# Aquatic Ecology & Water Quality

*A228 Leybourne & West Malling Bypass*
*Environmental Statement*
*Volume 2 (part)*

Southern Science Ltd

July 1995

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Kent County Council
HIGHWAYS & TRANSPORTATION

# CONTENTS

# SECTION ONE
# WATER QUALITY STUDY
# JULY 1992

# 1. INTRODUCTION

Southern Science Ltd were commissioned by Kent County Council (Building Design) to conduct a preliminary Water Quality Assessment of the Leybourne Stream in the vicinity of the proposed A228/M20 improvements.

# 2. SAMPLING

Sampling of watercourses in the vicinity of the proposed highway improvements was carried out on 14th July 1992. The weather on the sampling day was inclement with heavy rain throughout the sampling period.

At each sampling point the following features and parameters were observed, measured or estimated:

i) channel width;
ii) channel depth (at centre point);
iii) channel flow rate;
iv) water temperature;
v) dissolved oxygen concentration; and
vi) sample point description (including site photographs).

Water samples were submitted to Southern Science's NAMAS Accredited laboratory at Falmer, Sussex, where they were analysed for the following parameters:

i) biochemical oxygen demand (BOD-(ATU));
ii) suspended solids at 105°C;
iii) pH;
iv) ammoniacal nitrogen;
v) nitrate nitrogen;
vi) orthophosphate;
vii) chloride;
viii) conductivity at 20°C;
ix) alkalinity as CaCO3; and
x) total organic carbon.

Five sampling points were selected due either to their proximity to the proposed highway improvements or because they received drainage from this area and were used for recreational purposes. The location of the sampling points is indicated on Map 1.

# 3. RESULTS

The analytical and observational results for each of the sampled sites are presented in the following pages accompanied by a photograph of each site where available. (BD = below analytical detection point.

## Sample Point 1

**Southern tributary of Leybourne Stream in Woods Meadow.**

This stream was very turbid and dark in appearance. As the sample point was just downstream of the London Road run-off from the road into the stream is likely to have been taking place as a consequence of the heavy rainfall during sampling.

| Parameter | Units | Concentration 14/07/92 |
|---|---|---|
| Channel width | m | 0.5 |
| Channel depth | cm | 0.2 |
| Flow | m/s | 0.5 |
| Dissolved oxygen | mg/l (% sat'n) | 9.0 (86.0) |
| Temperature | °C | 17.2 |
| $BOD_5$ (ATU) | mg/l O | 12.0 |
| Suspended with solids at 105°C | mg/l | 190.0 |
| pH | units | 7.7 |
| Ammoniacal nitrogen | mg/l N | 0.12 |
| Nitrate nitrogen | mg/l N | 0.5 |
| Orthophosphate | mg/l P | 0.49 |
| Chloride | mg/l | 30.0 |
| Conductivity | usie/cm | 360.0 |
| Alkalinity | mg/l $CaCO_3$ | 95.0 |
| Total Organic Carbon | mg/l C | 17.0 |

## Sample Point 2

**Western tributary of Leybourne Stream in Woods Meadow.**

This tributary was much less turbid than the southern tributary and was surrounded by heavy growths of Balsam (***Impatiens glandulifera***).

| Parameter | Units | Concentration 14/07/92 |
|---|---|---|
| Channel width | m | 1.5 |
| Channel depth | cm | 0.15 |
| Flow | m/s | 0.5 |
| Dissolved oxygen | mg/l (% sat'n) | 9.4 (90.0) |
| Temperature | °C | 16.0 |
| $BOD_5$ (ATU) | mg/l O | 0.8 |
| Suspended with solids at 105°C | mg/l | 20.0 |
| pH | units | 8.2 |
| Ammoniacal nitrogen | mg/l N | BD |
| Nitrate nitrogen | mg/l N | 4.8 |
| Orthophosphate | mg/l P | 0.07 |
| Chloride | mg/l | 44.0 |
| Conductivity | usie/cm | 620.0 |
| Alkalinity | mg/l $CaCO_3$ | 185.0 |
| Total Organic Carbon | mg/l C | 2.8 |

## Sample Point 3

**Leybourne Stream near Leybourne C of E Primary School**

This section of the Leybourne Stream exhibited a greater diversity of flora than the two upstream tributaries. Road run-off from Castle Way appears to be discharged into the stream through gulleys and culverts along this section of the stream.

| Parameter | Units | Concentration 14/07/92 |
|---|---|---|
| Channel width | m | 1-3.0 |
| Channel depth | cm | 0.20 |
| Flow | m/s | 0.4 |
| Dissolved oxygen | mg/l (% sat'n) | 9.2 (90.0) |
| Temperature | °C | 16.7 |
| $BOD_5$ (ATU) | mg/l O | 3.0 |
| Suspended with solids at 105°C | mg/l | 8.1 |
| pH | units | 8.1 |
| Ammoniacal nitrogen | mg/l N | BD |
| Nitrate nitrogen | mg/l N | 4.1 |
| Orthophosphate | mg/l P | 0.1 |
| Chloride | mg/l | 42.0 |
| Conductivity | usie/cm | 580.0 |
| Alkalinity | mg/l $CaCO_3$ | 175.0 |
| Total Organic Carbon | mg/l C | 5.0 |

## Sample Point 4

**Castle Lake near The Alders**

Castle Lake (filled from old quarry workings) lies just to the south of the M20 and receives water from the Leybourne Stream. Several fishermen were active around the lake margins and there were several walks signposted in the vicinity.

| Parameter | Units | Concentration 14/07/92 |
|---|---|---|
| Channel width | m | |
| Channel depth | cm | |
| Flow | m/s | |
| Dissolved oxygen | mg/l (% sat'n) | 5.4 (68.0) |
| Temperature | °C | 18.8 |
| $BOD_5$ (ATU) | mg/l O | 13.0 |
| Suspended with solids at 105°C | mg/l | 46.0 |
| pH | units | 7.4 |
| Ammoniacal nitrogen | mg/l N | 0.39 |
| Nitrate nitrogen | mg/l N | BD |
| Orthophosphate | mg/l P | 0.07 |
| Chloride | mg/l | 43.0 |
| Conductivity | usic/cm | 510.0 |
| Alkalinity | mg/l $CaCO_3$ | 110.0 |
| Total Organic Carbon | mg/l C | 5.3 |

## Sample Point 5

### Castle Lake near The Osiers

Leybourne Lake is just to the north of the M20. Townsend Hook Fishing Club use the lake and have established fishing access points around its margins. The sample was taken from the bankside.

| Parameter | Units | Concentration 14/07/92 |
|---|---|---|
| Channel width | m | |
| Channel depth | cm | |
| Flow | m/s | |
| Dissolved oxygen | mg/l (% sat'n) | 6.6 (70.0) |
| Temperature | °C | 18.8 |
| $BOD_5$ (ATU) | mg/l O | 2.2 |
| Suspended with solids at 105°C | mg/l | 7.0 |
| pH | units | 7.7 |
| Ammoniacal nitrogen | mg/l N | BD |
| Nitrate nitrogen | mg/l N | BD |
| Orthophosphate | mg/l P | 0.04 |
| Chloride | mg/l | 68.0 |
| Conductivity | usie/cm | 670.0 |
| Alkalinity | mg/l $CaCO_3$ | 195.0 |
| Total Organic Carbon | mg/l C | 4.6 |

## 4. Discussion

The two tributaries to the Leybourne Stream are both very close to the proposed highway improvements and they have very different water quality characteristics. The southern tributary (***Site 1***) was turbid with the water cloudy and dark. The heavy rain during the morning of the survey had significantly affected the quality of the stream and it is probable that it received run-off from road and farmland. This is demonstrated by the high suspended solids concentration, organic carbon levels, biochemical oxygen demand and the fact it had the highest phosphate concentration of any of the sites sampled. The high BOD classifies the tributary at site 1 (NRA River Quality Objectives Classification 1990, Table 1) as of poor quality (Class 3) and the suspended solids concentration is well outside the EIFAC standards for salmonid and cyprinid fisheries.

The western tributary (***Site 2***) has a different character to the above with lower BOD, organic carbon and suspended solids concentrations. It is probable that this stream receives less road and agricultural run-off than the northern tributary and it is of a higher quality. All the measured parameters fell within the guideline limits of the EC Surface Water Directive for waters to be abstracted to drinking water supply and the tributary would be classed as being of good quality (Class 1a).

***Site 3*** was a point on the Leybourne Stream approximately 0.5km downstream of the above two tributaries. The stream at this sample point had water quality characteristics similar to those of its western tributary (Site 2) with the exception of a lower suspended solids load and slightly greater organic carbon content and BOD. Suspended solids appear to be settling out along the length of the stream and the presence of vegetation in the channel would assist this process. Using the measured parameters the stream would be classed as being of good quality (Class 1b) at this point.

***Site 4*** at Castle Lake was sampled during heavy rain which may have influenced the suspended solids concentration in this sample. A lower reading would have been expected with solids settling in the quiescent condition of the lake. The lake sample also exhibited a high BOD concentration although all other parameters were similar to those of the Leybourne Stream which drains into the lake. The lake was being fished at the time of sampling although both the BOD and suspended solids concentration exceed the EIFAC salmonid and cyprinid guideline limits. The lake would be classed as being of poor quality largely due to the high BOD measured (Class 3).

Leybourne Lake (***Site 5***) to the north of the M20 is leased by the Townsend Hook Fishing Club who have allocated fishing points around its margins. It is not clear whether it is connected to Castle Lake beneath the M20 but on the day of sampling its water quality was quite different. Suspended solids and BOD were lower while the chloride and conductivity levels were higher suggesting that the lake may have received motorway run-off containing salts. For the measured parameters the lake was within the EIFAC fisheries guidelines and would be classed as being of good quality (Class 1a).

The discussion above is based upon water quality from a single sampling visit and these measurements will have been influenced by the weather conditions on the day of the survey.

**TABLE 1** **RIVER QUALITY CLASSIFICATION (ADAPTED FROM NRA 1990 WATER QUALITY SURVEY CRITERIA)**

| RIVER CLASS | QUALITY CRITERIA | REMARKS | CURRENT POTENTIAL USES |
|---|---|---|---|
| 1a Good Quality | 1) 5 percentile Dissolved Oxygen Saturation greater than 80%<br>2) 95 percentile Biochemical Oxygen Demand not greater than 3mg/l<br>3) 95 percentile Ammonia not greater than 0.4mg/l<br>4) Where the water is abstracted for drinking water, it complies with requirements for A2.<br>5) Non-toxic to fish in EIFAC terms (or best estimates if EIFAC figures are unavailable) | 1) Mean Biochemical Oxygen Demand probably not greater than 1.5mg/l<br>2) No visible evidence of pollution | 1) Water of high quality suitable for potable supply abstractions<br>2) Game or other high class fisheries<br>3) High amenity value. |
| 1b Good Quality | 1) 5 percentile Dissolved Oxygen Saturation greater than 60%<br>2) 95 percentile Biochemical Oxygen Demand not greater than 5mg/l<br>3) 95 percentile Ammonia not greater than 0.9mg/l<br>4) Where water is abstracted for drinking water it complies with the requirements for A2<br>5) Non-toxic to fish in EIFAC terms (or best estimates if EIFAC figures are unavailable). | 1) Mean Biochemical Oxygen Demand probably not greater than 2mg/l<br>2) Mean Ammonia probably not greater than 0.5mg/l<br>3) No visible evidence of pollution<br>4) Water of high quality which cannot be placed in Class 1a because of the effect of physical factors such as canalisation, low gradient or eutrophication | Water of less high quality than Class 1a but usable for substantially the same purposes |
| 2 Fair Quality | 1) 5 percentile Dissolved Oxygen Saturation greater than 40%<br>2) 95 percentile Biochemical Oxygen Demand not greater than 9mg/l<br>3) Where water is abstracted for drinking water it complies with the requirements of A3<br>4) Non-toxic to fish in EIFAC terms (or best estimates if EIFAC figures are unavailable) | 1) Mean Biochemical Oxygen Demand probably not greater than 5mg/l<br>2) Water showing no physical signs of pollution other than humic colouration and a little foaming below weirs. | 1) Waters suitable for potable supply after advanced treatment.<br>2) Supporting reasonably good course fisheries<br>3) Moderate amenity value |
| 3 Poor Quality | 1) 5 percentile Dissolved Oxygen Saturation greater than 10%<br>2) Not likely to be anaerobic<br>3) 95 percentile Biochemical Oxygen Demand not greater than 17mg/l. This may not apply if there is a high degree of re-aeration | | Waters which are polluted to an extent that fish are absent or only sporadically present. May be used for a low grade abstraction for industry. Considerable potential for further use if cleaned up |
| 4 Bad Quality | Waters which are inferior to Class 3 in terms of dissolved oxygen and likely to be anaerobic at times | | Waters which are grossly polluted and are likely to cause nuisance. |
| X | Dissolved Oxygen greater than 10% saturation | | Insignificant water courses and ditches which are not usable, where the objective is simply to prevent nuisance. |

## KEY TO FIGURES

Site 1 Southern tributary of the Leybourne Stream

Site 2 Western tributary of the Leybourne Stream

Site 3 Leybourne Stream near the Leybourne C of E School

Site 4 Castle Lake

Site 5 Leybourne Lake

EC SWD (G) EC Surface Water Directive Guideline Levels (75/440/EEC)

Salm. EIFAC Salmonid Fishery Mandatory Limit (78/659/EEC)

Cypr. EIFIC Cyprinid Fishery Mandatory Limit (78/659/EEC)

## AUDIT TRAIL

| | |
|---|---|
| Report written by: | Dr Nathan Richardson (Environmental Scientist) |
| Report checked by: | Sarah Steines (Manager, Planning and Audit) |
| Analysis carried out by: | Falmer Laboratory |

# SECTION TWO
# AQUATIC ECOLOGY AND WATER QUALITY STUDY
# OCTOBER 1993

# 0. SUMMARY


1.1 Six sites along the route of the proposed West Malling and Leybourne By-pass were surveyed on 2 September 1993. An general assessment of the aquatic habitat was made, together with an invertebrate assessment based on National Rivers Authority (NRA) methods.

1.2 The sites surveyed contained a reasonable diversity of habitats. The nature of the invertebrate populations they supported indicated a relative lack of pollution and/or environmental stress. Where invertebrates could be identified to species-level, there were none which would be considered unusual for Kent. Further specialist surveys may be required if a more detailed account of aquatic flora and fauna is required.

1.3 The proposed highway improvements, as indicated on landscape drawing number 5839/226/22A, provided by the Client, show that the scheme will require:

- stream diversion and realignment;
- culverting and bridging;
- realignment of part of the Leybourne Lake margin.

There is also the likelihood of a change in flow regime of the Leybourne Stream due to road run-off. A small pond to the north of a proposed new Interchange may also be affected.

4. Design and construction of the bypass and interchanges should minimise the disruption to the streams and lake margins. Where watercourses require realignment, diversion or culverting, the aim should be to reproduce a form as close to the original natural form as possible. Further advice with regard to specific design and mitigation measures should be sought, to enhance the aquatic wildlife potential, when more detailed plans are made available.

The nature of the invertebrate populations they supported are typical of the restricted nature of the stream and tributaries. It is not possible to determine whether the inorganic inputs into the stream have resulted in a reduced species diversity. Certainly, many of the families and species of invertebrate found are tolerant of organic pollution.

## 1. INTRODUCTION

1.1 Following a baseline water quality survey carried out in connection with the proposed A228 West Malling Highway Improvements in July 1992, Southern Science Ltd were requested by Kent County Council to undertake a preliminary aquatic ecology survey of the same area.

1.2 The aim of the study was to describe the existing aquatic ecology which might be affected, either directly or indirectly, by the highway improvement proposals. The survey provides a broad assessment of nature conservation significance of the aquatic environment.

## 2. METHODS

2.1 A field survey was undertaken on 2 September 1993. Water samples were also taken, to enable a comparison with an earlier chemical water quality survey (ref 1). Six sites were visited along the proposed route of the by-pass (Figure 1). These sites were selected to correspond to the associated chemical sampling point, and to be representative of the stretch of watercourse in the vicinity. They are:

| | | CORRESPONDING SITE OF 1992 CHEMICAL WATER QUALITY SURVEY |
|---|---|---|
| A | Tributary of Leybourne Stream at TQ 6859 5835, at proposed new A 20 bridge | 1 |
| B | Leybourne Stream upstream of proposed route at TQ 6842 5835; | 2 |
| C | Leybourne Stream downstream of proposed balancing pond at TQ 6894 5875; | upstream of 3 |
| D | Castle Lake/Leybourne Lake at TQ 6936 5925; | 4 |
| E | Leybourne Lake at TQ 6994 5956; | 5 |
| F | Pond at TQ 6879 5975; | – |

2.2 Where possible, kick-net samples of the aquatic macro-invertebrate fauna were taken at each site using a 1.0 mm mesh pond-net. Each habitat type was sampled in proportion to its occurrence so that the overall sample was representative. At two of the sites (D and E) access was difficult and representative samples were taken from the bankside. Samples were examined using a dissecting microscope enabling identification of most invertebrates to family or species-level, sufficient for an assessment of the status of the fauna. A score of water quality was made using the Biological Monitoring Working Party (BMWP) score, used by the NRA in routine biological surveys (further explanation of the BMWP score is provided below).

2.3 Field notes were made for each site, including the in-stream and bankside vegetation, habitat characteristics, adjacent land-use. These notes are summarised in Figures 2 to 7. Chemical water quality samples were taken for a limited range of parameters. The results are presented in Appendix 4.

2.4 In addition to the field survey, historic records of biological water quality at one site have been provided by the NRA (Southern Region, see Appendix 3). These samples will have been taken in a similar manner to that described above (ie, a representative kick-net or bank-side net sample). NRA samples are preserved in formalin and transported back to the laboratory where the invertebrates are extracted, and identified to family level with the aid of a microscope.

### The Biological Monitoring Working Party (BMWP) Scoring System

2.5 This BMWP score takes account of the sensitivity of various invertebrates to organic pollution. A score is set for each invertebrate family, which is related to the sensitivity of that family to oxygen content of the water. The score system is shown in Appendix 1. Animals adapted to life in shallow, fast-flowing, oxygen-rich waters carry a high score (eg, stoneflies). Animals adapted to life in still or slow-flowing water are capable of thriving under low-oxygen conditions. These receive a low score (eg, worms and midge larvae). Organic pollution tends to consume the natural oxygen content of a watercourse and so the BMWP score is used to assess water quality, by comparing the observed score with that which one would expect in clean water.

2.6 The BMWP scoring system is based on oxygen-sensitivity therefore lakes and ponds, and watercourses which are naturally slow-flowing, with poor exchange of oxygen over the air-water interface will tend to produce lower BMWP scores than fast-flowing watercourses. This is an important feature to bear in mind when interpreting the results of this survey.

2.7 The ecological interest of the stream can be assessed using criteria such as naturalness, rarity, diversity. Diversity can be measured by counting the number of different types of invertebrate which occur in the sample. In general, a high diversity is considered to be of value as it tends to represent a complex, balanced system. Environmental stress, such as chemical pollution, or excessive nutrient enrichment leads to an impoverishment of the flora and fauna (ie, low diversity).

2.8 The Average Score Per Taxon (ASPT) is another useful score used by the NRA which combines the BMWP index with an index of diversity, namely the number of scoring taxa. The ASPT tends to give a more stable indication of the 'average sensitivity' of the invertebrate fauna, because it is less dependent on sampling effort or the occurrence in a sample of uncommon taxa. Experience of Kentish watercourses (ref 2) has indicated that an ASPT of less than 3 could be considered as 'low', whereas a score of 5 or more would be 'high'.

### Abundance Scoring

2.9 In line with NRA practice, a semi-quantitative scale of abundance was used, as presented in Table 2.1:

**Table 2.1 NRA Abundance Scoring Method used in this Survey**

| Number of Individuals Captured | Score |
|---|---|
| 1 | 1 |
| 2–10 | 2 |
| 11-100 | 3 |
| 101–1,000 | 4 |
| 1,001–10,000 | 5 |
| > 10,000 | 6 |

# 3 RESULTS

## RESULTS OF AQUATIC ECOLOGY SURVEY

3.1 A summary of the invertebrate fauna recorded at each site is provided in Tables 3.1 to 3.6. This includes an assessment of the BMWP and ASPT scores. Sketch maps of the sites are presented, together with photographs of the sites in Figures 2 to 7.

## SITE A: TRIBUTARY OF LEYBOURNE STREAM TO BE CROSSED BY THE NEW A20 BRIDGE

### General Description

3.2 From a small lake in the village of West Malling, this small stream flows through the village (part culverted) and over approximately half a kilometre of farmland before joining the Leybourne Stream, just downstream of the A20 road crossing. The stream receives intermittent run-off from both urban and agricultural land, and from the A20 itself. The stream was sampled just upstream of the confluence with the Leybourne Stream where it flows through a meadow supporting an apparently diverse grass/herb flora.

### Habitat Assessment

3.3 Though the stream is small it comprised a variety of habitats, including areas of bare shingle bed and areas choked by emergent aquatic weeds. Considering the observed diversity of habitat, the diversity of invertebrate species found was not as great as might be expected and this may be attributable to the effects of run-off as described above.

### Invertebrate Assessment

3.4 The invertebrate fauna was dominated by the freshwater shrimp (Gammarus pulex), which is a species with tolerance to a range of environmental situations. The presence of caddis fly larvae, riffle beetles and blackfly larvae are indicative of a moderately fast flowing watercourse. The BMWP score was 53. The ASPT of 4.4 is reasonable and suggests that the stream does not suffer from significant stress/pollution.

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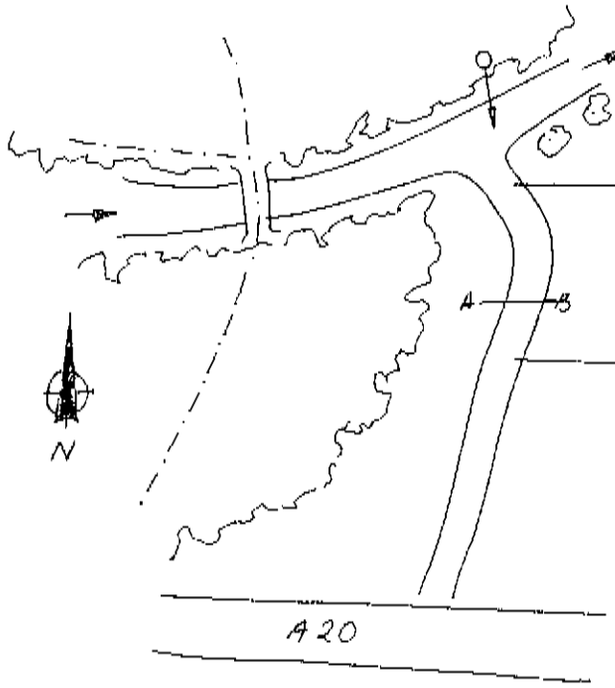
Aquatic Ecology Study

Figure 2: Leybourne Stream tributary, sample point A




Sparse in-stream vegetation near confluence, or in Leybourne Stream itself; Gravel bed.

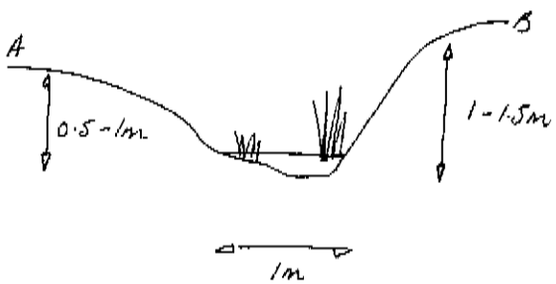
Narrow channel with steep right bank, choked with emergent weed including: Mentha, Eorippa, Apium, Epilobium and a variety of narrow-leaved emergents.

Scale (approx. only) 5m 2m

Landuse:
Left Bank - meadow and woodland
Right Bank - meadow

Bankside Vegetation:
Low plants (grasses with herbs) plus nettle, thistle, teasel, dock, all providing little shade.

Channel Cross Section:
Width - 0·3 to 1·0m
Depth - 0·1 to 0·2m




Surveyed 2-9-93 SES

**Table 3.1 Site A, Tributary of Leybourne Stream at TQ 6842 5835**

| *(surveyed 2/9/93/SES)* | | **Abundance** |
|---|---|---|
| **Gastropoda** | **Snails** | |
| *Hydrobiidae | | |
| Potamopyrgus jenkinsi | Jenkin's Spire Shell | 2 |
| *Lymnaeidae | Pond Snails | |
| Lymnaea peregra | Wandering Snail | 2 |
| *Planorbidae | Ramshorn Snails | |
| Planorbis (planorbis) | | 1 |
| **Bivalvia** | **Mussels and Cockles** | |
| *Sphaeriidae | Pea Mussels | |
| Pisidium sp. | Pea Shell Cockle | 3 |
| ***Oligochaeta** | **Worms** | 3 |
| **Malacostraca** | | |
| *Gammaridae | Freshwater Shrimps | |
| Gammarus pulex | | 5 |
| **Ephemeroptera** | **Mayflies** | |
| *Baeridae | | |
| Baetis sp. | Mayflies | 3 |
| **Coleoptera** | **Beetles** | |
| *Hydrophilidae | Scavenger Beetles | |
| Species I | | L 1 |
| *Helodidae | Beetles | L 1 |
| *Elmidae | Rifle Beetles | |
| Species A | | A 2 |
| Species I | | L 1 |
| Species II | | L 1 |
| **Trichoptera** | **Caddis Flies** | |
| *Sericostomatidae | Cased Caddis | |
| Sericostoma personatum | | 2 |
| **Diptera** | **True Flies** | |
| *Ceratopogonidae | Biting Midges | |
| *Simuliidae | Blackflies | 2 |
| Diptera sp. 1 | True Flies | 1 |
| Diptera sp. 2 | True Flies | 2 |
| **Number of Scoring Taxa:** | **12 (marked with *)** | |
| BMWP Score: | 53 | |
| ASPT: | 4.4 | |

**Key:**

A – Adult L – Larvae N – Nymph

Beetle species are likely to represented by both adults and larvae but the two are recorded separately thus: Adults – Species A to Z Larvae – Species I, II, III, IV etc.

## SITE B: LEYBOURNE STREAM JUST UPSTREAM OF PROPOSED HIGHWAY IMPROVEMENTS

### General Description

3.5 The Leybourne Stream rises approximately 7 km upstream of this sampling point, where it flows through Leybourne Wood, a mixed deciduous woodland. It is a relatively small lowland stream which drains a semi-rural catchment.

### Habitat Assessment

3.6 The stream shows a classic lowland pool riffle structure, which comprises alternating deep and shallow, eroding and depositing zones. Within Leybourne Wood, heavy shading from trees means that there is virtually no in-stream or emergent vegetation; this will act to exclude those invertebrate species which are dependent on aquatic weed for food, shelter or attachment. However, the moderate flow over a gravelly bed provides a valuable habitat for a range of other invertebrate species.

### Invertebrate Assessment

3.7 Like the tributary stream described above (Site A), the Leybourne Stream was dominated by the freshwater shrimp (Gammarus pulex sp.), and also supported caddis, mayfly and blackfly larvae, and riffle beetles. The BMWP score was 60 and the ASPT was 4.3. The invertebrate fauna is therefore broadly similar to the previous site. From a conservation viewpoint, none of the taxa identified to species-level are uncommon in Kent.

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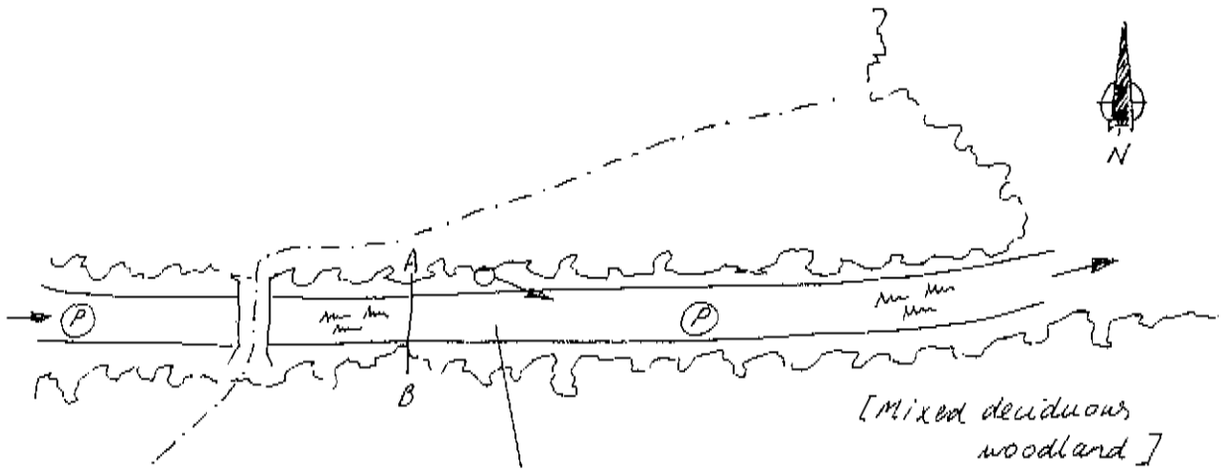
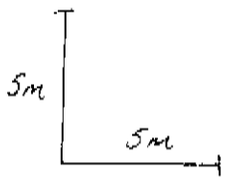
Figure 3: Leybourne Stream, sample point B




[Mixed deciduous woodland]

Pool/riffle features with little instream or emergent vegetation; gravel/sand bed with fallen leaves etc.

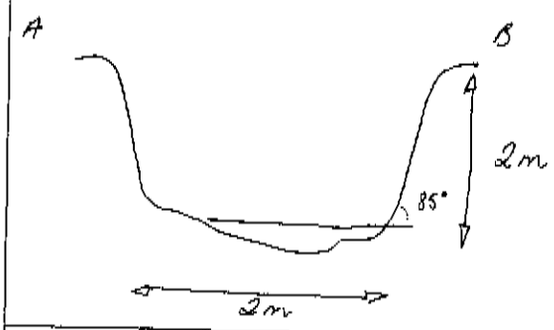



Scale (approx. only)

Landuse:
Mixed deciduous woodland, including elder, sycamore, horse chestnut, hazel, ivy, providing heavy shading of the stream channel; understorey of nettle and balsam.

Bankside vegetation:
Steep banks preclude any vegetation except mosses and liverworts.

Channel Features:
Width - 1-2m
Water Depth - 0·1 - 0·3m
Banks are bare clay in place.




Surveyed 2-9-93 SES

**Table 3.2 Site B, Leybourne Stream at TQ 6859 5835**

| *(surveyed 2/9/93/SES)* | | **Abundance** |
|---|---|---|
| **Gastropoda** | **Snails** | |
| *Hydrobiidae | Snails | |
| Potamopyrgus jenkinsi | Jenkin's Spire Shell | 2 |
| **Bivalvia** | **Mussels and Cockles** | |
| *Sphaeriidae | Pea Mussels | |
| Pisidium sp. | Pea Shell Cockle | 2 |
| ***Oligochaeta** | **Worms** | 1 |
| **Hirudinea** | **Leeches** | |
| *Glossiphoniidae | Leeches | |
| Glossiphonia complanata | | 2 |
| *Erpobdellidae | Leeches | 1 |
| **Malacostraca** | | |
| *Gammaridae | Freshwater Shrimps | |
| Gammarus pulex | | 4-5 |
| **Ephemeroptera** | **Mayflies** | |
| *Baetidae | Mayflies | |
| Baetis sp. | | 2 |
| **Hemiptera** | **Aquatic Bugs** | |
| Veliidae | Water Crickets | |
| Velia sp. | | 2 |
| **Coleoptera** | **Beetles** | |
| *Elmidae | Riffle Beetles | |
| Species A | | A 4 |
| Species B | | A 4 |
| Species I | | L 2 |
| Species II | | L 2 |
| **Trichoptera** | **Caddis Flies** | |
| *Hydropsychidae | Caseless Caddis | |
| Hydropsyche sp. | | 2 |
| *Limnephilidae | Cased Caddis | 2 |
| *Sericostomatidae | Cased Caddis | |
| Sericostoma personatum | | 2 |
| **Diptera** | **True Flies** | |
| *Ceratopogonidae | Biting Midges | 1 |
| *Chironomidae | Non-biting Midges | 2 |
| *Simuliidae | Blackflies | 2 |
| Dicranota sp. | True Flies | 2 |
| Diprera sp. 1 | True Flies | 2 |
| **Number of Scoring Taxa:** | **14 (marked with *)** | |
| BMWP Score: | 60 | |
| ASPT: | 4.3 | |

## SITE C: LEYBOURNE STREAM DOWNSTREAM OF LILLIEBURN

### General Description

3.8 Below the confluence with the tributary stream described above, the Leybourne Stream flows under the A228. It then flows for nearly half a kilometre through a village green, east of Castle Way. The green is highly managed and is used for informal recreation. At several points, the stream bed is used as a crossing point/play area. Highway run-off from the existing Castle Way appears to discharge to the stream via gulleys and culverts along this stretch.

### Habitat Assessment

3.9 In this stretch of the Leybourne Stream there are reaches partially shaded by individual trees along the stream bank, together with reaches with open grassy banks which allow a lot of light to reach the stream. A variety of aquatic plants exist in the open stretches. These conditions provide a diversity of aquatic habitats which are of value, though the intensive recreational use of land on both banks means that the habitat does not feature as a prime site for nature conservation.

### Invertebrate Assessment

3.10 This sampling point exhibited the greatest diversity of invertebrates of all the sites visited during this survey. The BMWP score was 107 and the ASPT 4.8, both of which indicate a good variety of fauna and the absence of significant environmental stress or pollution. The fauna included several different types of caddis fly larvae. Freshwater shrimps were abundant but did not dominate the fauna as they did at the sites further upstream. Several types of water snail were found, which were not present at the upstream sites. Sticklebacks and bullhead minnows were also observed. Of the invertebrates identified to species, none are notable from a nature conservation viewpoint.

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Figure 4: Leybourne Stream, sample point C

Surveyed 2-9-93 SES

Short stretches of emergent Sparganium, with Myosotis, Lycopus, Polygonum, Epilobium, Agrostis stolonifera.

Occasional Callitriche

Little Burn

Hazel, elder, willow with nettle and balsam beneath

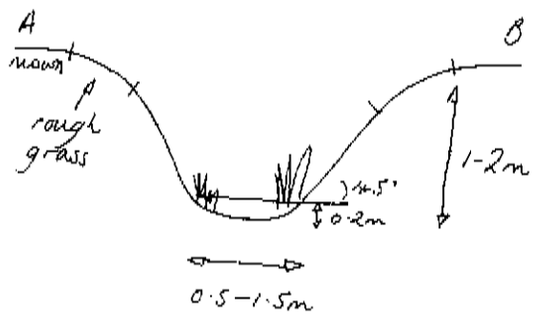
Scale: (Approximate Only) 20m length, 5m breadth

N

Landuse:
Mown Village Green used for informal recreation.

Bankside vegetation:
Rough grass and isolated trees provide alternating light and heavy shading of stream.

Channel Cross Section:
Width - 0·5 - 1·5m
Water depth - 0·05 - 0·4m




93-3-66006 October 1993 SES/73022

**Table 3.3 Site C, Leybourne Stream at TQ 6894 5875**
***(surveyed 2/9/93/SES)***

| | | Abundance |
|---|---|---|
| **Gastropoda** | **Snails** | |
| *Hydrobiidae | Snails | |
| Potamopyrgus jenkinsi | Jenkin's Spire Shell | 2 |
| *Lymnaeidae | Pond Snails | |
| Lymnaea palustris/trunculata | | 2 |
| Lymnaea peregra | Wandering Snail | 3 |
| *Ancylidae | Freshwater Limpets | |
| Ancylus fluviatilus | | 1 |
| **Bivalvia** | **Mussels and Cockles** | |
| *Sphaeriidae | Pea Mussels | |
| Pisidium sp. | Pea Shell Cockle | 2 |
| ***Oligochaeta** | **Worms** | 3 |
| **Hirudinea** | **Leeches** | |
| *Glossiphoniidae | Leeches | |
| Glossiphonia sp. | | 2 |
| *Erpobdellidae | Leeches | 2 |
| **Hydracarina** | **Water Mites** | 1 |
| **Malacostraca** | **Crustaceans** | |
| *Gammaridae | Freshwater Shrimps | |
| Gammarus pulex | | 3–4 |
| **Ephemeroptera** | **Mayflies** | |
| *Baetidae | Mayflies | 2 |
| **Hemiptera** | **Aquatic Bugs** | |
| *Mesovelidae | Water Bugs | |
| Mesovelia furcata | | 1 |
| *Notonectidae | Water Boatmen | |
| Notonecta (? glauca) | | 1 |
| **Coleoptera** | **Beetles** | |
| *Elmidae | Riffle Beetles | |
| Species A | | A 2 |
| Species B | | A 2 |
| Species I | | L 2 |
| Species II | | L 2 |
| **Trichoptera** | **Caddis Flies** | |
| *Rhyacophilidae | Caseless Caddis | |
| Agapetus sp. | | 2 |
| *Hydropsychidae | Caseless Caddis | |
| Hydropsyche sp. | | 2 |
| *Hydroptilidae | Cased Caddis | 1 |
| *Limnephilidae | Cased Caddis | 2 |
| *Leptoceridae | Cased Caddis | 2 |
| *Sericostomatidae | Cased Caddis | |
| Sericostoma personarum | | 2–3 |
| **Diptera** | **True Flies** | |
| *Chironomidae | Non-biting Midges | 3–4 |
| *Simuliidae | Blackflies | 4 |
| Stratiomyidae | Soldier Flies | 1 |
| Dicranota sp. | True Flies | 2 |
| **Number of Scoring Taxa:** | **22 (marked with *)** | |
| BMWP Score: | 105 | |
| ASPT: | 4.8 | |

## SITE D: CASTLE LAKE

### General Description

3.11 This lake is a former gravel working, now fed by the Leybourne Stream. Like the other lakes within the Leybourne Lakes SNCI it has developed a significant wildlife interest and is important for wintering and breeding wildfowl. The lake is set within a broadleaf woodland, which further enhances its value for wildlife by providing shelter and supporting a rich flora. Castle Lake is used by anglers and there are several signposted footpaths in the vicinity.

### Habitat Assessment

3.12 The open water of both Castle and Leybourne Lakes was not surveyed during this bankside survey. However, it is clear that the lakes are sufficiently productive to support the large numbers of wildfowl which use the lake, many of which are regarded as having conservation significance (hence the designation as an SNCI). The conservation significance of the plants and invertebrates themselves has not, however, been ascertained.

3.13 The following assessment relates only to the portion of Castle Lake which could be sampled from the shore, namely the narrow band of shallow water around its margin. The extremely steep sides of the gravel pit restricts the habitat interest of these lakes to some extent because of the restricted opportunity for rooted aquatic plants to become established. The plants which have established are dominated by the Common Reed (Phragmites). These plants are important for a variety of animals, including damselflies for example, which are able to rest on the stems of the plant.

### Invertebrate Assessment

3.14 The invertebrates present are adapted to conditions where the exchange of dissolved oxygen in the water is relatively low compared to flowing water sites. They include air-breathers (e.g. the dytiscid beetles) and the freshwater shrimp Crangonyx pseudogracilis, which is more tolerant of low dissolved oxygen than the more common Gammarus pulex.

3.15 The invertebrate sample examined from this site is typical of a lowland lake. Although the biotic scores were low (BMWP was 39, ASPT was 3.9), this may, in part, be attributable to the difficulty of obtaining a representative sample from the steep bank.

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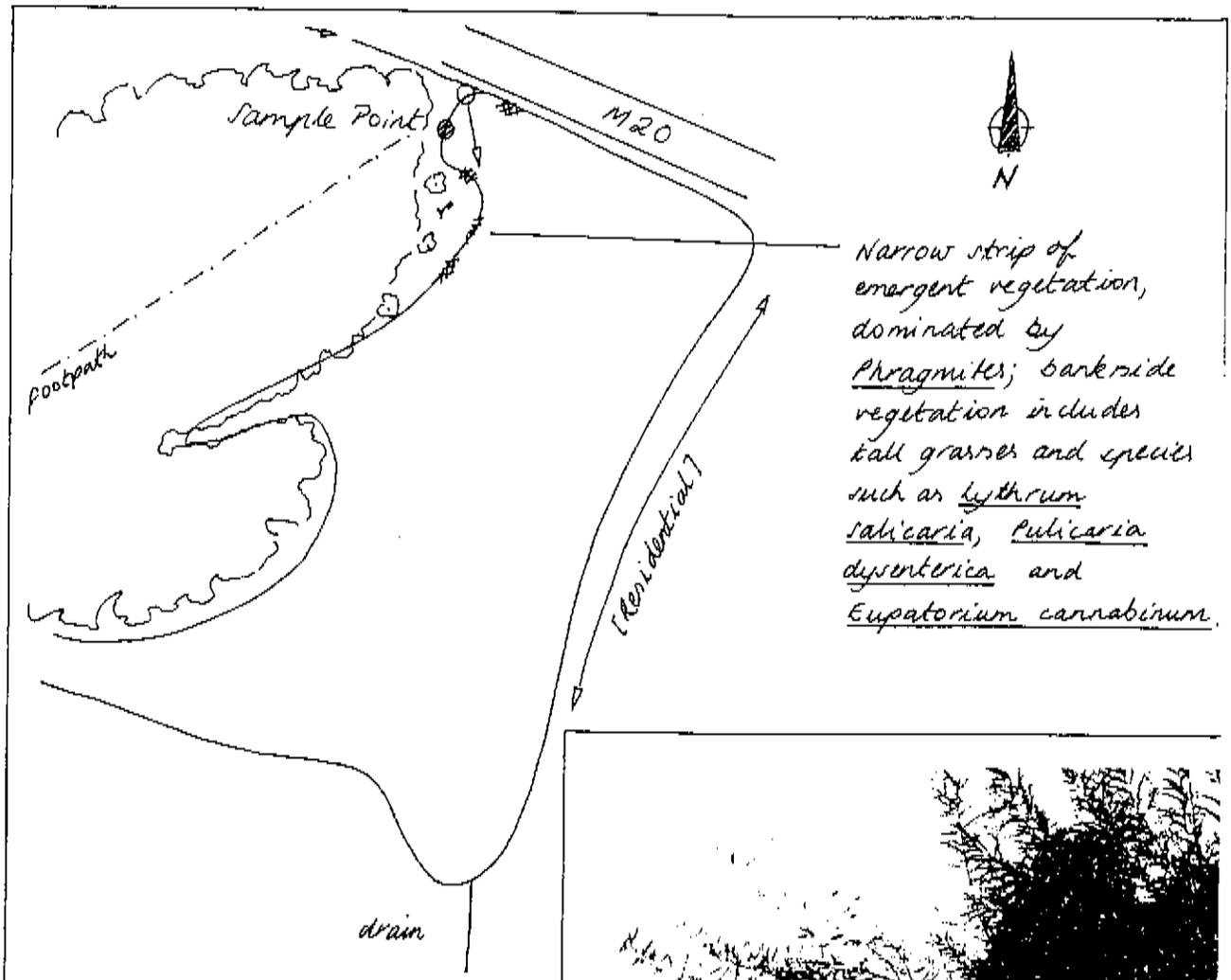
*Aquatic Ecology Study*

Figure 5: Castle Lake, sample point D.




Narrow strip of emergent vegetation, dominated by *Phragmites*; bankside vegetation includes tall grasses and species such as *Lythrum salicaria*, *Pulicaria dysenterica* and *Eupatorium cannabinum*.

Landuse:
Woodland (deciduous, with alder), residential properties, bankside fishing and walking.

Bankside Vegetation:
Overhanging trees (alder, willow) giving moderate shade over lake margins, with narrow beds of emergent vegetation (e.g. *Phragmites*) elsewhere.

Dimensions:
Approximately 150 x 50m
Depth unknown, though certainly very deep and steep-sided

Surveyed 2-9-93 SES

93-3-660/6 October 1993/SES/73022

**Table 3.4 Site D, Castle Lake at TQ 6936 5925**
***(surveyed 2/9/93)***

| | | Abundance |
|---|---|---|
| **Tricladida** | **Flatworms** | |
| *Planariidae | Flatworms | |
| Dugesia sp. | | 3 |
| **Gastropoda** | **Snails** | |
| *Hydrobiidae | Snails | |
| Bithynia sp. | | 3 |
| *Physidae | Bladder Snails | |
| Physa fontinalis | Bladder Snail | 3 |
| **Bivalvia** | **Mussels and Cockles** | |
| *Sphaeriidae | Pea Mussels | |
| Pisidium sp. | Pea Shell Cockle | 2 |
| ***Oligochaeta** | **Worms** | 2 |
| **Hydracarina** | **Water Mites** | 2 |
| **Malacostraca** | **Crustaceans** | |
| *Gammaridae | Freshwater Shrimps | |
| Crangonyx pseudogracilis | | 4 |
| **Odonata** | **Dragonflies and Damselflies** | |
| *Coaenagriidae | Damselflies | 3 |
| **Hemiptera** | **Aquatic Bugs** | |
| *Corixidae | Lesser Water Boatmen | 2 |
| **Coleoptera** | **Beetles** | |
| *Dytiscidae | Beetles | A 2 |
| **Diptera** | **True Flies** | |
| Ceratopogonidae | Biting Midges | |
| *Chironomidae | Non-biting Midges | 2 |
| **Number of Scoring Taxa:** | **10 (marked with *)** | |
| BMWP Score: | 39 | |
| ASPT: | 3.9 | |

## SITE E: LEYBOURNE LAKE

### General Description

3.16 As with Castle Lake (Site D) this lake is a water-filled gravel pit. Both lakes have been in existence for several decades and have been colonised by a variety of wildlife and acquired a significant local conservation interest.

3.17 The lake is bounded on its west and south banks by the M20 and Castle Way highways, whilst residential properties abut part of the eastern margin. There is public access to the lake margins to the north and Townsend Hook Fishing Club use the lake and have established fishing access points around its margin.

### Habitat Assessment

3.18 As with Castle Lake (Site D), Leybourne Lake is important in terms of nature conservation interest because of the wildfowl present. At the numerous fishing points (from one of which the sample was taken) there are shelves of shallow water and these have been exploited by species such as Canadian Pondweed (*Elodea spp*), Hornwort (*Ceratophyllum spp*) and Water Starwort (*Callitriche spp*). As a consequence, a greater diversity of water snails were encountered than in Castle Lake. The Yellow Water Lily (*Nuphar lutea*, see Figure 6) is a rooted plant and its presence suggests an area of relatively shallow water over part of Leybourne Lake.

### Invertebrate Assessment

3.19 The invertebrate fauna is similar to Castle Lake, though with a greater diversity of water snails, as commented on above. The BMWP score was 61 and the ASPT was 3.8, both of which are within the range expected for standing waters in this region. Of the taxa identified to species, all are commonly encountered in Kentish waters.

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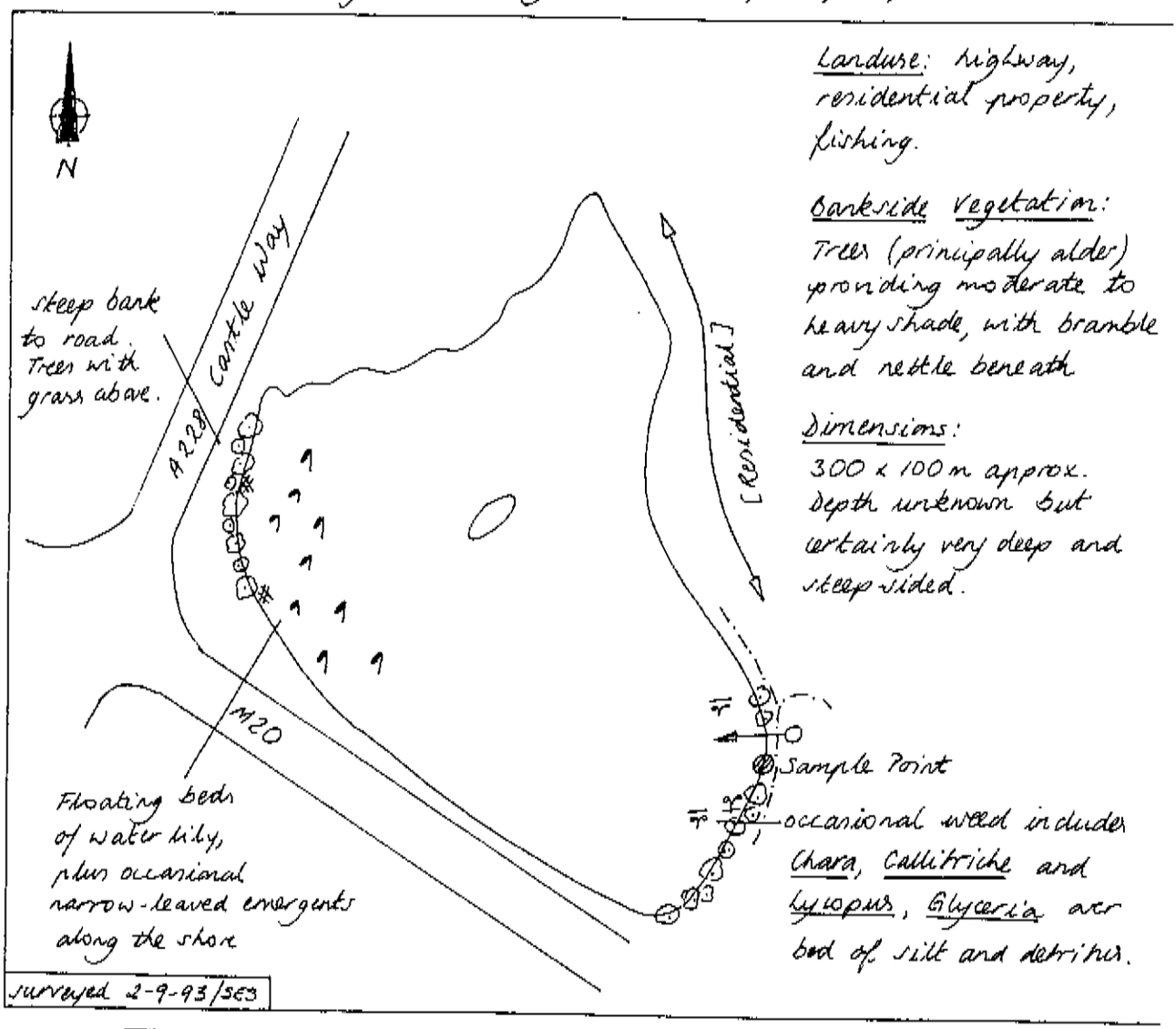
Aquatic Ecology Study

Figure 6: Leybourne Lake, sample point E



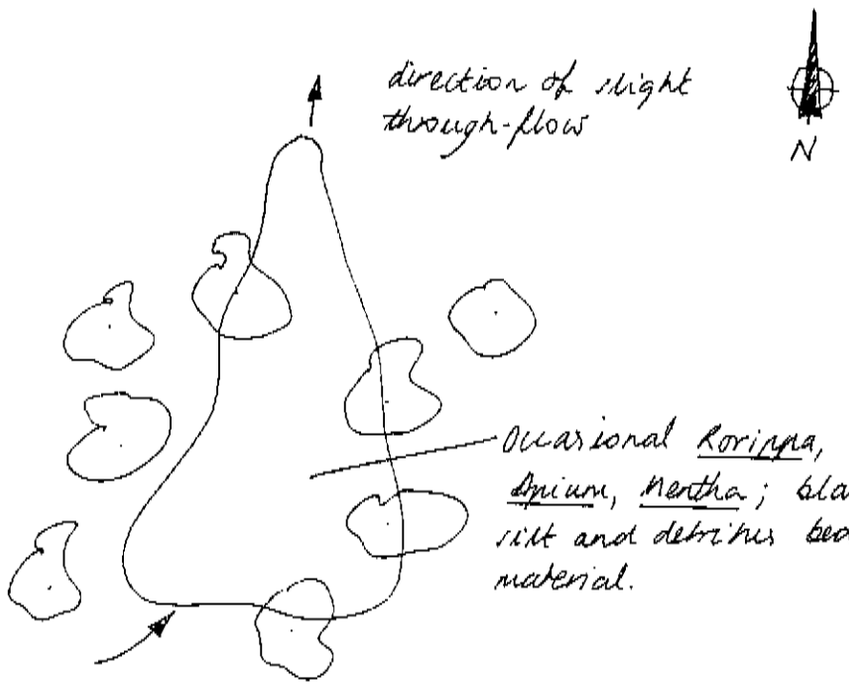

93-3-66018 October 1993/KEY/TM022

**Table 3.5 Site E, Leybourne Lake at TQ 6994 5956**
***(surveyed 2/9/93)***

| | | Abundance |
|---|---|---|
| **Tricladida** | **Flatworms** | |
| *Planariidae | Flatworms | |
| Dugesia sp. | | 3 |
| **Gastropoda** | **Snails** | |
| *Hydrobiidae | Snails | |
| Bithynia sp. | | 2 |
| *Lymnaeidae | Pond Snails | |
| Lymnaea palustris | Marsh Snail | 1 |
| *Physidae | Bladder Snails | |
| Physa fontinalis | Bladder Snail | 3 |
| Physa hererostropha? | Bladder Snail | 1 |
| *Planorbidae | Ramshorn Snail | |
| Planorbis (planorbis) | Ramshorn Snail | 2 |
| **Bivalvia** | **Mussels and Cockles** | |
| *Sphaeriidae | Pea Mussels | |
| Pisidium sp. | Pea Shell Cockle | 3 |
| ***Oligochaeta** | **Worms** | 2 |
| **Hydracarina** | **Water Mites** | 2 |
| **Malacostraca** | **Crustaceans** | |
| *Asellidae | Water Hoglice | |
| Asellus aquaticus | | 3 |
| Asellus meridianus | | 2 |
| *Gammaridae | Freshwater Shrimps | |
| Crangonyx pseudogracilis | | 3 |
| **Ephemeroptera** | **Mayflies** | |
| *Caenidae | Mayflies | |
| Caenis sp | | 1 |
| **Hemiptera** | **Aquatic Bugs** | |
| *Corixidae | Lesser Water Boatmen | N 2 |
| **Megaloptera** | **Alderflies and Spongeflies** | |
| *Sialidae | Alderflies | |
| Sialis lutaria | | 2 |
| **Coleoptera** | **Beetles** | |
| *Haliplidae | Beetles | A 1 |
| *Dytiscidae | Diving Beetles | |
| Species A | | A 2 |
| Species B | | A 1 |
| **Diptera** | **True Flies** | |
| *Chironomidae | Non-biting Midges | |
| **Number of Scoring Taxa:** | **16 (marked with *)** | |
| BMWP Score: | 61 | |
| ASPT: | 3.8 | |

Client: Kent County Council
Leybourne and West Malling Bypass
Aquatic Ecology Study

Figure 7: Pond, sample point F




Landuse: rough grassland / pasture

Bankside vegetation: deciduous trees, providing heavy shade; some nettle beneath.

Dimensions: Open water approx 1·5m x 7m at time of survey and less than 2cm depth. Estimate up to 10 x 10m in wetter seasons.

Surveyed 2-9-93 SES

93-3-66006 December 1993/SES/7/022

**Table 3.6 Site F, Pond at TQ 6879 5975**
***(surveyed 2/9/93)***

| | | Abundance |
|---|---|---|
| **Tricladida** | **Flatworms** | |
| *Dendrocoelidae | Flatworms | |
| Dendrocoelum lacteum | | 1 |
| **Bivalvia** | **Mussels and Cockles** | |
| *Sphaeriidae | Pea Mussels | |
| Pisidium sp. | Pea Shell Cockle | 4 |
| ***Oligochaeta** | **Worms** | 2 |
| **Malacostraca** | **Crustaceans** | |
| *Asellidae | Water Hoglice | |
| Asellus meridianus | | 2 |
| *Gammaridae | Freshwater Shrimps | |
| Gammarus pulex | | 5 |
| **Plecoptera** | **Stoneflies** | |
| *Nemouridae | Stoneflies | |
| Nemoura cinerea | | 2 |
| **Diptera** | **True Flies** | |
| Ceratopogonidae | Biting Midges | 2 |
| *Chironomidae | Non-biting Midges | 5 |
| **Number of Scoring Taxa:** | **7 (marked with *)** | |
| BMWP Score: | 27 | |
| ASPT: | 3.9 | |

### Leybourne Lakes Site of Nature Conservation Interest

3.23 The Kent Trust for Nature Conservation have provided details of the Leybourne Lakes Site of Nature Conservation Interest (SNCI). These are given in Appendix 2. This wetland SNCI, south of Snodland comprises a sinuous series of water-filled gravel pits, which includes both Castle Lake (see Site D) and Leybourne Lake (see Site E). Castle Lake is cut off from Leybourne Lake and the rest of the SNCI by the existing M20 – Castle Way (A 228) Interchange.

3.24 This SNCI includes pond, marsh and carr habitats whose status will indirectly depend on the maintenance of water quality in the watercourses which feed/flow through them. These factors reinforce the need to provide adequate pollution control measures during the construction and operational phases of the highway, in order that damage to these cited areas of nature conservation interest is avoided.

3.25 Brief consultation with KTNC has confirmed that there is little historic information regarding the nature conservation interest of flora and fauna of the study area, with the exception of the SNCI proper where the bird interest is the most well-documented aspect.

### Holborough to Burham Site of Scientific Interest (SSSI)

3.26 This wetland SSSI is several kilometres to the north of West Malling and so would not be directly affected by the proposed Highway Improvement Scheme.

### Kent Wildlife Survey Partnership Phase I Habitat Notes

3.27 Phase I Habitat Notes are available. However it is believed that, whilst they are probably of use with regards the landward ecology studies to be undertaken for the West Malling By-Pass Environmental Assessment, the amount of information regarding aquatic flora and fauna is limited. For this reason, they have not been obtained for this study.

### NRA Information: Leybourne Stream at Brook House

3.28 The NRA undertake routine invertebrate monitoring at key sites to maintain a record of river quality. One of these sampling points lies on the Leybourne Stream at Brook House, several kilometres upstream of the area of interest in this study. These data are reproduced in Appendix 3.

3.29 The Leybourne Stream at Brook House is a small shallow stream with a gravel, sand and silt stream bed, which indicates the presence of both eroding and depositing zones (a pool and riffle structure). The NRA data indicates a reasonably diverse fauna, characteristic of an unpolluted lowland stream with various beetle, caddis fly and snail species present.

3.30 NRA survey data identifies invertebrates to family level and so there are no details available regarding the occurrence of particular species (of nature conservation interest). The family-level taxon lists do not include any unusual taxa. The BMWP scores (1989-93) range between 53 and 97, whilst the ASPT ranges between 3.9 and 4.8. The Southern Science Ltd invertebrate samples taken from sites A, B and C comprised similar families and similar biotic scores.

### Results of Chemical Water Quality Survey

3.31 The results of the limited chemical water quality survey are presented in Appendix 4, together with the results of the previous more extensive Southern Science survey (ref 2) and a summary of NRA records for their routine water quality monitoring site at Birling Road.

### *Leybourne Stream Sampling Points*

3.32 In addition to the Southern Science survey reported previously (ref. 1), water quality data is routinely collected by the National Rivers Authority at the Birling Road Bridge on the Leybourne Stream, 0.5 km upstream of sample point B (Figure 1).

3.33 The NRA records over the period 1990 to 1993 indicate good water quality with high dissolved oxygen, a low organic loading (as measured by biochemical oxygen demand (BOD) and low ammonia concentrations.

3.34 Concentrations of nitrate and phosphate (plant nutrients in which commonly derive from agricultural run-off or/and treated sewage effluents) are also low. The Leybourne Stream had higher nitrate than other sites (> 4 mg/l) probably indicating run-off from agricultural land, though such concentrations are not considered high.

3.35 The Southern Science spot samples from the Leybourne Stream (Sites A and C) for both this and the previous survey show similar characteristics to the above. In addition, these analyses indicated a low suspended solids load in the Leybourne Stream.

### *Tributary of the Leybourne Stream (Site A)*

3.36 Samples taken from the tributary of the Leybourne Stream (Site A) indicated a water quality comparable to the previous Southern Science survey, though the samples from the previous survey were taken after heavy rain and contained a higher organic content (measured by BOD and total organic carbon), elevated suspended solids, ammonia and phosphate. This tributary was sampled downstream of the run-off channel from the London Road which is a likely source of these contaminants.

3.37 Spot samples taken for the current survey showed lead to be close to or below the detection limit (4 $\mu$g/l) at all the sites except this site, where a result of 15 $\mu$g/l was recorded. This supports the view that road run-off from the existing London Road is capable of depressing water quality in this stream. However, the NRA routine site at Birling Road lying downstream of the confluence of this tributary has a long record of good water quality, suggesting that road run-off is not having a significant adverse effect on the Leybourne Stream.

### *Leybourne Lake and Castle Lake (Sites D and E)*

3.38 Both lakes exhibited good water quality. As expected, the dissolved oxygen of the lakes was lower than at the flowing water sites.

3.39 Chloride concentrations were low at the lakes (and in the stream samples), and probably close to the base concentration characteristic of streams in this catchment. Chloride from road salting would not be expected in these samples taken in July. Alkalinity analyses suggests that the alkalinity of the stream is solely a function of its geology and is not affected by contamination.

# 4. Impact of Proposed By-pass on Aquatic Ecology

4.1 The following appraisal of the potential impact of the proposed highway scheme on aquatic ecology has been based using information derived from the Landscape Drawing (5839/226/22A). However, the details of the proposed engineering, landscaping and other aspects of the scheme are not known and therefore specific recommendations for pollution prevention and enhancement of wildlife and nature conservation value cannot be made. The following assessment of impact should therefore be regarded as preliminary.

4.2 In general, highway schemes can have three types of impact on existing watercourses and waterbodies. These are:

- realignment;
- culverting or bridging;
- change in the flow regime.

These may all involve reconstruction of the stream channel and this would directly disrupt the aquatic habitats and wildlife interest of the streams. The design of the proposed highway should aim to minimise these disruptions and mitigate their effects.

***Leybourne Stream (see Sites A,B C)***

4.3 The line of the proposed bypass passes obliquely over the Leybourne Stream and its tributary (Sites A and B) for a combined length of over 150 m. Stream disruption should be minimised. However, where diversions are necessary, consideration should be given to creating replacement channels which have wildlife features where possible such as the provision of shallow shelves to allow the colonisation by aquatic weeds. This would enable a greater diversity of flora and fauna to develop.

4.4 Pollution control measures (eg. sediment traps) will be required during construction works, to minimise the release of suspended solids from both the road works and the stream bed itself.

4.5 A balancing pond is being considered by Kent County Council in the vicinity of the Leybourne Stream. This would provide some buffering capacity to decrease the effect of run-off and potential contamination of the Leybourne Stream further downstream. It also affords the opportunity to create a wetland habitat (see recommendations).

4.6 Downstream of Site C, the course of the Leybourne Stream follows the proposed line of the bottom of an embankment of the new interchange. This may involve realignment of the stream. If this is the case, the following general design features should be accommodated into the new channel:

- minimisation of the length of stream to be disrupted;
- provision of a replacement channel which mirrors the original stream in its characteristics (e.g. meanders, eroding and depositing zones, avoidance of trapezoidal cuttings and hard revetments as far as possible);

4.7 It is anticipated that road run-off may be drained to the Leybourne Stream. A seasonally-high salt content could lead to a shift in the aquatic fauna towards a more restricted range of salt-tolerant invertebrates. The provision of a balancing pond would dampen the impacts of variations in salinity on the Leybourne Stream.

### *Castle Lake and Leybourne Lake (see Sites D and E)*

4.8 From Drawing 5839/226/22A, it appears that Castle Lake will not be directly affected by construction of the new interchange, and that its shoreline will remain unchanged. During construction of the interchange, however, there is an important need to protect the lake, and the lower part of the Leybourne Stream, from pollution.

4.9 From Drawing 5839/226/22A, it appears that approximately 150 metres of the shoreline of Leybourne Lake will be realigned during construction of the new interchange. If this is the case, the provision of a shallow ledge could be considered. The existing lake is extremely steep-sided on account of its former function as a gravel pit and consequently the availability of shallow water habitat is limited. If realignment of the lake margin can accommodate the construction of a shallow berm at the base of the slope, there could be significant advantages to wildlife by creating conditions suitable for shallow water plants. This, in turn, would encourage colonisation by invertebrate species dependant on submerged and emergent sheltered vegetation (eg, dragonflies, damselflies and beetles).

### *Site F – Pond north of the M20*

4.10 This pond was virtually dry at the time of sampling and would be expected to support a different community during wetter seasons. The source of this stream (which may be a spring) should be traced before informed recommendations can be made regarding the best approach for minimising the impact of the highway improvements and, if appropriate, the options for habitat creation.

# 5. Recommendations for Further Work

5.1 This survey was designed as a preliminary baseline aquatic ecology survey and therefore has a relatively broad scope. To minimise the potential for delererious impacts on aquatic ecology there is a need to discuss the detail of engineering plans to identify precisely the nature and extent of stream diversions and culverting proposals, and the incursions in to Castle Lake and Leybourne Lake. Detailed and appropriate mitigation measures can be identified only once this stage has been completed.

5.2 Southern Science would be pleased to advise on the feasibility and design of the proposed balancing pond and of drainage ditches, both in terms of their hydraulic design and in terms of the potential for providing a wildlife resource (as produced in connection with the Iwade Bypass Scheme).

5.3 KTNC have suggested to Southern Science that few if any studies have been undertaken to characterise the flora and fauna of the SNCI (Castle and Leybourne Lakes), other than its bird fauna. KTNC suggested that specialist surveys of certain taxonomic groups (eg, beetles, higher plants) are undertaken as a back-up to this baseline survey, in order to confirm the nature conservation status of the watercourses and water bodies which may be affected by the bypass construction.

5.4 The views of both the NRA and the statutory and non-statutory nature conservation bodies also need to be sought during scheme promotion.

## REFERENCES

1. Southern Science Ltd (1992) West Malling Water Quality Study Job N° 73011, Report N° 92131373

2. Steines, S E (1984) A practical classification of unpolluted running waters in Kent MSc Thesis, University of York

3. National Rivers Authority (1992) River Corridor Surveys – Methods and Procedures Conservation Technical Handbook N° 1

# APPENDIX 1: BMWP SCORE SYSTEM

## ALLOCATION OF BIOLOGICAL SCORES

| FAMILIES | SCORE |
|---|---|
| Siphlonuridae Heptageniidae Leptophlebiidae Ephemerellidae Potamanthidae Ephemeridae Taeniopterygidae Leuctridae Capniidae Perlodidae Perlidae Chloroperlidae Aphelocheiridae Phryganeidae Molannidae Baraeidae Odontoceridae Leptoceridae Goeridae Lepidostomatidae Brachycentridae Sericostomatidae | 10 |
| Astacidae Lestidae Agriidae Gomphidae Cordulegasteridae Aeshnidae Corduliidae Libellulidae Psychomyiidae Philopotamidae | 8 |
| Caenidae Nemouridae Rhyacophilidae Polycentropodidae Limnephilidae | 7 |
| Neritidae Viparidae Ancylidae Hydroptilidae Unionidae Corophiidae Gammaridae Platycnemidiidae Coenagriidae | 6 |
| Mesovelidae Hydrometridae Gerridae Nepidae Naucoridae Notonectidae Pleidae Corixidae Haliplidae Hygrobiidae Dytiscidae Gyrinidae Hydrophilidae Clambidae Helodidae Dryopidae Elminthidae Chrysomelidae Curculionidae Hydropsychidae Tipulidae Simuliidae Planariidae Dendrocoelidae | 5 |
| Baetidae Sialidae Piscicolidae | 4 |
| Valvatidae Hydrobiidae Lymnaeidae Physidae Planorbidae Sphaeriidae Glossiphoniidae Hirudidae Erpobdellidie Asellidae | 3 |
| Chironomidae | 2 |
| Oligochaeta (whole class) | 1 |

# APPENDIX 2: SITES OF NATURE CONSERVATION INTEREST NEAR THE STUDY AREA (CONT.)

Kent Trust for Nature Conservation

Sites of Nature Conservation Interest

| | | | |
|---|---|---|---|
| Site: | Leybourne Lakes etc. Snodland | Site ref no: | TM 30 |
| | | Map ref: | TQ 709605 |
| | | | TQ 694595 |
| | | | TQ 692592 |
| LPA: | Tonbridge & Malling | | |
| Parish: | East Malling & Larkfield | | |
| | Snodland | AONB: | No |
| Owner: | Private | SLA: | No |
| KTNC Grade: | I | AHNCV: | No |
| Category: | Grassland, open water, scrub, woodland, stream | TPO: | Yes |
| | | ASSA: | No |
| | | Grade I/II | |
| | | Agricultural land: | No |
| Area: | 105.6 ha/260 acres | Scheduled species: | Yes |
| | | Public rights of way: | Yes |

## DESCRIPTION

An area lying to the south of Snodland on the western side of River Medway consists of a series of water-filled gravel pits, a calcareous stream, dykes, rough grassland, scrub and woodland. The whole area supports a wide range of wildlife including many species associated with damp, marshy conditions of the Lower Medway which were present in greater numbers before gravel extraction began many years ago. The lakes, many of which are used by fishing clubs, are colonised by a range of aquatic and emergent plants, the degree of colonisation varying according to length of time since gravel extraction ceased and leisure activities now pursued.

The site is important for wintering and breeding water fowl, passerines etc. Over 90 species have been recorded recently; at least 24 of these are breeding species including Cetti's and grasshopper warbler, nightingale and yellow wagtail. Large numbers of wintering wildfowl requiring open water and little disturbance are present in all years, particularly on Abbey Meads Lake.

Botanical interest is high. The streams and dykes have good marginal and aquatic flora including flowering rush (*Butomus umbellatus*), water violet (*Hottonia palustris*), water speedwell (*Veronica anagallis-aquatica*), water crowfoot (*Ranunculus*), marsh sow-thistle (*Sonchus palustris*) and the very uncommon fen rush (*Juncus subnodulosus*). Damp grassy areas still contain colonies of early marsh orchid (*Dactylorhiza incarnata*), southern marsh orchid (*D praeter missa*), common spotted orchid (*D fuchsii*) and many hybrids. The scrubby area contains a variety of willow species including almond willow (*Salix triandra*), (which is very uncommon in Kent and mentioned in the Flora of Kent 1890s), alder and hawthorn etc. There are a few areas of relict woodland.

The entomological interest has not been investigated in detail but the area is known to contain several uncommon species including a ground beetle (*Benbidiur maritimum*) at its only Kent site. Over 20 species of butterfly have been recorded; many species of dragonfly are common.

# APPENDIX 3: NRA ROUTINE BIOLOGICAL MONITORING INFORMATION

## LEYBOURNE STREAM, BROOK HOUSE, TQ 6688 5877

### LIST OF INVERTEBRATE TAXA

| Site Code | 1E0088 | 1E0088 | 1E0088 | 1E0088 | 1E0088 | 1E0088 | 1E0088 | 1E0088 | 1E0088 | 1E0088 |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | 221189 | 190390 | 040790 | 191090 | 180491 | 190791 | 181091 | 120592 | 270892 | 210593 |
| **Taxa** | | | | | | | | | | |
| Planariidae* | 2 | 2 | – | 1 | 2 | 2 | 2 | 2 | 2 | 3 |
| Dendrocoelidae* | – | 2 | – | – | 1 | – | – | – | – | 2 |
| Hydrobiidae* | – | – | 2 | – | 2 | | – | – | – | – |
| Lymnaeidae* | 3 | 4 | 4 | 3 | 3 | 4 | 3 | 2 | 3 | – |
| Planorbidae* | – | | – | | – | | – | | 2 | 1 |
| Ancylidae* | 2 | 3 | 1 | – | 1 | 1 | 2 | – | – | – |
| Sphaeriidae* | 3 | 4 | 4 | 3 | 3 | 2 | 3 | 3 | – | 2 |
| OLIGOCHAETA* | 3 | 4 | 5 | 3 | 3 | 4 | 3 | 4 | 3 | 3 |
| Glossiphoniidae* | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 2 |
| Erpobdellidae* | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 |
| HYDRACARINA | 2 | 2 | 2 | – | – | 2 | 1 | 2 | 2 | 3 |
| Asellidae* | 3 | 2 | – | 2 | 2 | 1 | 2 | 1 | 2 | 3 |
| Gammaridae* | 3 | 4 | 3 | 4 | 3 | 3 | 4 | 3 | 2 | 4 |
| COLLEMBOLA | – | – | – | – | | – | | – | | 2 |
| Baetidae* | 3 | 4 | 2 | – | – | 2 | 3 | 3 | 3 | 4 |
| Veliidae | – | – | 2 | 2 | – | 2 | 1 | – | – | – |
| Gerridae* | – | – | – | – | – | – | – | – | 1 | – |
| Notonectidae* | 1 | – | – | – | – | – | – | – | – | – |
| Corixidae* | 1 | – | – | 1 | – | – | – | – | – | – |
| Haliplidae* | | 1 | 2 | 2 | 2 | 1 | – | – | – | 2 |
| Dytiscidae* | – | – | 1 | – | 1 | – | – | – | – | 1 |
| Hydrophilidae* | | – | 2 | 1 | – | – | – | – | – | – |
| Elmidae* | 3 | 4 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 3 |
| Sialidae* | – | – | – | – | – | – | – | – | – | 1 |
| Rhyacophilidae* | 2 | – | – | – | – | – | – | – | – | – |
| Psychomyiidae* | 2 | 2 | – | – | – | – | 2 | – | – | 1 |
| Hydropsychidae* | 3 | – | – | – | – | – | – | – | – | 2 |
| Hydroptilidae* | – | – | – | 1 | – | – | – | – | 1 | – |
| Limnephilidae* | 3 | 2 | – | 2 | – | – | 3 | – | 2 | 2 |
| Sericostomatidae* | 3 | 3 | – | – | – | | – | 2 | – | 2 |
| Tipulidae* | 2 | 2 | – | – | 1 | 1 | 1 | 1 | – | 2 |
| Psychodidae | – | 2 | – | 1 | – | – | – | 1 | – | – |
| Ceratopogonidae | – | 2 | 2 | – | 1 | 1 | – | 2 | 2 | 3 |
| Chironomidae* | 3 | 3 | 3 | – | 3 | 4 | 2 | 2 | 3 | 3 |
| Simuliidae* | – | – | – | – | – | 3 | 2 | – | – | 2 |
| Stratiomyidae | – | – | – | – | – | – | – | – | – | 2 |
| Dolichopodidae | 1 | – | – | – | – | – | – | – | – | – |
| Tabanidae | – | | – | | – | – | – | 1 | – | – |
| **No of Scoring Taxa** | **20** | **18** | **14** | **14** | **16** | **15** | **16** | **13** | **14** | **21** |
| **BMWP Score** | **96** | **84** | **64** | **60** | **63** | **59** | **69** | **53** | **56** | **97** |
| **ASPT Score** | **4.80** | **4.67** | **3.86** | **4.29** | **3.94** | **3.93** | **4.31** | **4.08** | **4.00** | **4.62** |

(* BMWP Scoring Taxa)

## Appendix 4: Chemical Water Quality Data

| Parameter | Leybourne Stream Sites | | | Tributary | Lake Sites | | Pond |
|---|---|---|---|---|---|---|---|
| | NRA Site (*) | C | A | B | Castle (D) | Leybourne (E) | F(**) |
| Dissolved Oxygen (% sat) | 91 | 93 (90) | 94 (90) | 92 (86) | 79 (68) | 117 (70) | No Sample |
| Temperature (°C) | | 14 (17) | 15 (16) | 13 (17) | 19 (19) | 18 (19) | |
| BOD$_5$ (ATU) (mg/l O) | 1.8 | 1.3 (3.0) | 1.6 (0.8) | 1.4 (12.0) | 3.2 (13.0) | 4.4 (2.2) | |
| Suspended Solids (mg/l) | | | | 190 | (46) | (7) | |
| pH (pH units) | 8.1 | (8.1) | (8.2) | (7.7) | (7.4) | (7.7) | |
| Ammoniacal Nitrogen (mg/l N) | | bd (bd) | bd (bd) | bd (0.12) | bd (0.39) | bd (bd) | |
| Nitrate Nitrogen (mg/l N) | | (4.1) | (4.8) | (0.5) | (bd) | (bd) | |
| Orthophosphate (mg/l P) | | (0.1) | (0.07) | (0.49) | (0.07) | (0.04) | |
| Chloride (mg/l) | 63 | (42) | (44) | (30) | (43) | (68) | |
| Conductivity (usie/cm) | 713 | (580) | (620) | (360) | (510) | (670) | |
| Alkalinity (mg/l $CaCo_3$) | 185 | (175) | (185) | (95) | (110) | (195) | |
| Total Organic Carbon (mg/l) | | (5) | (2.8) | (17) | (5.3) | (4.6) | |
| Lead (µg/l) | | bd | 5.4 | 15.0 | bd | bd | |

( ) = analysis from 1992 survey
bd = below detection limit

AUDIT TRAIL

| Title: West Malling By-pass Scheme - Aquatic Ecology Study | | |
|---|---|---|
| Job Number:73022<br>Order Number:letter | Client Name:<br>Contact:<br>Client Address: | Kent County Council<br>Mark Glanville<br>Sandling Block,<br>Springfield<br>Maidstone<br>Kent ME14 2LQ |
| Start Date: September 1993<br>Completion Date: October 1993 | | |
| Report Version: 1 | | |
| | | Initials/Date |
| Project Leader | Sarah Steines | SeS 11-10-93 |
| Report Written By | Sarah Steines | SeS 11-10-93 |
| Checked By | Nathan Richardson | NJR / 11/10/93 |
| | | Figures and headers/footers are non-standard format |

HIGHWAYS AGENCY

TOLLGATE HOUSE

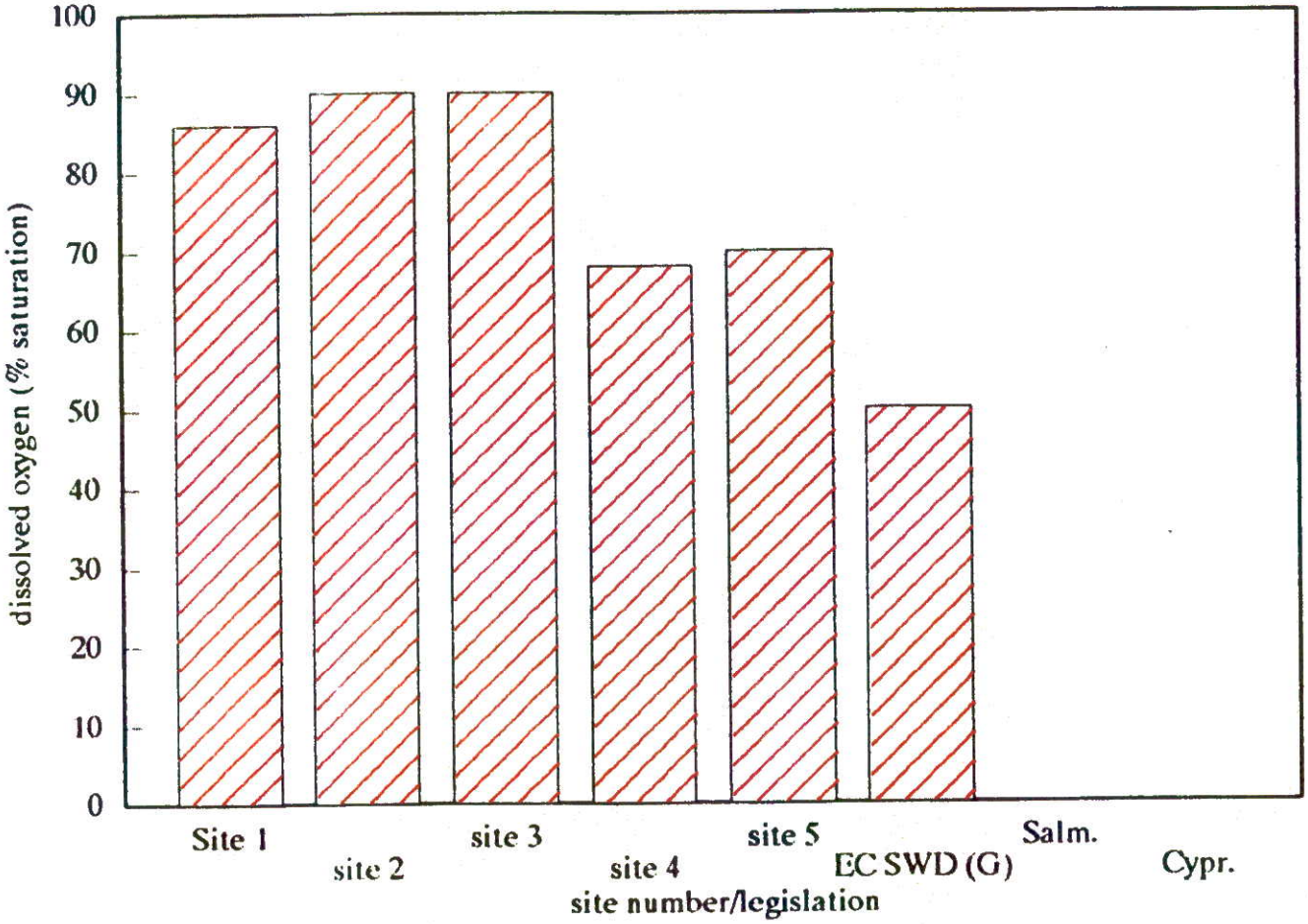


ENVIRONMENT & LANDSCAPE
Environmental Statement

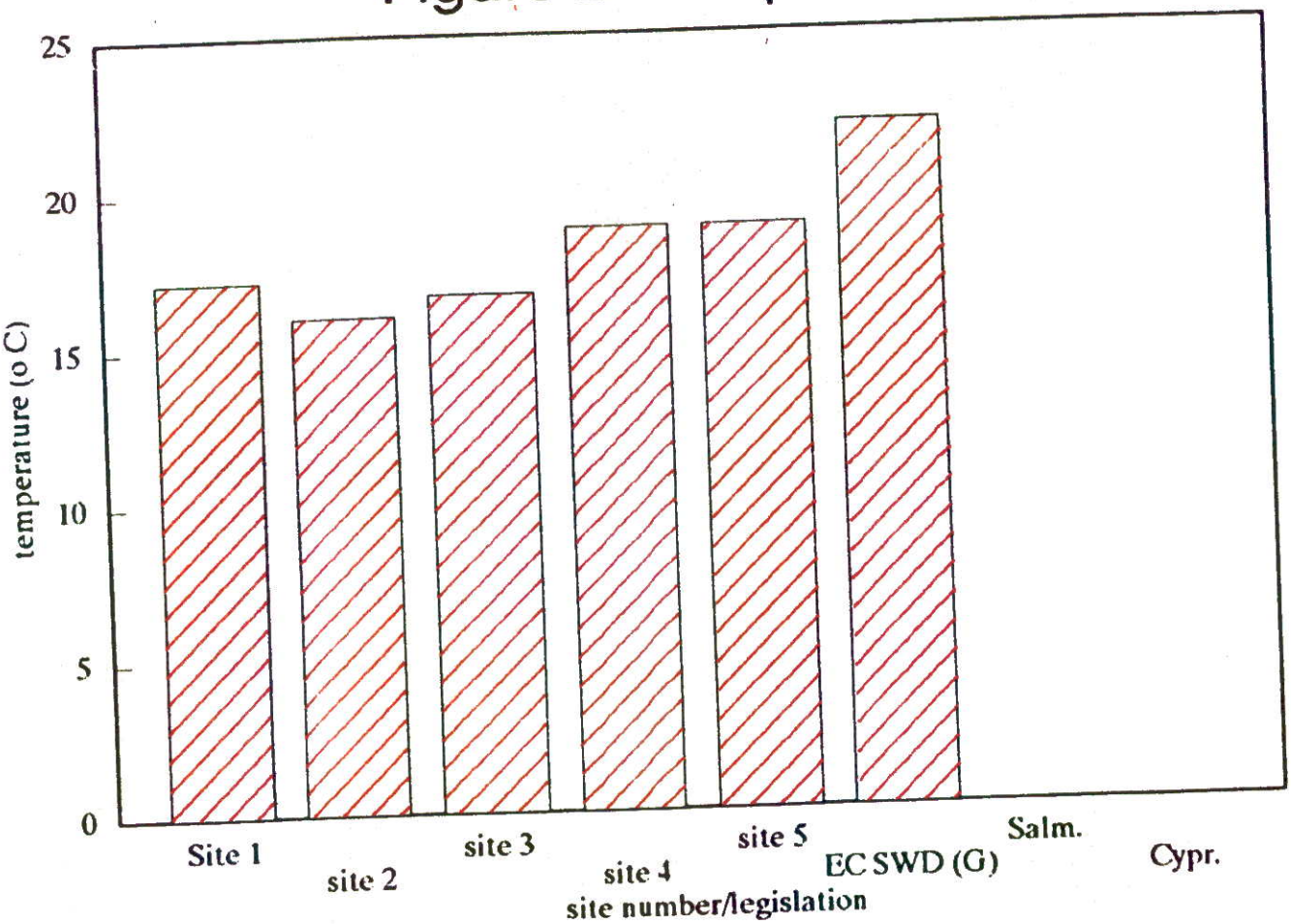


# A228 LEYBOURNE & WEST MALLING BYPASS – ENV. STATEMENT VOLUME 2 – AQUATIC ECOLOGY & WATER QUALITY 07/95

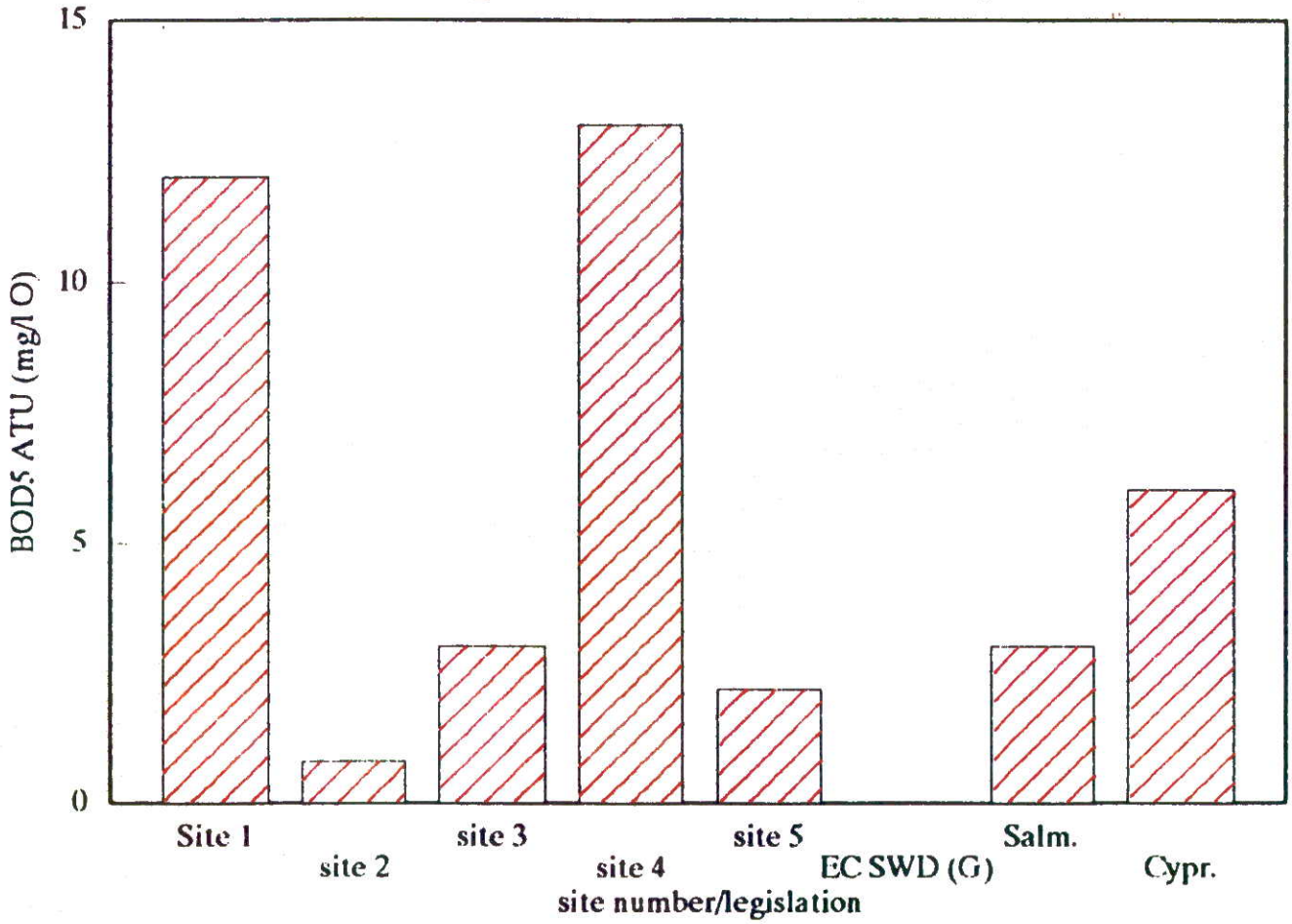
# Figure 1 Dissolved oxygen concentrations



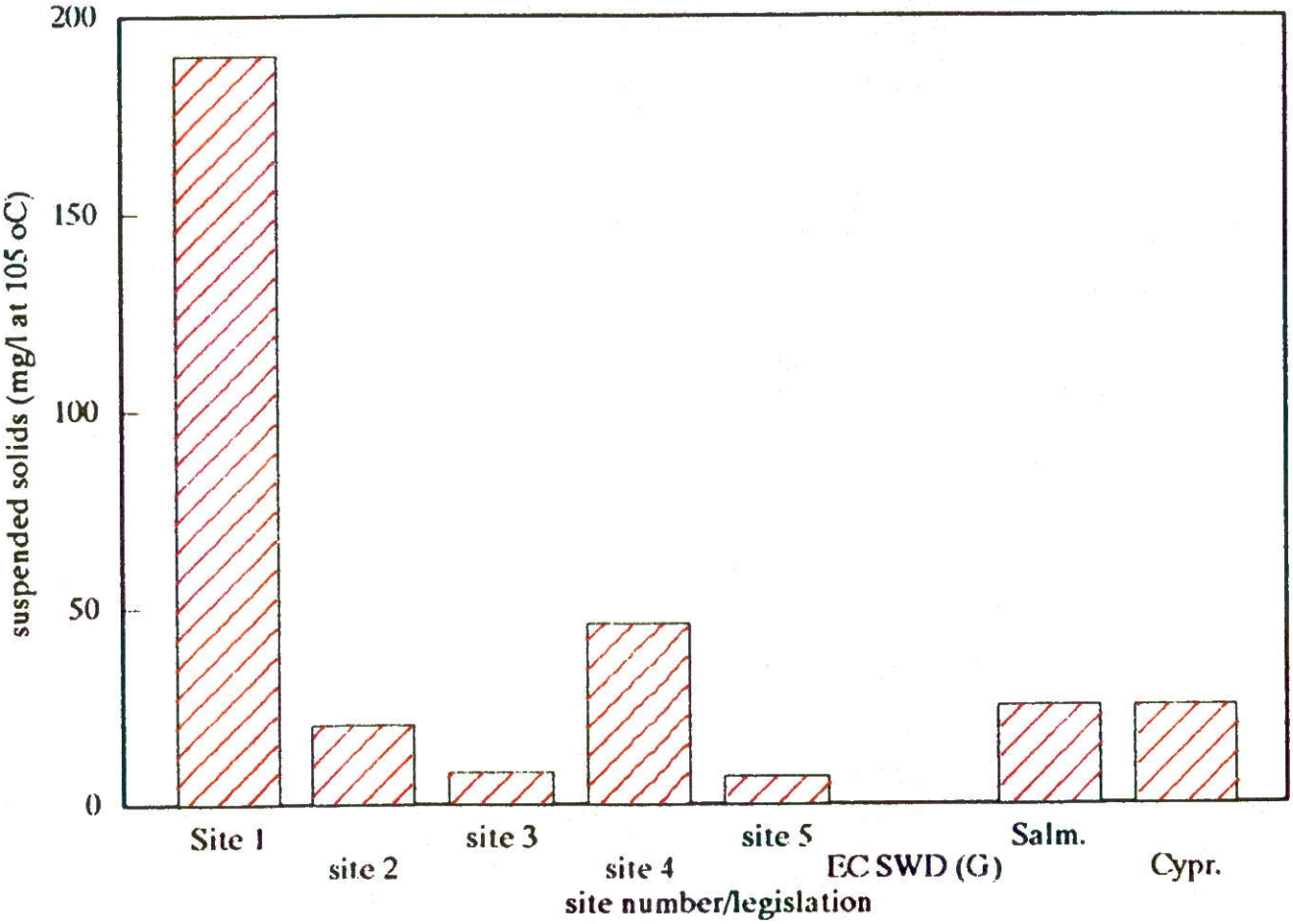
# Figure 2 Temperature



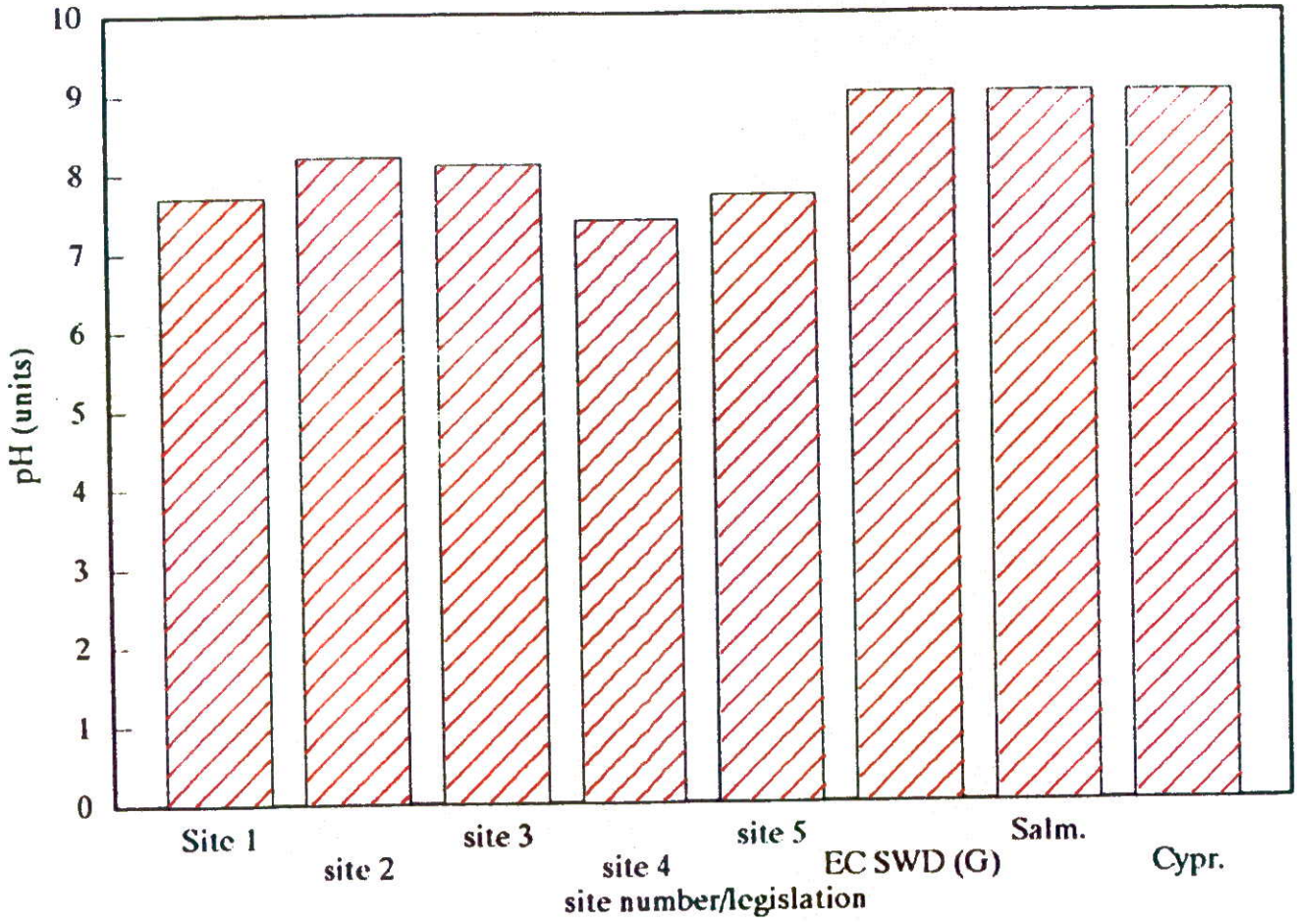
# Figure 3 BOD5(ATU)



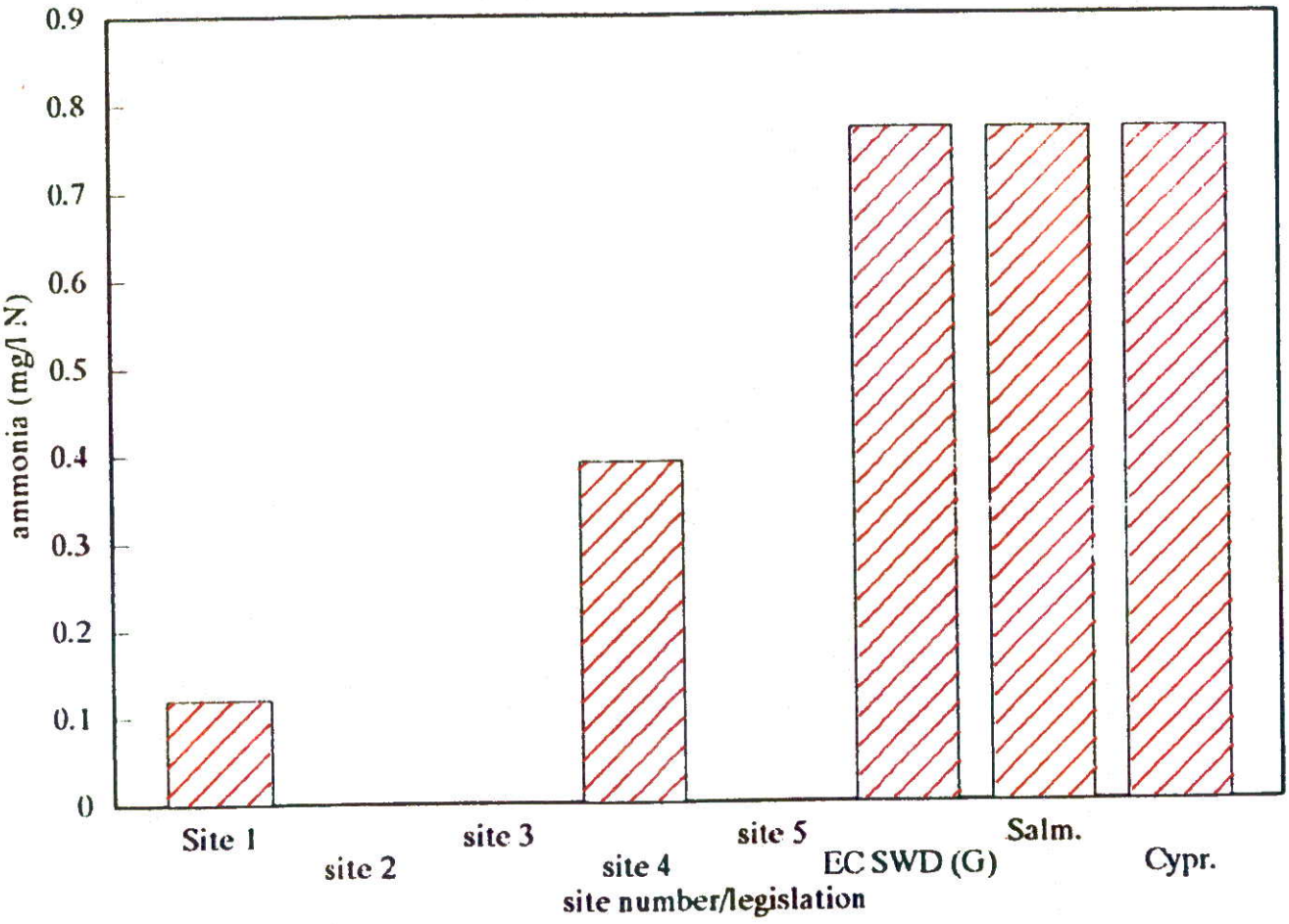
# Figure 4 Suspended Solids



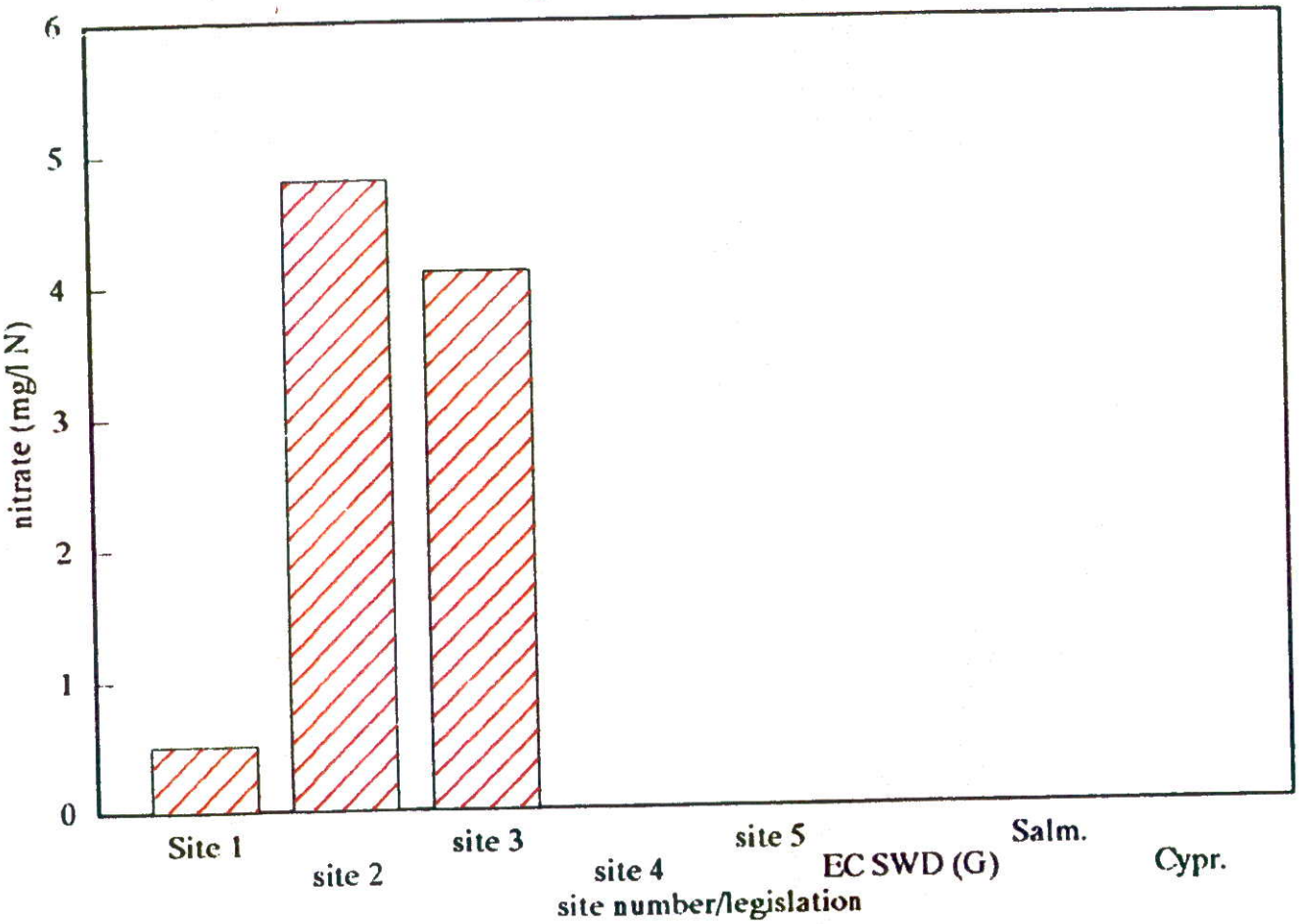
# Figure 5 pH


10
9
8
7
6
5
4
3
2
1
0
pH (units)
Site 1
site 2
site 3
site 4
site 5
EC SWD (G)
Salm.
Cypr.
site number/legislation

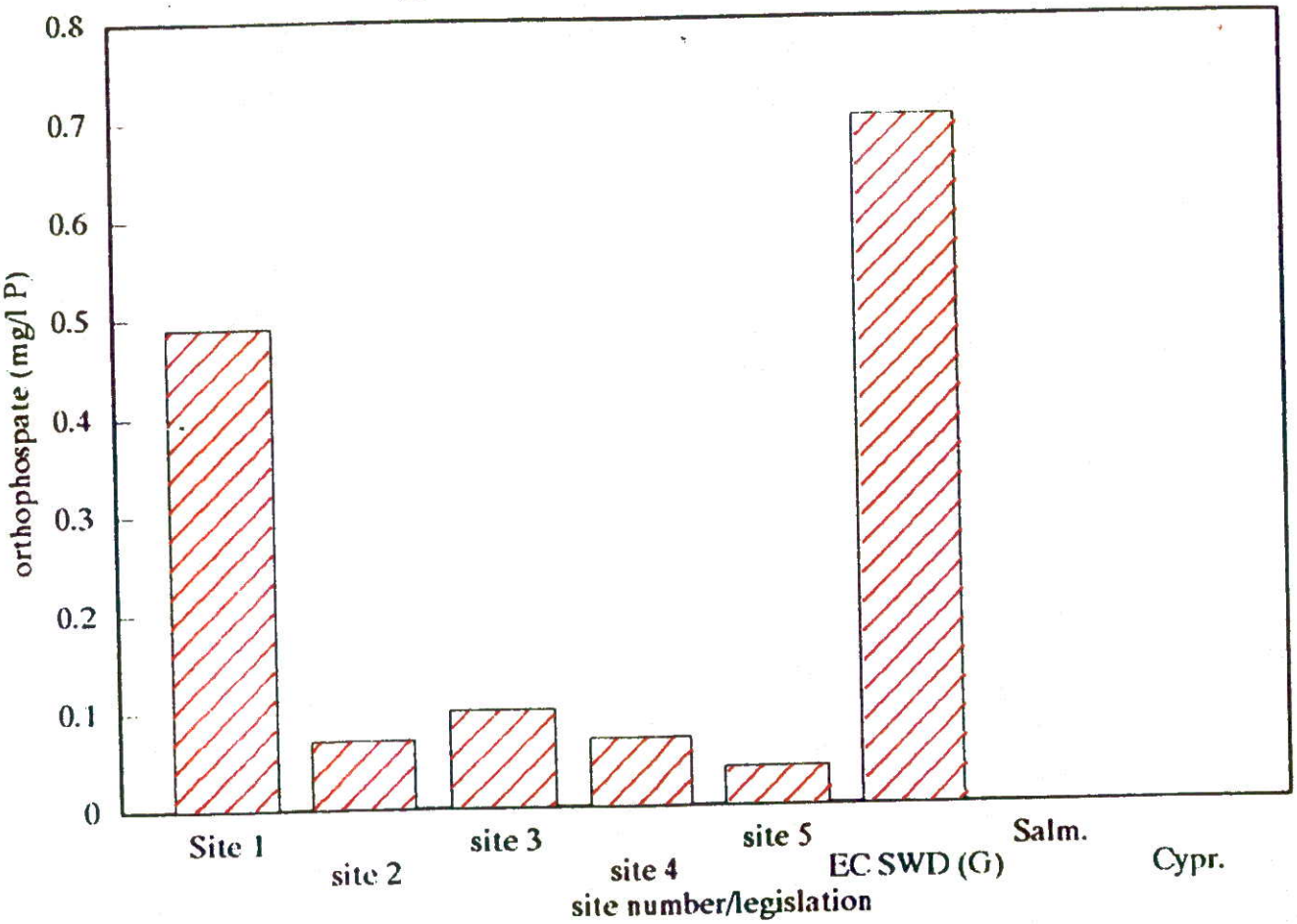
# Figure 6 Ammonia



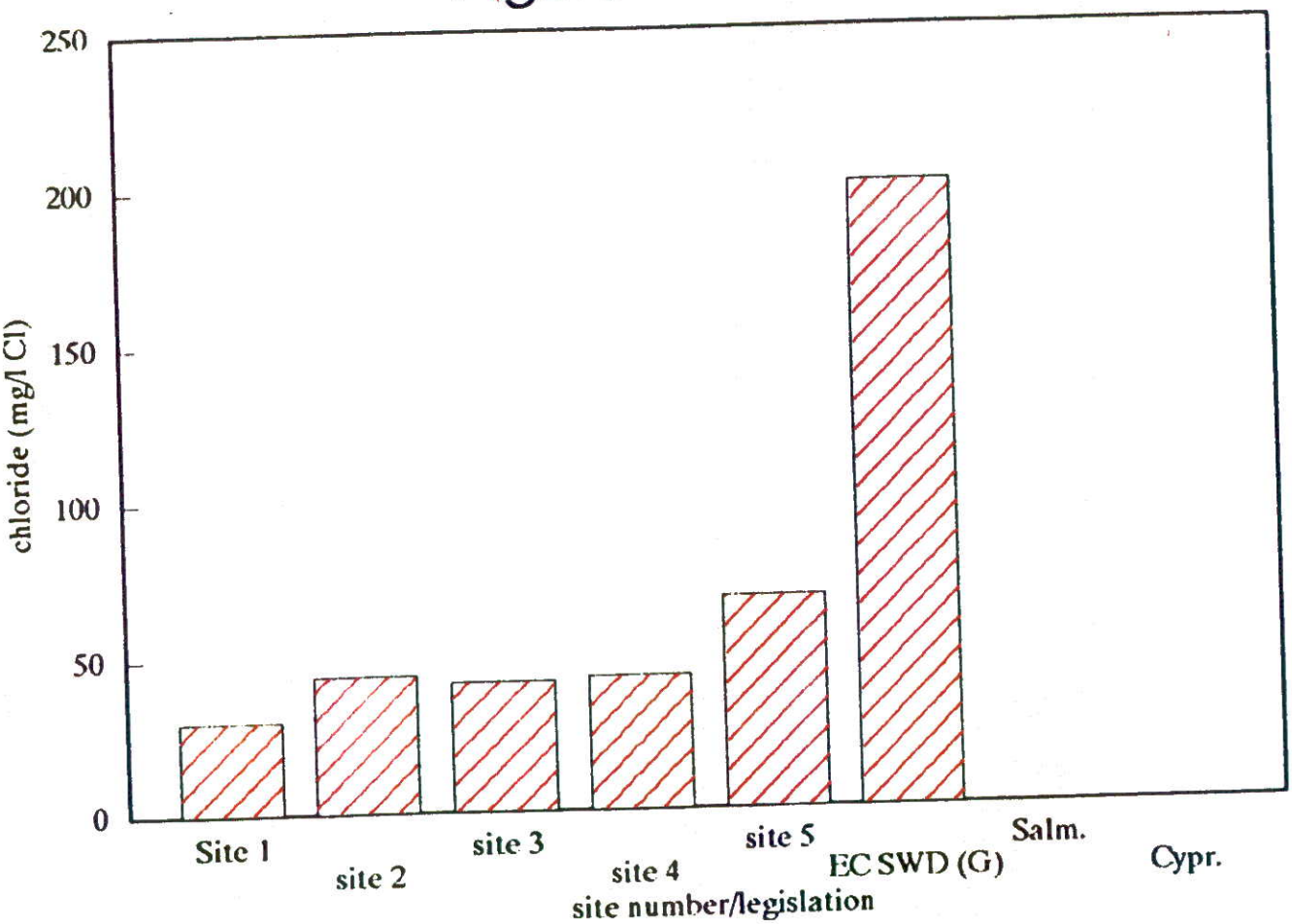
# Figure 7 Nitrate



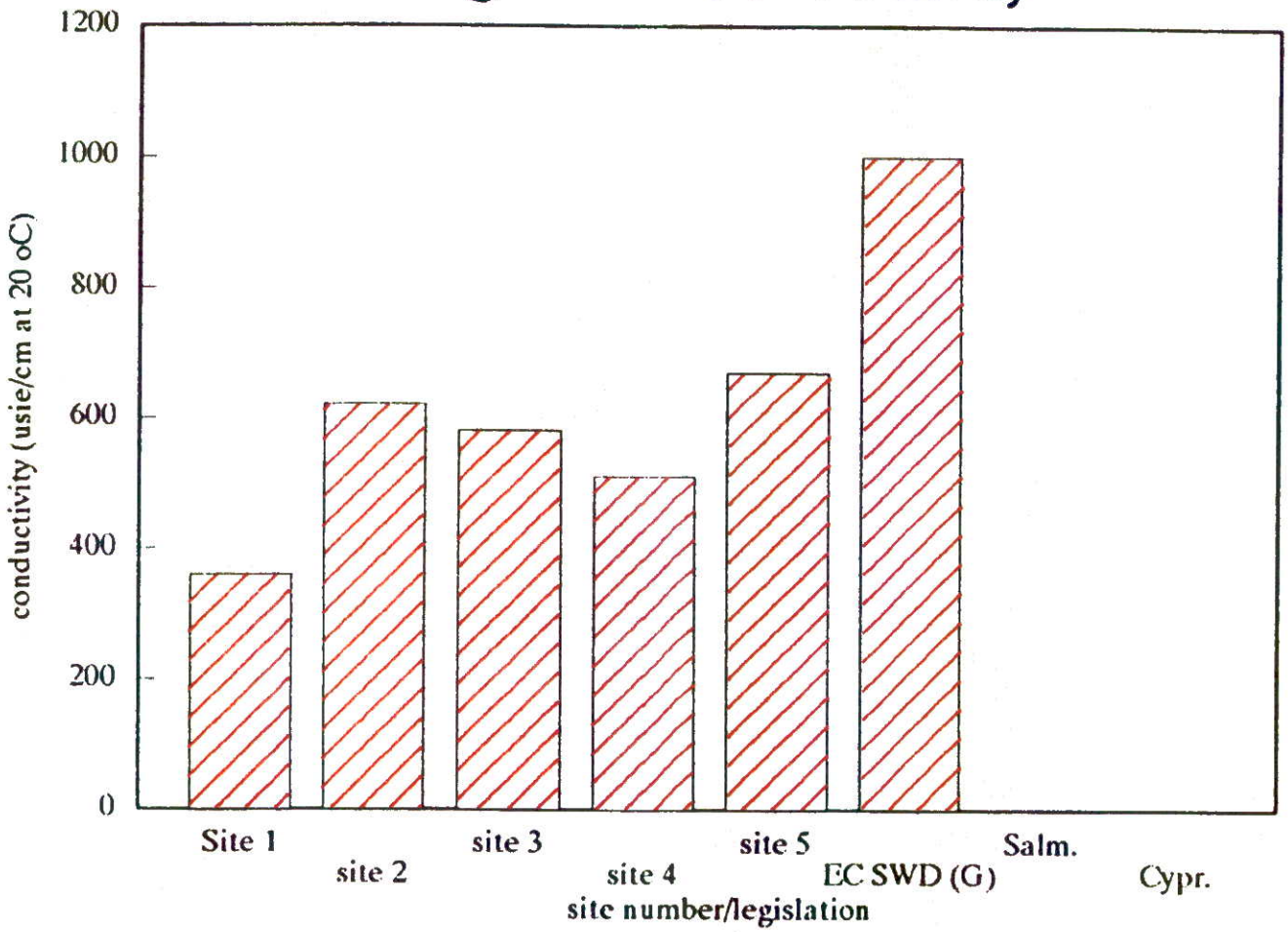
# Figure 8 Orthophosphate



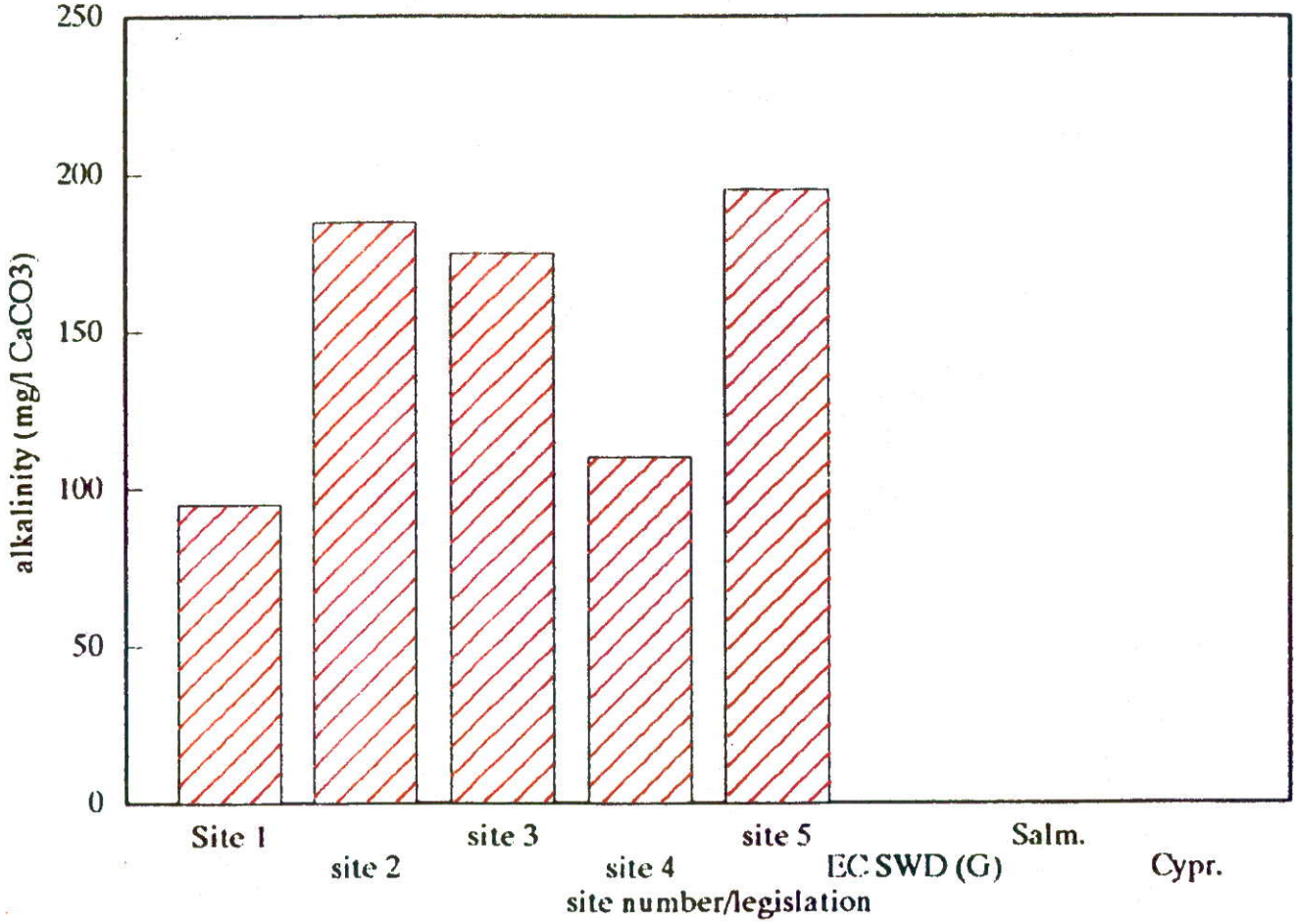
# Figure 9 Chloride



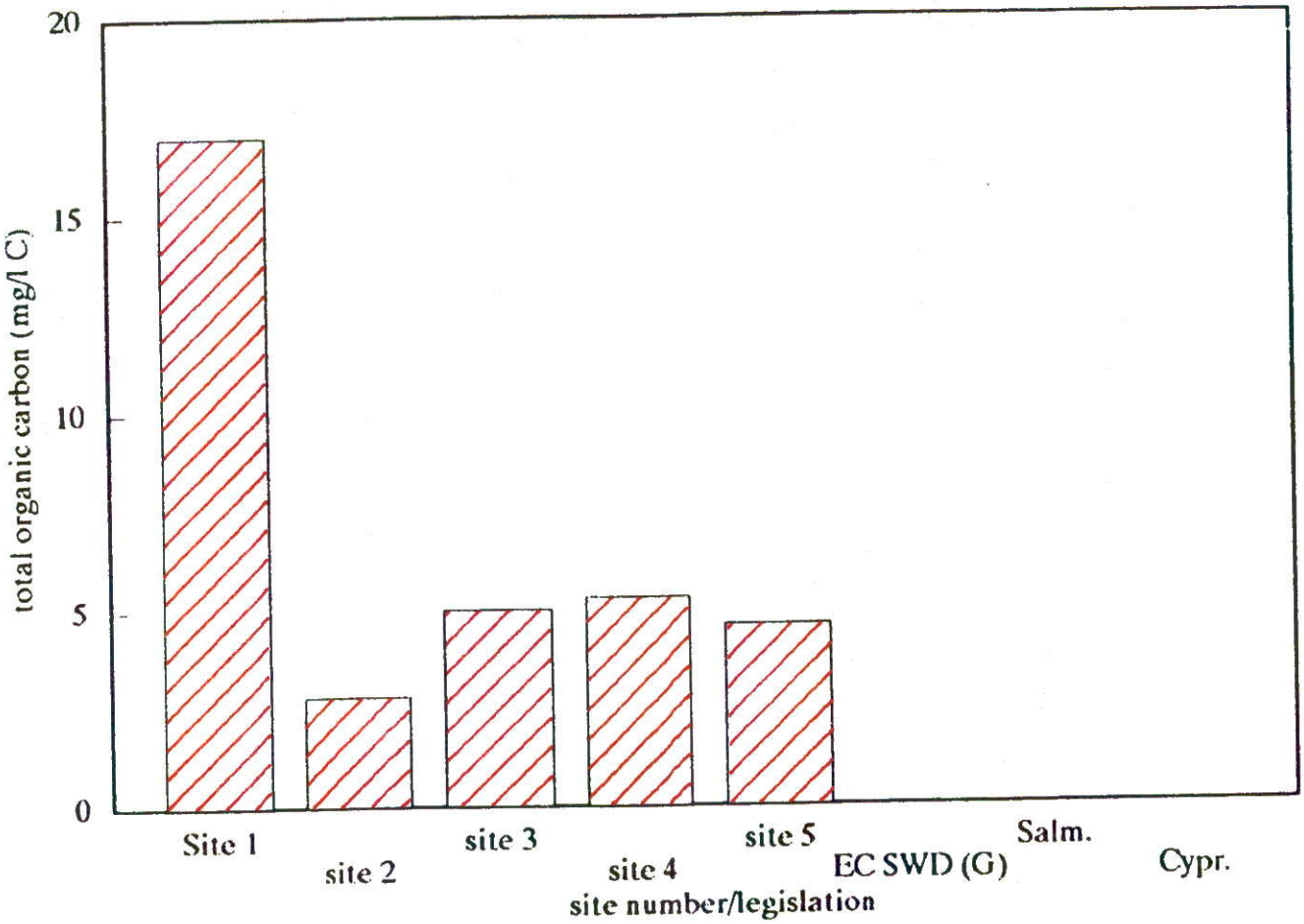
# Figure 10 Conductivity

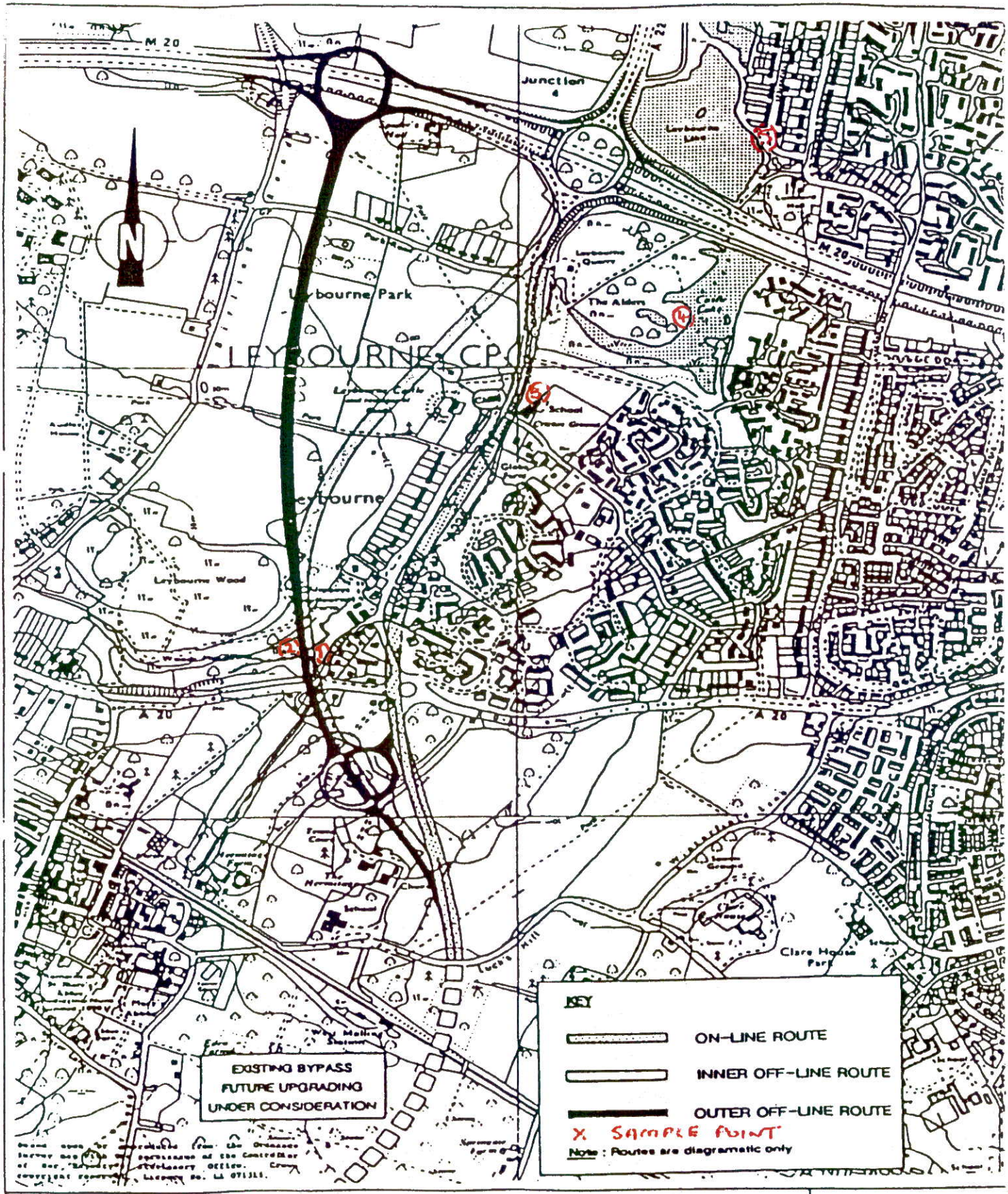


# Figure 11 Alkalinity



# Figure 12 Total Organic Carbon






MAP 1 Water Quality Sampling Points

**Figure 1: Location of sampling points with respect to proposed by-pass route**

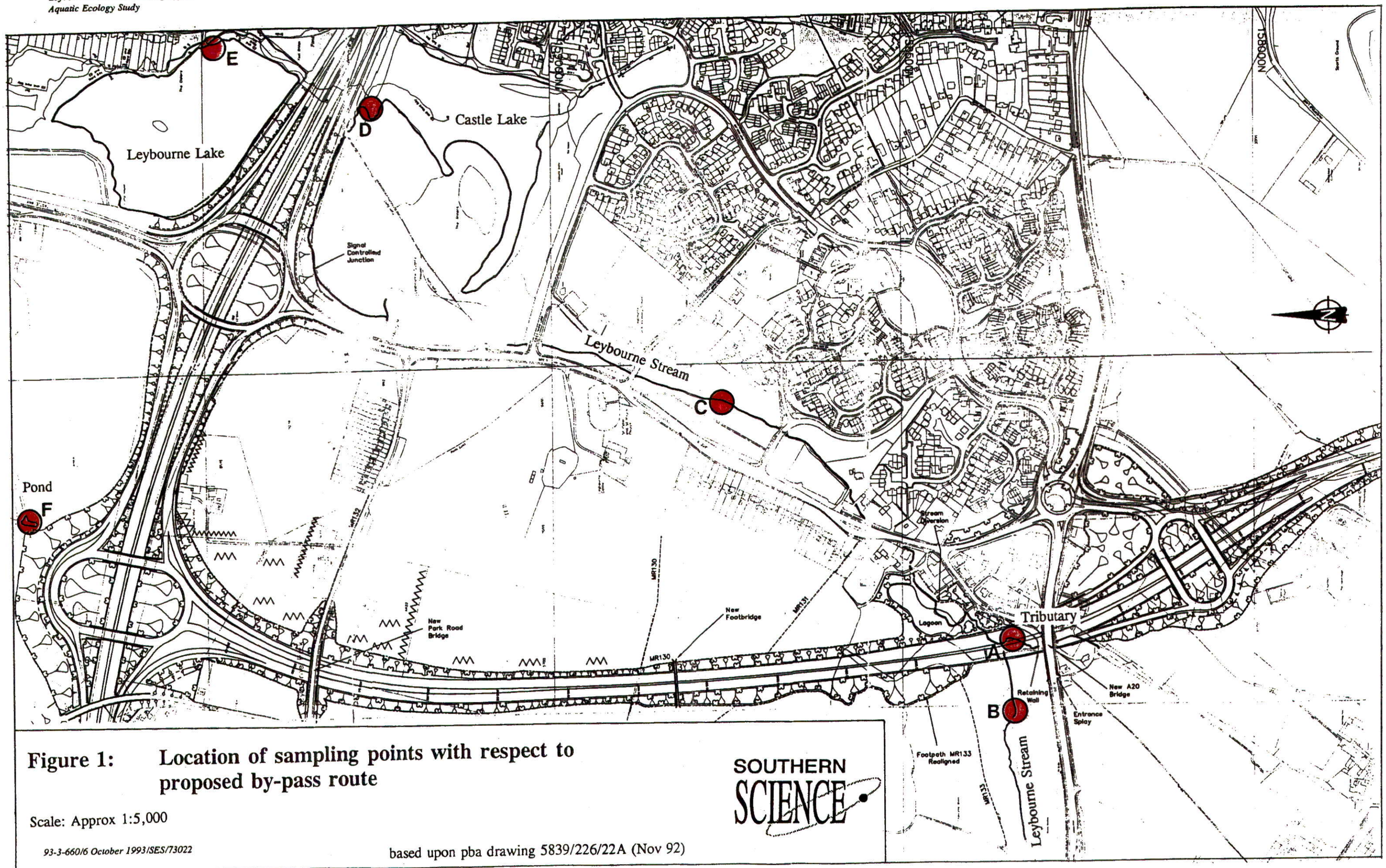



**Figure 1: Location of sampling points with respect to proposed by-pass route**

Scale: Approx 1:5,000

SOUTHERN SCIENCE

*93-3-660/6 October 1993/SES/73022*

based upon pba drawing 5839/226/22A (Nov 92)