2000

A SURVEY OF THE AQUATIC MACROINVERTEBRATES OF THE BERRY BROOK

A REPORT TO THE COLSON-STONE PARTNERSHIP

Pond Action

c/o Biological and Molecular Sciences
Oxford Polytechnic
Headington
Oxford OX3 OBP

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SUMMARY

1. THE BERRY BROOK

The Berry Brook rises on the eastern edge of Caversham and flows approximately parallel to the River Thames for 5 kilometres, before joining the Thames at Hallsmead Ait.

It is joined at SU747767 by a similar sized stream, flowing from Sonning Eye Lake. In its lower reaches the Berry Brook is connected to the drainage ditch system of the Thames floodplain.

The flow in the lower section of the Berry Brook is slow and can, occasionally, reverse.

2. METHODS

The stream was divided into five survey lengths of approximately 1km. In each length the physical features of the stream were recorded and duplicate water samples collected for chemical analysis.

Macroinvertebrates were surveyed in each length using standard survey methods to assess: (i) water quality and (ii) the conservation value of the macroinvertebrate community.

Water quality was assessed by calculating BMWP and ASPT scores for each length of the stream. The conservation value of the community in each length was assessed in terms of the occurrence of local or rare species and the relative number of species recorded.

Water quality and conservation value assessments provided the basis for an analysis of the sensitivity of the stream to disturbance and an assessment of the impact of the Caversham development.

3. THE AQUATIC MACROINVERTEBRATE COMMUNITY

A total of 105 macroinvertebrate species were recorded from the Berry Brook, including two local and one very local species (the caddis-fly *Apatania muliebris*).

The number of macroinvertebrate species recorded in each length generally increased downstream. Length 1 supported the fewest species, with the greatest number in Length 5. *Apatania muliebris* was found only in Length 3, where it was associated with a spring flowing into the Berry Brook.

4. WATER QUALITY

BMWP scores suggested that the water quality improved downstream. Scores were highest in Length 5 (where water quality would be classed as 'very good') and lowest in Lengths 1 and 2 (where water quality would be classed 'fair').

5. CONSERVATION VALUES OF THE MACROINVERTEBRATE COMMUNITIES

The conservation value of the macroinvertebrate communities was high in Length 3 (mainly due to the occurrence of A.muliebris) and moderate in Length 5. Lengths 1, 2 and 4 supported communities of low conservation value.

6. SENSITIVITY OF THE MACROINVERTEBRATE COMMUNITIES

The Berry Brook is, potentially, sensitive to the following changes caused by the proposed development:

(i) increased silt loadings.
(ii) increased concentrations of biodegradable organic matter.
(iii) toxic pollutants (including organic micropollutants and heavy metals) and oil.
(iv) changes in the flow regime.

If unmitigated, these could lead to loss of submerged water plants and severe disruption of the aquatic macroinvertebrate community. At particular risk is the very local species Apatania muliebris.

7. IMPACTS OF THE DEVELOPMENT FOLLOWING MITIGATION

The mitigation measures proposed, including the use of artificial wetlands, should minimise the impact of the development on the Berry Brook. However, the effects of the development should be monitored before, during and after construction to ensure that mitigation measures are effective.

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1. AIMS OF THE SURVEY

The aims of the survey were:

(i) To describe the aquatic macroinvertebrate communities of the Berry Brook.

(ii) To obtain physical and chemical data needed for the RIVer Invertebrate Classification And Prediction System (RIVPACS).

(iii) To assess the nature conservation value of the aquatic macroinvertebrate communities of the Berry Brook.

(iv) To assess water quality in the Berry Brook using the results of the macroinvertebrate survey.

(v) To provide baseline data for an assessment of the sensitivity of the aquatic macroinvertebrate communities of the Berry Brook.

(vi) To assess the likely impact of the proposed Redlands development on the aquatic macroinvertebrate communities of the Berry Brook.

2. METHODS

2.1 THE SECTIONS OF THE BROOK SURVEYED

The Berry Brook, below the proposed Redlands development, was divided into 5 sections for this survey. In accordance with Institute of Freshwater Ecology (IFE) survey methodology, most survey work was undertaken in a shorter length of each section (the 'sampling area'). The sampling area, which was either 50m long or 14 times the stream width (whichever was less), was chosen to be representative of the section as a whole.

Additional invertebrate samples were also collected throughout each section.

Grid references of the sampling areas and the boundaries of the larger sections are given in Table 1, together with other environmental information.

2.2 PHYSICAL CHARACTERISTICS

Width and depth of the sampling areas were measured with a tape. Width was recorded as an average of 10 readings, one reading taken every 5m. Average water depth was recorded from 10 transects, with depth measurements taken at 1/4, 1/2 and 3/4 of the stream width.

Composition of the bottom substrate was assessed by eye and classified using the Wentworth scale. Vegetation cover was estimated by eye as an approximate percentage. Where necessary, a hand-net was used to dredge sediment and plants for inspection.

Estimates of discharge capacity were provided by the National Rivers Authority.

Altitude, distance from source and slope were estimated from Ordnance Survey, 1:10,000 scale maps (second series).

A summary of the physical characteristics is provided in Table 1. Estimates of plant cover are given in Appendix 1.

2.3 WATER CHEMISTRY

Duplicate samples of water were taken from the sampling areas in acid-washed polythene bottles. The bottles were thoroughly washed with stream water before samples were taken. Samples were collected at a depth of 15 cm and sealed under water with the exclusion of air. The samples were kept cool and in the dark before their return to the laboratory for analysis.

Alkalinity was determined by titration against standard acid using a mixed indicator solution. Results are quoted in milliequivalents per litre (m.eq/l). One m.eq/l is approximately equal to 50 parts per million of calcium carbonate.

2.4 MACROINVERTEBRATE SURVEY METHODS

Aquatic macroinvertebrates were collected from The Berry Brook by sweep-netting in vegetation, by kick-sampling of stony substrata or by dredging silty substrata using a standard pondnet.

2.4.1 Macroinvertebrate survey to assess water quality

For the calculation of the BMWP and ASPT scores for assessing water quality, the invertebrate survey followed standard IFE methodology. The total sampling time of three minutes was divided such that the amount of time spent sampling in any microhabitat was proportional to the area which that microhabitat occupied within the sampling area. In addition to the three-minute timed sample, a brief period was spent in the sampling area looking for species likely to be undersampled with the area-dependent timed sampling method.

The three-minute timed sample was sorted in the laboratory. A subsample of this was sorted exhaustively in order to give an indication of the relative abundance of the species of macroinvertebrate. The remainder was sorted quickly for extra species.

All species which could not readily be identified were removed and preserved in 70% industrial methylated spirits (IMS) before identification.

2.4.2 Macroinvertebrate survey to assess conservation value

For the production of a more complete species list necessary for the assessment of conservation value, the quickly sorted three minute sample was retained and then sorted exhaustively.

In addition, a longer period was spent in the field searching for extra species. This non-time-dependent sampling was sorted in the field, species being identified on site or returned to the laboratory in IMS.

The aquatic macroinvertebrate groups recorded are listed in Table 2 A list of the keys and guides used in identification of macroinvertebrates is given in Section 10.

2.5 PREDICTION OF THE MACROINVERTEBRATE FAUNA

Environmental data was gathered for the IFE RIVPACS (River Invertebrate Prediction and Classification System) computer programmes. This system predicts the fauna that would be expected in a stream, assuming that it was unpolluted. By comparing the predicted fauna (ie the fauna that would be present stream if the stream was unpolluted) with the fauna recorded, it is possible make an objective assessment of the extent to which stream is affected by pollution. The environmental parameters listed in Table 1 were run through RIVPACS by IFE staff.

The programme predicts species likely to be present and calculates a predicted BMWP and ASPT score for the survey area.

2.6 WATER QUALITY

The macroinvertebrates recorded in the time-limited samples and the brief extra searches within the sampling areas were used to calculate the Biological Monitoring Working Party (BMWP) score and Average Score Per Taxon (ASPT) for each section.

The BMWP scoring system awards points to different families of macroinvertebrates which broadly reflect their tolerance of organic pollution and oxygen stress. Families which are intolerant of organic pollution and oxygen stress (usually families found in fast flowing rivers) score 10 points. Families which are more tolerant of organic pollution and oxygen stress score less points, down to 1 point.

The BMWP score is the total of the scores of all the families in a sample. The higher the score, the less likely it is that the stream is polluted.

Flow rate and size of stream can bias BMWP score (for example large streams often have higher BMWP scores because they can support more families). The ASPT is used to check the BMWP since it is generally less sensitive to these biases. The ASPT is the BMWP score divided by the number of families which have made up the BMWP score. The ASPT is particularly useful when comparing streams of different sizes.

A BMWP score sheet for the Berry Brook, together with the range of expected scores for streams and rivers of differing water quality, is shown in Table 6.

2.7 ASSESSMENT OF THE CONSERVATION VALUE OF THE MACROINVERTEBRATE COMMUNITIES IN THE STREAM

The conservation value of the aquatic macroinvertebrate communities was assessed using the criteria described in Table 2 (see page 7).

For comparisons of species-richness, only the results of the time-limited samples are considered. The assessment based on the occurrence of rare and local species uses data from time-limited samples and additional searches throughout each length.

Note: In this report the assessment of the conservation value of the macroinvertebrate communities has been made using data from a single season. Collecting in two or three different seasons of the year (ie spring, summer and autumn) usually results in the recording of 30-50% more species than are found in a single season. It is possible that, amongst these new species, further uncommon species could be recorded.

TABLE 1. ENVIRONMENTAL PARAMETERS OF FIVE SECTIONS OF THE BERRY BROOK: 13/3/91

SECTION		1	2	3	4	5
GRID REF (top of section)	SU	737745	743761	747767	753771	761772
GRID REF (bottom of section)	SU	743761	747767	753771	761772	766775
GRID REF (sampling area)	SU	741758	746767	753771	756771	765774
LONGITUDE		51.475	51.483	51.486	51.487	51.492
LATITUDE		-0.934	-0.927	-0.919	-0.912	-0.899
ALKALINITY (m.eq/l)		4.9	5.5	5.6	5.7	5.1
DISCHARGE		1	1	1	1	1
SUBSTRATUM (%)						
Silt		99	100	99	100	100
Sand		0	0	0	0	0
Gravel and pebbles		1	0	1	0	0
WIDTH (m)		1.8	2.7	5.5	4.8	4.8
DEPTH (cm)		30	29	100	73	90
ALTITUDE (m)		35	35	35	34	34
DISTANCE FROM SOURCE (km)		2.1	3.1	3.8	4.4	5.3
SLOPE (m/km) (approx)		0.2	0.2	0.2	0.2	0.2

TABLE 2. GROUPS OF MACROINVERTEBRATES SURVEYED FOR IN THE BERRY BROOK

GROUPS IDENTIFIED TO SPECIES LEVEL

Tricladida	(Flatworms)
Hirudinea	(Leeches)
Gastropoda	(Snails and limpets)
Bivalvia (excluding Pisidium spp.)	(Bivalves)
Malacostraca	(Shrimps and slaters)
Ephemeroptera	(Mayflies)
Odonata	(Dragonflies and damselflies)
Heteroptera	(Water bugs)
Plecoptera	(Stoneflies)
Megaloptera	(Alderflies)
Trichoptera	(Caddis-flies)
***Coleoptera**	(Water beetles)

*Adults from the following families of Coleoptera were recorded: Gyrinidae, Haliplidae, Dytiscidae, Elmidae, Hydraenidae, Hydrophilidae, Noteridae.

TABLE 2. SYSTEM USED FOR ASSESSING THE NATURE CONSERVATION VALUE OF AQUATIC MACROINVERTEBRATE COMMUNITIES

CONSERVATION VALUE	DESCRIPTION OF COMMUNITY
VERY HIGH	Supporting a rich community of macroinvertebrate species, including very local species and/or rare (ie Red Data Book) species. Note that some sites with rare species may be relatively species-poor. Sites in this category are likely either to be Sites of Special Scientific Interest in their own right, or within larger SSSI's.
HIGH	Supporting a rich community of common macroinvertebrate species. A number of local species present. No rare or very local species. Could include sites on SSSI's or sites of local nature conservation value.
MODERATE/LOW	Supporting at most, a few local species.

Within the two higher categories individal sites can be ranked on the basis of numbers of rare and uncommon species, provided that a constant amount of effort in sampling has been made.

3. THE AQUATIC MACROINVERTEBRATE COMMUNITIES OF THE STREAM

3.1 SPECIES-RICHNESS AND COMPOSITION OF THE FAUNA

Lists of the species recorded from all five sections of the Berry Brook are given in Appendix 2.

A summary of numbers of species in major groups recorded during this survey is given in Table 5.

105 species of macroinvertebrate were recorded, representing approximately 15% of the British fauna (in the groups identified to species level). Snails were well represented in the fauna with 17 species, most of these being present in section 5. There was a good, though not exceptional, number of species of beetle (31) (at an exceptional lowland site for water beetles 50 species might be expected).

The sections supported between 26 (section 1) and 62 (section 5) species. The number of species recorded from the sampling areas (see Section 2.1) varied from 20 (sample area 1) to 52 (sample area 5). In general, the species-richness increased with distance downstream. This was most noticeable when the records from the sampling areas were compared.

The number of species recorded from the whole of each section was more variable. This was largely because the extra search allowed small, but distinctive, areas of habitat to be sampled which supported species (especially water beetles) that were very patchily distributed in the stream. For example, one small area in section 2 yielded 5 species of beetle and 5 species of bug which were not recorded in the rest of the section.

The macroinvertebrate communities of all but the third section were dominated numerically by snail and crustacean species. Section 1 was dominated by the wandering snail *Lymnaea peregra*, which may reflect a lack of permanence of water in this section. Section 2 was dominated by a water slater (*Asellus aquaticus*), reflecting the large amount of leaf litter in this section, Section 3 was dominated by the freshwater shrimp *Gammarus pulex*, a species known to be quite sensitive to organic pollution. This probably reflected the influence of chalk springs in this section of the stream. Sections 4 and 5 were dominated by a valve snail (*Valvata piscinalis*).

3.2 LOCAL SPECIES

3 local species were recorded from the Berry Brook. Of these, one species, the caddis-fly *Apatania muliebris* is of particular note. This is a very local species associated with small streams which is always found near springs on stony substrata (Wallace et al 1990). The area of the Berry Brook where this species was found, close to the point where a spring flowed into the brook, on gravels in section 3, fits well with the description of the typical habitat of the species.

The other two local species, Lister's river snail (Viviparus contectus) and Leach's bithynia (Bithynia leachi), were recorded only from section 5.

3.3 WATER QUALITY

Lists of families which are part of the BMWP scoring system and which were recorded in each sampling area are given in Table 6.

The results show a steady increase in BMWP score with distance downstream, ranging from 70 in sampling area 1 to 163 in sampling area 5. This may be due either to an improvement in water quality or the increase in size of the stream (and hence an increase in the number of families recorded).

However, the ASPT values, which should not be greatly affected by the size of the stream, also increased with distance downstream. The ASPT rose from 4.11 in sampling area 1 to 5.08 in sampling area 4. The largest change in ASPT was betwen sections 2 and 3, This may have reflected the influence of the chalk springs, flowing into section 3, on the water quality (and also the influence of the stream from Sonning Eye Lake).

The BMWP and ASPT scores for the stream show that the water quality in section 5 was 'very good', in sections 3 and 4 'good' and in sections 1 and 2, 'fair'.

3.4 PREDICTION OF THE MACROINVERTEBRATE FAUNA

The environmental features of the Berry Brook were unlike those of any other stream in the IFE RIVPACS data-base (J.Wright, pers. comm). Because of this the RIVPACS computer programmes could not be used to predict the species expected in the Berry Brook.

This reflected the fact that the IFE database did not contain unpolluted reference sites with physical features similar to the Berry Brook.

4. CONSERVATION VALUE OF THE MACROINVERTEBRATE COMMUNITTIES OF THE BERRY BROOK

Because sites on the Berry Brook could not be classified using the RIVPACS system it was not possible to compare the number of species found in the each section of the Berry Brook with national averages. For this reason the conservation asessment was based on:

(a) internal comparison of the numbers of species in the five sections.
(b) the occurrence of rare and local species in each section.

This system is summarised in Table 4 but note that value in terms of numbers of species is based on comparison of the five sections of the Berry Brook only.

Section 1

Section 1 had a relatively low number of species and no local species. The nature conservation value of the macroinvertebate community in this section is therefore low.

Section 2

The representatve sampling area of section 2 had a relatively low number of species and no local species. The nature conservation value of most of this section is therefore low.

Section 3

The section had a relatively low number of species and one very local species, the caddis-fly Apatania muliebris (family: Limnephilidae). Although only one very local species was recorded, this species is sufficiently uncommon to warrant the designation of this section of stream as of high conservation value.

Apatania muliebris appears to have very specific habitat requirements, being found only in small streams close to their spring source, on gravels. This habitat occupies a very small area in section 3, the rest of the section being very silty.

Section 4

The section had an intermediate number of species (compared to the other sections of the Berry Brook) and no local species. The community in this section should be regarded as being of low to moderate nature conservation value.

Section 5

This section had the greatest number of species of the five sections and two locally common species, Lister's river snail (Viviparus contectus) and Leach's bithynia (Bithynia leachi). The macroinvertebrate community is, therefore, of moderate value to nature conservation.

These nature conservation assessments are summarised in Table 7.

TABLE 5. **NUMBERS OF AQUATIC MACROINVERTEBRATE SPECIES IN MAJOR GROUPS RECORDED FROM THE BERRY BROOK**

a number of species from whole section
b number of species from sample area (3 minute sample and brief search)

SECTION	1		2		3		4		5	
	a	b	a	b	a	b	a	b	a	b
GROUP										
TRICLADIDA	0	0	0	0	4	3	0	0	0	0
HIRUDINEA	3	2	3	3	2	2	1	1	3	3
GASTROPODA	10	8	6	5	8	7	11	11	16	16
BIVALVIA	0	0	0	0	1	1	0	0	2	2
MALACOSTRACA	2	2	4	4	4	4	3	3	3	3
EPHEMEROPTERA	0	0	1	1	1	0	2	2	2	2
PLECOPTERA	0	0	0	0	1	0	0	0	0	0
ODONATA	2	1	2	1	2	1	3	3	3	3
MEGALOPTERA	1	1	1	1	1	1	1	1	1	1
HETEROPTERA	2	2	9	4	4	2	4	4	6	4
TRICHOPTERA	0	0	2	1	6	3	8	7	6	6
COLEOPTERA	6	4	21	14	5	8	16	14	20	12
TOTAL SPECIES	**26**	**20**	**49**	**33**	**39**	**32**	**49**	**46**	**62**	**52**

TABLE 6. BMWP SCORING FAMILIES RECORDED FROM THE BERRY BROOK

SECTION	1	2	3	4	5
FAMILY					
10 points					
Ephemeridae	-	-	-	+	+
Lepidostomatidae	-	-	+	-	-
Leptoceridae	-	-	-	+	+
Molannidae	-	-	-	+	-
8 points					
Aeshnidae	+	-	-	-	-
7 points					
Limnephilidae	-	+	+	+	+
Polycentropodidae	-	-	+	-	+
6 points					
Ancylidae	-	-	+	+	+
Coenagrionidae	-	+	+	+	+
Gammaridae	+	+	+	+	+
Hydroptilidae	-	-	-	+	+
Unionidae	-	-	-	-	+
Viviparidae	-	-	-	-	+
5 points					
Corixidae	-	+	-	+	+
Dendrocoelidae	-	-	+	-	-
Dytiscidae	+	+	+	+	+
Elmidae	-	-	+	-	+
Gerridae	-	+	-	-	+
Gyrinidae	-	-	-	-	+
Haliplidae	+	-	+	+	+
Helodidae	-	+	+	-	-
Hydrometridae	+	-	+	-	+
Hydrophilidae	+	+	-	+	+
Ilyocoridae	-	-	-	-	+

TABLE 6. BMWP SCORING FAMILIES RECORDED FROM THE BERRY BROOK (CONTINUED)

SECTION	1	2	3	4	5
FAMILY					
5 Points (continued)					
Nepidae	-	+	-	-	-
Notonectidae	-	+	+	+	-
Planariidae	-	-	+	-	-
Pleidae	-	-	-	-	+
Tipulidae	+	+	+	+	+
Veliidae	+	-	-	-	-
4 points					
Baetidae	-	+	-	+	+
Piscicolidae	-	-	+	-	-
Sialidae	+	+	+	+	+
3 points					
Asellidae	+	+	+	+	+
Erpobdellidae	+	+	+	+	+
Glossiphoniidae	+	+	-	-	+
Hydrobiidae	+	+	+	+	+
Lymnaeidae	+	-	+	+	+
Physidae	-	+	+	+	+
Planorbidae	+	+	+	+	+
Sphaeriidae	-	-	+	-	+
Valvatidae	+	+	-	+	+
2 points					
Chironomidae	-	+	+	+	+
1 point					
Oligochaeta (whole class)	+	+	+	-	+
BMWP SCORE	70	92	119	122	163
NO. OF SCORING FAMILIES	17	22	26	24	33
ASPT	4.11	4.18	4.58	5.08	4.93

Approximate estimates of water quality associated with BMWP values

Score	**Water quality**		
0 - 15	Very poor	101 - 150	Good
16 - 50	Poor	151 +	Very good
51 - 100	Fair		

TABLE 7. **SUMMARY OF THE ASSESSMENTS OF NATURE CONSERVATION VALUE OF THE MACROINVERTEBRATE COMMUNITIES OF THE BERRY BROOK**

	SECTION 1	2	3	4	5	
FEATURE						
SPECIES RICHNESS		Low	Low	Low	Average	Above average
NUMBER OF LOCAL SPECIES		0	0	0	0	2
NUMBER OF VERY LOCAL SPECIES	0	0	1	0	0	
WATER QUALITY		Fair	Fair	Good	Good	Very good
VALUE OF COMMUNITY		Low	Low	High	Low	Moderate

5. THE SENSITIVITY OF THE MACROINVERTEBRATE COMMUNITIES OF THE BERRY BROOK

The Berry Brook is, potentially, sensitive to change caused by four factors:

1) increased silt loadings.

2) increased biodegradable organic matter.

3) toxic pollutants (including organic micropollutants and heavy metals) and oil.

4) changes in the flow regime.

5.1 SILT

Silting of stream beds can lead to the loss of submerged macrophytes. This is due to blanketing of the plants present and production of a substratum which is not suitable for the rooting of submerged species.

The Berry Brook, for most of its length, has a deep layer of silt. The submerged macrophytes which predominate in the stream are therefore those which are tolerant of such a substratum. It is unlikely, therefore, that silt accumulation per se will affect the brook.

Despite this, blanketing of the submerged flora, by large inputs of silt, especially during the construction phase, could have a deleterious effect on the brook. The small areas of gravel in Section 3 of the Brook, which supports the local species Apatania muliebris, could be especially at risk during summer when the cleansing flow from springs might be low.

Long term inputs of small amounts of silt might also increase the turbidity of the water to the detriment of submerged macrophytes.

The presence of silt also affects the dynamics of toxic pollutants (see 5.3).

5.2 BIODEGRADABLE ORGANIC MATTER

Biodegradable organic matter, either soluble or insoluble, causes deoxygenation of streams and the loss of the more sensitive macroinvertebrates. The lower sections of the Berry Brook would be most at risk from an increase in biodegradable organic matter as they support several species which are sensitive to low oxygen tension.

The ability of streams to clean themselves (which is the cause of the de-oxygenation) will mean that the lower sections of the brook are less likely to receive as great a loading of biodegradable organics as do the upper sections. However, urban run-off can have very high oxygen demand and so the threat to the lower sections should not be underestimated.

5.3 TOXIC POLLUTANTS AND OIL

Many toxic pollutants could enter the stream. As with most other pollutants mentioned here, the effects on the upper sections will be more immediate than those on the lower sections.

Many toxic pollutants, including heavy metals and organic micropollutants, become entrained in silt and accumulate there. Some organic pollutants (eg PCB's) are hydrophobic and have a mild chemical affinity for silts and are particularly likely to accumulate. The silty nature of the Brook is, therefore, potentially, likely to exacerbate the effects of many pollutants.

5.4 CHANGES IN FLOW REGIME

Changes in flow regime, either due to construction operations or run-off from hard surfaces during the operation phase, may be likely to wash away the loosely rooted submerged macrophytes. This scour, whilst being natural, to some extent, in the winter months, might be deleterious if it occurs during the main growth periods of spring, summer and autumn.

High flows could also increase the amount of erosion on the banks, removing vegetation that provides a valuable invertebrate habitat. It is possible that the physical force of the water after a flood event could wash away the gravel habitat of *Apatania muliebris*.

6. DESCRIPTION OF THE DEVELOPMENT PROPOSALS WITH THE POTENTIAL TO AFFECT THE BERRY BROOK

6.1 INTRODUCTION

This section describes the main aspects of the proposed Caversham development which are likely to have an impact on the Berry Brook. Areas where mitigation measures are likely to be needed are noted.

6.1.1 The physical proposals

The proposed business park will be built on the north of the site covering an area of approximately 20.2ha (50 acres).

Two 'feature' lakes will be created in the centre of the business park. The creation of one of these will involve the impoundment and excavation of a section of the existing channel of the Berry Brook.

The eastern margin of the site will be modified by the construction of the third Thames crossing and a road linking this bridge to the development site and the A4155. Services associated with the development site may also affect the lakes and the Berry Brook but the routes of these are currently unknown.

6.1.2 The construction phase and operation post completion

During construction of the business park, road, Thames bridge and flood bund, there are considerable risks of damage to the freshwater environment from nutrient release and surface run-off. The Berry Brook is vulnerable to impacts during the construction phase.

Following construction, the development area and the road will create sources of pollutants in the form of urban run-off and other wastes which may affect the Berry Brook.

6.2 THE PHYSICAL PROPOSALS

6.2.1 Impoundment of the Berry Brook in the development area

The current plans for the development area involve impoundment of parts of the Berry Brook to form one of the 'feature' lakes. Full information about this is not yet available. It will be necessary to know whether the 'feature' lakes will impinge upon the gravel aquifer and how flow regimes in the Brook will be affected.

Further information required.

Potential effects of the impoundment and widening include:

(i) **Habitat destruction in the area to be impounded** (and also in upstream areas which may be eroded in consequence; Linder, 1976). A preliminary survey suggests that the invertebrate community in this area is already damaged and that the proposed modifications would involve little loss of existing invertebrate conservation interest.

(ii) **Permanent changes to the flow regime of the Berry Brook:**

(a) Within the impounded areas there would be little loss of species diversity, since the present fauna is already adapted to ponded flow conditions (Pond Action, 'The Caversham lakes Study - Aquatic Habitats', November 1990). If the water in the feature lakes is permanent and relatively unpolluted, and if the lakes are designed sympathetically, the aquatic macroinvertebate fauna of the area has the potential to improve.

Possible beneficial effects

(b) It is not clear how much water flows out of the area of the site to be impounded at various times of the year. In the summer and autumn of 1990 (a very dry year) there was very little water flowing in this section of the Berry Brook. The impoundment of the Berry Brook has the potential to stabilise flows within the Brook if the lakes are designed correctly and to mitigate the effects of increased volume and velocity of surface run-off.

Possible beneficial effects

(iii) **Feature Lakes function as sediment traps.** The Feature Lakes will act as sediment traps, retaining suspended and entrained sediments in the stream. With this sediment will be retained pollutants (particularly organics, nutrients, heavy metals), coming from the development site and possibly from Caversham (see mitigation section).

This may have some beneficial effects on downstream water quality.

6.3 EFFECTS OF THE CONSTRUCTION PHASE

This section describes the likely impacts of disturbance associated with construction in the development area.

Impacts from construction work may occur at any time during the 10 year construction phase. The magnitude of some pollutant inputs during this phase may be much greater than in the operation phase. At Caversham the main impacts during construction are likely to result from discharges of nutrients, sediment and pumped water during the construction of buildings, car parks, roads and the Thames bridge.

6.3.1 Nutrient release from disturbance of grasslands

Construction work in the main development area will involve the disturbance of grazed grasslands on Lowfield farm. Road construction is also likely to result in disturbance of other grassland areas.

Disturbance of established grassland soils is known to release considerable quantities of nutrients, particularly nitrogen. The effects of these releases can persist over several years. The amount of nitrogen that would be mineralised cannot be precisely predicted but is likely to be in the range of 50-200kg/ha per annum (DOE 1986). Nitrogen from this source entering the Brook is a potential pollutant.

Current research on the effects of nitrates does not provide any conclusive evidence that nitrogen enrichment significantly disturbs lowland hardwater streams. The Berry Brook, however, is extremely slow-flowing for much of its length and may be disturbed in much the same way as still water sites can be. The road construction is likely to cause the most significant disturbance to grasslands which will affect the Berry Brook.

Mitigation measures may be required

6.3.2 Sediment inputs from areas disturbed by construction works

Construction sites are known to result in the export of very large amounts of sediment in surface run-off. Operations such as urbanisation and road building can result in at least 100-fold increases in suspended sediment inputs into adjacent waterbodies. At Caversham, sediment inputs are likely to occur not only during building construction but also during other phases of the scheme (e.g. creation of the Feature Lakes). Most (up to 90%) of this sediment is likely to be transported during storm events ie during about 10% of the time.

Potential effects of sediment inputs into streams include:

(i) **An increase in pollutant levels.** Sediments can be a major pollutant carrier and most heavy metals, organic pollutants, nutrients (particularly phosphorus) and biodegradable organic matter (responsible for the consumption of dissolved oxygen) are found in or on sediment particles.

(ii) **Blocking-up of coarse substrates.** This is only likely to affect the habitat of A.muliebris.

(iii) **Increase in water turbidity.** Where this is a short term effect there is little evidence that increased turbidity would, in itself, have a significant impact on aquatic communities. Longer term inputs of silt may have a more serious affect.

(iv) **Modification of substrates.** Most of the Berry Brook is heavily silted at present. The production of an unstable substratum is unlikely to greatly affect the Berry Brook (except as mentioned in 6.3.2.(ii)).

Construction in the development area could result in large inputs of suspended sediment to the Berry Brook (suspended sediment levels of up to 50g/l have been measured in streams draining from construction sites: Milliman and Meade 1983). Pollution from the oxidation of organics in this sediment could result in high oxygen stress and potentially detrimental effects on invertebrate and fish populations. Other detrimental effects could result from inputs of building site pollutants (as above).

The very local species Apatania muliebris requires a silt-free substratum as its habitat. Though this habitat will be maintained, to some extent, by the chalk spring clearing the silt from the gravels, it may not survive heavy silt inputs, especially during the summer months when the spring will be flowing least.

The ability of silts to carry toxic pollutants and biodegradable materials could seriously damage the more valuable communities of the lower sections of the stream.

Mitigation measures are required.

6.3.3 Non-silt pollutants derived from development area during construction phase

Spilt oils, petrol or other chemicals/products used in construction of urban areas can have an immediately detrimental effect on aquatic organisms if washed into water courses.

Mitigation measures are recommended for the construction period.

6.3.4 Pumped water from the development area

Water will be pumped from the development area while foundations are being excavated. The amount cannot yet be predicted with any certainty but **might** be in the order of 100 l/s (Ben Mitchell, personal communication, January 7 1991). Potential impacts of this are:

(i) Periodic increases in the volume and velocity of the stream with potentially damaging affects on stream ecology.

(ii) A slight/moderate increase in inert silt inputs as a result of pumping out groundwater and disturbance of the stream bed.

This rate of pumping is less than the run-off from 20 ha. of urban surface during a heavy storm.

Mitigation designed to handle rum-off should be im place to handle this pumping

6.4 OPERATION POST-COMPLETION

Detrimental impacts, during normal site operation, will come, mainly, from the urban areas, especially the business park and the roads. The main problems will be related to the amount and quality of urban water run-off.

6.4.1 The impact of urbanization on quantities of surface run-off

Urbanisation of the site will result in an increase in the area of impermeable surfaces which is likely to cause:

(i) An increase in the amount of surface run-off from the site (see Section 6.4.2 below).

(ii) An increase in the rate and velocity of runoff from the site, with very rapid run-off after storms and less water available over longer periods from lateral seepage (see Section 4.4.2).

6.4.2 The impact of increased surface run-off on the Berry Brook

There is currently no information available on predicted changes to the flow regime of the Berry Brook following development of the business park. However, the stream is small and therefore potentially very sensitive to changing water regimes and associated secondary effects. Urbanisation-induced changes in stream flow regimes have been shown to include coarsening of stream bed substrate, changes in stream width, erosion and scour (eg Cherkauer 1975, Robinson 1976).

Consequently, the business park could have a relatively large impact on the physical environment of the Berry Brook, suggesting that there is considerable potential for damage to the stream's plant and animal communities.

A heavy fall of rain on a large area of hard surface has the potential to increase the flow of the Berry Brook considerably. The increase in flow of the Berry Brook, which will depend on the proportion of water which it receives from the site, the proportion of hard surfaces on the site and the 'balancing' effects of any mitigation need to be estimated. The present increase in flow of the Berry Brook after heavy rain also needs to be estimated.

Of the local species of macroinvertebrate present in the Berry Brook, the two snails *Viviparus contectus* and *Bithynia leachi*, are able to withstand considerable water flow variations, provided that the aquatic vegetation is not scoured. The effects of higher flows on the caddis *Apatania muliebris* are more difficult to predict. As its habitat is near springs it can presumably withstand reasonable flow rates. The main danger will be the possible washing away of its gravel habitat.

It appears that the main aquatic plants which form habitat for invertebrates are *Callitriche* sp. and *Elodea* sp., which can withstand much greater flows than that seen in the Brook at the present time. Marginal plants are less sensitive to scour. However, as most of the marginal plants in the Berry Brook are rooted on relatively loose silt, they might be susceptible to exceptional increases in flow. In order, properly, to assess the amount of vegetation scour, especially after heavy rain during the summer months, more information is needed on the likely increase in flows.

Further information is needed about the macrophytes of the Berry Brook downstream of the Caversham site and about the likely increase in flow rate after heavy rain. Mitigation measures are likely to be necessary.

6.4.3 The impact of urbanization on the quality of surface run-off

(i) Introduction

Many studies have shown that a considerable fraction of urban-related water pollution is attributable simply to storm run-off carrying sediment and pollutants washed from hard surfaces and adjoining areas.

Such pollutants include: nutrients (a considerable proportion of which come from the decay of the urban structure itself); organic and nutrient materials from litter; petroleum products; heavy metals (particularly lead, zinc, copper); grit and suspended sediment from roads and car parking areas; chloride from winter road-salting operations; biocides from the management of amenity areas; organic matter from plant debris and animal (eg dog) faeces.

The rapid run-off from hard urban surfaces means that these substances are directed, largely unaltered, into receiving waters. Most are carried off in the first flush of storm water, which is additionally polluting since it displaces the anaerobic wastewater, rich in bacteria, that has been standing in the gully pots of the roadside drains since the last storm.

Studies have shown that the polluting qualities of urban storm run-off are similar to, and sometimes worse than, domestic sewage (Lang and Armour, 1980).

(ii) Surface water quality impacts associated with the Caversham site

Quantitative information on pollutants likely to be entering waterbodies adjacent to the site is not available. Nor is there any detailed baseline survey information for the Berry Brook. In the absence of this information, the results of other studies (eg the USA's nationwide run-off programme) have been used to predict the likely degree of impact of surface water run-off pollutants on the lakes, Berry Brook and groundwater.

6.4.4 The impact of surface water run-off on the Berry Brook

The oxygen demand of urban run-off is frequently at a level similar to that of secondary treatment plant discharges. The Berry Brook has, in general, good water quality (Section 3.3) and so heavy inputs of biodegradable organic matter would be deleterious.

Mitigation in the form of urban run-off controls and/or advanced waste treatment will be necessary.

American work has noted that streams and rivers polluted by urban run-off frequently contained heavy metal levels in excess of criteria recommended for aquatic life (Athayde et al 1983). However proportionally few effects obviously deleterious to freshwater organisms were noted. The ability of the silt in the Berry Brook to retain many of the pollutants draining from urban surfaces could exacerbate the effects of the run-off. Aquatic plant species are more greatly affected by pollutants in sediment than in the water. This could reduce or modify the habitat available to invertebrates. More recent work has shown many secondary effects of heavy metal toxicity on aquatic species (eg effects on community structure by increases in selective predation etc.)

Mitigation measures are necessary

7. MITIGATION

This section outlines the mitigation measures which have been proposed in order to avoid, reduce or remedy any of the identified environmental effects. The order follows that of the previous section i.e. the construction phase and operation post-completion (there are no physical proposals of relevance to the Berry Brook).

7.1 CONSTRUCTION PHASE

7.1.1 Increase in sediment loads to the Berry Brook

Mitigation: settling tanks/sediment lagoons are to be used 'as necessary' to reduce silt load to the Berry Brook. The NRA are to advise upon the standards to be applied. 'Polishing' of the effluent by running over grass may also be advised.

Reed beds, or some other form of artificial wetland, will be constructed and managed. **These biological control measures should be in place before construction on the site commences.**

7.1.2 Environmental monitoring and contingency fund

During the construction phase, the quality of water in the Berry Brook, and the status of local macroinvertebrates in the Brook should be monitored. This will allow action to be taken should any problems arise.

7.2 OPERATION POST-CONSTRUCTION

7.2.1 Increase in the volume and velocity of storm run-off to the stream

Mitigation: it is proposed that storm runoff will be directed into balancing ponds where the velocity will be attenuated. This may also result in some modification to total run-off volumes.

7.2.2 Potential pollution of the stream as a result of urban surface water run-off

Mitigation: Storm retention/siltation in balancing ponds and reed beds.

7.2.3 Road run-off

Mitigation: surface drainage from the link road will pass through gullies before discharge, via reed beds/artificial wetlands, to the nearest water body.

7.2.4 Environmental monitoring and contingency fund

During operation, the quality of water in the Berry Brook, and the status of local macroinvertebrates in the Brook will be monitored. This will allow action to be taken, using monies from the contingency fund, should any problems arise.

7.3 CONSERVATION ENHANCEMENT

The creation of reed beds/artificial wetlands would lead to an enhancement of the nature conservation interest of the site.

The provision of funds to manage the site would allow the further development of the conservation interest of the reed beds/artificial wetlands.

It would also be possible to use the artificial wetlands as a demonstration project on the use of simple alternative technology for water quality enhancement.

8. THE PREDICTED EFFECTS OF THE PROPOSED DEVELOPMENT FOLLOWING MITIGATION MEASURES

This section outlines the significant effects which are likely to result after mitigation measures have been implemented. The actual effects, before, during and after completion, will be monitored to assess the success of the mitigation measures. The section is arranged in the same order as previous chapters.

8.1 THE PHYSICAL PROPOSALS

8.1.1 Impoundment of parts of the Berry Brook in the development area

The Berry Brook as it flows across the proposed development site is of low value to nature conservation ('The Caversham Lakes Study: Aquatic Habitats', A report for the Colson-Stone Patnership, Section 5.2., Pond Action, November 1990).

The creation of the Feature Lakes, if design is sympathetic to conservation, would create larger bodies of water which could support all the species which are at present in the Berry Brook in this area of the site.

The Feature Lakes will act as silt traps before the water from run-off reaches the Berry Brook. If managed correctly, they can also act as balancing ponds to stabilise the flow of the Brook. The Feature Lakes could be regarded as a mitigation measure.

8.2 EFFECTS OF THE CONSTRUCTION PHASE

8.2.1 Sediment inputs from all areas of disturbance

The provision of siltation lagoons/sedimentation tanks to NRA specifications is likely to considerably reduce the inputs of inert and contaminated sediments to the lakes and stream. The construction of an artificial wetland should remove the majority of the remaining oranics and inert and contaminated sediments.

The construction of the wetland itself will, inevitably, lead to an increased suspended solids load entering the stream. This work should be supervised on site by a trained ecologist. The net benefit of the wetland construction, however, outweighs the problems involved.

The stream has areas of moderate to high value and will be monitored during the construction phase in order to detect and mitigate against possible damage to stream communities. A contingency fund will be set aside for any extra works needed to mitigate perceived detrimental effects.

8.2.2 Oils and other chemical pollutants from the development area

Standard mitigation measures will intercept a proportion of such substances, but are unlikely to eliminate them completely from run-off to the Berry Brook. The additional construction of an artificial wetland should minimise these problems.

8.3 OPERATION POST COMPLETION

8.3.1 The impact of urbanization on the amount of surface run-off

It is not yet possible to predict whether changes in the amount of urban run-off are likely to have a significant impact on communities in the Berry Brook. More information is required about the hydrology of the Berry Brook and likely flow regimes in the stream following mitigation before the impacts after mitigation can be described.

It seems likely that a small incrase in flow will not be detrimental to the macroinvertebrate communties of the Brook. Sudden high discharges, however, could be detrimental.

8.3.2 The impact of urbanization on the quality of surface run-off

(i) Surface run-off from the development area

If urban surface run-off passes through well-maintained oil filters and the 'feature' lakes, run-off quality is likely to be significantly improved before reaching the artificial wetlands. Passage through the wetlands should protect the water quality in the Berry Brook.

(ii) Road run-off

If standard mitigation measures are applied there will be small but persistent impacts due to oil and other pollutants on the receiving water. The construction of artificial wetlands should reduce the effects of road run-off to insignificant levels.

9. DEGREE OF CHANGE

9.1 ENHANCEMENTS (BENEFICIAL CHANGE)

In this section the main enhancements of the site for wetland plants and invertebrates (beneficial changes) are reviewed.

9.1.1 Managing the run-off from Caversham

Impoundment of the Brook within the Feature Lakes will help to increase the retention of silts and pollutants which presently flow from Caversham.

9.1.2 Impoundment of the Berry Brook

The Features Lakes have the potential to support communities of moderate to high value on the development site. At present the value of the Berry Brook to conservation in this area is low.

9.1.3 Development and demonstration of artificial wetlands

Mitigation, in the form of artificial wetlands, could be run by the Conservation Centre as a research and educational exercise.

9.2 MITIGATED IMPACTS (NO CHANGE)

This section is not relevant to this report.

9.3 NEUTRAL OR DETRIMENTAL CHANGE

In this section the main neutral or detrimental changes on the site are reviewed.

9.3.1 Surface water and road run-off management

When all mitigation measures are fully implemented (including the planting of reed beds or some alternative wetland treatment), and as they will be in place before development starts, it is unlikely that significant negative impacts on the Berry Brook will occur as a result of surface run-off during the construction and operation phases. However, full implementation requires that **suggested additional measures** are implemented **before** construction begins. Without these it is possible that some detrimental impacts will occur.

However, small streams are especially vulnerable to, and commonly damaged by, pollution and changes in water regime downstream of urban areas. **It is advised that the hydrology of the Brook is investigated more thoroughly.**

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APPENDICES

APPENDIX 1. DETAILED SECTION DESCRIPTIONS

1.1 SECTION 1 (SU737745 - SU743761)

1.1.1 General description

The sampling area of section 1 was 1.8m wide with an average depth of 30cm on ca. 20cm of substrate. The substratum was composed of soft silt, covered in places with organic debris, and a small amount of gravel. There was a 50% cover of mixed stands containing *Carex* sp., *Apium nodiflorum*, *Phragmites australis*, *Epilobium hirsutum* and *Sparganium erectum*. Shading was heavy on both banks and the flow was imperceptible.

Upstream from the sampling area there was much less vegetation cover and downstream the vegetation cover was much greater. Other features of the section resembled those of the sampling area.

1.1.2 Macroinvertebrates

20 macroinvertebrates were recorded from the sampling area and a further 6 from extra searches of the rest of the section. No local species were recorded.

The fauna was dominated numerically by the wandering snail *Lymnaea peregra*. This is an adventitious species and its dominance suggests that the fauna of this section may be disturbed in some way, perhaps by ponded flow conditions.

10 species of snail were recorded from this section, accounting for approximately 40% of the fauna.

The BMWP score (70) and the ASPT value (4.11) indicate that the water quality is fair. The highest scoring family in the section is Aeshnidae (8 points). The species here (*Aeshna cyanea*, the southern hawker) is characteristic of slow flowing streams and small ponds.

With 26 species and no local species the value to conservation of the macroinvertebrate community of this section is low.

1.2 SECTION 2 (SU74376 - SU747767)

1.2.1 General description

The sampling area of section 2 was 2.7m wide with an average depth of 29cm on ca. 30cm of substrate. The substratum was composed of soft silt, mostly covered with organic debris. There was a 60% cover of *Carex* sp., and a 30% cover of *Callitriche* sp. with occasional *Epilobium hirsutum*. Shading was heavy on the left bank and light on the right-hand bank. The flow was imperceptible.

Most of the rest of the section was similar, though there were some areas of more open vegetation cover, dominated principally by *Sparganium erectum* near the top of the section.

1.2.2 Macroinvertebrates

33 macroinvertebrates were recorded from the sampling area and a further 16 from extra searches of the rest of the section. Most of the extra species were recorded from more open stands of vegetation at the top of the section.

The fauna was dominated numerically by a water slater, Asellus aquaticus, probably reflecting the amount of leaf litter in the section. The whirlpool ramshorn Anisus vortex, a species associated with the bases of emergent plants was also common.

21 species of beetle were recorded from the section, accounting for approximately 40% of the fauna. The only other well represented group was the Malacostraca (shrimps and slaters) with four species. Another water slater, Asellus meridianus, was recorded from this section. This species is usually out-competed by Asellus aquaticus in water which is rich in organic matter. Its presence here may point to the presence of small springs in the area.

The BMWP score (92) and the ASPT value (4.18) indicate that the water quality is fair. The highest scoring family in the section is Aeshnidae (8 points), though this family was not found in the sampling area. The highest scoring family in the sampling area is the Limnephilidae (7 points). The limnephilid recorded here, Limnephilus flavicornis, is found in a wide variety of still and flowing waters, usually amongst vegetation.

With 33 species and no local species in the sampling area the value to conservation of the macroinvertebrate community of this section is low. All of the 16 extra species recorded were common, and so the extra sampling does not change the evaluation of the conservation value.

1.3 SECTION 3 (SU747767 - SU753771)

1.3.1 General description

The sampling area of section 3 was 5.5m wide with an average depth of 100cm on ca. 30cm of substrate. The substratum was composed of soft silt with a small amount of gravel, with some organic debris on the surface. There was a 50% cover of mixed stands of Elodea sp. and Callitriche sp. Bank vegetation included Apium nodiflorum, Carex sp. and Phragmites australis with a few willows. Shading was light on both banks. The flow was slack (ca. 7cm/sec).

Most of the rest of the section was similar, though there was heavier shading near the top of the section. In the top of the section a small spring flows onto gravels just below 'The Flowing Spring' public house.

At the very top of the section, the Berry Brook merges with a stream flowing from the Sonning Eye Lake. On the day of survey, the amount of water being carried by this stream was in excess of that being carried by the Berry Brook. Local information suggested that this is true for most of the year.

1.3.2 Macroinvertebrates

32 macroinvertebrates were recorded from the sampling area and a further 7 from extra searches of the rest of the section. One of the extra species recorded was the very local limnephilid caddis fly *Apatania muliebris*. This was found on gravels at the inflow of the spring near the top of the section.

The fauna was dominated numerically by a freshwater shrimp *Gammarus pulex*. This is a species associated with relatively clean, non-stagnant water. Its dominance here may reflect the presence of springs flowing into the section, or the input of water from the stream flowing from the Sonning Eye Lake.

Snails (8 species), shrimps and slaters (4 species) and caddis flies (6 species) were proportionally well represented. The presence of *Aselus meridianus*, along with that of *Apatania muliebris* being indicative of the spring inflows. The dearth of extra species found outside the sampling area is indicative of the general homogeneity of the section.

The BMWP score (119) and the ASPT value (4.58) indicate that the water quality is good. One family (Lepidostomatidae) scoring 10 points (the maximum) in the BMWP scoring system was recorded from the sampling area. The lepidostomatid caddis fly recorded here (*Crunoecia irrorata*) is characteristically found amongst dead leaves in shallow water of permanent trickles and oozes and at the margins of tiny woodland streams. The specimens recorded here, were captured from a small, heavily shaded inflow at the side of the stream.

Were it not for the presence of *A.muliebris*, the macroinvertebrate community of the section would be of low value to nature conservation, only 32 species, with no local species, being recorded from the sampling area. However, the presence of *A.muliebris* in another part of the section renders it of high value to conservation. The record of *C.irrorata* from the sampling area might suggest that other, small, areas of habitat may be present which would be suitable for *A.muliebris*.

1.4 SECTION 4 (SU753771 - SU761772)

1.4.1 General description

The sampling area of section 4 was 4.8m wide with an average depth of 73cm on ca. 40cm of substrate. The substratum was composed of soft silt with small amounts of organic debris on the surface. There was an 80% cover of *Callitriche* sp. Bank vegetation included *Carex* sp., *Iris pseudacorus* and *Phragmites australis*. Shading was largely absent on both banks. The flow was slack (ca. 7cm/sec).

Most of the rest of the section was similar, though there were some areas with slightly heavier shading and some areas with stands of *Elodea*. Noticeable changes in flow rate occur in the Brook in this section. This is presumably due to the interconnection with the ditch system of the flood plain.

1.4.2 Macroinvertebrates

46 macroinvertebrates were recorded from the sampling area and a further 3 from extra searches of the rest of the section.No local species of macroinvertebrate were recorded.

The fauna was dominated numerically by the valve snail Valvata piscinalis. This is a species associated with relatively clean, permanent flowing water or large ponds. A mayfly, Cloeon dipterum, and a lesser water water boatman, Sigara falleni, were also common. Both species are common in relatively open stands of submerged vegetation in still or slow-flowing water.

Snails (11 species), caddis flies (7 species) and beetles (16 species) were proportionally well represented. Few extra species were recorded in the extra sampling, reflecting the homogeneity of this section and the poor deveopment of the marginal stands of plants.

The BMWP score (122) and the ASPT value (5.08) indicate that the water quality is good. Three families scoring 10 points (the maximum) in the BMWP scoring system were recorded from the sampling area. These were the Ephemeridae, the Leptoceridae and the Molannidae. A single species of each of these families was found. Ephemera vulgata (Ephemeridae) is characteristic of rivers with a muddy bottom. Athripsodes aterrimus (Leptoceridae) is found in still or flowing waters among plants and on muddy sand. Molanna angustata (Molannidae) is common in slow flowing lakes and rivers.

With 46 species and no local species in the sampling area the value to conservation of the macroinvertebrate community of this section is low.

1.5 SECTION 5 (SU761772 - SU766775)

1.5.1 General description

The sampling area of section 4 was 4.8m wide with an average depth of 90cm on ca. 80cm of substrate. The substratum was composed of soft silt with small amounts of organic debris on the surface. The water was turbid and the vegetation cover difficult to estimate. Callitriche sp. dominated the submerged flora with some Veronica beccabunga near the banks. A single plant of the local aquatic plant Ceratophyllum demersum (rigid hornwort) was dredged from the section. Marginal vegetation included stands of Sparganium erectum (5-10% cover) and smaller amounts of Carex sp. and Phragmites australis. Shading was largely absent on both banks. The flow was slack and appeared to reverse in direction during the period of sampling.

Most of the rest of the section was similar, though there were some larger stands of P.australis in the lower sections of the stream near to the confluence with the River Thames. No sampling was performed close to the confluence with the Thames.

1.5.2 Macroinvertebrates

52 macroinvertebrates were recorded from the sampling area and a further 10 from extra searches of the rest of the section. 2 local species of macroinvertebrate were recorded, Lister's river snail (Viviparus contectus) and Leach's bithynia (Bithynia leachi). Both of these species are characteristic of slow flowing rivers. Several specimens of B.leachi and two specimens of V.contectus were recorded.

A valve snail Valvata piscinalis numerically dominated the fauna. Several other snails and a water slater, Asellus aquaticus, were also very common. The numerical abundance of invertebrates in this section was noticeably higher than in any of the other sections.

Snails (16 species), and beetles (14 species) were proportionally well represented. Of the 10 extra species recorded from searches of the rest of the section, 8 were beetles. This reflects the presence of occasional good stands of marginal species, and especially of Sparganium erectum.

The BMWP score (163) and the ASPT value (4.93) indicate that the water quality is very good. Two families scoring 10 points (the maximum) in the BMWP scoring system were recorded from the sampling area. These were the Ephemeridae and the Leptoceridae. The Ephemeridae were represented by Ephemera vulgata as they were in section 2. The Leptoceridae are represented by two species, Athripsodes aterrimus and Mystacides longicornis: both species are characteristic of still or slow flowing water with vegetation and muddy substrata.

With 52 species and two local species in the sampling area, the value to conservation of the macroinvertebrate community of this section is moderate.

APPENDIX 2. AQUATIC MACROINVERTEBRATES RECORDED FROM FIVE SECTIONS OF THE BERRY BROOK

Abundance codes: 1-10 = A; 11-100 = B; 101-1,000 = C.
Other: + = present, but not found in sampling area.

SPECIES	1	2	3	4	5
TRICLADIDA (flatworms)					
Dendrocoelum lacteum	-	-	A	-	-
Polycelis felina	-	-	+	-	-
Polycelis nigra	-	-	A	-	-
Polycelis tenuis	-	-	A	-	-
HIRUDINEA (leeches)					
Erpobdella octoculata	A	A	A	A	B
Erpobdella testacea	-	-	-	-	B
Glossiphonia complanata	A	A	-	-	
Glossiphonia heteroclita	-	-	-	-	+
Theromyzon tessulatum	F	A	-	-	-
Piscicola geometra	-	-	A	-	-
GASTROPODA (snails)					
Acroloxus lacustris	-	-	A	A	A
Anisus vortex	B	B	A	B	C
Armiger crista	-	-	-	-	A
Bathyomphalus contortus	B	B	-	-	A
Bithynia leachi	-	-	-	-	B
Bithynia tentaculata	A	B	-	A	C
Gyraulus albus	+	-	A	A	B
Lymnaea palustris	B	+	-	-	B
Lymnaea peregra	B	-	B	B	C
Lymnaea stagnalis	+	-	A	B	C
Physa fontinalis	-	A	A	B	B
Planorbarius corneus	-	-	-	-	B
Planorbis carinatus	-	-	-	A	C
Planorbis planorbis	A	-	-	A	-
Potamopyrgus jenkinsi	B	-	B	A	A
Valvata piscinalis	B	B	+	B	C
Viviparus contectus	-	-	-	-	A

APPENDIX 2. AQUATIC MACROINVERTEBRATES RECORDED FROM FIVE SECTIONS OF THE BERRY BROOK (continued)

	1	2	3	4	5
BIVALVIA (bivalves)					
Anodonta anatina	-	-	-	-	A
Sphaerium corneum	-	-	B	-	B
MALACOSTRACA (shrimps and slaters)					
Asellus aquaticus	A	A	B	B	C
Asellus meridianus	-	A	A	-	-
Crangonyx pseudogracilis	-	A	B	B	B
Gammarus pulex	A	B	B	B	B
EPHEMEROPTERA (mayflies)					
Cloeon dipterum	-	A	+	B	B
Ephemera vulgata	-	-	-	A	A
PLECOPTERA (stone-flies)					
Nemurella picteti	-	-	+	-	-
ODONATA (dragonflies)					
Aeshna cyanea	A	+	-	-	-
Enallagma cyathigerum	-	-	-	A	-
Coenagrion puella/pulchellum	-	-	-	A	A
Ischnura elegans	+	A	+	A	B
Pyrrhosoma nymphula	-	-	A	-	+
MEGALOPTERA (alderflies)					
Sialis lutaria	A	A	A	A	B
HETEROPTERA (bugs)					
Gerris odontogaster	-	+	-	-	+
Hesperocorixa linnei	-	+	-	-	-
Hesperocorixa sahlbergi	-	A	-	-	-
Hydrometra stagnorum	A	-	A	-	-
Ilyocoris cimicoides	-	-	-	-	A
Nepa cinerea	-	-	A	-	-
Notonecta glauca	-	A	A	A	+
Plea leachi	-	-	-	-	A
Sigara fossarum	-	A	-	-	-
Sigara nigrolineata	-	+	-	-	-
Sigara distincta	-	-	-	A	-
Sigara dorsalis	-	+	+	B	A
Sigara falleni	-	-	+	A	A
Velia caprai	A	+	-	-	-

APPENDIX 2. AQUATIC MACROINVERTEBRATES RECORDED FROM FIVE SECTIONS OF THE BERRY BROOK (continued)

	1	2	3	4	5
TRICHOPTERA (caddis flies)					
Agraylea multipunctata	–	–	–	B	–
Agraylea sexmaculata	–	–	–	–	A
Anabolia nervosa	–	–	B	A	–
Apatania muliebris	–	–	+	–	–
Athripsodes aterrimus	–	–	+	A	A
Crunoecia irrorata	–	–	A	–	–
Cyrnus flavidus	–	–	–	–	A
Glyphotaelius pellucidus	–	+	–	–	–
Halesus digitatus	–	–	+	–	–
Halesus radiatus	–	–	–	A	A
Limnephilus extricatus	–	–	–	A	–
Limnephilus flavicornis	–	A	–	–	–
Limnephilus lunatus	–	–	–	A	–
Limnephilus rhombicus	–	–	–	A	–
Molanna angustata	–	–	–	A	–
Mystacides longicornis	–	–	–	–	A
Plectrocnemia conspersa	–	–	A	–	A
COLEOPTERA (beetles)					
Agabus didymus	–	–	–	+	–
Agabus paludosus	–	A	–	–	–
Agabus sturmii	–	–	–	–	+
Anacaena bipunctatus	–	–	–	–	+
Anacaena globulus	A	+	–	–	+
Anacaena limbata	–	B	–	A	A
Gyrinus substriatus	–	–	–	–	+
Haliplus fluviatilis	–	–	–	A	A
Haliplus lineatocollis	A	A	–	A	A
Haliplus ruficollis	–	–	–	–	+
Haliplus wehnckei	–	–	+	A	A
Helochares lividus	–	–	–	A	–
Helophorus brevipalpis	A	A	–	–	A
Helophorus grandis	–	A	–	–	A
Helophorus obscurus	–	A	–	–	+
Hydraena testacea	–	+	–	–	–
Hydrobius fuscipes	–	+	–	–	+
Hydroporus palustris	+	A	A	–	+
Hydroporus planus	A	–	–	–	–
Hygrotus inaequalis	–	A	A	–	–
Hygrotus versicolor	–	+	–	A	A
Hyphydrus ovatus	–	A	+	–	A
Ilybius quadriguttatus	–	+	–	–	–

APPENDIX 2. AQUATIC MACROINVERTEBRATES RECORDED FROM FIVE SECTIONS OF THE BERRY BROOK (continued)

	1	2	3	4	5
COLEOPTERA (continued)					
Laccobius bipunctatus	-	A	-	-	+
Laccobius minutus	-	A	-	-	-
Laccobius striatulus	-	+	-	+	-
Laccophilus minutus	-	-	A	-	-
Laccophilus hyalinus	-	-	-	-	+
Ochthebius minimus	+	+	-	-	-
Oulimnius tuberculatus	-	-	-	-	A
Potamonectes depressus-elegans	-	A	-	A	A

APPENDIX 3. STATUS OF IN GREAT BRITAIN OF LOCAL SPECIES OF AQUATIC MACROINVERTEBRATE RECORDED FROM THE BERRY BROOK

Bithynia leachi: HYDROBIIDAE: GASTROPODA.

Leach's bithynia. Locally common in the south east of England. Associated with slow-flowing and still water.

Viviparus contectus: VIVIPARIDAE: GASTROPODA.

Lister's river snail. Locally common in the south east of England. A species of permanent still and slow flowing water.

Apatania muliebris: LIMNEPHILIDAE: TRICHOPTERA.

A limnephilid caddis fly. The larvae of this parthenogenetic species is usually found in small streams and trickles, apparently always near springs and on a stony substratum. The species is widespread but very local.