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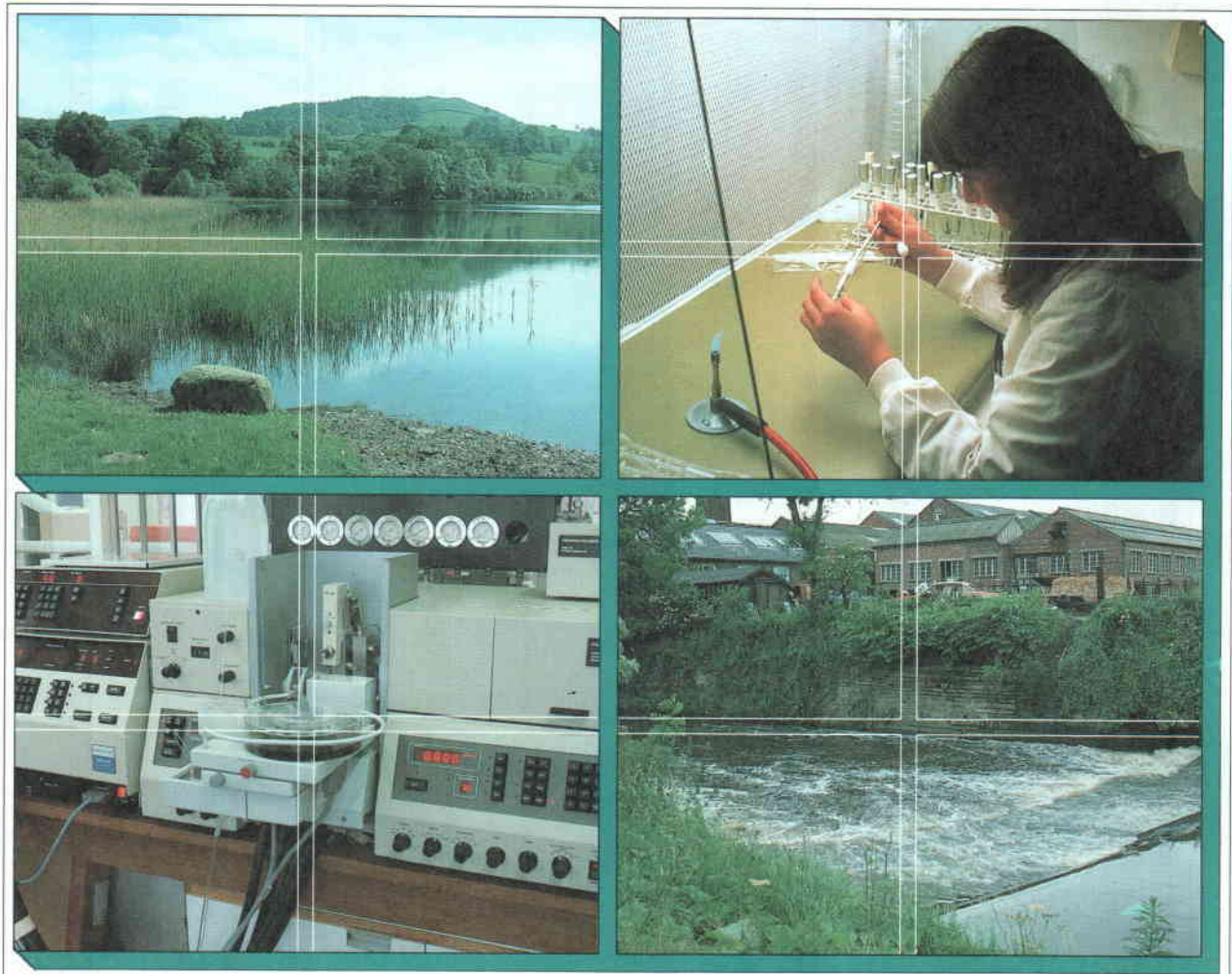
**Institute of
Freshwater
Ecology**

AQUATIC INVERTEBRATE SURVEYS AT AVON CAUSEWAY

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Report To:
IFE Report Ref. No:

Terence O'Rourke plc
RL/T04071v7/1



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Report date: August 1996
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1. INTRODUCTION

1.1 Background to Contract

Terence O'Rourke plc have been commissioned by Dorset Engineering Consultancy to undertake a broad range of ecological surveys along the corridor of the Avon Causeway in connection with an assessment of possible improvements to the road. The study area includes a 1.5km length of road and three substantial wet ditches which may be affected by the proposals.

The Institute of Freshwater Ecology (IFE) have been subcontracted to undertake a survey of the aquatic invertebrates in these three ditches in order to obtain information on the habitat features and invertebrates prior to any proposed road construction. A survey of flying adult dragonflies was also included in the study.

1.2 Contract requirements

The detailed contract requirements proposed by the IFE and accepted by Terence O'Rourke plc are as follows:

To undertake a summer survey of the aquatic invertebrates of three ditches (D12, D13 and D16) which cross the route of the Avon Causeway.

To collect three replicate pond-net samples (1 min. duration) upstream and also downstream of the causeway.

To document the range of habitats occurring in each ditch, upstream and downstream of the causeway.

To sort and identify the fauna in the laboratory using standard IFE procedures.

To identify the fauna at species level where available keys and size of specimens make this feasible. (But Sphaeriidae, Oligochaeta and Chironomidae not to be identified).

To undertake a survey of adult dragonflies along each ditch on the date of the aquatic invertebrate survey. Two additional half-day surveys to be made later in the summer in order to increase the species list.

To present the results from the aquatic invertebrate and adult dragonfly surveys in a report, together with an evaluation of the results in terms of nationally and locally rare species. The report to include brief reference to the implications of the limited scope of the study and any recommendations for further work.

2. STUDY SITES

2.1 Choice of sampling sites

A summer survey of the aquatic invertebrates was required on each of the wet ditches designated D12, D13 and D16 on Figure 1. The purpose was to obtain baseline information on the fauna prior to possible improvements to the Avon Causeway. Each ditch flows in a north to south direction, and road construction has the potential to affect the ditches to the south of the causeway. It was therefore important to include upstream 'control sites' and downstream 'future impact sites'.

Biological samples taken along the length of a ditch can vary in their faunal composition for a number of reasons, including the fact that habitat features vary along the ditch. Replicate samples taken both upstream and downstream of the causeway can demonstrate the amount of variation in each section of the ditch. This can, in turn, be used to establish whether or not differences already exist upstream and downstream of the present causeway. After road improvements have been completed, a repeat survey might establish whether the fauna downstream of the causeway has changed from the pre-construction community.

The IFE originally proposed that three replicate pond-net samples of 1 minutes duration be taken upstream and downstream on ditches D12, D13 and D16. On-site appraisal of the ditches lead to some amendments to this protocol for D13. Sampling site locations for all three ditches are given below. All distances for upstream sites are from the north limit of the present road and all distances for downstream sites are from the south limit of the present road.

Ditch D12

Upstream sites 1, 2 and 3 were 90, 60 and 30 metres respectively north of the road. Downstream sites 4, 5 and 6 were 65, 95 and 125 metres respectively south of the road. Note that the downstream sites were positioned to the south of the proposed new route, and would therefore be available for resampling at a later date, if required.

Ditch D13

Upstream sites 1, 2 and 3 were only 17, 14 and 4 metres respectively north of the road. The samples were taken in standing water, there being no perceptible flow. Upstream of site 1 the channel was blocked by a large bed of yellow flag (*Iris pseudacorus*) and beyond this point, the channel itself was dry.

To the south of the road the ditch was dry, and therefore no samples could be taken. However, where ditch D13 joined D12 (the latter having first flowed south and then east) a single sample was taken and designated as D13 site 4. Information on the fauna of this location could be of relevance if D13 downstream of the road starts to flow later in the year, because upstream recolonization might then take place from the fauna at D13 site 4.

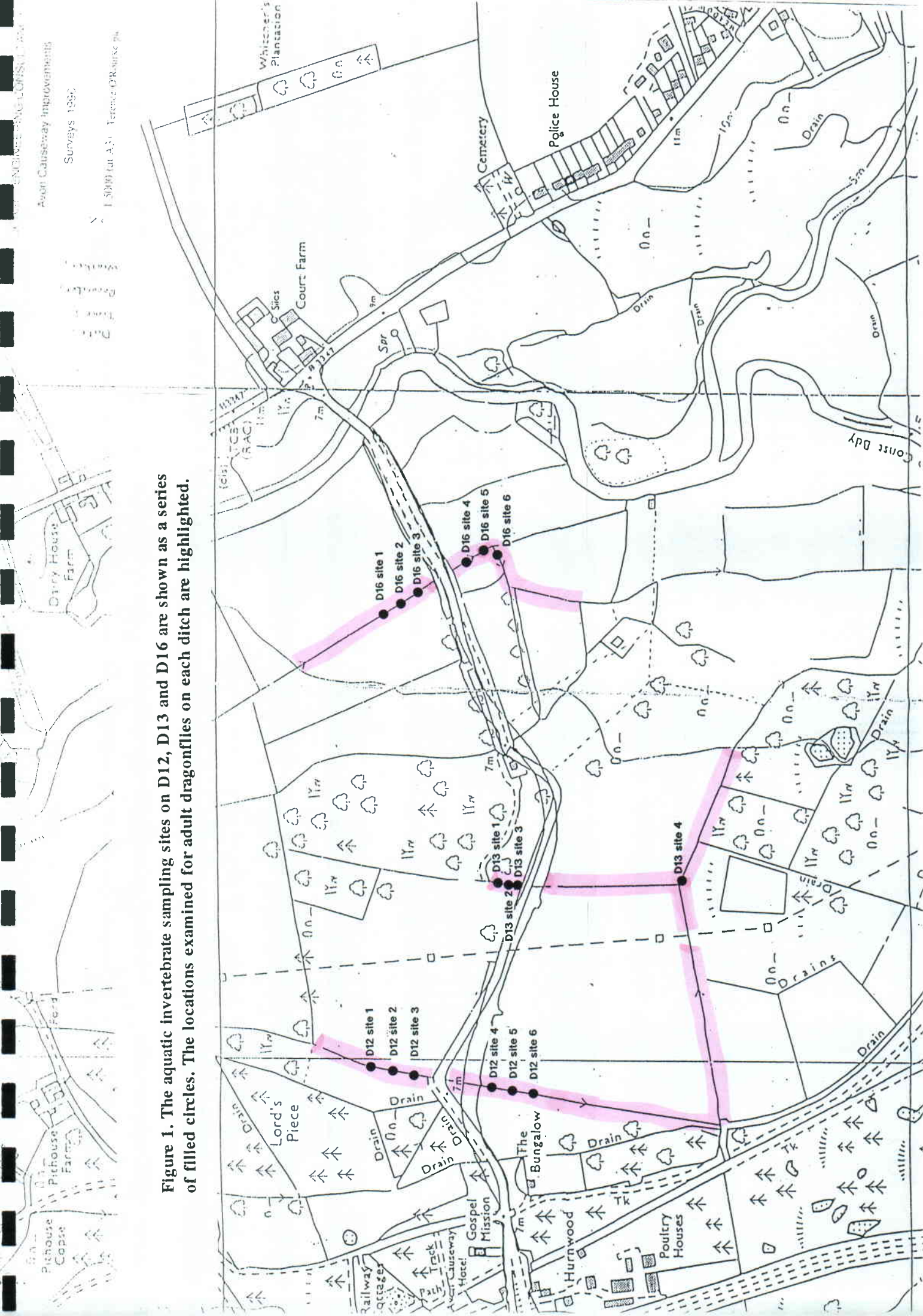
Ditch D16

Upstream sites 1, 2 and 3 were 90, 60 and 30 metres respectively north of the road. Downstream sites 4, 5 and 6 were 30, 60 and 90 metres respectively south of the road.

Date: _____
 Drawn: _____
 Checked: _____

Dairy House Farm
 Pichouse Farm
 Lord's Piece
 Poultry Houses
 The Bungalow
 Gospel Mission
 Hotel
 Avon Causeway
 Railway
 Tack
 Spr
 Siles
 Court Farm
 Cemetery
 Police House
 Whitcher's Plantation
 Conest Bdy

Figure 1. The aquatic invertebrate sampling sites on D12, D13 and D16 are shown as a series of filled circles. The locations examined for adult dragonflies on each ditch are highlighted.



2.2 Site Habitat Features

Information on the habitat features of each of the sampling sites on ditches D12, D13 and D16 is presented in Table 1. Further descriptive information on the upstream and downstream sections of each ditch is given below.

D12 Upstream of road

The upstream section of the straightened and dredged D12 ditch has an average width of 2 metres but widens out to 2.5 metres at Site 3 where poaching has occurred. The water is only 0.15 metres deep at this point but increases to 0.5 metres further upstream at Site 2. Water flow is rippled across the poached area but for the remaining surveyed area there is no perceptible flow. The substrate comprises coarse gravel with some silt accumulation particularly in the deeper water. Aquatic plants include filamentous algae, *Callitriche*, and *Potamogeton natans* which are best represented in Site 3 by the poached area. Emergent reeds, rushes and grasses grow on the water's edge. The 2 metre high embanked earth banks are steep (> 45 degrees) on both sides except for the poached area. Dredged material is visible on the bank top. The vegetation structure of the bank faces and bank tops is mostly simple and consists of tall herbs while the land use on both sides is uniform uncut rough pasture.

D12 Downstream of road

The downstream section of the D12 ditch shares many features with the upstream section but shows less variation in bank features and a smaller range of plants. It has a water width of approximately 2 metres throughout with an unconsolidated substrate of gravel and pebbles covered by silt. The depth of the water is from 0.35 - 0.4 metres and the flow is a smooth glide. As in the upstream section, there is deposited iron ochre which colours the water orange when disturbed. The aquatic vegetation at Sites 4 - 6 includes extensive patches of filamentous algae, *Potamogeton natans*, and *Glyceria fluitans*. The banks are mainly of earth with some clay visible at Site 4. The bank height is 1.5 metres. The slope of the right bank is gentle but the left bank is mostly steep (> 45 degrees) with an embankment raising the height to about 3 metres; dredged materials can be seen along the bank top. Horses graze rough pasture on the right bank, which has a uniform vegetation structure of predominantly grasses, down to the water's edge. The left bank is covered by tall herbs comprising a simple vegetation structure behind which lies rough pasture that had been cut for hay at the time of the survey.

D13 Upstream of road

The water in this stretch of the ditch is confined to an area delimited by the road to the south and a large bed of yellow flag (*Iris pseudacorus*) across the ditch at the northern end. As a result, Sites 1 - 3 are in close proximity. The water width is 1.5 metres on average with a mean depth of 0.2 metres showing no perceptible flow over a compact substrate in which matted tree roots predominate with some gravel, silt and detritus. *Callitriche* occurs along the length of the ditch but *Potamogeton natans*, and *Alisma* are restricted to the southern end. Bryophytes and liverworts grow on the banks and tree roots. The bank top width is about three metres and the height about 1 metre. The earth banks have both steep and gently-sloped sections. The left bank face and top have a complex vegetation structure reflecting the land use which is a plantation of

TABLE 1. Habitat features for each sampling site on ditches D12, D13 and D16

	D12 (1)	D12 (2)	D12 (3)	D12 (4)	D12 (5)	D12 (6)	D13 (1)	D13 (2)	D13 (3)	D13 (4)	D16 (1)	D16 (2)	D16 (3)	D16 (4)	D16 (5)	D16 (6)
	U/S	U/S	U/S	D/S	D/S	D/S	U/S	U/S	U/S	D/S	U/S	U/S	U/S	D/S	D/S	D/S
Distance from road (metres)	90 (north)	60 (north)	30 (north)	6.5 (south)	9.5 (south)	1.25 (south)	17 (north)	14 (north)	4 (north)	Cont./ D12	90 (north)	60 (north)	30 (north)	60 (south)	90 (south)	
Structure										Not sampled						
Water width (metres)	2	2	2.5	2	2	2	2	1.5	1.5	1.5 DRY	2	2	2	2.5	2.5	2.5
Water depth (metres)	0.45	0.5	0.15	0.4	0.35	0.35	0.2	0.2	0.2	0.2	0.4	0.5	0.7	0.15	0.15	0.15
Flow type	NP	NP	RP	SM	SM	SM	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Water colour	Orange	Orange	Orange	Orange	Orange	Orange										
Substrate	GP/S	GP	GP	S/GP	S/GP	S/GP	TR/S/GP	TR/S/GP	TR/S/GP	TR/S/GP	SI/CP	SI/CP	SI/CP	GP/SI	GP/SI	SI/CP
Bank composition	EA	EA	EA	EA/CL	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA
Bank modification	EM	EM	PC	EM (L)	EM (L)	EM (L)	NO	NO	NO	NO	EM	EM	EM	EM PC (L)	EM PC (L)	EM PC (L)
Aquatic plants																
Bryophytes/liverworts																
Emergent broad-leaved herbs	+	+	+													
Emergent reeds/rushes/sedges																
Floating-leaved (rooted)																
Free-floating																
Amphibious																
Submerged broad-leaved																
Submerged fine/linear leaved																
Filamentous algae																
Bank vegetation (R)																
Bare																
Short herbs																
Tall herbs																
Trees																
Shading																
Bank vegetation (L)																
Bare																
Short herbs																
Tall herbs																
Trees																
Shading																
Land use (L)	RP	RP	RP	RP (hay)	RP (hay)	RP (hay)	BL	BL	BL	BL	IG	IG	IG	RP (cattle)	RP (cattle)	RP (cattle)
Land use (R)	RP	RP	RP	RP (horses)	RP (horses)	RP (horses)	RP	RP	RP	RP	IG	IG	RP	RP	RP	RP

ABBREVIATION KEY

- U/S Upstream
- D/S Downstream
- L Left bank
- R Right bank
- BL Broadleaf woodland
- CL Clay
- EA Earth
- EM Embanked
- GP Gravel/pebble
- IG Improved grass
- NP No perceptible flow
- PC Poached
- R Ripped run
- RP (flow) Ripped run
- RP (landuse) Rough pasture
- S Sand
- SI Silt
- SM Smooth glide
- TR Tree roots

poplar trees with undergrowth. The right bank face has a simple vegetation structure of semi-continuous trees and low plants with uniform uncut rough pasture behind. The trees on both banks result in extensive shading of the channel with overhanging boughs and exposed bankside and underwater tree roots. Coarse woody debris is also present.

D13 Downstream of road

Apart from a pool adjacent to the road which probably contains run-off water, this section is dry as far as the confluence with the ditch running west to east at the southern end of the field (a continuation of D12). The course of the ditch runs through a continuous band of trees including willow and alder with clumps of tall herbs on the outer edge. The trees form the boundary between two fields of rough pasture. The confluence is marked by extensive areas of *Juncus bulbosus* both in and on the edge of the rusty coloured water.

D16 Upstream of road

This straight-sided resectioned ditch has an average water width of 2 metres with a water depth varying from 0.4 to 0.7 metres, being deepest near to the road and becoming progressively shallower upstream. Flow is a smooth glide with some marginal deadwater. The substrate is predominantly silt overlying gravel/pebbles. In the water are *Potamogeton crispus*, *Callitriche*, and *Lemna*, with emergent *Apium*, *Sparganium*, *Phragmites* and *Carex*. The steep-sided earth banks are embanked with tall herbs along the whole length on both sides; trees including *Salix* and hawthorn are scattered on the right bank and the land use is uncut rough pasture.

D16 Downstream of road

This ditch carries water south from the road for about 75 metres before making a right-angled turn to the west. The average water width is 2.5 metres with a mean depth of 0.15 metres with very slow to almost no perceptible flow for most of its surveyed length over an unconsolidated gravel/pebble substrate overlain by a thin layer of silt. There are a few marginal deadwater areas and one stretch of rippled run. Aquatic plants include extensive patches of filamentous algae, *Potamogeton crispus* and *Potamogeton pectinatus*, *Ranunculus*, *Sparganium emersum*, *Callitriche* and *Lemna* with emergent *Carex* and *Phalaris*. *Potamogeton* and *Ranunculus* are absent from the shallower water of Site 4. The earth banks are mostly steep but on the left bank there are some areas with a gentle slope and evidence of poaching by cattle. Bank top width is 5 metres and bank height between 0.75 and 1 metre. There are no trees on the left bank on which the vegetation structure is either bare, uniform low-growing grasses, or simple structure with tall herbs. The current land use is rough pasture, which was being grazed by cattle at the time of the survey. The right bank has isolated trees including *Salix* and hawthorn.

3. METHODS FOR INVERTEBRATES

3.1 Field procedures

Aquatic Invertebrate Surveys

At each sampling location, a one minute pond-net sample was taken which included all habitats approximately in proportion to their occurrence. The contents of the pond-net were emptied into a labelled polythene bag before being transported to the laboratory where the material in each sample was fixed and preserved. The survey took place on 4 July 1996.

Adult Dragonfly Surveys

A total of three surveys were undertaken for adult dragonflies. The first took place on the same day as the aquatic survey, and the subsequent surveys were conducted on warm sunny afternoons on the 18 July and 13 August 1996. Each of ditches D12, D13 and D16 were walked, both upstream and downstream of the causeway. The full extent of the dragonfly survey area is highlighted on Figure 1 and extends well beyond the area sampled for aquatic invertebrates. Binoculars were used and where necessary, a sweep net was also employed to examine specimens. The field guide by Aguilar *et al.* (1986) was used to confirm identifications where necessary.

3.2 Laboratory Procedures

Each aquatic invertebrate sample was placed in a 500 micron sieve and washed thoroughly with water to remove the fixative. A portion of the material was then placed in a rectangular flat-bottomed tray and searched for animals. The process was repeated with subsequent aliquots until all the invertebrates had been removed. The fauna was then identified as far as available keys allowed. The Oligochaeta (true worms) and Chironomidae (non-biting midge larvae) were not identified, as agreed in the contract, but it was decided to identify the Sphaeriidae (pea-mussels) to species because they can provide useful information on the permanence or otherwise of a watercourse.

Once the identification phase was complete, the data were transferred to a spreadsheet and validated prior to the production of the final tables and Appendix 1.

4. RESULTS

4.1 Aquatic Invertebrate Survey

Taxon Richness

The faunal lists for each individual sampling site on D12, D13 and D16 are presented in Tables 2, 3 and 4 respectively, and the number of taxa at each sampling site are given at the foot of each table. It is apparent that none of the sites was particularly taxon rich. A full list of the 76 taxa recorded during the study may be found in Appendix 1.

The taxonomic richness upstream and downstream of the road on each ditch, expressed as the mean number (and range) of taxa per site, is presented below.

	D12	D13	D16
Upstream (sites 1-3)			
Mean (and range)	18.3 (18-19)	10.7 (9-14)	15.0 (14-16)
Total no. taxa	28	18	22
Downstream (sites 4-6)			
Mean (and range)	16.7 (15-20)	24*	17.7 (13-22)
Total no. taxa	26		35

* data for 1 site only (D13 site 4)

In the two ditches (D12 and D16) where mean taxon richness per site can be compared upstream and downstream of the road, differences are very marginal. Whereas D12 had a mean of 18.3 taxa upstream and 16.7 downstream, D16 had a mean of 15.0 taxa upstream and 17.7 downstream of the road. On D12 the total number of taxa recorded upstream and downstream were 28 and 26 respectively. In contrast, on D16, whereas the total number upstream was 22, downstream of the causeway the three sites contributed a total of 35 taxa. Possible reasons for this will be considered later.

Ditch D13 had a very limited fauna of between 9 and 14 taxa per site (mean of 10.7) upstream of the road and only 18 taxa in total at sites 1-3. In contrast, downstream of the causeway at the junction of D13 and what appeared to be the continuation of D12, site 4 had 24 taxa. Faunistically, it had more in common with the sites on D12 than D13.

Table 2 Invertebrate fauna of ditch D12, including samples 1-3 upstream and samples 4-6 downstream of the Avon Causeway

Group/common name	Taxon name	U/s road			D/s road		
		1	2	3	4	5	6
TRICLADIDA (Flatworms)	<i>Polycelis nigra</i> group	+			+	+	+
	<i>Dendrocoelum lacteum</i> (Muller)	+	+	+			
BIVALVIA (Mussels)	<i>Pisidium casertanum</i> (Poli)	+	+	+	+	+	
OLIGOCHAETA (Worms)	Oligochaeta	+	+	+	+	+	
CRUSTACEA (Hog Lice, Shrimps etc.)	<i>Asellus meridianus</i> Racovitza	+	+	+	+	+	+
	<i>Crangonyx pseudogracilis</i> Bousfield	+	+	+	+	+	+
ODONATA (Damselflies, Dragonflies)	<i>Pyrhosoma nymphula</i> (Sulzer)					+	
HEMIPTERA (Water Bugs)	<i>Hydrometra</i> sp.		+				
	<i>Velia</i> sp.	+	+		+		+
	<i>Gerris</i> sp.		+		+		
	<i>Notonecta</i> sp.		+	+	+		+
	Corixidae			+			
	<i>Sigara semistriata</i> (Fieber)						+
COLEOPTERA (Water Beetles)	<i>Haliphus</i> sp.		+	+	+	+	+
	<i>Haliphus heydeni</i> Wehncke			+	+	+	+
	<i>Haliphus lineatocollis</i> (Marshall)		+	+	+		+
	<i>Hydroporus</i> sp.	+	+				
	<i>Hydroporus incognitus</i> Sharp	+					
	<i>Hydroporus tessellatus</i> Drapiez			+			
	<i>Agabus</i> sp.	+	+	+	+	+	
	<i>Agabus bipustulatus</i> (L.)	+		+			
	<i>Rhantus</i> sp.					+	+
	<i>Colymbetes fuscus</i> (L.)				+		
	<i>Dytiscus</i> sp.	+	+	+			
	<i>Gyrinus</i> sp.					+	+
	<i>Helophorus brevipalpis</i> Bedel	+	+	+	+	+	+
	<i>Anacaena bipustulata</i> (Marshall)	+					
<i>Anacaena globulus</i> (Paykull)				+			
<i>Ochthebius minimus</i> (Fabricius)						+	
MEGALOPTERA (Alderflies)	<i>Sialis lutaria</i> (L.)	+	+	+	+	+	+
DIPTERA (True Flies)	Tipulidae			+			
	<i>Pericoma trivialis</i> group	+	+		+		
	Ceratopogonidae					+	
	Chironomidae	+	+	+	+	+	+
	Stratiomyidae	+					
	Tabanidae		+				
	Dolichopodidae				+		
Ephydriidae				+			
Number of taxa per sampling unit		18	19	18	20	15	15

Table 3 Invertebrate fauna of ditch D13/12. Samples 1-3 are upstream of the Avon Causeway and sample 4 is downstream on the continuation of ditch D12 (D13 was dry downstream of the causeway).

Group/common name	Taxon name	U/s road			D/s road
		1	2	3	4
TRICLADIDA (Flatworms)	<i>Dendrocoelum lacteum</i> (Muller)			+	
GASTROPODA (Snails)	<i>Anisus leucostoma</i> (Millet)		+	+	
BIVALVIA (Mussels)	<i>Pisidium casertanum</i> (Poli)				+
	<i>Pisidium nitidum</i> Jenyns			+	
	<i>Pisidium personatum</i> Malm				+
OLIGOCHAETA (Worms)	Oligochaeta	+	+	+	+
CRUSTACEA (Hog Lice, Shrimps etc.)	Cladocera	+	+	+	
	<i>Asellus aquaticus</i> (L.)	+	+	+	
	<i>Asellus meridianus</i> Racovitza				+
	<i>Crangonyx pseudogracilis</i> Bousfield	+			
ODONATA (Damselflies, Dragonflies)	<i>Aeshna cyanea</i> (Muller)			+	
HEMIPTERA (Water Bugs)	<i>Velia</i> sp.			+	+
	<i>Gerris</i> sp.	+			
	<i>Notonecta</i> sp.				+
	Corixidae			+	
	<i>Hesperocorixa sahlbergi</i> (Fieber)				+
	<i>Sigara nigrolineata</i> (Fieber)				+
	<i>Sigara semistriata</i> (Fieber)				+
COLEOPTERA (Water Beetles)	<i>Haliphus heydeni</i> Wehncke				+
	<i>Hydroporus pubescens</i> (Gyllenhal)				+
	<i>Agabus</i> sp.				+
	<i>Agabus bipustulatus</i> (L.)	+	+	+	+
	<i>Agabus melanocornis</i> Zimmermann				+
	<i>Rhantus</i> sp.				+
	<i>Helophorus aequalis</i> Thomson	+		+	+
	<i>Helophorus brevipalpis</i> Bedel	+	+	+	+
	<i>Helophorus flavipes</i> Fabricius			+	+
	<i>Hydrobius fuscipes</i> (L.)				+
	<i>Limnebius truncatellus</i> (Thunberg)		+		
DIPTERA (True Flies)	<i>Molophilus</i> sp.				+
	<i>Pericoma trivialis</i> group		+		+
	Chironomidae	+	+	+	+
	Ephydriidae				+
	Muscidae				+
Number of taxa per sampling unit		9	9	14	24

Table 4 Invertebrate fauna of ditch D16, including samples 1-3 upstream and samples 4-6 downstream of the Avon Causeway

Group/common name	Taxon name	U/s road			D/s road		
		1	2	3	4	5	6
TRICLADIDA (Flatworms)	<i>Polycelis nigra</i> group	+	+	+	+		
GASTROPODA (Snails)	<i>Lymnaea</i> sp.				+		
	<i>Lymnaea peregra</i> (Muller)	+	+	+		+	
	<i>Lymnaea truncatula</i> (Muller)					+	
	<i>Gyraulus albus</i> (Muller)						+
	<i>Acroloxus lacustris</i> (L.)					+	
BIVALVIA (Mussels)	<i>Pisidium milium</i> Held	+			+		+
	<i>Pisidium subtruncatum</i> Malm					+	
OLIGOCHAETA (Worms)	Oligochaeta	+	+	+	+		+
HIRUDINEA (Leeches)	<i>Glossiphonia complanata</i> (L.)				+		+
	<i>Erpobdella octoculata</i> (L.)						+
CRUSTACEA (Hog Lice, Shrimps etc.)	Cladocera		+			+	
	Ostracoda	+	+	+	+		+
	<i>Asellus aquaticus</i> (L.)	+	+	+	+	+	+
	<i>Crangonyx pseudogracilis</i> Bousfield	+	+	+	+	+	+
	<i>Gammarus pulex</i> (L.)				+		
EPHEMEROPTERA (Mayflies)	<i>Caenis luctuosa</i> group				+		
HEMIPTERA (Water Bugs)	<i>Notonecta</i> sp.			+			
	Corixidae		+				
	<i>Hesperocorixa sahlbergi</i> (Fieber)						+
COLEOPTERA (Water Beetles)	<i>Haliphus wehncke</i> (Gerhardt)				+		
	<i>Hydroporus</i> sp.						+
	<i>Hydroporus palustris</i> (L.)	+					+
	<i>Agabus</i> sp.	+	+	+	+		+
	<i>Gyrinus</i> sp.				+		
	<i>Helophorus aequalis</i> Thomson	+	+	+		+	
	<i>Helophorus brevipalpis</i> Bedel	+	+	+	+	+	+
	<i>Anacaena globulus</i> (Paykull)			+			
	<i>Ochthebius minimus</i> (Fabricius)			+		+	+
	<i>Hydraena riparia</i> Kugelann	+		+			
MEGALOPTERA (Alderflies)	<i>Sialis lutaria</i> (L.)	+	+	+	+	+	+
TRICHOPTERA (Caddis Flies)	<i>Limnephilus lunatus</i> Curtis				+	+	
DIPTERA (True Flies)	<i>Tipula</i> sp.				+		
	<i>Pericoma trivialis</i> group				+		+
	<i>Anopheles claviger</i> (Meigen)		+				+
	<i>Anopheles atroparvus</i> group	+					
	Ceratopogonidae			+			
	<i>Simulium (Simulium) ornatum</i> group				+		
	Chironomidae	+	+	+	+	+	+
	<i>Clinocera</i> group				+		
	Muscidae				+		
Number of taxa per sampling unit		15	14	16	22	13	18

The taxonomic richness of the non-insect and insect groups changes from D12 through D13 to D16 as indicated below:

	D12	D13	D16
Upstream sites			
Non-insects	6	7	8
Insects	22	11	14
Downstream sites			
Non-insects	5	4*	16
Insects	21	20*	19
Upstream + Downstream			
Non-insects	6	10	16
Insects	32	24	25

*data for one site only (all other figures refer to the fauna at 3 sites combined)

It is apparent that overall, insect richness is greatest in ditch D12 (32 taxa) whereas non-insect richness is highest in D16 (16 taxa). It is notable that all the 16 non-insect taxa are represented at the downstream sites 4-6, but that only 50% of them occurred upstream of the road. These points are examined in more detail in the next section.

Taxonomic Composition

Of the 76 taxa listed in Appendix 1, just 22 were non-insects. The remaining 54 insect taxa were dominated by the Water Bugs (8 Hemiptera), Water Beetles (26 Coleoptera) and True Flies (15 Diptera). Some of the major insect groups which characterise flowing water, including the Mayflies (1 Ephemeroptera) and Caddis Flies (1 Trichoptera) were poorly represented.

Ditch D12 (Table 2).

As indicated in the previous section, this ditch was dominated by insects. The limited number of non-insect taxa suggests that the ditch may have dried out in the recent past. *Pisidium casertanum* is typical of sites with intermittent flow and is known to have some resistance to desiccation (Ham & Bass, 1982). In addition, water bugs, water beetles and true flies are early colonisers of newly flowing water bodies. Note that of the total of 38 taxa in D12 (sites 1-6), just 16 were found both upstream and downstream of the causeway.

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Ditch 13 (Table 3)

The fauna upstream of the causeway also has a limited non-insect fauna, but of interest is the presence of *Anisus leucostoma*, a common snail which is characteristic of ponds and marshy areas which dry out (Macan 1977). Unlike D12, the upstream section of D13 has a relatively restricted insect fauna, possibly due to the fact that all sites were in close proximity to each other. The single downstream sampling location (site 4) was the most taxon rich site examined, and had more in common with the sites in ditch D12, probably because it appears to have been the continuation of D12.

Ditch D16 (Table 4)

Upstream of the causeway the water was deep and ponded. There was a marginal increase in non-insects, water beetles and true flies were dominant among the insects, and the fauna included two common species of mosquito larvae. Downstream of the causeway the ditch was wider and shallower with running water in places. A much wider range of taxa (35 in total) were recorded, including many which are characteristic of running waters. The non-insects included three species of snail, a mussel, two leeches and the amphipod crustacean *Gammarus pulex*, none of which had been recorded in D12, D13 or above the causeway in D16. The insects included the first mayfly and caddis of the survey and also the first blackfly larvae (*Simulium ornatum* group), which need flowing water to feed. The insects may have colonised the downstream section of D16 as a result of deposition of eggs by flying adults, or alternatively, both the non-insects and the insects may have colonised as a result of direct winter flooding from the nearby R. Avon.

Nationally and locally rare species

There were no Red Data Book (RDB) species recorded during the aquatic invertebrate survey in July 1996, although an RDB dragonfly was recorded during the adult dragonfly survey (see next section).

Species which, although not allocated to an RDB threat category, are rare and known from one hundred or fewer 10 km squares of the National Grid are described as Nationally Notable (=Nationally Scarce). Within the Nationally Notable designation, a distinction is sometimes made between 'Notable A' species (30 or fewer 10km squares) and 'Notable B' species (31-100 squares).

During the aquatic invertebrate survey, two 'Notable B' water beetles (Foster, 1992) were recorded. The haliplid beetle *Haliphus heydeni* was recorded both upstream and downstream of the causeway on D12 and was also present at Site 4 on D13, which was essentially a continuation of D12 (see Figure 1). The hydrophilid beetle *Anacaena bipustulata* was recorded at a single site (Site 1) on D12, upstream of the causeway.

4.2 Adult dragonfly Survey

Ten species of adult Odonata were recorded as a result of the surveys conducted on 4 and 18 July and 13 August 1996 (Table 5). They included three species of damselflies (Zygoptera) and seven dragonflies (Anisoptera). One of the dragonflies (*Aeshna* sp.) was seen in the far distance and could not be identified to species with certainty.

Ditch D12 yielded the greatest number of taxa with eight species. There were no rare species but *Orthetrum coerulescens* (the keeled skimmer) is a characteristic species of lowland heathland in southern England and the moorlands of western Britain (Merritt *et al.* 1996).

Table 5 Adult dragonflies recorded on three dates in the vicinity of ditches D12, D13 & D16 (1 = 4 July; 2 = 18 July; 3 = 13 August 1996)

Dragonfly Species	D12		D13		D16	
	u/s	d/s	u/s	d/s	u/s	d/s
Zygoptera						
<i>Calopteryx splendens</i> (Harris)		2	3			2,3
<i>Pyrrhosoma nymphula</i> (Sulzer)		2				2,3
<i>Coenagrion puella</i> (L.)						2
Anisoptera						
<i>Aeshna</i> sp.	3					
<i>Anax imperator</i> Leach	1					
<i>Cordulegaster boltonii</i> (Donovan)	3	3				
<i>Libellula fulva</i> Muller						2
<i>Orthetrum coerulescens</i> (Fabricius)	2					
<i>Sympetrum striolatum</i> (Charpentier)		2		3		3
<i>Sympetrum danae</i> (Sulzer)		2				
Number of species	4	5	1	1	0	5

Ditch D13 was examined upstream of the causeway in the vicinity of sites 1-3 and also all the way downstream to site 4, plus a short distance to the west and to the east. Two common species were recorded.

On ditch D16, no Odonata were seen upstream of the causeway, but downstream, three damselfly and two dragonfly species were recorded. The latter included *Libellula fulva* Muller (the scarce chaser) which is known to breed in the R. Avon and also in the Moors River. *Libellula fulva* is a Red Data Book species and is currently in the RDB3 (Rare) threat category (Merritt *et al.* 1996).

A more intensive study over a wider timespan is likely to yield additional species which hunt over this area, having bred in nearby ditches, seepages, ponds, streams and rivers.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

A survey of the aquatic invertebrates on three ditches (D12, D13 and D16) at locations upstream and downstream of the Avon Causeway in July 1996 revealed a limited range of taxa (76 in total -see Appendix 1).

Ditches D12 and D13 had a fauna dominated by insect groups with an ability to colonise new water bodies. This, together with the presence of one or two non-insects which can tolerate intermittent water suggests that the ditches may have been dry in the recent past.

Ditches D12 and D13 (site 4 only) were the only locations to support rare taxa with Notable B status. It is of interest that both species were present upstream of the causeway on D12.

In ditch D16, downstream of the causeway, the invertebrate assemblage included elements of a river fauna. The proximity of the R.Avon suggests that winter flooding, migration via ditches connected to the river, or in the case of the insects, oviposition by adults, was responsible for this colonization.

The faunal composition of these ditches would be expected to change with the seasons, and hence the taxon list would be increased by sampling in other seasons, and in particular in autumn and spring. If the ditches are prone to drying/flooding in dry/wet years, then it is probable that there would be greater differences in the fauna between years than would be expected in permanent running waters. Management of the ditches in the form of periodic dredging would also influence the range of habitats and food resources available to the aquatic fauna.

During the survey of adult dragonflies, ten species were recorded over three visits in July and August. Of particular note was the RDB3 dragonfly *Libellula fulva* which is known to breed in both the R.Avon and the Moors River nearby. Dragonflies can move considerable distances from their place of emergence and the use of these ditches as hunting grounds was not unexpected.

5.2 Recommendations

If a comprehensive survey of the aquatic fauna of these ditches is necessary prior to road construction, then further surveys will be required in additional seasons (eg autumn and spring).

An aquatic invertebrate survey on ditches D12 and D16 (both upstream and downstream) on completion of the modifications to the Causeway should provide relevant information on any deleterious impacts of road construction.

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Appendix 1. Full listing of the aquatic invertebrates recorded as a result of pond-net sampling in ditches D12, D13 & D16 on 4th July 1996. Note that water bugs and water beetles identified to genus only were nymphs/larvae. (NB = Nationally Notable B, that is, species currently known to occur in 31-100 10km squares of the National Grid).

TRICLADIDA (Flatworms)

Polycelis nigra group
Dendrocoelum lacteum (Muller)

GASTROPODA (Snails)

Lymnaea sp.
Lymnaea peregra (Muller)
Lymnaea truncatula (Muller)
Anisus leucostoma (Millet)
Gyraulus albus (Muller)
Acroloxus lacustris (L.)

BIVALVIA (Mussels)

Pisidium casertanum (Poli)
Pisidium milium Held
Pisidium nitidum Jenyns
Pisidium personatum Malm
Pisidium subtruncatum Malm

OLIGOCHAETA (Worms)

Oligochaeta

HIRUDINEA (Leeches)

Glossiphonia complanata (L.)
Erpobdella octoculata (L.)

CRUSTACEA (Hog lice, Shrimps etc.)

Cladocera
Ostracoda
Asellus aquaticus (L.)
Asellus meridianus Racovitza
Crangonyx pseudogracilis Bousfield
Gammarus pulex (L.)

EPHEMEROPTERA (Mayflies)

Caenis luctuosa group

ODONATA (Damselies, Dragonflies)

Pyrrhosoma nymphula (Sulzer)

Aeshna cyanea (Muller)

HEMIPTERA (Water bugs)

Hydrometra sp.

Velia sp.

Gerris sp.

Notonecta sp.

Corixidae

Hesperocorixa sahlbergi (Fieber)

Sigara nigrolineata (Fieber)

Sigara semistriata (Fieber)

COLEOPTERA (Water beetles)

Halplus sp.

Halplus heydeni Wehncke

NB

Halplus lineatocollis (Marsham)

Halplus wehncke (Gerhardt)

Hydroporus sp.

Hydroporus incognitus Sharp

Hydroporus palustris (L.)

Hydroporus pubescens (Gyllenhal)

Hydroporus tessellatus Drapiez

Agabus sp.

Agabus bipustulatus (L.)

Agabus melanocornis Zimmermann

Rhantus sp.

Colymbetes fuscus (L.)

Dytiscus sp.

Gyrinus sp.

Hydrophilidae

Helophorus aequalis Thomson

Helophorus brevipalpis Bedel

Helophorus flavipes Fabricius

Hydrobius fuscipes (L.)

Anacaena bipustulata (Marsham)

NB

Anacaena globulus (Paykull)

Ochthebius minimus (Fabricius)

Hydraena riparia Kugelann

Limnebius truncatellus (Thunberg)

MEGALOPTERA (Alderflies)

Sialis lutaria (L.)

TRICHOPTERA (Caddis flies)

Limnephilus lunatus Curtis

DIPTERA (True flies)

Tipulidae

Tipula sp.

Molophilus sp.

Pericoma trivialis group

Anopheles claviger (Meigen)

Anopheles atroparvus group

Ceratopogonidae

Simulium (Simulium) ornatum group

Chironomidae

Stratiomyidae

Tabanidae

Clinocera group

Dolichopodidae

Ephydriidae

Muscidae

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