

The Faunal Richness of Headwater Streams

Progress Report for the Period
July - November 1991

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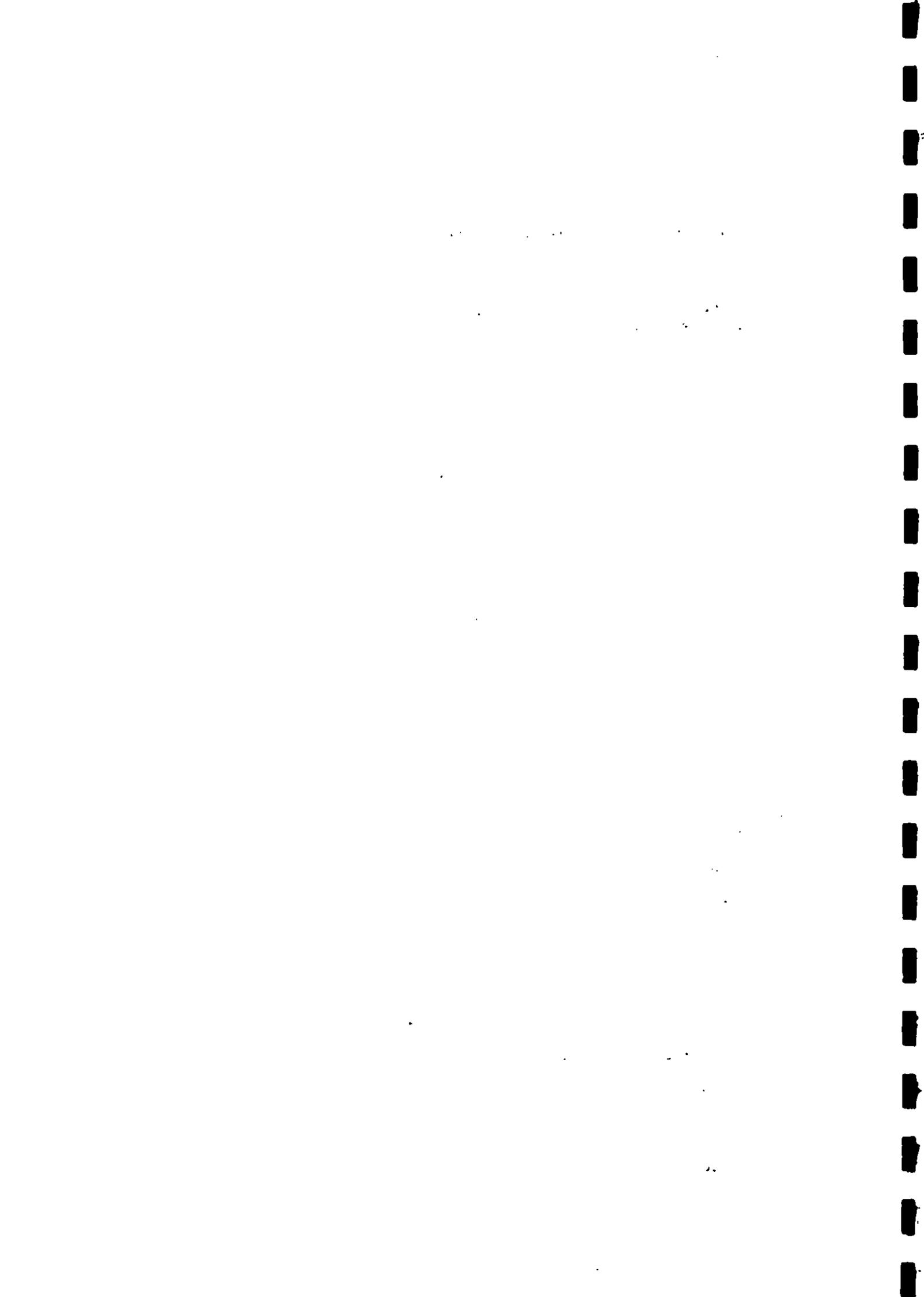
December 1991

Progress Report 242/4/Y



NRA

National Rivers Authority



1. TECHNICAL PROGRESS

1.1 Objectives

The complete work programme for this headwater stream study comprises four stages and is scheduled for the total period 1st October 1990 to 31st January 1995. This report concludes coverage of Stage 1 and documents the progress made so far in meeting the objectives of Stage 2.

The overall and specific objectives of each stage are detailed in the Project Investment Appraisal (PIA) which is Schedule 2 of the Memorandum of Agreement for Research Contract (ref:54015000) between the National Rivers Authority (NRA) and the Institute of Freshwater Ecology (IFE).

1.2 Work Programme

1.2.1 Stage 1

Stage 1 of the study was primarily a review of known data on macro-invertebrate assemblages in small streams.

1.2.2 Stage 2

Stage 2 involves a field-based study of the contribution of individual streams to the total faunal richness of a set of selected catchments. The streams to be sampled should be chosen to be of good environmental quality. The work programme is as follows:

Macro-invertebrate data

- . Finalise the choice of sampling sites in consultation with the project leader.
- . Undertake field sampling and laboratory processing of samples collected from headwater sites in each of three seasons (spring, summer and autumn) of a single year.
- . Identify all taxa to the best achievable level (normally species).
- . Identify taxa from other appropriate headwater samples, such as those collected during the 1990 NRA River Quality Survey and the DcE-sponsored Countryside Surveys of 1988 and 1990.

Environmental data

- . Derive environmental data required for RIVPACS by field measurement or from cartographic sources. The latter should also be used to derive other topographical, geological, soil type and geographical information relevant to the project.
- . In addition other habitat features or management practices which might explain the presence or absence of species should be noted.

Land use

- . Carry out ground surveys of land-use in the 1km squares containing the sample sites.

- . Utilize available satellite imagery of the whole study catchment to place the study sites in context.
- . Undertake an assessment of current and historical farming/land-use practices. from a variety of sources such as maps, parish records, planning records, aerial photography, MAFF Annual Agricultural Censuses and Farm Business Surveys.

Reporting

- . Produce Progress Reports as required.
- . Produce a draft main report, Part 1 by 1st February 1993 and a final main report, Part 1 as an NRA Note by 31st March 1993.

The following text is sectioned in accordance with Schedule 1 of the research contract and outlines the progress made in meeting the scientific objectives within the prescribed project budget.

1.3 Progress Achieved

1.3.1 Stage 1

All items of the Stage 1 work programme were completed on schedule.

1.3.2 Stage 2

Headwater Sites - Biological.

Sampling for aquatic macro-invertebrates has been successfully completed for most sites for all three scheduled seasons. The sampling dates are given in Appendices 1-4.

Three sites sampled in the Cam catchment in spring were abandoned in summer and autumn because their fauna was indicative of very poor water quality. A fourth site on the Lugg, taken as an alternative to a main choice site of unknown quality, was also abandoned when the main site was found to be acceptable.

The NRA project leader was generally kept informed of the progress of the sampling schedules. In particular, her advice was sought in deciding how to proceed with the sampling programme in the Cam catchment.

Headwater Sites - Environmental

Standard, field-measured physical data were collected from each site at the time of biological sampling. These included time variant data for individual seasons and time invariant data collected in summer.

Headwater Sites - Land-use

Land-use ground-truth surveys of the each headwater sub-catchment were undertaken by two casual appointees, Rebecca Dunn and Owen Smith, over the period 1st July to 23rd August 1991.

The necessary 1:10,560 (6") maps for this work were supplied by Anglian, Yorkshire, Welsh and Wessex NRA regions whose co-operation is acknowledged.

At the same time as the land-use surveys, river corridor surveys of the full stream network upstream of the biological sampling point were also carried out by the same field recorders.

Details of the survey methodology were given to the surveyors in the form of a Field Handbook. Both surveyors had previous experience of most of the procedures. Each had been involved in the 1990 Countryside Survey organised by the Institute of Terrestrial Ecology (ITE).

All sites were surveyed (Appendix 5) with the exception of four which had been abandoned as biological sites after the spring sampling, two replacement sites on the Cam and one site on the Stour where access was denied by the principal land-owner.

Lower Catchment Sites - Biological

The full lists of samples received from the NRA regions for each of season are given in Appendices 1-4.

All the spring samples have been received, as have all except the Lugg catchment samples from summer. No autumn samples have yet been forwarded by the NRA.

Lower Catchment Sites - Environmental

Standard environmental data for lower catchment sites, excluding chemical information, have been received for all three seasons for Lugg catchment sites and spring and summer for the Stour.

Lower Catchment Sites - Land-use

Land-use data for these sub-catchments will be derived from the MAFF Annual Parish statistics and remote sensing. The full national data-sets for 1978, 1984 and 1988 have already been acquired by IFE and are held on magnetic tape.

General and administrative

The Project Leader and Manager have jointly prepared a headwater poster display. It comprises two A0 panels depicting aspects of Stage 1 and early parts of Stage 2 of the work programme and the general objectives of the study.

These panels were prepared specifically for display at an International Conference on Water Quality to be held in Brussels between the 16th and 18th of December 1991. They will then be available for any further promotional activity by either NRA or IFE. Additional panels may subsequently be prepared in the same style.

Existing links between the Project Manager and the Newcastle University NELUP group have been further strengthened. This multi-disciplinary team are preparing a decision support system for assisting land-use management. Their models will be based on data collected from parts of the Tyne and the whole Cam catchments.

A meeting between IFE and NELUP has been arranged for December 12th where matters of mutual interest and co-operation will be discussed.

2. INTERIM RESULTS.

2.1 Stage 1

Detailed results of the Stage 1 review have been well circulated in a NRA Research and Development Document (Furse *et al* 1991).

Since completing this review additional headwater faunal lists have been received from the North West and South West Regions of the NRA. These data can be included in any updated version of the review.

2.2 Stage 2

2.2.1 Biological

Headwaters

Appendices 1-4 show the progress made in sample sorting. To the end of November all samples collected in spring and summer have been sorted, together with 9 of the 42 collected in autumn. Only one has been identified.

No lower catchment samples have yet been sorted or identified.

Countryside Survey Sites

At the time of reporting all 361 of the 1990 Countryside Survey samples have been identified to species or best achievable level, except for Sphaeriidae, Oligochaeta and Chironomidae. A further 125 of the 160 "Countryside Survey" type samples collected in 1988 have also been identified to the same taxonomic levels.

Most of these 521 sampling points are on headwater streams of relevance to the present study. The samples are known to have confirmed and extended the list of "headwater taxa" presented in the Stage 1 report.

Much of the biological data have been validated and stored on a Micro-Vax II mainframe computer. An initial ordination and classification of headwater sites in the data set will soon be possible.

2.2.2 Environmental

Headwaters

All seasonal sample registers have been compiled, giving details of the sampling locations and collection dates and methods.

No collation or analyses of physical data have yet been undertaken.

Results of chemical determinations for total alkalinity ($\text{mg l}^{-1} \text{CaCO}_3$) and nitrate ($\text{mg l}^{-1} \text{NO}_3$) are given in Appendix 6. The mismatch between the summer and autumn results for the Rowmire Spring Stream needs clarification and further water samples must be taken in 1992. The autumn figures are considered more likely to be accurate.

Lower Catchment Sites

Compilation of sample registers is almost complete but no collation or analyses of environmental data have yet been undertaken.

Countryside Survey Sites

Seasonal sample registers have been partially compiled, giving details of the sampling locations and collection dates and methods.

No collation or analyses of physical data have yet been undertaken. No chemical data are available for these sites.

2.2.3 Land use

Headwaters

The land-use survey dates are given in Appendix 5.

No data collation or analyses have yet been carried out on the data.

Originally it was hoped to use Geographic Information System technology to store and interpret the data. In view of the reported difficulties of this approach being experienced by the Countryside Survey team at ITE, it may yet prove to be more cost effective to use stand-alone digitization software for area data and direct manual measurements and counts of linear and point features.

Lower Catchment Sites

No specific interpretation of MAFF or satellite data has yet been attempted for this project.

However some interpretation of land-use in the Derwent catchment has been undertaken for other purposes. An example of the type of sub-catchment information which can be output, using established IFE procedures, is given in Appendix 7.

Countryside Survey Sites

No data collation or analyses have yet been carried out for these sites.

IFE are currently digitizing the results of ground-surveyed land-cover data, simultaneously collected with the aquatic macro-invertebrate sample, in the 1km square containing the stream site.

3. WORK PROGRAMME FOR THE NEXT REPORTING PERIOD

The period considered here is from 1st December 1991 until 31st March 1992.

3.1 Biological and Environmental Sampling of Headwater Sites

- . Sorting of the autumn samples will be completed
- . Identification of the sorted samples will begin
- . Environmental site data will be collated and stored on computer.
- . Environmental and biological sampling schedules for the two Cam replacement sites will be planned.
- . Chemical sampling schedules for sites dry in summer and autumn will be planned. This may require NRA co-operation.
- . Lists will be drawn up of landowners' requests for data feedback and these will be met as results become available.

3.2 Lower Catchment Sites

- . It is anticipated that all outstanding NRA samples and accompanying environmental data-sheets from these sites will be delivered to IFE.
- . Some initial sorting of lower catchment samples may be possible.
- . Sample registers for these sites will be completed and stored on computer.
- . If available in time, environmental site data will be collated and stored on computer.

3.3 Countryside Survey Sites

- . Identification of the 54 outstanding samples collected in 1988 will be completed to the same level as samples already identified.
- . Identification of Oligochaetes, Chironomidae and, hopefully, Sphaeriidae for all 1988 and 1990 samples will be completed.
- . All available biological data will be collated and stored on computer.
- . Initial ordination and classification analyses of headwater sites in this data-set will be carried out.
- . Outstanding sample registers will be compiled and stored on computer.
- . Compilation of environmental data files will begin and may be completed.

3.4 Land-use

- . Trial analyses of some of the field surveyed land-use data will be undertaken in order to determine the best practicable procedures.
- . Trial analyses of some of the field surveyed river corridor data will be undertaken in order to determine the best practicable procedures.
- . Investigation of sources of archived/published land-use data for the study catchments will begin
- . Lists will be drawn up of landowners requests for data feedback and these will be met as results become available.

4. COST OF WORK DURING THE REPORTING PERIOD

The total cost of the work undertaken during the reporting period is likely to be in line with the Memorandum of Agreement.

Detailed costings will be made available to the NRA, via the IFE Finance Officer as soon as possible.

5. ESTIMATE OF TOTAL COST OF WORKS

The estimated total cost of the works under each category of expenditure remain as listed in Section 10 of the PIA and Schedule 8 of the project contract

It should be noted that the listed figures are given on a cost increase basis with a base date of 1990-91.

6. ESTIMATE OF COSTS FOR THE NEXT REPORTING PERIOD

Costs for the next reporting period are expected to be in line with the anticipated cost-base adjusted budget.

7. FACTORS LIKELY TO AFFECT THE SATISFACTORY COMPLETION OF THE WORK

The work is generally on schedule and it is anticipated that all major contract deadlines will be met. There are, however, a number of factors that have effected, or may effect, the work programme and the timing of specific tasks.

Firstly, the collection of samples was more time-consuming than had been budgeted. However, this has been offset by a more rapid rate of sample sorting that had been allowed for.

Secondly, the land-use survey took two days less than anticipated. The casual appointees were paid for the full period but returned home early, with an agreement that they could be freely consulted, for up to two days each, should difficulties be experienced in interpreting their field recordings. Two Cam catchments, first sampled biologically in summer, remain unsurveyed.

Thirdly, the initial site selection procedures, preparation of project reports and poster display material and general project administration have been much more consuming of the Project Managers time than estimated for. This has led to a slight delay in starting the census, map and archive aspects of land-use data collection (see Schedule 6 of the Memorandum of Agreement). It is anticipated that this delay can be made up over the next financial year.

Finally, the possible assistance of the Institute of Hydrology, with automated, digitized catchment-boundary definitions, is being investigated informally. If realised, this co-operation may lead to re-allocation of funding and staff time schedules.

8. REFERENCE

Furse M.T., Winder J.M., Symes K.L. and Clarke R.T. (1991) The faunal richness of headwater streams. A review of existing information. National Rivers Authority Research and Development Document, No. 08Y, 135pp.

<u>HEADWATER SITES (sampled by IFE)</u>		NGR	SPRING	SUMMER	AUTUMN
UN-NAMED WATERCOURSE	BURWELL	(TL 587 660)	06 MAY 1991 *	05 AUG 1991 *	29 OCT 1991 *
CAUNDLE DITCH	TEVERSHAM	(TL 504 573)	07 MAY 1991 *	05 AUG 1991 *	29 OCT 1991 *
NINE WELLS SPRING	NINE WELLS	(TL 460 542)	07 MAY 1991 *	06 AUG 1991 *	29 OCT 1991 *
UN-NAMED WATERCOURSE	LANGLEY WOOD	(TL 615 419)	07 MAY 1991 *	DRY 6-8-91 *	DRY 30-10-91 *
THE SLADE	HADSTOCK COMMON	(TL 547 436)	07 MAY 1991 *	DRY 6-8-91 *	DRY 30-10-91 *
RIVER CAM	PRIOR'S WOOD	(TL 549 308)	08 MAY 1991 *	06 AUG 1991 *	30 OCT 1991 *
HOFFER BROOK	THRIPLow	(TL 452 470)	09 MAY 1991 *	SITE ABANDONED	
GASCOTE DEAN	CAXTON	(TL 298 584)	09 MAY 1991 *	SITE ABANDONED	
UN-NAMED WATERCOURSE	CALDECOTE	(TL 337 565)		07 AUG 1991 *	31 OCT 1991 *
UN-NAMED WATERCOURSE	WHADDON GAP	(TL 343 461)	08 MAY 1991 *	06 AUG 1991 *	31 OCT 1991 *
ARRINGTON BROOK	ARRINGTON	(TL 325 505)	09 MAY 1991 *	DRY 6-8-91 *	DRY 30-10-91 *
UN-NAMED WATERCOURSE	WELLHEAD SPRINGS	(TL 328 431)	09 MAY 1991 *	SITE ABANDONED	
UN-NAMED WATERCOURSE	DOWN HALL FARM	(TL 308 438)		07 AUG 1991 *	31 OCT 1991 *
RUDDERY SPRING	ASHWELL	(TL 279 403)	09 MAY 1991 *	DRY 7-8-91 *	DRY 30-10-91 *
<u>LOWER CATCHMENT SITES (sampled by NRA)</u>					
RIVER RHEE	ASHWELL	(TL 270 398)	30 APR 1991	NOT DATED	
WHADDON BROOK	WHADDON	(TL 539 465)	30 APR 1991	NOT DATED	
BLACK PEAK SPRING STREAM	MELDRETH	(TL 383 474)	14 MAY 1991	18 JUL 1991	
SWAFFAM BULBECK LODGE	COMMERCIAL END	(TL 554 635)	15 MAY 1991	NOT DATED	
MILL RIVER	WENDY	(TL 321 475)	30 APR 1991	NOT DATED	
RIVER GRANTA	HILDERSHAM	(TL 545 485)	07 MAY 1991	28 JUN 1991	
BOURN BROOK	FOX'S BRIDGE	(TL 383 548)	14 MAY 1991	26 JUN 1991	
REACH LODGE	UPWARE LOCK	(TL 537 698)	13 MAY 1991	NOT DATED	
BOTTISHAM LODGE	LODGE	(TL 532 630)	13 MAY 1991	NOT DATED	
RIVER RHEE	WIMPOLE LODGE	(TL 334 485)	30 APR 1991	18 JUL 1991	
RIVER RHEE	HARSTON	(TL 417 511)	30 APR 1991	NOT DATED	
RIVER CAM	HAUXTON MILL	(TL 432 527)	07 MAY 1991	23 JUL 1991	
RIVER CAM	ANSTEY HALL	(TL 438 549)	14 MAY 1991	26 JUL 1991	
RIVER CAM	DIMMOCK'S COTE	(TL 537 723)	13 MAY 1991	NOT DATED	

Prior's Wood site formerly called Amberden Hall. Sites at Caldecote and Down Hall Farm to be sampled again in spring 1992. Sites at Thriplow, Caxton and Wellhead Springs abandoned because of poor water quality.

<u>HEADWATER SITES (sampled by IFE)</u>		NGR	SPRING	SUMMER	AUTUMN
BILLER HOWE NOOK SLACK	TURF RIGG	(NZ 918 007)	14 MAY 1991 *	13 AUG 1991 *	23 OCT 1991
MILL BECK	BATHINGWELL WOOD	(SE 822 838)	14 MAY 1991 *	13 AUG 1991 *	21 OCT 1991
ROWMIRE SPRING STREAM	ROWMIRE PLANTATION	(SE 828 653)	14 MAR 1991 *	13 AUG 1991 *	21 OCT 1991
BISHOP WILTON BECK	BISHOP WILTON	(SE 802 554)	14 MAY 1991 *	14 AUG 1991 *	21 OCT 1991
LONG GILL	NEWGATE FOOT	(SE 866 935)	14 MAY 1991 *	13 AUG 1991 *	21 OCT 1991
HALLEYKELD SPRING STREAM	HALLEYKELD RIGG	(SE 939 860)	16 MAY 1991 *	15 AUG 1991 *	23 OCT 1991
UN-NAMED WATERCOURSE	NAB FARM	(SE 880 951)	14 MAY 1991 *	13 AUG 1991 *	21 OCT 1991
MARR'S BECK	RAPE CLOSE LANE	(SE 810 735)	15 MAY 1991 *	14 AUG 1991 *	22 OCT 1991
BELLYMAR DIKE	HARTOFT RIGG	(SE 754 955)	16 MAY 1991 *	15 AUG 1991 *	21 OCT 1991 *
GILL DIKE	FROST HALL	(SE 642 987)	16 MAY 1991 *	14 AUG 1991 *	23 OCT 1991
COWHOUSE BECK	SNAPER HOUSE	(SE 598 912)	16 MAY 1991 *	15 AUG 1991 *	22 OCT 1991
MIREFALLS GILL	REIN'S WOOD	(SE 566 853)	15 MAY 1991 *	14 AUG 1991 *	22 OCT 1991
SLEDHILL GILL	YOWLASS WOOD	(SE 531 870)	15 MAY 1991 *	14 AUG 1991 *	22 OCT 1991
WHEAT BECK	DALE HEAD	(SE 496 950)	15 MAY 1991 *	14 AUG 1991 *	22 OCT 1991
<u>LOWER CATCHMENT SITES (sampled by NRA)</u>					
SCAMPSTON BECK	SCAMPSTON	(SE 868 757)	02 MAY 1991	05 AUG 1991	
WHISPERDALES BECK	LOW DALES	(SE 958 922)	02 MAY 1991	05 AUG 1991	
HODGE BECK	HOLD CAULDRON	(SE 668 869)	24 MAY 1991	05 AUG 1991	
HOLBECK	MOVINGHAM CARRS	(SE 669 773)	02 MAY 1991	15 AUG 1991	
SAILS BECK	ALLERTHORPE COMMON	(SE 743 476)	02 MAY 1991	16 AUG 1991	
BIELBY BECK	HAYTON	(SE 820 457)	02 MAY 1991	19 AUG 1991	
PICKERING BECK	LEVISHAM	(SE 816 911)	18 APR 1991	15 AUG 1991	
RIVER SEVEN	SINNINGTON	(SE 745 853)	24 MAY 1991	05 AUG 1991	
RIVER SEPH	LASKILL	(SE 563 907)	24 APR 1991	05 AUG 1991	
MENETHORPE BECK	MENETHORPE	(SE 768 676)	02 MAY 1991	05 AUG 1991	
SPITTLE BECK	BRAISTHWAITE BRIDGE	(SE 727 624)	23 APR 1991	05 AUG 1991	
RIVER RYE	HELMSLEY	(SE 615 836)	24 APR 1991	02 AUG 1991	
RIVER RYE	NUNNINGTON	(SE 664 794)	02 MAY 1991	02 AUG 1991	

The location and name of the lower catchment site on the Whispedale Beck both need to be confirmed by NRA Yorkshire region.

APPENDIX 3. Sample locations, dates and sorting progress (* = sample sorted/dry). From River Lugg catchment.

<u>HEADWATER SITES (sampled by IFE)</u>		NGR	SPRING	SUMMER	AUTUMN
UN-NAMED WATERCOURSE	GREAT WACTON	(SO 534 433)	20 MAY 1991	* 19 AUG 1991	* 05 NOV 1991
UN-NAMED WATERCOURSE	BREDENBURY	(SO 603 558)	20 MAY 1991	* 19 AUG 1991	* 05 NOV 1991
UN-NAMED WATERCOURSE	BARNSTONE FARM	(SO 577 532)	20 MAY 1991	* DRY 20-8-91	* 05 NOV 1991
STRETFORD BROOK	PUDLESTON COURT	(SO 561 593)	20 MAY 1991	* SITE ABANDONED	
UN-NAMED WATERCOURSE	DUNHAMPTON FARM	(SO 586 603)	21 MAY 1991	* 20 AUG 1991	* 06 NOV 1991
UN-NAMED WATERCOURSE	DINHORE MANOR	(SO 490 503)	21 MAY 1991	* 20 AUG 1991	* 06 NOV 1991
NEWBRIDGE BROOK	SHOAL'S BANK	(SO 394 494)	21 MAY 1991	* DRY 21-8-91	* 07 NOV 1991
GLADESTRY BROOK	CEFNHIR	(SO 210 558)	22 MAY 1991	* DRY 21-8-91	* 07 NOV 1991 *
UN-NAMED WATERCOURSE	GLASNANT	(SO 182 508)	22 MAY 1991	* 21 AUG 1991	* 07 NOV 1991 *
UN-NAMED WATERCOURSE	LOWER LYE	(SO 407 672)	21 MAY 1991	* DRY 20-8-91	* DRY 6-11-91 *
UN-NAMED WATERCOURSE	CRINFYNYDD	(SO 176 602)	22 MAY 1991	* 21 AUG 1991	* 06 NOV 1991
UN-NAMED WATERCOURSE	HILL HOUSE DINGLE	(SO 303 685)	22 MAY 1991	* 20 AUG 1991	* 06 NOV 1991
UN-NAMED WATERCOURSE	PEN-TWYN	(SO 187 729)	22 MAY 1991	* 20 AUG 1991	* 06 NOV 1991
<u>LOWER CATCHMENT SITES (sampled by NRA)</u>					
MORETON BROOK	SHELWICH GREEN	(SO 534 433)	04 APR 1991		
BACK BROOK	KINGTON	(SO 303 570)	03 APR 1991		
CURL BROOK	PEMBRIDGE	(SO 390 585)	03 APR 1991		
MAIN DITCH	LEOMINSTER	(SO 501 597)	03 APR 1991		
STRETFORD BROOK	STRETFORD	(SO 441 553)	03 APR 1991		
RIVER LODEN	STOKE LACY	(SO 619 494)	04 APR 1991		
HACKLEY BROOK	NOAKES BRIDGE	(SO 634 548)	04 APR 1991		
TEDSTONE BROOK	BROMYARD	(SO 657 551)	04 APR 1991		
HINDWELL BROOK	COMBE	(SO 345 635)	03 APR 1991		
RIVER ARROW	BROADWARD	(SO 498 571)	03 APR 1991		
RIVER FROME	YARKHILL	(SO 614 427)	04 APR 1991		
RIVER LUGG	MORDIFORD	(SO 570 375)	19 APR 1991		

Pudleston Court and Dunhampton Farm were each sampled in spring as alternative sites. Dunhampton Court proved to be the more suitable and Pudleston Court was abandoned in subsequent seasons.

APPENDIX 4. Sample locations, dates and sorting progress (* = sample sorted/dry) River Stour catchment.

<u>HEADWATER SITES (sampled by IFE)</u>		NGR	SPRING	SUMMER	AUTUMN
UN-NAMED WATERCOURSE	GASPER	(ST 763 335)	01 MAY 1991 *	30 JUL 1991 *	15 OCT 1991
UN-NAMED WATERCOURSE	WOODLANDS MANOR	(ST 816 309)	01 MAY 1991 *	30 JUL 1991 *	15 OCT 1991
UN-NAMED WATERCOURSE	COWHERD SHUTE FARM	(ST 858 239)	03 MAY 1991 *	30 JUL 1991 *	15 OCT 1991
UN-NAMED WATERCOURSE	WEST WOOD	(ST 694 219)	01 MAY 1991 *	DRY 30-7-91 *	DRY 15-10-91 *
UN-NAMED WATERCOURSE	LYON'S GATE	(ST 856 055)	02 MAY 1991 *	29 JUL 1991 *	14 OCT 1991
UN-NAMED WATERCOURSE	ALTON COMMON	(ST 717 047)	01 MAY 1991 *	29 JUL 1991 *	14 OCT 1991
UN-NAMED WATERCOURSE	TWYFORD	(ST 862 186)	01 MAY 1991 *	31 JUL 1991 *	14 OCT 1991
UN-NAMED WATERCOURSE	FARRINGTON	(ST 846 152)	03 MAY 1991 *	31 JUL 1991 *	14 OCT 1991
UN-NAMED WATERCOURSE	WOOLLAND	(ST 782 069)	02 MAY 1991 *	29 JUL 1991 *	14 OCT 1991
UN-NAMED WATERCOURSE	OKEFORD FITZPAINE	(ST 801 105)	02 MAY 1991 *	29 JUL 1991 *	14 OCT 1991
GUSSAGE	GUSSAGE ST. ANDREW	(ST 973 145)	29 APR 1991 *	DRY 29-7-91 *	DRY 15-10-91 *
UN-NAMED WATERCOURSE	DELPH WOOD	(SZ 013 972)	03 MAY 1991 *	31 JUL 1991 *	15 OCT 1991
<u>LOWER CATCHMENT SITES (sampled by NRA)</u>					
SHREEN WATER	COLESBROOK	(ST 807 278)	13 MAY 1991	12 AUG 1991	
RIVER LODDEN	GILLINGHAM	(ST 815 261)	12 MAY 1991	12 AUG 1991	
CAUNDLE BROOK	BLACKMORE FORD	(ST 675 097)	18 MAR 1991	13 JUN 1991	
FONTMELL BROOK	FONTMELL PARVA	(ST 825 147)	18 MAR 1991	20 JUN 1991	
RIVER ALLEN	WALFORD MILL	(SU 010 006)	06 MAR 1991	27 JUN 1991	
RIVER CALE	SYLES FARM	(ST 759 199)	02 MAY 1991	31 JUL 1991	
RIVER STOUR	TRILL BRIDGE	(ST 790 205)	13 MAY 1991	12 AUG 1991	
CAUNDLE BROOK	WARR BRIDGE	(ST 733 143)	27 MAR 1991	17 JUL 1991	
RIVER LYDDEN	COX'S WATER	(ST 743 129)	27 MAR 1991	17 JUL 1991	
RIVER STOUR	PLECK	(ST 765 176)	05 APR 1991	30 JUL 1991	
RIVER LYDDEN	BAGBER BRIDGE	(ST 765 157)	04 APR 1991	04 JUL 1991	
RIVER STOUR	SPETISBURY	(ST 919 020)	25 MAR 1991	26 JUN 1991	

APPENDIX 5 . Survey dates for ground-truth land-use surveys of headwater sites.

RIVER CAM CATCHMENT

UN-NAMED WATERCOURSE	BURWELL	(TL 587 660)	18th JULY 1991
CAUNDLE DITCH	TEVERSHAM	(TL 504 573)	19th JULY 1991
NINE WELLS SPRING	NINE WELLS	(TL 460 542)	17th JULY 1991
UN-NAMED WATERCOURSE	LANGLEY WOOD	(TL 615 419)	19th JULY 1991
THE SLADE	HADSTOCK COMMON	(TL 547 436)	17th JULY 1991
RIVER CAM	PRIOR'S WOOD	(TL 549 306)	20th JULY 1991
HOFFER BROOK	THRILOW	(TL 452 470)	SITE ABANDONED
GASCOTE DEAN	CAXTON	(TL 296 584)	SITE ABANDONED
UN-NAMED WATERCOURSE	CALDECOTE	(TL 337 565)	NOT SURVEYED
UN-NAMED WATERCOURSE	WHADDON GAP	(TL 343 461)	17th JULY 1991
ARRINGTON BROOK	ARRINGTON	(TL 325 505)	20th JULY 1991
UN-NAMED WATERCOURSE	WELLHEAD SPRINGS	(TL 328 431)	SITE ABANDONED
UN-NAMED WATERCOURSE	DOWN HALL FARM	(TL 308 438)	NOT SURVEYED
RUDDERY SPRING	ASHWELL	(TL 279 403)	20th JULY 1991

Prior's Wood site formerly called Amberden Hall. Sites at Thriplow, Caxton and Wellhead Springs abandoned because of poor water quality. Sites at Caldecote and Down Hall Farm were not surveyed because they were replacement sites, selected after the Cam land-use survey had been completed.

RIVER DERWENT CATCHMENT

BILLER HOWE NOOK SLACK	TURF RIGG	(NZ 916 007)	27th JULY 1991
MILL BECK	BATHINGWELL WOOD	(SE 822 638)	24th JULY 1991
ROWMIRE SPRING STREAM	ROWMIRE PLANTATION	(SE 828 653)	24th JULY 1991
BISHOP WILTON BECK	BISHOP WILTON	(SE 802 554)	28th JULY 1991
LONG GILL	NEWGATE FOOT	(SE 866 935)	24th JULY 1991
HALLEYKELD SPRING STREAM	HALLEYKELD RIGG	(SE 939 860)	27th JULY 1991
UN-NAMED WATERCOURSE	NAB FARM	(SE 860 951)	22nd JULY 1991
MARR'S BECK	RAPE CLOSE LANE	(SE 610 735)	24th JULY 1991
BELLYMAR DIKE	HARTOFT RIGG	(SE 754 955)	21st JULY 1991
GILL DIKE	FROST HALL	(SE 642 987)	21st JULY 1991
COWHOUSE BECK	SNAPER HOUSE	(SE 598 912)	25th JULY 1991
MIREFALLS GILL	REIN'S WOOD	(SE 566 853)	22nd JULY 1991
SLEDHILL GILL	YOWLASS WOOD	(SE 531 870)	25th JULY 1991
WHEAT BECK	DALE HEAD	(SE 496 950)	24th JULY 1991

RIVER LUGG CATCHMENT

UN-NAMED WATERCOURSE	GREAT WACTON	(SO 534 433)	4th AUGUST 1991
UN-NAMED WATERCOURSE	BREDEBURY	(SO 603 558)	11th AUGUST 1991
UN-NAMED WATERCOURSE	BARNSTONE FARM	(SO 577 532)	5th AUGUST 1991
STRETFORD BROOK	PUDLESTON COURT	(SO 561 593)	SITE ABANDONED
UN-NAMED WATERCOURSE	DUNHAMPTON FARM	(SO 586 603)	5th AUGUST 1991
UN-NAMED WATERCOURSE	DINMORE MANOR	(SO 490 503)	8th AUGUST 1991
NEWBRIDGE BROOK	SHOAL'S BANK	(SO 394 494)	11th AUGUST 1991
GLADESTRY BROOK	CEFNIHR	(SO 210 558)	9th AUGUST 1991
UN-NAMED WATERCOURSE	GLASNANT	(SO 182 508)	10th AUGUST 1991
UN-NAMED WATERCOURSE	LOWER LYE	(SO 407 672)	12th AUGUST 1991
UN-NAMED WATERCOURSE	CRINFYNYDD	(SO 176 602)	7th AUGUST 1991
UN-NAMED WATERCOURSE	HILL HOUSE DINGLE	(SO 303 685)	6th AUGUST 1991
UN-NAMED WATERCOURSE	PEN-TWYN	(SO 187 729)	13th AUGUST 1991

Pudleston Court and Dunhampton Farm were each sampled in spring as alternative sites. Dunhampton Court proved to be the more suitable and Pudleston Court was abandoned.

RIVER STOUR CATCHMENT

UN-NAMED WATERCOURSE	GASPER	(ST 763 335)	18th AUGUST 1991
UN-NAMED WATERCOURSE	WOODLANDS MANOR	(ST 816 309)	4th-6th JULY 1991
UN-NAMED WATERCOURSE	COWHERD SHUTE FARM	(ST 858 239)	7th JULY 1991
UN-NAMED WATERCOURSE	WEST WOOD	(ST 694 219)	8th JULY 1991
UN-NAMED WATERCOURSE	LYON'S GATE	(ST 656 055)	2nd JULY 1991
UN-NAMED WATERCOURSE	ALTON COMMON	(ST 717 047)	3rd JULY 1991
UN-NAMED WATERCOURSE	TWYFORD	(ST 862 186)	8th JULY 1991
UN-NAMED WATERCOURSE	FARRINGTON	(ST 846 152)	17th AUGUST 1991
UN-NAMED WATERCOURSE	WOOLLAND	(ST 782 069)	ACCESS DENIED *
UN-NAMED WATERCOURSE	OKEFORD FITZPAINE	(ST 801 105)	10th JULY 1991
GUSSAGE	GUSSAGE ST.ANDREW	(ST 973 145)	11th JULY 1991
UN-NAMED WATERCOURSE	DELPH WOOD	(SZ 013 972)	12 & 16th AUG 1991

* Access denied to the major portion of the sub-catchment. A very small section, only, surveyed on 9th July 1991.

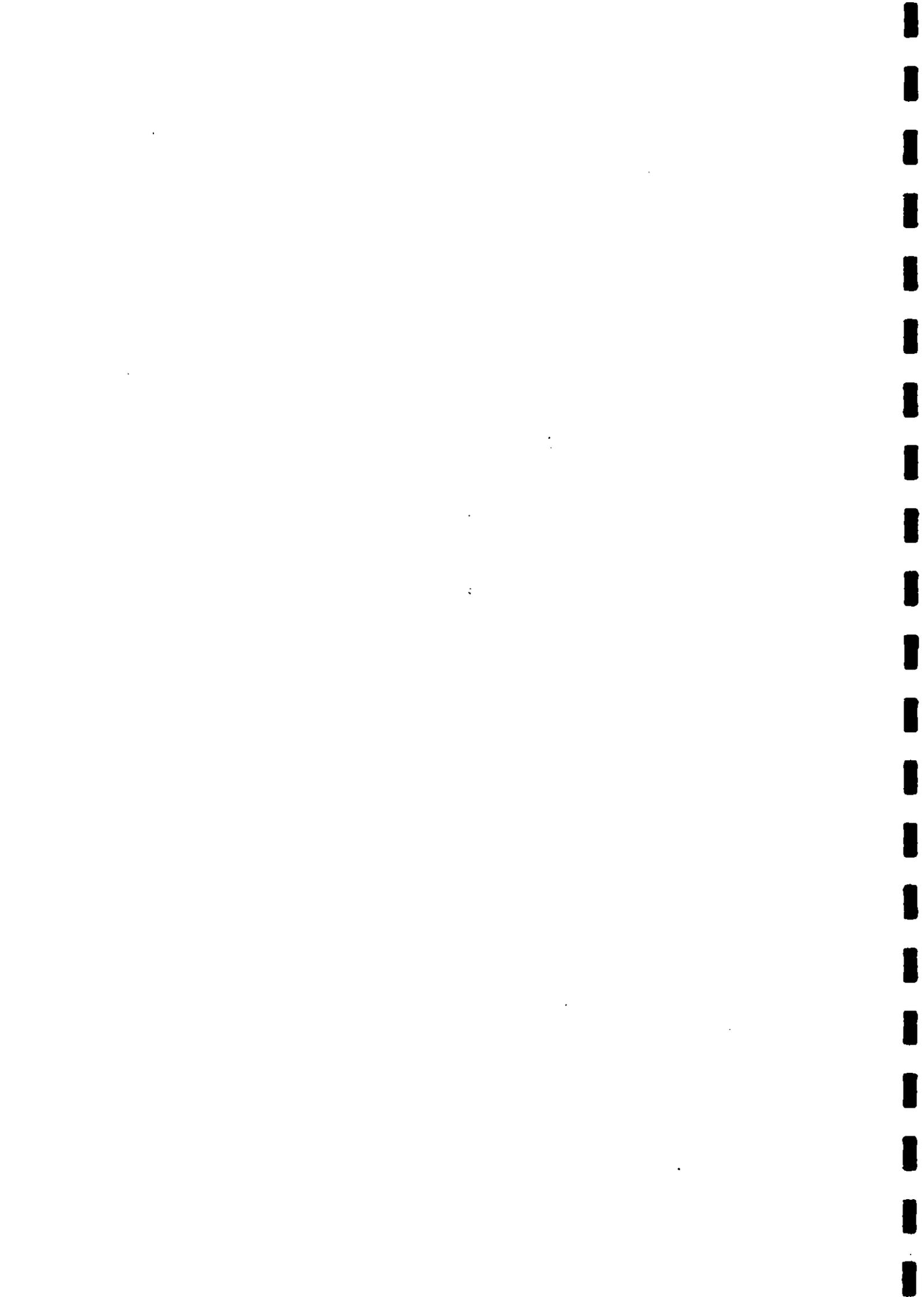
APPENDIX 6 Summer and autumn total alkalinity (mg l⁻¹ CaCO₃) and nitrate (mg l⁻¹ NO₃) values for headwater sites. NGR's and sampling dates as given in Appendices 1-4.

		ALKALINITY		NITRATE	
		SUMMER	AUTUMN	SUMMER	AUTUMN
<u>RIVER CAM CATCHMENT</u>					
UN-NAMED WATERCOURSE	BURWELL	223.5	300.0	12.20	7.46
CAUNDLE DITCH	TEVERSHAM	210.0	226.5	10.95	7.40
NINE WELLS SPRING	NINE WELLS	225.5	246.0	9.20	7.22
UN-NAMED WATERCOURSE	LANGLEY WOOD	DRY	DRY	DRY	DRY
THE SLADE	HADSTOCK COMMON	DRY	DRY	DRY	DRY
RIVER CAM	PRIOR'S WOOD	260.5	271.0	0.32	0.14
UN-NAMED WATERCOURSE	CALDECOTE	189.0	194.5	28.9	7.63
UN-NAMED WATERCOURSE	WHADDON GAP	195.0	108.0	4.52	1.78
ARRINGTON BROOK	ARRINGTON	DRY	DRY	DRY	DRY
UN-NAMED WATERCOURSE	DOWN HALL FARM	183.5	219.0	1.59	3.51
RUDDERY SPRING	ASHWELL	DRY	DRY	DRY	DRY
<u>RIVER DERWENT CATCHMENT</u>					
BILLER HOWE NOOK SLACK	TURF RIGG	5.5	1.5	N.D.	0.20
MILL BECK	BATHINGWELL WOOD	140.5	118.5	13.60	15.00
ROWMIRE SPRING STREAM	ROWMIRE PLANTATION	2.5	262.0	N.D.	12.50
BISHOP WILTON BECK	BISHOP WILTON	128.5	129.5	9.70	12.50
LONG GILL	NEWGATE FOOT	92.0	84.0	0.76	0.82
HALLEYKELD SPRING STREAM	HALLEYKELD RIGG	167.5	173.0	1.47	1.50
UN-NAMED WATERCOURSE	NAB FARM	8.0	1.5	0.20	0.15
MARR'S BECK	RAPE CLOSE LANE	134.0	78.0	16.20	20.00
BELLYMAR DIKE	HARTOFT RIGG	4.5	0.5	0.10	2.00
GILL DIKE	FROST HALL	17.0	13.5	0.09	0.20
COWHOUSE BECK	SNAPER HOUSE	182.0	176.5	1.46	1.50
MIREFALLS GILL	REIN'S WOOD	161.5	162.0	10.55	12.50
SLEDHILL GILL	YOWLASS WOOD	138.5	151.5	7.10	6.60
WHEAT BECK	DALE HEAD	76.5	77.0	0.37	0.70
<u>RIVER LUGG CATCHMENT</u>					
UN-NAMED WATERCOURSE	GREAT WACTON	258.5	196.5	3.55	6.71
UN-NAMED WATERCOURSE	BREDENBURY	271.0	258.5	5.91	5.59
UN-NAMED WATERCOURSE	BARNSTONE FARM	DRY	273.0	DRY	2.25
UN-NAMED WATERCOURSE	DUNHAMPTON FARM	266.0	267.5	5.32	5.19
UN-NAMED WATERCOURSE	DINMORE MANOR	204.5	225.0	1.08	0.90
NEWBRIDGE BROOK	SHOAL'S BANK	DRY	162.5	DRY	2.85
GLADESTRY BROOK	CEFNIHR	DRY	32.5	DRY	0.22
UN-NAMED WATERCOURSE	GLASNANT	73.5	18.5	0.14	0.55
UN-NAMED WATERCOURSE	LOWER LYE	DRY	DRY	DRY	DRY
UN-NAMED WATERCOURSE	CRINFYNYDD	55.0	29.0	0.24	0.90
UN-NAMED WATERCOURSE	HILL HOUSE DINGLE	82.5	38.5	3.75	4.29
UN-NAMED WATERCOURSE	PEN-TWYN	140.5	64.0	0.51	0.81
<u>RIVER STOUR CATCHMENT</u>					
UN-NAMED WATERCOURSE	GASPER	54.0	46.5	1.37	1.46
UN-NAMED WATERCOURSE	WOODLANDS MANOR	277.5	229.5	0.38	1.85
UN-NAMED WATERCOURSE	COWHERD SHUTE FARM	129.5	119.5	0.76	0.87
UN-NAMED WATERCOURSE	WEST WOOD	DRY	DRY	DRY	DRY
UN-NAMED WATERCOURSE	LYON'S GATE	172.5	151.5	1.70	1.43
UN-NAMED WATERCOURSE	ALTON COMMON	259.5	170.0	2.52	3.01
UN-NAMED WATERCOURSE	TWYFORD	277.5	257.5	6.01	5.30
UN-NAMED WATERCOURSE	FARRINGTON	222.5	251.0	4.74	5.04
UN-NAMED WATERCOURSE	WOOLLAND	164.5	183.5	1.44	0.34
UN-NAMED WATERCOURSE	OKEFORD FITZPAINE	205.5	235.0	2.42	3.48
GUSSAGE	GUSSAGE ST. ANDREW	DRY	DRY	DRY	DRY
UN-NAMED WATERCOURSE	DELPH WOOD	81.0	72.5	3.13	2.97

N.D. = Not detected

APPENDIX 7. Land-use change in the Stamford Bridge (R.Derwent) sub-catchment, 1978-1988. As derived from MAFF Parish Census data.

	ATTRIBUTE	1978	1984	1988	84-78	88-84	88-78	X84-78	X88-84	X88-78
1	Total area (hectares)	110969	110204	118458	-766	8255	7489	-0.7	7.5	6.7
2	Recent grassland (hectares)	13402	11616	9697	-1785	-1919	-3705	-13.3	-16.5	-27.6
3	Other grassland (excl. rough grazing) (hectares)	29428	28046	28270	-1382	224	-1158	-4.7	0.8	-3.9
4	Rough grazing (hectares)	7317	6633	6559	-685	-74	-759	-9.4	-1.1	-10.4
5	Woodland (hectares)	1086	1504	1909	418	406	824	38.5	27.0	75.9
6	All other land (hectares)	0	1413	1420	1413	7	1420	+++	0.5	+++
7	Wheat f.t. (hectares)	10021	19509	21515	9547	1947	11494	95.3	9.9	114.7
8	Barley f.t. (hectares)	35723	28316	26514	-7407	-1802	-9209	-20.7	-6.4	-25.8
9	Oats f.t. (hectares)	1567	1004	1146	-563	142	-421	-35.9	14.2	-26.9
10	Mixed corn f.t. (hectares)	80	26	34	-54	8	-46	-67.1	29.1	-57.6
11	Rye f.t. (hectares)	23	3	48	-20	45	25	-87.2	1524.4	108.3
12	Maize f.t. or f.s.f. (hectares)	33	20	19	-13	0	-13	-39.5	-1.8	-40.6
13	Potatoes (early and maincrop) (hectares)	2141	2251	2254	110	3	113	5.1	0.1	5.3
14	Sugar beet not f.s.f. (hectares)	0	2722	2555	2722	-167	2555	+++	-6.1	+++
15	Hops (hectares)	0	0	0	0	0	0
16	Horticultural crops (excl. mushrooms) (hectares)	542	378	278	-164	-100	-264	-30.2	-26.5	-48.8
17	Beans f.s.f. (hectares)	133	104	929	-29	825	796	-21.6	792.2	599.3
18	Turnips, swedes, beet & mangolds f.s.f. (ha)	2339	1358	1204	-1182	-153	-1335	-46.5	-11.3	-52.6
19	Kale, cabbage, savoy, kohlrabi & rape f.s.f. (ha)	726	505	378	-221	-127	-348	-30.4	-25.2	-47.9
20	Other crops f.s.f. (hectares)	0	446	1053	446	607	1053	+++	136.2	+++
21	Rape grown for oilseed (hectares)	799	4070	3824	3271	-245	3025	409.4	-6.0	378.7
22	Bare fallow (hectares)	11	6	121	-5	115	110	-46.8	1892.4	960.1
23	Other crops (not f.s.f.) (hectares)	475	216	476	-259	260	1	-54.6	120.7	0.2
24	Total crops and fallow (hectares)	54825	60992	62349	6167	1357	7523	11.2	2.2	13.7
25	Cows/heifers in milk - mainly dairy	13873	14738	11940	865	-2798	-1932	6.2	-19.0	-13.9
26	Cows/heifers in milk - mainly beef	6517	5492	6382	-1026	891	-135	-15.7	16.2	-2.1
27	Cows in calf but not milk - dairy	1427	1341	1084	-86	-257	-343	-6.0	-19.2	-24.1
28	Cows in calf but not milk - beef	1226	1140	1265	-86	126	39	-7.0	11.0	3.2
29	Heifers in calf (1st calf) - mainly dairy	3359	3226	3079	-133	-147	-279	-3.9	-4.6	-8.3
30	Heifers in calf (1st calf) - mainly beef	877	778	1260	-98	482	384	-11.2	62.0	43.8
31	Cattle >2-y-o male (excl. bulls for service)	3876	3306	2713	-570	-593	-1163	-14.7	-17.9	-30.0
32	Cattle >2-y-o female - for slaughter	1673	1047	771	-627	-275	-902	-37.5	-26.3	-53.9
33	Cattle >2-y-o female - others	760	716	382	-44	-334	-378	-5.8	-46.6	-49.7
34	Cattle 1 to 2-y-o male (excl. bulls for service)	8382	6599	4731	-1782	-1868	-3651	-21.3	-28.3	-43.6
35	Cattle 1 to 2-y-o female - for slaughter	5850	4884	3620	-966	-1264	-2230	-16.5	-25.9	-38.1
36	Cattle 1 to 2-y-o female - for dairy	3313	3081	2002	-232	-1079	-1312	-7.0	-35.0	-39.6
37	Cattle 1 to 2-y-o female - for beef	1203	1004	1262	-198	257	59	-16.5	25.6	4.9
38	Cattle 6 to 12 months male (incl. bull calves)	6883	8082	7254	1200	-828	372	17.4	-10.2	5.4
39	Cattle 6 to 12 months female	5053	5593	4808	540	-785	-246	10.7	-14.0	-4.9
40	Cattle <6 months - for slaughter	137	997	135	860	-863	-3	626.3	-86.5	-2.0
41	Cattle <6 months male (incl. bulls for service)	6897	7332	6577	436	-756	-320	6.3	-10.3	-4.6
42	Cattle <6 months female	5615	5087	4613	-527	-474	-1002	-9.4	-9.3	-17.8
43	Total cattle and calves	77451	74908	64359	-2543	-10549	-13091	-3.3	-14.1	-16.9
44	Total pigs	80239	95679	113679	15440	17999	33440	19.2	18.8	41.7
45	Total sheep and lambs	235852	261184	303035	25332	41852	67183	10.7	16.0	28.5
46	Total poultry	336350	389032	393818	52682	4786	57468	15.7	1.2	17.1
47	Total vegetables grown in the open	4673	3061	2194	-1613	-866	-2479	-34.5	-28.3	-53.0
48	Total area under glass or plastic structures (ha)	3	3	3	0	-1	-1	-0.8	-19.8	-20.4
49	Total orchards and small fruit (hectares)	12	17	15	5	-2	3	38.8	-10.3	24.5
50	Total hardy nursery stock (hectares)	49	50	39	2	-11	-9	3.4	-22.2	-19.6
51	Total area of glasshouses & protected crops (ha)	18	17	16	-1	-1	-2	-3.3	-6.3	-9.4



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