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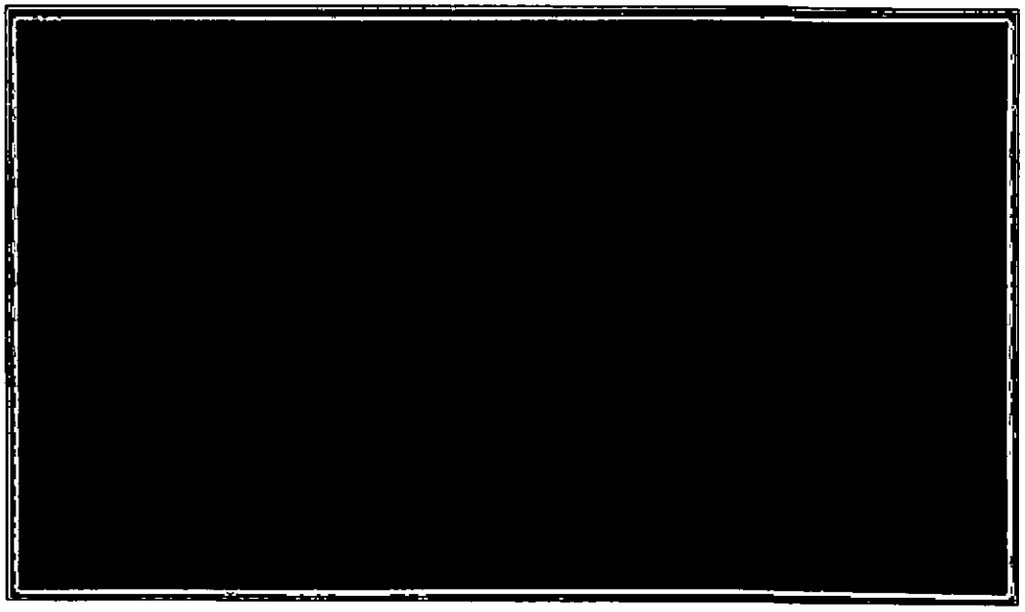

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WATER QUALITY MONITORING ON THE RIVACRE BROOK

Interim Report (1)
March 1992

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Interim Report (1): March 92
Report to: British Nuclear Fuels plc, Capenhurst
TFS Project No: T11053q1

CONTENTS

1. Summary

Interim Report (1) March 1992

The analysis of macroinvertebrate and water samples from the Rivacre Brook system (September 1991), adjacent to the Capenhurst site are compared and contrasted with the results of earlier monitoring carried out by the Institute of Freshwater Ecology in 1989 and 1990.

Changes in water quality, as indicated by the invertebrates and water samples, appear to be minor.

The Rivacre Brook continues to be classified as "Poor" when the invertebrate communities are equated with the NRA water quality status.

2. Introduction

BACKGROUND

The Institute of Freshwater Ecology was contracted by BNFL to investigate aspects of water quality in the Rivacre Brook system (Gledhill, 1990). In April 1991 at the Windermere Laboratory (Institute of Freshwater Ecology) it was agreed that a continued, but reduced, programme of water quality monitoring using macroinvertebrates was desirable.

Macroinvertebrate and water samples are to be taken at five sites, September 1991 & 1992 and March 1992 & 1993.

This interim report provides a comparison between data collected in September 1991 and the earlier study (Gledhill, (1990).

METHODS

The five sampling stations (Fig. 1) include three (1-3) from the stream draining the Capenhurst site; Station 9 - a short distance downstream from the confluence with Rivacre Brook; Station 6, upstream from the confluence (a site not previously sampled). Station numbers and positions (except 6) correspond to those used by Gledhill (1990).

Sampling techniques and processing followed the protocol required for the application of RIVPACS (River InVertebrate Prediction and Classification System), additional information on the abundance of invertebrate species, species diversity and the community structure, permit direct comparison with the earlier study (Gledhill, 1990). Water analyses were undertaken at the Windermere Laboratory.

2. INTERIM RESULTS

Water Analyses

Table 1 permits a direct comparison between spot-samples taken on 20 September 1991 and those obtained in spring and autumn in the earlier study (conductivity and pH were not previously measured and there are no earlier data for Station 6).

These are single spot-samples and are not assumed to describe average conditions.

Substrates and Plant Cover

Table 2 lists the visual estimates of stream bed substrate types, in terms of % cover and the area occupied by plant material at each station. Where available, corresponding data from 1989 & 1990 are given.

Macroinvertebrates Recorded

Tables 3-7 (Stations 1,2,3,6,9) present lists of species occurring in September 1991 with their corresponding common names and the invertebrate family to which they belong. The number of each species and family are shown for each station and the BMWP score (a numerical scale of sensitivity to pollution) is included. The format follows that of the earlier report.

Diversity Indices and ASPTs

Two diversity indices have been calculated -

Simpson Index and Shannon-Weaver Index (see Gledhill,1990 for details).

The ASPT (average score per taxon) for each station is calculated by dividing the total score (BMWP) by the number of scoring taxa . This index reflects the balance between pollution-tolerant and pollution-intolerant invertebrates found.

Index values in September 1991 and previous results are presented in Table 8 (no comparable data for Station 6).

Predicted v. Observed Total Scores (BMWP)

Physical and chemical characteristics of each site were used to generate predictions of faunal composition on a seasonal basis. As the variables used were closely similar in September 1991 to those used in the earlier study, predicted values are as for "Au. 89" (Gledhill, 1990). The corresponding total scores (mean values) and their error estimates are presented with the observed total scores (Table 9).

Environmental Quality Index (EQI)

The assessment of water quality, as used by the NRA, is likely to change shortly. The new proposals include a grading system which incorporates an "ecological override". This would operate when EQI values fall outside their permitted range corresponding to the observed chemical water quality class (Table 10). Results from autumn 1989 (Gledhill,1990) are compared with September 1991 data and the consequences of the proposed new approach are set out in Table 11.

3. INTERIM CONCLUSIONS

Water Analyses (Table 1)

Stations 1-3; ammonia levels are a little higher than previously found, calcium carbonate a little lower, chloride has a surprisingly wide range (more variable than before) when the streams short retention time is considered, other results appear closely similar or within the same range as previously found.

Station 6; extremely low flow at this new site, with organic debris and a sewage treatment works upstream combine to give high values for soluble phosphate (expressed as phosphorus), total oxidised nitrogen and total organic carbon. In contrast ammonia was low, though no earlier data are available for comparisons at this station.

Station 9; as for stations 1-3, ammonia (expressed as nitrogen) is higher than recorded previously, other results show similar concentrations or variability to previous values.

Substrates and Plant Cover (Table 2)

Substrate composition, in terms of visual allocation to crude particle size designation, has been closely similar at stations 1-3 on all sampling occasions.

For station 6 no comparisons are possible with earlier data, but the low flow rate is thought likely to have contributed to the relatively high percentage of fine silt / clay recorded.

Station 9 was more silty than reported on previous occasions (Gledhill,1990). One or two recently introduced large concrete slabs raised the percentage of boulder-cobble substrate recorded.

Plants were recorded only at station 9. As on the previous autumn visit, a small quantity of filamentous algae was present. A new stand of canadian pondweed (Elodea sp.) had become established at station 9.

Macroinvertebrates Recorded (tables 3-7)

Species (or families) previously unrecorded -

Station 1. Asellidae (water hoglouse)- high numbers downstream may have prompted upstream migration, alternatively colonisation via the R.Dee wash-water is possible. Planariidae (flatworms) - appearance possibly associated with large increase in prey species (Oligochaeta & Asellidae). Corixidae and Diptera (water boatmen and fly larvae), small numbers - chance occurrence.

Station 2 & 3. No new taxa.

Station 6. No previous data.

Station 9. Baetidae (mayflies) and Mesovelidae (bug) - associated with trailing grass from uncut banks or the newly established pondweed. Tipulidae (cranefly larva) - prefers fine sediment (which has increased at this station). Psychomyiidae (caddis larva) - associated with rocks / stones in fast flow (newly introduced concrete slabs). Osmylidae (lace wing larva) - single specimen, chance event.

Striking changes in abundance -

Increases

Station 1 & 2. A large increase in Sphaeriidae (bivalves), Asellidae (water hoglouse), Gammaridae (shrimps) and Oligochaeta (worms) - no explanation offered. Erpobdellidae (leeches) may have increased in response to a rise in prey abundance.

Station 3 & 9. Similar increase in Asellidae and Gammaridae occurred.

Station 6. No comparable data.

Station 9. Asellidae were more numerous.

Decreases

Station 1,2 & 3. Hydrobiidae, Lymnaeidae (snails), Ancylidae (limpet) were absent or reduced in numbers. Sphaeriidae (bivalves) provided a contrast between these stations with a fall in numbers at 2 & 3.

Station 6. No comparable data.

Station 9. Hydrobiidae and Oligochaeta showed clear declines - no explanation offered.

Diversity Indices & ASPTs (Table 8)

The Simpson Index and the Shannon-Weaver Index utilise the number of different taxa and the numbers of individuals within each taxon. Therefore, despite a greater number of taxa at some stations, the indices have shown reduced values in response to the striking predominance of Asellidae at all stations (jointly with Oligochaeta at station 1).

Changes in ASPT values reflect particularly small shifts in the presence/absence of invertebrate families when the number of families is quite low, as in the Rivacre Brook system. Consequently downward trends at stations 2 & 3 and upward trends at 1 & 9 are not considered to be significant, for the present.

Predicted v. Observed Total Scores (BMWP) (Table 9)

As with the ASPT values, the low total scores are fluctuating in response to the loss or gain of one or two scoring taxa. This is illustrated by adjacent and very similar stations, 1 & 2, having their highest and lowest observed scores (respectively) in September 1991. The comparatively high score at station 9 reflects the appearance of four new scoring taxa (a fifth, Osmylidae, has no BMWP score allocation). This is countered by the absence of three previously recorded scoring taxa.

Environmental Quality Index (EQI) (Table 10 & 11)

The derived mean EQIs for the autumn 1989 and 1991 samples are compared and stations 2 & 3 provide closely similar values. In September 1991 stations 1 & 9 had higher EQIs, while overall the values were within the new proposed ranges corresponding to Class 3 ("Poor") water quality. An exception was the Autumn 1989 Station 1 sample, which fell within the Class 4 ("Bad") EQI range.

5. Acknowledgements

Mr. Terry Gledhill and Mr. Ben James assisted with sample collection. Staff at the Windermere and Wareham laboratories of the Institute of Freshwater Ecology analyzed water samples and ran RIVPACS predictions, respectively.

6. References

Gledhill,T. (1990) An assessment and comparison of water quality using macroinvertebrate animals at selected sites on the Rivacre Brook, The Wirral, Cheshire. Report to: British Nuclear Fuels plc, Capenhurst. 36pp (+Appendices).

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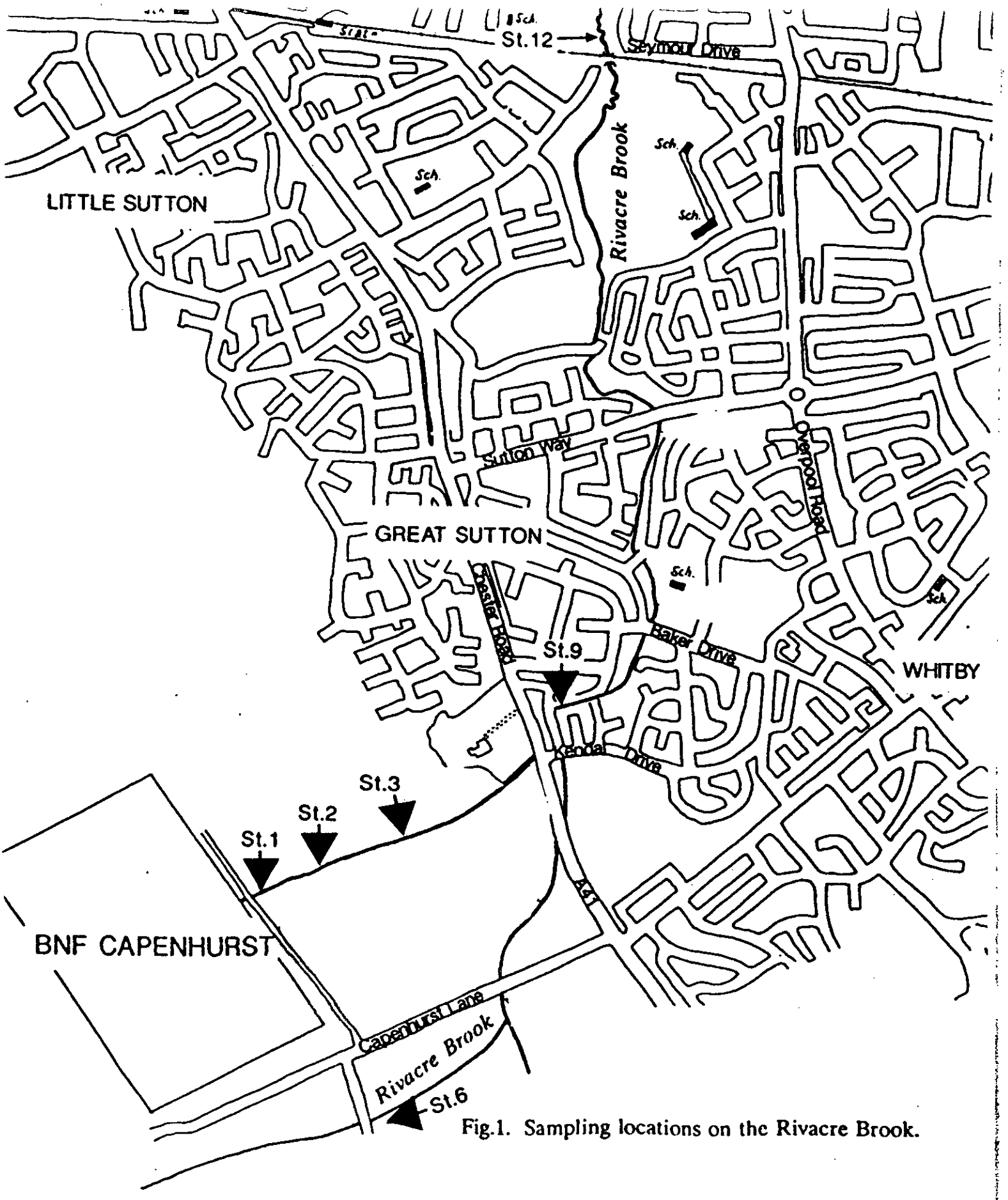

Fig.1. Sampling locations on the Rivacre Brook.

Table 1. Water chemistry data* for Autumn (Au) 1991, with corresponding results from initial report (Gledhill,1990).

Station	Ammonia NH3.N	Total Oxidised Nitrogen	Soluble Reactive Phosphorus	Chloride Cl
	mg l	mg l	mg l	mg l
1 - Au 91	0.336	3.34	0.532	64.8
1 - Sp 90	0.092	3.96	0.457	62.0
1 - Au 89	0.162	3.31	0.356	50.9
1 - Sp 89	0.007	3.70	0.593	67.2
2 - Au 91	0.135	2.44	0.348	81.7
2 - Sp 90	0.081	3.96	0.470	59.0
2 - Au 89	0.090	3.89	0.400	53.0
2 - Sp 89	0.006	2.87	0.515	74.1
3 - Au 91	0.330	3.69	0.511	75.2
3 - Sp 90	0.069	3.48	0.450	61.0
3 - Au 89	0.051	4.33	0.416	53.1
3 - Sp 89	0.008	3.13	0.504	77.5
6 - Au 91	0.032	4.99	10.060	67.3
9 - Au 91	0.471	3.25	0.678	66.5
9 - Sp 90	0.228	3.09	0.630	201.2
9 - Au 89	0.050	2.63	0.586	261.0
9 - Sp 89	0.085	2.90	0.656	46.7

Table 1 (conti.)

Station Date	Calcium Carbonate mg l	Total Organic Carbon mg l	Conductivity uS/cm	pH units
1 - Au 91	45.95	3.55	460	7.3
1 - Sp 90	77.35	3.26	-	-
1 - Au 89	56.90	-	-	-
1 - Sp 89	-	3.35	-	-
2 - Au 91	43.70	3.79	490	7.3
2 - Sp 90	78.85	3.43	-	-
2 - Au 89	56.30	-	-	-
2 - Sp 89	-	3.43	-	-
3 - Au 91	43.45	4.00	487	7.3
3 - Sp 90	80.60	3.51	-	-
3 - Au 89	53.75	-	-	-
3 - Sp 89	-	3.44	-	-
6 - Au 91	137.30	9.55	722	7.6
9 - Au 91	52.35	4.45	465	7.5
9 - Sp 90	81.75	3.97	-	-
9 - Au 89	66.25	-	-	-
9 - Sp 89	-	4.38	-	-

* These are single spot samples and are not assumed to describe average conditions. This should be born in mind as the values are compared with earlier analyses (Gledhill,1990)(spring 1989 & 1990, autumn 1989), except site 6 (no direct comparison possible).

Table 2. Estimates of stream bed substrate type and plant % cover for Rivacre Brook sampling stations, with corresponding data from an earlier study (Gledhill, 1990).

Substrate and vegetation cover.

STATION DATE	Boulder /Cobble %	Pebble /Gravel %	Sand %	Silt /Clay %	Algae cover %	Macro-phyte %
1. Au. 91	-	10	70	20	-	-
Sp. 90	-	10	60	30	-	-
Au. 89	-	10	60	30	-	-
Sp. 89	-	10	60	30	-	-
2. Au. 91	-	60	30	10	-	-
Sp. 90	-	65	25	10	3	-
Au. 89	-	65	25	10	-	-
Sp. 89	-	70	20	10	20	-
3. Au. 91	10	50	20	20		
Sp. 90	-	60	30	10	40	-
Au. 89	-	60	30	10	-	-
Sp. 89	-	80	10	10	-	-
6. Au. 91	20	-	20	60		
Sp. 90	-	-	-	-	-	-
Au. 89	-	-	-	-	-	-
Sp. 89	-	-	-	-	-	-
9. Au. 91	20	-	20	60	10	10
Sp. 90	2	75	18	5	40	-
Au. 89	2	80	10	8	10	-
Sp. 89	2	80	10	8	50	-

Table 3. Invertebrates recorded from Station 1, with numbers of individual taxa, their BMWP score, number of different taxa and the average score per taxon (ASPT).

RIVACRE BROOK St.1 20.9.91

Common name	Scientific name	Number in sample	Family	No. per family	Score (BMWP)
Worms	Oligochaeta	2615	"Oligochaeta"	2615	1
Flatworms	Dugesia sp.	9	Planariidae	58	5
	Polycelis sp.	49			
Leeches	Erpobdella octoculata	36	Erpobdellidae	36	3
	Glossiphonia complanata	1	Glossiphoniidae	1	3
Snails	Lymnaea peregra	1	Lymnaeidae	1	3
Pea mussels	Pisidium nitidum	49	Sphaeriidae	223	3
	Pisidium subtruncatum	34			
	Pisidium henslowanum	26	(sub-sample)		
	Pisidium personatum	2			
Water-hoglouse	Asellus aquaticus	1118	Asellidae	1118	3
Freshwater shrimps	Crangonyx pseudogr.	148	Gammaridae	148	6
Bugs	Hesperocorixa sahlbergi	2	Corixidae	3	5
	H.linnei	1			
Fly larvae	Diptera sp	3	Diptera	3	-
Midge larvae	Chironomidae	30	Chironomidae	30	2
	Culicidae	10	Culicidae	10	-

Number of different taxa = 12

Total number of specimens N = 4246

BMWP score = 34 ASPT = 3.4

Table 4. Invertebrates recorded from Station 2, with numbers of individual taxa, their BMWP score, number of different taxa and the average score per taxon (ASPT).

RIVACRE BROOK St. 2 20.9.91

Common name	Scientific name	Number in sample	Family	No. per family	Score (BMWP)
Worms	Oligochaeta	394	"Oligochaeta"	394	1
Flatworms	Dugesia sp.	9	Planariidae	46	5
	Polycelis sp.	37			
Leeches	Erpobdella octoculata	39	Erpobdellidae	39	3
	Glossiphonia complanata	1	Glossiphoniidae	1	3
	Helobdella stagnalis	1			
Pea mussels	Pisidium nitidum	1	Sphaeriidae	1	3
Water-hoglouse	Asellus aquaticus	1395	Asellidae	1395	3
Freshwater shrimps	Crangonyx pseudogr.	116	Gammaridae	116	6
Midge larvae	Chironomidae	16	Chironomidae	16	2

Number of different taxa = 8

Total number of specimens N = 2011

BMWP score = 26 ASPT = 3.25

Table 5. Invertebrates recorded from Station 3, with numbers of individual taxa, their BMWP score, number of different taxa and the average score per taxon (ASPT).

RIVACRE BROOK St. 3 20.9.91

Common name	Scientific name	Number in sample	Family	No. per family	Score (BMWP)
Worms	Oligochaeta	16	"Oligochaeta"	16	1
Flatworms	Dugesia sp.	16	Planariidae	58	5
	Polycelis sp.	42			
Leeches	Erpobdella octoculata	1	Erpobdellidae	1	3
	Glossiphonia complanata	1	Glossiphoniidae	1	3
Snails	Potamopyrgus jenkinsi	2	Hydrobiidae	2	3
Pea mussels	Pisidium casertanum	1	Sphaeriidae	1	3
Freshwater shrimps	Crangonyx pseudogr.	119	Gammaridae	119	6
Water-hoglouse	Asellus aquaticus	910	Asellidae	910	3
Midge larvae	Chironomidae	14	Chironomidae	14	2

Number of different taxa = 9

Total number of specimens N = 1122

BMWP score = 29 ASPT = 3.22

Table 6. Invertebrates recorded from Station 6, with numbers of individual taxa, their BMWP score, number of different taxa and the average score per taxon (ASPT).

RIVACRE BROOK St. 6 20.9.91

Common name	Scientific name	Number in sample	Family	No. per family	Score (BMWP)
Worms	Oligochaeta	57	"Oligochaeta"	57	1
Leeches	Glossiphonia complanata	12	Glossiphoniidae	12	3
Pea mussels	Pisidium personatum	1	Sphaeriidae	1	3
Freshwater shrimps	Crangonyx pseudogr.	26	Gammaridae	26	6
Water-hoglouse	Asellus aquaticus	3812	Asellidae	3812	3
Mayfly	Caenis sp.	1	Caenidae	1	7
Beetles	Agabus bipustulatus	3	Dytiscidae	46	5
	Dytiscidae larvae	43			
Midge larvae	Chironomidae	167	Chironomidae	167	2
	Diptera	3	Diptera	3	-

Number of different taxa = 9

Total number of specimens N = 4146

BMWP score = 30 ASPT = 3.75

Table 7. Invertebrates recorded from Station 9, with numbers of individual taxa, their BMWP score, number of different taxa and the average score per taxon (ASPT).

RIVACRE BROOK St. 9 20.9.91

Common name	Scientific name	Number in sample	Family	No. per family	Score (BMWP)
Worms	Oligochaeta	6	"Oligochaeta"	6	1
Flatworms	Polycelis nigra gp	1	Planariidae	1	5
Leeches	Glossiphonia complanata	5	Glossiphoniidae	8	3
	Helobdella stagnalis	3			
	Erpobdella octoculata	44	Erpobdelliidae	44	3
Snails	Potamopyrgus jenkinsi	1	Hydrobiidae	1	3
	Lymnaea peregra	3	Lymnaeidae	3	3
	Succinia (semi-terest.)	8		8	-
Freshwater shrimps	Crangonyx psuedogr.	25	Gammaridae	25	6
Water-hoglouse	Asellus aquaticus	1732	Asellidae	1732	3
Mayfly	Baetidae	3	Baetidae	3	4
Bug	Velia sp.	2	Mesoveliidae	2	5
Beetles	Dytiscidae	3	Dytiscidae	3	5
Lace wing	Osmylus fulvicephalus	1	Osmylidae	1	-
Caddis	Tinodes waeneri	10	Psychomyiidae	10	8
Diptera	Tipulidae	1	Tipulidae	1	5
Midge larvae	Chironomidae	52	Chironomidae	52	2
Blackfly	Simulium ornatum	1	Simuliidae	1	5

Number of different taxa = 16

Total number of specimens N = 1901

BMWP score = 61 ASPT = 4.06

Table 8. Macroinvertebrate diversity indices and BMWP average score per taxon (ASPT) for Rivacre Brook sampling stations in Autumn 1991, a comparison with values obtained in a previous study (Gledhill,1990) are shown.

RIVACRE BROOK.

STATION DATE	SIMPSON INDEX (taxon level)	SHANNON-WEAVER INDEX (taxon level)	ASPT
1. Autumn 91	0.55	1.56	3.40
Spring 90	0.66	1.77	2.40
Autumn 89	0.67	1.92	3.00
Spring 89	0.26	0.83	2.50
2. Autumn 91	0.48	1.37	3.25
Spring 90	0.86	2.93	3.64
Autumn 89	0.85	2.99	3.45
Spring 89	0.81	2.60	3.50
3. Autumn 91	0.33	1.02	3.22
Spring 90	0.81	2.59	3.25
Autumn 89	0.85	3.00	3.42
Spring 89	0.77	2.58	3.69
6. Autumn 91	0.15	0.56	3.75
Spring 90	-	-	-
Autumn 89	-	-	-
Spring 89	-	-	-
9. Autumn 91	0.17	0.68	4.06
Spring 90	0.86	2.88	3.56
Autumn 89	0.74	2.42	3.64
Spring 89	0.83	2.81	3.75

Table 9. RIVPACS predictions of mean Total Scores (BMWP), error limits and observed Total Scores for each Rivacre Brook station (sd - standard deviation, lcl - lower confidence limit, ucl - upper confidence limit). Values are compared with those of the previous study (Gledhill,1990).

BMWP Total Scores

		--------- predicted ----------				
Stn.	date	mean	sd	lcl	ucl	observed
1.	Au. 91	115	20.67	74.48	155.52	34
	Sp. 90	122	21.54	79.78	164.22	12
	Au. 89	115	20.67	74.48	155.52	24
	Sp. 89	122	21.54	79.78	164.22	12
2.	Au. 91	96	17.97	60.78	131.22	26
	Sp. 90	114	18.63	77.49	150.51	40
	Au. 89	96	17.97	60.78	131.22	38
	Sp. 89	114	18.63	77.49	150.51	35
3.	Au. 91	107	18.72	70.31	143.69	29
	Sp. 90	122	20.07	82.67	161.33	26
	Au. 89	107	18.72	70.31	143.69	41
	Sp. 89	122	20.07	82.67	161.33	48
6.	Au. 91	90.4	17.31	56.46	124.30	30
	Sp. 90	-	-	-	-	-
	Au. 89	-	-	-	-	-
	Sp. 89	-	-	-	-	-
9.	Au. 91	156	20.95	114.94	197.06	61
	Sp. 90	158	20.37	118.07	197.93	32
	Au. 89	156	20.95	114.94	197.06	51
	Sp. 89	158	20.37	118.07	197.93	45

Table 10. Water quality classification, a proposed new system (NRA, 1991) and the corresponding ranges of Environmental Quality Indices (EQIs).

Current water quality classes	Proposed grading system	Corresponding mean EQI ranges
1A "excellent"	A	0.90 -
1B "good"	B	0.65 - 0.99
2 "fair"	C	0.60 - 0.85
3 "poor"	D	0.40 - 0.65
4 "Bad"	E	- 0.55

Table 11. Environmental quality index (EQI) expressed as BMWP score (EQIs), ASPT (EQIa), total scoring taxa (EQIt) and mean EQI (EQIs+EQIa+EQIt/3). Data for autumn 1991 are compared with autumn 1989 data (Gledhill,1990).

Environmental Quality Index		stn.1	stn.2	stn.3	stn.6	stn.9
EQIs	1989	0.21	0.40	0.38	-	0.33
	1991	0.30	0.27	0.27	0.33	0.39
EQIa	1989	0.55	0.66	0.62	-	0.58
	1991	0.62	0.62	0.58	0.75	0.74
EQIt	1989	0.32	0.43	0.61	-	0.38
	1991	0.80	0.58	0.69	0.44	0.81
mean EQI	1989	0.36*	0.50	0.54	-	0.43
	1991	0.57	0.49	0.51	0.51	0.65

* - value outside range for water quality class 3 ("poor"), overide system downgrades to class 4 ("bad"). The remaining mean EQI values fall within the range corresponding to class 3.