DEVON AREA
INTERNAL REPORT

ENVIRONMENT AGENCY

BIOLOGICAL INVESTIGATION INTO THE IMPACT OF THE STORM OVERFLOW AT MIDDLE MARWOOD SEWAGE TREATMENT WORKS.

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(CATCHMENT 30A)

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ENVIRONMENT AGENCY

EA - South West/B30-X4-K4

Biological Investigation into the Impact of the Storm Overflow at Middle Marwood Sewage Treatment Works.

1.0 Introduction

Middle Marwood Sewage Treatment Works has an embargo (ref 7.5), preventing any further connections to the works. The storm overflow reportedly operates almost continuously with a significant proportion of the flow not receiving any biological treatment. In September 1998 a request was received from Environment Protection to undertake a biological impact assessment at this location.

The aim of this investigation is to look at the impact of the storm overflow (subsequent to the start of the survey the storm overflow was found to be discharging at two discrete points) individually and in combination with the final effluent on the macroinvertebrate population in Marwood Stream. The final effluent is discharged down stream of the storm overflows, see figure 1.

Our impact on the biodiversity of the site was taken into account during the planning of this investigation. Conservation were contacted in an effort to identify any sites recognised or designated as sensitive at or in the vicinity of Middle Marwood STW, see appendix 4 for results.

Marwood Stream has a River Ecosystem Use Class of 2 (RE2), see appendix 2 for class standards table. The stream is a tributary of Knowl Water, which has marginally failed its River Quality Objective of RE2 (ref. 7.1).

1.1 Project Team

Project Manager – Trevor Cronin
Project Leader – Stuart Hunter
Project Biologist – Alex Grant

2.0 Method

2.1 Biological Sampling

On 5th November 1998 Alex Grant and myself undertook a site visit to Middle Marwood Sewage Treatment Works. Three sites were selected for biological sampling; site 1 upstream, site 2 down stream of the two storm discharges and up stream of the final effluent and site 3 down stream of the final effluent and storms, figure 1. The location of each site is detailed in Table 1.

Table 1. Showing the location of biological sample points.

SITE NO.	WATERCOURSE	SITE LOCATION	NGR
1	Marwood Stream	Immediately u/s compound – u/s both discharges	SS 5370 3768
2	Marwood Stream	Immediately u/s FE discharge, 10m d/s storm discharge	SS 5368 3768
3	Marwood Stream	50m d/s FE discharge	SS 5368 3768

Biological samples were collected using the standard three minute kick method, followed by a one minute search. The samples were preserved and retumed to the laboratory for sorting to family level. For results see table 3.

Biological data was analysed using the BMWP Scoring system.

The BMWP score is a simple method of assessing the biological quality of a watercourse. It was derived by the Biological Monitoring Working Party in 1980 for the water quality survey of England and Wales (ref 7.2).

A numeric value is allocated to each invertebrate taxon, based on its tolerance to organic pollution. A score of one being tolerant and ten sensitive e.g. stoneflies and most mayfly nymphs score ten. The BMWP score is the sum of the values of each taxon found in the sample.

The Average Score Per taxon (ASPT) is the BMWP score divided by the number of scoring taxa. It represents the average sensitivity of the taxa found. ASPT is a more reliable indicator of biological water quality than BMWP score because it is independent of sample size (a larger sample is likely to include more families thus inflating BMWP score). ASPT is also affected less by differences in sampling effort and seasonal variation.

2.2 Microbiological and Chemical Sampling

Five sites were selected for microbiological and chemical sampling. Site 1 up stream of the sewage treatment works, site 2 between the storm and final effluent and site 3 down stream of the final effluent. Site 5 was storm overflow 'A' and site 4 the final effluent. See figure 1.

In situ dissolved oxygen, temperature and pH were also recorded using a hand held probe.

Sampling took place on 5th November 1998 and was repeated on 23rd November 1998. On each occasion one sample was taken at each of the five sites. The samples were analysed for basic sanitary and the pollution indicator bacteria Faecal Streptococci, Faecal Coliforms and Total Coliforms.

3.0 Results

Historical data from routine monitoring at URN 73011002 (fig. 2) show two RE2 failures both biochemical oxygen demand (BOD). The first on 12th April 1996 (10.3 mg/l, RE2 limit 4.0 mg/l) the second on 20th August 1996 (4.3 mg/l). Daily rainfall data for two gauges, one at Braunton the other Bittadon (fig. 3) was collected. It can be seen (fig. 4) heavy rainfall was recorded on 12th April 1996 and on the day before the sample of the 20th August 1996. For complete routine monitoring sample results and corresponding rainfall data see appendix 3.

The biological samples and a set of microbiological and chemical samples were collected on 5th November 1998. A second set of microbiological and chemical samples were collected on 23rd November 1998. Rainfall data for the day of the samples and two days previously is shown in table 2.

Table 2. Rainfall data for the surveys.

Date in November 1998	Daily Rainfall Totals in mm
3	2.0
4	5.8
5	3.5
21	0.0
22	9.8
23	18.1

3.1 Results from Biology

Alex Grant sorted biological samples in the Biology Laboratory. The samples were identified to family level the results can be seen in Table 3.

Table 3. Results of Biological Survey

SITE NO.	SITE LOCATION	NO OF FAMILIES	BMWP	ASPT	CONDU-CTIVITY
1	Immediately u/s compound – u/s both discharges	20	109	5.45	316
2	Immediately u/s FE discharge, 10m d/s storm discharges	23	121	5.26	316
3	50m d/s FE discharge	21	109	5.19	316

As table 3 shows, Site 1 up stream of the sewage works has the highest average score per taxon (ASPT) of 5.45, even though it was found to have the least number of families. The families that were present at site 1 are classed as more sensitive to pollution. Sites 2 and 3 have similar ASPT scores 5.26 and 5.19 respectively. Site 2 was found to have the highest BMWP score of 121, this is due to the fact that more families were found to be present than at sites 1 & 3.

3.1.1 RIVPACS

The environmental data obtained from the three sites was run through RIVPACS (River Invertebrate Prediction and Classification System), in order to compare the observed macroinvertebrate fauna with that predicted. The results are detailed in Table 4.

Table 4. Comparison of the observed data and the expected taxa, BMWP and ASPT scores derived from RIVPACS.

	OBSERVED			**RIVPACS - EXPECTED**		
SITE	**NO OF TAXA**	**BMWP**	**ASPT**	**NO OF TAXA**	**BMWP**	**ASPT**
1 – Imm. u/s compound	20	109	5.45	23.4	149.8	6.38
2 –d/s storm discharges u/s main discharge	23	121	5.26	23.5	150.2	6.39
3 – d/s both discharges	21	109	5.19	23.5	150.0	6.38

Comparison of the two sets of data shows an impact on the biological quality of the three sites samples. However, the reduction in biological water quality is equally apparent at the site sampled upstream of the sewage treatment works. This indicates that the sites are unsuitable for RIVPACS analysis. The land adjacent to this section of the Marwood Stream is fairly intensively grazed, with the livestock having free access to the stream. This has resulted in substantial trampling and erosion of the very shallow banks and the watercourse itself. The effect of this is likely to have detrimental effects on water quality and substrate, and will have an impact on the macroinvertebrate fauna of the stream.

3.2 Results from Chemical Samples

Tables 5 and 6 show the results from the chemical samples for the two sampling runs. The results from 5th November show no samples from the stream exceed RE2 standards. The highest concentrations were found down stream of the works but were within class limits. The results from 23rd November show the same pattern; higher results down stream but concentrations found were within allowed limits.

Table 5. Results from Chemical samples 5th November 1998.

SITE	AMMONIA mg/l	BOD mg/l	D.O. %	pH	UN-IONISED AMMONIA mg/l
1. Up Stream STW	0.044	1.3	91.3	7.65	0.0004
2. Between FE and SSO's	0.081	1.4	91.0	7.65	0.0007
3. Down Stream STW	0.091	2.1	97.6	7.6	0.0007
4. Final Effluent	0.03	1.5	85.2	7.7	0.0003
5. Storm Sewage Overflow 'A'	0.528	5.1	49.5	7.3	0.0023

Table 6. Results from Chemical Sampling 23rd November 1998.

SITE	AMMONIA mg/l	BOD mg/l	D.O. %	pH	UN-IONISED AMMONIA mg/l
1. Up Stream STW	0.036	1.3	-	7.75	-
2. Between FE and SSO's	0.271	2.1	-	7.7	-
3. Down Stream STW	0.263	2.0	-	7.7	-
4. Final Effluent	0.118	1.9	-	7.45	-
5. Storm Sewage Overflow 'A'	1.48	7.2	-	7.2	-

3.3 Results from Microbiological Samples

Figures 5 & 6 show the results for the microbiological samples, results are in number per 100ml.

The results from 5th November 1998 show the highest concentrations of microbiological pollution indicators being discharged into the stream through the storm overflow. Both Faecal and Total Coliform counts are over 100,000. The samples were not diluted during analysis or much higher figures would be expected. The upstream concentrations were significantly lower than the concentrations found down stream of the works.

Lower concentrations of pollution indicator bacteria were found in analysis of the second set of samples taken on 23rd November 1998. There is still a large increase in concentrations down stream of the works compared to upstream of the works.

4.0 Discussion

The results from the biological data collected during this investigation indicate; mediocre water quality at each of the three sites sampled. A search revealed no sewage fungus or sewage debris. No other source of polluting input was found between the sites sampled Due to the already mediocre water quality (attributed to the cattle poaching) no significant effect on biological water quality could be detected from either the final effluent discharge or the storm discharges.

It is also possible the effect of the cattle poaching could mask any deleterious effects from the storm overflow.

The chemical sample results on the days surveyed indicate that the Storm Discharges are having no significant effect on the water quality of Marwood Stream by itself or in combination with the Final Effluent discharge. The stream samples were all within the RE2 class limits.

Microbiological sample results show more of the effect of the storm discharges on the stream. Results from the first sample run on 5th November show very high concentrations of bacteria entering the stream from the storm overflows. In fact the stream shows higher concentrations than the final effluent discharging into it. The samples taken on the 23rd November were found to have a much lower bacterial concentration.

When rainfall data on the day of sampling and the day before are compared for the two surveys, it can be seen there was more rain on and prior to the second survey, see table 2. On the 4th and 5th November there was relatively little rain. The effect of this on discharge quality is that less storm water would be expected to pass through the works. Thus a more concentrated effluent will be discharged through the storm overflow, accounting for the higher counts of pollution indicator bacteria. On the 22nd and 23rd November there was heavier rain, this would lead to a larger volume of storm water entering the works. In this situation it is expected that an increased volume of a more dilute discharge will be entering the watercourse accounting for the drop in bacteria concentrations.

It has been suggested that the storm overflows operate almost continuously with a significant proportion of the flow not receiving any biological treatment.

A sewage treatment works performance under wet weather conditions is typically to treat up to three times dry weather flow (3 DWF). Flows in excess of 6 DWF pass directly to the receiving water as storm discharges. Flows in excess of 3 DWF usually go to storm tanks. Storm tanks either overflow to the watercourse when full or pass the storm water back through the works when flow drops below 3 DWF (ref. 7.3).

A storm overflows function is therefore to discharge storm water during periods of wet weather when the works receives 6 DWF or the storm tanks are overflowing. Storm overflows also discharge during periods of mechanical or electrical failure within the works. This storm overflow is allegedly discharging during all weather conditions (reported by

EPO), during the two surveys these allegations were corroborated. The evidence indicates that the volume of effluent currently received by the works leads to hydraulic overloading.

Knowl Water has failed to reach its RE2 objective as a result of elevated BOD (ref. 7.1). The failure occurred at Routine Monitoring point 73011002, approx. 5.5 Km down stream of the works (fig 2). However, as the impact of the STW appears not to be greatly affecting the watercourse immediately down stream of the discharges, it seems unlikely that it will be the cause of failures some 5.5 Km downstream. More of an impact on the water quality in Marwood Stream could possibly be shown by further investigation work carried out in dry weather. When stream flows are lower and the storm overflow discharge is less diluted by surface water runoff.

Looking at possible sources of contamination closer to the monitoring point has highlighted a number of farms situated on tributaries of the Knowl Water. A number of these have been identified as potential sources of pollution (ref 7.4).

5.0 Conclusions

5.1 Biological Water Quality

Due to the environmental impacts upstream of the sewage treatment works it is not possible to detect any deterioration in biological water quality as a result of the storm sewage discharge at Middle Marwood Sewage Treatment Works.

5.2 Storm Sewage Overflow

The chemical results from this investigation show no significant detrimental impact on water quality from the storm overflows on there own, or in combination with the final effluent discharge.

5.3 Knowl Water RQO

This investigation suggests the failure of Knowl Water to meet its river quality objective of RE2 as a result of elevated BOD, is not solely due to the storm overflow at Middle Marwood STW.

6.0 Recommendations

Although no significant detrimental impact could be shown from this investigation. Consideration should be given to whether monitoring of the storm overflows should be undertaken to support the continuation of the current embargo.

7.0 References

7.1

Environment Agency, February 1999. *Taw Leap*

7.2

National Rivers Authority, Leaflet. *Biological Water Quality Monitoring.*

7.3

Foundation for Water Research. November 1994. *Urban Pollution Management (UPM).*

7.4

Knowl Water File. *TASK FORCE 1994/95 "Knowl Water".*

7.5

National Rivers Authority, South West Region. *Schedule of Development Constraint Settlements*. January 1996.

Figure 1.

Middle Marwood Sewage Treatment Works Showing Biological and Chemical Sample Positions

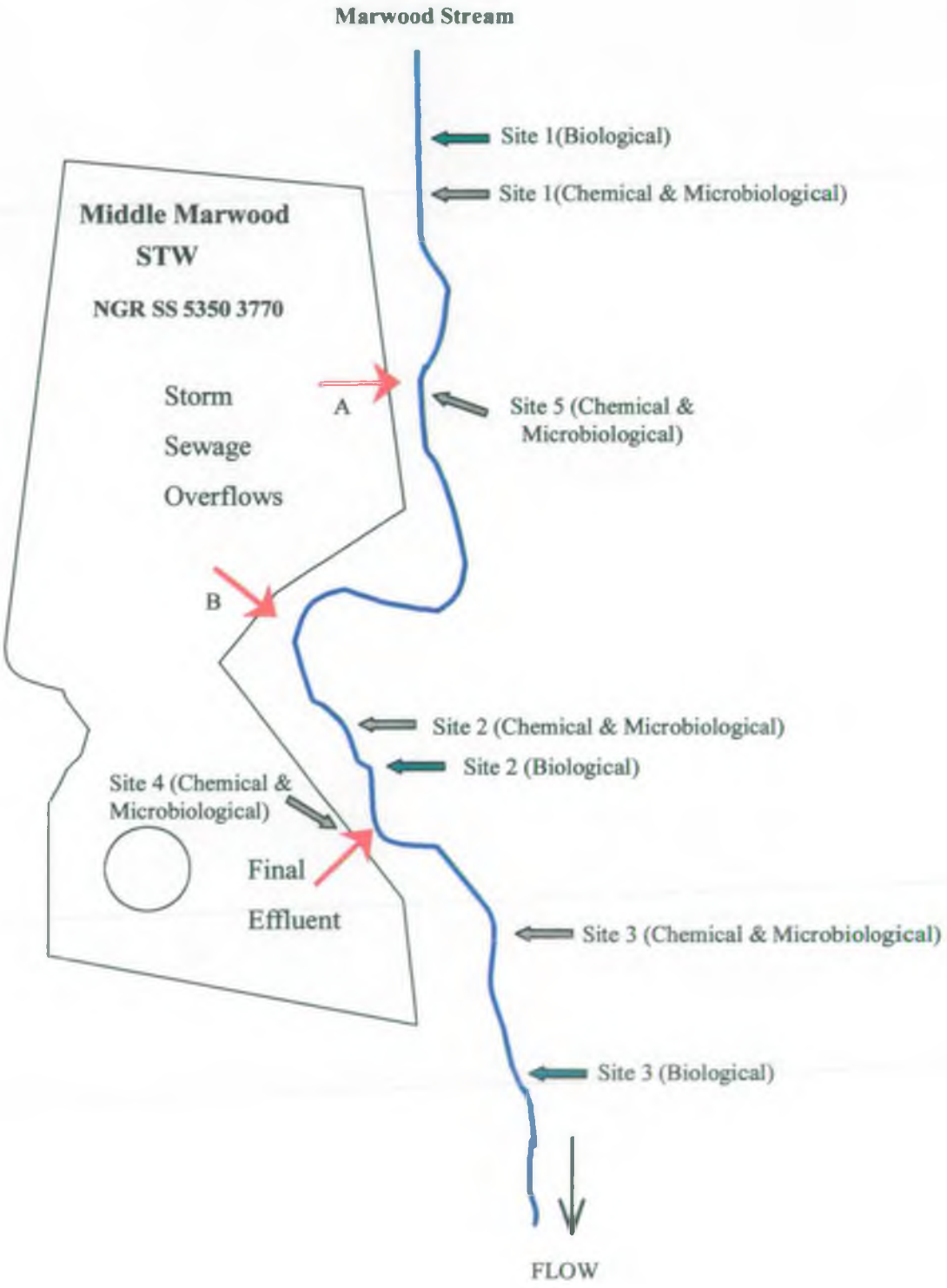


Figure 2

Knowl Water from Middle Marwood STW to Routine Monitoring Point 73011002

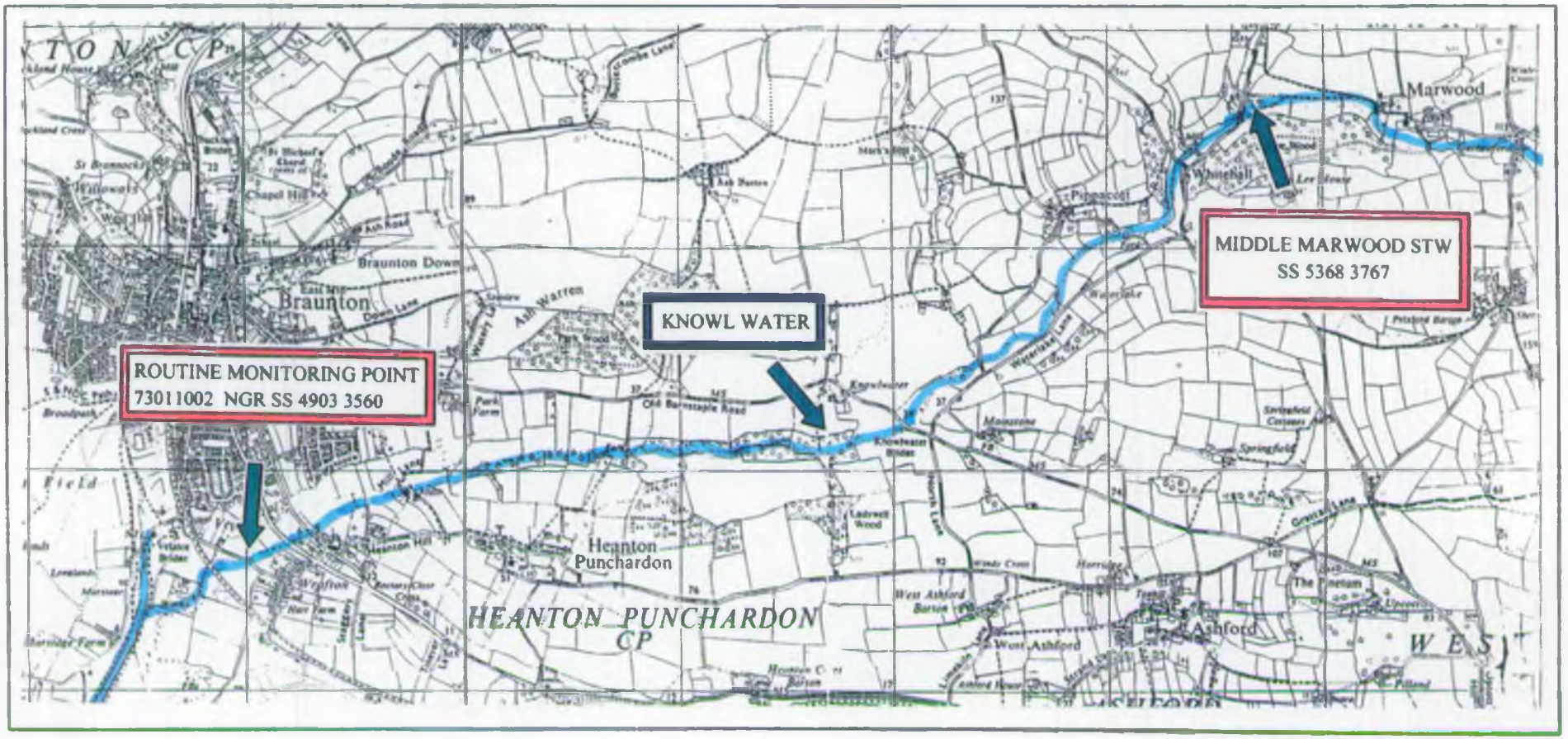


Figure 3

Showing location of Rainfall Gauges in relation to Middle Marwood STW.

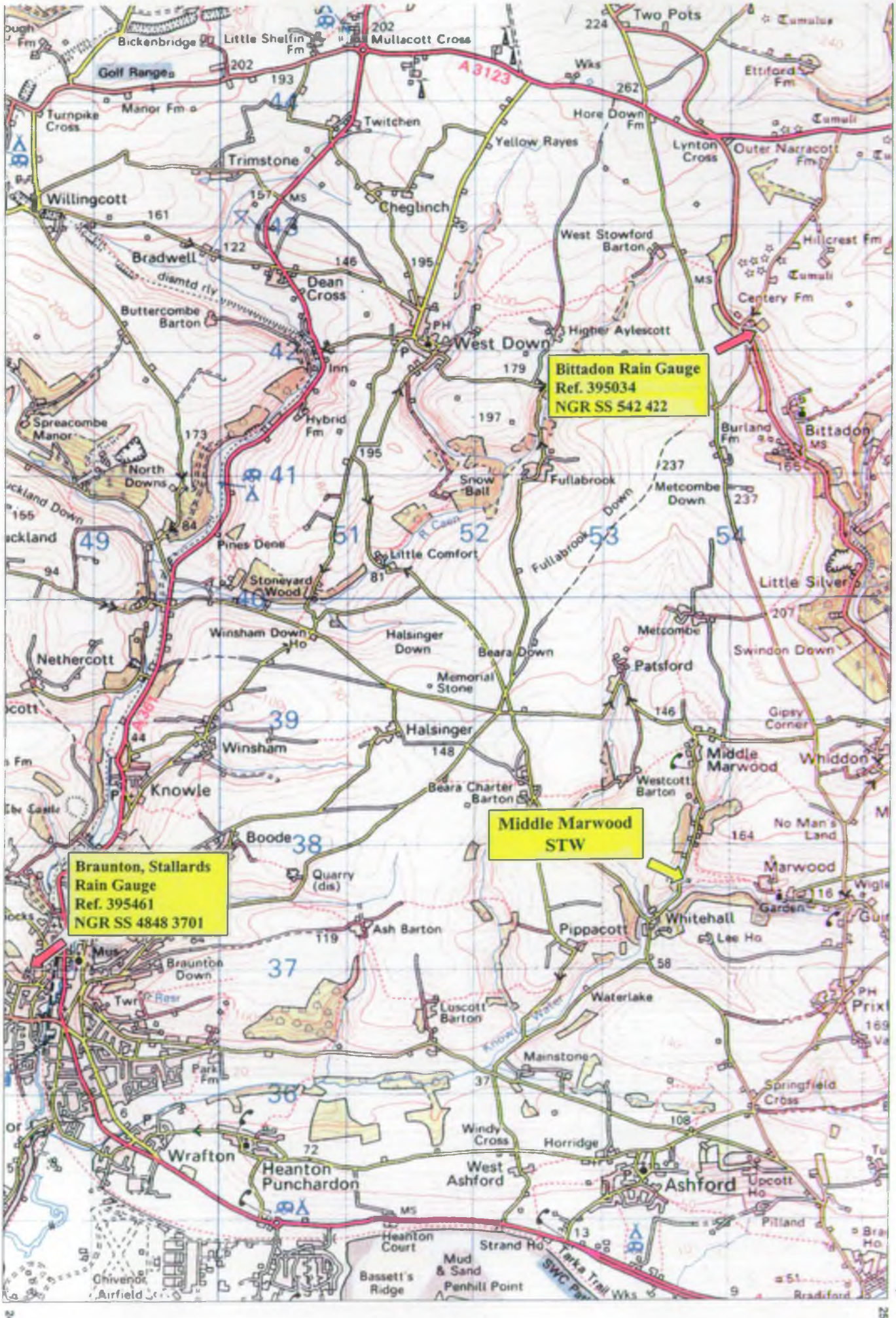


Figure 4

Graph showing Biochemical Oxygen Demand from Routine Monitoring samples and Rainfall data from the two nearest gauges.

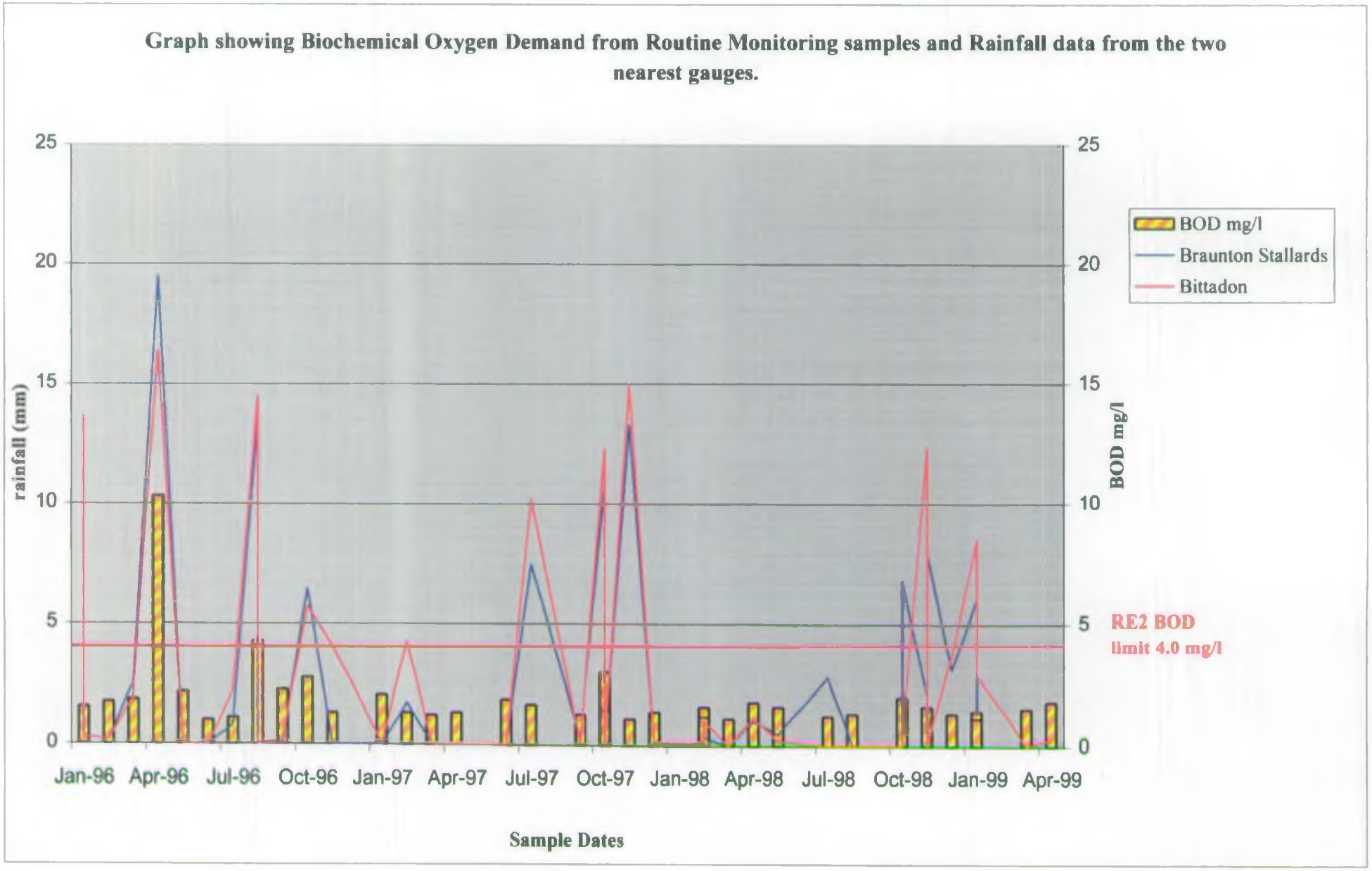
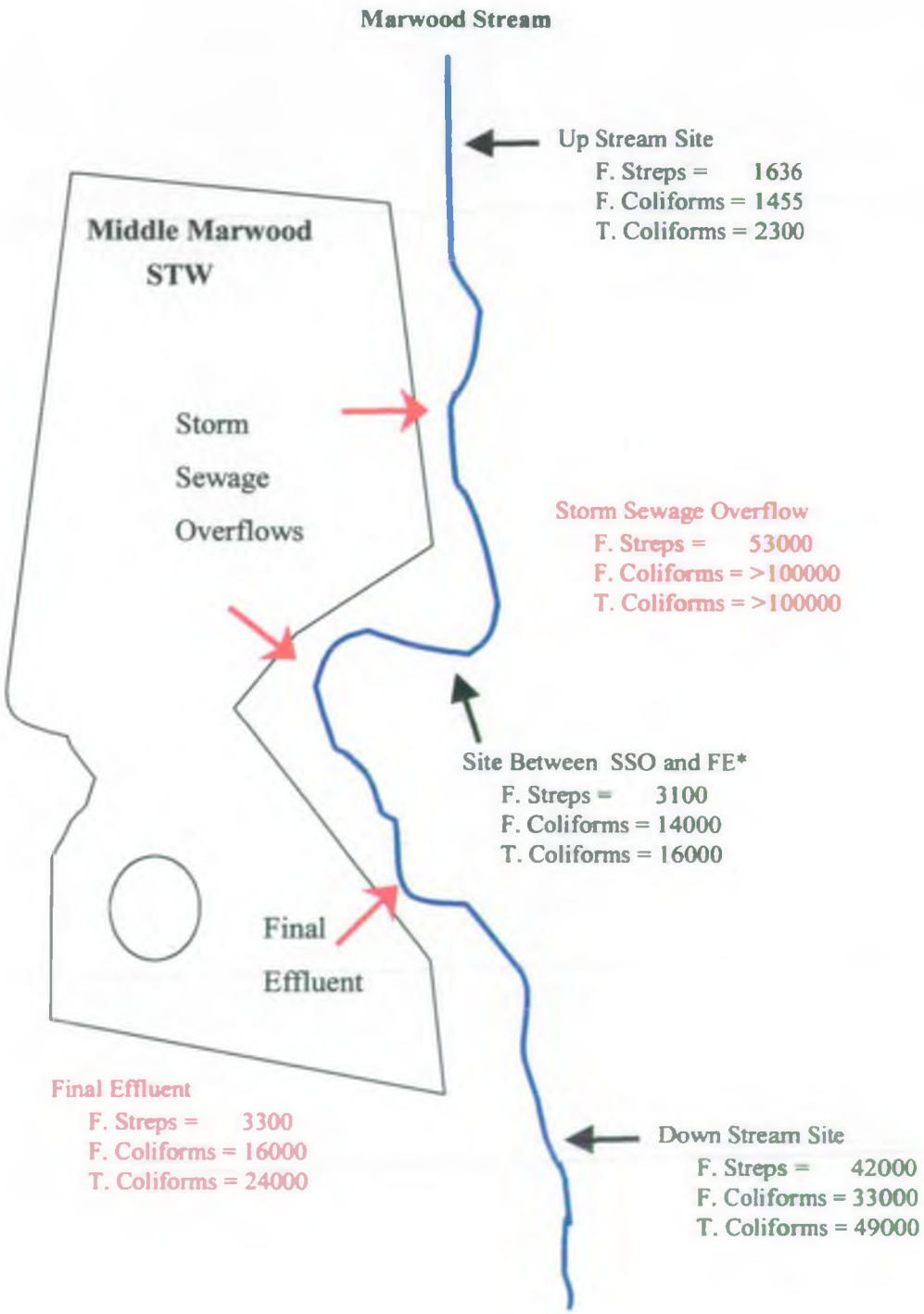


Figure 5

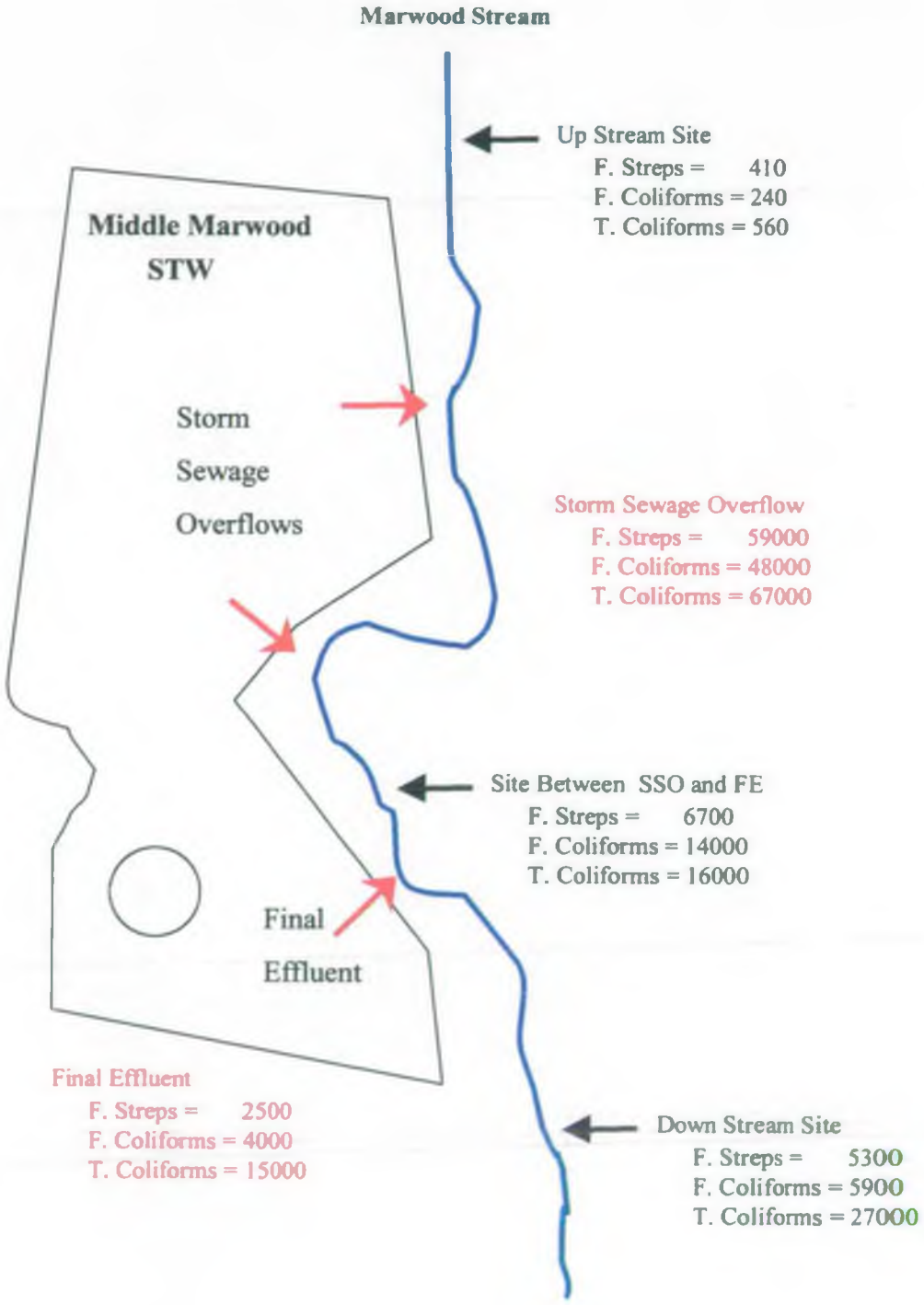
Diagram showing Results from Microbiological samples on 5th November 1998.



* Sample taken between FE and SSO does not take into account all storm discharge.

Figure 6

Diagram showing Results from Microbiological samples on 23rd November 1998.



APPENDICES

Appendix 1

Plate 1

Looking Upstream Marwood Stream. Showing FE and SSO's.

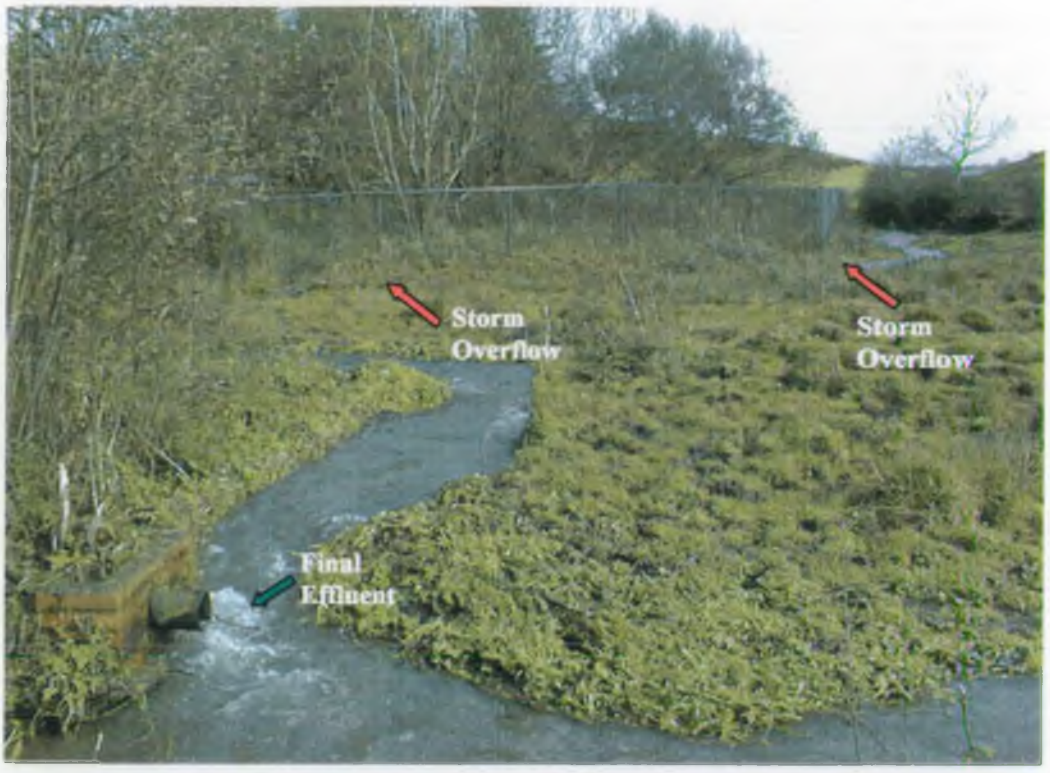


Plate 2

Final Effluent Discharge Situated Downstream From Storm Discharge.

Plate 3

Showing Storm Overflow Discharging under fence into stream

Appendix 2

Standards For The Five River Ecosystem Use Classes

Use Class	DO % sat 10%ile	BOD (ATU) mg/l 90%ile	Total Ammonia mgN/l 95%ile	Un-ionised Ammonia mgN/l 95%ile	pH 5%ile & 95%ile	Hardness mg/l Ca CO_3	Disolved Copper ug/l 95%ile	Total Zinc ug/l 95%ile	Class Description
1	80	2.5	0.25	0.021	6.0-9.0	≤ 10 >10 and ≤ 50 >50 and ≤ 100 >100	2 22 40 112	30 200 300 500	Water of very good quality suitable for all fish species
2	70	4.0	0.6	0.021	6.0-9.0	≤ 10 >10 and ≤ 50 >50 and ≤ 100 >100	2 22 40 112	30 200 300 500	Water of good quality suitable for all fish species
3	60	6.0	1.3	0.021	6.0-9.0	≤ 10 >10 and ≤ 50 >50 and ≤ 100 >100	2 22 40 112	300 700 1000 2000	Water of fair quality suitable for high class coarse fish populations
4	50	8.0	2.5	-	6.0-9.0	≤ 10 >10 and ≤ 50 >50 and ≤ 100 >100	2 22 40 112	300 700 1000 2000	Water of fair quality suitable for coarse fish populations
5	20	15.0	9.0	-	-	-	-	-	Water of poor quality which is likely to limit coarse fish populations

Appendix 3

Table Showing Historical Routine Sample Data at URN 73011002 and Rainfall at Gauges Shown.

					Daily Rainfall mm	
				Un-ionised	Ref. 395461	Ref. 395034
Samlple Date	BOD mg/l	Ammonia mg/l	DO %	Ammonia mg/l	Braunton Stallards	Bittadon
11-Jan-96	1.4	0.040	99.0	0.0003	11.2	13.7
26-Jan-96	1.5	0.030	98.0	0.0002	0.3	0.3
26-Feb-96	1.7	0.050	97.0	0.0004	0.2	0.2
21-Mar-96	1.8	0.070	99.1	0.0006	2.5	1.9
12-Apr-96	**10.3**	0.480	96.0	0.0029	19.5	16.4
14-May-96	2.1	0.030	104.0	0.0007	0	0
12-Jun-96	1	0.030	94.0	0.0007	0	0
31-Jul-96	1.1	0.080	93.0	0.0013	0.8	2.1
20-Aug-96	**4.3**	0.060	93.0	0.0011	0	0
11-Sep-96	2.2	0.030	122.0	0.0021	0	0.2
16-Oct-96	2.7	0.060	97.0	0.0008	6.5	5.7
08-Nov-96	1.3	0.040	92.0	0.0003	0	4.1
23-Jan-97	2	0.040	97.0	0.0004	0	0
27-Feb-97	1.3	0.040	99.0	0.0004	1.7	4.3
19-Mar-97	1.2	0.030	91.0	0.0005	0	0
15-Apr-97	1.3	0.030	120.0	0.0014	0	0
04-Jun-97	1.8	0.030	106.0	0.0010	0	0
24-Jul-97	1.6	0.120	92.0	0.0020	7.5	10.2
01-Sep-97	1.2	0.030	101.0	0.0005	0.2	0
07-Oct-97	2.9	0.031	93.0	0.0006	10.8	12.3
21-Oct-97	1.4	0.030	98.0	0.0004	0	0
17-Nov-97	1	0.041	99.0	0.0005	13.3	15
04-Dec-97	1.2	0.030	97.0	0.0002	0	0
15-Dec-97	1.3	0.033	100.0	0.0003	0	0.1
02-Feb-98	1.5	0.032	98.0	0.0003	0	0.1
19-Feb-98	1.1	0.030	99.0	0.0004	0.3	0.9
16-Mar-98	1	0.030	98.0	0.0004	0	0
14-Apr-98	1.7	0.089	96.0	0.0009	0.9	1
11-May-98	1.5	0.033	97.0	0.0006	0.4	0.2
08-Jul-98	1.1	0.030	96.0	0.0006	2.7	0
27-Aug-98	1.2	0.057	96.0	0.0012	0	0
07-Oct-98	1.3	0.030	97.0	0.0007	0	0
20-Oct-98	1.9	0.038	96.5	0.0005	6.8	0.2
03-Nov-98	1.2	0.032	98.0	0.0003	2	12.3
30-Nov-98	1.5	0.051	107.2	0.0006	8	0
14-Dec-98	1.2	0.058	99.0	0.0008	3	3.6
12-Jan-99	1.3	0.038	102.0	0.0003	6	8.5
27-Jan-99	1	0.072	96.0	0.0007	1.4	2.8
02-Mar-99	1.4	0.046	98.0	0.0004	No Result	0
08-Apr-99	1.7	0.030	101.0	0.0005	No Result	0.3

RE2 Failures in Red

Appendix 4

Table Showing areas of Environmental Sensitivity in the vicinity of Middle Marwood Sewage Treatment Works.

NGR: SS 5360 3760

Type of Site	NGR	Description
County Wildlife Site	SS 5320 3740	Ancient semi-natural woodland
		partly replanted with broadleaves
Unconfirmed County	SS 5360 3770	Broadleaved Woodland
Wildlife Site		
Unconfirmed County	SS 5360 3740	Semi-improved Natural Grassland
Wildlife Site		
Unconfirmed County	SS 5380 3760	Ancient woodland and
Wildlife Site		Broadleaved Woodland
Unconfirmed County	SS 5370 3810	Semi-improved Natural Grassland
Wildlife Site		
County Wildlife Site	SS 5370 3810	Ancient semi-natural woodland
		Partly replanted with conifers

Note: Unconfirmed County Wildlife Sites have not been visited by Devon Wildlife Trust and the Landowners have not been contacted. These are only POTENTIAL areas and should not be mentioned in any correspondence with landowners.