~~EP/06/99~~ EA-SOUTH WEST Box 14

DEVON AREA
INTERNAL REPORT

ENVIRONMENT AGENCY

NON-COMPLIANCE OF THE BIDWELL BROOK WITH RIVER QUALITY OBJECTIVES

January 1999
DEV/EP/06/99
(CATCHMENT 07B)

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NON-COMPLIANCE OF THE BIDWELL BROOK WITH RIVER QUALITY OBJECTIVES

1.0 INTRODUCTION

1.1 DERIVATION

Devon Area Investigations were requested by Environment Protection (South) to establish the cause of non-compliance with River Quality Objectives (RQO) that have been set for the Bidwell Brook. Compliance with RQO's is assessed using the River Ecosystem Classification, and the water quality requirements for each Class are shown in Appendix 1. Non-compliance of the Bidwell Brook was the result of elevated biochemical oxygen demand (BOD) concentrations. Two sites are used for determining water quality on the Bidwell Brook: Dartington Lodge (URN 70722202) and Tigley (URN 70722271).

1.2 SITE DESCRIPTION

The Bidwell Brook rises approximately 1km NNW of Rattery and flows generally westwards for some 8km before its' confluence with the River Dart at Totnes (Map 1). Whilst the upper catchment is predominantly given to agriculture the lower catchment includes the town of Dartington and part of Totnes.

2.0 TEAM

Project Leader: Trevor Cronin
Project Manager: Robin Pearson

3.0 METHOD

(i) Consult with the Environment Protection Officer regarding possible causes of poor water quality

(ii) Analyse historic water quality data from the Routine Monitoring Programme

(iii) Determine biological quality from the Routine Biological Programme

(iv) Review entries in the Pollution Incident Logging System (PILS)

(v) Consult Agency records of consented discharges

(vi) Visually inspect the watercourse from Dartington Lodge upstream to the source.

(vii) Undertake a small sampling programme

4.0 RESULTS

4.1 HISTORIC DATA

4.1.1 WATER QUALITY

The Bidwell Brook, source to Tigley, significantly[1] failed RE1 in 1997, marginally[1] failed in 1995 and was compliant in 1993, 1994 and 1996. The stretch downstream from Tigley failed its' long term RQO of RE1 in 1997 (Reference 1). This stretch also significantly failed long-term RE1 in 1995, although this was not identified by the LEAP document. These non-compliances were the result of elevated BOD values.

Whilst the LEAP document draws on data obtained from 1993, initial analysis of data from the two GQA sites shows that water quality was frequently very poor prior to this. Consideration will be given, therefore, to historic data from 1990. Selected routine monitoring data are reproduced in Table 1(a) Dartington Lodge and 1(b) Tigley.

4.1.2 PILS

The PILS archive contains a number of entries referring to poor water quality both in the Bidwell Brook, particularly in the Dartington area, and in the tributary that originates in Redlake (Appendix 3). None was coincident with the specific dates on which poor water was found at Dartington Lodge or at Tigley.

4.1.3 CONSENTED DISCHARGES

These are given in Appendix 4.

4.1.4 BIOLOGY

Biological quality is Class **a** (very good) upstream of Tigley and Class **c** (fairly good) in the lower catchment (Reference 2).

[1] See Appendix 2 for definition *significant/marginal* in this context

4.2 INVESTIGATION FIELDWORK AND ASSOCIATED SAMPLING PROGRAMME

An initial sampling run was undertaken on 25/03/98 during wet weather[2]. (Map 2 and Table 2).

On 17/04/98 the following areas were intensively inspected for point source discharges: Bidwell Brook between Dartington Lodge and Shinners Bridge and the Redlake tributary from Shinners Bridge to the source, the farm area on the Dartington Estate, Week, Tigley, Venton, Allercombe Farm area and Rattery. A number of combined storm overflows having the capacity to compromise water quality were identified on the Bidwell Brook in the Dartington area.

On 04/06/98 further samples were taken at 6 Sites (Map 3 and Table 3).

Following identification of CSO's on 17/04/98 drawings of the mains sewer system were requested from South West Water and the CSO's so identified inspected on 06/07/98 (Map 4.). A sample from the Dartington to Totnes combined main sewer was taken on the same date (Table 4.).

5.0 DISCUSSION

5.1 HISTORIC DATA

5.1.1 WATER QUALITY

Elevated BOD values show a strong correlation with rainfall (Charts 1-36 show the dates on which elevated values were found in relation to rainfall). For any date on which raised values were coincident at both sites the link with rainfall seems likely.

BOD values at the Dartington Lodge site were ≥ 2.5 mgl^{-1} (the RE1 90%ile) on 21 occasions between 19/01/90-10/06/98. Of these, it appears that 15 are probably rain related, 8 are possibly rain related and 13 are not. Eight of the 21 values identified above also exceeded BOD 4.0 mgl^{-1} (the RE2 90%ile), and seven of these are thought to be rain related (Table 1(a)).

At Tigley, during the same period, 12 samples had BOD values of ≥ 2.5 mgl^{-1}, of which 8 are thought to be rain-related, one is possibly related and 3 are not. Five samples exceeded BOD 4.0 mgl^{-1} of which 4 are believed to be rain-related (Table 1(b)).

For the period 1993-5 (the period considered by LEAPS) there were 8 raised BOD values at Dartington Lodge:

[2] Rainfall on 25/03/98 was 17.6mm at Rattery

(i) 13/01/93 – Rain related and probably from runoff. BOD values were similarly raised at Tigley and solids levels were high at both sites.

(ii) 30/09/93 - Rain related and probably from runoff. The BOD value at Tigley was 2.4 and total ammonia was 0.13 mgl-1 compared with a mean of 0.0365 mgl-1 for all other samples (without associated raised BOD values) that year. Solids at Dartington Lodge were raised.

(iii) 30/11/93 – At Dartington Lodge the BOD was 2.5 mgl^{-1}, D.O. was slightly depressed at 83% and total ammonia was elevated at 0.53 mgl-1. At Tigley the D.O. was only slightly reduced at 88% and suspended solids were slightly raised at 58 mgl-1, otherwise water quality was fairly normal. There had been substantial rainfall on the day of sampling and on the previous day.

(iv) 03/02/94 - BOD and total ammonia were both raised at Dartington although the sample from Tigley was normal. Again there had been substantial rainfall and the elevated values are believed to result from this.

(v) 25/02/94 – The situation was the same as above except that BOD levels were also raised at Tigley.

(vi) 27/01/95 – Both sites had elevated BOD values but water quality was slightly worse at Tigley suggesting that a more localised source was involved upstream of the Tigley site.

(vii) 16/05/95 – Another sample that is believed to be linked to wet weather at the time of sampling. BOD was also raised at Tigley.

(viii) 11/07/95 – Whilst there was little rain on the day of sampling there had been 42.9mm two days prior. No sample was taken at Tigley. It is possible that this value was rain related.

From the above it can be seen that the elevated values responsible for non-compliance as identified in the LEAP document are likely to be rain related, and furthermore the rain effect is probably diffuse runoff as elevated levels are coincident at both sites.

Assuming a definite relation between rainfall and high BOD values, the effect of rainfall can be established by removing the relevant elevated concentrations. The RE Class can then be recalculated. This has been done in Tables 5(a) (Dartington Lodge) and 5(b) (Tigley). In the absence of high rainfall both sites would have complied with RE1 (for BOD) between 1993-5 (the period considered by the LEAP document).

On a few occasions samples were obtained where BOD levels seem to have been unaffected by wet weather. These instances are unexplained. They may result from a number of factors, such as the rate or location of rainfall.

There are a number of elevated samples that are not coincident with rainfall (Tables 1(a) and (b)). As these are mainly associated with samples collected from the Dartington site during 1990 – 1993 they may be linked with the former Dartington and Week waste water treatment works. This is further discussed in paragraph 5.2.

5.1.2 BIOLOGY

The LEAP report suggested that some degree of organic pollution was taking place (possible sources are discussed in paragraph 5.2). The substrate at the biological monitoring point upstream of Dartington Lodge is mainly mud and silt which may reflect in a reduced fauna. However, the RIVPACS method used for determining biological classification takes this into account so that the Class c classification of the lower catchment represents a real water quality influence.

5.2 INVESTIGATION DATA

Five of the seven sites on the Bidwell Brook had slightly raised BOD levels in comparison with a mean level[3] of 1.8 mgl^{-1}(Table 2.). In the absence of previous samples, BOD levels on the Redlake tributary as well as the two tributaries that run through Parklands Farm and Willing Farm were also considered raised. BOD levels showed a tendancy to increase towards the upper catchment. This is believed to have resulted from the effects of rainfall during the sampling run and the sequence in which sites were sampled (beginning at the bottom of the catchment).

Consideration will now be given to the potential point sources of pollution identified by the investigation.

DARTINGTON LODGE (NGR 7988 6150)
The Lodge immediately adjacent to the sample point at Dartington is believed to have a septic tank discharge. Whilst there was no flow on 17/04/98, because of the proximity of the discharge and sample point there is obviously the potential for contamination of samples.

PUDDAVEN COTTAGE (NGR 7945 6156)
A septic tank discharging to the Bidwell Brook was found at Puddaven Cottage (NGR7945 6158). There was no visual evidence of an impact but the discharge was previously unknown to the Agency.

QUEENS HEAD **PUBLIC HOUSE** (NGR 7924 6174)
There was no flow at this consented discharge on 25/03/98.

For the highest BOD and flow values obtained from the routine monitoring programme (725 mgl^{-1} and 0.05 ls^{-1} respectively) the impact on the receiving watercourse will be to raise the BOD from 1.8 mgl^{-1} (the mean) to 1.96 mgl^{-1} (Appendix 5). This discharge is unlikely, therefore, to have been responsible for any of the BOD concentrations that were greater than 2.5 mgl^{-1} at Dartington Lodge.

[3] The mean value at Dartington Lodge between 1993-5 – "less than" values halved

PIPED DISCHARGES TO THE REDLAKE TRIBUTARY

Several pipes of unknown origin were found at the top of the Redlake tributary. None was flowing nor was there any indication that discharges had recently occurred.

COMBINED STORM OVERFLOWS

Operation of the CSO'S during wet weather is likely to result in BOD values at Dartington Lodge that are disproportionately high in comparison with any enhancement resulting from the general effects of rainfall. Whilst the effect of the discharge from Dartington and Week WWTW (see below) cannot be separated from any effects due to CSO operation in the data from Dartington Lodge, the WWTW was decommissioned in September 1992. Between September 1992 and June 1998 there were 10 samples with raised BOD concentrations (plus one with a raised NH_4 concentration). Two of these (25/02/94 and 27/01/95) probably resulted from diffuse runoff as they were coincident with comparable BOD concentrations at Tigley on the same date. The remaining 8 samples may be associated with CSO discharges.

Water-borne sewage debris has been reported on a number of occasions by the public (PILS), and CSO 2 was seen to be discharging during wet weather[4] on 23/04/98.

The crude sewage sample taken from a manhole in the Dartington to Totnes combined main sewer (adjacent to CSO1, Map 4.) on 06/07/98 had a BOD of 322 mg l^{-1}. Using model calculations the effect of such a discharge to the watercourse can be estimated (Appendix 6). Assuming raised river levels during wet weather and a ratio of 125:1 in the flows of the Bidwell Brook:crude discharge (BOD attenuation over this distance is not significant and need not be allowed for) the BOD at Dartington Lodge would be 4.34 mg l^{-1} if one CSO was flowing, and 6.84, 9.3 and 11.73 mg l^{-1} if two, three or four were discharging, as is likely during very wet conditions. (These values are in addition to the raised background BOD concentrations resulting from all sources during wet weather). Thus it is likely that operation of the CSO,s will cause the BOD at Dartington Lodge to exceed 2.5 mgl^{-1}.

DARTINGTON AND WEEK WASTE WATER TREATMENT WORKS

(NGR 7920 6188)

The removal of Dart & Week WWTW was coincident with improved BOD, NH_3 and DO values at Dartington Lodge. This is clearly seen in Table 6.

Table 7. combines data from Table 1.0(A) and Table 6 to show that the discharge from this site was almost certainly responsible for elevated BOD or ammonia concentrations on at least 10 occasions prior to September 1992.

RATTERY WASTE WATER TREATMENT WORKS (NGR 7448 6139)

[4] Rainfall on 23/04/98 was 13.3mm at Rattery

The Environment Protection Officer reports that there is significant sewage fungal growth downstream of the outfall at this site. From the historic data, however, the final effluent discharge appears to be having almost no impact on the receiving watercourse (Table 8.). This may be anticipated under wet conditions, where flows are raised in the receiving water and dilution is increased, but there is frequently no impact under dry conditions even when effluent BOD concentrations are comparatively high. This was the case on 17/06/92 (no rain in previous week), 13/03/93 (1.8mm rain in previous week) and 28/09/94 (no rain in previous 2 days), among others.

There is currently no upstream and downstream monitoring at this site.

ALLERCOMBE FARM (NGR 7458 6136)
A probable septic tank discharge at the entrance to the farm was seen to be ponding some 5m from the Bidwell Brook. This is obviously a potential source of pollution.

YARNER FARM (NGR 7812 6195)
Whilst there have been past incidents related to this site no problems were observed during the course of the investigation.

SHINNERS BRIDGE TRIBUTARY (NGR 7871 6218)
The tributary is grossly polluted by a piped discharge that is believed to originate at Old Parsonage Farm (Map 3) and as a result substantial areas of sewage fungus are present below Shinners Bridge.

Samples taken from the tributary on 04/06/98 had high BOD and ammonia levels (Table 3.) and were impacting on the Bidwell Brook downstream of the tributary confluence. This tributary is likely to be a contributory factor in poor water quality at Dartington Lodge.

PUDDAVEN TRIBUTARY (NGR 7962 6157)
As a result of septic tank impact from a number of properties in Puddaven water quality on this tributary has been historically poor . The properties concerned were sewered to the main in October 1997.

From 1993 onwards there has been a strong link between rainfall and elevated BOD values at Dartington Lodge. Poor water quality in the tributary at Puddaven is not thought to have been the principal cause of elevated BOD values at Dartington Lodge, therefore (the effect of rainfall on septic tank discharges would be to dilute rather than accentuate any impact). This is more likely to have resulted from operation of the combined storm overflows. However, poor water quality from 1990-92 shows less of a correlation with rainfall and may have been associated with the Puddaven tributary, or with Dartington & Week WWTW (see below).

For a 'worst case scenario' the impact of the Puddaven tributary at Dartington Lodge can be estimated by mass balance, where the input from the tributary is assumed to be crude sewage with a nominal BOD of 300 mgl^{-1} and that no attenuation will occur

(Appendix 7). For a flow ratio of 100:1 (Bidwell Brook:Tributary) the BOD at Dartington Lodge would be 4.75 mgl^{-1}. This could have accounted for 13 of the 20 samples that exceeded BOD 2.5 mgl^{-1} from 1990 up until the associated properties were connected to the mains sewer in October 1997 (Table 1.). However, BOD values in the tributary are unlikely to have been this high. The BOD of a typical septic tank effluent might be 50 mgl^{-1}. At this level the resultant BOD at Dartington Lodge would be 2.27 mgl^{-1}, which is insufficient to have accounted for any of the samples that exceeded BOD 2.5 mgl^{-1},the RE1 90%ile, between these dates.

WILLING FARM TRIBUTARY (NGR 7464 6133)
The BOD value obtained on 25/03/98 was high in comparison with other samples taken the same day. Although no sources of pollution were identified at the farm on this date the farm is a possible cause of BOD enhancement as is general runoff.

OTHER TRIBUTARIES
There was no evidence from the investigation fieldwork that any of the remaining tributaries were compromising water quality.

6.0 CONCLUSION

Poor water quality at Dartington Lodge probably derives from a combination of three principal factors: the general enhancement of BOD values during wet weather, the continuous discharge from Old Parsonage Farm to the Shinners Bridge tributary and operation of the Dartington to Totnes combined main sewer overflows. The general enhancement referred to above will be, in itself, the product of a combination of runoff, point source inputs and any poor water carried by the tributaries.

There are no point source inputs to the Bidwell Brook upstream of Tigley that are suspected of causing the elevated results that have been found. The correlation with wet weather indicates that poor water quality results from agricultural land runoff.

At present there is insufficient evidence to request any improvements to the Dartington to Totnes main sewer. There may be a case for a more detailed investigation of the frequency and duration of discharges from the CSO's.

The poor water discharge to the Shinners Bridge tributary is resulting in localised gross pollution at the road bridge. Odours from the discharge culvert have been the cause of frequent public complaint. The watercourse is readily accessible some 50m downstream at the Dartington Cider Press and there may be health implications.

7.0 RECOMMENDATIONS

The cause of polluting discharges at Old Parsonage Farm is established and appropriate remedial measures taken to prevent continuing contamination of the Shinners Bridge tributary.

ACTION: ENVIRONMENT PROTECTION

In proposed submissions to the AMP3 programme the Agency has included two of the CSO's shown on Map 3 (CSO's **2** and **3**). It is recommended that the CSO's **1** and **4**, which are part of the same sewer line, are also included.

ACTION: TACTICAL PLANNING

The sample points upstream and downstream of Rattery WWTW are re-assessed with respect to the exact location of the outfall.

ACTION: MONITORING

REFERENCES

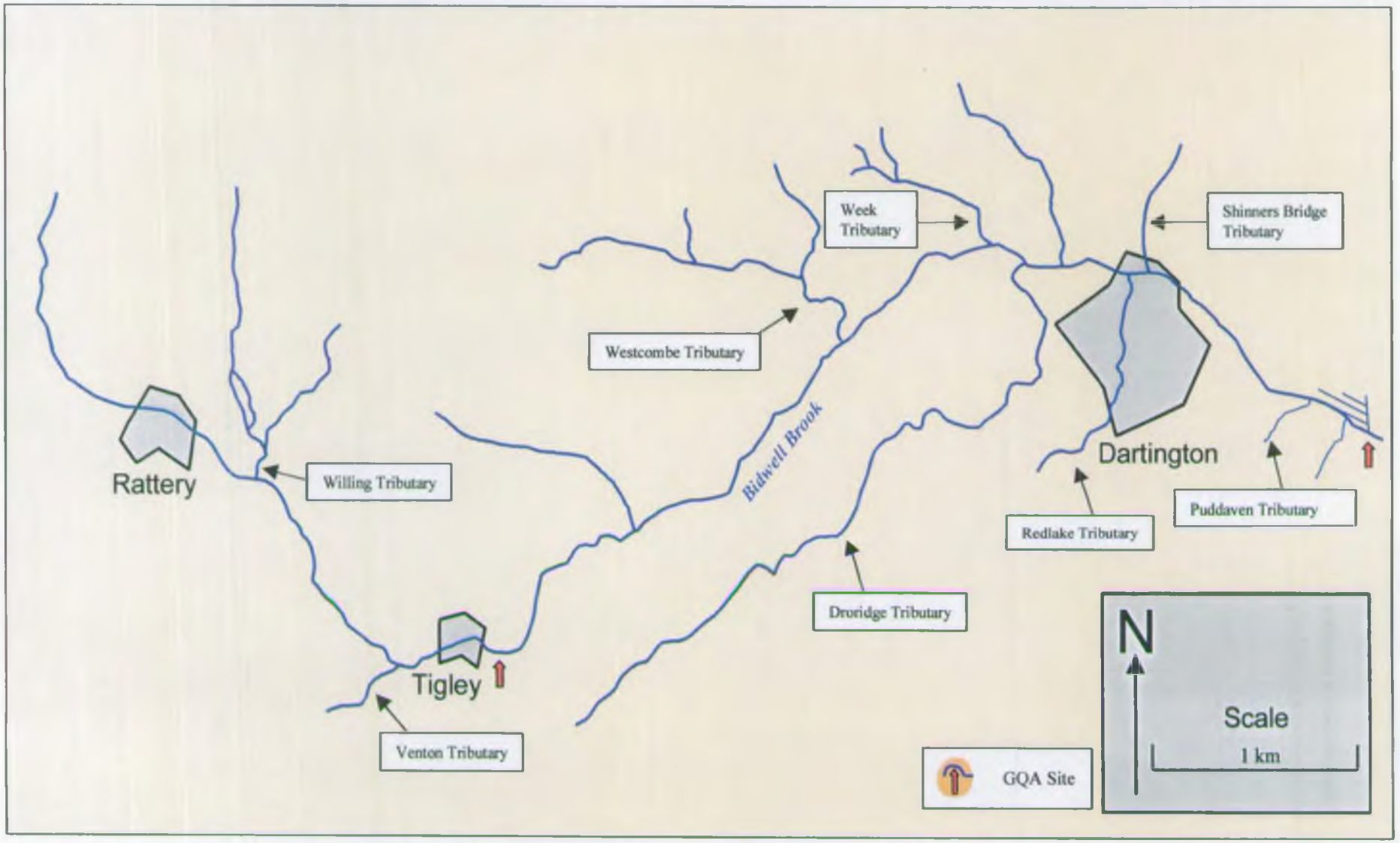
1. *Local Environment Agency Plan, River Dart, Consultation Report, June 1997* and
   Local Environment Agency Plan, River Dart, Action Plan, July 1998

   1995 Biology Survey, Environment Agency, Devon Area Biology Section

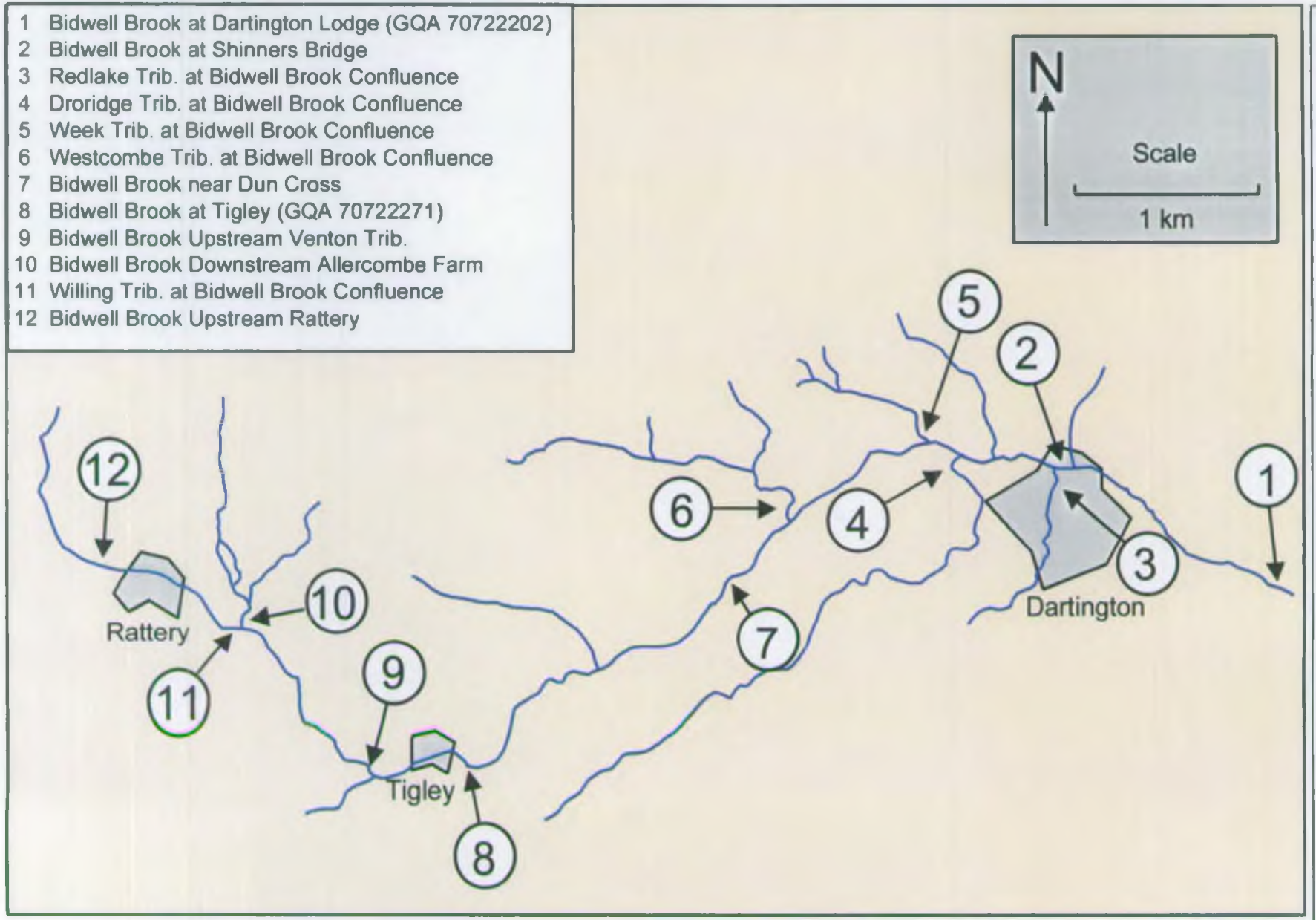
   Environmental monitoring, modelling and control, The Water Block, p154-155, The Open University, 1997

   New River Water Quality Schemes: A Procedural Manual, National Rivers Authority, 1995

MAP 1. BIDWELL BROOK CATCHMENT



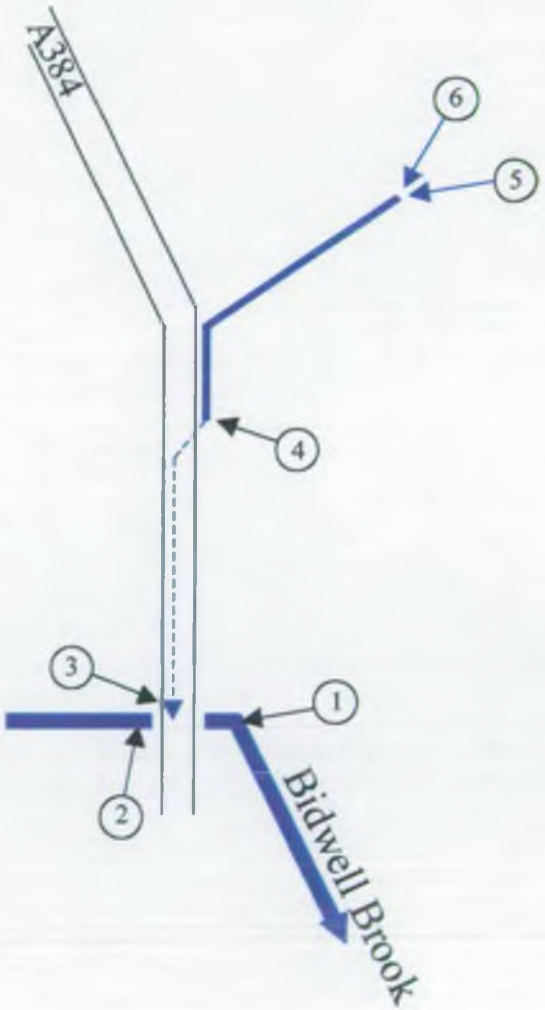
Initial Investigation Sampling Points 25/03/98

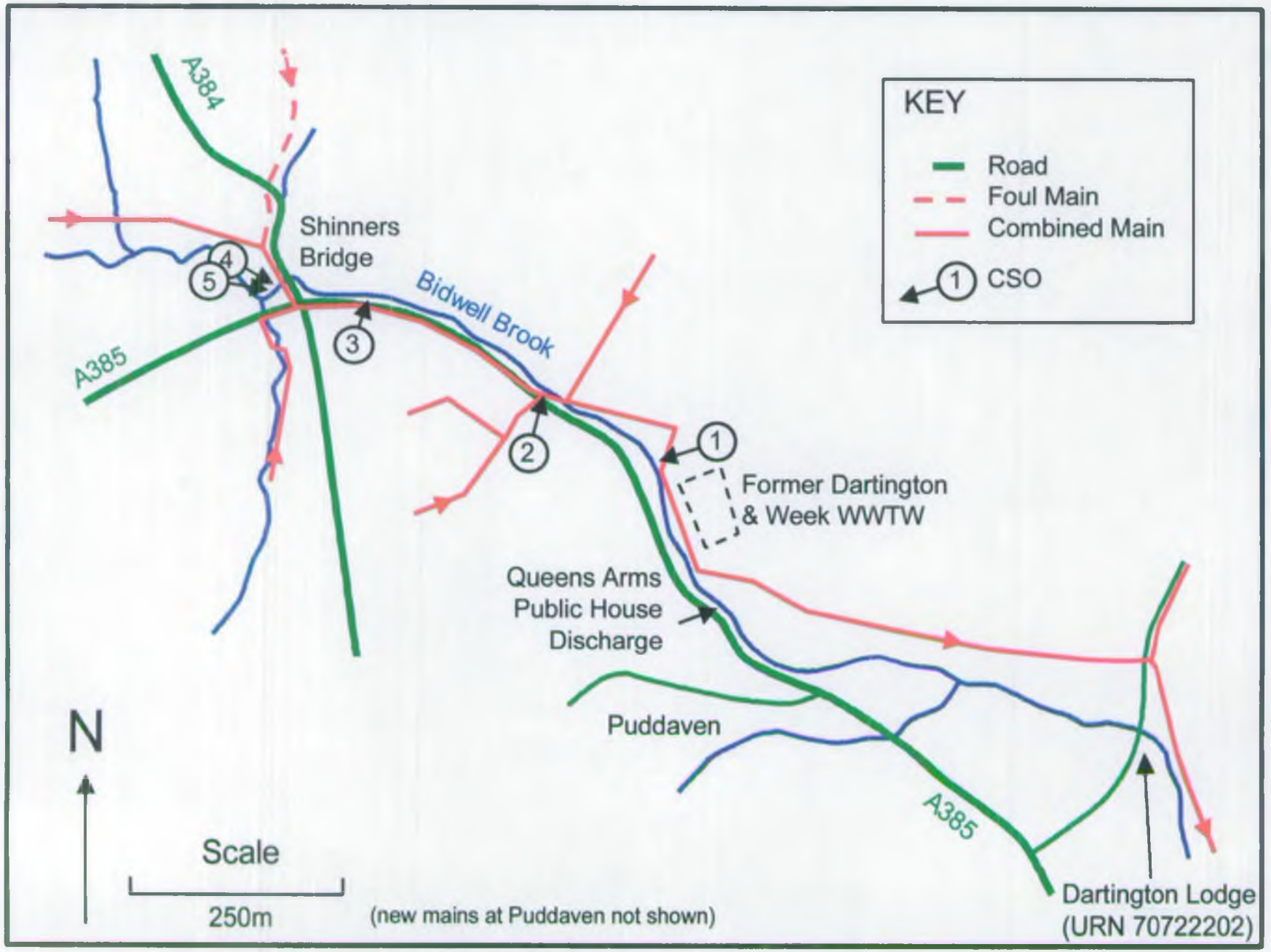


MAP 2. BIDWELL BROOK: INITIAL INVESTIGATION SAMPLING POINTS

MAP 3. INVESTIGATION SAMPLES TAKEN 04/06/98

1 Downstream Shinners Bridge
2 Upstream Shinners Bridge
3 Culvert at Shinners Bridge
4 Stream at Cider Press Entrance
5 Farm Drain
6 Piped Surface Water





MAP 4. Inputs to the Bidwell Brook at Dartington

TABLE 1.0 (A) WATER QUALITY FOR SELECTED DETERMINANDS AT DARTINGTON LODGE (1990-JUNE 1998)

values exceeding RE 1 90%ile
values exceeding RE 2 90%ile

DATE	pH	BOD	DO	NH3	NH3 NON-ION	SULPHATE	ORTHO-PHOSPHATE	NITRATE	SUSPENDED SOLIDS 105 C	SUSPENDED SOLIDS 500 C	Rainfall related	Rainfall day,day-1,day-2
19/01/90	7.6	5	84	0.64	0.01<	12.4	0.26		134	108	no	0,0,0,
23/03/90	7.9	1.4	94	0.4	0.01	16.1	0.22		4	2	no	0.3,0,2.5
27/03/90	7.9	2.6	87	0.27	0.01<	16	0.14		4	2	no	0.5,0,0
25/05/90	7.7	1.5	65	0.23	0.01<	15.9	0.37		6	3	no	0,0,0
05/06/90	7.5	3.5	44	0.86	0.01	19.1	1.12		4	1	yes	4.4,1.9,2.1
11/06/90	7.7	3.4	55	0.17	0.01<	16.1	0.51		5	2	possibly	2.1,0,0
12/07/90	7.8	1.5	50	0.11	0.01	16.4	0.56		6	2	no	0,0,0
30/07/90	7.5	11	51	1.03	0.01<	17.2	0.78		15	8	yes	0.3,49,4.7
20/08/90	7.6	1.3	47	0.14	0.01<	16.8	0.6		3	1	possibly	0,2.5,17.5
01/10/90	7.7	2.6	99	0.27	0.01<	25.3	0.44		10	7	yes	0,3.3,53.4
01/11/90	7.7	2.4	76	0.14	0.01<	18.7	0.22		3	1	possibly	1.7,0.9,10.7
09/11/90	7.6	1.4	64	0.12	0.01<	18.1	0.3		3	1	yes	8,4.1,0
14/01/91	7.7	2.1	91	0.1	0.01<	13.5	0.06		5	3		
04/02/91	7.8	1.4	91	0.29	0.01<	15.6	0.18		6	4	no	0,0,0
26/02/91	8	1.2	93	0.1	0.01<	14	0.07		9	7		
23/04/91	7.9	1.9	99	.01<	0	15.5	0.14		4	2		
23/05/91	7.7	2.3	72	0.61	0.01	18	0.49		6	3	no	0,0,0
17/06/91	7.9	1.6	73	0.18	0.01<	16.7	0.27		5	1	no	0,0.8,1.9
16/07/91	8	1.2	86	0.06	0.01<	13.2	0.01<		4	2		
13/08/91	8	1.2	61	.02<	0	15.8	0.43		9	5	no	1.1,0,0.4
26/09/91	7.7	1.7	56	0.213	0.0023	17.7	0.511		<2		possibly	0.4,0.5,7.8
09/10/91	7.93	1.5	87	0.228	0.004	14.1	0.163		6			
24/11/91	7.8	1.1	81	0.12	0.0013	16.1	0.1		3.2			
12/12/91	7.8	3.3	89	0.54	0.0039	15.4	0.21		12		no	0,0,0
22/01/92	8	2.2	95	0.28	0.0032	15	0.15		12		no	0,0,0
20/02/92	7.9	1.3	No Data	0.27	.0001<	15.1	0.13		6.6		possibly	0,0,2.4
17/03/92	7.8	2	90	0.53	0.0057	14	0.25		2.4		no	0,0,0
28/04/92	7.9	6.1	90	0.72	0.0107	13	0.23		47		yes	0,17.2,0.3
27/05/92	7.9	2.7	58	0.62	0.0127	14	0.45		4.9		possibly	5.1,0,0
17/06/92	7.6	3.6	55	0.81	0.0076	16.3	0.54		5.5		no	0,0,0
07/07/92	7.7	1.3	54	0.31	0.0037	14	0.42		4.5		no	0.6,0,0
15/08/92	7.5	2.1	37	1.1	0.0096	18	0.89		4.3		possibly	5.6,0,23.3
23/09/92	7.8	2.7	65	0.48	0.0066	19	0.28		8.9		yes	10.4,6.9,3
04/11/92	7.8	1	90	0.05	0.01<	13	0.05		9.7			
16/11/92	7.9	1.0<	88	0.13	0.01<	11	0.04		12			
17/12/92	7.8	1.6	97	0.63	0.01<	14	0.1		12		yes	45.4,1.5,3.4
13/01/93	7.1	4.7	98	0.41	0.01<	10	0.24		356		yes	16,8,4.9
10/02/93	8	1.0<	94	0.05	0.01<	13	0.05<		10			
13/03/93	8.1	1.0<	96	0.03	0.01<	15	0.05<		5.4			
21/04/93	8	1.3	94	0.04	0.0007	13	0.05<		4.5			
24/05/93	7.9	1.8	92	0.07	0.0012	14	0.09		10			
05/07/93	8	1.0<	95	0.07	0.0018	16	0.07		3.4			
20/08/93	8	1.0<	97	0.04	0.001	14	0.07		3.1			
30/09/93	7.8	5	91	0.26	0.0033	12	0.17		34		yes	6.3,17.7,5
14/10/93	7.9	1.4	99	0.03	0.0005	12	0.04		12			
18/11/93	7.9	1.0<	92	0.07	0.0009	14	0.04		5.7			
30/11/93	7.8	2.5	83	0.53	0.0052	13	0.09		14		yes	10,27.9,9
15/12/93	7.6	2.3	90	0.11	0.0007	10	0.07		28			

Dartington and Week WWTW decommissioned September 1992

TABLE 1.0 (A)(cont.) WATER QUALITY FOR SELECTED DETERMINANDS AT DARTINGTON LODGE (1990-JUNE 1998)

values exceeding RE 1 90%ile
values exceeding RE 2 90%ile

DATE	pH	BOD	DO	NH3	NH3 NON-ION	SULPHATE	ORTHO-PHOSPHATE	NITRATE	SUSPENDED SOLIDS 105 C	SUSPENDED SOLIDS 500 C	Rainfall related	Rainfall day,day-1,day-2
10/01/94	7.7	1	101	0.06	0.0005	8	0.04		14			
03/02/94	7.7	2.7	92	0.29	0.0024	11	0.08		55		yes	11.1,26.5,12.6
25/02/94	7.8	2.7	96	0.19	0.0019	9	0.06		55		yes	22.8,7.4,14.7
23/03/94	7.9	1.7	96	0.14	0.002	9	0.06		10			
13/04/94	8.1	1.5	95	0.04	0.0008	13	0.03		6.5			
06/05/94	8	1.5	93	0.06	0.0013	11	0.05		4.4			
07/07/94	8.2	1.7	109	0.07	0.0027	14	0.07		3.5			
11/08/94	7.9	1.3	101	0.14	0.0031	13	0.11		7.9			
28/09/94	8.1	1.1	85	0.06	0.0017	13	0.09		4.5			
12/10/94	8	1.1	99	0.07	0.0015	14	0.08		2.6			
01/11/94	7.8	1.5	94	0.04	0.0005	11	0.04		25			
24/11/94	8	1.0<	95	0.06	0.0013	12	0.04		7.9			
27/01/95	7.6	5.7	97	0.17	0.0011		0.08				yes	41.1,5.3,7.1
22/02/95	7.9	1.1	98	0.06	0.0008		0.03					
06/04/95	8.7	1.8	132	0.03<	0.0031		0.03					
21/04/95	8.8	1.9	127	0.03<	0.0031		0.02		<3			
16/05/95	7.9	5.6	92	0.08	0.0012		0.08		12		yes	11.8,2.2,0
22/05/95	8.1	1.7	102	0.06	0.0016		0.07		3.8			
14/06/95	8.15	1	101	0.05	0.0017		0.07		3.2			
03/07/95	8.2	1.9	107	0.06	0.0026		0.07		4.1			
11/07/95	8.05	3.9	91	0.15	0.0049		0.1		3.6		possibly	1,0.8,42.9
11/08/95	8.1	1.2	95	0.04	0.0015		0.06		3.6			
13/09/95	7.95	1.6	93	0.1	0.002		0.15		4.6			
15/09/95	8.05	1.3	92	0.1	0.0028		0.14		<3			
12/10/95	7.9	1.0<	89	0.03	0.0006		0.07		<3			
09/11/95	8	1.3	96	0.03<	0.0006		0.05		<3			
04/12/95	7.95	1.0<	94	0.03	0.0005		0.03		<3			
19/01/96	7.95	1	98	0.03<	0.0005		0.03		4.3			
19/02/96	8	1.4	104	0.03<	0.0004		0.02		<3			
07/03/96	8.15	1.5	103	0.03<	0.0007		0.04		<3			
28/03/96	8	1.4	100	0.03<	0.0004		0.02		3.8			
19/04/96	8.1	1.7	114	0.04	0.001		0.05		4.1			
15/05/96	8.4	1.9	105	0.04	0.0022		0.04		5.5			
18/06/96	8.1	1.1	98	0.04	0.0012		0.07		5.3			
10/07/96	8.2	1.0<	97	0.05	0.0019		0.06		<3			
06/08/96	8.2	2.2	106	0.12	0.005		0.09		4			
17/09/96	8.15	1.4	96	0.12	0.0038		0.1		4			
08/10/96	8	1	95	0.06	0.0013		0.08		<3			
12/12/96	7.95	1.5	101	0.03<	0.0004		0.03		5			
23/01/97	8	1.8	99	0.12	0.0016		0.05					
06/02/97	8.05	1.2	96	0.04	0.0008		0.04					
10/03/97	8	1.1	100	0.03<	0.0005		0.03					
11/04/97	8.25	2.2	115	0.04	0.0012		0.04					
19/05/97	7.6	9.2	91	0.88	0.0086		0.17				yes	12.6,16.9,2.1
30/06/97	8.15	1.0<	98	0.03<	0.0011		0.06					
23/09/97	8.15	1.0<	100	0.03<	0.0009		0.058					
07/10/97	7.95	2.2	95	0.03	0.0008		0.077					
28/10/97	8.05	1.1	99	0.03<	0.0006		0.026					
12/11/97	7.95	1.2	96	0.03<	0.0005		0.028					
23/11/97	7.9	2.1	97	0.04	0.0006		0.03					
03/12/97	7.85	2.9	103	0.052	0.0005		0.029				possibly	0.1,1.8,8
06/01/98	7.85	1.5	101	0.07	0.001		0.032					
04/02/98	7.9	2.4	89	0.094	0.001		0.049					
24/02/98	8.05	1.3	101	0.048	0.0009		0.051					
23/03/98	8.05	1<	98	0.04	0.0008		0.03					
28/04/98	8.1	1.2	100	0.064	0.0017		0.041					
10/06/98	8	2.4	93	0.2	0.0035		0.123					

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TABLE 1.0 (B) WATER QUALITY FOR SELECTED DETERMINANDS AT TIGLEY (1990 TO JUNE 1998)

values exceeding RE 1 90%ile
values exceeding RE 2 90%ile

DATE	TEMP	pH	BOD	DO	NH3	NH3 NON-ION	SULPHATE	ORTHO-PHOSPHATE	NITRATE	SUSPENDED SOLIDS 105	SUSPENDED SOLIDS 500 C	Rainfall related	Rainfall day,day-1,day-2
19/01/90		7.4	6.3	86	.36<	0.01<	13.1	0.19	5	293	237	no	0,0,0
23/03/90		8	1.1	100	.01<	0.01<	13.1	0.05	6.4	4	3		
27/03/90		8	1.6	98	.01<	0.01<	13.2	0.05	6.5	2	1		
25/05/90		8	1.2	98	.03<	0.01<	13.5	0.11	5.88	3	2		
05/06/90		8	1.1	88	.02<	0.01<	15.7	0.13	5.74	6	3		
11/06/90		8.1	2.9	102	.03<	0.01<	13.3	0.15	5.5	3	2	possibly	2.1,0,0
12/07/90		8.1	1.8	93	.01<	0	17.5	0.16	5.2	9	5		
30/07/90		7.7	6.2	85	0.41	0.01<	17.3	0.36	4.1	64	48	yes	0.3,49,4.7
20/08/90		8.1	0.9	94	.04<	0.01	14.4	0.2	4.6	2	<1		
01/10/90		8.1	1.4	50	.06<	0.01<	17.5	0.11	6.1	6	5	yes	0,3.3,53.4
01/11/90		7.8	1.8	93	.03<	0.01<	14.6	0.05	6.2	7	2		
09/11/90		7.8	1	82	.02<	0.01<	15.5	0.07	5.8	5	3		
14/01/91		7.7	2.1	96	.04<	0.01<	11.3	0.02	7	7	5		
04/02/91		7.8	0.8	99	.04<	0.01<	12.5	0.06	6.3	4	3		
26/02/91		7.9	1.3	97	.03<	0.01<	11.7	0.03	6.3	13	10		
23/04/91		8	1.6	102	.06<	0.01<	12.9	0.03	6.6	9	6		
23/05/91		8	1.2	100	.07<	0.01<	13	0.07	6	40	33		
17/06/91		8.1	1.8	113	.08<	0.01<	13.7	0.08	5.3	13	9		
16/07/91		8	1	96	.06<	0.01<	11.5	0.01<	5.4	9	6		
13/08/91		8.2	3.3	99	0.02	0	12	0.03	5.7	12	6	no	1.1,0,0.4
26/09/91		8.13	2.2	88	0.053	0.0016	13.7	0.091	4.83	4.5			
09/10/91		8.03	1	94	0.029	0.0007	12	0.095	5.47	9			
24/11/91		7.9	1	95	0.02	0.0003	14.4	0.04	6.08	6.2			
12/12/91		7.9	1.1	99	0.04	0.0004	12.7	0.05	5.98	4.1			
22/01/92		8	1.2	104	0.05	0.0006	13	0.06	6.06	6.3			
20/02/92		7.9	1	90	0.05	.0001<	13.7	0.05	6.07	9.8			
17/03/92		7.9	1.3	97	0.03	0.0004	13	0.04	5.78	18			
28/04/92		8.1	2.2	102	0.1	0.0024	13	0.05	4.85	22			
27/05/92		8.2	2.2	88	0.07	0.0034	12	0.06	5.52	20			
17/06/92		8.1	1.1	90	0.03	0.001	13.2	0.09	4.87	15			
07/07/92		8.1	1.4	83	0.04	0.0015	12	0.12	4.76	9.6			
15/08/92		8	1.0<	94	0.03	0.0008	14	0.15	4.57	9.8			
23/09/92		8	1.2	110	0.08	0.0016	14	0.09	5.46	13			
04/11/92		7.8	1.0<	97	0.03	0.01<	11	0.04	5.78	12			
16/11/92		7.9	1.4	97	0.2	0.01<	8	0.05	6.06	22			
17/12/92		7.8	1.8	102	0.07	0.01<	11	0.05<	6.07	4.9			
13/01/93	9.1	6.9	3.7	102	0.31	0.01<	9	0.15	2.93	218		yes	16,8,4.9
10/02/93	7.7	7.9	1.0<	98	0.03	0.01<	10	0.05<	5.88	3.4			
13/03/93	6.5	8.1	1.2	102	0.08	0.01<	12	0.07	5.67	5.8			
21/04/93	10.3	8.1	1.1	97	0.02	0.0005	11	0.05<	5.28	9.4			
24/05/93	12.6	7.9	1.4	96	0.06	0.001	13	0.1	4.95	17			
05/07/93	14.7	8	1	100	0.05	0.0013	16	0.06	5.18	6.2			
20/08/93	14.8	8	1.3	99	0.06	0.0015	11	0.07	4.78	4.6			
30/09/93	11.3	7.8	2.4	95	0.13	0.0017	12	0.11	4.45	12			
14/10/93	10.4	7.9	1.1	100	0.02<	0.0003	10	.02<	4.489	11			
18/11/93	8.8	7.9	1.0<	89	0.02<	0.0003	12	0.03	4.892	4.4			
30/11/93	7.9	7.9	1.7	88	0.06	0.0008	11	0.06	4.673	58			
15/12/93	7.3	7.7	1.4	99	0.03	0.0002	9	0.04	4.383	32			

TABLE 1.0 (B) (Cont.) WATER QUALITY FOR SELECTED DETERMINANDS AT TIGLEY (1990 TO JUNE 1998)

values exceeding RE 1 90%ile
values exceeding RE 2 90%ile

DATE	TEMP	pH	BOD	DO	NH3	NH3 NON-ION	SULPHATE	ORTHO-PHOSPHATE	NITRATE	SUSPENDED SOLIDS 105	SUSPENDED SOLIDS 500 C	Rainfall related	Rainfall day,day-1,day-2
10/01/94	8.2	7.6	1	105	0.02<	0.0001	7	0.03	4.286	10			
03/02/94	8.5	7.7	1.9	99	0.08	0.0007	11	0.05	3.288	32			
25/02/94	8	7.7	2.8	99	0.13	0.0011	9	0.06	2.687	179		yes	22.8,7.4,14.7
23/03/94	10	8	1.4	100	0.04	0.0007	9	0.04	3.582	13			
13/04/94	8	8.1	2.1	99	0.03	0.0006	13	0.04	3.689	6.7			
06/05/94	11.8	8.2	1.7	97	0.03	0.001	9	0.05	4.077	4.6			
07/07/94	14.1	8.1	1.1	93	0.05	0.0014	12	0.08	4.077	4.3			
11/08/94	15.6	8.1	1.1	111	0.06	0.002	10	0.09	3.969	6			
28/09/94	12.5	8.1	1.0<	97	0.04	0.0011	11	0.08	3.768	2.8			
12/10/94	12.4	8	1.0<	95	0.1	0.0022	13	0.3	3.674	12			
01/11/94	11.6	7.8	1.2	97	0.02	0.0003	10	0.04	3.688	44			
24/11/94	12	8	1.0<	96	0.11	0.0023	11	0.04	3.976	6.7			
27/01/95	7.9	7.6	5.9	88	0.18	0.0012		0.08	1.589			yes	41.1,5.3,7.1
22/02/95	9.3	7.9	1	99	0.03<	0.0004		0.02	3.793				
06/04/95	12.8	8.2	1.1	102	0.03<	0.0011		0.05	3.686				
21/04/95	9.8	8.1	1.0<	104	0.03<	0.0005		0.03	3.986				
16/05/95	10	8	3.9	97	0.17	0.0031		0.13	3.91			yes	11.8,2.2,0
22/05/95	12.3	Not sampled											
14/06/95	13.7	8.15	1	93	0.03	0.001		0.07	3.567				
03/07/95	15.7	8.15	1.7	95	.03<	0.0011		0.07	2.885				
11/07/95	16.3	Not sampled				0.0013							
11/08/95	16.6	8.15	1.1	92	.03<	0.0008		0.13	3.287				
13/09/95	12.5	8.1	1.3	101	0.03	0.0008		0.13	3.274				
15/09/95	14.4	Not sampled											
12/10/95	14.2	8.05	1<	93	.03<	0.0008		0.07	4.676				
09/11/95	10.8	8.05	1.7	101	0.04	0.0009		0.07	3.868				
04/12/95	10.4	7.9	1	97	0.04	0.0006		0.03	4.877				
19/01/98	10.1	8	1<	98	.03<	0.0006		0.04	5.084				
19/02/98	4.5	8	1.3	108	0.03	0.0004		0.04	5.186				
07/03/98	7.9	8.05	1.7	99	0.23	0.0045		0.07	4.85				
28/03/98	6.8	7.9	2.4	104	0.07	0.0008		0.05	5.18				
19/04/96	10.6	8	2.3	107	0.18	0.004		0.08	4.352				
15/05/96	12.9	8.2	1.7	97	0.04	0.0016		0.06	4.267				
18/08/96	14.1	8.1	1.8	95	0.05	0.0015		0.07	4.569				
10/07/96	14.1	8.2	1.6	93	0.03<	0.0012		0.09	4.378				
06/08/96	15	8	4.4	94	0.18	0.0043		0.15	3.731			yes	10.1,2.5,0
17/09/96	12.9	8.15	1.6	94	0.14	0.0047		0.11	3.75				
08/10/98	12.7	8.05	1	97	.03<	0.0008		0.08	4.278				
12/12/96	7.6	8	1.4	101	0.04	0.0006		0.03	5.388				
23/01/97	5.9	8.05	1.5	104	0.07	0.0011		0.05	5.17				
06/02/97	8.9	8.05	1.4	96	0.04	0.0008		0.04	5.178				
10/03/97	9.1	8	1.3	100	0.03<	0.0005		0.03	5.289				
11/04/97	9.4	8.2	1.1	101	0.03<	0.0006		0.06	4.688				
19/05/97	13.7	7.75	6.2	94	0.33	0.0047		0.2	3.54			yes	12.8,16.9,2.1
30/06/97	14.2	8.15	1.0<	96	0.03<	0.0011		0.06	4.577				
23/09/97	12.7	8.15	1.0<	98	0.03<	0.0009		0.064	4.4545				
07/10/97	12.9	8	3.9	95	0.22	0.0049		0.248	4.1655			yes	18.2,8.1,0
28/10/97	10.3	8	1.2	99	0.03<	0.0006		0.039	4.9669				
12/11/97	9	7.9	1.2	95	0.03	0.0005		0.032	5.0793				
23/11/97	8.7	7.9	1.0<	96	0.03	0.0005		0.031	5.3473				
03/12/97	7	7.9	2.5	104	0.055	0.0007		0.03	5.5546			possibly	0,1.8,8
06/01/98	10.5	7.8	1.0<	101	0.03<	0.0004		0.025	5.1624				
04/02/98	6.5	8	1.9	93	0.047	0.0007		0.037	5.3831				
24/02/98	8.4	8.1	1.5	99	0.06	0.0012		0.055	4.9677				
23/03/98	9.1	8.05	1.6	96	0.684	0.0143		0.058	5.7721			no	0,0,0
28/04/98	11.6	8.05	1.2	98	0.07<	0.0041		0.035	4.3558				
10/06/98	14.1	8	1.3	96	0.1	0.0008		0.084	3.7526				

TABLE 2. ANALYSIS FOR INVESTIGATION SAMPLES TAKEN 25/03/98

		Dartington Lodge	Shinners Bridge	Redlake Tributary	Droridge Tributary	Week Tributary	Westcombe Tributary	Dunn Cross	Tigley	u/s Venton Tributary	d/s Allercombe Farm	Willing Tributary	u/s Rattery
pH		8	8.1	8.05	8.05	8.15	8.05	8	8	7.95	7.75	8	7.7
TEMP °C	°C	9.7	9.8	9.7	9.3	9.7	10	10.1	10.3	10.4	10.2	10.5	9.9
D.O.%	% sat	102.7	102.6	98.7	100	101.5	100	98.4	100.4	100.4	99.2	99.9	99.3
D.O.%	mg l^{-1}	11.7	11.6	11.2	11.5	11.5	11.3	11.1	11.2	11.2	11.1	11.1	11.2
BOD	mg l^{-1}	1.8	1.7	4.1	1.3	1	1.5	3.7	3.3	3	2.5	3.7	1.2
AMMONIA	mg l^{-1}	0.069	0.119	0.062	0.069	0.03	0.055	0.399	0.217	0.232	0.188	0.356	0.03
T.O.N	mg l^{-1}	5.57	5.4	2.03	5.58	4.94	6.86	4.79	4.81	5.12	4.84	5.79	5.14
NITRATE	mg l^{-1}	5.54	5.35	2	5.56	4.94	6.81	4.72	4.76	5.08	4.82	5.74	5.14
NITRITE	mg l^{-1}	0.026	0.0473	0.0273	0.0193	0.004	0.0451	0.0703	0.0481	0.0412	0.0249	0.0477	0.005
NH3 NON-IO	mg l^{-1}	0.0012	0.0027	0.0012	0.0013	0.0007	0.0011	0.0073	0.0041	0.0039	0.002	0.0068	0.0003
SS 105 C	mg l^{-1}	5.8	4	11.7	<3	3	7.7	7.7	19.4	11.5	12.5	9.6	9.1
ALK 4.5	mg l^{-1}	137	117	137	150	112	111	100	85	82	81	86	48
ORTHO-PHOS	mg l^{-1}	0.035	0.042	0.035	0.025	0.011	0.035	0.106	0.127	0.114	0.144	0.092	0.01
T.INORG.N	mg l^{-1}	5.64	5.52	2.09	5.65	4.97	6.91	5.19	5.03	5.35	5.03	6.15	5.17
WEATH PREC		Rain	Rain	Rain	Rain	Rain	Rain	Rain	Rain	Rain	Showery	Showery	Showery
FLOW		Normal	Normal	Low	Low	Low	Low	Normal	Normal	Normal	Normal	Normal	Normal

TABLE 3. ANALYSIS FOR INVESTIGATION SAMPLES TAKEN 04/06/98

		D/S Shinners Bridge	U/S Shinners Bridge	Culvert at Shinners Bridge	Cider Press Car Park	Farm Drain	Piped Surface Water
TEMP	°C	12.8	12.8	14	15.8	13.4	11.9
D.O.%	% sat	95.6	93.1	30	21	19	87.5
BOD ATU	mg l^{-1}	1.8	1.3	17.3	31.5	284	1.2
COD	mg l^{-1}	<12	<12	<56	82	532	<12
C ORG TOT	mg l^{-1}	1.67	1.64	9.7	16	144	1.16
AMMONIA	mg l^{-1}	0.098	0.063	2.66	3.6	17.2	0.064
T.O.N	mg l^{-1}	4.33	4.39	1.14	<0.2	<1	5.53
NITRATE	mg l^{-1}	4.29	4.36	0.947	<0.2	0.9	5.51
NITRITE	mg l^{-1}	0.0364	0.0339	0.193	<0.004	<0.1	0.018
NH3 NON-IO	mg l^{-1}						
SS 105 C	mg l^{-1}	3.6	4.5	<13.4	18.1	60	<3
SS 500 C	mg l^{-1}					<20	
ALK 4.5	mg l^{-1}	138	134	294	271	458	200
ORTHO-PHOS	mg l^{-1}	0.101	0.082	0.896	1.24	6.2	0.031
PHOSPHATE	mg l^{-1}	0.129	0.102	1.5	1.92	8.19	0.055
T.INORG.N	mg l^{-1}	4.43	4.45	3.8	3.8	18.2	5.59
FStrP100ml		570	189	14000	15000	240000	2500
FcolP100ml		2700	580	30000	34000	390000	1364
ColP100ml		4300	2100	23000	80000	4000000	7400
WEATH PREC		DRY *	DRY *	DRY *	DRY *	DRY *	DRY *
FLOW		NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL

* dry on day of sampling but showery for 2 days prior.

TABLE 4. ANALYSIS FOR CRUDE SEWAGE SAMPLE TAKEN 06/07/98

pH		7.5
TEMP	°C	16.7
D.O.%	% sat	58.2
BOD ATU	mg l^{-1}	322
COD	mg l^{-1}	783
C ORG TOT	mg l^{-1}	68.9
AMMONIA	mg l^{-1}	29.8
T.O.N	mg l^{-1}	<0.2
NITRATE	mg l^{-1}	<0.2
NITRITE	mg l^{-1}	0.0053
NH3 NON-IO	mg l^{-1}	0.29
SS 105 C	mg l^{-1}	
SS 500 C	mg l^{-1}	
ALK 4.5	mg l^{-1}	268
ORTHO-PHOS	mg l^{-1}	6.6
PHOSPHATE	mg l^{-1}	
T.INORG.N	mg l^{-1}	30
FStrP100ml		3400000
TColP/ml		>100000
FcolP100ml		7200000
ColP100ml		>9999999 see result per ml
WEATH PREC		Showery
FLOW		Normal

TABLE 5A

BOD COMPLIANCE WITH RE CLASS 1993 - 5 :BIDWELL BROOK AT DARTINGTON LODGE

Date	All Data			With Wet Weather Removed		
	Raw	Face Value	Optimistic	Raw	Face Value	Optimistic
13/01/93	4.7	4.7	4.7			
10/02/93	1.0<	0.5	0	1.0<	0.5	0
13/03/93	1.0<	0.5	0	1.0<	0.5	0
21/04/93	1.3	1.3	1.3	1.3	1.3	1.3
24/05/93	1.8	1.8	1.8	1.8	1.8	1.8
05/07/93	1.0<	0.5	0	1.0<	0.5	0
20/08/93	1.0<	0.5	0	1.0<	0.5	0
30/09/93	5	5	5			
14/10/93	1.4	1.4	1.4	1.4	1.4	1.4
18/11/93	1.0<	0.5	0	1.0<	0.5	0
30/11/93	2.5	2.5	2.5			
15/12/93	2.3	2.3	2.3	2.3	2.3	2.3
10/01/94	1	1	1	1	1	1
03/02/94	2.7	2.7	2.7			
25/02/94	2.7	2.7	2.7			
23/03/94	1.7	1.7	1.7	1.7	1.7	1.7
13/04/94	1.5	1.5	1.5	1.5	1.5	1.5
06/05/94	1.5	1.5	1.5	1.5	1.5	1.5
07/07/94	1.7	1.7	1.7	1.7	1.7	1.7
11/08/94	1.3	1.3	1.3	1.3	1.3	1.3
28/09/94	1.1	1.1	1.1	1.1	1.1	1.1
12/10/94	1.1	1.1	1.1	1.1	1.1	1.1
01/11/94	1.5	1.5	1.5	1.5	1.5	1.5
24/11/94	1.0<	0.5	0	1.0<	0.5	0
27/01/95	5.7	5.7	5.7			
22/02/95	1.1	1.1	1.1	1.1	1.1	1.1
06/04/95	1.8	1.8	1.8	1.8	1.8	1.8
21/04/95	1.9	1.9	1.9	1.9	1.9	1.9
16/05/95	5.6	5.6	5.6			
22/05/95	1.7	1.7	1.7	1.7	1.7	1.7
14/06/95	1	1	1	1	1	1
03/07/95	1.9	1.9	1.9	1.9	1.9	1.9
11/07/95	3.9	3.9	3.9			
11/08/95	1.2	1.2	1.2	1.2	1.2	1.2
13/09/95	1.6	1.6	1.6	1.6	1.6	1.6
15/09/95	1.3	1.3	1.3	1.3	1.3	1.3
12/10/95	1.0<	0.5	0	1.0<	0.5	0
09/11/95	1.3	1.3	1.3	1.3	1.3	1.3
04/12/95	1.0<	0.5	0	1.0<	0.5	0
s		1.37	1.48		0.51	0.71
m		1.82	1.71		1.23	1.1
n		39	39		31	31
s2		1.88	2.19		0.26	0.5
m2		3.3	2.93		1.5	1.2
s2/m2		0.57	0.75		0.18	0.41
s		0.67	0.75		0.4	0.59
m		0.37	0.26		0.12	-0.08
90%ile		**3.43**	**2.67**		**1.89**	**1.6**
RE CLASS		**RE2**	**RE2**		**RE1**	**RE1**

TABLE 5B

BOD COMPLIANCE WITH RE CLASS 1993 - 5 :BIDWELL BROOK AT TIGLEY

Date	All Data			With Wet Weather Removed		
	Raw	Face Value	Optimistic	Raw	Face Value	Optimistic
13/01/93	3.7	3.7	3.7			
10/02/93	1.0<	0.5	0	1.0<	0.5	0
13/03/93	1.2	1.2	1.2	1.2	1.2	1.2
21/04/93	1.1	1.1	1.1	1.1	1.1	1.1
24/05/93	1.4	1.4	1.4	1.4	1.4	1.4
05/07/93	1	1	1	1	1	1
20/08/93	1.3	1.3	1.3	1.3	1.3	1.3
30/09/93	2.4	2.4	2.4	2.4	2.4	2.4
14/10/93	1.1	1.1	1.1	1.1	1.1	1.1
18/11/93	1.0<	0.5	0	1.0<	0.5	0
30/11/93	1.7	1.7	1.7	1.7	1.7	1.7
15/12/93	1.4	1.4	1.4	1.4	1.4	1.4
10/01/94	1	1	1	1	1	1
03/02/94	1.9	1.9	1.9	1.9	1.9	1.9
25/02/94	2.8	2.8	2.8			
23/03/94	1.4	1.4	1.4	1.4	1.4	1.4
13/04/94	2.1	2.1	2.1	2.1	2.1	2.1
06/05/94	1.7	1.7	1.7	1.7	1.7	1.7
07/07/94	1.1	1.1	1.1	1.1	1.1	1.1
11/08/94	1.1	1.1	1.1	1.1	1.1	1.1
28/09/94	1.0<	0.5	0	1.0<	0.5	0
12/10/94	1.0<	0.5	0	1.0<	0.5	0
01/11/94	1.2	1.2	1.2	1.2	1.2	1.2
24/11/94	1.0<	0.5	0	1.0<	0.5	0
27/01/95	5.9	5.9	5.9			
22/02/95	1	1	1	1	1	1
06/04/95	1.1	1.1	1.1	1.1	1.1	1.1
21/04/95	1.0<	0.5	0	1.0<	0.5	0
16/05/95	3.9	3.9	3.9			
22/05/95						
14/06/95	1	1	1	1	1	1
03/07/95	1.7	1.7	1.7	1.7	1.7	1.7
11/07/95						
11/08/95	1.1	1.1	1.1	1.1	1.1	1.1
13/09/95	1.3	1.3	1.3	1.3	1.3	1.3
15/09/95						
12/10/95	1<	0.5	0	1<	0.5	0
09/11/95	1.7	1.7	1.7	1.7	1.7	1.7
04/12/95	1	1	1	1	1	1
s		1.09	1.19		0.49	0.65
m		1.49	1.4		1.17	1.06
n		36	36		32	32
s2		1.18	1.42		0.24	0.43
m2		2.23	1.95		1.37	1.13
s2/m2		0.53	0.73		0.17	0.38
s		0.65	0.74		0.4	0.57
m		0.19	0.06		0.08	-0.1
90%ile		**2.79**	**2.15**		**1.8**	**1.54**
RE CLASS		**RE2**	**RE1**		**RE1**	**RE1**

TABLE 6. DARTINGTON AND WEEK WWTW: FINAL EFFLUENT AND RECEIVING WATER ANALYSIS

	Final Effluent				Upstream				Downstream				Enhancement			
	Dissolved oxygen % saturation	BOD mg l⁻¹	Total ammonia mg l⁻¹	Ortho-phosphate mg l⁻¹	Dissolved oxygen % saturation	BOD mg l⁻¹	Total ammonia mg l⁻¹	Ortho-phosphate mg l⁻¹	Dissolved oxygen % saturation	BOD mg l⁻¹	Total ammonia mg l⁻¹	Ortho-phosphate mg l⁻¹	Dissolved oxygen % saturation	BOD mg l⁻¹	Total ammonia mg l⁻¹	Ortho-phosphate mg l⁻¹
25/01/90		4.3	< .5													
13/02/90		4.5	< .5													
01/03/90		4.8	< .5													
27/03/90		39	17.7													
02/04/90		33	16.7													
26/04/90		39	20.2													
02/05/90		60	21.4													
11/06/90		15.1	10.1													
27/06/90		43	21.2													
12/07/90		14.3	15.3													
30/07/90		40	7.6													
20/08/90		34	16.4													
29/08/90		32	16.4													
10/09/90		23	12.6													
01/10/90		16.1	7.9													
25/10/90		16.1	7.9													
01/11/90		21	9													
14/11/90		23	7.7													
28/11/90		21	8													
12/12/90		80	16.5													
14/01/91		6.9	0.8													
21/01/91		9.2	0.8													
04/02/91		33	14.3													
26/02/91		17.9	5.5													
12/03/91		5	3.1													
23/04/91		45	12.2			2.6	<.5			3.5	0.6			0.9	0.35	
18/05/91		76	24.8			1.8	<.5			3	<.5			1.2	0	
23/05/91		51	22.3			2.2	<.5			6	1.9			3.8	1.65	
17/06/91		22	6.1			0.8	<.5			3.4	0.5			2.6	0.25	
27/06/91		5.3	2.7			1.3	<.5			1.5	<.5			0.2	0	
25/09/91		42	14.4			1.6	<.5			1.6	1.1			0	0.85	
09/10/91		no data	8.1			1.9	<.5			2.3	<.5			0.4	0	
28/10/91		70	19.5			<1	<.5	<.5		4.3	1.5	0.6		4.3	1.25	
15/11/91		9.3	5.3			1.3	0.07	0.05		2	0.21	0.07		0.7	0.14	0.02
24/11/91		12.2	6.8			1	0.17	0.06		1.5	0.3	0.17		0.5	0.13	0.11
29/11/91		>38.6	14.4			<1	0.46	0.08		1.4	0.67	0.15		1.4	0.19	0.07
12/12/91		34	10.7			1.1	<.02	0.04		3.3	0.69	0.41		2.2	0.68	0.37
03/01/92		45.4	16.2		108	1.5	0.28		107	3.5	1.1		1	2	0.82	
22/01/92		31.7	13.6		90	1.2	0.02	0.04	95	2.5	0.34	0.15	5	1.3	0.32	0.11
20/02/92		24.5	13.1		97	<1	0.06	0.05	95	1.9	0.49	0.17	-2	1.9	0.43	0.12
17/03/92		>37.6	16		98	1.2	<.02	0.04	97	2.4	0.71	0.28	-1	1.2	0.71	0.24
09/04/92		21.4	10.6		102		0.05	0.04	108		0.23	0.12	6	0	0.18	0.08
28/04/92		>30.5	6.9		100	3.8	0.28	0.09	97	4.3	0.48	0.2	-3	0.5	0.2	0.11
27/05/92		>38.3	17.8		98	1.6	0.11	0.09	107	4.3	0.85	0.48	9	2.7	0.74	0.37
12/06/92		>28.9	20		92	1.1	0.02	0.07	81	2.7	1.4	0.67	-1	1.6	1.38	0.6
17/06/92		34.9	38.4		91	<1	0.03	0.08	88	4.8	2.4	0.77	-3	4.8	2.37	0.69
07/07/92		34.7	22.9		86	1.1	0.04	0.09	81	6.2	4	1.7	-5	5.1	3.96	1.61
14/07/92		64.3	26.8		94	2.1	0.03	0.13	89	6.4	1.9	0.79	-5	4.3	1.87	0.66
15/08/92		30.6	26		92	<1	0.05	0.14	86	4.4	2.9	1.1	-6	4.4	2.85	0.96
04/09/92		29.4	12.9		100	1.2	0.03	0.06	98	1.5	0.24	0.11	-2	0.3	0.21	0.05
23/09/92		34.5	19.4		106	1.5	0.66	0.16	82	3.9	1.6	0.39	-24	2.4	0.94	0.23
Average values mg l⁻¹ (all <values halved)		30.16	13.89		98.57	1.61	0.15	0.08	94.36	3.31	1.14	0.48	-2.21	1.95	0.66	0.38
Average values as % increase													-2.29	121.50	561.00	488.55

TABLE 7. IMPACT OF DARTINGTON AND WEEK WWTW

Date	BOD				Total Ammonia			
	Upstream	Discharge	Downstream	Dartington Lodge	Upstream	Discharge	Downstream	Dartington Lodge
23/05/91	2.2	51*	6	2.3	<0.05	22.3	1.9	0.61
12/12/91	1.1	34	3.3	3.3	<0.02	10.7	0.69	0.54
22/01/92					0.02	13.6	0.34	0.28
20/02/92					0.06	13.1	0.49	0.27
17/03/92					<0.02	16	0.71	0.53
28/04/92	3.8	>30.5*	4.3	6.1	0.28	6.9*	0.48	0.72
27/05/92	1.6	>38.3	4.3	2.7	0.11	17.8	0.85	0.62
17/06/92	<1	34.9	4.8	3.6	0.03	36.4	2.4	0.81
07/07/92					0.04	22.9	4	0.31
15/08/92					0.05	28	2.9	1.1
23/09/92	1.5	34.5	3.9	2.7	0.66	19.4	1.6	0.48

Discharge causing exceedence at Dartington Lodge

* 28/04/92: whilst the upstream concentration exceeds the RE1 90%ile the discharge is exacerbating the problem at Dartington Lodge

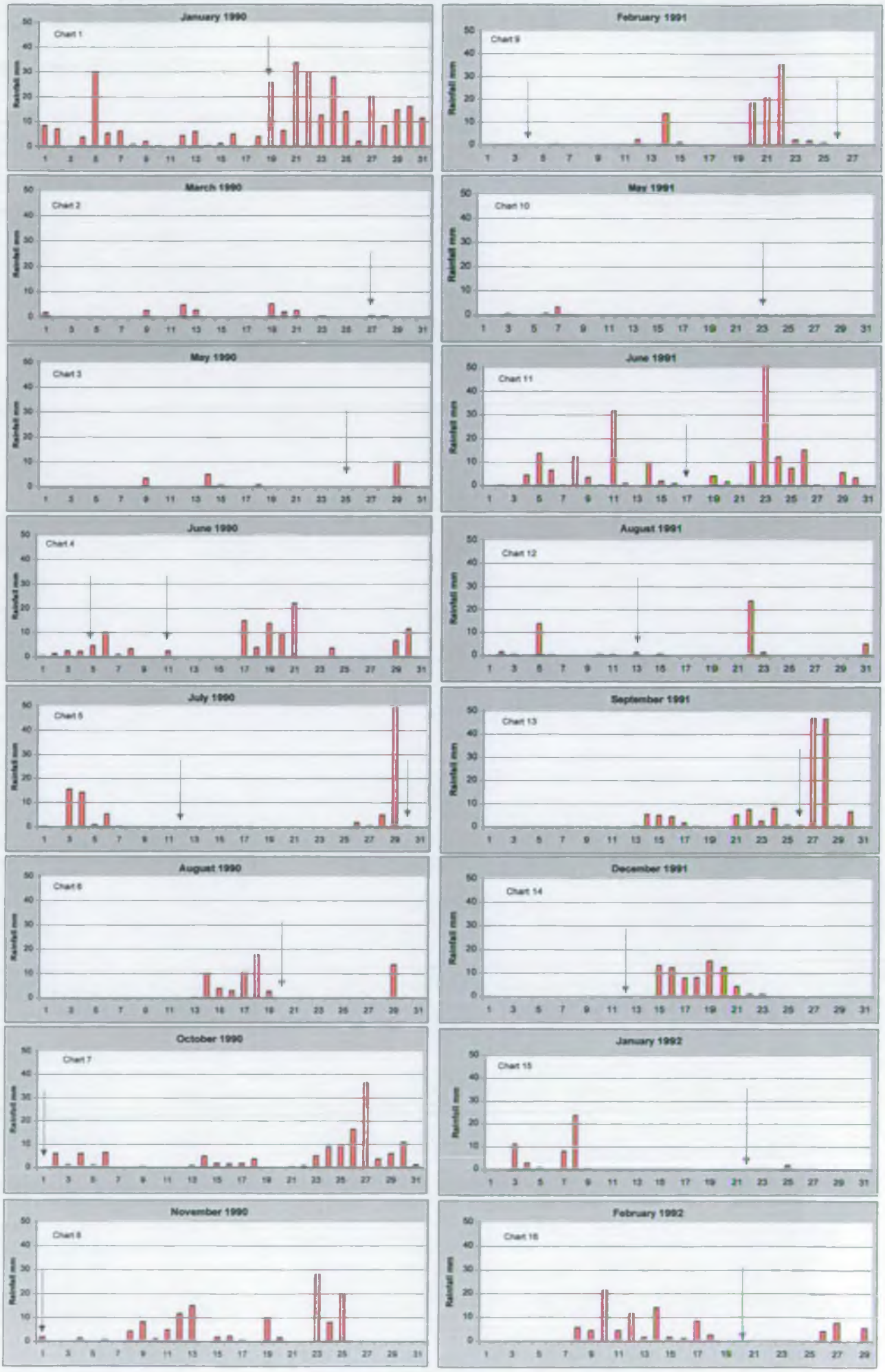
TABLE 8. RATTERY WWTW: BOD ENHANCEMENT

Date	Final Effluent	Upstream	Downstream	Enhancement
23/04/91	7.5	1.5	1.8	0.3
23/05/91	33	1.4	0.7	-0.7
17/06/91	42	1.2	1.2	0
16/07/91	12.2	0.7	0.8	0.1
13/08/91	36		>28	
24/11/91	15.2	5.5	1.1	-4.4
12/12/91	11.2	1.3	1.1	-0.2
22/01/92	17	<1	1.6	1.1
20/02/92	10.9	<1	1.1	0.6
17/03/92	10.5	1.2	<1	-0.7
28/04/92	15.4	1.1	<1	-0.6
27/05/92	28.6	1.7	1	-0.7
17/06/92	>34.3	1	<1	-0.5
07/07/92	21	<1	<1	0
23/09/92	14.3	<1	<1	0
04/11/92	13.9	<1	<1	0
16/11/92	26.8	<1	1.1	0.6
17/12/92	21	<1	<1	0
13/01/93	6.3	2.3	2.3	0
10/02/93	5.9	<1	1	0.5
13/03/93	>22.6	1.1	<1	-0.6
21/04/93	17.7	1.1	1.1	0
24/05/93	33	1.2	<1	-0.7
05/07/93	12.7	<1	<1	0
20/08/93	13.8	<1	<1	0
30/09/93	14.2	1.1	1.1	0
14/10/93	16.6	1.1	1.1	0
18/11/93	10.9	<1	<1	0
30/11/93	15.2	1.2	1.3	0.1
15/12/93	5.3	1.1	1.3	0.2
10/01/94	19.9	<1	<1	0
03/02/94	4.9	1.7	1.9	0.2
25/02/94	3.6	1.1	1.3	0.2
23/03/94	4.6	1	<1	-0.5
13/04/94	10.8	1.3	1.1	-0.2
06/05/94		<1	1.3	0.8
07/07/94	16.5	1.6	1.7	0.1
11/08/94	12.5	<1	<1	0
28/09/94	13.9	<1	<1	0
12/10/94	61.1	<1	<1	0
01/11/94		<1	1.1	0.6
24/11/94		<1	<1	0
22/02/95		1	<1	-0.5
03/03/95		1.4	1.6	0.2
06/04/95		1.3	1.2	-0.1
21/04/95		1	1.2	0.2

No or negative effect

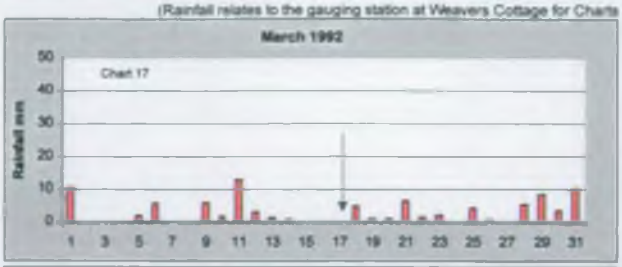
CHARTS 1-36. POOR WATER QUALITY IN RELATION TO RAINFALL IN THE BIDWELL BROOK (1990 - JUNE 1998).

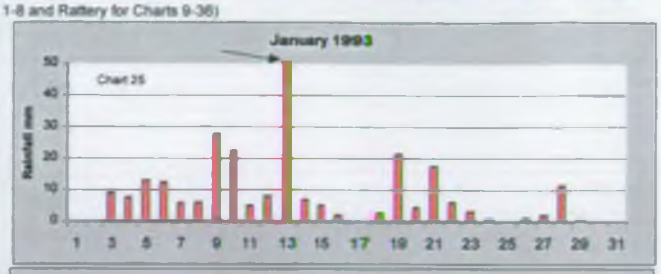
(Rainfall relates to the gauging station at Weavers Cottage for Charts 1-8 and Rattery for Charts 9-36)

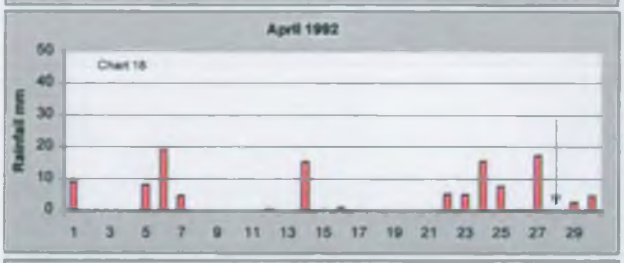


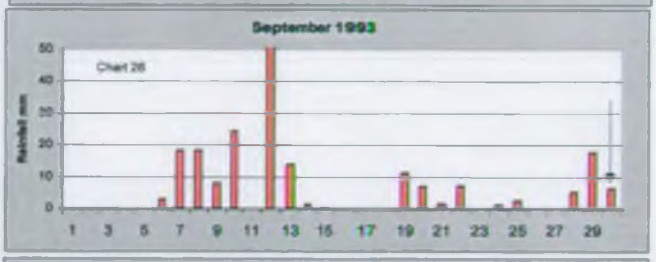
CHARTS 1-36. POOR WATER QUALITY IN RELATION TO RAINFALL IN THE BIDWELL BROOK (1990 - JUNE 1998).

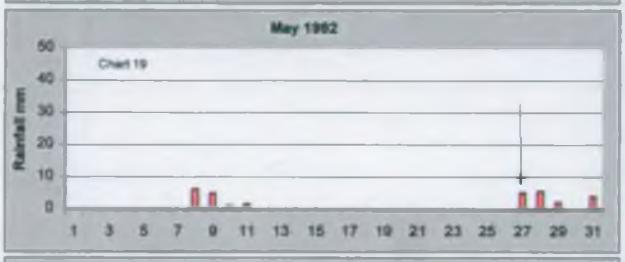
(Rainfall relates to the gauging station at Weavers Cottage for Charts 1-8 and Rattery for Charts 9-36)

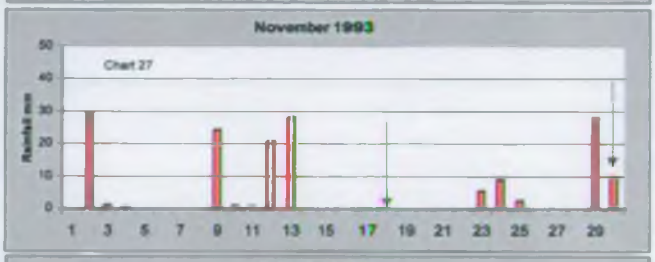


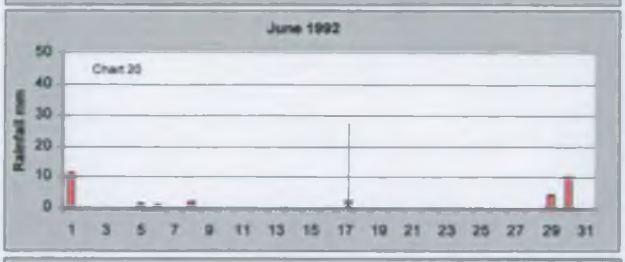


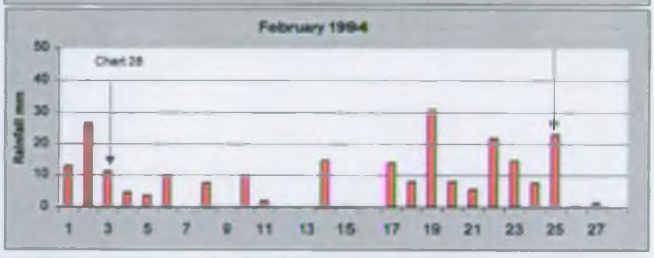


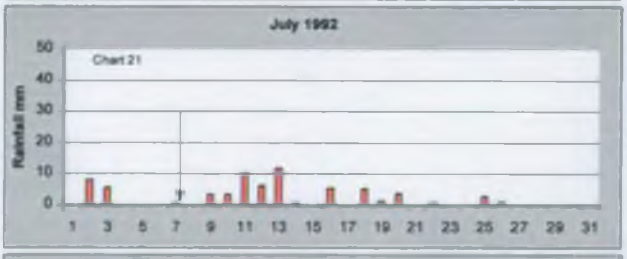


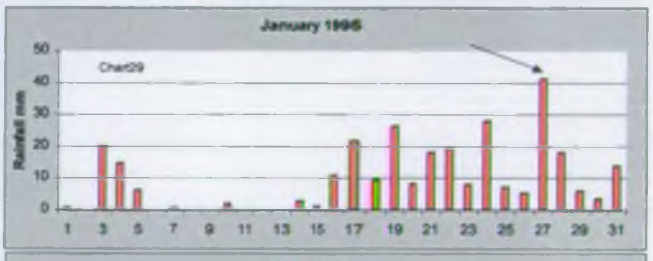


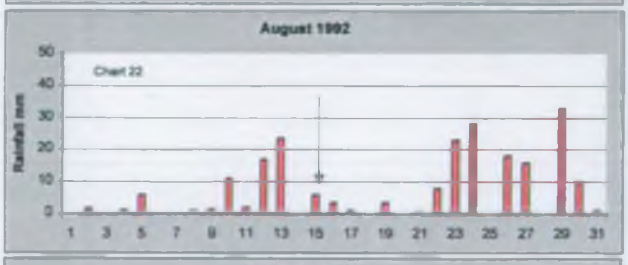


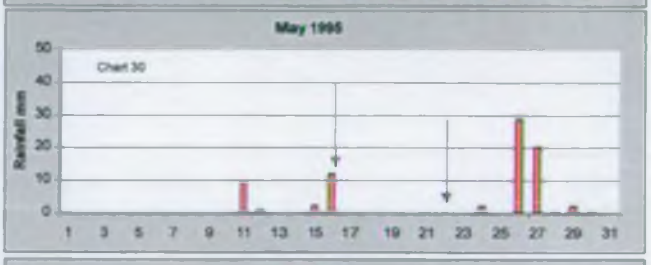


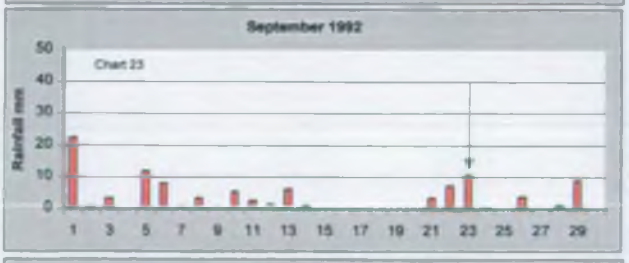


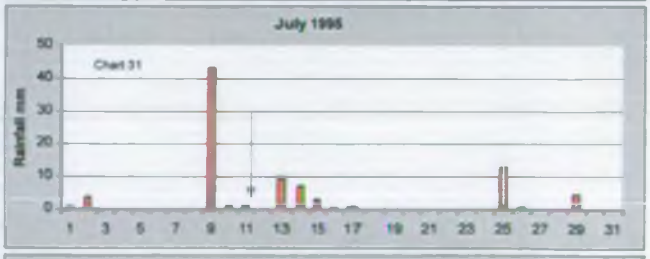


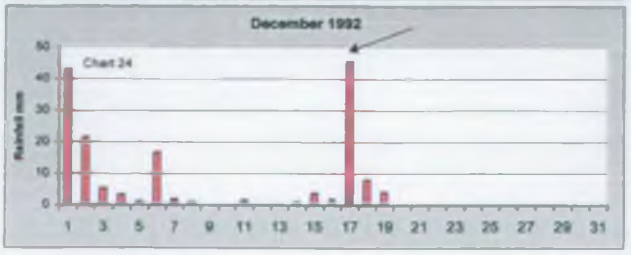


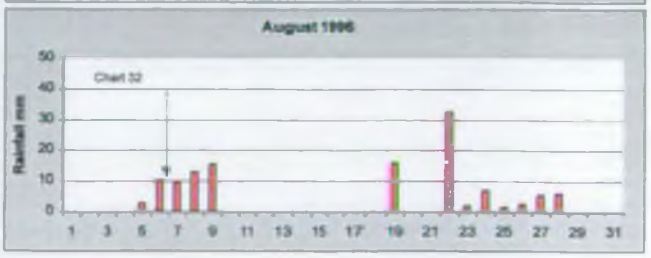






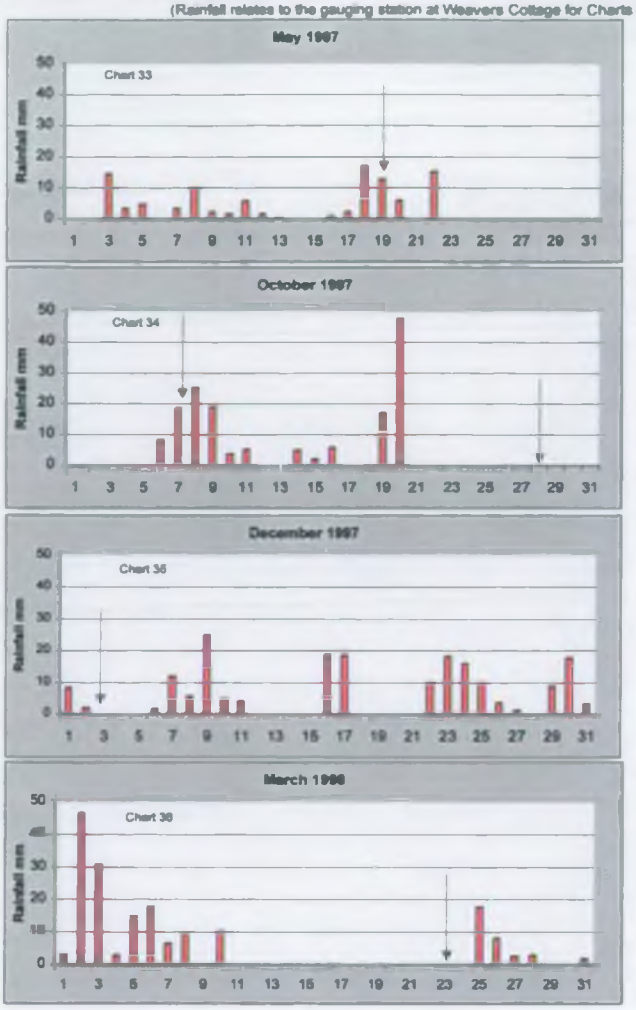






CHARTS 1-36. POOR WATER QUALITY IN RELATION TO RAINFALL IN THE BIDWELL BROOK (1990 - JUNE 1998).

(Rainfall relates to the gauging station at Weavers Cottage for Charts 1-8 and Rattery for Charts 9-36)



APPENDIX 1. 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
RE1	80	2.5	0.25	0.021	6.0-9.0	≤ 10	2	30	Water of very good quality suitable for all fish species
						>10 and ≤ 50	22	200	
						>50 and ≤ 100	40	300	
						>100	112	500	
RE2	70	4.0	0.6	0.021	6.0-9.0	≤ 10	2	30	Water of good quality suitable for all fish species
						>10 and ≤ 50	22	200	
						>50 and ≤ 100	40	300	
						>100	112	500	
RE3	60	6.0	1.3	0.021	6.0-9.0	≤ 10	2	300	Water of fair quality suitable for high class coarse fish populations
						>10 and ≤ 50	22	700	
						>50 and ≤ 100	40	1000	
						>100	112	2000	
RE4	50	8.0	2.5	-	6.0-9.0	≤ 10	2	300	Water of fair quality suitable for coarse fish populations
						>10 and ≤ 50	22	700	
						>50 and ≤ 100	40	1000	
						>100	112	2000	
RE5	20	15.0	9.0	-	-	-	-	-	Water of poor quality which is likely to limit coarse fish populations

APPENDIX 2. COMPLIANCE: SIGNIFICANT AND MARGINAL FAILURES

Water quality is assessed using a standard statistical method. However, because we cannot be wholly sure that the resultant classification is accurate (there are uncertainties in the data that are the result of sample size and chance) failure to meet the relevant standards is expressed as marginal or significant where

marginal means we are at least 50% but less than 95% confident that the river stretch has failed, and

significant means we are at least 95% confident that the river stretch has failed

APPENDIX 3. INFORMATION FROM THE POLLUTION INCIDENT LOGGING SYSTEM (PILS)

23.9.94	SHINNERS BRIDGE CSO OPERATING
29.1.95	STORM WATER OVERFLOW ADJ. KINGFISHER, DARTINGTON
8.8.95	DISCOLOURED AT WEEK, U/S SHINNERS BRIDGE.
4.1.96	WILLING FARM, RATTERY. YARD RUNOFF. FARMS CAMPAIGN. ENTERING WATERCOURSE (ENE OF RATTERY)
10.1.96	CORBETT COTT. , RATTERY. CLEANING OF SLURRY TANKER D/S RATTERY
6.3.96	ADJ. TO DARTINGTON VILLAGE HALL (SSLDS / DISCOLOURATION)
6.9.96	COBBATON FARM. SLURRY. FORMAL SAMPLES
10.5.97	DISCOLOURED AT SHINNERS BRIDGE (GREY) **
10.8.97	SHINNERS BRIDGE XYLENE SMELL. NOT ENTERING WATERCOURSE
18.2.98	DISCOLOURED (WHITE)

** EXCEEDANCES AT BOTH SITES ON 19.5.97

NO OTHER APPARENT RELATION BETWEEN ABOVE INCIDENTS AND EXCEEDANCES

APPENDIX 4. CONSENTED DISCHARGES TO THE BIDWELL BROOK

Site	Consent No.	Consent conditions			
		BOD	SSLDS	Volume	
Brimhay Nursery School	DRA 1533	20	30	1.14 $m^3 d^{-1}$	
Meadowbank Young Peoples Centre	DRA 1460	20	30	4.55 $m^3 d^{-1}$	
Orchard Park	NRA-SW-0381	20	30	50 $m^3 d^{-1}$	
Dartington Textiles Mill	NRA-SW-1167				SSO: no consent conditions
Allerton	FDA 2461				No consent conditions
Tigley Farm	FDA 1184				No consent conditions
Rattery WWTW	SWWA 382				Descriptive Consent
Rattery WWTW	NRA-SW-1494				SSO: no consent conditions
Allercombe Farm	FDA 2456				No consent conditions
Glebe Farm	DRA T12/R	20	30	4.1 $m^3 d^{-1}$	No consent conditions
Smallcombe Farm	FDA 1306				No consent conditions
Queens Arms	NRA-SW-3819	40	60	4.5 $m^3 d^{-1}$	
Dartington (Shinners Bridge)	NRA-SW-1166				SSO: no consent conditions
Yarner Farm	DRA 1095	20	30	1.46 $m^3 d^{-1}$	

APPENDIX 5.

The calculation is made by simple mass balance:

$$L_0 = \frac{(Q_{up} \times L_{up}) + (Q_e \times L_e)}{Q_{up} + Q_e} \qquad (1)$$

where L_0 is BOD of river/effluent mixture
Q_{up} is flowrate upstream of the effluent discharge
L_{up} is BOD of river upstream of effluent discharge
Q_e is flowrate of effluent
L_e is BOD of effluent

Q_{up} is 0.231 m^3s^{-1} and was obtained from flow measurements taken on 12/07/91 by Agency Water Resources officers slightly upstream of Dartington Lodge. (The flow rate for the River Dart at Austins Bridge on the same date had a value that was exceeded for 40% of the (gauged) time; that is, it represents a good mean flow, and so the flow rate of the Bidwell Brook on 12/07/91 is also likely to be a reliable mean value).

Substituting the relative values in equation (1):

$$L_0 = \frac{(231\ ls^{-1} \times 1.8\ mgl^{-1}) + (0.05\ ls^{-1} \times 725\ mgl^{-1})}{231\ ls^{-1} + 0.05\ ls^{-1}}$$

$$= \frac{415.8 + 36.25}{231.05}$$

$$= 1.956\ mgl^{-1}$$

APPENDIX 6.

We can estimate the degree of BOD reduction between the CSO discharge point and Dartington Lodge using the expression

$$L = L_0 \exp\left[-\frac{k_L \chi}{U_0}\right] \qquad (2)$$

Where L = ultimate BOD (CBOD)at point χ
L_0 = BOD of river/effluent mixture
k_L = BOD decay rate constant, d-1
χ = distance downstream from effluent discharge point, m
U_0 = river velocity, md^{-1}

From equation (1) BOD^{20}_5 of river/effluent mixture:

$$BOD^{20}_5 = \frac{(125 \times 1.8) + (1 \times 322)}{126}$$

$$= 4.34\ mgl\text{-}1$$

APPENDIX 6 (Cont.)

The relationship CBOD to BOD^{20}_5 is given by

$$L_0 = \frac{BOD^{20}_5}{(1-e^{-kt})} \qquad (3)$$

and therefore

$$L_0 = \frac{4.34}{(1-e^{(0.25)(5)})}$$

$$= \frac{4.34}{0.18}$$

$$= 6.08 \text{ mgl-1}$$

In equation (2) k_L is temperature dependant and is derived from k_{20} (0.25 d^{-1}) by

$$k_L = k_{20}(1.047)^{T-20} \qquad (4)$$

Assuming a temperature of 15^0C and $k_{20} = 0.25\ d^{-1}$:

$$k_L = 0.25(1.047)^{15-20}$$

$$= 0.199$$

The distance between the CSO discharge point and Dartington Lodge is approximately 700m. Substituting in equation (2):

$$L = 6.08 \exp\left[-\frac{(0.199)(700)}{17280}\right]$$

$$= 6.08 \exp\ (-0.00806)$$

$$= 6.03$$

and, converting CBOD back to BOD^{20}_5

$$BOD^{20}_5 = L_0\ (1-e^{-kt})$$

$$= 6.03(0.713)$$

$$= 4.299 \text{ or } 4.3\ mgl^{-1}$$

The reduction in BOD^{20}_5 between the two sites is, therefore, $4.34 - 4.30 = 0.04\ mgl^{-1}$. This, as stated in the text, is negligible and need not be taken in to account.

APPENDIX 6 (Cont.)

Estimates of the BOD enhancement at Dartington Lodge can therefore be made by mass balance (equation (1)):

CSO x 1 discharge $\quad \frac{(125 \times 1.8) + (1 \times 322)}{126} \quad = 4.34 \text{ mgl}^{-1}$

CSO x 2 discharges $\quad \frac{(125 \times 1.8) + (2 \times 322)}{127} \quad = 6.84 \text{ mgl}^{-1}$

CSO x 3 discharges $\quad \frac{(125 \times 1.8) + (3 \times 322)}{128} \quad = 9.30 \text{ mgl}^{-1}$

CSO x 4 discharges $\quad \frac{(125 \times 1.8) + (4 \times 322)}{129} \quad = 11.73 \text{ mgl}^{-1}$

APPENDIX 7.

Equation (1) (Appendix 5) is again used. Substituting the relevant values gives:

$$L_0 = \frac{(100 \text{ ls}^{-1} \times 1.8 \text{ mgl}^{-1}) + (1 \text{ ls}^{-1} \times 300 \text{ mgl}^{-1})}{101 \text{ ls}^{-1}}$$

$$= 4.752 \text{ mgl}^{-1}$$