NRA

Anglian Region

Hiz, Oughton and Purwell Environmental Appraisal

Volume 1 of 3
Final Report

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

in association with

Engineering - Science Environmental Engineers
NAIAD - Aquatic Environmental Services
Arcady Design

December 1993

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N R A - ANGLIAN REGION

MEMORANDUM

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HIZ RIVER SUPPORT SCHEME - PROJECT APPRAISAL GROUP
INTERIM MEETING TO DISCUSS SWKP REPORT

Further to the decision of the Project Appraisal Group at last Friday's meeting to convene an Interim Meeting of the Group to disucss Scott Wilson Kirkpatrick's Final Report, please note that this meeting has been arranged for

9.30am on Thursday, 27th January 1994

and will be held in Meeting Room 1, Kingfisher Hse, Peterborough.

Claire will circulate a briefing paper to all Group members summarising the principal findings and recommendations of the SWKP Report in time for the meeting.

B.M.J.Barton
Project Manager

Copies to:

Geoff Mason	Hydrogeologist, P'boro
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NATIONAL RIVERS AUTHORITY - ANGLIAN REGION

HIZ, OUGHTON AND PURWELL ENVIRONMENTAL APPRAISAL

FINAL REPORT (DECEMBER 1993)

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FOREWORD

The project leading to this report was carried out under contract to the National Rivers Authority (NRA), Anglian Region by Scott Wilson Kirkpatrick (SWK), Consulting Engineers, in association with Engineering-Science (ES), NAIAD Aquatic Environmental Services (NAIAD) and Arcady Designs (AD).

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AD	J Simmonds BSc MA AMLI	Landscape Architect

NRA (Anglian Region) Working Group:

C Redmond	Conservation Officer
B Barton	Water Resources Engineer
G Mason	Hydrogeologist

The project team gratefully acknowledge the co-operation and assistance received from various organisations and private individuals during this investigation.

Staff at the NRA offices at Peterborough and Brampton assisted with the provision of mapping, hydrological and historical reference data.

Particular thanks are also due to Mr Edwards of the Charlton Society, Mr T James at the Hertfordshire Environmental Record Centre, Dr G Copp at Hertfordshire University, Mr B Sawford of North Herts District Council and Miss Dagmar Junghanns of English Nature.

EXECUTIVE SUMMARY

The essential objectives of this environmental appraisal were to catalogue the present-day ecological, conservation and amenity value of the in-river, riparian and associated wetland systems of the River Hiz, Oughton and Purwell, from their respective sources downstream to Cadwell Bridge, just north of Hitchin.

These objectives were achieved through the combined processes of historical data review, consultation with interested bodies and considerable original baseline field survey work.

This final report details the results of a 6-month study undertaken during April-September 1993, during which river corridor surveys and river landscape assessments were completed in accordance with standard NRA methodology, supplemented throughout with in-stream community and channel morphology surveys.

Each of the three river systems and their interrelated environmental factors are reported in a methodic, geographic manner, inclusive of a separate section dealing specifically with Oughtonhead Common.

The three river catchments are located on the Chalk aquifer and groundwater resources in the area have been extensively utilised for many years for public water supply purposes. These abstractions are believed to have contributed to a significant depletion in baseflows within the local aquatic ecosystems. Because of this, and the long history of public complaints concerning alleged diminution of flows in the River Hiz, the NRA highlighted the locality as one of the top twenty sites in the national "Alleviation of Low Flows" study. The environmental appraisal completed for this report was therefore intended to aid the NRA in defining the problem and hence provide guidance on environmentally appropriate ameliorative solutions.

The overall conclusions of the environmental appraisal are that the River Purwell and its associated wetlands currently retain greater botanical and conservation value than the River Oughton system. Both rivers are recorded as severely below potential with respect to in-stream communities. Similarly, in-stream habitat and community structure within the River Hiz are also recorded as severely derogated. More seriously, the River Hiz retains even less botanical or conservation interest than the Purwell or the Oughton.

Although the ecology of these watercourses is therefore degraded to an extent that warrants little intervention, the associated wetland habitats such as Purwell Meadows/Ninesprings, Oughtonhead Common/Nature Reserve and Knebworth Woods offer greater conservation significance. It is in these areas that it is recommended that the NRA might positively advise and support beneficial environmental management plans in close liaison with local Trusts, the District Council and riparian owners.

Despite a rather derogated overall picture with respect to biological and conservation matters, all three rivers and the Common remain locally important for their cultural links and associated amenity and visual contribution to the landscape. Their general presence within or proximity to the town of Hitchin and attractive villages such as Charlton enhances their

value as green corridors linking urban and rural areas. Also, for their visual and recreational amenity value of "flowing water" within the public eye, areas such as the Mill Pond at Charlton and the formal water gardens adjacent to St Marys Parish Church in the centre of Hitchin, would greatly benefit from restoration engineering, such as desilting and possibly seasonal flow support. However, it is important that the latter option is not undertaken at the expense of decreasing baseflows within and derogation of the presently valuable wetlands of the Purwell valley.

1. INTRODUCTION

1.1 Project Description

The Rivers Hiz, Oughton and Purwell are East Anglian streams which rely for their habitat characteristics and ecology on substantial base flows from the underlying Chalk aquifer. The Hiz rises at Charlton to the south west of Hitchin (Figure 1A) in Hertfordshire, and in its upper reaches is fed by two tributaries. The first, the River Purwell has two arms, the most northerly of which rises at Willian to the north east of Hitchin. The southern arm comprises the Ippollitts Brook, rising at Newton Wood, about five kilometres to the south east of Hitchin (Figure 1B), and the Ash Brook rising to the east at Great Wymondley. A second tributary, the River Oughton, rises to the north west of Hitchin from springs at Oughtonhead Common, and joins the main river at the northern edge of Hitchin, downstream of the Purwell confluence.

In its upper reaches, the Hiz drains intensively farmed land around the urban conurbation of Hitchin, which in common with much of East Anglia has undergone recent residential and industrial development. This has increased both water demand and surface water discharge as sewage effluent and agricultural run off. Water supply to the area is abstracted largely from the underlying Chalk aquifer which requires increasingly careful management.

The Rivers Hiz and Oughton, together with the Oughton's associated wetland sites have, over the years, been seriously affected by reduced flows and groundwater levels. The River Purwell has been less seriously affected but there is a need to ensure that spring flows are protected to maintain the condition of that river and its associated wetlands.

An investigation to appraise the hydrology and hydrogeology and propose solutions to alleviate the low flow problem in the rivers concerned was submitted recently to the National Rivers Authority (NRA).

The report (MacDonald, 1992) confirmed that increased abstraction, mainly from public water supply boreholes is the cause of lowered groundwater levels and river flows. Options proposed to resolve the problem include relocation of public water supply abstraction, river supports, river recirculation and replacement of public water supplies from Grafham Water. The proposed solutions are complex and general cost estimates (1993) exhibit a broad range between £0.5 and £9.0 million, depending on the option or combination of options chosen.

The current study therefore stems from the wish of the NRA to place the various engineering options in context, with respect to a detailed environmental appraisal to define the present "baseline" conservation value of the river systems upstream of Cadwell Bridge.

1.2 Objectives and Scope of Work

Scott Wilson Kirkpatrick (SWK) were appointed by the NRA Anglian Region in April 1993 to undertake an environmental appraisal of the Rivers Hiz, Oughton and Purwell and their associated wetlands. The Terms of Reference for the project are given in Appendix A.

In August 1993, the original Terms of Reference were extended to incorporate river corridor survey work within the upper reaches of the Purwell system up to Newton Woods (Figure 1B).

As partially noted in 1.1 above, the objectives of the project were to assist the NRA in identifying the current extent of low-flow problems, whether there is a need to instigate ameliorative solutions and if so, identify solutions appropriate to the local environment.

The scope of work required the Hiz, Oughton, Oughtonhead Common and the Purwell to be reported as four sections, with the following information to be catalogued for change.

- aquatic and riparian species and habitat	)	River Corridor
- adjacent wetland habitat and species	)	Survey
- channel invertebrate populations	)	In-Stream
- fish populations	)	Communities
- landscape value	)	River Landscape
- amenity and recreational value	)	Assessment
- channel morphology	)	River Engineering

Through the process of desk reviews, reference searches, local and external consultation and field survey work in the respective disciplines, the data relevant to this appraisal was essentially compiled between mid April to end August 1993, with the first draft final report passed to the NRA in mid-September 1993.

1.3 Background

Historically, the water resource function of flow in a watercourse was (simplistically) to dilute effluent discharges to the channel and provide water for irrigation and public supply. The conservation value of the river system and the requirements of instream and riparian communities were largely overlooked. Aquifers were resources for consumption and little attention was paid to the effects abstraction might have upon communities or habitats depending on groundwater for their characteristics.

Following the establishment of the NRA in 1989, with its broad duties for the management, protection and enhancement of the aquatic environment, there is now a recognised need to achieve a balance between the demands of the abstractor and the

environment. The NRA is also committed to tackling the inherited problem of low river flows. Against this background, the upper catchment of the River Hiz was identified within the NRA's 'top 20' schedule of locations requiring the most urgent attention.

1.3.1 River Corridor Survey

The approach to the riparian and wetland ecology involved the steps of consultation, field survey, assessment and integration with other disciplines and reporting.

After an initial meeting with the NRA and in accordance with the Project Plan consultations were held with English Nature (EN), the Herts Wildlife Trust (HWT), the Herts Environmental Records Centre, the Local Planning Authorities, County Record Office and local amenity and action groups. The data from these organisations provided some general information as well as detail on the ecological resources of the catchments and the Common in particular. This information was used to direct some of the preplanned ecological surveys and to determine if other surveys should be recommended, such as the subsequent extension into the Upper Purwell/Knebworth Wood region.

The Common received a less intensive survey with the purpose of confirming the presence and distribution of the ecological resources noted by EN and the HWT.

During all of these surveys notes were made to support the determination of effects of previous management and to identify opportunities for environmentally appropriate solutions if ameliorative work is required.

1.3.2 In-stream Communities

One aim of the present study has been to incorporate instream community data into an evaluation of the upper Hiz and tributaries. The process proceeded through two phases. The first stage involved fieldwork to assess the condition of the upper Hiz and tributaries in terms of instream habitat and community diversity. The second discussed the measures needed to retain or increase habitat and community diversity in the various streams. In addition, in derogated stretches, the flow regime which would have characterised the river in its 'natural' state was suggested. Re-instating these flow conditions however, does not necessarily regenerate such conditions. To expedite recovery, it may be necessary to alter channel morphology, re-instate plants, riffles and pools, and reintroduce the organisms that colonised them.

Historically, the river systems upstream of Cadwell Bridge are reputed to have supported a fish assemblage and instream communities typical of English chalk streams (trout, dace and roach). Data in the form of instream macro-invertebrate and vascular plant species lists are held at the Hertfordshire Environmental Records Centre in Hitchin, and support these anecdotal reports. In 1982, fish species were limited to three- and nine-spined sticklebacks and the macro-invertebrate community at Purwell Ninesprings was not particularly diverse. The locally rare flatworm *Crenobia alpina* which favours cold unpolluted spring habitats was recorded in 1982,

and has also been recorded in the past at the nearby Ashwell spring on the River Rhee. In 1982, the Purwell also supported mayfly species (*Cloeon*) although none of particular conservation importance, and several vegetable-case-building caddisfly larvae. However, the assemblage was generally dominated by species with less exacting environmental requirements such as beetles, water bugs, fly larvae, water mites and snails. In contrast, the River Oughton supported a far more diverse instream community, including several mayfly and a wealth of dragonfly and caddisfly species recorded between 1920 and 1980 (Appendix C2).

There have been few recent appraisals of the study area to document instream or wetland communities. A notable exception is Copp (1992) who comprehensively surveyed 0-group fish distribution in non-tidal reaches of the River Great Ouse and its tributaries. His survey showed that the upper reaches of the River Hiz and its tributaries were dominated by *Gasterosteus aculeatus* and *Pungitius pungitius* (three- and nine-spined sticklebacks) and generally supported only short-lived, short-bodied species. Undergraduate students of Dr Copp at the Department of Environmental Science, University of Hertfordshire, have recently carried out several studies of instream communities and environmental conditions in the upper reaches of the River Hiz. From a survey of macro-invertebrates, plants (Champion, 1992) and conservative physio-chemical variables (Vascovics, 1991) at eleven sites in and around Hitchin in 1991, conditions were described as 'organically polluted and eutrophic or mesotrophic in character'. Weber (1992) in a study of microhabitat-species relationships in Ashwell Springs, the St Ippollitts Brook and the River Chess stated that 'scrapers', which are adapted for removing attached algae from rocks or log surfaces, were dominant. Within this group was included the pollution insensitive caddisfly species *Agpetus fuscipes, Apatania muliebris* and *Drusus annulatus* which generally colonise eroding habitats. However, it is unclear from the study report whether these species were recorded in the St Ippollitts Brook, Bagshaw (1992), in a study of the dietary requirements of three- and nine-spined sticklebacks, recorded *Cottus gobio* (bullhead), *Noemacheilus barbatulus* (stoneloach), *Gobio gobio* (gudgeon) and *Rutilis rutilus* (roach) in the upper catchment although the regions in which each species occurred is not made clear.

The National Rivers Authority's fishery staff surveyed the channel downstream of the present study area in 1983, 1985 and 1989. On each occasion the sampled channel supported a biomass of about $3g/m^2$ and was classified as a poor fishery. The site was dominated by roach (71% biomass) with stoneloach, gudgeon and pike also occurring (although the pike population and had been in decline since 1983). During the present habitat and macro-invertebrate survey, large brown trout were seen in the lower sections of the River Oughton, and these are reported to have originated from trout farms on the Oughton or on the Hiz at Ickleford.

Water quality in the streams draining the area around Hitchin and in the Hiz itself was cariable but the stretch generally fell within NWC chemical class 2. Urban run-off, organic pollution and low habitat diversity were blamed for the low value. Sites further downstream (nearer the Ivel confluence) were classified 1b, the river having by this point undergone a degree of self-purification.

1.3.3 Landscape Assessment

The survey area is centred on Hitchin, a traditional market town with medieval origins. Several environmental factors now form limits to the towns size, and the Green Belt surrounds the town. This protects both the identity and character of Hitchin, recognised as being of national importance by the Council for British Archaeology (N.H.D. Local Plan, 1990).

Geology

The geology of an area is the major factor determining its topography and soils, which together with climate determine the natural vegetation and influence farming practices, and underlay the visual appeal of any area. The solid geology of the area is essentially Cretaceous Chalk, which forms the nearby Chilterns. Later Eocene deposits have been much eroded and two periods of Pleistocene ice ages have produced most of the superficial deposits (Herts. Env. Forum, 1990).

Soils

The soils are essentially calcareous, with small pockets of leached acid soils, and generally well drained. Agricultural Land classification for the study area, is Grade 3, except for a small island of Grade 2 centred on Little Wymondly (Soil Survey, 1993).

County Landscape

The most recent comprehensive survey of the County's landscape was undertaken in the 1960s, to assess amongst other things the landscape quality (Herts. Env. Forum, 1990). To this end the County was divided into tracts which were "areas of land having a uniform character and quality, and which were as far as possible visually self contained" 96 different tracts were defined. Each of these tracts were scored, based on a checklist of landscape components, and on the negative side eyesores and detractive elements, to allow comparison between the various tracts to be made, and for them to be graded into bands. The results are shown in Figure 2.

From this information it is possible to place the study area in perspective. The landscape directly to the west of Hitchin, is assessed as grades 1 and 2 Distinguished, and has been designated as The North Chilterns Countryside Heritage area, which contains within it the Chilterns AONB. To the south and east the landscape is assessed as 3 and 4 Pleasant, whilst to the north the landscape is graded 5 and 6, Uninteresting. Further, the North Hertfordshire District Council has designated (NHD Local Plan, 1990) the countryside within the Greenbelt to the west of Hitchin as Landscape Conservation Area 1, "the Chilterns escarpment between Luton and Hitchin, and the dip slope southwards to Lilly Bottom, Whitwell, Langley and Old Knebworth" and aims to protect this landscape.

Figure 3 shows the location of the Landscape Heritage areas, which are areas of high landscape and habitat value, and the location of the designated Areas of Outstanding Natural Beauty (AONB), within Hertfordshire (Herts. Env. Forum, 1990).

It should be noted that the County Council intends to carry out a new detailed survey in 1992/93 (September 1993 not begun yet), to monitor qualitative changes that have occurred in the County and to identify those areas in need of protection and those which required improvement (Edwards; Bright; pers. comm, 1993).

Perception

The Mott MacDonald report of 1992, collected varied and wide ranging information including photographs of old prints of the river and anecdotal evidence. One such comment attributed to Mr Francis Lucas who in the last century was apt to refer to the Hiz, as "the is' in Winter and the 'was' in Summer", indicates that perhaps the river flows in the past have been variable. However specific prints show scenes of punting and skating on the mill pond at Charlton, and skating on the lake above the bridge at St Ippollitts, and a Mr William Lucas, relative of the miller at West Mill, 18th century/early 19th, recalls punting on the River Oughton.

Such observations and historical records certainly indicate to the general public that the rivers contained more water in the past.

More recent correspondence between the AWA, and latterly the NRA, and The Charlton Society (Letters of Complaint, 1981-89) expressing concern over observed low flows confirms that in the view of the public the water level in the River Hiz is dropping, and that members are concerned for the general amenity and wildlife of the area.

Figure 4 shows all the definitive footpaths in the study area (Public Right of Way, 1993), together with designated Public Open Space and Nature Reserves. This clearly illustrates the importance of the river network to the amenity of the area.

LIMIT OF STUDY AREA

RIVER OUGHTON

RIVER PURWELL

WILLIAN BROOK

RIVER HIZ

IPPOLLITTS BROOK

ASH BROOK

PIRTON CP

IPPOLLITTS CP

WYMONDLEY CP

NORTH HERTFORDSHI

See figure 1b

LOCATION OF STUDY AREA

93BBB/001A

Scale 1:25000

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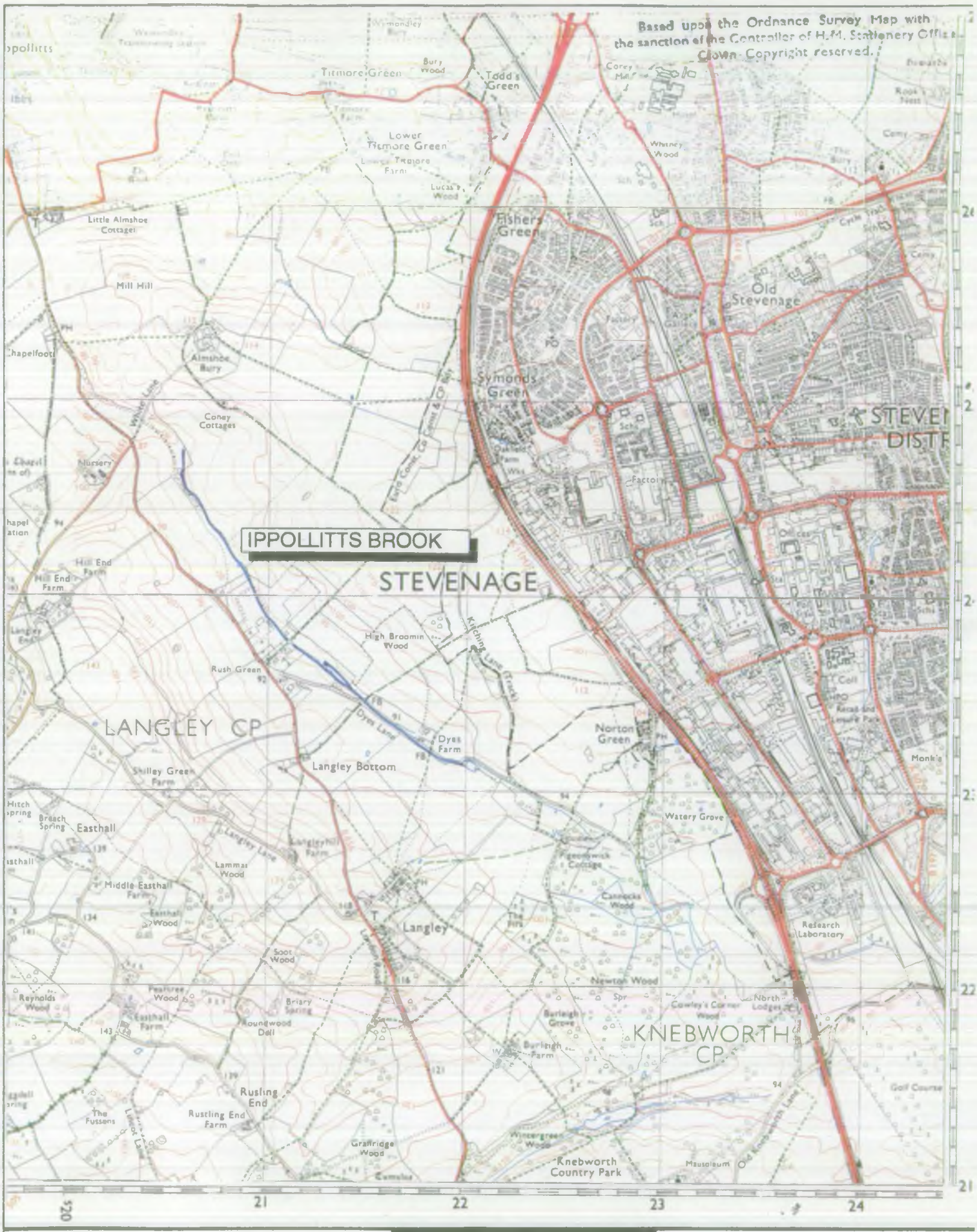

LOCATION OF EXTENSION STUDY AREA (RCS ONLY)

Hiz, Oughton and Purwell Environmental Appraisal

Scale 1:25000

93BBB/001B

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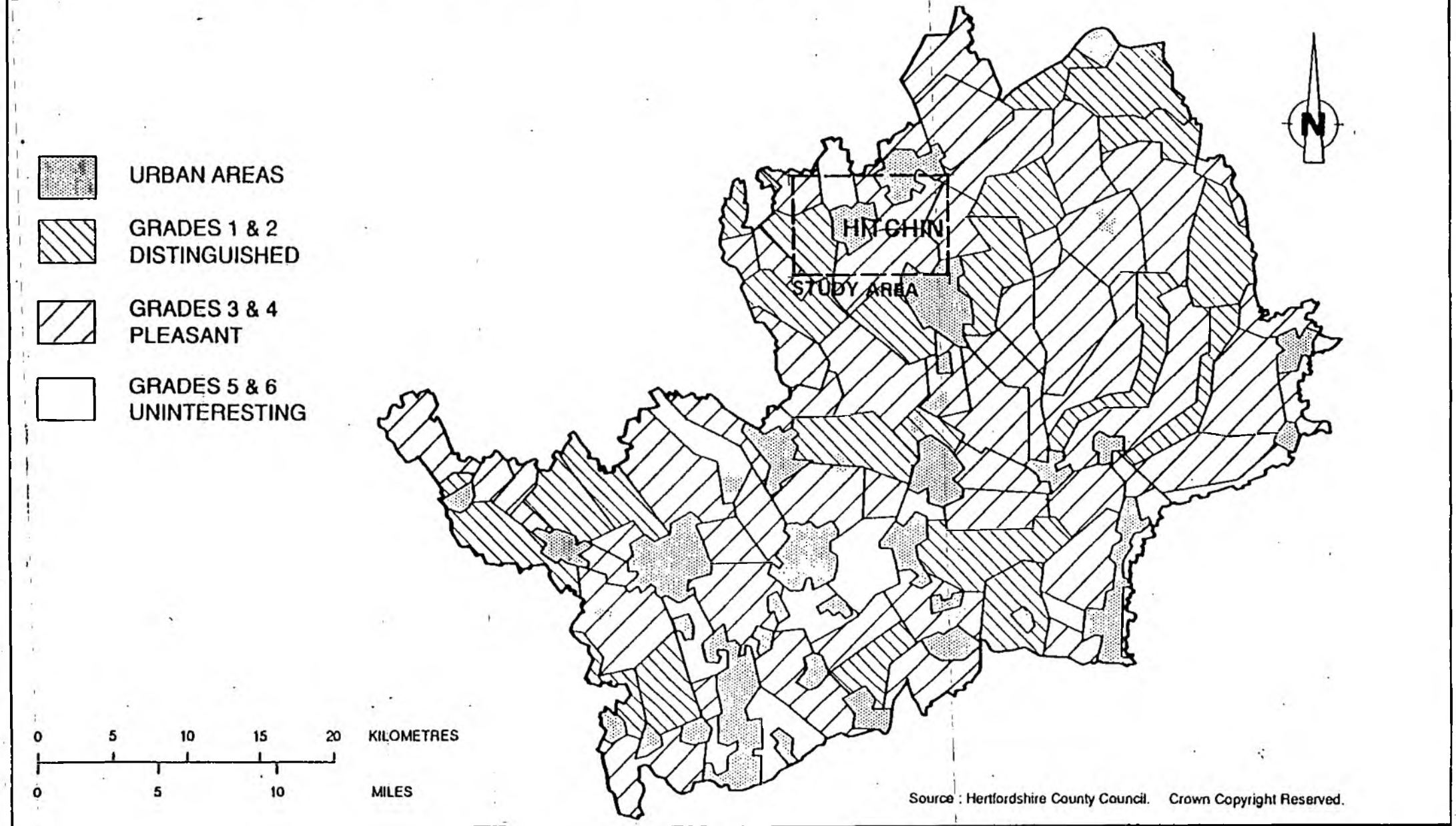

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COUNTY LANDSCAPE DESIGNATION

Hiz,Oughton and Purwell Environmental Appraisal

scale 1:300,000 APPROX

93BBB / 002

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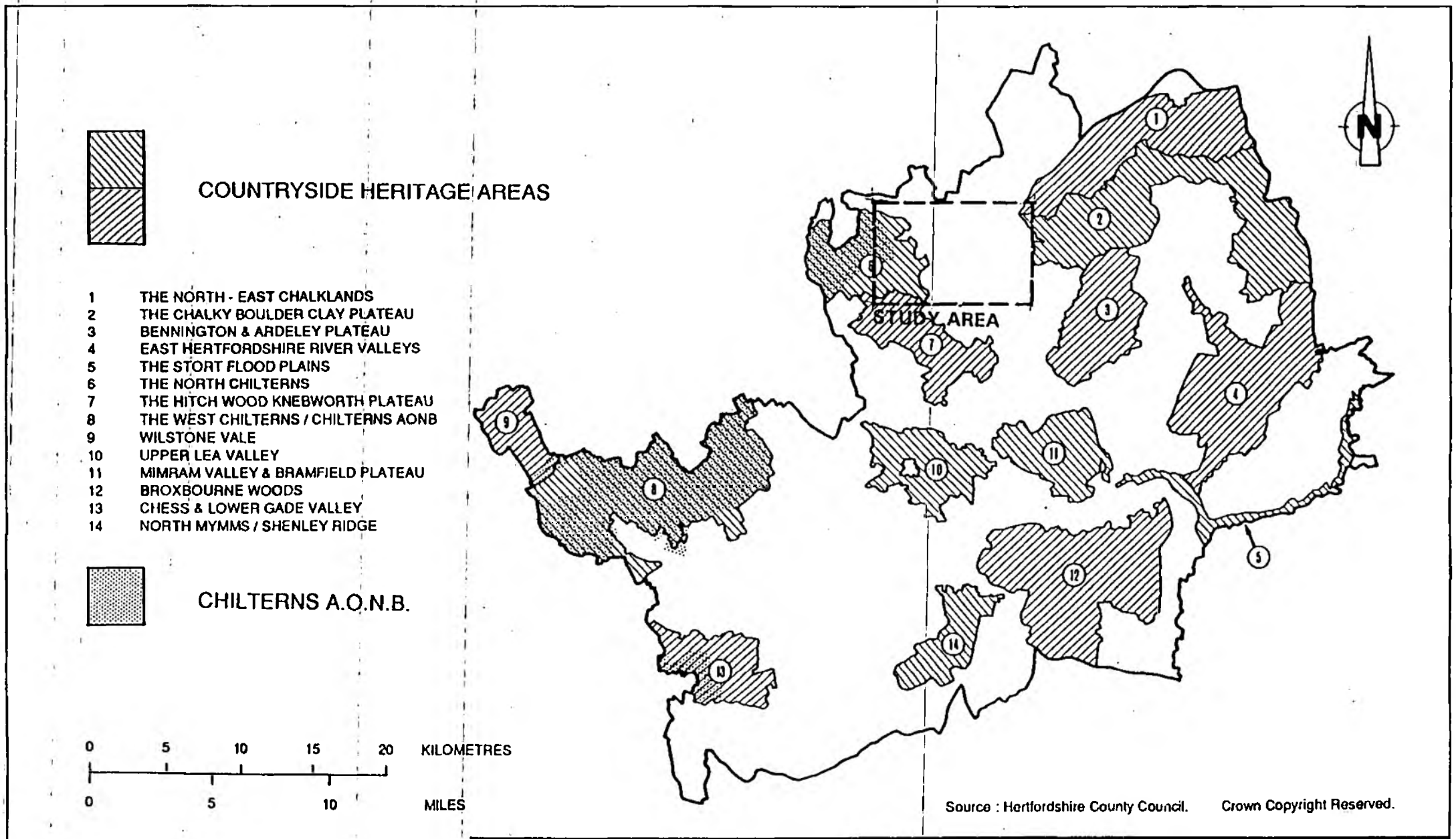

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COUNTY LANDSCAPE HERITAGE AND AONB 'S

Hiz, Oughton and Purwell Environmental Appraisal

scale 1:300,000 APPROX

93BBB/003

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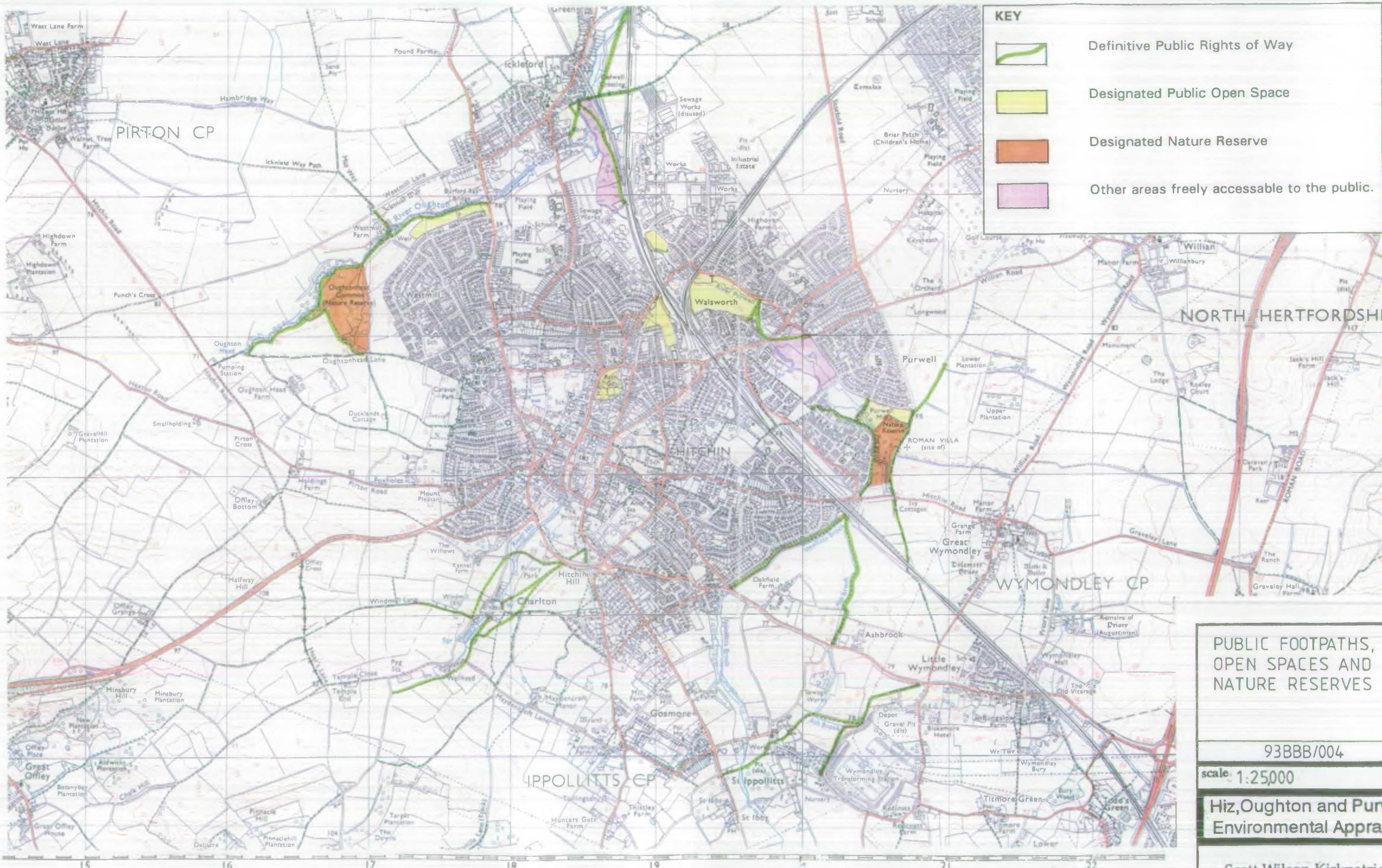

PUBLIC FOOTPATHS, OPEN SPACES AND NATURE RESERVES

93BBB/004

scale 1:25,000

Hiz, Oughton and Purwell Environmental Appraisal

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2. APPRAISAL METHODOLOGY

2.1 River Corridor Survey

The River Corridor Survey Methodology used is the National Method, as published in *River Corridor Surveys*, Conservation Technical Handbook No. 1, National Rivers Authority, August 1992. The surveys were carried out over various dates in the summer of 1993 by Chris Birkinshaw, under the supervision of John Henry Looney. In conducting the surveys, particular attention was given to associated wetland areas that were in direct hydrological continuity with the rivers and for those species thought to be sensitive to changing water levels. An audit of Section 8 of the River Purwell, and less extensive checks of other sections in the survey area was carried out by John Henry Looney on 17 August 1993, as well as other quality checks on other days. The results were found to be in accordance with the published methodology, though with less information on possible management activities since the water level sensitive vegetation was focused on. The results from all surveys are provided in the Appendices, along with keys to the symbols and abbreviations used. The location of sections and resulting coding of the river sections has been done to coordinate with the earlier NRA surveys of the River Ivel, which included part of the Rivers Hiz and Purwell. Therefore from Cadwell until the Hiz and Purwell divide the Hiz is coded as if it were the Purwell (PUR 001 - 007). The remainder of the rivers has been divided into 500m sections and coded as the Purwell (PUR 001-038), the Hiz (HIZ 001-007), and the Oughton (OUG 001 - 009), see Figures 5A and 5B.

For the purpose of assessing the quality of the sections "notable species" are native aquatic, swamp or marsh species which were recorded in 3 or fewer sections (including adjacent wetland habitats to 50m). The term used in the National Methodology "notable river dependent habitats" would be more accurately titled "adjacent wetland habitats" as sometimes the river was dependent on the wetland rather than the reverse.

To help determine the presence of the better sections, as no nationally or regionally rare aquatic plants were recorded in the river corridor itself, quality is best assessed in a general way on the basis of the cover of aquatic vegetation. Sections containing more than 15% cover of submerged aquatic plants and/or more that 15% cover of emergents are discussed by each river course below.

The Hertfordshire and Middlesex Wildlife Trust, the Hertfordshire Environmental Record Centre, English Nature and the North Hertfordshire District Council Museum Service were all contacted and helpfully supplied data as backgroundi to the study. Three days were spent by John Henry Looney at the Record Centre accessing their data, and in discussion with Trevor James in particular on two occasions about the Hiz system.

Plant species names and descriptive information on their habitat preferences are taken from a range of sources. These include Stace, C. (1991). *New Flora of the British Isles.* Cambridge University Press; Clapham, A.R., Tutin, T.G. and Warburg, E.F. (1981). *Excursion Flora of the British Isles.* Third Ed. Cambridge University Press;

Jermy, A.C., Chater, A.O. and David, R.W. (1982). *Sedges of the British Isles.* BSBI Handbook No 1.; Hubbard, C.E. (1984). *Grasses. A Guide to their Structure, Identification, uses and Distribution in the British Isles.* Penguin; Rose, F. (1981, Revised c 1991). *The Wild Flower Key, British Isles - N.W. Europe.* F Warne, Penguin Group.

2.2 Instream Communities

Temperature, flow regime, habitat availability and water quality influence stream communities. Flow (the combined effect of current velocity, geology and channel dimensions upon substrate particle size) affects habitat structure, whereas temperature and water quality affect production and nutrient transport within the ecosystem.

The chalk stream habitat is maintained by a continuous flow of cold, good-quality groundwater. The headwaters are generally eroding, the suspended load being deposited downstream where the channel is generally deeper and the water slower flowing. Game fish and the macro-invertebrates they depend on are sensitive to environmental changes, so low flow can stress communities by affecting temperature and water quality and by disrupting habitat. Habitat features lost in this way are only slowly recreated.

The macro-invertebrate community is an important component of the river ecosystem, forming a link in the food chain through which energy from primary production is transferred to higher trophic levels. Providing water quality is high, a diverse macro-invertebrate fauna may develop, including carnivores, herbivores and detritus feeders, each of which are adapted to exploit a particular habitat niche within the river ecosystem. Although macro-invertebrate populations are on a lower trophic level and are less mobile than fish, they have similar flow, water chemistry and habitat requirements and their populations are more easily sampled. It follows therefore, that ensuring that there is sufficient flows to maintain a balanced invertebrate community will safeguard associated fisheries.

Measuring the Needs of Instream Communities

Water management in the UK lags behind the US in terms of setting flow specifications which consider ecological demands. Since 1987, Yorkshire NRA has set prescribed flows as a proportion of dry weather flow (DWF) weighted by environmental characteristics. DWF is set for sensitive rivers, and 0.5 x DWF for those which are less sensitive. This defines the amount of water required for pollution dilution and conservation, and allows the amount available for external uses to be determined.

The principal methodologies available for appraisal of aquatic in-stream communities are detailed below, along with the sampling techniques utilised during the study.

PHABSIM

The inclusion of ecosystem needs in flow management calculations has been the subject of research in North America and New Zealand since the late 1970's. The Co-operative Instream Services Group of the US Fish and Wildlife Service developed the 'Instream Flow Incremental Method' (IFIM) to enable the amount of physical habitat available for various lifestages of fish to be estimated at different flows. The application of similar methodology (Physical HABitat SIMulation - PHABSIM) in the UK is being researched by the National Rivers Authority (NRA) in association with the Institutes of Freshwater Ecology and Hydrology.

PHABSIM produces hydraulic and habitat simulations within a stream reach, using defined parameters and criteria. The hydraulic simulation predicts depth, velocity and channel index (cover or substrate) as a function of flow. Habitat suitability is based on the preference of certain species for combinations of physical parameters. The two simulations are combined within the PHABSIM software to calculate the weighted usable area of a stream at different discharges available to target species. In this way, changes in aquatic populations will be predicted from changes in flow regime, enabling biological data to be entered into water resource planning processes.

Multivariate statistics

Multivariate statistical analysis of community data can group sites with similar community and habitat characteristics by simultaneously analysing suites of species collected at various sites and times. In contrast, univariate statistical techniques can only analyse variation in single 'indicator' populations.

Classification techniques such as two-way indicator species analysis (TWINSPAN) (Hill, 1979) analyse the variance within a site-species data set and repeatedly arrange the species lists into two sub-groups in such a way that the differences between the groups are maximised. This generates corresponding site groups based on species distribution. Indicator species may then be highlighted, the presence or absence of which demonstrates large differences between sub-groups.

Ordination techniques condense the variation within a data set into components which are easier to manipulate, the hope being that each component will describe a pattern of species abundance determined by a dominant environmental factor. In this way, sites with similar communities can be revealed. Detrended correspondence analysis (DECORANA) is a version of the routine in which various shortcomings have been eliminated (Hill, 1979a).

Biotic indices

Community data can also be summarised as diversity and other biotic indices, the aim being to condense community structure into a single index. The indices most widely used in the water industry are the 'biological monitoring working party' (BMWP) score and the associated 'average score per taxon' (ASPT). BMWP assigns prescribed scores to individual species which are summed to produce total site scores;

ASPT is derived by dividing BMWP by the total number of taxa in the sample. Both scores measure biological quality and reflect not only water chemistry but also habitat availability but reflect community structure at family level only. Many of the NRA's samples have been collected for water quality purposes, so a low flow estimation using historic data must be able to accept the limitation of family level identification.

Low flows cause suspended particulate materials to be deposited on eroding habitat, and by reducing dilution, may exacerbate the effects of organic pollution. These effects cause BMWP score and ASPT to decline, but the effects are difficult to distinguish from those caused by pollution or channel maintenance. So, to reveal the low-flow effects, the impact of effluent discharges and unsympathetic channel engineering must first be removed from the scores.

A methodology to achieve this might adopt the maximum possible value of a particular biotic score as a starting point, and down rate it to take account of environmental stresses such as water quality, channel engineering, and location. The product would be a coarse estimate of the biotic potential of a stretch of river, which is not attained would indicate derogation, for which flow is likely to be the cause.

ASPT is the most appropriate index for such a methodology and this is further discussed in NRA Project Report 237/2/T.

RIVPACS

RIVPACS predicts community structure from the physico-chemical conditions at a particular point on a channel. However, it is of limited value in assessing the effects of low flows because it predicts assemblages associated with the low-flow derogated habitat rather than those which might occur under 'natural' conditions. Such predictions enable water quality to be limiting when the predicted fauna has been achieved, but are inadequate when considering low flows, for which it is necessary to show that the community is below potential, is unbalanced and supports smaller populations of fish than would otherwise be the case.

HABSCORE

HABSCORE has recently been developed by the Environmental Appraisal Unit of the Welsh NRA as a tool for managing salmonid populations in Welsh rivers. Like RIVPACS, the system relies on the fact that the carrying capacity of a stream depends upon channel structure and environmental regime. Multivariate models were then developed from data collected at pristine sites with different environmental characteristics, to predict species occurrence from physico-chemical variables. HABSCORE can detect anomolies due to impacting factors such as water quality, but unlike PHABSIM is unable to simulate the effects of different flow regimes.

Sampling protocol

Benthic macro-invertebrates were sampled at eighteen sites, located as shown in Figure 6, and an attempt was made to separate assemblages from discrete habitats. However, at many of the sites, the stream was so narrow and the habitat so uniform that sub-sampling was impossible. Three one-minute collections were made with a standard hand net (frame size 0.35m x 0.25m, net depth 0.3m, mesh 1mm) at each site, along with a further inspection of larger habitat features. Samples were individually stored in polyethylene buckets and preserved in the field with 4% formalin. In the laboratory, they were sieved to remove larger pieces of sediment and plant material, and sorted to separate macro-invertebrates from other benthic material. The specimens were then preserved in industrial alcohol, observed under a binocular microscope, identified by referring to FBA keys, and counted.

The following groups were identified to species:

Tricladida, Oligachaeta, Mollusca, Hirudinea, Malacostraca, Ephemeroptera, Plecoptera, Odonata, Hemiptera, Coleoptera, Trichoptera and Megaloptera.

Abundance was estimated on a log scale for each species as follows:

1 individual = 1
1 to 10 individuals = 2
10 to 100 individuals = 3
100 to 1000 individuals = 4
1000 to 10000 individuals = 5

Macro-invertebrates species lists were prepared for each habitat at each site and archived as spreadsheets (SuperCalc 4) files. The data were arranged in the 'Cornell' format required by the multivariate statistics packages, and manipulated by 'TWINSPAN' and 'DECORANA' with the rare species 'downweighted' option invoked. BMWP score and ASPT were calculated for each site on both sampling occasions.

Dissolved oxygen concentration, pH conductivity and temperature were determined with portable instruments at each site. Channel width and depth at the centre were measured at sites where the bottom was stable. At other sites these values were estimated. At monthly intervals, the NRA determined current velocity and cross-sectional area at each site, from which they calculated discharge.

2.3 River Landscape Assessment

There has been much written about landscape assessment and various techniques developed. These can broadly be divided into objective or subjective approaches, and the current consensus combines the objective and the subjective approaches in a multi-dimensional approach based on aesthetic taste operating within the context of informed opinion, the trained eye and common sense.

The overall value of a landscape is more than the sum of its parts, and if landscape can be defined as the appearance of land, then natural beauty is larger in concept than landscape. The landscape is a major contributory factor to the natural beauty of an area, and factors which influence the character of the landscape will also influence its beauty (Countryside Commission, 1987). The Countryside Commission published a checklist of factors affecting natural beauty, including physiographic features, aesthetic factors, predominantly visual, associations both cultural and historical, emotional response, public accessibility and relative value (ie rare/common).

The NRA has produced a document "River Landscape Assessment" (Conservation Tech. Handbook 2, 1993), based upon this rationale and described a methodology for assessing river landscape, which has formed the basis for the current survey. The landscape assessment of the Hiz, Oughton and Purwell rivers is a strategic assessment, to assess the relative quality of the river valley landscapes and the importance of the river within the landscape together with recommendations on proposed management regimes.

Such an assessment begins with collecting and reviewing background information and familiarisation with the study area, followed by structured survey undertaken by formal observations at sample points to provide broad information about the variation in the character and quality of the river landscape. This survey information is collated, evaluated and presented as Macro Survey, which assesses the wider landscape of the river valley, defined by the limits of views from the river, or the visual envelope, and as Micro Survey, which assesses the landscape of the river itself, created by the river channel and its immediate banks.

2.4 Channel Morphology

The aims of the morphological study of the Rivers Hiz, Oughton and Purwell has been to identify the morphological features and characteristics of those rivers. The basic characteristics of the rivers are channel site and shape, bed material and bed slope. There are a range of features overlying the basic stream variables. These include evidence of adjustment in channel form such as deposition and erosion. There are features which result from man's management of the river: mills, weirs, channel lining, reshaping and realigning the channel. There are also transient features such as ripples, dunes and anti-dunes.

The morphological assessment was based on visual inspection during a walkover survey of each river. During the inspection a description of the channel shape and bed material was recorded. Evidence of channel adjustment was recorded, and where possible the cause of the adjustment was identified. The effects of man's interference with and management of the channel were recorded: this includes the construction of control structures in the channel, for example mills and weirs, changes in the channel shape or form, and lining of the channel. Wherever possible features were photographed to provide a permanent record.

The survey was undertaken in September 1993, when river flows were likely to be close to their minimum and vegetation was abundant. There may therefore be a benefit in undertaking a repeat survey during the winter or early spring. Plant growth would be at its minimum so inspection of the channel would be easier. Also the discharge will be greater, and thus likely to be closer to the conditions which govern channel form. It is the flows which occur just once or twice a year on average which have the greatest long term sediment carrying capacity, and therefore the most influence on channel form.

PIRTON CP

IPPOLLITTS CP

WYMONDLEY CP

NORTH HERTFORDSHI

HITCHIN

P1 P2 P3 P4 P5 P6 P7 P8 P9 P10 P11 P12 P13 P14 P15 P16 P17 P18 P19 P20 P21 P22 P23 P24 P25 P26 P27 P28 P29 P30 P31 P32 P33 P34

H1 H2 H3 H4 H5 H6 H7

01 02 03 04 05 06 07 08 09

LOCATION OF RIVER CORRIDOR SURVEY SECTIONS

93BBB/005A

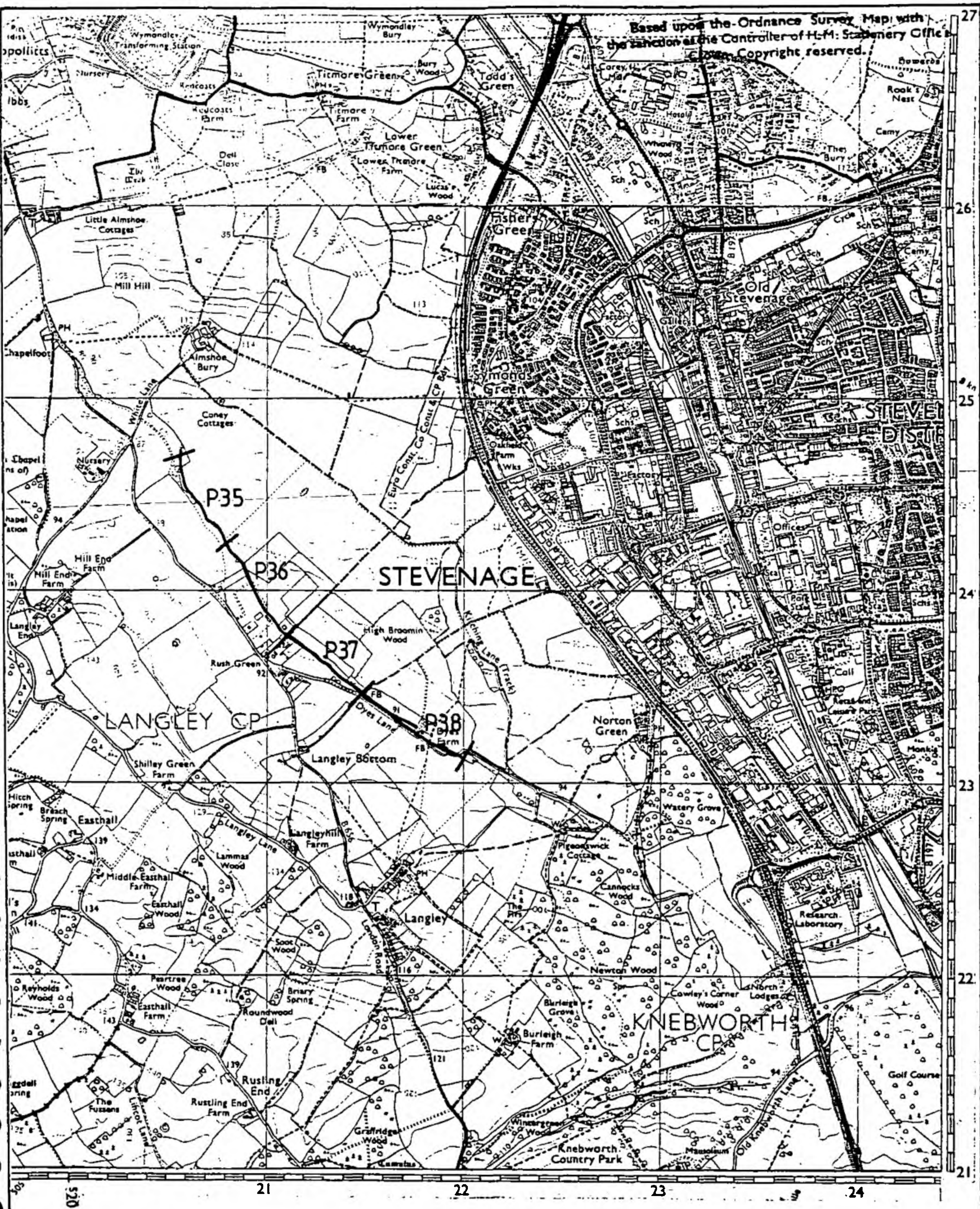
Scale 1:25000

Hiz, Oughton and Purwell Environmental Appraisal

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

in association with

Engineering – Science Environmental Engineers
NAIAD – Aquatic Environmental Services
Arcady Design – Landscape Architects



LOCATION OF RIVER CORRIDOR SURVEY SECTIONS

Hiz, Oughton and Purwell Environmental Appraisal

Scale 1:25000

93BBB/005B

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

in association with

Engineering – Science Environmental Engineers
NAIAD – Aquatic Environmental Services
Arcady Design – Landscape Architects

PIRTON CP

WYMONDLEY CP

IPPOLLITTS CP

NORTH HERTFORDSHIRE

HITCHIN

LOCATION OF IN-STREAM COMMUNITY SAMPLING SITES.

93BBB/006

Scale 1:25000

Hiz, Oughton and Purwell Environmental Appraisal

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

in association with

Engineering – Science Environmental Engineers
NAIAD – Aquatic Environmental Services
Arcady Design – Landscape Architects

3. RIVER HIZ

3.1 Baseline Survey Results and Observations

The following four sections generally highlight the baseline observations obtained during the river corridor, instream communities, landscape and channel morphology field surveys undertaken between May-September 1993.

3.1.1 River Corridor Survey

The results of the river corridor surveys of the River Hiz (PUR 001 - 006 and HIZ 001 - 007) are given in Appendix B1. Using the evaluation criteria defined above (Section 2.1) the following sections are noted as of greater interest (see Figure 5A for location).

Notable Plant Species:

Hiz (PUR 003)

Carex paniculata Greater Tussock Sedge is a species of peaty, medium base rich soils where water levels are at least seasonally high; in fens and beside slow flowing streams.

Rumex hydrolapathum Great Water Dock grows in wet places and shallow water.

Hiz (PUR 004)

Potamogeton crispus Curled pondweed is a submerged aquatic and grows in still and flowing fresh water.

Elodea canadensis Canadian pondweed is a submerged aquatic, introduced and grows in still or slow moving water. It is not of conservation value.

Hiz (PUR 005)

Potamogeton crispus

Hiz (HIZ 001)

Petasites hybridus Butterbur grows in wet meadows and copses and by streams, but is not of particular conservation value.

Hiz (HIZ 003)

Petasites hybridus

Hiz (HIZ 005)

Carex spicata Spiked sedge grows on roadsides and waste grounds, and in meadows, on heavier and damper soils, and is also found on chalk. It is frequent in southern and midland England.

Glyceria notata (x pedicellata) Hybrid sweet grass is "not uncommon" besides slow flowing rivers, through England. Also in shallow ponds, streams, ditches and in swampy depressions.

Epilobium parviflorum Small-flowered Hairy Willow-herb grows on stream banks, in marshes and in fens, and is common.

Hiz (HIZ 006)

Ranunculus sceleratus Celery-leaved crowfoot is common in and by slow streams, ditches and shallow ponds of mineral-rich water with a muddy bottom.

Hiz (HIZ 007)

Ranunculus sceleratus

None of the above species convey any particular conservation value, though the presence of these and associated plant species do provide suitable habitat for other groups.

Notable River-Dependent Habitats

These are described in full in the results provided in Appendix B1. From these there are two of greater interest.

1. Hiz and Oughton Confluence (Gerry's Hole)

   The area where the River Oughton joins the Hiz (PUR 003) is also known as Gerry's Hole (see Figure 5A and Figure 15A), and consists of a range of habitats and wetland that is of local conservation importance. This is in part due to the presence of a former mill. The river in this section meanders and has a shingle substrate. In the north it is 30% covered by submerged aquatics (*Ranunculus penicillatus, Callitriche* sp.) with occasional patches of emergents (*Sparganium erectum*); in the centre it is 70% covered by emergents (*Sparganium erectum*) with submerged aquatics between the emergent stands (*Callitriche* sp., *Potamogeton pectinatus*); and in the south because of greater shading it has only occasional patches of emergents (*Sparganium erectum*) and submerged aquatics (*Callitriche* sp., *Ranunculus penicillatus*). Throughout the section the banks are dominated by tall dicots (*Urtica dioica, Epilobium hirsutum, Galium aparine*) with grasses of secondary importance (*Arrhenatherum elatius, Dactylis glomerata, Phalaris arundinacea*). Bank side trees (*Acer pseudoplatanus, Aesculus hippocastanum, Fraxinus excelsior, Populus nigra var italica, Salix alba*) and shrubs (*Crataegus monogyna,*

Sambucus nigra, Salix cinerea) are frequent and a hedge runs along the west bank in the centre of the section. The former mill stream which joins this river and the Oughton includes a marshy area with *Carex paniculata, Cirsium palustre, Eupatorium cannabinum, Glyceria maxima, Mentha aquatica, Phalaris arundinacea, Rumex hydrolapathum* and *Sparganium erectum.* A small mill pond at the south of the section is totally covered with *Sparganium erectum.* Much of the willow plantation on the east side of the river is rough grassland with abundant ruderals but some areas are marshy and more interesting. Species growing here include: *Agrostis stolonifera, Angelica sylvestris, Carex otrubae, Cirsium palustre, Deschampsia cespitosa, Epilobium hirsutum, Equisetum palustre, Holcus lanatus, Juncus effusus, Phalaris arundinacea, Poa trivialis, Potentilla anserina, Ranunculus repens, Symphytum x uplandicum.*

Records from the Hertfordshire Record Centre show the following species as present: *Agrostis canina, A vinealis* (only 12 sites in county), *Caltha palustris, Campanula glomerata, Catabrosa aquatica, Galium uliginosum, Geranium pratense, Juncus compressus, J subnodulosus, Lemna trisulca, Melilotus altissima, Ophioglossum vulgare, Scirpus lacustris, Senecio aquaticus, Trifolium arvense, Vulpis bromoides, Hieracium murorum, Cerastium pumilum, Dactylorhiza praetermissa.*

2 Priory Park

The marshy area in Priory Park along the river Hiz (HIZ 005) is also of some interest with a wider range of wetland species (see Figure 5A and Figure 15A). For the major part of this section the watercourse has been landscaped to form a long shallow lake, bridged in the centre by the A602. North of the bridge the lake lies in Priory Park and is home to many ducks. Here the water is cloudy and the lake contains no aquatic plants apart from filamentous algae and fringing clumps of sedge (*Carex acutiformis* and *Carex riparia*). Close to the Priory Conference Centre the banks are artificial but further away they are natural and on the east side support a rich flora of moisture loving plants (*Eupatorium cannabinum, Carex acutiformis, Cirsium palustre, Epilobium hirsutum, Epilobium parviflorum, Filipendula ulmaria, Glyceria maxima, Juncus effusus, Lotus uliginosus, Scrophularia auriculata, Urtica dioica*). The land on the east has mown walkways and patches of species-rich marsh (see below). The land on the west side of the lake supports a plantation.

South of the bridge the water in the lake is also cloudy and contains no aquatic plants apart from patches of fringing sedge. The banks support a tall vegetation of moisture loving plants (*Carex acutiformis* (rare), *Epilobium hirsutum, Filipendula ulmaria, Galium aparine, Glyceria maxima, Lotus uliginosus, Phalaris arundinacea, Urtica dioica*). The land on the west of the lake is no longer farmed and the bank vegetation fills the whole of this small field. On both sides of the lake there are many fringing trees (*Alnus glutinosa* and *Salix alba*).

Much of the stream entering the lake at the south end are shaded by bankside trees and shrubs and contains no aquatic plants but, in the centre it is unshaded and full of emergents (*Apium nodiflorum, Iris pseudoacorus, Mentha aquaticum, Myosotis scorpioides, Rorippa nasturtium-aquaticum, Solanum dulcamara, Sparganium erectum, Veronica beccabunga*) with banks supporting a species-rich flora of moisture-loving plants (*Angelica sylvestris, Carex acutiformis, Cirsium palustre, Epilobium hirsutum, Filipendula ulmaria, Glyceria maxima, Juncus inflexus, Lotus uliginosus, Lycopus europaeus, Urtica dioica*). *Carex spicata* and *Glyceria notata* were recorded in a small area of poached grassland next to the stream in the extreme south of this section.

In Priory Park, in the valley bottom, on the east side of the lake, are some areas of marsh. Species recorded here included - *Carex acutiformis, Cirsium palustre, Deschampsia cespitosa, Eleocharis palustris, Epilobium hirsutum, Epilobium parviflorum, Eupatorium cannabinum, Filipendula ulmaria, Galium uliginosum, Glyceria maxima, Hypericum tetrapterum, Juncus articulatus, Juncus effusus, Lotus uliginosus, Lychnis flos-cuculi, Mentha aquatica, Phalaris arundinacea, Ranunculus repens, Scrophularia auriculata, Typha latifolium, Urtica dioica, Veronica beccabunga.*

Sections with well developed aquatic vegetation

Sections PUR 001 and PUR 002 (Figure 7) along the River Hiz were found to have >15% cover of submerged aquatics, while only section PUR 003 has >15% cover of emergent vegetation. These all lie below the confluence with the Oughton and the sewage treatment works and therefore presumedly have a greater volume and reliability of water.

Other Conservation Notes from the River Corridor Survey

The section of the Hiz including Wellhead and the mill pond (HIZ 007) was found to contain little conservation interest, inspite of being complex in structure. The area of the wet wood was known to be of interest earlier (T James, pers comm), yet this has been lost due to the management regime present. The area could be improved through appropriate management of the wood, with some expectation that some of the botanical interest would return (as demonstrated by the return of aquatic vegetation at the source this year after 4 years of drought). The area of the Hiz around the Windmill Pub in Charlton (HIZ 006) is largely of little conservation interest.

3.1.2 In-stream Communities

Instream macro-invertebrates were sampled and habitat assessed at five sites during May 1993 (Figure 6, Table 1). The sites were resampled in August 1993 along with a further two sites in the upper reaches of the River Rhee.

RIVER HIZ

Site	5	TL 175276	Well head at Charlton
Site	6	TL 179281	Windmill public house at Charlton
Site	16	TL 190303	Upstream of Purwell confluence
Site	12	TL 191305	Downstream of Purwell confluence
Site	13	TL 187317	Downstream of Oughton confluence

Table 1
Location of sites in the upper River Hiz catchment
at which benthic macro-invertebrates
were collected during summer 1993

Full species lists for each site are given in Appendix B2. A brief description of habitat at each site and values of physico-chemical variables on each sampling data are also given in Appendix B2. Physico-chemical variables and flow are tabulated (Table 2, May 1993, and Table 3, August 1993).

Multivariate analyses were undertaken as follows:

TWINSPAN classification - Data from the May and August samplings were combined so that the data set present to TWINSPAN was as large as possible. The sequence of species and site sub-divisions generated by TWINSPAN is shown in Figure 8. The process was interpreted initially after the second cut level, which by experience has been shown to reveal most about processes controlling population distribution. However, the macro-invertebrate communities at sites on the upper Hiz and tributaries were generally of uniformly limited diversity. The TWINSPAN classification was therefore interpreted after the first cut level, the point at which differences between the resultant groups would be greatest.

DECORANA ordination - The relative strengths of axes 1-4 (in eigenvalues) in the DECORANA ordination and the relative importance of each axis in explaining total variance are given in Table 4. The distribution of sites between axes 1 and 2 are shown in Figure 9.

Site	1	2	3	4	5	6	7	8	9	10
DO	9.9	9.6	9.5	10.4	13.5	13.9	8.7	10.4	10.8	9.1
Temp	9.0	12.2	9.5	9.2	10.6	10.9	13.8	13.5	9.6	9.1
pH	7.6	7.8	7.7	7.8	7.8	7.7	7.6	8.1	8.1	7.8
Cond	–	–	–	–	–	–	–	–	–	–
Flow-01	.02	–	.18	0	.10	.03	–	–	–	–
Flow-02	.02	–	.16	0	.06	.03	–	–	–	–
Flow-03	.01	–	.04	0	.04	.03	–	–	–	–
Flow-04	.02	–	–	–	–	–	–	–	–	–
Flow-05	–	–	–	–	–	–	–	–	–	–
Flow-06	0	–	0	.03	0	.01	–	.09	0	0
Flow-07	0	–	0	.02	0	0	–	.07	0	0

Site	11	12	13	14	15	16	17	18	19	20
DO	11.6	9.8	10.9	9.9	10.7	9.9	9.9	8.7	–	–
Temp	11.2	11.5	12.6	9.7	10.7	11.7	10.4	12.3	–	–
pH	7.7	7.7	7.9	7.6	7.9	7.9	8.2	8.0	–	–
Cond	–	–	–	–	–	–	–	–	–	–
Flow-01	–	–	–	.07	–	–	–	.04	–	–
Flow-02	–	–	–	.12	–	–	–	.04	–	–
Flow-03	–	–	–	.08	–	–	–	.04	–	–
Flow-04	–	–	–	.05	–	–	–	.03	–	–
Flow-05	–	–	–	–	–	–	–	–	–	–
Flow-06	–	–	–	.02	–	–	–	0	–	–
Flow-07	–	–	–	0	–	–	–	0	–	–

DO = dissolved oxygen (mgl-1)
pH = pH units
Cond = Electrical conductivity (u-Siemens)
Flow = flow (cumecs) followed by month of measurement

Table 2
Physico-chemical variables and flow measured at sites
on the Rivers Hiz, Oughton and Purwell during May 1993

Site	1	2	3	4	5	6	7	8	9	10
DO	–	9.5	9.5	9.2	–	8.9	10.0	10.2	–	–
Temp	–	18.0	13.5	14.0	–	12.5	14.5	14.5	–	–
pH	–	7.7	7.6	7.8	–	7.4	7.4	7.7	–	–
Cond	–	610	590	590	–	450	490	500	–	–

Site	11	12	13	14	15	16	17	18	19	20
DO	10.0	9.6	9.0	9.9	9.8	9.3	8.2	9.3	9.6	8.6
Temp	16.5	16.5	15.5	10.5	15.5	17.0	15.5	16.5	13.5	15.0
pH	7.8	7.8	7.6	7.4	7.9	7.9	7.8	7.8	7.8	7.6
Cond	580	580	610	430	480	420	590	500	450	470

DO = dissolved oxygen (mgl-1)
pH = pH units
Cond = Electrical conductivity (u-Siemens)
Flow = flow (cumecs) followed by month of measurement

Table 3
Physico-chemical variables and flow measured at sites
on the Rivers Hiz, Oughton and Purwell during August 1993

DECORANA axes - rare species downweighted

Axis	Eigen Value	% variation accounted for
1	0.281	39
2	0.205	28
3	0.140	19
4	0.103	14

Table 4
Proportion of between site variation accounted for by DECORANA axes 1-4

Most (67%) of the variance is accounted for by axes 1 and 2 so these have been plotted, and sites grouped by TWINSPAN linked with broken lines. The distribution of sites on the basis of the multivariate analyses are shown in Figure 10.

BMWP scores and ASPTs were calculated for each site and are given in Table 5 (May 1993) and Table 6 (August 1993). The extent to which each site achieved its potential ASPT was also calculated along with a mean value for the two sampling periods. The sites were then arranged within two groups, the first comprising those achieving less than 80% of their target. The second group comprised sites achieving greater than 80% of their target (a value selected as the median of the measured range). The distribution of sites classified on the basis of ASPT are shown in Figure 11.

A classification combining the multivariate and ASPT-based analyses is shown in Figure 14. Sites which classified similarly under the two systems retained their original groupings, whereas sites which classified differently formed an intermediate group.

3.1.3 River landscape assessment

Designations

The river is a typical spring fed chalk stream, which rises at Wellhead and at various locations downstream. From Wellhead the river flows north east within a landscape assessed as Grades 1 and 2 Distinguished (Herts. Env. Forum, 1990) and designated as part of the North Chilterns Countryside Area, designated Green Belt, Landscape Conservation Area 1, and the designated Conservation Area of the village of Charlton, part of which has been designated an Area of Archaeological Significance (N.H.D. Local Plan, 1990).

As the river approaches the town of Hitchin, but still within the Green Belt, it flows through the grounds called Priory Park, a designated Conservation Area (N.H.D. Local Plan, 1990).

Site	1	2	3	4	5	6	7	8	9	10
BMWP	22	33	50	52	31	30	12	51	25	30
ASPT	3.7	3.7	4.2	4.0	3.9	3.8	4.0	3.9	3.6	3.8
Taxa	6	9	12	13	8	8	3	13	7	8
Groups Identified	6	10	16	13	12	8	3	14	7	8
Target ASPT	5.2	4.6	5.2	5.2	5.4	5.2	5.2	5.2	5.2	5.2
% Target	69	80	81	77	72	73	77	75	69	73

Site	11	12	13	14	15	16	17	18	19	20
BMWP	55	52	50	18	58	55	22	35	--	--
ASPT	4.2	3.7	3.3	4.5	3.6	3.7	3.7	3.9	--	--
Taxa	13	14	15	4	16	15	6	9	--	--
Groups Identified	16	19	17	5	17	16	6	9	--	--
Target ASPT	5.2	4.9	4.4	5.4	5.2	5.2	5.2	5.2		
% Target	81	76	75	83	69	71	71	75		

Table 5
BMWP scores and ASPT's calculated for each site from instream macro-invertebrate samples collected during May 19932

Site	1	2	3	4	5	6	7	8	9	10
BMWP	–	28	51	55	–	26	22	49	–	–
ASPT	–	3.5	4.3	4.2	–	3.7	3.7	4.1	–	–
Taxa	–	8	12	13	–	7	6	12	–	–
Groups Identified	–	9	14	15	–	7	7	12	–	–
Target ASPT	5.2	4.6	5.2	5.2	5.4	5.2	5.2	5.2	5.2	5.2
% Target	–	76	83	81	–	71	71	79	–	–

Site	11	12	13	14	15	16	17	18	19	20
BMWP	86	63	55	16	57	44	11	26	66	111
ASPT	4.8	3.9	3.9	4.0	3.6	3.7	3.7	4.3	4.4	4.3
Taxa	18	16	14	4	16	12	3	6	15	23
Groups Identified	20	18	17	3	18	12	3	7	17	27
Target ASPT	5.2	4.9	4.4	5.4	5.2	5.2	5.2	5.2	5.2	5.2
% Target	93	80	89	74	69	71	71	83	83	83

Table 6
BMWP scores and ASPT's calculated for each site from instream macro-invertebrate samples collected during August 1993

The River Hiz flows through the centre of the town of Hitchin, a medieval borough by 1268, designated an area of Archaeological significance (County Archaeological Records Office, 1993). The town still retains most of its medieval topography and many fine late medieval houses. The river flows insignificantly through much of the town, is often piped, to reappear in the town's open spaces. North Hertfordshire District Council have discussed the idea of creating a riverside walk through the town, which would link the various open spaces (Bright, pers. comm, 1993).

The River Hiz re-emerges north of Hitchin in Green Belt separating Hitchin from Ickleford, into an area of wet grassland grades 5 and 6, Uninteresting. Icknield Way crosses the River Hiz in this area, although a bridge (old railway sleepers), is now used, and the old road is designated as a byway open to all traffic (Def. Map of Public Rights of Way, 1993).

History

The river was used at Charlton by two water mills, one called Charlton Mill, a water corn mill, which remained in use until 1953, and the other called Grove Mill, which in 1985 was used as factory and offices (County Archaeo. Rec. Office). Of note Henry Bessemer was born at Charlton House, opposite the Windmill Pub in the village.

Within the town of Hitchin the river flows adjacent to the Priory, a Grade 1 Listed Building, on the site of a Carmelite Friary founded in 1317 and dissolved in 1538, used today as a conference centre. It is a large country house incorporating details of earlier priory buildings of the 15th century, whose southern section was substantially rebuilt about 1775 in the Adam Style.

The river also reappears adjacent to the Parish Church of St Mary's, a Grade A Listed Building, which was built in the 12th century, of which little remains, the present building being mainly of the 14, 15, 17 and 19th centuries.

Grove Mill dates from at least 1813 and is situated at the junction of the Purwell and Hiz, and was initially a silk mill, then a water corn mill, and later still a chamois leather dressers, and today is used as commercial premises (County Archaeo. Rec. Office).

Soils

The soils in this part are mostly well drained calcareous, mainly medium texture, on chalk and chalky drift, becoming leached well drained soils on gravelly fluvioglacial and river drift at Priory Park on the southern edge of Hitchin, to emerge through moderately well drained leached soils to the north of Hitchin (Soil Survey, 1993). The agricultural land classification is Grade 2 (Agric. Land Classif., Sheet 147) principally a corn growing area, with pasture and recreational uses predominating in the urban fringe.

Landscape Areas

The field survey records have been collated reviewed and analysed. This requires a description and classification of the full range of both macro and micro river landscape character areas, delineated on the Macro Survey, Figure 12 and Micro Survey, Figure 13, together with typical sketches.

Macro Survey

Sketch and photographic plate numbers refer to Appendix B3

A02 Arable Open (Sketch 1)

Wide open long valley landscape of predominantly large arable fields, where surviving hedgerows, predominantly Hawthorn, mark roads and tracks. It is a peaceful landscape although intensively farmed, offering long distance views to the north, and to the south the woodland cover to the steeper slopes clearly picks out the chalk escarpment that limits the views in this direction.

PE2 Pastoral Enclosed (Sketch 2)

Small scale pasture fields occupying short but moderately steep slope down to the River Hiz, and Charlton village. Views are restricted to the south by the slope and to the north the views are partly restricted by the woodland associated with the river. Hedges are in very poor condition, often repaired by wire, and fields are further subdivided by post and wire.

The village of Charlton is set within and against this backdrop.

AE1 Arable Enclosure (Sketch 3)

Gentle sloping valley landscape of predominantly large arable fields, where surviving hedgerows mark roads and tracks. It is a peaceful, well managed landscape with distant views, only to the south west as woodland associated with the river and wetlands dominates the landscape from the valley floor.

PK1 Parkland (Sketch 4)

Classic parkland landscape through which the river forms a linear lake feature, visually contained within the river valley and road embankment to the south west and views to the east over the town. Currently the estate is used as a private golf course and grounds to a conference centre and commercial headquarters.

UE1 Urban Enclosure

The river now enters the built up area of Hitchin Town Centre, often piped under buildings and roads or passing insignificantly through both commercial

and industrial premises.

US1 Urban Space

Briefly the River Hiz emerges at the front entrance of "The Priory" to form a pool in an intimate urban space enclosed by attractive historic buildings which form an attractive street scene.

US2 Urban Space

Again the River Hiz emerges in front of the Parish Church of St Mary in a formal civic design as the centre piece of a 1930s redesign following slum clearance. The scheme still physically survives, although the commercial activities have not located themselves around the space and made it the Town Centre as planned. (Plate 1)

RG1 Recreation Ground

The River Hiz emerges into open space again along the edge of a walled recreation ground, including tennis courts, play equipment and bandstand, specimen tree planting and decorative shrub planting located near to the Town Centre.

RG2 Recreation Ground

Again the River Hiz re-emerges into open space, flat green sward visually contained by the railway embankment to the east and surrounding housing.

RG3 Recreation Ground

Another flat green sward recreation ground, visually contained by the railway embankment and surrounding housing.

PK2 Parkland (Sketch 5)

Once again the Hiz passes under the railway embankment to re-emerge in a flat floodplain, where the Hiz and the Oughton join. The area is predominantly meadow grassland although Willow trees have been planted to a grid pattern, and allotments occupy one corner. The area is visually contained by the railway line to the east, Ickleford to the north and west and to the south the tree planting obscures any views of the sewage works located there.

PO3 Pasture Open

Flat floodplain pastoral landscape, contained within the 'y' of two railway embankments and the village of Ickleford. Fields divided by post and wire, although remnants of hawthorn hedges remain as isolated scrub in fence lines. Of note Icknield Way crosses the floodplain in this area at Cadwell crossing.

River Corridor - Micro Survey

NO2 The upriver spring of the River Hiz emerges in a depression in pastoral field at Wellhead, forming a wet to muddy area associated with a few surrounding mature trees. (Plate 2)

NE2 The river then all but disappears to reappear together with further springs in a woodland wetland, which drains to the millpond at Charlton, observed to be virtually dry, detracting greatly from the visual character of the scene.

NO3 The river passes in a steep sided natural channel through the village of Charlton across farmyards and field and garden boundaries, its position marked by hedges and clumps of trees growing on its banks. The channel has been modified at The Windmill Pub at Charlton, where a public footpath crosses the river, and a weir retains a small pond overlooked by the pub garden. The pond water is slack, and although the water was free of debris and host to ducks, it appeared discoloured and dirty.

NE3 Downstream Folly Alder wood totally encloses the stream, and ivy covered ground layer, growing to the edge of the stream channel and to the tree trunks, adds further to privacy of this stretch.

This river corridor dominated by the major woodland features so closely associated with the river is accessible to the public by the small country lane which runs the length of the valley and by a number of public footpaths on both valley sides which cross the river at the Windmill Pub in the village of Charlton.

NO4 Through the Priory Parkland the river has been managed by weirs and the banks widened and retained to create a wider linear lake feature, although woodland is still retained to one bank. (Plate 3)

UO1 As the river flows past the Prior the channel narrows again, is crossed by several brick bridges and forms a pond in front of the Priory adjacent to the road before disappearing through the built up town.

UO2 The river reappears as the centre piece of a formal urban space in front of the parish church, where further weirs retain the level. The water is here observed to be slack and discoloured detracting from the visual quality of this

public space in which the water feature, associated bridges and formal steps, together with the green sward of the Church grounds is much used, particularly in summer, for general passive recreation.

UE1 For the most part the river flows insignificantly through private car parks, and factory premises, through pipes and concrete lined channels in areas inaccessible to the general public. Importantly it emerges in a further two public parks, UO3 and UO4, where it is observed to be clean, but shallow and slow flowing. (Plate 4)

NE4 From the junction of the rivers Purwell and Hiz the rivers flow north past Grove Mill, now commercial premises, through a steep sided wooded ravine, before passing once more under the railway embankment to emerge in a marshy area, where the river is joined by the Oughton.

NO5 The river continues to flow gently past the rear of Ickleford, where it is crossed by Icknield Way, a public byway, which is connected by a number of other public footpaths. (Plate 5)

3.1.4 Channel Morphology

The River Hiz rises south of Hitchin at NGR TL 175275, elevation approximately 75 MOD. It flows north through the centre of Hitchin and out towards Arlesley. The existing morphology is described from the source working downstream. The photographic plates referenced are presented in Appendix B.4.

From the source of the River Hiz shown on the 1:25000 OS map at Wellhead (TL 175275) to the village of Charlton about 400 metres downstream. The stream bed was dry when surveyed in early September 1993. It varied from damp with thick vegetation at Wellhead Farm (Plate 1) to damp and bare near Charlton (Plates 2 and 3). The channel cross-section was approximately uniform: a shallow trapezoidal shape about 3m wide.

The first flow was visible in the village of Charlton (Plate 4) at the bottom of the garden of the "Windmill" public house. Initially the flow is very low for the size of the channel, and the accumulation of fine organic silt indicates that the stream has lacked power to move sediment for some time.

Downstream of Charlton the river channel appeared to be relatively steep so that it remained relatively clear of organic sediment despite the low flow. This can be seen at the cattle watering hole (Plate 5) at TL 180284. A small tributary flowing from the west adjacent to Willow Lane appeared to be almost full with organic silt (Plate 6).

About 200 metres upstream of the A602 Stevenage Road bridge the river appears to have been artificially broadened to a width of about 20m. This width is totally out of equilibrium with the volume of water flowing in the river. The result is extensive deposition of fine black organic silt over the entire bed, as the river gradually moves

back to natural equilibrium. In places this organic mud now extends as almost dry flats up to one third of the way across the river. There are local road drainage outfalls adjacent to the bridge. The road bridge and its environs are shown on Plates 7 to 10.

Downstream of the Stevenage Road bridge reach the River Hiz flows into Hitchin. This section is typical of urban watercourses, with the channel variously lined and culverted. An initial lined section (Plates 11 - 13) leads to a gauging weir (Plates 14 and 15) just upstream of the market. The river is culverted under the market to a large ornamental pool east of the church (Plate 16). The pool is heavily silted. A horseshoe weir with a bar screen (Plate 17) controls water levels in this pool. The river continues through the town centre in a series of channelled and culverted sections (Plate 18) for a distance of 200 to 300 metres.

North of the town centre the River Hiz emerges to flow along property boundaries in an artificially narrow and straightened channel. This continues for a further 600 metres or so. The river then flows across parkland. Here again the channel had been lined, though in places undermining of the lining is visible (Plate 19), and in places silting has occurred (Plate 20). A multiple pipe culvert (4 No x 600 diameter) near the railway bridge (TL 190303) shows a water mark on the concrete pipes indicating them to flow at about 70% full. This is probably indicative of a more flashy flow regime downstream of the town caused by urban runoff.

The confluence of the Hiz and the Purwell occurs at the road crossing at TL 190303. The two streams pass under the road in separate culverts at different levels, to join just downstream of the road. The name of an adjacent road "Millstream Close" is indicative of earlier, more extensive management at this location.

Below the confluence with the Purwell system the flow in the River Hiz is stronger. Also from this point the effects of urbanisation on the river are less visible: the stream is not constrained within a lined, or partially lined, channel; only limited channel realignment or reshaping appears to have taken place.

3.2 Analysis and Discussion

3.2.1 River Corridor and In-stream Communities

The macro-invertebrate communities in all sections of the River Hiz and tributaries lacked many of the species which normally characterises chalk stream habitats. In particular, there were none of the stoneflies, mayflies and cased caddisflies normally associated with cold, unpolluted, alkaline, flowing water. These had been replaced by the more ubiquitous burrowing, scraping and filter-feeding species adapted for survival in the quiescent, depositing conditions produced by prolonged periods of low flow. The assemblage included water bugs (*Hemiptera)*, beetles (*Coleoptera*), the amphipod *Gammarus pulex*, snails (*Gastropoda*), leeches (*Hirudinea*) and worms (*Oligochaeta*), and the habitat comprised silt on the chalk substrata with few submerged emergent or marginal vascular plants.

The majority of the Hiz is of little botanical and conservation interest, this is due in part to the lack of water and also to inappropriate management eg of the wood at Mill Pond and the river through the town. The best sections of the river Hiz from the river corridor survey are those below the confluence with the Oughton, where all three tributaries are together and the flow from the treatment works is also included. It is in these sections (PUR 001-003) that the aquatic vegetation is of greater quantity and the river has the appearance of a chalk fed stream. As noted above there are not any nationally or regionally rare species and along the Hiz there are wetland areas of secondary importance compared to those along the Oughton and Purwell (see below). The areas of interest, Gerry's hole and Priory Park are described above, and while of some interest would not warrant significant investment in increasing the quantity or modifying their supply of water. They would however benefit from an increased management regime directed towards maintenance of their vegetation, as carried out by the Wildlife Trust and others, combined with a water maintenance scheme that while primarily directed towards the other two tributaries would benefit the Hiz. This would be fairly easily accommodated for Gerry's Hole (as it is fed by all three water courses), but Priory Park (and possibly Butts Close - a minor spring source in Hitchin referred to in the Mott MacDonald report with limited conservation interest) would require special planning to positively affect them. The source of the Hiz at Wellhead and the Mill pond and associated woodland may benefit from increased water supply, as shown by the return of some aquatic vegetation this year after 4 years of no water, however this would need to be combined with appropriate management of these areas.

3.2.2 Landscape Corridor

The River Hiz from Wellhead to the Priory on the edge of town is mostly accessible to the public by the small country lane which runs the length of the valley and by the number of public footpaths on both valley sides which cross the river at the Windmill Pub in Charlton, and link the town centre with open countryside.

The river passes through a landscape that the Field Landscape Survey has classed as Grade 1 or 2, and has been variously designated as attractive with significant associations to be conserved.

The river has been managed to provide features within the village of Charlton and Hitchin town centre, both of which are Conservation Areas, and is further significant for the woodland associated with it. The field survey assesses the landscape quality of this river channel section to be mostly Grade 2.

The river continues, unseen for the most part, to flow within a modified channel, through the centre of the attractive and historic market town of Hitchin, to emerge in areas of public open space.

The field survey identifies these areas as either Urban space predominantly hard in character or recreation grounds being predominantly soft in character. There are two areas defined as urban space; the Priory and in front of the Parish Church, which the field survey assesses as generally Grade 2, for both the landscape quality of the space and the river channel.

A further four areas are defined as recreation grounds. However in terms of landscape quality the field survey assessment is mostly Grade 3. The river channel has been artificially defined in significant sections, and the field assessment of landscape quality is mostly Grade 3.

To the north of the town, the river flows between Hitchin and Ickleford through a landscape modified and defined by the roadway embankments, which visually contain and divide this flat, urban fringe landscape, accessible by the public footpaths which cross the area, most notably the Icknield Way.

This landscape has been generally designated as uninteresting, and the field survey assessment of Grade 3 to both the general landscape and to the river channel confirms the visual banality of this area.

In summary, the present flow rate has a visually deleterious effect on the amenity features which rely on the river, in particular the Charlton Mill pond, duck pond at the Windmill Pub, Charlton, and the formal water garden in front of Hitchin Parish Church.

3.3 Conclusions

3.3.1 Channel morphology

The River Hiz has been extensively managed by mankind. For approximately 2km through the centre of Hitchin it flows through lined channels, culverts and ornamental pools without a hint of a natural channel. Upstream of Hitchin there is a section of relatively unimproved channel, though it lacks water upstream of Charlton. Downstream of the Purwell confluence, and more particularly downstream of the Oughton confluence, the River Hiz reverts to a natural channel.

3.3.2 Landscape Corridor

The River Hiz can be divided into three categories. The southern section from Wellhead to the Parish Church of St Mary, typified by the generally good quality of the landscape, together with the features associated with the river, and the public accessability make the river an important landscape and cultural feature to be conserved and restored. In particular the millpond and Windmill Pub pond at Charlton and the formal water feature to St Mary's Church, Hitchin should be retained.

As it passes through the town of Hitchin the river is associated with public open space. Having regard to the Local Council's wish for a riverside walk, the river is important for its associations with amenity. The generally poor landscape quality of the spaces is exacerbated by the low river flows. Water quality impacts amenity interests through the town because flows and therefore dilution are low. This increases the risk of "knock-on" impacts in terms of nuisance algae and odours from deposited organic material. Considerable enhancement could be achieved with greater flushing.

The final section of the River Hiz, benefitting from the combined flows of the Hiz, Oughton and Purwell, flows past Ickleford to Cadwell, through an uninteresting urban fringe landscape. The potential for enhancement of the landscape is not great in this area, although an enhancement of the river flows in this area would increase the significance of the river.

3.3.3 River Corridor and In-stream Communities

To reinstate the botanical interest that would have been present in the upper Hiz (above the confluence with the Purwell) would require maintaining water flow throughout the year, to a depth of about 10cm near the source, combined with a range of management activities to limit shading, and other land use activities that would affect the vegetation. The level of intervention required to supply this water is not considered feasible or justified on ecological ground and a range of management practices to help manage the vegetation and to use the available water to its best advantage are given in Section 3.4 below. These should be coupled with any landscape measures and coordinated with the Wildlife Trust and other individuals.

Analysis of species distribution with multivariate statistics revealed four site groups (Figure 8). These groups were characterised by different species assemblages and diversity, although in general, the macro-invertebrate communities were limited. Two of the four groups (A and B) contained some species with a requirement for running water although the molluscs, oligochaete worms and leeches associated with generally depositing conditions were also abundant. Species with a requirement for flow included the mayfly *Ephemerella ignita*, the net-spinning caddisfly larvae *Hydropsyche siltalai* and *H angustipennis*, and the stone-cased caddisfly *Agapetus fuscipes*. Sites in these groups showed less evidence of low-flow stress than those in groups C and D (Figure 10), and included two sites on the River Rhee samples in August. Sites in groups C and D were dominated by the beetle, bug, mollusc and leech species generally associated with depositing habitats.

Sites were allocated to two similar groups on the basis of an ASPT low-flow index developed recently for the NRA by Scott Wilson Kirkpatrick (Figure 11). A classification based on a combination of the multivariate and ASPT-based systems is shown in Figure 14. From this analysis the following conclusions can be drawn:

(a) The River Hiz between Wellhead and the edge of the Hitchin conurbation was severely derogated. Through the town the instream community continued to be derogated until flow was augmented by Hitchin STW discharge. Archive data from 1982 show that although the instream community was not particularly diverse, it contained the mayflies *Cloeon* and *Baetis*, both of which had disappeared by 1993. The upper Hiz in general was less interesting in terms of habitat and community structure than the Purwell or the Oughton.

The study highlighted the upper Hiz (and the northern Purwell tributaries) as the most lowflow derogated sections of the upper catchment. In this respect, the analyses pre-empted changes observed later in the summer, when the sites were resampled (August 1993) and found to be dry.

The conservative physico-chemical variables (temperature, pH, dissolved oxygen and electrical conductivity) measured during the study suggested that water quality in the system was reasonably uniform.

3.4 Recommendations

From Wellhead to St Marys Church in Hitchin, the River Hiz flows through an attractive valley designated as "Distinguished" on a County scale, two Conservation Areas and Green Belt and is valued by its residents, some of whom have formed themselves into the Charlton Society, for visual amenity and the recreational walks afforded by the many footpaths within the valley. The field survey also classifies this landscape as of good quality, Grade 1/2, and recommends conservation and restoration. However the visual quality of the river itself is classified as Grade 2/3, and is thought to generally detract from the visual amenity.

Most importantly the river is at its most visually exposed and accessible where ponds have been formed; the Mill pond at Charlton, the pond at the Windmill Pub, Charlton; the widening of the river within the ground of Priory Park to form a "Lake", and the formal water garden to St Marys Parish Church within the centre of Hitchin. Therefore, from the point of view of landscape it is recommended that scarce resources are concentrated on reinstating these features.

Although the biological quality of the system perhaps does not warrant such intervention, any increased flow in the river could be used more effectively by differing profiles of part of the watercourse and possibly by changing the bed to allow seasonal riffles where appropriate, which would also help invertebrates. There are not many appropriate locations between Wellhead and the town to allow this and any management efforts would best be focused on the Millpond, which could be redredged and act as a pool for a larger part of the year. The Mill pond at Charlton, was recorded by this survey (Summer 1993) to be dry, and detracting from the visual character of this area. Increasing flows should be encouraged to re-establish this pond. It may be interesting to study the previous management of the river by mills and sluices, as the Charlton Mill must have in part created this pond and varied the flow rate.

The pond at The Windmill Pub, Charlton is recorded in this survey as appearing slack, discoloured and dirty, and probably due to a combination of sediment deposition at the weir, together with the disturbance and dirt created by the ducks, further exacerbated by overhanging vegetation. Maintenance to clear existing sediment and cutting back of vegetation. Maintenance to clear existing sediment and cutting back of vegetation, but retaining trees, to let more light would improve the site. However increased flow rates are to be encouraged, sufficient to carry the sediment away. It may be that such flows only need to be intermittant.

The river widening within Priory Park, a Conservation Area, has created a "Lake" set within a Parkland Landscape, used for recreational purposesd and of local ecological benefit. However the "dirty" appearance of the water detracts from the otherwise good visual quality of this area. Maintenance to remove existing sediment together with increased flow rates are to be encouraged to improve the water quality. It is recommended that the NRA provide guidance on the better use of the water that is present, by co-ordinating with the Trust and other local initiatives from the Council or other interested persons or groups.

The formal water gardens to St Mary's Church, A Grade A listed Building, in the centre of Hitchin is important culturally, historically and for the passive recreation afforded. Unfortunately the river here is observed to be slack and discoloured and noted to be detracting from the visual amenity of this central civic open space. Maintenance to remove existing sediment together with increased flow rates are to be encouraged to improve the water quality.

Within the town of Hitchin a further detailed survey is recommended to be carried out in order to identify opportunities and restrictions for improving the river corridor and landscape areas, and should fully involve the Local Council. With regard to water quality it should be noted that on entering the town through Priory Park the water is described as dirty. However re-emerging through the recreation ground (UO3), it is observed to be clear. This may be due to increase in flows from surface water discharge within the town.

The main measures required to improve the conservation interest around Gerry's Hole are to improve the management of the site and the vegetation, with possibly only limited alterations to the structures there controlling the water courses. There appears usually to be sufficient water resources at the confluence, so that better use of them by appropriate river engineering measures would be sufficient. The actual requirements would need to be discussed and agreed with the Trust and the District Council, as there would be little reason to alter the water management unless there was an appropriate conservation management plan with the resources available to implement and more importantly maintain the management regime. It is proposed here that the NRA could contribute via discussions with the Trust and council to learn if this is feasible. It is important to note that this site (Gerry's Hole) is only of minor importance compared to the Oughtonhead sites and those on the Purwell, which should receive the greater attention.

The final section to the North of Hitchin is graded as "Uninteresting" on a County scale and recorded as Grade 3 by this survey, and therefore has the lowest priority for resources as this area has the least potential for enhancement of the landscape. After joining with the Purwell and Oughton, the river could benefit from appropriate river management activities designed to maintain any flood protection and enhance conservation at the same time. The area of the confluence of the Hiz and Oughton would best be managed in consultation with the Trust or Mr T James of the Record Centre (see the recommendations for the Oughton, Section 4.3).

If flow support measures were to be recommended, by recirculating water from lower reaches, this would probably prevent further loss of habitat and decline in species diversity. This would also almost certainly satisfy the demands of residents who have been campaigning for greater flows in the vicinity of Charlton, without being fully aware of what habitat and species losses had occurred. Under such conditions, habitat and community structure would improve sufficiently to resemble those occurring in the Purwell upstream of the Hiz confluence at present. Habitat diversity, and as a consequence, species diversity, would improve as sediment was carried downstream by the higher discharge. This would reveal gravels, cobbles and the underlying chalk, which would be recolonised by submerged, emergent and marginal vegetation as the wetted perimeter extended outward. The flow/sediment balance would have to be assessed at the point of abstraction to minimise any increase in deposition downstream of the abstraction point. Finally, the process could be expedited by judicious channel management in the form of riffle and pool reinstatement which would also enhance the value of the habitat for fish. Flows similar to those occurring in summer 1993, in the Purwell, downstream of the Ash Brook/Ippollitts Brook confluence, would probably be adequate for this purpose. Although not current metered during the present study, this flow was estimated between 0.01 and 0.05 cumecs.

However, to restore conditions to those occurring earlier in the century would require groundwater to be transferred to the area by reducing abstraction or flow support, in addition to the described channel modifications. Even so, this would not necessarily guarantee the recolonisation of species lost, as the stable mosaic of micro-habitats and species niches characterising the natural chalkstream is easily destroyed but may take many years to re-establish. Transfer of gravels and their associated biota from existing undisturbed streams might expedite the recolonisation process.

However, although it is not felt that the River Hiz would respond to measures of this kind sufficiently rapidly to justify the possible investment entailed, if there were an adequate flow of good quality groundwater to the upper catchment, and the channel profile included areas of eroding as well as depositing habitat, the River Hiz would support a diverse well-balanced benthic macro-invertebrate community. This, in turn, would sustain coarse and game fisheries. Habitat improvements brought about by supporting flows in the channel with water recirculated from downstream would enable the moderate coarse fishery downstream of Hitchin to extend upstream. This would supplement the present bottom-feeding/short-bodies assemblage sufficiently to restore angling interest to the fishery.

LIMIT OF STUDY AREA

RIVER OUGHTON

RIVER PURWELL

RIVER HIZ

IPPOLLITTS BROOK

ASH BROOK

P2 P3 P7 P8 P9 P10 P18 P30 P31

05 06 07 08

PIRTON CP

WYMONDLEY CP

IPPOLLITTS CP

HITCHIN

NORTH HERTFORDSHIRE

RIVER CORRIDOR SECTIONS WITH WELL DEVELOPED AQUATIC VEGETATION.

93BBB/007

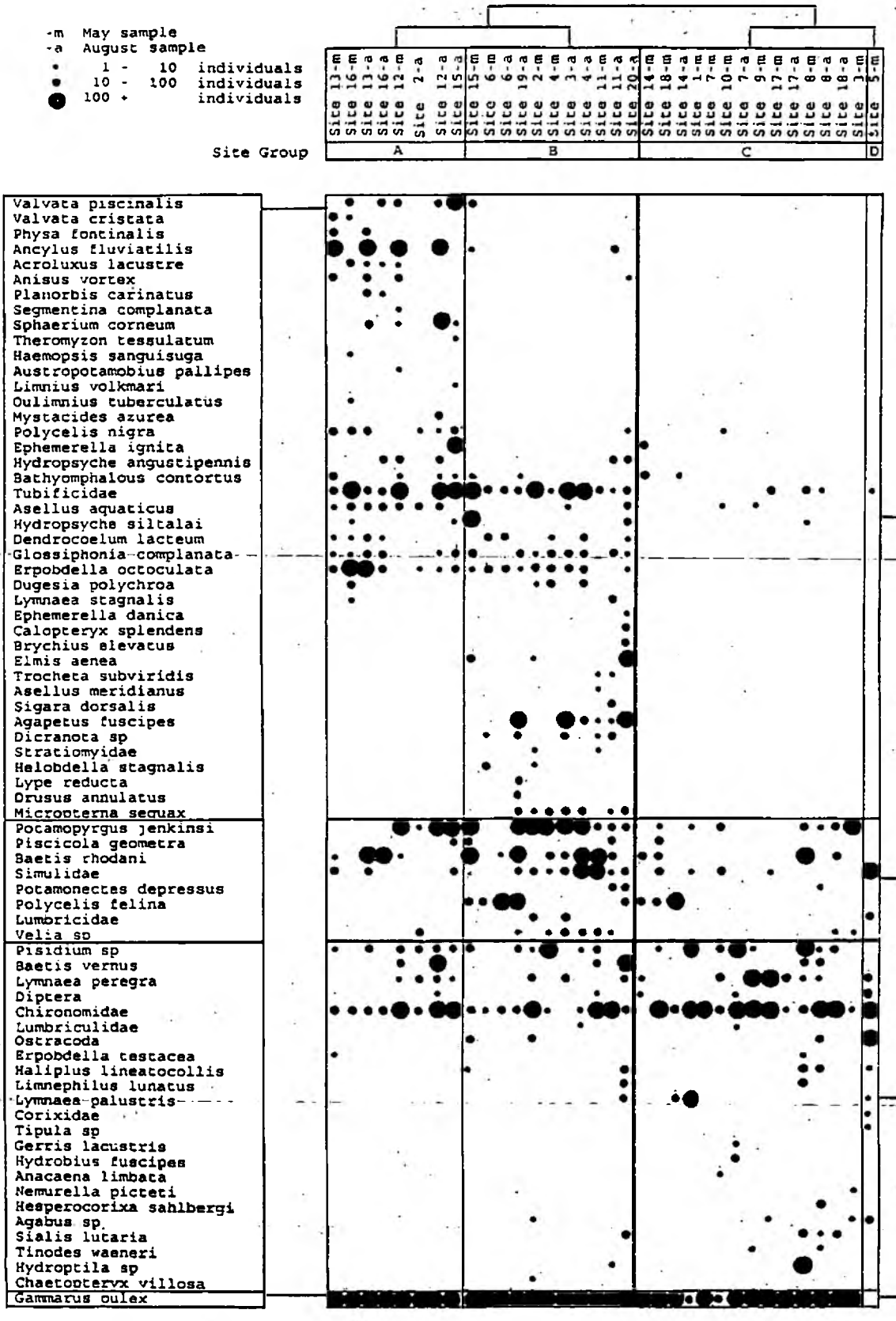
Scale 1:25000

Hiz, Oughton and Purwell Environmental Appraisal

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

in association with

Engineering – Science Environmental Engineers
NAIAD – Aquatic Environmental Services
Arcady Design – Landscape Architects



TWINSPAN classification of sites on the upper River Hiz and tributaries based on instream macro-invertebrate community structure in May and August 1993

TWINSPAN CLASSIFICATION MAY AND AUGUST 1993

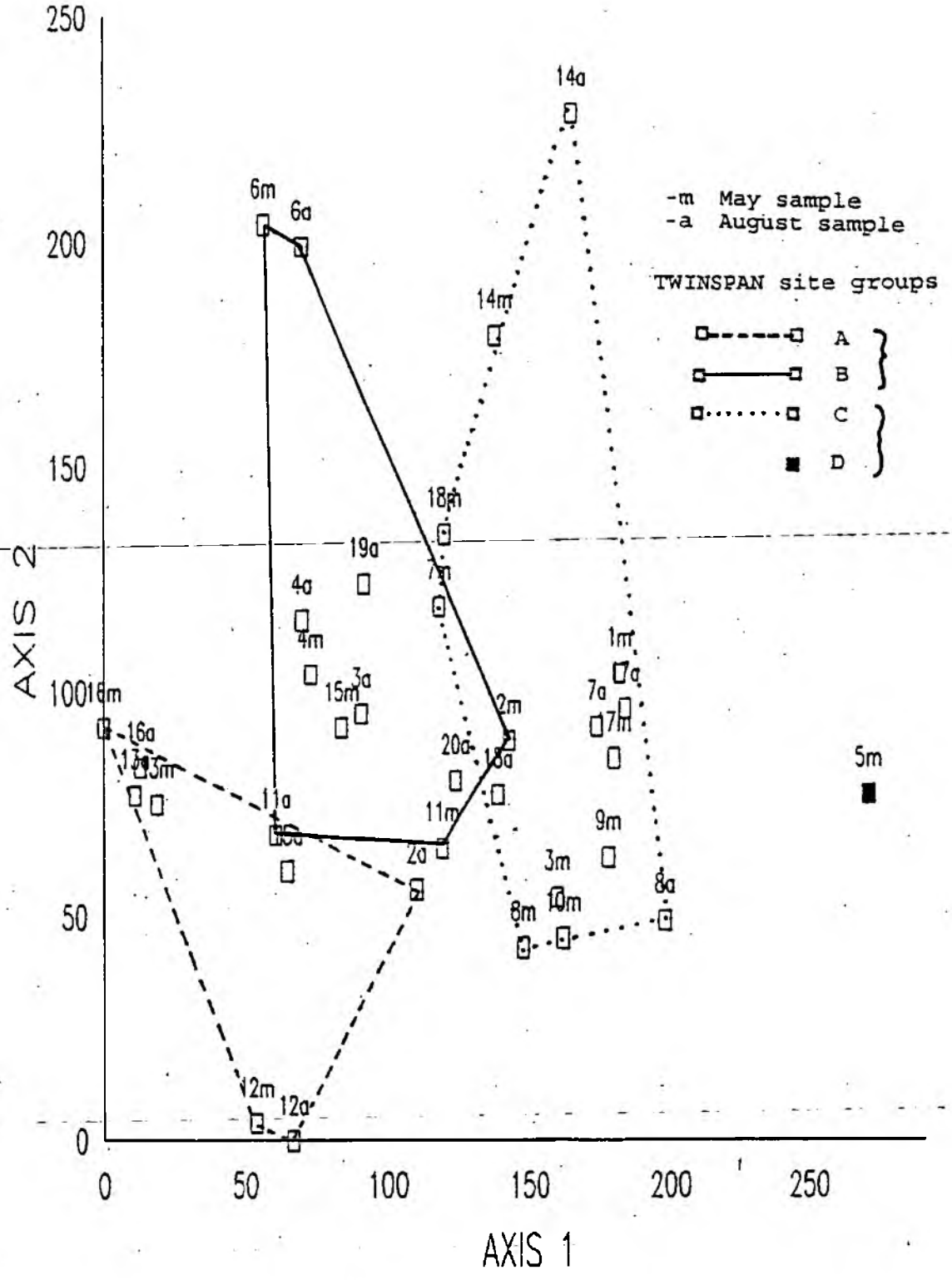
Hiz, Oughton and Purwell Environmental Appraisal

scale. NTS

93BBB/008

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

in association with
Engineering – Science Environmental Engineers
NAIAD – Aquatic Environmental Services
Arcady Design – Landscape Architects



DECORANA axes 1 and 2 plotted for sites on the upper Hiz and tributaries sampled in May and August 1993

DECORANA AXES: MAY AND AUGUST 1993

Hiz, Oughton and Purwell Environmental Appraisal

scale NTS

93BBB/009

Scott Wilson Kirkpatrick
Consulting Engineers

in association with
Engineering – Science Environmental Engineers
NAIAD – Aquatic Environmental Services
Arcady Design – Landscape Architects

KEY

GOOD

BAD

PIRTON CP

WYMONDLEY CP

IPPOLLITTS CP

NORTH HERTFORDSHI

FLOW DEROGATION BASED UPON MULTIVARIATE ANALYSIS

93BBB/010

Scale 1:25000

Hiz, Oughton and Purwell Environmental Appraisal

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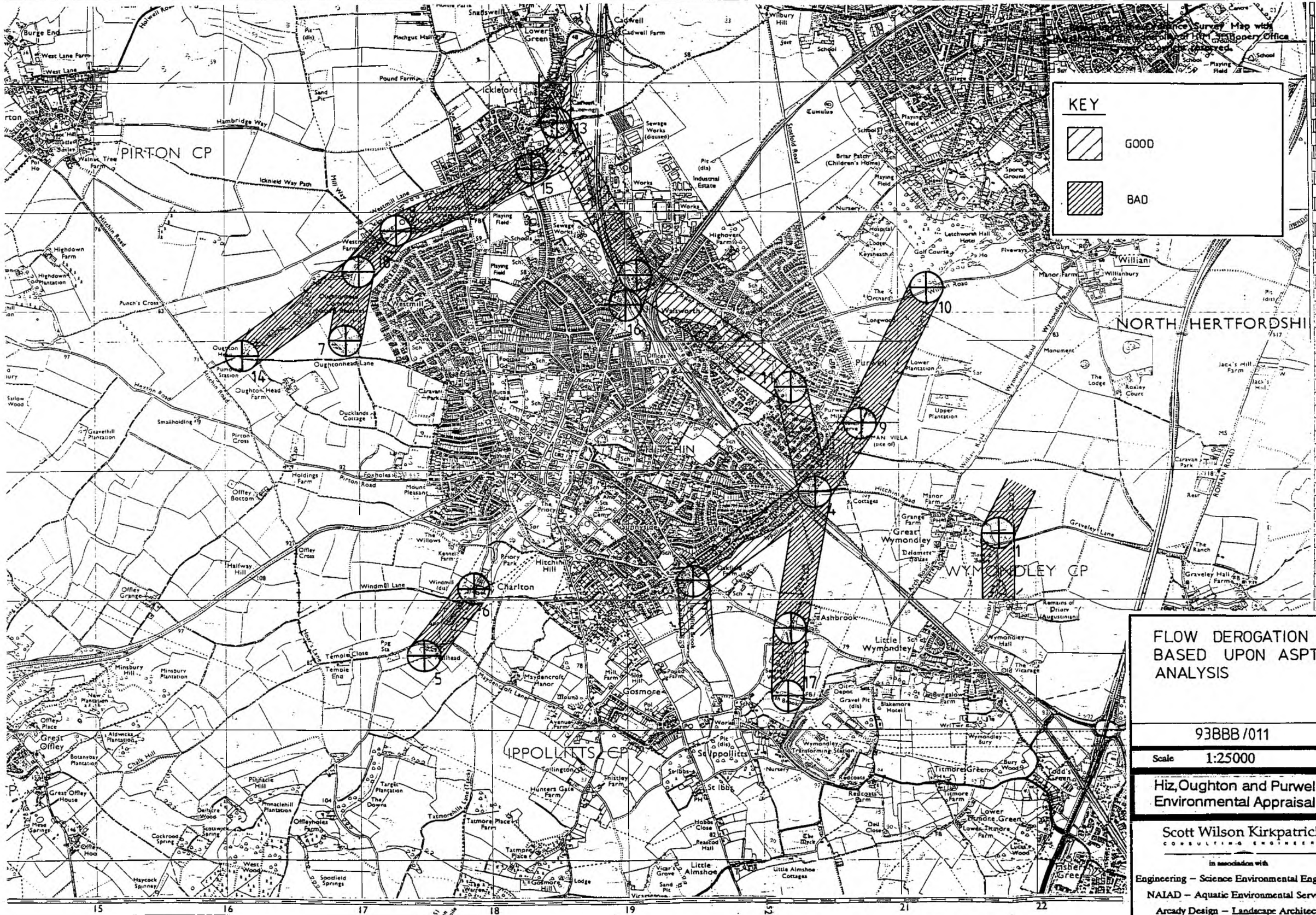

FLOW DEROGATION BASED UPON ASPT ANALYSIS

93BBB/011

Scale 1:25000

Hiz, Oughton and Purwell Environmental Appraisal

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

in association with

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NAIAD – Aquatic Environmental Services
Arcady Design – Landscape Architects

CODE	QUALITY CLASS	MANAGEMENT
AO1	1/2	Conservation/Restoration
AO2	1/2	Conservation/Restoration
AO3	2	Conservation/Restoration
AO4	2	Conservation/Restoration
AO5	2	Conservation/Restoration
AO6	2	Conservation/Restoration
AE1	2	Conservation/Restoration
AE2	2	Conservation/Restoration
AE3	2/3	Conservation/Restoration
PE1	2/3	Restoration/Enhancement
PE2	3	Conservation/Restoration
PE3	3	Restoration
PE4	3	Restoration
PE5	3	Restoration
PK1	1/2	Conservation/Restoration
PK2	3	Restoration/Enhancement
PK3	1/2	Conservation
UE1	Hitchin Town Centre.	Detailed appraisal required
US1	2	Conservation/Restoration
US2	2	Restoration/Enhancement
RG1	3	Restoration/Enhancement
RG2	3/4	Enhancement
RG3	3/4	Enhancement
RG4	3/4	Enhancement

KEY — **MACRO SURVEY**

- AO Arable landscape with distant views
- AE Arable landscape with few or no distant views
- PE Pastural Landscape with few or no distant views
- PK Parkland landscape, of grassland and scattered trees.
- UE Urban Enclosure Hitchin Town Centre.
- US Urban Space, essentially hard in character
- RG Urban space essentially green in charcater.

LANDSCAPE AREAS - MACRO SURVEY

93BBB/012

scale .1:25000

Hiz,Oughton and Purwell Environmental Appraisal

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

In association with
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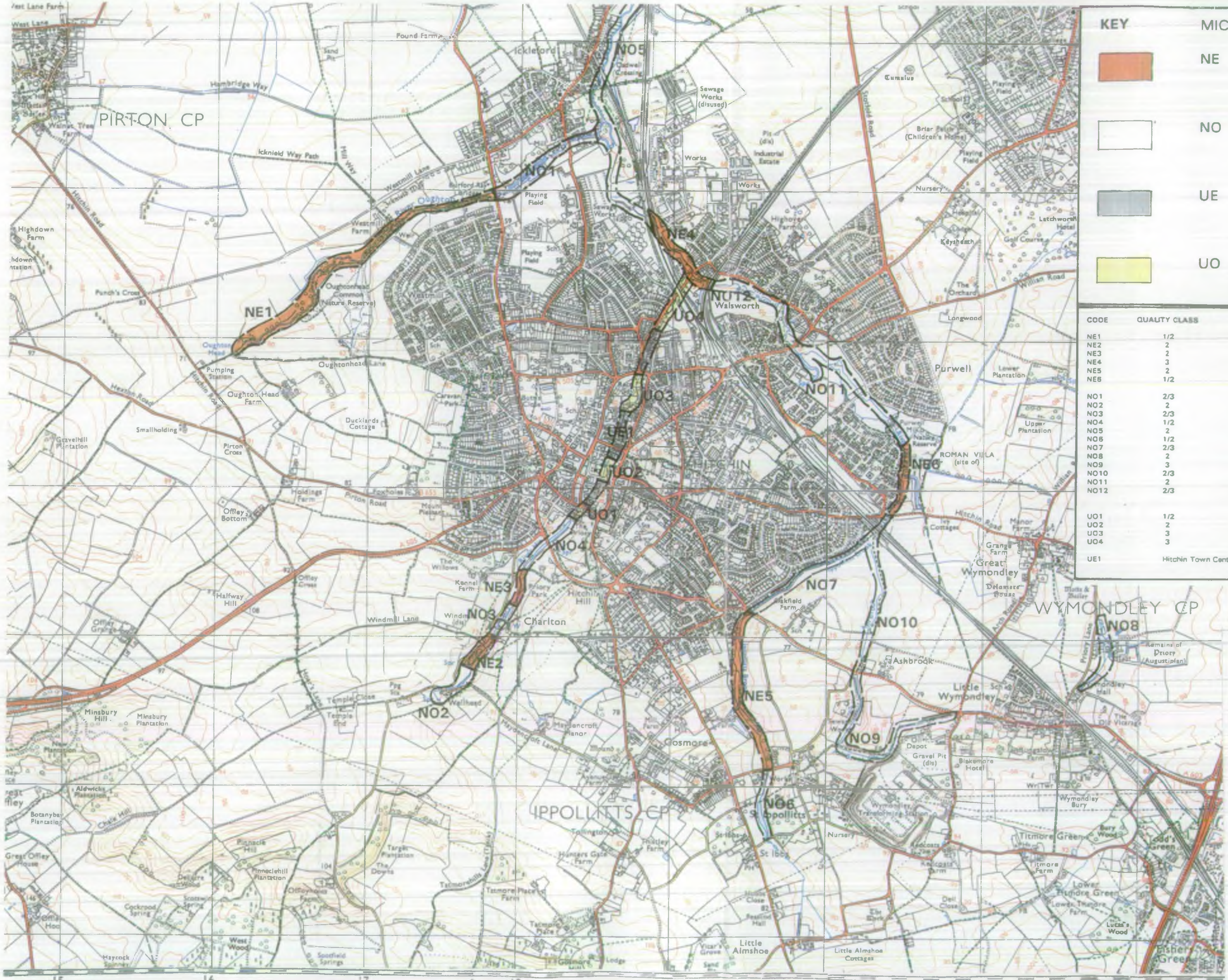
Arcady Design – Landscape Architects



KEY	MICRO SURVEY	
(orange)	NE	Enclosure by woodland or high banks.
(white)	NO	One bank at least open with few elements to interupt the view.
(grey)	UE	Enclosure by walls and buildings
(yellow)	UO	Essentially urban, although buildings at a distance

CODE	QUALITY CLASS	MANAGEMENT
NE1	1/2	Conservation/Restoration
NE2	2	Conservation/Restoration
NE3	2	Conservation/Restoration
NE4	3	Enhancement
NE5	2	Conservation/Restoration
NE6	1/2	Conservation/Restoration
NO1	2/3	Restoration/Enhancement
NO2	2	Conservation/Restoration
NO3	2/3	Conservation/Restoration
NO4	1/2	Conservation/Restoration
NO5	2	Conservation/Restoration
NO6	1/2	Conservation/Restoration
NO7	2/3	Restoration/Enhancement
NO8	2	Conservation/Restoration
NO9	3	Restoration/Enhancement
NO10	2/3	Conservation/Restoration
NO11	2	Conservation/Restoration
NO12	2/3	Enhancement
UO1	1/2	Conservation/Restoration
UO2	2	Conservation/Restoration
UO3	3	Enhancement
UO4	3	Enhancement
UE1	Hitchin Town Centre	Detailed assessment required.

RIVER CORRIDOR
MICRO SURVEY

93BBB/013

scale 1:25000

Hiz, Oughton and Purwell Environmental Appraisal

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

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Engineering – Science Environmental Engineers
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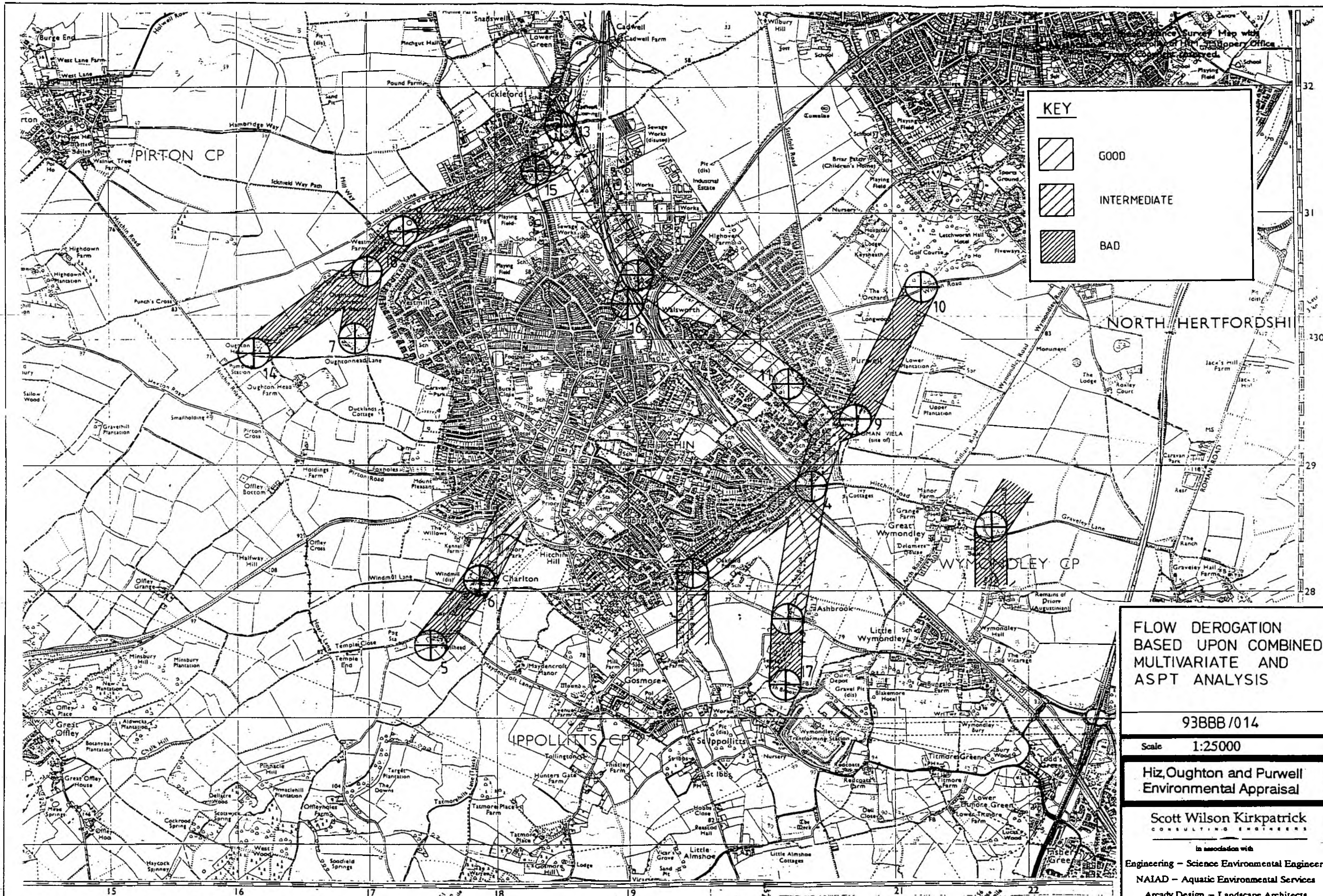
KEY
GOOD
INTERMEDIATE
BAD
FLOW DEROGATION BASED UPON COMBINED MULTIVARIATE AND ASPT ANALYSIS
93BBB/014
Scale 1:25000
Hiz, Oughton and Purwell Environmental Appraisal
Scott Wilson Kirkpatrick
CONSULTING ENGINEERS
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PIRTON CP
NORTH HERTFORDSHI
WYMONDLEY CP
IPPOLLITTS CP
HITCHIN
Ickleford
Walsworth
Purwell
Charlton
Great Wymondley
Little Wymondley
Gosmore
St Ippollitts
Great Offley

GERRY'S HOLE

OUGHTONHEAD NATURE RESERVE

OUGHTONHEAD COMMON

PURWELL MEADOWS

PURWELL NINESPRINGS

PRIORY PARK

FOLLY ALDER SWAMP

PIRTON CP

WYMONDLEY CP

IPPOLLITTS CP

NORTH HERTFORDSHI

AREAS OF NATURE CONSERVATION INTEREST

93BBB/015A

Scale 1:25000

Hiz, Oughton and Purwell Environmental Appraisal

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4. RIVER OUGHTON

4.1 Baseline Survey Results and Observations

The following four sections generally highlight the baseline observations obtained during the river corridor, instream communities, landscape and channel morphology field surveys undertaken between May-September 1993.

4.1.1 River Corridor Survey

The results of the river corridor surveys of the River Oughton (OUG 001 - 009) are given in Appendix C1. Using the evaluation criteria defined above (Section 2.1) the following sections are noted as of greater interest.

Notable Plant Species

OUG 002

Pulicaria dysenterica Fleabane is common in marshes and wet meadows and ditches throughout the British Isles.

OUG 003

Carex pendula Pendulous sedge is a species preferring acid, but base rich heavy soils, but is also found on less clayey soils where there is a constant water supply, such as wet ditches. It is frequently introduced, which may be the case here.

OUG 004

Rorippa x sterilis Brown or Winter Water-cress, is cultivated throughout the British Isles. (now? *Nasturtium microphyllum x officinale*).

Carex disticha Brown sedge is a plant of mixed herb-sedge fens and wet meadows, preferring areas with a fluctuating water-table. More frequent in the calcareous fens of Eastern England.

Carex paniculata Greater Tussock Sedge is a species of peaty, medium base rich soils where water levels are at least seasonally high; in fens and besides slow flowing streams.

Dactylorhiza praetermissa Marsh Orchid grows in wet meadows, marshes and fens throughout the British Isles.

Juncus subnodulosus Blunt-flowered rush grows in fens, marshes, and dune slacks with basic ground water, often on calcareous peat. It is only locally abundant where found.

Pulicaria dysenterica

Rumex hydrolapathum Great Water Dock grows in wet places and shallow water.

OUG 007

Dryopteris carthusiana Narrow buckler-fern grows in damp and wet woods, marshes and wet heaths, and is noted in CTW as rather common.

OUG 008

Carex disticha

Carex paniculata

Dactylorhiza praetermissa

Juncus subnodulosus

Pulicaria dysenterica

Rumex hydrolapathum

OUG 009

Juncus bufonius The toad rush group grow on muddy margins of ponds, lakes and streams, in ditches, marshes and wet fields. The main species is common in moist open habitats.

Glyceria declinata Glaucous sweet-grass is probably moderately common in the British Isles, on muddy or dried up margins or in the shallow water of ponds, ditches and streams.

Notable River-Dependent Habitats

There are two main areas of river-dependent habitat along the Oughton (see Figure 15A), that also supports the interest in the river itself. These are Oughtonhead Common (see Chapter 5) and also Oughtonhead Nature Reserve, which is managed by the Hertfordshire and Middlesex Wildlife Trust. Both areas are of important conservation value, though the Common was denotified as an SSSI in 1970, due to loss of interest from drying out and lack of management, and currently only maintains some of its former interest. However, a return to earlier management methods, such as light intensity grazing and basic ditch maintenance, combined with a better use of the water that is available could help preserve some of the remaining interest as well as recover some of the earlier interest. That this could occur has been shown by the return of *Ranunculus flammula* after shallow clearance dredging of one of the ditches on the Common. The area of the Reserve is currently undergoing change through the process of succession and without habitat management and water resource management it too will lose some of its interest. However the Trust and the North Hertfordshire District Council recognise this and are currently working to preserve the interest of the Reserve.

1. Oughtonhead Common (Figure 16)

This area is mainly reported in Chapter 5, however the information from the river corridor surveys of the Oughton is included here. This attractive, clear, meandering river flows along one edge of Oughtonhead Common. It has silt or shingle substrate and the water is clear. Emergents are frequent and include stands of *Phragmites australis, Carex acutiformis/ Carex riparia*, and *Rorippa nasturtium-aquaticum/Mentha aquatica. Callitriche* sp. is quite frequent either growing amongst stands of *Rorippa nasturtium-aquaticum* or by itself. The land to the north of the river the supports a band of wet woodland. The land to the south of the river supports stands of tall, moisture-loving herbs (*Epilobium hirsutum* (dominant), *Galium aparine, Filipendula ulmaria, Lythrum salicaria* (rare), *Urtica dioica*) and patches of scrub and woodland.

Oughtonhead Common has not been grazed for many years and is being devalued as scrub invades and the wet grassland becomes rank, nevertheless some areas still have an interesting flora. Species recorded here included - *Agrostis stolonifera, Angelica sylvestris, Arrhenatherum elatius, Apium nodiflorum, Carduus acanthoides, Carex disticha, Carex paniculata, Cirsium arvense, Dactylorhiza praetermissa, Deschampsia cespitosa, Dactylis glomerata, Equisetum palustre, Filipendula ulmaria, Galium uliginosum, Lactuca serriola, Juncus bufonius, Juncus effusus, Juncus inflexus, Juncus subnodulosus, Lathyrus pratensis, Lolium perenne, Lotus uliginosus, Lythrum salicaria, Mentha aquatica, Ranunculus repens, Rumex acetosa, Odontites verna, Ononis spinosa, Potentilla anserina, Poa trivialis, Pulicaria dysenterica, Vicia cracca.*

2. Oughtonhead Nature Reserve (Figure 17)

Oughtonhead Nature Reserve lies next to the Common on the opposite (north) side of the Oughton. It is a Herts and Middlesex Wildlife Trust Reserve and is owned by the Herts County Council. The Trust manage the site on the basis of an informal agreement. Much of the summary following is copied from the Trust's management plan for the site.

The site consists of mainly a linear strip of mixed wet woodland running adjacent to the Oughton. Most of the reserve is on a Pleistocene deposit of chalky boulder clay with some gravel. The soils derive from peat deposits and tend towards acidity, but are neutralised by the chalky alkaline water, producing a fen soil type. The site was formerly a managed fen, used for growing osiers as well as cut for sedges. Around 1920 cricket bat willows were planted at the eastern end. Most of the site is now in an advance state of natural succession, first by willow swamp and then by ash, oak and downy birch. The two western compartments (Figure 17) are dominated by mature alder carr which is being invaded by sycamore. In the drier areas the understorey is dominated by hazel and elder, with a wide range of other shrubs.

The original fen vegetation now only exists as small remnants located adjacent to the river, typified by the presence of tussock sedge. The site once supported several Herts rarities, notably grass of parnassus and bog cotton at the eastern end, which was once a bog. This area has developed into mature willow/fen carr. Surviving plants of fen and swamp habitats include greater pond sedge, *Dryopteris carthusiana, D dilitata, D filix-mus* and *Athyrium felix-femina.* Flowering plants include lesser spearwort, marsh marigold, purple loosestrife and woodruff. There is a fairly extensive area of common reed at the eastern end of the site and smaller areas along the river margins. The margins are also dominated in places by beds of greater pond sedge and great willowherb.

Although this area was not part of the river corridor survey, the wet wood on the north side of the section OUG 007 was recorded during a superficial inspection and included the following species:

Canopy and shrub layer - *Acer pseudoacorus, Alnus glutinosa, Fraxinus excelsior, Prunus spinosa, Salix cinerea, Sambucus nigra.*

Ground layer - *Angelica sylvestris, Dryopteris dilatata, Dryopteris carthusiana, Festuca gigantea, Hedera helix, Mercurialis perennis, Rubus fruticosus, Stachys sylvatica.*

In terms of botanical value the site is generally of high local value, and for the tall fen vegetation present is of high regional value also. The Trust has prepared a draft management plan for the site, which propose a wide range of activities that would preserve and enhance the site. Many of these measures are discussed below.

Sections with well developed aquatic vegetation

Section OUG 006 along the River Oughton was found to have >15% cover of submerged aquatics, while sections OUG 005 to 008 had >15% cover of emergent vegetation (Figure 5). These sections all lie either on the Common, or adjacent to it or adjacent to the Reserve, and support the higher conservation value of these areas (see below).

Other Conservation Notes from the River Corridor Survey

Section OUG 004, while it does not have any species of particular conservation importance does contain a number of species of wet woodland habitat, and also vegetation of tall moisture loving species *Filipendula ulmaria* and *Phragmites australis*. Because of its association with the former management of the mill and its proximity to the Nature Reserve, this section warrants consideration for inclusion in any management proposals.

Section OUG 008, which is the smaller stream crossing the Common, has been recently dredged by the NHDC. This was carried out as part of a developing

management plan, that reflects much of the Plan drafted by Trevor James in 1974. The NHDC recognise that the dredging has been too extensive and that the reinstatement of grazing and the management of the water resources available to the Common need to be conducted together. The dredging has removed most of the biomass in the water course, but on 21 July some vegetation was recorded as having returned. Both OUG 008 and OUG 009 could be improved if the banks were less steep.

4.1.2 In-stream Communities

Instream macro-invertebrates were sampled and habitat assessed at five sites during May 1993 (Figure 6, Table 7). The sites were resampled in August 1993.

RIVER OUGHTON

Site	14	TL 162299	Oughtonhead
Site	7	TL 169300	Springs at Oughtonhead Common
Site	18	TL 170305	Downstream of common springs confluence
Site	8	TL 173308	Downstream of Westmill
Site	15	TL 186314	Bowmans Mill, Ickleford

Table 7
Location of sites in the catchment
at which benthic macro-invertebrates
were collected during summer 1993

Full species lists for each site are given in Appendix C2 at the end of this report. A brief description of habitat at each site and values of physico-chemical variables on each sampling data are also given in Appendix C2. Physico-chemical variables and flow are tabulated (Table 2, May 1993, and Table 3, August 1993).

Multivariate analyses were undertaken as follows:

TWINSPAN classification - Data from the May and August samplings were combined so that the date set present to TWINSPAN was as large as possible. The sequence of species and site sub-divisions generated by TWINSPAN is shown in Figure 8. The process was interpreted initially after the second cut level, which by experience has been shown to reveal most about processes controlling population distribution. However, the macro-invertebrate communities were generally of uniformly limited diversity. The TWINSPAN classification was therefore interpreted after the first cut level, the point at which differences between the resultant groups would be greatest.

DECORANA ordination - The relative strengths of axes 1-4 (in eigenvalues) in the DECORANA ordination and the relative importance of each axis in explaining total variance are given in Table 4. The distribution of sites between axes 1 and 2 are shown in Figure 9.

DECORANA axes - rare species downweighted

Axis	Eigen Value	% variation accounted for
1	0.281	39
2	0.205	28
3	0.140	19
4	0.103	14

Table 4
Proportion of between site variation accounted for by DECORANA axes 1-4

Most (67%) of the variance is accounted for by axes 1 and 2 so these have been plotted, and sites grouped by TWINSPAN linked with broken lines. The distribution of sites on the basis of the multivariate analyses are shown in Figure 10.

BMWP scores and ASPTs were calculated for each site and are given in Table 5 (May 1993) and Table 6 (August 1993). The extent to which each site achieved its potential ASPT was also calculated along with a mean value for the two sampling periods. The sites were then arranged within two groups, the first comprising those achieving less than 80% of their target. The second group comprised sites achieving greater than 80% of their target (a value selected as the median of the measured range). The distribution of sites classified on the basis of ASPT are shown in Figure 11. A classification combining the multivariate and ASPT-based analyses is shown in Figure 14. Sites which classified similarly under the two systems retained their original groupings, whereas sites which classified differently formed an intermediate group.

4.1.3 River Landscape Assessment

Designations

The river is a typical spring fed chalk stream, which rises at Oughtonhead and in Oughtonhead Common, a mature alder willow woodland with marginal fen designated as a Nature Reserve (NHD Local Plan, 1990) and listed by the County as an important Neutral grassland site; Fen Swamp; Wet Grassland and Aquatic Habitat (Herts. Env. Forum, 1990). Oughtonhead is 200m from the Chiterns AONB eastern limit (Variation Order, 1990), within the North Chiltern Countryside Heritage Area and the river flows north east, through a landscape assessed as Grades 1 and 2, Distinguished and designated as Green Belt and a Landscape Conservation Area (NHD Local Plan, 1990).

Soils

The soils in this part are mostly well drained calcareous, mainly medium texture, on chalk and chalky drift, changing to poorly drained soils on alluvium where the river

valley narrows to the north of Hitchin (Soil Survey, 1993). The agricultural land classification is Grade 2 (Ag. Land Classif., Sheet 147) principally a corn growing area, with pasture and recreational uses predominating in the urban fringe.

History

The river flows between Hitchin and Ickleford, approximately 200m south, but parallel to Icknield Way, and there is evidence of continuous human presence in the river valley from the finds of Neolithic implements, Roman pottery and medieval jewellery. In the past the river was used to drive two mills, Westmill a water corn mill, which burnt down in 1961, the Mill House dates from the 17th century, and an early 19th century steam corn mill which still survives incorporated into the modern Mill at Ickleford which Bowmans bought in 1917 (County Archaeo. Records Office, 1993).

Landscape Areas

The field survey records have been collated reviewed and analysed. This requires a description and classification of the full range of both macro and micro river landscape character areas, delineated on the Macro Survey (Figure 12) and Micro Survey (Figure 13), together with typical sketches.

Macro Survey

Sketch and photographic plate numbers refer to Appendix C3

OA1 Open Arable (Sketch 1)

Gently sloping bowl shaped valley of predominantly large arable fields where surviving hedgerows, predominantly hawthorn, mark roads and tracks; a particular feature is the double hedgerow marking Icknield Way. It is a peaceful landscape although intensively farmed, offering long distance views of gently rolling rural landscape broken up by blocks of woodland. Within this area the river is clearly identified by the linear woodland associated with it, and Oughtonhead Common, a designated Nature Reserve of wetland landscape occupying the flat valley floor.

PE1 Enclosed Pasture (Sketch 2)

Linear valley, in which the river is clearly defined by the associated trees; adjacent flat land of the valley bottom is used for a variety of uses; designated open space, Trout Farm and Bowmans flour mill, and slopes are used for grazing. The Icknield Way to the north on slightly higher ground, and residential housing and school playing field and buildings on gently rising land to the south limit views out.

River Corridor - Micro Survey

NE1 Natural Enclosure

From the spring at Oughtonhead to the Bedford Road crossing, the stream is clearly marked by woodland and or hedge and standard trees, providing cover to both sides of the stream.

The spring appears at the bottom of a 12ft deep steep sided gully set within a mixed native woodland. Downstream the banks gradually reduce in height until being canalised at Westmill where the stream changes level. However for most of this stretch of stream the river banks appear terraced on the south bank, accommodating a footpath.. (Plate 1)

The stream flows slowly over a smooth silted channel bed within an initially meandering channel, often only inches deep, which straightens out just above Westmill. The bed is clearly visible and supports emergent vegetation in parts, and for the most part is free of debris, although there is a noticeable amount of rubbish as the stream passes close to the residential area just below Westmill.

This is a delightful woodland setting, improving as the spring at Oughtonhead is approached, with public footpath (road used as a path) alongside the river linking the open countryside and the historic Icknield Way, to the town of Hitchin, providing valuable amenity close to the population centre.

NO1 Natural Open

Modified river landscape, where construction of a weir together with excavation has been used to create a lake for a now disused Trout Farm (Plate 2), still retaining the whitened dead stumps of flooded trees in the flat valley floor, and woodland on the north bank of the river has been further planted to include some conifers. As the stream enters the land owned by Bowmans Mill it becomes a regular channel artificially retained in parts, with close mown grass banks, and standard trees in parts. Finally the river flows under first the old flint bridge within the Mill grounds, and then the newer brick built road bridge, before passing through private gardens to emerge in the wetland and join the Hiz. This section of the river is inaccessible to the general public, both visually and physically.

4.1.4 Channel Morphology

The River Oughton is the most westerly branch of the River Hiz system in the Hitchin area. It rises at national grid reference TL 161299, at a level of approximately 62 MOD. It flows east, with one tributary joining from the south, to its confluence with the River Hiz at TL 185314, at a level of approximately 50 MOD. The morphology of the River Oughton is described working from its source downstream to the confluence with the Hiz. Photographic plates referenced are presented in Appendix C4.

It is convenient to split the River Oughton in order to describe its morphology. The first reach is from the source through Oughtonhead Common.

The stream rises in a hollow some 3 to 5 metres deep, located about 200 metres east of Oughtonhead pumping station. Water rises from a small hollow in the bank (see Plate 1), through the bed of the stream and from a cast iron pipe (Plate 2). The flow from the spring is relatively weak and unable to fill the stream channel. At the spring itself the bed material comprising chalk pebbles with some sand could be seen, however a short distance downstream the gravelly bed became obscured by organic silt.

For approximately 500m the stream flows in an incised valley, typically 2 to 5 metres below the general ground level. The stream meanders within the incised valley. The channel is trapezoidal in cross-section with the bed essentially flat and level: there is no noticeable deepening on the outsides of bends. The channel is over-large for the present flow and this has resulted in the accumulation of organic debris and silt. The apparently original gravelly bed with some sand has become overlain with more fine sand and upwards of 200mm soft organic mud in places. Indeed, even when the silt was disturbed it was rapidly deposited showing the stream was unable to carry very fine silt in suspension. An equilibrium between sediment supply and carrying capacity was reached only where the channel was artificially constrained. For example Plate 3 shows a fallen tree and log "stepping stones" which concentrate the flow: the local increase in stream power changes the bed from black organic silt to grey and yellow chalk, gravel and sand.

Some 100 to 200m upstream of the boundary of Oughtonhead Common (approx TL 164301) a remnant of a former bank was just visible. Set back about 1 metre from the right bank, the earlier bank and its crest about 400 to 600mm above the existing water level. This may be evidence of either a considerably greater flow in the past or of earlier downcutting.

At the western edge of Oughtonhead Common there is a large pool (Plate 4). On the day of the survey it was being used as a bathing pool by young children. The eroded nature of the banks suggest that this pool is regularly used by children and animals for bathing and drinking respectively.

Through Oughtonhead Common the flow in the river becomes greater, however it is still typically 200mm below the top of the bank. The channel is approximately 6 to 8 metres wide with a constant trapezoidal cross-section. Silting with both sand and organic silt is widespread. From the spring downstream to about TL 169305, the eastern end of the Common, the channel appears to be naturally sinuous.

From the eastern edge of the Common the River Oughton flows in a man-made channel for about 300 metres to a former mill at Westmill Farm. The river is embanked on its right (south) bank and has been straightened. The millstream is shown on Plate 5. An overflow sluice about 100m upstream of the mill is shown in Plates 6 and 7. The sluice structure is old and suffering structural damage: tree roots are dislodging bricks from the body of the structure, whilst a small scour hole has

developed downstream. The scour hole is considered to be indicative of a much higher discharge than was occurring on the day of the survey (6.9.93). A view of the mill buildings from the sluice is shown on Plate 8.

The only tributary of the River Oughton rises at the southern edge of Oughtonhead Common and flows north to a confluence that would have originally been at approximately the upstream end of the millstream. However, with the construction of the mill this tributary appears to have been diverted parallel to and south of the millstream. Its confluence with the main stream now occurs where the sluice discharges into the bypass channel.

This tributary flows in a uniform, ditchlike and fairly straight channel. It appears to have been artificially deepened and possibly straightened in an attempt to drain the poor ground of the Common: Plate 9 shows the view looking upstream close to the source.

Downstream of the Common the River Oughton is held back behind a concrete weir to form a small lake. The weir is 600mm high, 5 metres wide with a 100mm (deep) by 600mm (wide) notch at its centre, as shown on Plate 10. About 10 metres downstream of the weir the river is culverted (Plate 11). The culvert is formed from a 750mm diameter concrete pipe with about 150mm silt in the invert. Water marks on the pipe suggest a previous depth of flow of around 100mm.

Immediately downstream of Westmill the River Oughton has been embanked to form a duck pond and garden feature as shown on Plate 12. After this the bypass and millstream rejoin and the stream returns to something approaching a natural unimproved stream. The stream is once again slightly sinuous, but with a narrower channel situated in a narrower corridor. It would appear that pressures to use the better quality agricultural land either side of the river have led to it gradually becoming constrained.

Plate 13 shows an obstruction about 100m downstream of Westmill Farm. This may be natural debris washed down from the farm, or it may be a crude weir to raise water levels though the farm downstream of the mill. Again the bed is a mixture of organic silt deposits where flow is sluggish and natural flinty gravel (Plates 14 and 15) where the flow is swifter. A typical view downstream is shown in Plate 16.

The River Oughton runs close to the northern outskirts of Hitchin at this point, and at least three large (approx 600mm diameter) surface water outfalls were seen on the right (south) bank. One of these (Plate 17) showed a heavy growth of green slime and smelt very organic. This was thought to indicate improperly connected foul drains discharging into the surface water system.

After Burford Ray Bridge (Plate 18) the channel is again artificially straightened as it approaches a former mill. Its confluence with the River Hiz is about 200 metres further downstream.

4.2 Analysis and Discussion

4.2.1 River Corridor and In-stream Communities

The River Oughton is best considered in two parts, that below the Mill, which is of little ecological interest until the confluence with the Hiz, and that above the Mill, when it is in effect part of the Common area and closely associated with the Nature Reserve.

The part below the mill does not warrant on ecological grounds any intervention other than that which might co-ordinate with other areas, or if the footpath along it justified some management activities. Even if co-ordination with the activities proposed for the Common area or Gerry's hole is desired for this short section, any benefits could be considered to be knock-on from the main area of interest.

However, the River Oughton and the small stream joining it on the Common (OUG 004-008) do have a larger quantity of aquatic plants and a higher number of notable species (see Section 4.1.1), almost certainly from association with the Common and the Reserve, both areas of acknowledged nature conservation interest. It is not possible in practice to separate the management of these water courses from that of the Common and Reserve, and these are discussed in more detail below (Chapter 5).

The Reserve, however, is very different from the Common in its previous management history and conservation interest and needs both a continuous water supply and much more active management to retain or regain some of its conservation value. The Trust has compiled a draft Management Plan for the Reserve (Appendix C.5), which is currently being discussed by them, and a good opportunity exists for the NRA to co-ordinate water management activities to support and enhance the work of the Trust on the Reserve.

The macro-invertebrate communities in all sections of the River Oughton lacked many of the species which normally characterises chalk stream habitats. In particular, there were none of the stoneflies, mayflies and cased-caddisflies normally associated with cold, unpolluted, alkaline, flowing water. These had been replaced by the more ubiquitous burrowing, scraping and filter-feeding species adapted for survival in the quiescent, depositing conditions produced by prolonged periods of low flow. The assemblage included water bugs *(Hemiptera)*, beetles *(Coleoptera)*, the amphipod *Gammarus pulex*, snails *(Gastropoda)*, leeches *Hirudinea)* and worms *(Oligochaeta)*, and the habitat comprised silt on the chalk substrata with few submerged, emergent or marginal vascular plants.

4.2.2 Landscape Corridor

The River Oughton is accessible to the public for most of its length, connecting the town with countryside. The river rises in a landscape variously designated as attractive, bordering an AONB, and assessed in the field as Grade 1/2. It is further significant for the woodland and wetland associated with the river.

As the river flows past Westmill and between Hitchin and Ickleford the river enters a typical urban fringe landscape blighted by Horse paddocks, characterised by the proliferation of post and wire fences and poor management. The abandonment of the river by the Trout Farm and Bowmans Mill, have further marginalised the river. In the field the landscape quality of this areas is assessed as Grade 2/3.

4.3 Conclusions

4.3.1 Channel Morphology

The River Oughton is morphologically the most interesting branch of the River Hiz system in and around Hitchin. It has not suffered the extensive urbanisation of the River Hiz, nor the channelisation of the upper parts of the Purwell. Upstream of Westmill Farm there is no evidence of management by man on the main stream except the millstream. However reduced flows are leading to silt deposition on this stretch.

4.3.2 Landscape Corridor

The river can be considered in two sections. From Oughtonhead to Westmill, the good quality of the landscape, the associated woodland and wetland and accessibility make the river an important features of the landscape, which should be conserved and enhanced. In particular Oughtonhead Common, a designated Nature Reserve, with County significance should be conserved, not only for its wildlife value but for the public amenity and landscape variety it provides.

From West Mill to the junction with the Hiz, the river passes through an area of mixed use, and varying public accessibility. This section has potential for restoration and enhancement, particularly the Trout Farm Lake.

4.3.3 River Corridor and In-stream Communities

The nature conservation interest of the River Oughton is of some value near the source and adjacent to the Common. The section between the Common and the Mill is of less interest but needs to be included with those above due to the influence of the Mill race and other structures on the hydrology of the Common and Reserve. Below the Mill the river is of little ecological interest until the confluence with the Hiz at the area known as Gerry's Hole. This area would benefit more from appropriate management than increased water supply.

Species distribution analysis with the multivariate routines TWINSPAN and DECORANA, and the ASPT-based system developed recently for the NRA by Scott Wilson Kirkpatrick, revealed four site groups (Figure 8). These groups were characterised by difference species assemblages and differed in species diversity, although in general, the macro-invertebrate communities were limited. Two of the four groups (A and B) contained species with a requirement for running water. These species included the net-spinning caddisfly larvae *Hydropsyche siltalai* and *H angustipennis*, and the stone-cased caddisfly *Agapetus fuscipes*. The other two site

groups (C and D) contained beetle, bug, mollusc and leech species common to many depositing freshwater habitats. The distribution of these site groups is shown in Figure 10.

Sites were allocated to similar groups on the basis of the ASPT index. The distribution of these site groups is shown in Figure 11. A classification based on a combination of the multivariate and ASPT-based systems is shown in Figure 14. From this analysis the following conclusion can be drawn:

The River Oughton was severely below potential but it is the most valuable section of the whole river system upstream of Cadwell. It is presently suffering the effects of a complete lack of flow during 1990, and features none of the 'lotic' species (requiring eroding habitat) such as mayflies *Ephemera vulgata* and *E ignita*, recorded in the 1920s. Even *Ephemerella ignita*, and *Cloeon* which were recorded in 1965, have disappeared from most of the channel (*Ephemerella ignita* was recorded in the August 1993 survey only at site 15, just above the confluence with the River Hiz). As well as being stressed by low discharge, the system suffers from the ponding effect of various weirs and sluices installed in its upper reaches. However, habitat around the springs at the source is not completely silted and would probably recover relatively rapidly if flows were restored. Furthermore, the River Oughton is an integral feature within the Oughtonhead Common habitat, which has declined in recent years and now should be preserved. The system would benefit from severe winter flushing to remove the accumulated sediment.

The conservative physico-chemical variables (temperature, pH, dissolved oxygen and electrical conductivity) measured during the study suggested that water quality in the system was reasonably uniform.

4.4 Recommendations

From Oughton Common to Westmill the river flows through an attractive landscape designated as "Distinguished" on a County scale and close to a Nationally designated AONB, through Green Belt and a Nature Reserve, accessible to the public by footpaths for all of this stretch. This survey values this landscape as Grade 1/2, and the river corridor is similarily Grade 1/2. However it is noted that the river whilst being clear and supporting emerging vegetation it is only inches deep, and appears in danger of disappearing, marginalising the river within a landscape it created.

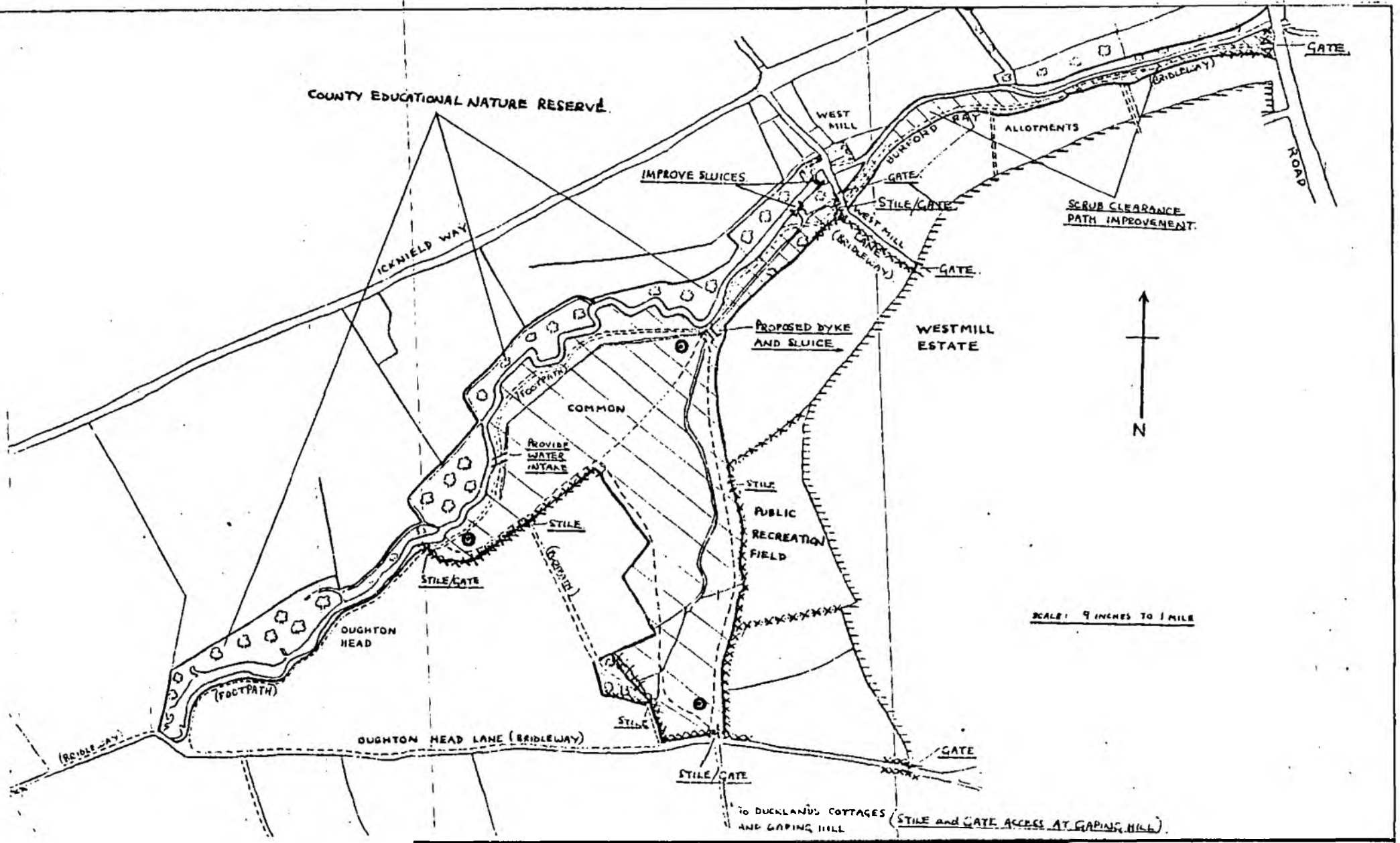
Increases in water level would enhance the visual quality of this area. Again it may be useful to investigate the historical management of the river here by West Mill, which may have helped to maintain the wetland habitats of Oughton Head Common.

The recommendations for improving the water and conservation management of the area around the Reserve and the Common are jointly discussed in Chapter 5.4. Beyond West Mill the river passes through an urban fringe landscape, where the river is strongly influenced by man from the litter to be found, the affects of the disused Trout farm land the management at the modern Bowmans Mill. This study Grades this area as Grade 2/3, and the river corridor as 2/3, with scope for restoration and

enhancement. However, resources should be targeted at public areas as this would benefit the most number of people. In this respect, management of the vegetation to the river banks to the section of the river below West Mill beside the public footpath, could make this river section more interesting.

If flow support measures were to be recommended flows in the River Oughton by recirculating water from lower reaches, this would probably prevent further loss of habitat and decline in species diversity. Under such conditions, habitat and community structure in the Oughton would improve sufficiently to resemble those occurring in the Purwell upstream of the Hiz confluence at present. Habitat diversity, and as a consequence, species diversity, would improve as sediment was carried downstream by the higher discharge. This would reveal gravels, cobbles and the underlying chalk, which would be recolonised by submerged, emergent and marginal vegetation as the wetted perimeter extended outward. Finally, the process could be expedited by judicious channel management in the form of riffle and pool reinstatement. Flows similar to those occurring in the Purwell downstream of the Ash Brook/Ippollitts Brook confluence would probably be adequate for this purpose. Although not current metered during the present study, this flow was estimated between 0.01 and 0.05 cumecs.

However, to restore conditions to those occurring earlier in the century would require groundwater to be transferred to the area by reducing abstraction, in addition to the described channel modifications. Even so, this would not necessarily guarantee the return of species diversity, as the stable mosaic of micro-habitats and species niches characterising the natural chalkstream is easily destroyed but may take many years to re-establish. Transfer of gravels and their associated biota from existing undisturbed streams might expedite the recolonisation process. **Only the River Oughton system might respond to measures of this kind sufficiently rapidly to justify the investment entailed.** If there were an adequate flow of good quality groundwater to the upper catchment, and the channel profile included areas of eroding as well as depositing habitat, the River Oughton would support a diverse well-balanced benthic macro-invertebrate community. This in turn would sustain coarse and game fisheries. Habitat improvements brought about by supporting flows in the channel with water recirculated from downstream would enable the moderate coarse fishery downstream of Hitchin to extend upstream. This would supplement the present bottom-feeding/short-bodied assemblage sufficiently to restore angling interest to the fishery.



⊙ PROPOSED GROUNDWATER MONITORING PIEZOMETERS

OUGHTONHEAD COMMON

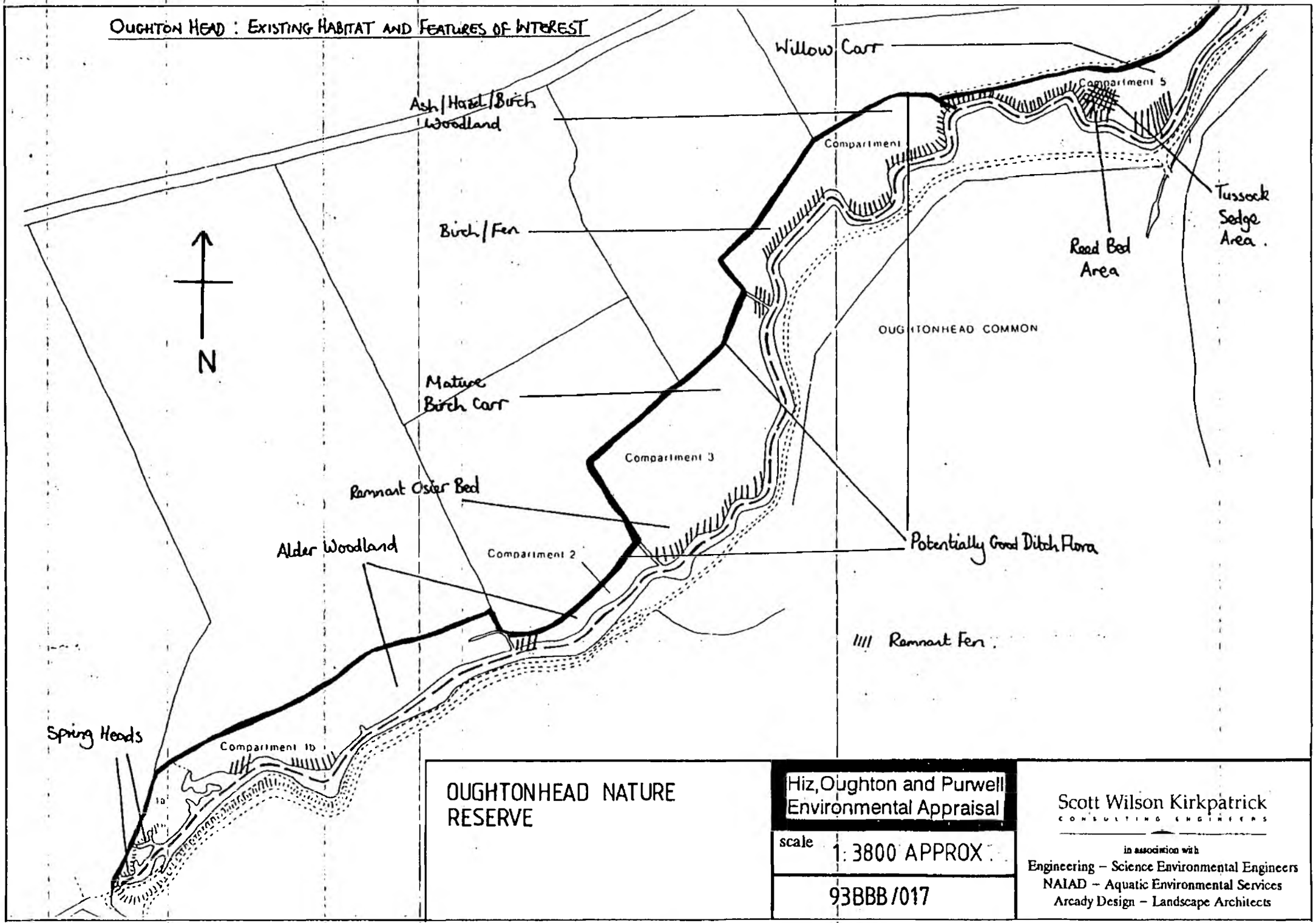
Hiz, Oughton and Purwell Environmental Appraisal

scale 1:7700 APPROX

93BBB/016

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

in association with
Engineering – Science Environmental Engineers
NAIAD – Aquatic Environmental Services
Arcady Design – Landscape Architects


OUGHTON HEAD : EXISTING HABITAT AND FEATURES OF INTEREST
Willow Carr
Ash/Hazel/Birch Woodland
Compartment 5
Compartment
Birch/Fen
Tussock Sedge Area.
Reed Bed Area
N
OUGHTONHEAD COMMON
Mature Birch Carr
Compartment 3
Remnant Osier Bed
Potentially Good Ditch Flora
Alder Woodland
Compartment 2
Remnant Fen.
Spring Heads
Compartment 1b
1a
OUGHTONHEAD NATURE RESERVE
Hiz, Oughton and Purwell Environmental Appraisal
scale 1:3800 APPROX.
93BBB/017
Scott Wilson Kirkpatrick
CONSULTING ENGINEERS
in association with
Engineering – Science Environmental Engineers
NAIAD – Aquatic Environmental Services
Arcady Design – Landscape Architects

5. OUGHTONHEAD COMMON

5.1 Wetland Ecosystem

5.1.1 Conservation Background

Oughtonhead Common (Figure 16) was denotified as an SSSI in 1970 for two reasons: first the botanical interest of the common had decreased as a result of its drying up. This was probably due largely to the dredging of the stream and dumping of dredged material on the banks which tends to prevent flooding of the Common. Secondly the NCC (as it was then) had become aware of other comparable sites of greater interest. It must also have been affected by the abstraction at the borehole located about 300m from the spring source of the Oughton. However, the Common was long understood to be an important biological reserve, due to the supply and type of water and the long history of management as a common with light intensity grazing, at least from Medieval times. This involved grazing as Common, but also the requirement to maintain ditches and fences. Grazing stopped about 1914. It is known that river levels have been decreasing for about 150 years, with records from the mills that levels were not adequate for operation by the mid 19th century. In the 1950's the river was dredged in order to drain adjacent farmland and this has subsequently prevented flooding of the Common and further affected the river level. Water extraction from the Chalk for public use began to affect river levels about 1920, when wells were bored at Charlton, and Oughtonhead Well, sunk in 1944 has also further affected river baseflow.

Over 300 species of plant have been recorded on the Common, including many rare marshland species, though many of these have disappeared since the grazing of cattle ceased and since river level declined. Over 130 species of bird are recorded and a wide range of invertebrates inhabit the common as well as other animal groups. The biological importance of the Common is well defined in the paper by Trevor James "The Flora of Oughtonhead Hitchin", in the Transactions of the Hertfordshire Natural History Society, Vol 28, 79-90, 1980, and it is not attempted here to define the full value of the site. This paper and the management plan drafted in 1974 by T James are included in Appendix C5 and these define the interest as well as propose a suitable management strategy that is discussed below.

The surveys conducted as part of this study, and reported in Chapter 4, have confirmed that the interest documented in the 1970s and more recently by a study carried out for the District Council by Rebecca Simmons are still present. The return of Ranunculus flammula after dredging is indicative of the improvements that could be expected from a return to the former types of management practised on the Common.

5.1.2 Hydrogeology

Recent geological field mapping at a scale of 1:10,000 has been undertaken by the British Geological Survey (BGS) for a large proportion of the project area (Aldiss, 1992). Unfortunately, the northern fringe of this mapping exercise just excluded the

bulk of Oughtonhead Common, but did incorporate the spring head and part of the south eastern branch of the Common. For its general relevance, the following text is extracted from the BGS Open File Report;

"In the past it has been believed that the major springs around Hitchin all arise at the Melbourn Rock, as a consequence of it being a relatively hard, fractured layer immediately overlying an interval of marly chalks at the top of the Lower Chalk, the Plenus Marls (eg Hill, 1912). The recent mapping in the Hitchin area suggests that this is only approximately true. Springs at Oughtonhead (1612 2290) emerge from the Grey Chalk and are probably controlled by high-angle faulting seen to displace the Melbourn Rock just to the south. Springs on the Purwell in the north-east of the area (1990 2973) possibly emerge at the Melbourn Rock, but those nearby at Ninesprings (2060 2889) probably emerge from within the 'shelly bedded chalks'. Springs at Wellhead (1747 2757) emerge at or just above the Melbourn Rock".

With respect to the superficial geological deposits overlying Chalk bedrock, it is noted that Peat and Alluvium crop out below Oughtonhead in the floor of the Oughton River Valley. At Oughtonhead, the valley has been incised by up to 5m, but the amount of incision decreases to about 2m at Northing 300. Although the Lower Chalk crops out in the incised valley walls and locally also in the stream-bed, up to 1m of peat is thought to be present. The presence of this peat deposit is based mainly on observations from the area to the north (TL13SE) where between 0.5 and 1.0m of 'fibrous reed and alder carr organic deposits' overlying gravel has been recorded.

The associated, but presently unknown thickness of Alluvium is composed of brown clayey gravelly sand, sandy gravel, slightly gravelly silty clay and silty sandy clay. Thin organic deposits could also be present and a basal gravel would be expected. The gravel is mostly flint, with some chalk.

It is anticipated that Chalk groundwater is in hydraulic continuity with the overlying alluvium and peat. This hydrochemical mix of upwelling alkaline chalk groundwater through the overlying deposits of acidic sands, gravels and peats will have been a dominant factor during the development of the fen/wetland ecosystem of the Common. The loss of this "basal feeder" system as a result of a general reduction in groundwater levels is a significant contributing factor in drying out the Common.

In order to monitor the present hydraulic regime of the fen and confirm the shallow hydrogeological conceptual model, limited drilling investigations are recommended to allow the installation of up to three pairs of piezometers, located across the Common as indicated in Figure 16. Ideally, piezometer installation should aim to separately monitor hydraulic heads within the individual units of peat, alluvium and underlying Chalk. Detailed designs for the monitoring station will need to take account of rig and subsequent personnel access, type of installation (preferably data loggers/transducers) and especially long-term security (vandalproof).

The objectives of long term monitoring would be to allow a baseline understanding of the relationship between seasonal variations in spring/river flow and groundwater heads with respect to present and possible future public water supply abstraction

patterns, as well as confirming the response of the groundwater system to any environmental engineering or management plans which may subsequently be implemented.

5.2 Analysis and Discussion

Lesser Spearwort

Oughtonhead Common (and Nature Reserve) are of local or County importance and with appropriate management could possibly be reinstated to greater importance if species returned, as demonstrated by *Ranunculus flammula* returning after dredging on the Common. The habitats on the Common have been devalued in recent years as a result of reduced water inputs and lack of grazing. The Common is a Countryside Commission Countryside Stewardship site, and the District Council (B Sawford) thinks it is starting to improve. A range of management activities are underway, including shrub clearance, grass cutting and some dredging (which was done by the District to aid the conservation interests but was carried out too thoroughly), and they intend to reinstate light grazing after fencing can be accomplished. Therefore there are corresponding activities that the NRA could support in the area of water management that would enhance the work of the Council on the Common (see below).

One particular aspect related to the ecology that limits the options available is that the weir put in across the stream and ditch in 1976-77 (not the river) has created a wetland area that is not the type of conservation resource that the Common was known and designated for, the weir was to act as a stopgap. The former ecological interest was created by a permanently high water table, with upwelling nutrient poor mineral rich water in natural seepage areas. With the impounding of the stream the area is going to tall fen or mire, which while of interest is not the same as the marsh that was present. It would not be able to create a marsh and maintain it without raising the water table permanently, which is probably not an option. Therefore a range of management opportunities are discussed below which could contribute to the maintenance or increase of the botanical diversity and interest of the Common, though which would not recreate the conditions of the marsh which previously existed. The Common would benefit, probably disproportionately, from reduced abstraction if this led to an increase in the water table level.

5.3 Conclusions

The ecology of the River Oughton has declined, partly due to a combination of declining management of the adjacent areas and the reduction in the water in the river. However the river is linked with the Common and Reserve and management suggestions are made to improve and maintain the ecological interest and conservation value of these areas. These suggestions are to co-ordinate with proposed and current activities of the Wildlife Trust and the District Council.

It is concluded that there are a number of actions that the NRA could consider, both to conserve the remaining ecological resources of the area of Oughtonhead, and to enhance them. The river Oughton, the Common and the Nature Reserve would all benefit from a coordinated strategy, combining water resource enhancement (possibly)

and management, with the conservation management strategies that have been developed by the North Hertfordshire District Council (Trevor Jones and Brian Sawford in particular) and the Wildlife Trust for the Nature Reserve (Martin Baker). These Management Plans, in draft, are included in confidence in Appendix C5. It is likely that the Plan for the Common, which is dated 1974, would need some consideration to ensure that the measures proposed are still fully appropriate - however the Council has in part already done this and further consultation with them would be correct to determine how best the NRA could participate with and enhance the actions proposed. Both the Council and the Trust would welcome support from the NRA along the lines of river engineering and water management measures to assist them with their conservation goals.

5.4 Recommendations

The following measures are proposed as outline recommendations and also as examples of the types of action the NRA could consider.

- It is viewed as unlikely that any significant reduction to the abstraction at the Oughtonhead borehole is possible. However it may be possible to reduce the abstraction so that the amount is less than 100% of the resource. If this is possible it would allow some recovery in the groundwater level which would help the marsh on the Common in particular, as well as likely increasing the water in the river and therefore the Reserve. (However, it is essential that any compensatory increase in abstraction from the Wymondley borehole is carefully monitored to ensure that the Purwell systems are not affected - see Chapters 6 and 7).

- When the Oughton was dredged previously the dredgings were deposited on the side towards the Common, effectively preventing any flooding when water levels are high. It may be possible for the NRA to remove or relocate this material and allow some seasonal flooding of the Common when water levels are higher in the river. Other similar water resource management options could be considered in more detail with the Council and Trust to ensure coordination.

- Along the Oughton above the Mill (Section OUG 004), it could be possible to restore the West mill sluice and mill race, which has structural problems currently. In particular it leaks through the banks and therefore the agreed minimal level of water maintenance at present can not be maintained. It would also be possible to reinstate the Mill which the present owner would be in favour of apparently (T James, personal communication). The Nature Reserve is currently drying out, and these measures would be of significant benefit to preserving the ecological resources there.

- A more impractical option would be to relocate the Oughtonhead PWS borehole to the spring area at TL 160308, which might lessen the effects of drawdown beneath the Common and would be in an area with perennial water, but without the ecological interest. Another location suggested for

sourceworks relocation are the sands and gravels extraction area near TL 167320 (T James in discussion). The practicality of these two suggestions is dependent upon further hydrogeological, modelling and economic studies and liaison between the NRA and the Water plc and is of course beyond the scope of this particular study.

It may be that some of the abstraction load from the Oughtonhead and Wellhead PWS boreholes could be taken from the Purwell abstraction well in order to assist these systems. However, as the Purwell sites are of higher ecological interest, especially when Knebworth is included, it would be essential to monitor the groundwater levels and not allow a level of drawdown that would affect the surface waters in the Purwell.

6. RIVER PURWELL

6.1 Baseline Survey Results and Observations

The following four sections generally highlight the baseline observations obtained during the river corridor, instream communities, landscape and channel morphology field surveys undertaken between May-September 1993.

6.1.1 River Corridor Survey

The results of the river corridor surveys of the River Purwell (PUR 006-038) are given in Appendix D1. Using the evaluation criteria defined above (Section 2.1) the following sections are noted as of greater interest. See Figures 5A and 5B for locations of sections.

Notable Plant Species

PUR 008

Carex rostrata Bottle Sedge is a plant of swamps, lake margins and peaty areas with high water level, and occurs as a flush plant where the base status is not too high. It is only scattered in the south of England.

Dactylorhiza pratermissa Marsh Orchid grows in wet meadows, marshes and fens throughout the British Isles.

Polygonum bistorta Common Bistort grows in meadows and grassy roadsides, but is only common in the north of England.

PUR 010

Alisma plantago-aquatica Water Plantain grows in shallow water and on mud beside slow-flowing rivers, it is widely distributed.

Carex disticha Brown sedge is a plant of mixed herb-sedge fens and wet meadows, preferring areas with a fluctuating water-table. More frequent in the calcareous fens of eastern England.

Juncus subnodulosus Blunt-flowered rush grows in fens, marshes, and dune slacks with basic ground water, often on calcareous peat. It is only locally abundant where found.

Lysmachia nummularia Creeping jenny is found in hedge banks, moist woods and grassy places, though it is only 'local' in distribution and mainly in the south.

Dactylorhiza maculata Spotted Orchid grows in heaths, bogs and acid grasslands.

Stachys palustris Marsh woundwort is a plant of streamsides and boggy places, and is fairly widespread.

PUR 017

Ceratophyllum demersum Rigid hornwort grows in still fresh water, it is local in ponds, ditches and streams throughout England.

Potamogeton crispus Curled pondweed is a submerged aquatic and grows in still and flowing fresh water.

PUR 020

Stachys palustris

PUR 029

Carex paniculata Greater Tussock Sedge is a species of peaty, medium base rich soils where water levels are at least seasonally high; in fens and besides slow flowing streams.

Carex pendula Pendulous sedge is a species preferring acid, but base rich heavy soils, but is also found on less clayey soils where there is a constant water supply, such as wet ditches. It is frequently introduced, which may be the case here.

PUR 031

Myosoton aquaticum Water chickweed grows in marshes, streamsides and wet woodlands on basic soils.

Potamogeton natans Pondweed is found in lakes, ponds, rivers, and ditches, especially on a highly organic substratum and is usually in water less than 1 m deep.

PUR 032

Myosoton aquaticum

PUR 035

Rorippa microphylla One rowed Water cress is common in streams, ditches, and other running water.

Mentha arvensis Corn mint grows in arable fields and damp open places.

Carex pseudocyperus Cyperus sedge is a plant of eutrophic or mesotrophic open water swamps, or along sides of slow flowing dykes and in ponds, oxbows and derelict canals. It can be found in shaded woods.

PUR 036

Alisma plantago-aquatica

Ceratophyllum demersum

Mentha arvensis

PUR 037

Galium palustre Lesser Marsh Bedstraw is locally common in mowing marshes or fens with water standing only intermittently, throughout the British Isles.

Myosotis laxa Water forget-me-not is common in damp places throughout the British Isles.

Ranunculus aquatilis Water crowfoot grows in ponds, ditches and streams throughout lowland Britain.

Ranunculus flammula Lesser spearwort is common in wet places throughout the British Isles.

PUR 038

Juncus conglomeratus Conglomerate Rush grows in wet pastures, damp woods, but is somewhat restricted to acid but not extremely base-poor soils, it is locally abundant throughout.

Lythrum portula Water Purslane grows at muddy margins of pools or puddles in open communities, locally on non-calcerous soils throughout the British Isles.

Mentha aquatica

Water mint grows in marshes and wet woods and by streams and ponds, common throughout the British Isles.

Myosotis laxa

Ranunculus flammula

Notable River-Dependent Habitats

There are four areas of important nature conservation interest along the Purwell and its tributaries, up to Knebworth woods (Figure 15A & B). These are Purwell Meadows, Purwell Ninesprings, Folly Alder Wood, and the Knebworth Woods SSSI complex.

1. Purwell Meadows (Figure 18)

Purwell Meadows (Figure 18) is owned by the North Hertfordshire District Council (since 1983), and is regarded to equivalent of SSSI status, and is to become a local Nature Reserve. It has historically been a grazing meadow, of the type known as a Lammas Meadow, with grazing after hay cutting. The usual date being 13 August, with grazing allowed until Lady Day, the 6th April. However, this regime has not been practised for some time. The following notes are taken from documents on file with the Record Centre and also the Management Plan for the site (copy in Appendix D5).

The site is calcareous loam on alluvium, with associated flush-line springs and riparian marsh, thorn scrub, and other riparian habitats. The site has apparently never been ploughed and with low-grade grazing for a very long time. There has been a mill since the 16th century which would have affected water flow in different courses. The range of grassland and marshland habitats (Figure 18) is exceptionally wide, with true chalk grassland, base rich marsh, drier neutral pasture grassland, and the meadow is the last example of alluvial grazing meadow. This last type used to be a feature of the Hiz system, but most is now derelict or improved. The higher plant flora is well recorded with over 264 species recorded between 1967 and 1983. The list of uncommon species includes:

Berula erecta, Caltha palustris, Campanula rotundifolia, Cardamine pratensis, Carex distans, C. disticha, C. nigra, C. panicea, C. paniculata, C. rostrata, Catabrosa aquatica, Cerastium arverse, Eleocharis palustris, Epllobium palustre, Equisetum fluviaile, Eupatortum canabirum, Galium uliginosum, Geranium pasillum, Inula conyza, Isolepis setaceus, Juncus subnodulosus, Linum catharticum, Lychnis flos-cuculi, Lystmachia nummularia, Myosoton aquaticum, Oenanthe fistulosa, Ononis spinosa, Ophrys apifera, Polygala vulgaris, Polygonum bistoria, Potenilla erecta, Primula veris, Ranunculu flammula, Rumex pulcher, Saxifraga granulata, Scabiosa columbaria, Senecio aquaticus, Stachys palustris, Succisa pratensis, Triglochin palustre, Valeriana dloica, Veronica anagallis-aquarica, Ranunculus penicillatus, Dactylorchis praetermissa. These plants (names from their list, so some forms are now different) are either of local rarity or are of particular rarity within Hertfordshire. The above provides some of the information available on this site and more detail is provided within Appendix D5 and below. The site is of more than local improtance, and would be affected by a decline in water level.

The survey as part of this study has broadly confirmed that the documented interest remains.

The water course in this section is complicated and will be discussed in three parts - the old water cress bed, the main channel, and the minor channel (which splits off to the west of the main channel in the middle of the section). The old water cress bed is shallow and about 10m wide. For most of its area

it contains a dense stand of emergents (*Apium nodiflorum, Epilobium hirsutum, Myosotis scorpioides, Rorippa nasturtium-aquaticum, Veronica anagallis-aquatica, Veronica beccabunga*). The main watercourse is fast flowing with a shingle substrate. For much of its length it is fringed by emergents (*Alopecurus geniculatus, Apium nodiflorum, Glyceria notata, Myosotis scorpioides, Rorippa nasturtium-aquaticum, Veronica anagallis-aquatica, Veronica beccabunga*) and has occasional patches of submerged aquatics (*Callitriche* sp., *Ranunculus penicillatus*). The minor water course is shallower, narrower, muddier and slower flowing than the major water course. It is shaded for much of its length by bankside scrub and trees. It contains dense stands of *Berula erecta* and *Apium nodiflorum*. All three of these features lie in species-rich, unimproved grassland grazed by cattle. The vegetation on their banks is moist grassland with rushes, sharing many species with the adjacent pasture (for species list see below). Along most of their length the banks are lightly grazed and poached, this keeps the vegetation open and promotes species diversity.

The grassland surrounding this section is very species rich. Part of its diversity is because of the uneven topography which provides conditions of variable moisture status. Species recorded in the pasture and on the river banks include:- *Achillea millefolium, Agrostis castellana, Agrostis stolonifera, Angelica sylvestris, Arrhenatherum elatius, Caltha palustris, Carex acutiformis, Carex rostrata, Cirsium lanceolatum, Cirsium palustre, Conium maculatum, Cynosurus cristatus, Dactylis glomerata, Dactylorhiza pratermissa, Epilobium hirsutum, x Festulolium loliaceum, Filipendula ulmaria, Galium uliginosum, Glechoma hederacea, Glyceria notata, Holcus lanatus, Juncus effusus, Juncus inflexus, Lathyrus pratensis, Lolium perenne, Lotus uliginosus, Lycopus europaeus, Mentha aquatica, Ononis spinosa, Phalaris arundinacea, Plantago lanceolata, Poa trivialis, Polygonum bistorta, Potentilla anserina, Prunella vulgaris, Ranunculus repens, Ranunculus sceleratus, Rorippa nasturtium-aquaticum, Rumex acetosa, Solanum dulcamara, Trifolium pratense, Trifolium repens, Trisetum flavescens, Veronica beccabunga.*

2. Purwell Ninesprings

The area around Purwell Ninesprings (Figure 19), and the Hertfordshire and Middlesex Wildlife Trust Reserve there have been managed as wetland habitats since at least the 14th century from mill and other records (Farris, N 1986, Purwell and Ninesprings, Hertfordshire's Past, 20, 16-20). However, since there is a Roman villa on the site as well, it is likely this type of management has been present in some form since Roman times at least. The site, leased by the Wildlife Trust and managed as a nature reserve, consists of about 18 acres of wetland, including alder carr, two meadows, small areas of water, hedge and shrub, sedge beds, an alder and ash wood and some derelict areas. The site has a complex hydrology, with a spring line fen with alkaline water. The Trust regard that the area has not changed substantially in about 30 years, and that certainly the meadows have not been grazed in that

time. About 150 species of plant have been found on the site, with many of the locally or county rarities listed above.

The Trust note in their 1980 Annual Report that the key to the habitats is the water table level, and that this had fallen in the 5 or 6 years before then, with less water in the wood than at any time before. Within the last ten years they note that parts of the wood were always under water in winter and that this no longer occurs. The main meadow, the north meadow, the ditches and pond had become wetter due to increased flow from the north (Willian) and that silting had led to slower water flow. It seems that the pond dried out completely in dry conditions, with virtually no open water on the reserve.

The survey as part of this study has shown much of the interest noted in the Trust's and Record Centre's files remains.

Apart from the ditch in the extreme north of this section (which contains no aquatic plants), the water course here is complex and botanically interesting. The channels, and the adjacent swamp, marsh and wet woodland, are fed by an array of springs. The water course is artificial, broad, shallow and muddy. It contains occasional patches of *Callitriche* sp. and frequent stands of mixed emergents (*Alisma plantago-aquatica, Carex acutiformis, Carex vesicaria, Epilobium hirsutum, Glyceria maxima, Iris pseudoacorus, Mentha aquatica, Myosotis scorpioides, Phalaris arundinacea, Phragmites australis, Ranunculus repens, Rorippa nasturtium-aquaticum, Sparganium erectum, Typha latifolia, Veronica anagallis-aquatica, Veronica beccabunga*). Throughout the section, the banks support patches of shrubs (*Crataegus monogyna, Prunus spinosa*) and some fine standard trees (particularly *Salix alba*). Where not too heavily shaded the banks also support a wide range of moisture loving species (*Angelica sylvestris, Dactylorhiza maculata, Epilobium hirsutum, Iris pseudoacorus, Lamium album, Lycopus europaeus, Lysimachia nummularia, Lythrum salicaria, Mentha aquatica, Myosotis scorpioides, Phalaris arundinacea, Phragmites australis, Poa trivialis, Ranunculus repens, Ranunculus sceleratus, Rorippa nasturtium-aquaticum, Urtica dioica, Veronica beccabunga*). The wood at the south end of the section is described below.

There are three different wetland habitats adjacent to the water course.

Swamp

The land adjacent to the sharp bend in the channel, in the middle of the section, seems to be continually inundated and supports a swamp of *Phragmites australis*.

Marsh

Surrounding the swamp, on land which is inundated for only part of the year, is a marsh. Species recorded here include - *Achillea millefolium, Agrostis stolonifera, Angelica sylvestris, Caltha palustris, Carex acutiformis*

(dominant), Carex disticha, Cirsium palustre, Eleocharis palustris, Epilobium hirsutum, Filipendula ulmaria, Galium uliginosum, Glyceria maxima, Juncus articulatus, Juncus inflexus, Juncus subnodulosus, Lychnis flos-cuculi, Mentha aquatica, Myosotis scorpioides, Phalaris arundinacea, Poa trivialis, Polygonum amphibium, Ranunculus repens, Scrophularia auriculata, Solanum dulcamara, Stachys palustris.

Wet Woodland (Figure 15)

Species recorded here include:

trees - *Alnus glutinosa, Fraxinus excelsior, Larix decidua, Quercus robur*

shrubs - *Crataegus monogyna, Corylus avellana, Euonymus europaeus, Prunus spinosa*

herbs - *Apium nodiflorum, Carex acutiformis, Carex ? vesicaria, Eupatorium cannabinum, Dryopteris dilatata, Geum urbanum, Glechoma hederacea, Hedera helix, Iris pseudoacorus, Juncus inflexus, Lonicera periclymenum, Mercurialis perennis, Solanum dulcamara, Stachys sylvatica, Veronica anagallis-aquatica*

The damselfly *Ishnura elegans* was recorded here and a Heron was seen in the adjacent wood.

3. Folly Alder Wood (Figure 15A)

Throughout the whole of this section of the Purwell the water course flows through a wet, alder-dominated wood and was difficult to map in detail. In addition to the main channel, there are several minor ditches and some shallow ponds. None of the channels or pools contain any submerged aquatics and emergents are limited to the wet woodland herbs (see list below) which grow along their edges. At the north end, the river flows through wooded gardens.

The wet woodland has a canopy dominated by *Alnus glutinosa* and a rich and varied ground flora (reflecting changes in soil moisture status). The wood is unmanaged. Species recorded here include:

canopy - *Acer pseudoplatanus, Alnus glutinosa* (dominant), *Fraxinus excelsior, Ilex aquifolia, Quercus robur, Salix alba, Salix fragilis, Sorbus aucuparia, Taxus baccata,*

shrub layer - Cornus sanguinea, *Corylus avellana, Crataegus monogyna, Ligustrum vulgare, Lonicera periclymenum, Rosa sp., Salix cinerea, Sambucus nigra, Ulmus sp., Viburnum opulus*

ground flora - *Ajuga reptans, Angelica sylvestris, Apium nodiflorum, Bromus ramosus, Caltha palustris, Carex paniculata, Carex pendula (introduced) Carex sylvatica, Carex ? vesicaria, Circaea lutetiana, Deschampsia cespitosa, Dryopteris dilatata, Eupatorium cannabinum, Festuca gigantea, Geranium robertianum, Glechoma hederacea, Geum urbanum, Hedera helix, Holcus lanatus, Hypericum androsaemum, Iris pseudoacorus, Mentha aquatica, Mercurialis perennis, Milium effusum, Myosotis scorpioides, Poa trivialis, Ranunculus repens, Rumex sanguineus, Solanum dulcamara, Stachys sylvatica, Urtica dioica.*

4. Knebworth Woods SSSI - the ditches of Knebworth Woods SSSI (Figure 20)

The following information is partly taken from the SSSI Notification and other documents in the files of the Record Centre.

This woodland site (Figure 20) is of a type nationally rare, but well represented in Hertfordshire. It is a most important woodland in the north of the county lying on poorly drained acidic soils derived from underlying clay with flints. It is almost all ancient in origin and is ecologically diverse with rides, ponds and small areas of both acidic and neutral grassland. Oak and oak/hornbeam are the dominant woodland types with some mixed deciduous type characteristic of SE England. In the main part of the wood coppiced hornbeam is over-mature and the ground flora is suppressed (see confirming notes below on this survey). The SSSI complex consists of several different community types, including watery grove - a mixed deciduous woodland, Burleigh meadow - acidic grassland and heathland, and an area of neutral grassland. Also the area at Norton Wood and Newton wood are of interest for their damp or wet community types. Notes exist on the site from early this century, with recent surveys providing species list and location maps. This complex is significant because of the wet or damp communities present and the probable link with the Purwell system, certainly of surface flows, means there is limited option for lowering ground water levels in this area.

The results from the brief survey undertaken as part of this study follows.

The area of the Knebworth Woods SSSI was not possible to survey using the National River Corridor Methodology because there were too many ditches and almost without exception did not contain any aquatic plants. Therefore a general description of the woods was undertaken to allow comparison to the SSSI and other data available.

Knebworth Woods SSSI lies on the low permeability clayey soil (derived from Chalky till) which covers much of the gently rounded plateau of the Chiltern Hills. The site has been notified on account of the large area of damp hornbeam/birch/oak ancient woodland which is rich in bryophytes and invertebrates, and a small area of acidic grassland and wet, species rich pasture (Burleigh Meadow). In addition, the site includes several ponds with regionally rare plants.

The wood contains a complex network of ditches. Apart from a short section in the north west of the SSSI, which has some apparently natural meanders, all of these are straight and clearly man-made. The deepest and widest ditches are those associated with the wood embankments (marking out the current or former wood boundaries), but within the wood and often running along each side of woodland tracks and rides there are many narrow, shallow ditches. Where the canopy is dense (eg below Hornbeam) the ditches are largely unvegetated with their base covered in earth, leaf litter and twigs, but where the canopy is lighter, the damper ditches support moisture-loving woodland herbs, bryophytes and marsh plants (generally very rare) including - *Angelica sylvestris* (rare), *Carex pseudocyperus* (rare), *Carex remota, Deschampsia cespitosa, Galium palustre* (rare), *Glechoma hederacea, Glyceria fluitans* (rare), *Juncus conglomeratus* (rare), *Juncus effusus, Lotus uliginosus* (rare), *Lysimachia nemorum, Mentha arvensis* (rare), *Sphagnum* sp and *Solanum dulcamara*. Most of these species also grew in damp spots elsewhere in the wood. The drier ditches are either unvegetated (below a dense canopy) or were grassy with *Holcus lanatus* and *Agrostis canina*. The majority of the ditch network was heavily shaded. The ditch banks were either bare, or covered with stands of *Mnium hornum* or woodland herbs (*Agropyron caninum, Agrostis canina, Ajuga reptans, Brachypodium sylvaticum, Bromus ramosus, Calamagrostis epigejos, Carex sylvatica, Circaea lutetiana, Dryopteris dilatata, Dryopteris filix-mas, Festuca gigantea, Geranium robertianum, Geum urbanum, Hyacinthoides non-scripta, Mercurialis perennis, Milium effusum, Oxalis acetosella, Primula vulgaris, Poa nemoralis, Potentilla sterilis, Pteridium aquilinum, Rubus fruticosus, Scrophularia nodosa, Stachys sylvatica, Urtica dioica, Viola* sp). Often herb species which prefer drier condition were commoner o the free-draining bank sides than elsewhere in the wood (eg *Brachypodium sylvaticum).*

On the date of the visit (26 August 1993), most of the ditch network was dry, only a few small areas contained a little standing water. In winter many of the ditches will contain water but it seems unlikely that the ditch network will function efficiently to remove water from the wood. This is because a) the gradients across the wood are very slight and b) some of the ditches are blocked by fallen trees or redundant. An inspection after heavy rain would help clarify this.

In conclusion the ditches of Knebworth Woods SSSI are, in themselves, of little botanical interest. However, much of the natural history interest of the site as a whole is related to its poor drainage and consequent seasonal water-logging. An increase in the rate of water output from this system would reduce its biological value.

Sections with well developed aquatic vegetation

Along the Purwell there are a number of locations with a well developed aquatic vegetation. Only PUR 008 has >15% cover of submerged aquatics, but PUR 007 to 010, PUR 018, and PUR 030 and PUR 031 have > 15% emergent vegetation.

Sections 7 to 10 coincide with the Purwell Meadows and Nine Springs complex of sites, while 18 is in part a pond, 30 is in the Folly Alder Swamp area and 31 also has a pond.

Other Conservation Notes from the River Corridor Survey

The Almshoebury swallowhole, a Countryside Heritage Site (See Figure 15B and Appendix D.5), has a documented record of botanical interest and photographs showing it full of water (April 1979 and May 1937). However there was only limited interest in the survey conducted as part of this study.

In the north of this section, around the sink, the water course contains little water and is heavily poached with a patchy vegetation of *Agrostis stolonifera, Holcus lanatus, Gnaphalium uliginosum, Mentha arvensis, Plantago major, Polygonum hydropiper, Rorippa palustris, Veronica anagallis-aquatica* and *Veronica beccabunga*. Further south, up to the wood, the channel is totally covered with stands of *Glyceria fluitans, Rorippa microphylla* and, to a lesser extent, *Apium nodiflorum, Juncus effusus, Lycopus europaeus, Holcus lanatus, Ranunculus repens, Solanum dulcamara*, and *Veronica beccabunga*. Here the banks support pasture grasses. The remaining part of this section passes through a small hornbeam and oak wood and between two species-rich hedges (with *Acer campestre, Carpinus betulus, Corylus avellana, Crataegus monogyna, Sambucus nigra*) and is for the most part dry, heavily shaded and unvegetated (apart from a small area in the north of the wood which contains *Epilobium hirsutum, Juncus effusus, Lycopus europaeus, Ranunculus repens, Rorippa microphyllum*). The banks of the ditch support woodland herbs (e.g. *Agropyron caninum, Brachypodium sylvaticum, Geum urbanum, Mercurialis perennis*) or *Urtica dioica*.

6.1.2 In-stream communities

Instream macro-invertebrates were sampled and habitat assessed at eight sites during May 1993 (Figure 6, Table 8). The sites were resampled in August 1993.

RIVER PURWELL

Site	3	TL 195282	St Ippollitt's brook downstream of STW
Site	1	TL 218285	Ash brook at Great Wymondley
Site	4	TL 204288	Purwell downstream of Ash brook confluence
Site	10	TL 212304	Willian tributary, Willian
Site	9	TL 208294	Willian tributary upstream of confluence
Site	2	TL 202278	Ash brook at Oakfield
Site	17	TL 202273	Ash brook upstream of STW
Site	11	TL 203297	Purwell at Purwell

Table 8
Location of sites in the River Purwell catchment at which benthic macro-invertebrates were collected during summer 1993

Full species lists for each site are given in Appendix D2 at the end of this report. A brief description of habitat at each site and values of physico-chemical variables on each sampling data are also given in Appendix D2. Physico-chemical variables and flow are tabulated (Table 2, May 1993, and Table 3, August 1993).

Multivariate analyses were undertaken as follows:

TWINSPAN classification - Data from the May and August samplings were combined so that the date set present to TWINSPAN was as large as possible. The sequence of species and site sub-divisions generated by TWINSPAN is shown in Figure 8. The process was interpreted initially after the second cut level, which by experience has been shown to reveal most about processes controlling population distribution. However, the macro-invertebrate communities at sites on the upper Hiz and tributaries were generally of uniformly limited diversity. The TWINSPAN classification was therefore interpreted after the first cut level, the point at which differences between the resultant groups would be greatest.

DECORANA ordination - The relative strengths of axes 1-4 (in eigenvalues) in the DECORANA ordination and the relative importance of each axis in explaining total variance are given in Table 4. The distribution of sites between axes 1 and 2 are shown in Figure 9.

DECORANA axes - rare species downweighted

Axis	Eigen Value	% variation accounted for
1	0.281	39
2	0.205	28
3	0.140	19
4	0.103	14

Table 4
Proportion of between site variation accounted for by DECORANA axes 1-4

Most (67%) of the variance is accounted for by axes 1 and 2 so these have been plotted, and sites grouped by TWINSPAN linked with broken lines. The distribution of sites on the basis of the multivariate analyses are shown in Figure 10.

BMWP scores and ASPTs were calculated for each site and are given in Table 5 (May 1993) and Table 6 (August 1993). The extent to which each site achieved its potential ASPT was also calculated along with a mean value for the two sampling periods. The sites were then arranged within two groups, the first comprising those achieving less than 80% of their target. The second group comprised sites achieving greater than 80% of their target (a value selected as the median of the measured range). The distribution of sites classified on the basis of ASPT are shown in Figure 11. A classification combining the multivariate and ASPT-based analyses is shown in Figure 14. Sites which classified similarly under the two systems retained their

original groupings, whereas sites which classified differently formed an intermediate group.

6.1.3 River landscape assessment

Designations

Ippollitts Brook

The study area begins at St Ibbs, south of the village of St Ippollitts, a conservation area, and flows north through designated Green Belt (NHD Local Plan, 1990) to Ninesprings.

The soils in this area are well drained leached soils, in an area of Grade 3 agricultural land (Agric. Land Classif., Sheet 147).

Ash Brook

Ash Brook can be traced to a spring at the edge of Priory Lane near Priory House, Little Wymondley, the site of an Augustinian Priory and a Scheduled Ancient Monument. The Priory was probably founded before 1231 and together with a tithe barn, 15th century, listed Building Grade II, is located within a moated enclosure. Part of the nave of the original priory chapel is incorporated in the fabric of Priory House, a Grade I listed building (County Archaeo. Records Office, 1993).

The brook passes through Little Wymondley, a medieval village scheduled as an Area of Archaeological interest, retaining a number of listed buildings, and crosses open countryside, designated Green Belt (NHD Local Plan, 1990) to Ninesprings.

Ash Brook rises in an area of imperfectly drained calcareous soils, in an area classified as Grade 2 agricultural land, centred on Little Wymondley, set within land generally classified as Grade 3 (Agric. Land Classif., Sheet 147).

Purwell River

Purwell Ninesprings is a designated Nature Reserve (NHD Local Plan, 1990), a complex of wetland habitats. It is a spring site that was excavated to form watercress beds (now defunct) and is also listed by Hertfordshire District Council as an important Fen Swamp (Herts. Env. Forum, 1990). On the edge of Hitchin it is just within the Green Belt which extends into the town as a linear feature associated with the river, to the crossing by the Cambridge Road.

Purwell Ninesprings is also the site of Roman British settlement, designated as an area of Archaeological Significance and Interest and including the site of a Roman Villa which is a scheduled Ancient Monument (County Archaeo. Records Office, 1993).

Purwell Mill was a former water corn will of the 18th/early 19th century, a Grade II Listed Building (County Archaeo. Records Office, 1993).

The River Purwell is essentially within the town of Hitchin and as such soil and agricultural land classification are not considered.

Landscape Areas

The field survey records have been collated, reviewed and analysed. This requires a description and classification of the full range of both macro and micro river landscape character areas, delineated on the Macro Survey (Figure 12) and Micro Survey (Figure 13) together with typical sketches.

Macro Survey

Sketch and photographic plate numbers refer to Appendix D3

Ippollitts Brook

AO3 Arable Open

Gently sloping, flat bottomed valley landscape of predominantly large arable fields, sometimes defined by native hedgerows or broken by woodland blocks. A peaceful, well managed rural scene including occasional farms, buildings and houses. (Sketch 1)

PK3 Parkland

Small scale enclosed classic parkland landscape including formal avenue of limes, together with scatter of mature parkland trees including some conifers. Cows grazing in the pasture contribute to this peaceful scene from the past.

AE2 Arable Enclosure

Arable field bounded by native hedgerow marking the position of the road on the crest of the hill. Woodland in the valley bottom marks the position of the river, above which only glimpses of distant hilltops can be seen. (Sketch 2)

PE3 Pastoral Enclosure

Enclosed pastoral landscape, fields subdivided by post and wire fences and older boundaries marked by native hedgerows. The area is interrupted by houses set in their own gardens, and views are restricted by adjacent housing to the north and west. To the east the position of the river is clearly identified by the woodland associated with it, which limits the views in this direction.

Ash Brook

AO4 Arable Open

Gently sloping open landscape, predominantly large arable fields delineated by native hedgerows, occupying a slight depression to relatively high ground thus restricting distant views of surrounding rolling countryside. Within this area the spring is clearly marked by the grouping of mature Willow trees.

AE3 Arable Enclosure

Enclosed arable landscape of small irregular shaped fields confined within this intimate twisting river valley. The steeper slopes are clothed in deciduous woodland but a sewage works detracts from the rural character.

AO5 Arable Open

Gently sloping open arable landscape, where surviving native hedgerows mark roads and tracks. It is a peaceful, well managed landscape, in which Ash Brook and Ippollitts Brook are picked out by the trees along their banks. Views are limited by the wooded railway embankment, but to the north the residential southern edge of Hitchin is seen covering the slopes. (Sketch 3)

Purwell River

AO6 Arable Open

Sloping open landscape of large arable fields bounded by native hedgerows, with distant views to the east across Hitchin. Significant within this landscape is the woodland associated with Ninesprings, a wetland Nature Reserve.

PE4 Pastoral Enclosure

Enclosed pastoral Landscape, occupying flat valley floor retaining some peripheral native hedging together with a scattering of trees and native shrubs. Surrounding residential areas to the valley sides restrict distant views out of the area. (Plate 1)

RG4 Recreational Ground

Greensward public open space/playing fields occupy the flat valley floor and surrounding residential areas on slightly rising ground limit views out. (Plate 2)

River Corridor - Micro Survey

The river is accessible to the public on designated public footpaths for most of its length except for the section through and above Little Wymondley, the wooded section of Ippollitts Brook, and pasture fields around Purwell Mill.

Ippollitts Brook

NO6 Natural Open

The stream hardly appears in the lake feature within the parkland landscape of St Ippollitts, although it obviously was of greater consequence as a bridge was built across its northern end (Plate 3), which now stands like a romantic ruin, its three arches spanning a grassy ditch. However the footpath still crosses the parkland via the avenue of Limes, over the bridge and up the valley slope to St Ippollitts Church.

NE5 Natural Enclosure

The downstream course of the brook is clearly marked by the woodland associated with it totally enclosing the stream, which flows slowly in irregular and various channels in a wetland woodland floor environment indicated by the evident reed growth. This area is private and access is difficult.

NO7 Natural Open

The brook emerges to flow gently but directly along the back of housing on the southern edge of the town, marked by the hedgerow and trees growing to its southern bank. The river here is shallow but clean with little or no aquatic vegetation. A public footpath is well maintained and connects through to Ninesprings. (Plate 4)

Ash Brook

NO8 Natural Open

Water rises in at least one spring above Little Wymondley near the remains of an Augustinian Priory. It is clearly visible as a puddled depression in a pasture field for cows and marked by a group of mature Willows growing close by. A pond and moat are features of the present farm on the site of the Priory, made use of by a number of ducks. The stream flows straight through the modern farmyard in no more than a ditch, slightly discoloured and supporting little or no aquatic vegetation, but is marked by a row of recently planted Willows. Through Little Wymondley the river is piped.

NO9 Natural Open

The brook continues through a well defined valley, which bends back upon itself and is crossed by an embankment for the new A602 into Hitchin. The channel is briefly modified by the associated road works, but for the most part flows slowly, in part not at all, in a natural linear channel marked by hedgerows and trees to one bank. Water when it appears is clear, free of debris, but with little or no emergent vegetation. A public footpath follows the brook for part of this stretch linking Little Wymondley with St Ippollitts.

NO10 Natural Open

From the Sewage Works to the junction with Ippollitts Brook Ash Brook flows gently in a natural linear channel marked by hedgerow and trees to one bank. The water is clear and clean with little or no aquatic or emergent vegetation. A footpath follows the brook for the entire length of this stretch.

Ninesprings Nature Reserve

NE6 Natural Enclosure

Visually contained by surrounding trees and woodland, this wetland environment is now maintained as a Nature Reserve, allowing public access (Plate 12).

River Purwell

NO11 Natural Open

At Purwell Bridge the river is observed to be low, slightly discoloured, including some debris, flowing slowly and supporting some emergent vegetation,and trees line the riverside. Purwell Bridge provides road access for the mill, now a house, and neighbouring property and pedestrian access across the valley bottom from one residential area to another (Plate 6). The river continues to flow gently in several shallow channels across Purwell meadows. This meadow is accessible to the public for walking.

NO12 Natural Open

The river flows to one side of Walsworth Common, a public open space, in a regular channel closely mown and marked by the occasional tree.

6.1.4 Channel Morphology

The River Purwell has a number of head streams rising to the south and east of Hitchin. Ippollitts Brook is the most southerly rising near St Ippollitts at an elevation of about 70 MOD at the time of the survey. Ash Brook is the central headstream rising west of Little Wymondley at an elevation of about 72 MOD. A fishing lake

and a series of unnamed agricultural drains north of Great Wymondley and east of Purwell are the most easterly headwaters, rising at an elevation of 60 to 65 MOD.

The headstreams are described from their sources downstream, starting with Ippollitts Brook working eastwards, then proceeding down the River Purwell. The photographic plates referenced are presented in Appendix D4.

Ippollitts Brook

Upstream of St Ibbs, Ippollitts Brook is a series of man-made ditches which only flow when water levels are very high. At St Ibbs, the channel has been artificially widened to form an ornamental lake. At the time of survey the channel upstream of the lake was only damp (Plate 1) and there was very little water in the lake (Plate 2). Downstream of the lake the stream bed was again only damp.

Upstream of the A602 there is a slight flow, the flow increases as the brook flows close around the north-eastern edge of Hitchin adjacent to Nine Spring Road, (Plates 3 and 4). The channel has been straightened in the process of urban development, and possibly early agricultural development, however slight residual sinuosity was evident. The character and nature of the channel remain essentially similar down to the Ash Brook confluence and the start of the River Purwell. Plate 5 shows the Brook about 100m upstream of the confluence. There are a number of surface water drainage outfalls on the left bank of St Ippollitts Brook as it passes around the outskirts of Hitchin.

Ash Brook

The Ash Brook rises to the west of Little Wymondley, initially a dry, ditchlike channel with a gravel bed (Plate 6). It passes under the new A602 Little Wymondley bypass in a concrete channel with natural substrate in the bed. Water staining on the banks of this concrete channel shows that flows have occurred here (Plate 7).

The channel remains straight and ditch-like as it winds west, then north past a small sewage treatment works. There is a slight flow in the Brook as it passes under the new A602 Little Wymondley bypass. Runoff from the road is discharged to the Ash Brook with a balancing pond to reduce peak flows (Plate 8). Downstream of the A602 the Ash Brook continues: the channel has been straightened, and in places deepened, resulting in a ditch-like appearance. Plate 9 shows the channel just downstream of the A602. Plate 10 shows the channel just upstream of its confluence with St Ippollitts Brook.

Willian Tributary

The Willian tributary is evident from the south-western outskirts of Letchworth. initially dry it has been straightened and deepened to form a field edge ditch. Plate 11 shows a general view looking up its valley.

River Purwell

The River Purwell is formed at the confluence of Ippollitts Brook and Ash Brook and is swelled by water flowing out of an apparently spring-fed fishing lake (Plate 12) and inflow from the Willian tributary. With the combined flow the River appears to have become less amenable to channelisation and loses the ditchlike appearance of its tributaries though even here some straightening is evident. A typical view of the channel upstream of Purwell Mill is shown in Plate 13. The bed of this section of the River Purwell appears to be actively mobile with recent debris partially buried in the bed sediments; the bed is generally sandy though both sandy and gravelly sections of bed were visible.

At Purwell Mill the stream has been engineered in the past to provide power to the mill. No flow was visible in the left branch which was the millstream. This dry channel is adjacent to a housing estate and is gradually being filled by fly-tipping of domestic, garden and construction waste.

The main flow is in the right branch past Purwell Mill. This continued through Purwell Meadows Nature Reserve. The channel is sinuous and irregular, and appears to have been unaffected by man (Plate 14). Downstream of the Nature Reserve the river is crossed by the A505 with a concrete weir (?) downstream (Plate 15).

Downstream of the A505 the River Purwell flows through a public open space before flowing through a recreation ground and sports grounds. Initially the channel maintains a natural unimproved appearance similar to the nature reserve. Immediately downstream of the A505 crossing a former channel is visible on the left of the existing channel. for approximately 100m of this section of channel the bed is sandy rather than gravelly. The upstream limit of the sandy section is at a point at which a pipe crosses the river bed (Grid Ref 197301, Plate 16). The sand bed is the site of well formed dunes/ripples (Plate 17).

There is a footbridge across the River Purwell at the boundary between the open space and the sports ground. Beside the bridge is a widened section of stream which appears to have been a ford. Through the recreation ground the river assumes a more engineered appearance with an approximately constant width and uniform side slopes (Plate 18); the natural sinuosity of the channel has been maintained. The river is relatively broad through the recreation ground and may be silting up in places. The bed is composed of gravel.

Downstream of the recreation ground the River Purwell flows through a brick arch culvert under the railway to its confluence with the River Hiz.

6.2 Analysis and Discussion

6.2.1 River Corridor and In-stream Communities

The ecological interest of the River Purwell is somewhat better than that of either the Hiz or the Oughton. The river itself has 7 river corridor sections with larger amounts of aquatic vegetation and these and other sections have most of the notable species observed as defined above. Also there are more areas of notable river-dependent habitat and these are of a value that is higher than those along the Hiz or Oughton, including the Oughtonhead sites. The macro-invertebrate communities in all sections of the River Purwell lacked many of the species which normally characterises chalk stream habitats. In particular, there were none of the stoneflies, mayflies and cased-caddisflies normally associated with cold, unpolluted, alkaline, flowing water. These had been replaced by the more ubiquitous burrowing, scraping and filter-feeding species adapted for survival in the quiescent, depositing conditions produced by prolonged periods of low flow. The assemblage included water bugs *(Hemiptera)*, beetles *(Coleoptera)*, the amphipod *Gammarus pulex*, snails *(Gastropoda)*, leeches *Hirudinea)* and worms *(Oligochaeta)*, and the habitat comprised silt on the chalk substrata with few submerged, emergent or marginal vascular plants.

The site at Purwell Meadows is regarded by the Council as of SSSI status (the NCC informed them in 1984 that it was to be designated, though this has not yet occurred), and this is actively being managed by the Council and will soon be designated as a Local Nature Reserve (B Sawford, personal communication - Oughtonhead Common will also be designated). This site has some spring sources and lies below the apparently perennial source of the Purwell at Ninesprings, yet it is dependent on the river and groundwater springs to maintain the botanical diversity that has developed over hundreds of years of management.

Purwell Ninesprings, which is near to the Meadows but not contiguous, is a more diverse site with significant biological interest. The Trust has noted that the water levels have fallen and it is likely that any further decrease would lead to a loss of some of the biological diversity present. It will also be essential to maintain the management practices to preserve biological interest.

Further up the Purwell, Folly Alder Swamp may be the perennial source, as it is a complex site hydrologically and hydrogeologically. The botanical interest here is good and should be preserved.

Finally the site of Knebworth Woods SSSI is of national significance and the habitats there are all water dependent, either wet or damp woodland or grassland communities with a wide range of species. It would be important to determine the hydrogeological continuity of this area with the water resource that is abstracted at Wymondley to determine whether the site would be affected by an increase in abstraction. Any decrease in the groundwater table level would not be acceptable to English Nature.

6.2.2 Landscape Corridor

The River Purwell and its tributaries, Ippollitts Brook and Ash Brook, flow through pleasant rolling countryside which forms the urban fringe to the south east of Hitchin,l assessed as "Pleasant" on a County scale.

Within this catchment the landscape assessment in the field attributes the highest quality, Grade 1/2 to Ippollitts Brook, which passes through the parkland below St Ippollitts where once it formed a lake, with an ornamental bridge crossed by a public footpath.

The river continues through a river valley landscape assessed in the field as Grade 2, in which Folly Alder Swamp is a visually significant woodland associated with the river.

The river then forms the southern edge of Hitchin and defines the route of a public footpath on the dividing line between town and country.

Ash Brook, although accessible by public footpaths for much of its length, does not form a particularly significant feature. Rising near the Priory at Little Wymondley, the river is significant for its cultural associations and in-river features. The river passes for the most part through pleasant countryside assessed in the field as Grade 2, except for an enclosed loop of slightly reduced landscape quality.

Purwell Ninesprings Nature Reserve, of County significance, is an important amenity, both for its wildlife value and visual qualities, and forms a significant feature in the surrounding landscape generally defined as "Pleasant", and assessed in the field as Grade 2. Downstream of Ninesprings, the river flows north west through the eastern edge of Hitchin, in a continuous open space defined by residential use and variously used for horse grazing, meadows, and recreation ground, and thereby generally accessible to the general public.

6.3 Conclusions

6.3.1 Channel Morphology

The upper reaches of the Purwell system are predominantly ditch-like streams which have been narrowed, deepened and straightened by man. The notable exception is the lake on Ippollitts Brook which has been broadened and deepened to form a feature in a parkland landscape. However, downstream of the confluence of Ippollitts Brook and Ash Brook the river shows less evidence of interference by man. The section of the River Purwell through Purwell Meadows nature reserve shows the least signs of human management.

The River Purwell and its tributaries are generally gravel bed rivers, with evidence of active bed movement at times. One stretch of sandy bed showed particularly fine dune formation, just downstream of the A505. In this reach a former channel was also visible.

6.3.2 Landscape

The River Purwell flows through a landscape of less intrinsic visual quality than the Hiz and Oughton.

However the parkland landscape at St Ippollitts could be conserved and restored to increase its visual and amenity value in this urban fringe area, and the spring and ponds associated with the Priory at Little Wymondley at least maintained.

Of greater importance is the conservation of Purwell Ninesprings, for its visual amenity within the larger landscape and the variety and value of its river landscape, which is related to its diversity and rarity value.

Purwell Meadows and Walsworth Common form an important linear feature of great amenity value and potential to a great number of people, and may form part of the riverside walkway suggested by the local Council. At present there is great potential to enhance these landscapes and restore and enhance the contribution of the river within these areas.

6.3.3 River Corridor and In-stream Communities

Species distribution analysis with the multivariate routines TWINSPAN and DECORANA, and the ASPT-based system developed recently for the NRA by Scott Wilson Kirkpatrick, revealed four site groups (Figure 8). These groups were characterised by difference species assemblages and differed in species diversity, although in general, the macro-invertebrate communities were limited. Two of the four groups (A and B) contained species with a requirement for running water. These species included the net-spinning caddisfly larvae *Hydropsyche siltalai* and *H angustipennis*, and the stone-cased caddisfly *Agapetus fuscipes*. The other two site groups (C and D) contained beetle, bug, mollusc and leech species common to many depositing freshwater habitats. The distribution of these site groups is shown in Figure 10.

Sites were allocated to similar groups on the basis of the ASPT index. The distribution of these site groups is shown in Figure 11. A classification based on a combination of the multivariate and ASPT-based systems is shown in Figure 14. From this analysis the following conclusion can be drawn:

(a) The River Purwell between the confluence with the northern tributaries and the confluence with the River Hiz suffered less from low flows than any of the other stream sections studied. Habitat, aquatic vascular plant and macro-invertebrate diversity were greatest in this section of channel, but the condition of the ecosystem was still below potential.

(b) In their lower reaches, the Ash and St Ippolitts Brooks were less low flow-stressed than the upper sections. Sewage effluent discharged to the Ash Brook probably maintained species which otherwise would have been lost.

(c) The northern tributary of the Purwell and the upper reach of the Ash Brook at Wymondley also supported a restricted fauna. However, archive data suggests that the northern ditches and the associated springs and cress beds have supported only a limited fauna for the past ten years. These ditches have probably carried intermittent summer flows for many years.

The conservative physico-chemical variables (temperature, pH, dissolved oxygen and electrical conductivity) measured during the study suggested that water quality in the system was reasonably uniform.

The River Purwell contains sections of some biological interest, these almost always associated with adjacent river dependent habitats. The biological interest present in Purwell Meadows and Purwell Ninesprings is the highest in the Hitchin area, and it would be more important to preserve these areas than to try to reinstate some of the interest in the Oughtonhead area. The Knebworth Woods SSSI complex is also very important and any increase in abstraction from the Purwell area would need to be carefully monitored to ensure that the groundwater levels were not allowed to decrease there.

6.4 Recommendations

The River Purwell and its tributaries flow through a landscape assessed as "Pleasant" on a County scale, through Green Belt, and through a Nature Reserve. It is significant that for much of its length it is accessible by public footpaths and flows through many areas designated as Public Open Space.

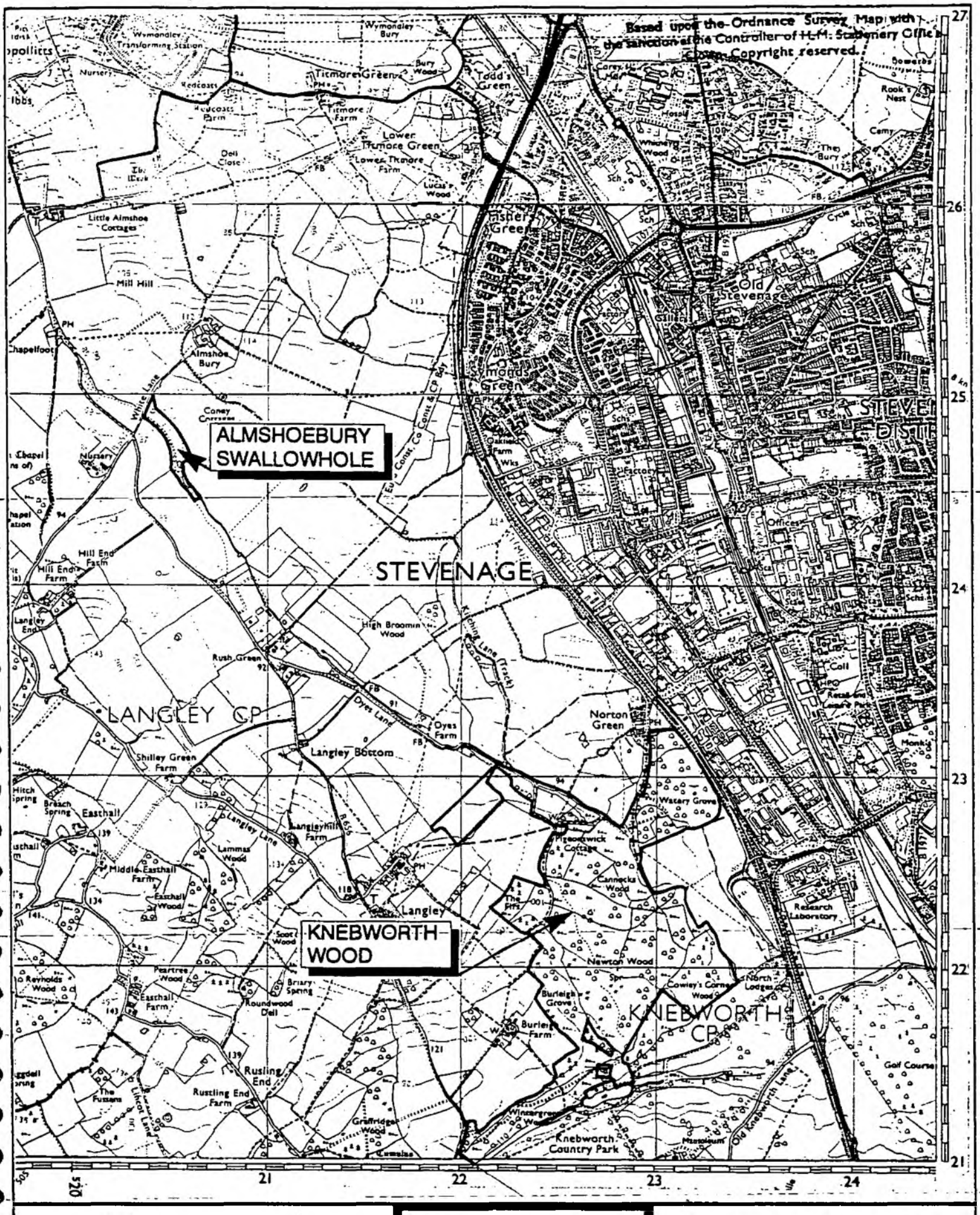
Low flows within this system are most noticeable at St Ippollitts, a Conservation Area, where a formal Parkland Landscape, situated below the village church, once included a lake, of which only a grassy hollow and bridge now remain. Increased flows to re-establish this feature are to be encouraged to restore the character of this area, whilst considering the effect on the current use of this pasture as grazing land.

It is also important that flow rates are adequate to maintain Folly Alder Wood and Purwell Ninesprings, which quite apart from their ecological value, are important and highly visible features within the landscape.

The water course through Purwell Ninesprings and also Purwell Meadows is particularly complex and this contributes to the biological diversity and interest present. The Trust and the Council are managing these sites to preserve them and the NRA may be able to assist by supporting any modifications to the water course banks to ensure the biological diversity is maintained.

It is obvious that this general area of groundwater discharge significantly contributes to river baseflow and hence the biological diversity of the associated wetlands. It is therefore to be anticipated that any alteration of the existing hydrogeological regime (through increased groundwater abstraction) would almost certainly have an adverse impact on the ecological balance of this sensitive area.

Purwell Meadows and Walsworth Common are important landscapes because of their proximity to the town. However these two landscapes are very different in character, Purwell Meadows is representative of a historical landscape managed for grazing and species rich, whilst Walsworth Common is a modern landscape managed for recreation with little ecological interest. The latter could be much improved by landscaping and should form part of the more detailed survey recommended to identify opportunities and restrictions to enhancement of the river landscape and river corridor within the town of Hitchin.



AREAS OF NATURE CONSERVATION AREA - EXTENSION OF STUDY AREA

Hiz, Oughton and Purwell Environmental Appraisal

Scale 1:25000

93BBB/015B

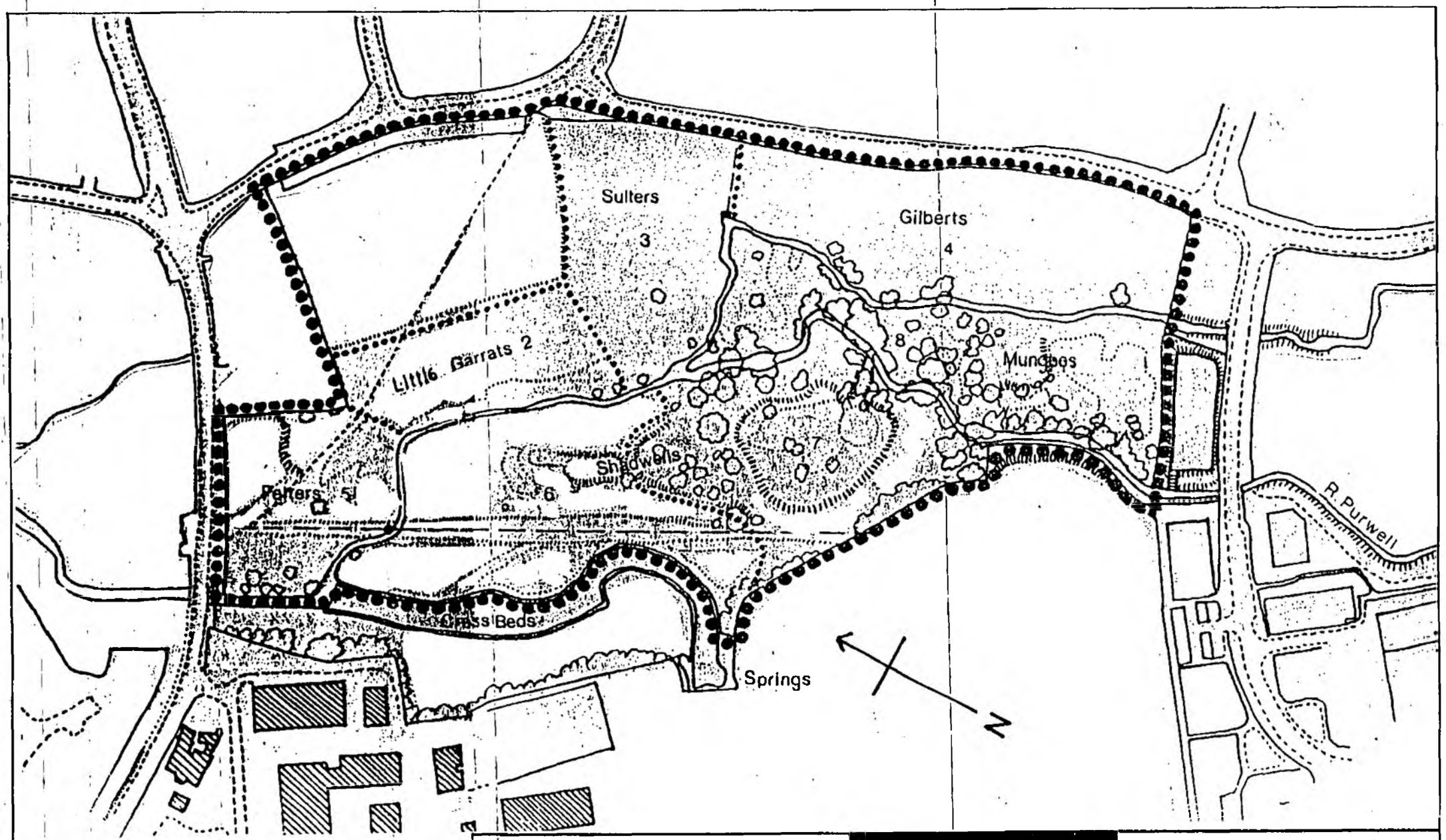
Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

In association with

Engineering – Science Environmental Engineers

NAIAD – Aquatic Environmental Services

Arcady Design – Landscape Architects



PURWELL MEADOWS

Hiz, Oughton and Purwell
Environmental Appraisal

scale 1 2000 APPROX

93BBB/018

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

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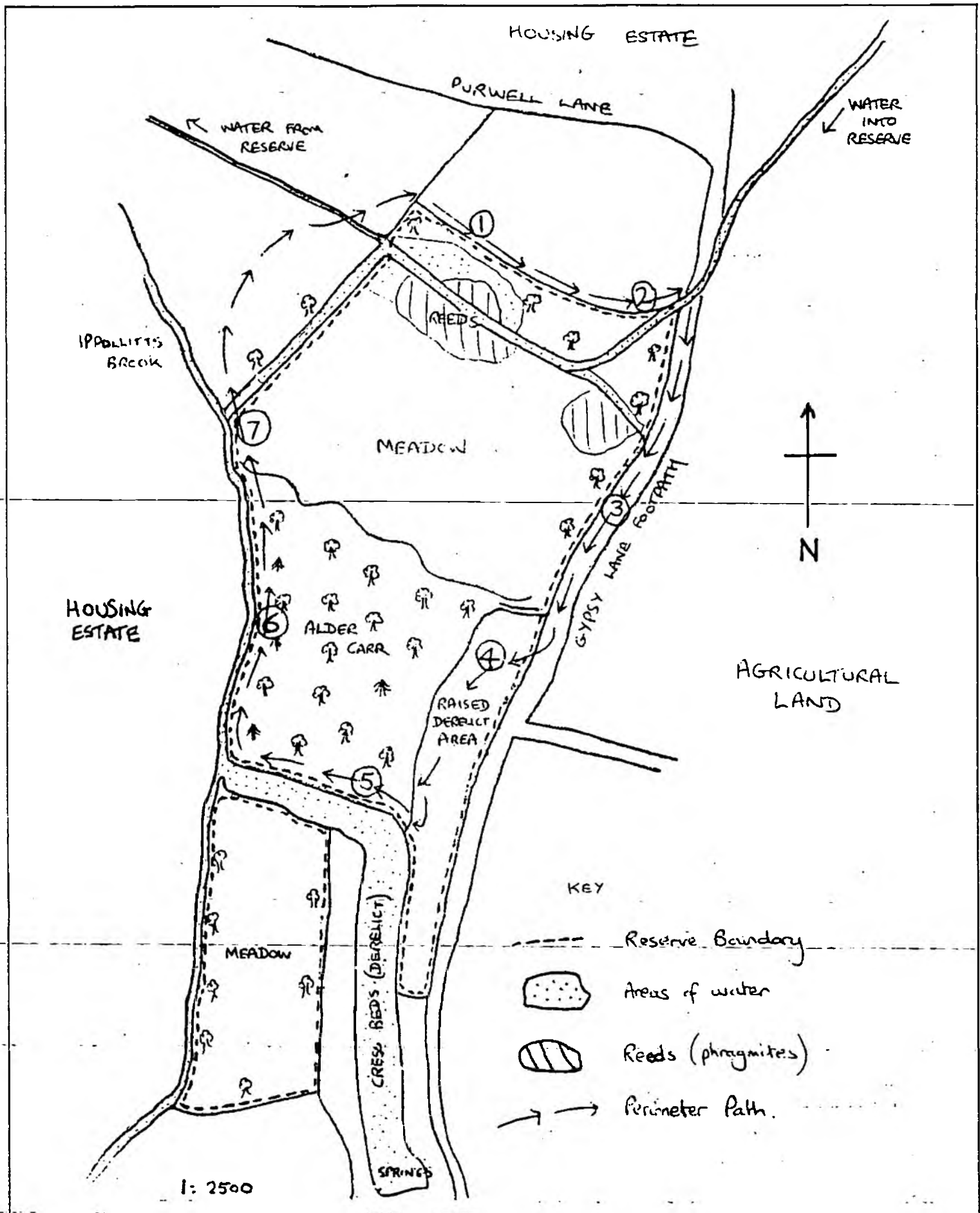
Engineering – Science Environmental Engineers
NAIAD – Aquatic Environmental Services
Arcady Design – Landscape Architects



PURWELL NINESPRINGS

Hiz, Oughton and Purwell Environmental Appraisal

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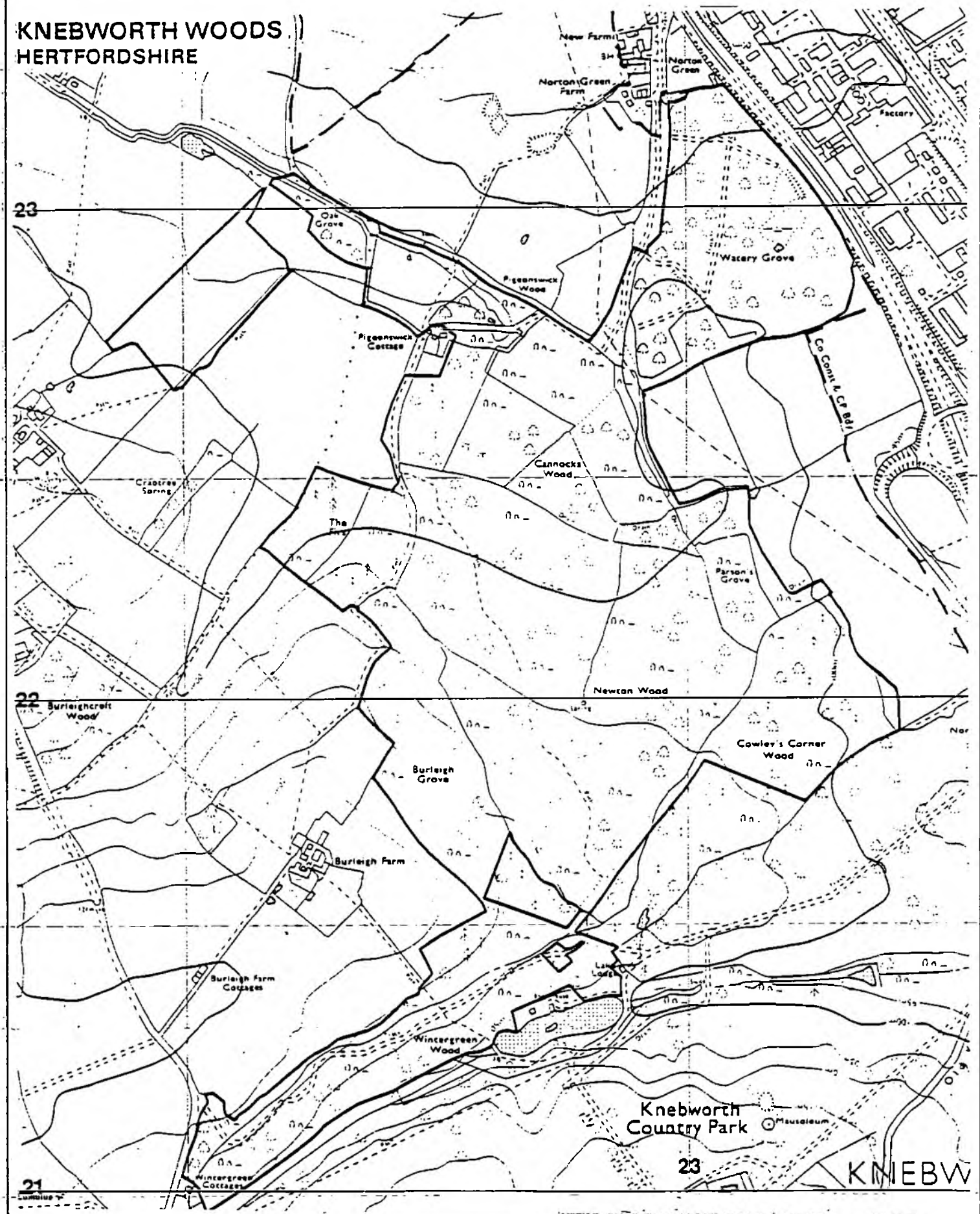

KNEBWORTH WOODS SSSI

Hiz,Oughton and Purwell Environmental Appraisal

scale 1:10000

93BBB/020

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

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NAIAD – Aquatic Environmental Services
Arcady Design – Landscape Architects

7. ENVIRONMENTAL SUMMARY

1. The river corridor surveys have confirmed that the River Purwell and its associated wetlands retain a somewhat greater botanical and conservation value than the River Oughton system. However, with respect to in-stream communities, the River Oughton perhaps offers better prospects for amelioration, though both systems are currently recorded as severely below potential. In comparison, all sections of the River Hiz retain little current botanical or conservation interest and in-stream habitat and community structure are generally severely derogated.

2. As no nationally or regionally rare aquatic plants were recorded, water course quality is best assessed in a general way on a subjective basis of the cover of aquatic vegetation. Sections containing more than 15% cover of submerged aquatic plants and/or more that 15% cover of emergents are listed in Table 9 and shown in Figure 7.

Section	>15% Cover	
	Submerged Aquatics	Emergents
PUR 001	*	
PUR 002	*	
PUR 003		*
PUR 007		*
PUR 008	*	*
PUR 009		*
PUR 010		*
PUR 018		*
PUR 030		*
PUR 031		*
OUG 005		*
OUG 006	*	*
OUG 007		*
OUG 008		*

TABLE 9. Sections with well developed aquatic vegetation (see Figure 7)

3. The majority of the river sections are botanically very poor having a low species diversity and low percentage cover of aquatic plants. The banks are frequently dominated by *Urtica dioica*, *Epilobium hirsutum* or rank grasses with ruderals. Possible explanations for the low botanical value of many of the sections are:

- shading from bank side trees and shrubs - eg Pur 024
- the deep, narrow profile of the water channel in which the bottom is completely shaded by the overhanging bank vegetation - eg Pur 022
- the flashy nature of water flow - eg Pur 028
- lack of water - eg Pur 033
- abundance of waterfowl - eg Oug 002

4. Of greater conservation significance than the rivers themselves are some of the adjacent wetland habitats. Sections with important adjacent wetland vegetation (not including Knebworth Woods SSSI complex) are:

PUR 008	Purwell Meadow
PUR 010	Purwell Nine Springs
PUR 019	Purwell Nine Springs
PUR 029	St Ippollitts - Folly Alder Swamp - a wet alder wood
PUR 030	St Ippollitts - Folly Alder Swamp - a wet alder wood
OUG 004	Oughtonhead Common and Nature Reserve
OUG 005	Oughtonhead Common and Nature Reserve
OUG 006	Oughtonhead Common and Nature Reserve
OUG 007	Oughtonhead Common and Nature Reserve
HIZ 005	Priory Marsh

5. Oughtonhead Common and Nature Reserve, and the Purwell Meadow and Purwell Nine Springs complex are of greatest value. The wetland habitats on Oughtonhead Common have been devalued in recent years as a result of reduced water inputs and lack of grazing, therefore currently this site is botanically less interesting than the Purwell Meadow/Nine Springs sites. However, Oughtonhead Common has immense potential (many of its former wetland rarities will remain as dormant seeds in the soil seed bank) and with appropriate management it could be restored as a site of high importance.

6. Some water courses which have dried up in the past now have well developed aquatic vegetation (eg Oughtonhead Common). Therefore, the species which make up this vegetation must be considered, to some extent at least, tolerant of periods of desiccation. However, it is likely that other less tolerant species have been lost, and with a continuation of a lack of water the system and its habitats will deteriorate further and will not retain the botanical diversity in the seed bank indefinitely.

7. With respect to their assessed landscape value, all three rivers are important for their cultural links, associated amenity and visual contribution, either directly or indirectly with their associated woodland.

The Hiz and the Oughton flow through the most attractive landscape, and are important for the links they provide between the town and the surrounding countryside. However the Purwell and Ippollitts Brook are also important for their proximity to the town for so much of their length.

The River Hiz is perhaps the most important river from a landscape point of view, rising in attractive countryside and flowing through the centre of Hitchin. From a visual aspect this river appears the most damaged, suffering from both low flows and associated poor water quality from Charlton to the centre of Hitchin.

8. It is apparent from the field surveys conducted during this study that minimal scientific interest remains within the River Hiz. Despite this, general recommendations may be summarised with respect to visual, amenity, landscape and river engineering facets. Charlton Mill Pond, the Windmill P.H., Priory Park and the formal water gardens adjacent St Mary's Parish Church in Hitchin are all areas where public access and visual perception of a "problem" are at an enhanced level. Therefore, consideration should be given to reinstating these high profile areas. Restoration measures might include river engineering or channel maintenance such as localised dredging/desilting or modification to produce riffles and pools.

Increased flow rates, either by seasonal flow support/augmentation or recirculation, would encourage flushing of the system and provide a basis for a gradual improvement in habitat structure and hence macroinvertebrate species community and fisheries diversity. However, recolonisation could be expected to be slow and may be expedited by importation of relevant substrate and biota.

9. Summary recommendations for the River Oughton and Oughtonhead Common are closely interlinked. For the river, particularly downstream of Westmill to its confluence with the River Hiz at Gerry's Hole, management of vegetation on the river banks is an identified need. Additionally, it was concluded, unlike the River Hiz and River Purwell, that instream communities within the River Oughton might respond sufficiently rapidly to engineering measures, to improve flow and habitat structure, to justify the investment entailed.

10. For Oughtonhead Common and the adjacent Nature Reserve, a comprehensive water and conservation management strategy, already outlined by the North Herts. District Council and the Wildlife Trust, would form a useful vehicle for NRA participation and co-ordination.

Furtherance of conservation goals could be achieved through a broad action plan of controlled scrub removal, occasional mowing or light grazing, ditch clearance and a generally improved water supply to the Common. The latter suggestion might involve NRA advice or participation in the following activities:-

(i) repair and maintenance of the sluice and millrace at Westmill.

(ii) construction of a retaining dyke and sluice at the Common outfall to provide control on ditch levels.

(iii) provision of an intake duct or channel from the River Oughton headwaters onto the Common. This would be positioned to provide an avenue through the right bank, which is presently raised by dredged material and forms a barrier against overtopping by the river. This channel is required to allow ecologically beneficial, seasonal flooding of the Common.

(iv) exploration of the potential to relax or transfer some or all of the groundwater abstraction load from Oughtonhead PWS sourceworks, in order to assist local recovery of groundwater levels.

This latter suggestion is perhaps somewhat premature. Sourceworks relocation should not be considered an option until the basic hydrogeological regime of Oughtonhead Common is understood. A conceptual model of the system is required, which can only be logically obtained by detailed monitoring and analysis of the following aspects of the surface and groundwater systems:

- spring flows and quality
- ditch flows and quality
- river flows and quality
- PWS abstraction pattern and groundwater quality
- piezometric variations within the chalk, sands and gravels, alluvium/peat

A minimum of one years data would be required to identify seasonal interrelationships between the above factors. For obvious reasons, it is recommended that any financial resources are committed to obtaining a detailed hydroenvironmental understanding of the present system, prior to embarking upon any subsequent aspects of a conservation management strategy.

11. The wetlands complex of Purwell Meadows/Ninesprings is identified as the most valuable collective habitat and ecological mosaic remaining within the present study area.

The conservation importance of this relatively large area is enhanced because the composite or contiguous habitat block holds more importance than the sum of its individual parts. Further value is attached to this area because of its inherent historic and cultural links, allied to its landscape and amenity significance derived from the close proximity of Hitchin town centre and its associated "public perception zone". The nature conservation and heritage/landscape value extends up-catchment through sites such as Folly

Alder Wood/St Ippollitts, Almshoebury Swallowhole and Knebworth Woods. The diversity of the hydroenvironmental habitats within the valley of the River Purwell therefore impart significant cumulative value to the system as a whole. It is imperative that water resources are managed with the utmost care and sympathy in order not to adversely impact the hydrogeological controls on the ecological environment.

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