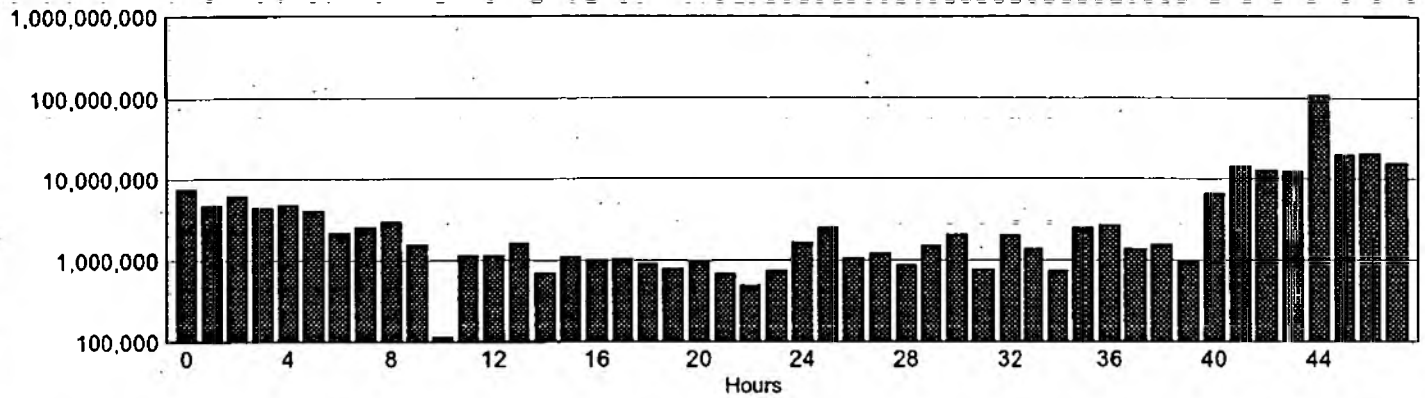
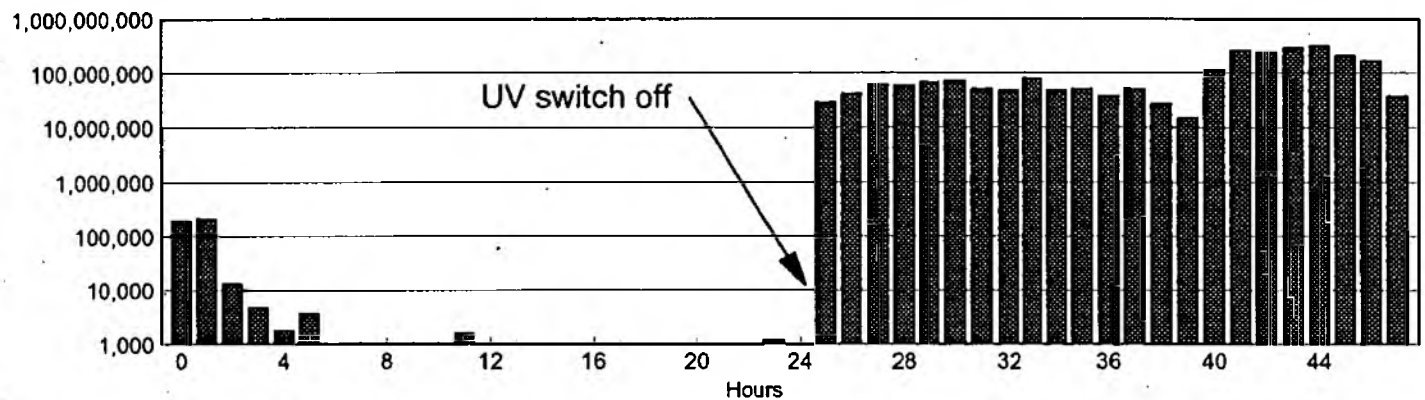


Figure 6. Faecal coliforms per second - time series plot

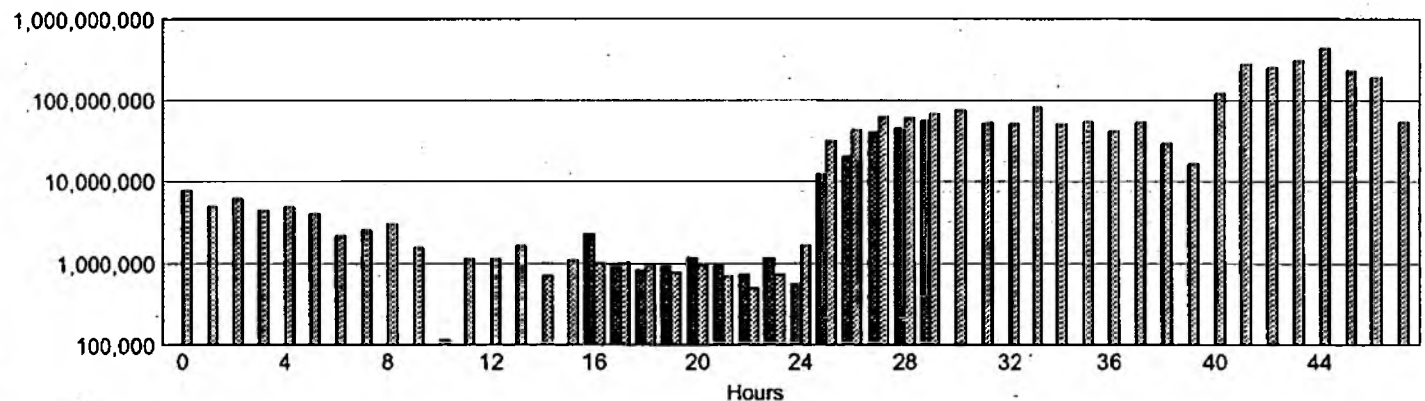
River Menalhyl upstream of St Columb Major STW final effluent - WSTW1706A



St Columb Major STW final effluent - WSTW1706FE



River Menalhyl downstream of St Columb Major STW - R25A011 actual (solid fill) and calculated (light fill)



River Menalhyl at ford - ECBR0902

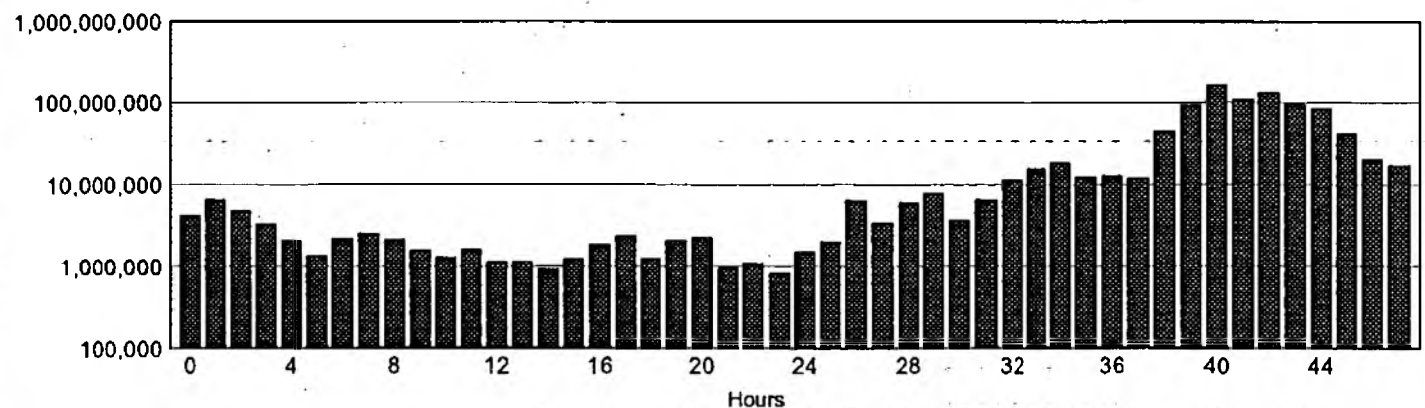
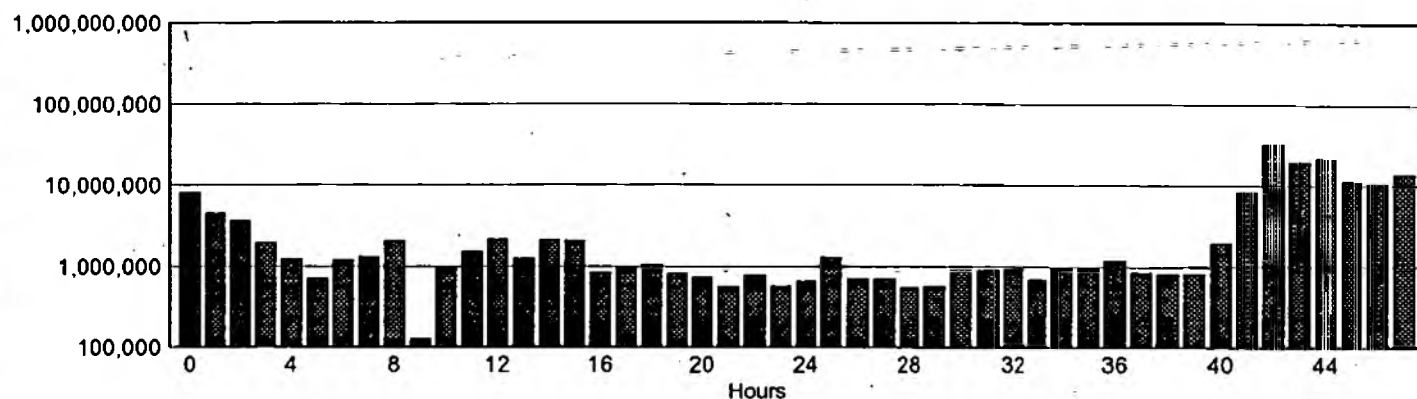
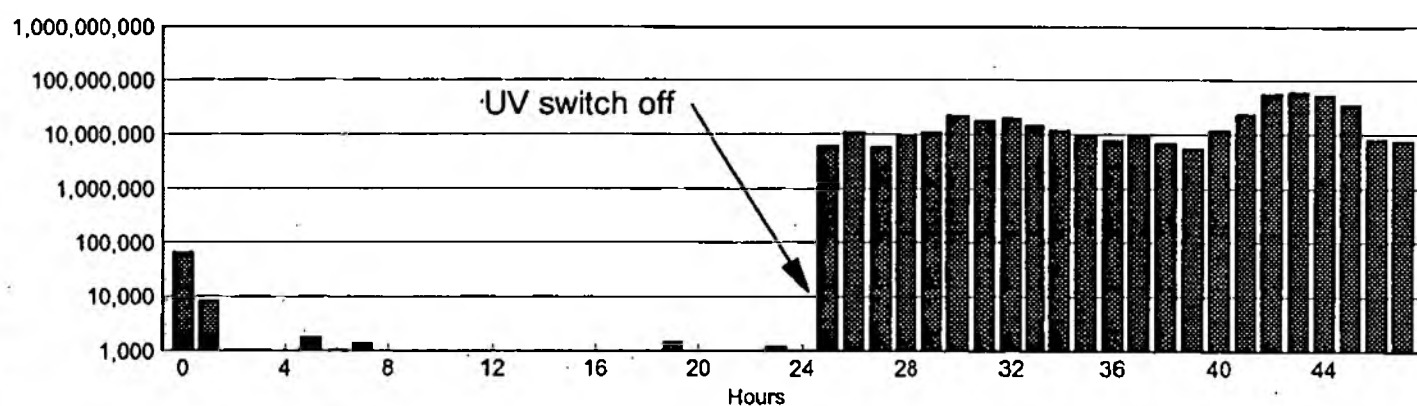


Figure 7. Faecal streptococci per second - time series plot

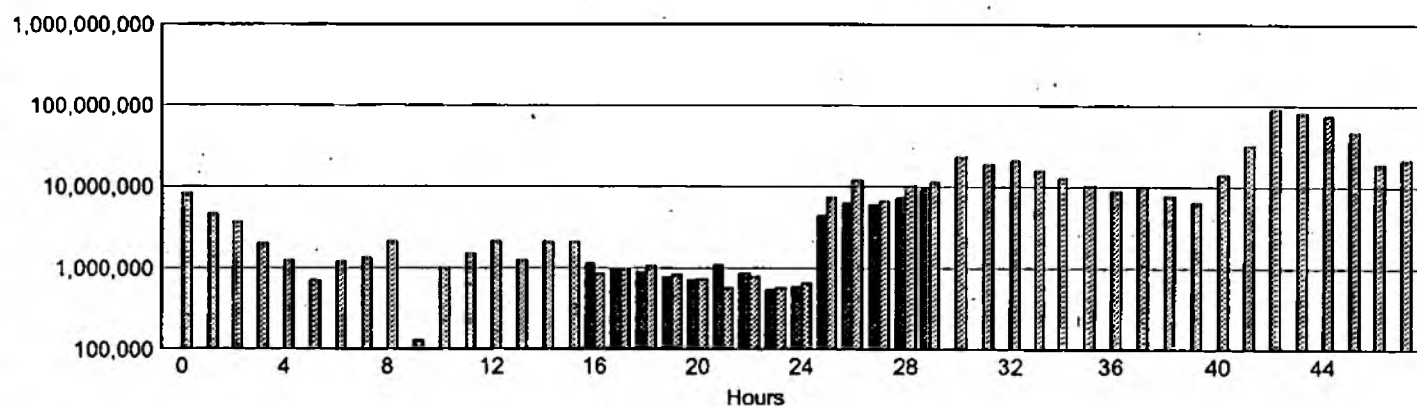
River Menalhyl upstream of St Columb Major STW final effluent - WSTW1706A



St Columb Major STW final effluent - WSTW1706FE



River Menalhyl downstream of St Columb Major STW - R25A011 actual (solid fill) and calculated (light fill)



River Menalhyl at ford - ECBR0902

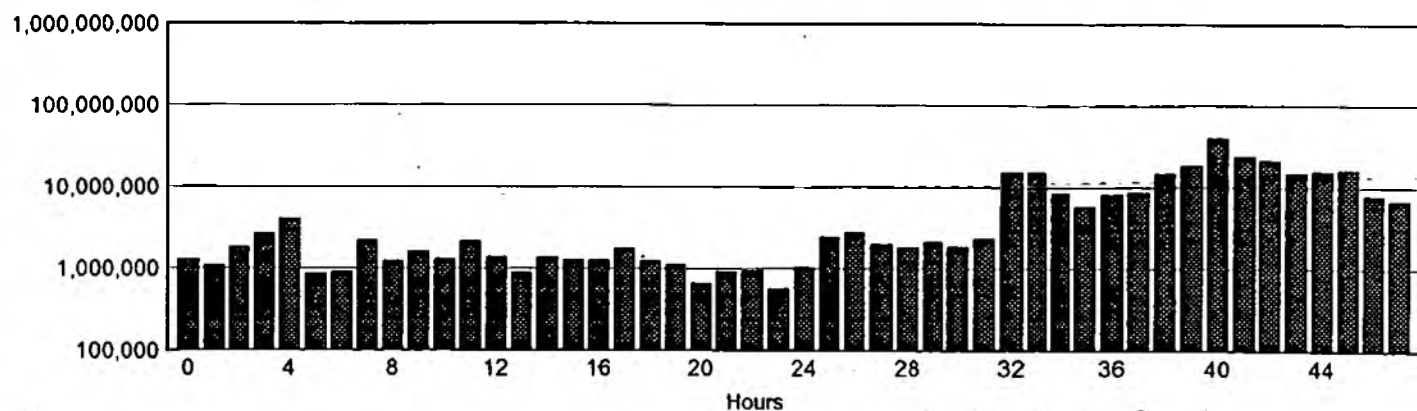
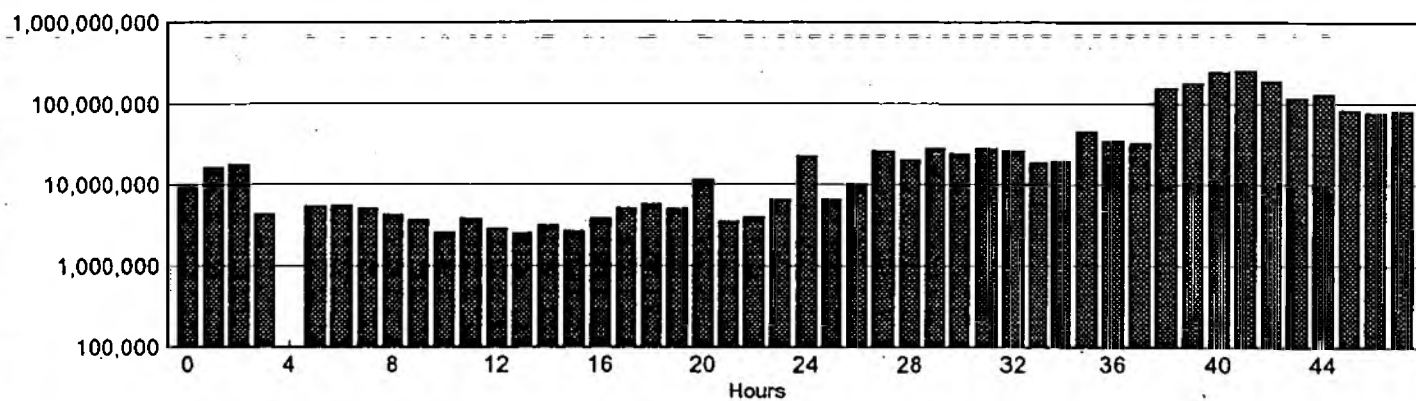
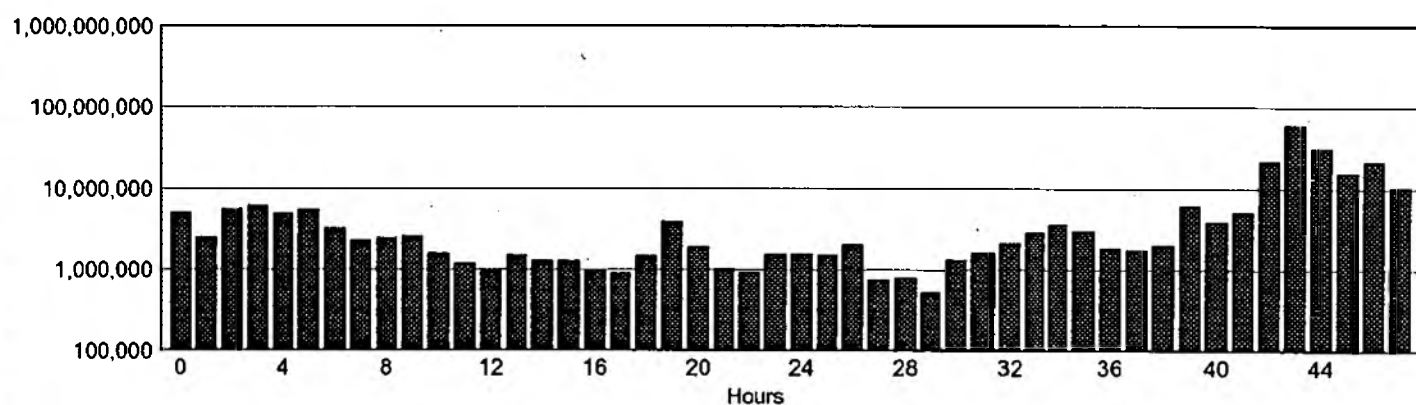


Figure 8. Total coliforms per second - time series plot

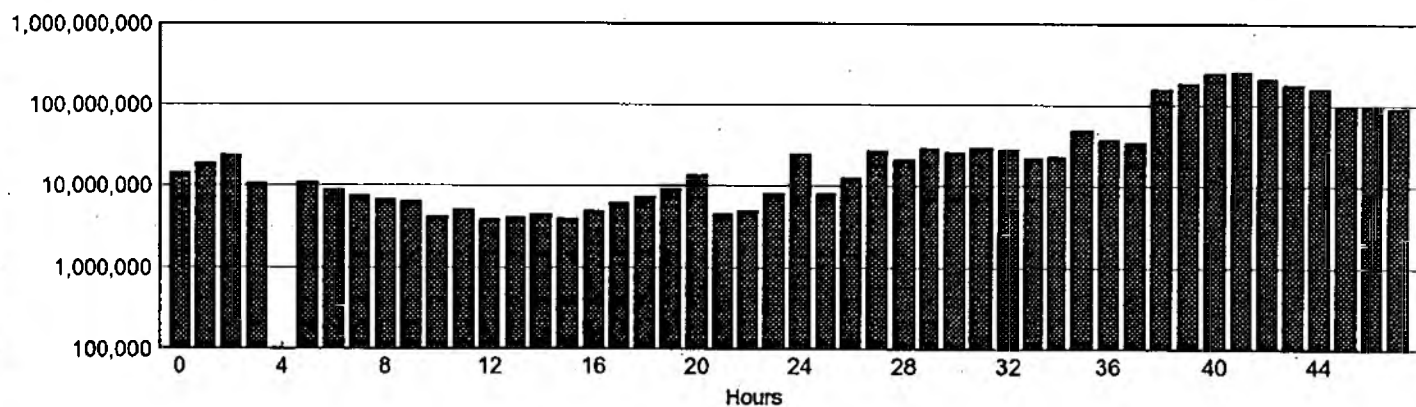
River Menalhyl at ford - ECBR0902



River Gluvian at road bridge - ECBR0904



River Menalhyl at Mawgan Porth - R25A003 (calculated)



River Menalhyl at Mawgan Porth - R25A003

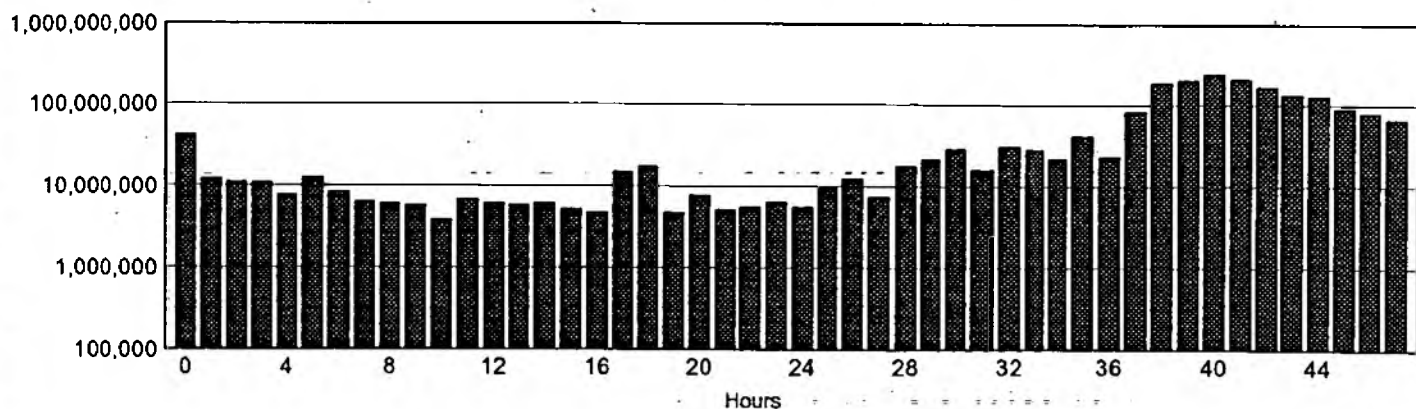
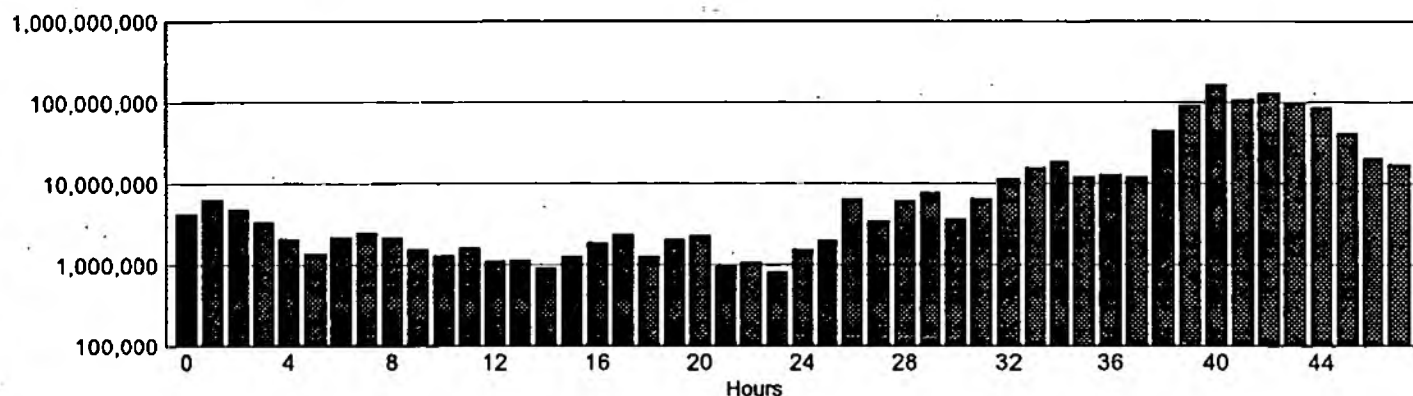
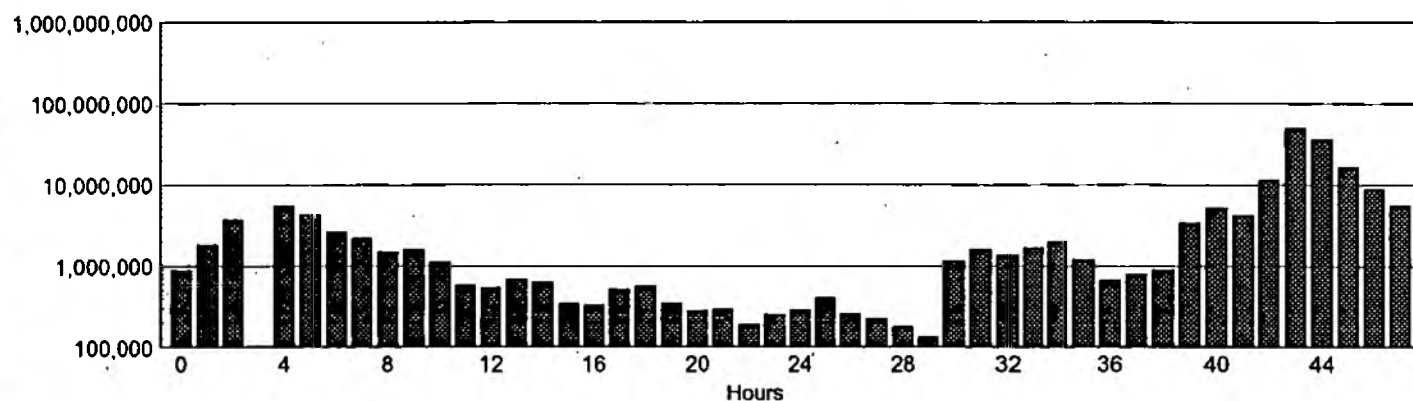


Figure 9. Faecal coliforms per second - time series plot

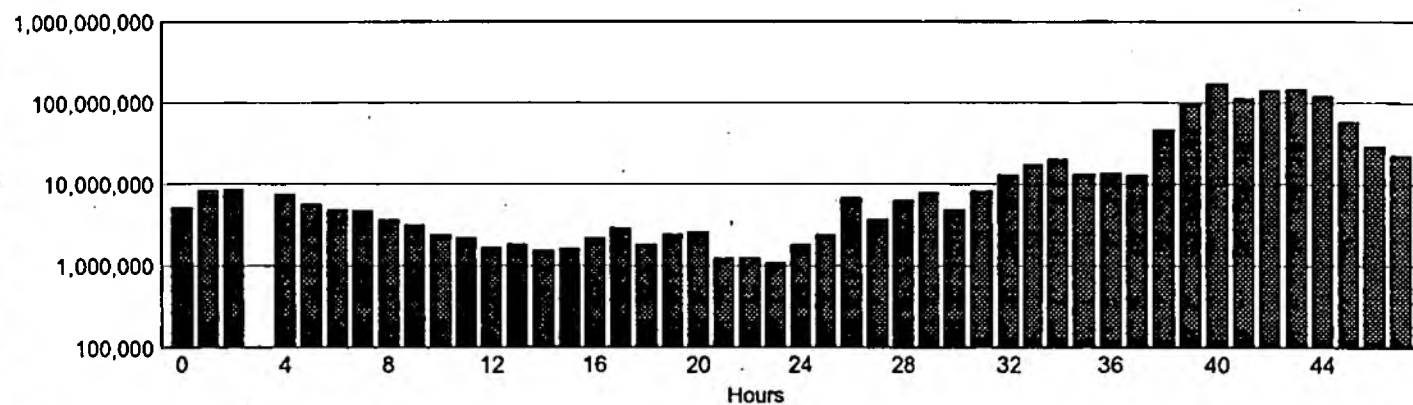
River Menalhyl at ford - ECBR0902



River Gluvian at road bridge - ECBR0904



River Menalhyl at Mawgan Porth - R25A003 (calculated)



River Menalhyl at Mawgan Porth - R25A003

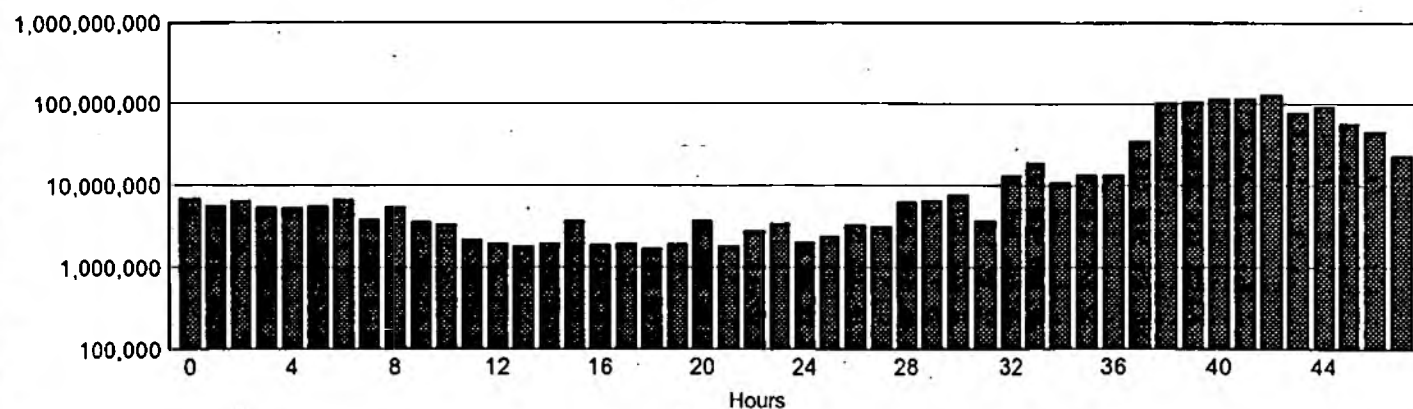
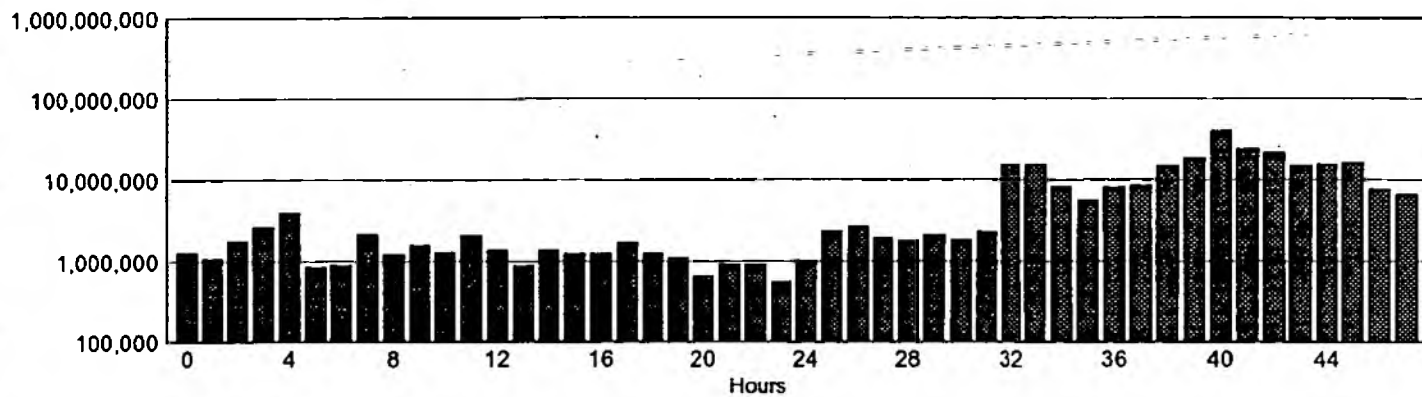
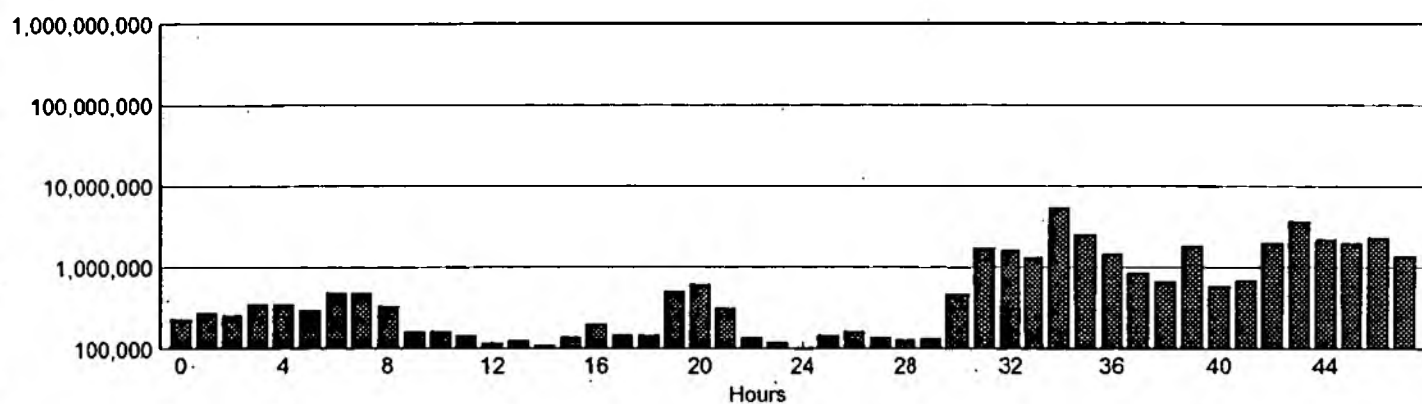


Figure 10. Faecal streptococci per second - time series plot

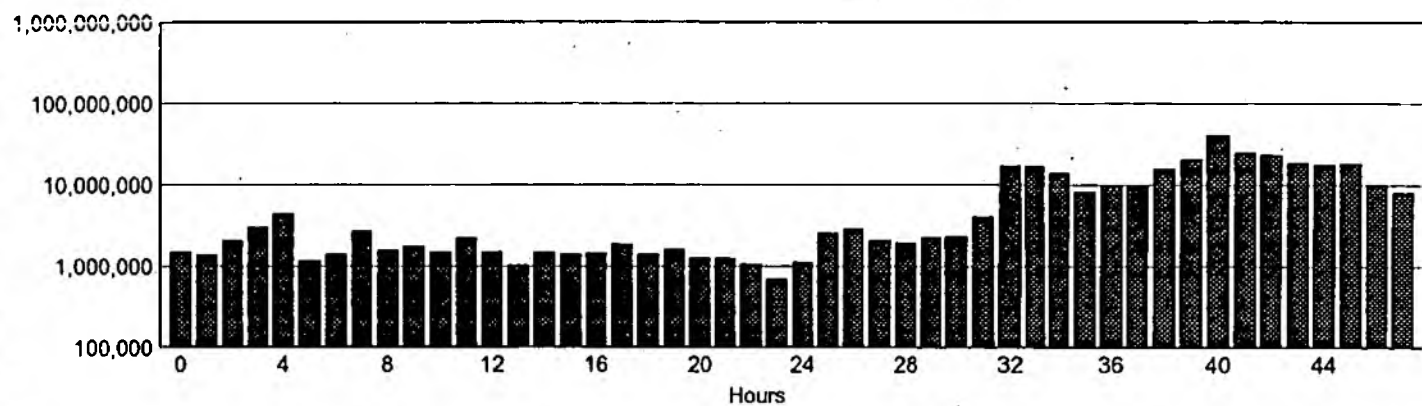
River Menalhyl at ford - ECBR0902



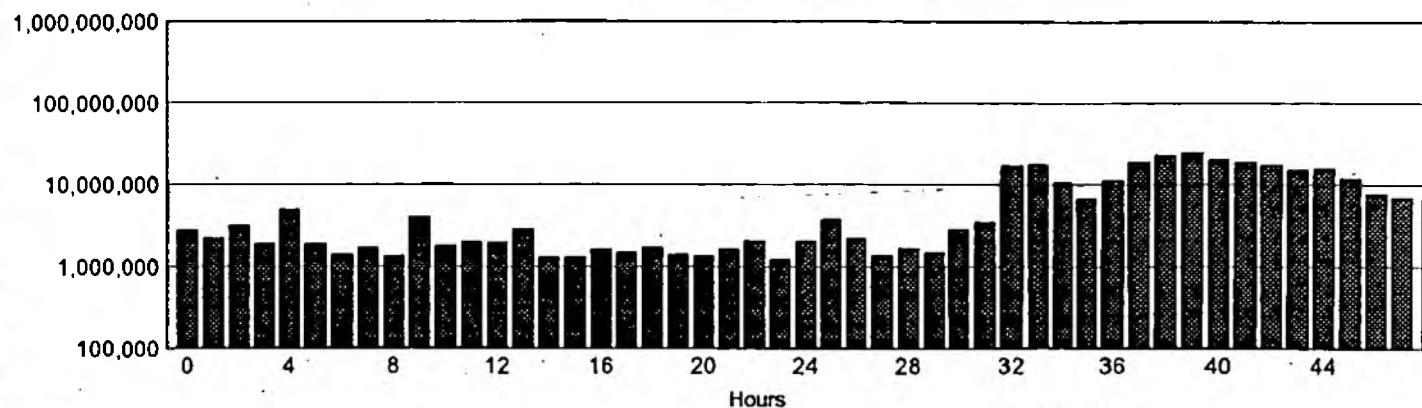
River Gluvian at road bridge - ECBR0904



River Menalhyl at Mawgan Porth - R25A003 (calculated)



River Menalhyl at Mawgan Porth - R25A003



Appendix 1. Menalhyl survey schedule and guidance notes

Day 1

- 07:00 A arrives at STW in vehicle 1 with runs 1,2,4,6,8,10,12 and 14
- 08:00 A starts run 1
- 13:00 B arrives at STW in vehicle 2
- 14:00 A departs with run 1 in vehicle 2
B starts run 2
- 15:00 D arrives at BRIDGE in vehicle 3 with runs 3,5,7,9,11,13,15,16 and 17
- 16:00 D starts run 3
- 19:15 F calls in at STW and BRIDGE and departs with runs 2 and 3
- 19:30 C arrives at STW
E arrives at BRIDGE
- 20:00 B and C start run 4
D and E start run 5
- 23:15 G calls in at STW and BRIDGE and departs with runs 4 and 5

Day 2

- 00:00 B and C start run 6
D and E start run 7
- 07:00 A arrives at STW in vehicle 2
- 07:15 H calls in at STW and BRIDGE and departs with runs 6 and 7
- 07:30 I arrives at bridge
C departs
E departs
- 08:00 B and D depart in vehicle 2 (B picks up D from BRIDGE)
A starts run 8 and adds globigii to site B
I starts run 9
- 13:15 J arrives at BRIDGE
- 13:30 I departs BRIDGE, calls in at STW and departs with runs 8 and 9
- 14:00 A starts run 10
J starts run 11
- 19:00 B and D arrive at BRIDGE in vehicle 2
- 19:15 B arrives at STW in vehicle 2
- 19:30 J departs BRIDGE, calls in at STW and departs with runs 10 and 11
C arrives at BRIDGE
E arrives at STW
- 20:00 A departs in vehicle 2
D and E start run 12
B and C start run 13
- 23:15 K calls in at STW and BRIDGE and departs with runs 12 and 13

Day 3

00:00 D and E start run 14

B and C start run 15

07:15 L calls in at STW and BRIDGE and departs with runs 14 and 15

07:30 M arrives at BRIDGE (B transfers runs 16 and 17 to M)

C departs

E departs

08:00 B departs in vehicle 3

D departs in vehicle 1

M starts run 16

12:00 A arrives in vehicle 2 (M transfers run 17 to A)

13:30 M departs with run 16

14:00 A starts run 17

19:30 A departs with run 17

GUIDANCE NOTES FOR RIVER MENALHYL UV DISINFECTION SURVEY

The survey will be carried out over three days and will involve up to 12 people. It is essential that samplers and couriers stick to the attached timetable. If for any reason you are unable to arrive on time you must phone the survey minder at St Columb STW (either Tim Geatches, Rich Walmsley or Pete Long). They will take any appropriate action. If sampler M has any problems then contact Tim Geatches at work or home. Contact numbers will be:

G443 (Spare) - No vodaphone

H97 (BRIDGE) - 0831 803 841

L877 (STW) - 0836 794 816

Tim Geatches (Work) - 0208 78301 ext. 5055

Tim Geatches (Home) - 0566 782955

Locations of meeting points are as follows:

BRIDGE - Mawgan Porth bridge over the River Menalhyl (NGR SW 849 672)

STW - St Columb Major STW (NGR SW 906 640)

Couriers

Please allow two hours to travel from Exeter to St Columb. This should be plenty of time. Call in to the STW first and then travel onto the BRIDGE when picking up samples. Exeter labs are expecting delivery times as follows:

Day one

Courier A - 15-30 - 16-00

Courier F - 21-30 - 22-00

Day two

Courier G - 01-30 - 02-00

Courier H - 09-30 - 10-00 (Inform lab on arrival marked samples will be close to 10 hour limit)

Courier I - 15-30 - 16-00

Courier J - 21-30 - 22-00

Day three

Courier K - 01-30 - 02-00

Courier L - 09-30 - 10-00 (Inform lab on arrival marked samples will be close to 10 hour limit)

Courier M - 15-30 - 16-00

Courier A - 21-30 - 22-00

If you are going to be later than these times please ring the bacti lab via Comms Room or Reception.

Samplers

Please allow two hours to travel from Exeter to BRIDGE or STW. You need only bring yourself and your safety equipment. Please book yourself in and out with Comms Room. All logs, labels, bottles, sampling equipment and location maps will be in H97 (BRIDGE) and G443 (STW). Sampler M will need to transfer runs 16 and 17 to their own vehicle from H97 at the BRIDGE. Please make sure you have the correct run before starting. Each section of the run will start on the hour and will be given on the logsheets.

Appendix 2. Bacteriological data

TC = Total coliforms per 100 ml FC = Faecal coliforms per 100 ml

FS = Faecal streptococci per 100 ml

Phage = Bacteriophage viral tracer plaque forming units per ml

* = samples taken at Mewgan Porth Bridge thereafter upstream of ditch

Flow = litres per second

River Menaihl upstream STW WSW1706A					St Colum Major STW final effluent WSW1706FE					River Menaihl downstream STW (calc.) R25A011					River Menaihl downstream STW (calc.) R25A011					River Menaihl at ford ECBR0902					River Glavian at road bridge ECBR0904					River Menaihl at Mawgan Porth (act.) R25A003					River Menaihl at Mawgan Porth (calc.) R25A003				
Date	Time	TC	FC	FS	Flow	TC	FC	FS	Flow	TC	FC	FS	Flow	TC	FC	FS	Flow	TC	FC	FS	Flow	TC	FC	FS	Flow	TC	FC	FS	Flow	TC	FC	FS	Flow						
19-Oct-94	08:00:00	19000	4500	4800	188	1500	440	150	43					15434	3873	3852	211																						
19-Oct-94	09:00:00	10000	2900	2800	182	1100	310	20	41					8202	2417	2238	203																						
19-Oct-94	10:00:00	8000	3900	2300	157	130	40	<10	30					8633	3230	1901	190																						
19-Oct-94	11:00:00	15000	2900	1300	151	80	30	<10	16					13571	2825	1175	187																						
19-Oct-94	12:00:00	12000	3300	850	145	70	10	<10	18					10883	2937	758	163																						
19-Oct-94	13:00:00	3300	2900	510	139	80	20	<10	18					2931	2570	453	157																						
19-Oct-94	14:00:00	4400	1800	880	135	40	<10	<10	15					3984	1440	792	150																						
19-Oct-94	15:00:00	3300	1900	1000	132	20	<10	<10	14					2985	1718	905	148																						
19-Oct-94	16:00:00	8000	2300	1800	130	120	<10	<10	18					7042	2020	1405	148																						
19-Oct-94	17:00:00	1000	1200	100	128	50	<10	<10	17					880	1058	88	145																						
19-Oct-94	18:00:00	2700	90	790	127	50	<10	<10	18					2403	80	702	143																						
19-Oct-94	19:00:00	2700	900	1200	128	20	<10	<10	18					2398	800	1065	142																						
19-Oct-94	20:00:00	2800	900	1700	125	<10	<10	<10	18					2448	787	1488	143																						
19-Oct-94	21:00:00	2500	1300	1000	124	10	<10	<10	19					2189	1127	867	143																						
19-Oct-94	22:00:00	1400	570	1700	123	10	<10	<10	18					1223	497	1483	141																						
19-Oct-94	23:00:00	1900	900	1700	122	50	<10	<10	17					1874	790	1492	139																						
20-Oct-94	00:00:00	2700	830	700	121	10	<10	<10	20	3600	1900	800	141	2318	712	901	141																						
20-Oct-94	01:00:00	1800	880	800	120	50	<10	<10	17	2600	720	700	137	1970	753	701	137																						
20-Oct-94	02:00:00	2400	770	880	110	20	<10	<10	17	3200	810	880	138	2103	874	770	138																						
20-Oct-94	03:00:00	2100	850	890	118	10	<10	<10	15	2300	880	580	134	1888	577	614	134																						
20-Oct-94	04:00:00	2100	810	820	118	20	<10	<10	14	3100	880	540	132	1879	724	564	132																						
20-Oct-94	05:00:00	2700	580	480	118	20	<10	<10	13	1800	700	830	131	2434	522	432	131																						
20-Oct-94	06:00:00	2100	420	880	118	80	<10	<10	12	2800	580	680	130	1912	381	580	130																						
20-Oct-94	07:00:00	2300	820	480	118	50	<10	<10	12	3300	900	410	130	2092	584	437	130																						
20-Oct-94	08:00:00	3400	1400	580	117	40	<10	<10	13	5000	440	450	130	3064	1280	504	130																						
20-Oct-94	09:00:00	3800	2100	1100	118	1000000	180000	38000	18	70000	9000	3300	134	122837	23342	5508	134																						
20-Oct-94	10:00:00	17000	800	800	118	1180000	180000	48000	23	250000	14000	4400	141	203447	30115	8332	141																						
20-Oct-94	11:00:00	2500	1000	800	118	1540000	300000	29000	20	210000	20000	4300	139	223723	44022	4888	138																						
20-Oct-94	12:00:00	23000	720	450	121	2000000	270000	44000	22	200000	31000	5000	143	327154	42148	7150	143																						
20-Oct-94	13:00:00	3100	1200	480	124	1200000	290000	47000	23	240000	38000	6300	147	190370	48386	7742	147																						
20-Oct-94	14:00:00	2300	1800	800	127	1080000	380000	110000	20					148928	50382	15857	147																						
20-Oct-94	15:00:00	1900	580	700	130	>3000000	320000	110000	18						35594	12878	148																						
20-Oct-94	16:00:00	2200	1500	700	133	830000	270000	110000	18					100878	33507	13729	151																						
20-Oct-94	17:00:00	2400	1000	510	137	1580000	380000	70000	21					208423	51373	9748	158																						
20-Oct-94	18:00:00	2100	520	680	141	>99999	290000	89000	17						31867	8031	158																						
20-Oct-94	19:00:00	2800	1700	800	145	>3000000	320000	58000	18						33332	8358	181																						
20-Oct-94	20:00:00	7000	1800	780	148	710000	180000	38000	20					90890	24205	5220	188																						
20-Oct-94	21:00:00	1300	900	580	152	870000	270000	48000	19					75800	30800	5831	171																						
20-Oct-94	22:00:00	1400	1000	510	158	780000	180000	40000	17					75945	18824	4391	173																						
20-Oct-94	23:00:00	1100	800	510	160	880000	90000	37000	17					85514	9188	3534	177																						
21-Oct-94	00:00:00	10000	4000	1200	164	1280000	450000	47000	25					177989	82995	7258	189																						
21-Oct-94	01:00:00	21000	8400	4900	168	830000	820000	58000	42					182800	130720	15120	210																						
21-Oct-94	02:00:00	18000	7400	19000	173	1180000	800000	140000	40					232480	118888	41723	213																						
21-Oct-94	03:00:00	7900	8900	11000	177	1030000	740000	150000	40					195371	142034	38622	217																						
21-Oct-94	04:00:00	120000	80000	12000	181	910000	730000	120000	44					274489	181922	33120	225																						
21-Oct-94	05:00:00	18000	10700	8100	185	1220000	500000	84000	42																														

Appendix 3. Bacteriological loadings data

TC = Total coliforms per second

FC = Faecal coliforms per second

FS = Faecal streptococci per second

River Menahil upstream STW				St Colum Major STW final effluent				River Menahil downstream STW (act.)				River Menahil downstream STW (calc.)				River Menahil at ford				River Glavin at road bridge				River Menahil at Mewgan Porth (act.)				River Menahil at Mewgan Porth (calc.)			
WS171706A				WS171706E				R25A011				R25A011				ECBR0902				ECBR0904				R25A003				R25A003			
Date	Time	TC	FC	FS	TC	FC	FS	TC	FC	FS	TC	FC	FS	TC	FC	FS	TC	FC	FS	TC	FC	FS	TC	FC	FS	TC	FC	FS			
19-Oct-94	06:00:00	3.19E+07	7.58E+06	8.08E+06	6.45E+05	1.89E+05	8.43E+04				3.20E+07	7.75E+06	8.13E+06																		
19-Oct-94	09:00:00	1.87E+07	4.70E+06	4.54E+06	4.51E+05	2.09E+05	8.20E+03				1.87E+07	4.31E+06	4.54E+06																		
19-Oct-94	10:00:00	1.29E+07	6.12E+06	3.61E+06	4.29E+04	1.37E+04					1.29E+07	6.14E+06	3.61E+06																		
19-Oct-94	11:00:00	2.27E+07	4.38E+06	1.90E+06	1.44E+04	4.80E+03					2.27E+07	4.38E+06	1.99E+06																		
19-Oct-94	12:00:00	1.74E+07	4.79E+06	1.23E+06	1.29E+04	1.80E+03					1.74E+07	4.79E+06	1.23E+06																		
19-Oct-94	13:00:00	4.50E+08	4.03E+08	7.09E+05	1.44E+04	3.90E+03	1.80E+03				4.60E+08	4.03E+08	7.11E+05																		
19-Oct-94	14:00:00	5.94E+08	2.10E+06	1.19E+06	8.00E+03						5.95E+08	2.10E+06	1.19E+06																		
19-Oct-94	15:00:00	4.39E+08	2.51E+06	1.37E+06	2.80E+03		1.40E+03				4.39E+08	2.51E+06	1.37E+06																		
19-Oct-94	16:00:00	1.04E+07	2.99E+06	2.08E+06	2.18E+04						1.04E+07	2.99E+06	2.08E+06				4.44E+07	1.30E+07	3.70E+06	3.09E+06	8.45E+05	2.39E+05									
19-Oct-94	17:00:00	1.28E+08	1.54E+06	1.28E+05	8.50E+03						1.29E+08	1.54E+06	1.28E+05				8.10E+06	4.19E+06	1.29E+06	3.11E+06	2.65E+06	2.27E+05									
19-Oct-94	18:00:00	3.43E+08	1.14E+03	1.00E+06	8.00E+03						3.44E+08	1.14E+03	1.00E+06				1.81E+07	8.44E+06	1.07E+06	4.98E+06	8.88E+05	2.29E+05									
19-Oct-94	19:00:00	3.40E+08	1.13E+06	1.51E+06	3.20E+03	1.80E+03					3.41E+08	1.14E+06	1.51E+06				1.77E+07	4.78E+06	1.77E+06	2.48E+06	1.80E+06	2.73E+05									
19-Oct-94	20:00:00	3.50E+08	1.13E+06	2.13E+06							3.50E+08	1.13E+06	2.13E+06				4.35E+06	3.31E+06	2.81E+06	8.48E+06	3.98E+06	2.58E+05									
19-Oct-94	21:00:00	3.10E+08	1.81E+06	1.24E+06	1.90E+03						3.10E+08	1.81E+06	1.24E+06				2.08E+06	3.99E+06	3.99E+06	8.10E+06		3.45E+05									
19-Oct-94	22:00:00	1.77E+08	7.81E+05	2.09E+06	1.80E+03						1.77E+08	7.81E+05	2.09E+06				8.44E+06	1.38E+06	8.50E+05	4.80E+06	5.40E+06	3.45E+05									
19-Oct-94	23:00:00	2.52E+08	1.10E+06	2.07E+06	8.50E+03						2.53E+08	1.10E+06	2.07E+06				5.54E+06	2.18E+06	8.90E+05	5.40E+06	4.20E+06	2.94E+05									
20-Oct-94	00:00:00	8.27E+08	1.00E+06	8.47E+05	2.00E+03			5.08E+08	2.29E+06	1.13E+06	3.27E+08	1.00E+06	8.47E+05				6.19E+06	2.49E+06	2.16E+06	6.19E+06	2.49E+06	2.16E+06									
20-Oct-94	01:00:00	2.29E+08	1.03E+06	8.80E+05	8.50E+03			3.56E+08	9.80E+05	9.98E+05	2.29E+08	1.03E+06	8.80E+05				4.29E+06	2.13E+06	1.21E+06	2.24E+06	2.18E+06	4.72E+05									
20-Oct-94	02:00:00	2.80E+08	8.10E+05	1.05E+06	3.40E+03			4.55E+08	8.50E+05	8.98E+05	2.80E+08	8.10E+05	1.05E+06				3.75E+06	1.58E+06	1.57E+06	2.42E+06	1.48E+06	3.30E+05									
20-Oct-94	03:00:00	2.30E+08	7.74E+05	8.21E+05	1.50E+03		1.50E+03	3.08E+08	8.11E+05	7.77E+05	2.30E+08	7.74E+05	8.23E+05				2.58E+06	1.29E+06	1.29E+06	2.54E+06	1.59E+06	1.59E+05									
20-Oct-94	04:00:00	2.48E+08	8.58E+05	7.37E+05	2.80E+03			4.09E+08	1.10E+06	7.13E+05	2.48E+08	8.58E+05	7.37E+05				3.84E+06	1.80E+06	2.08E+06	1.57E+06	1.10E+06	1.82E+05									
20-Oct-94	05:00:00	3.19E+08	8.84E+05	8.88E+05	2.80E+03			2.39E+08	8.17E+05	1.09E+06	3.19E+08	8.84E+05	8.88E+05				2.84E+06	1.17E+06	1.38E+06	1.18E+06	5.74E+05	1.15E+05									
20-Oct-94	06:00:00	2.48E+08	4.88E+05	7.79E+05	7.20E+03			3.38E+08	7.28E+05	8.58E+05	2.48E+08	4.88E+05	7.79E+05				2.51E+06	1.13E+06	8.79E+05	8.29E+05	8.34E+05	1.10E+05									
20-Oct-94	07:00:00	2.71E+08	7.37E+05	8.88E+05	8.00E+03	1.20E+03	1.20E+03	4.29E+08	1.17E+06	5.33E+05	2.72E+08	7.33E+05	8.88E+05				3.12E+06	8.05E+05	1.38E+06	1.48E+06	8.84E+05	1.25E+05									
20-Oct-94	08:00:00	3.88E+08	1.84E+06	8.35E+05	8.20E+03			8.50E+08	5.77E+05	8.43E+05	3.88E+08	1.84E+06	8.35E+05				2.85E+06	1.25E+06	1.29E+06	1.29E+06	8.27E+05	1.08E+05									
20-Oct-94	09:00:00	4.80E+08	2.48E+06	1.30E+06	1.80E+03	2.88E+07	8.08E+06	8.58E+08	1.71E+07	4.47E+06	4.80E+08	2.48E+06	1.30E+06				3.88E+06	1.88E+06	1.24E+06	1.29E+06	3.47E+05	1.37E+05									
20-Oct-94	10:00:00	2.01E+07	1.09E+06	7.08E+05	2.87E+06	4.14E+07	1.10E+07	3.53E+08	1.97E+07	8.20E+06	2.01E+07	1.09E+06	7.08E+05				6.12E+06	2.33E+06	1.71E+06	8.02E+06	5.30E+05	1.98E+05									
20-Oct-94	11:00:00	2.98E+08	1.19E+06	7.14E+05	3.88E+06	8.08E+07	5.80E+06	2.07E+08	1.24E+07	8.98E+06	3.11E+08	1.24E+07	6.51E+06				8.74E+06	1.24E+06	1.24E+06	8.08E+06	5.04E+05	1.48E+05									
20-Oct-94	12:00:00	2.78E+07	8.71E+05	6.53E+05	4.40E+06	5.84E+07	8.88E+06	2.80E+08	4.43E+07	7.15E+06	2.78E+07	8.71E+05	6.53E+05				4.88E+06	8.02E+07	1.02E+07	1.02E+07	2.04E+06	1.10E+06									
20-Oct-94	13:00:00	3.84E+08	1.49E+06	8.70E+05	2.70E+06	8.97E+07	1.08E+07	2.80E+08	6.82E+07	1.14E+07	3.84E+08	1.49E+06	8.70E+05				1.13E+07	2.27E+06	8.48E+05	3.85E+06	3.47E+05	4.89E+05									
20-Oct-94	14:00:00	2.87E+08	2.03E+06	1.02E+06	2.18E+06	7.20E+07	2.20E+07	2.19E+08	7.40E+07	2.30E+07	2.87E+08	2.03E+06	1.02E+06				3.59E+08	8.30E+05	8.13E+05	1.87E+06	2.81E+05	8.05E+05									
20-Oct-94	15:00:00	2.47E+08	7.87E+05	8.19E+05	5.12E+07	1.79E+07			6.20E+07	1.85E+07	3.88E+08	1.08E+06	8.17E+05				3.88E+08	1.08E+06	8.17E+05	1.01E+06	2.81E+05	3.14E+05									
20-Oct-94	16:00:00	2.89E+08	2.00E+06	8.31E+05	1.48E+06	4.88E+07	1.88E+07	1.82E+08	8.10E+06	5.58E+05	1.82E+08	2.00E+06	8.31E+05				6.48E+08	8.10E+06	5.58E+05	8.12E+06	1.88E+05	1.37E+06									
20-Oct-94	17:00:00	3.29E+08	1.37E+06	6.99E+05	3.28E+06	7.98E+07	1.47E+07	3.31E+08	8.12E+07	1.54E+07	3.29E+08	1.37E+06	6.99E+05				2.29E+07	1.50E+06	1.07E+06	1.43E+06	2.45E+05	1.18E+05									
20-Oct-94	18:00:00	2.98E+08	7.33E+05	8.58E+05	3.00E+07	4.93E+07	1.17E+07		6.50E+06	1.97E+06	2.98E+08	7.33E+05	8.58E+05				6.50E+06	1.97E+06	2.30E+06	1.53E+06	2.87E+05	8.34E+04									
20-Oct-94	19:00:00	3.77E+08	2.47E+06	8.87E+05	5.12E+07	9.28E+06			5.37E+07	1.07E+07	3.77E+08	2.47E+06	8.87E+05				1.03E+07	8.30E+06	2.88E+06	1.51E+06	3.87E+05	1.45E+05									
20-Oct-94	20:00:00	1.04E+07	2.88E+06	1.17E+06	1.42E+08	3.80E+07	7.80E+06		2.58E+07	8.77E+06	1.04E+07	2.88E+06	1.17E+06				2.02E+07	3.44E+06	1.04E+06	2.02E+07	2.54E+05	1.85E+05									
20-Oct																															

Appendix 4. Sanitary data

BOD = biochemical oxygen demand (mg/l)

AN = ammonia expressed as nitrogen (mg/l)

SS = suspended solids at 105°C (mg/l)

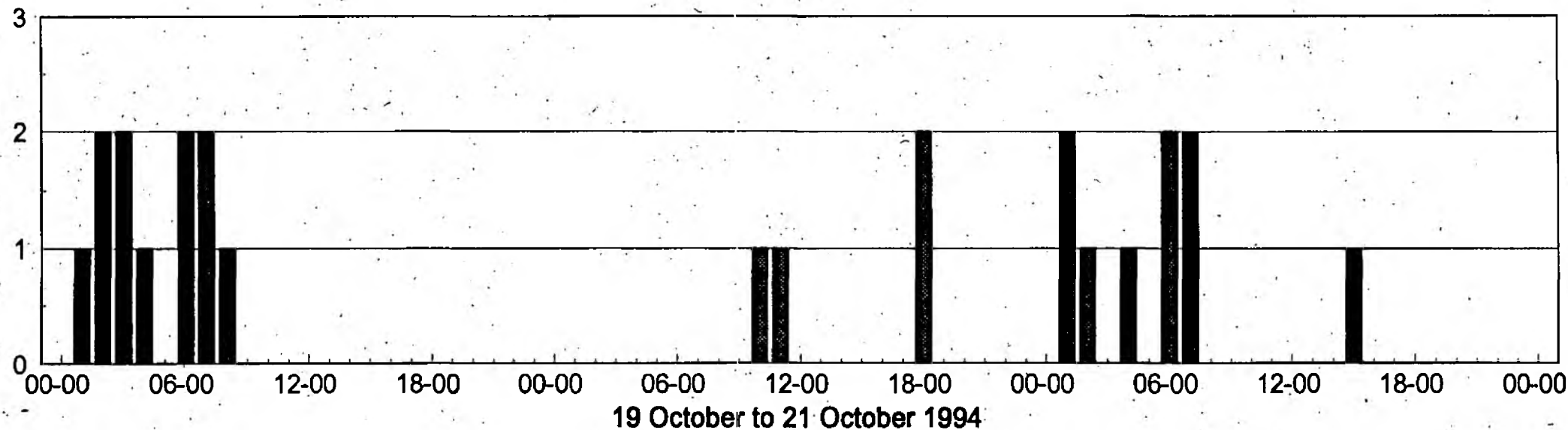
Flow = litres per second

St Columb Major STW final effluent consent conditions - BOD = 5 mg/l AN = 4 mg/l SS = 10 mg/l

		River Menalhyl upstream STW WSTW1706A				St Columb Major STW final effluent WSTW1706FE				River Menalhyl downstream STW R25A011			
Date	Time	BOD	AN	SS	Flow	BOD	AN	SS	Flow	BOD	AN	SS	Flow
20-Oct-94	00:00:00	1.3	<0.02	2.4		7.5	<0.5	9.4		<1.0	<0.02	3.0	
20-Oct-94	01:00:00	1.4	<0.02	<2.0		7.9	<0.5	11.0		2.3	0.02	3.3	
20-Oct-94	02:00:00	1.3	<0.02	<2.0		7.2	<0.5	11.0		2.2	<0.02	2.0	
20-Oct-94	03:00:00	1.2	<0.02	3.0		6.8	<0.5	8.6		2.1	<0.02	3.0	
20-Oct-94	04:00:00	1.2	<0.02	2.2		6.7	<0.5	8.8		1.9	<0.02	3.3	
20-Oct-94	05:00:00	1.3	<0.02	2.4		6.7	<0.5	9.4		3.1	<0.02	2.2	
20-Oct-94	06:00:00	1.2	<0.02	2.2		5.9	<0.5	8.8		1.8	<0.02	2.2	
20-Oct-94	07:00:00	1.3	<0.02	3.1		6.3	<0.5	8.6		1.7	<0.02	<2.0	
20-Oct-94	08:00:00	1.4	<0.02	<2.0		6.0	<0.5	8.4		1.6	<0.02	2.8	
20-Oct-94	09:00:00	1.5	<0.02	2.4		8.3	<0.5	8.2		2.0	<0.02	3.3	
20-Oct-94	10:00:00	1.5	<0.02	2.2	118	8.0	<0.5	9.0		2.2	<0.02	4.1	
20-Oct-94	11:00:00	1.4	<0.02	3.3		9.4	<0.5	8.2		2.7	0.03	5.4	
20-Oct-94	12:00:00	1.3	<0.02	3.3		8.9	<0.5	9.7		2.3	0.02	3.3	
20-Oct-94	13:00:00	1.4	<0.02	3.5	124	10.1	<0.5	10.0		2.4	0.03	3.5	

Lesneweth rainfall

Hourly totals to nearest 1 mm



Penryn rainfall

Hourly totals to nearest 1 mm

