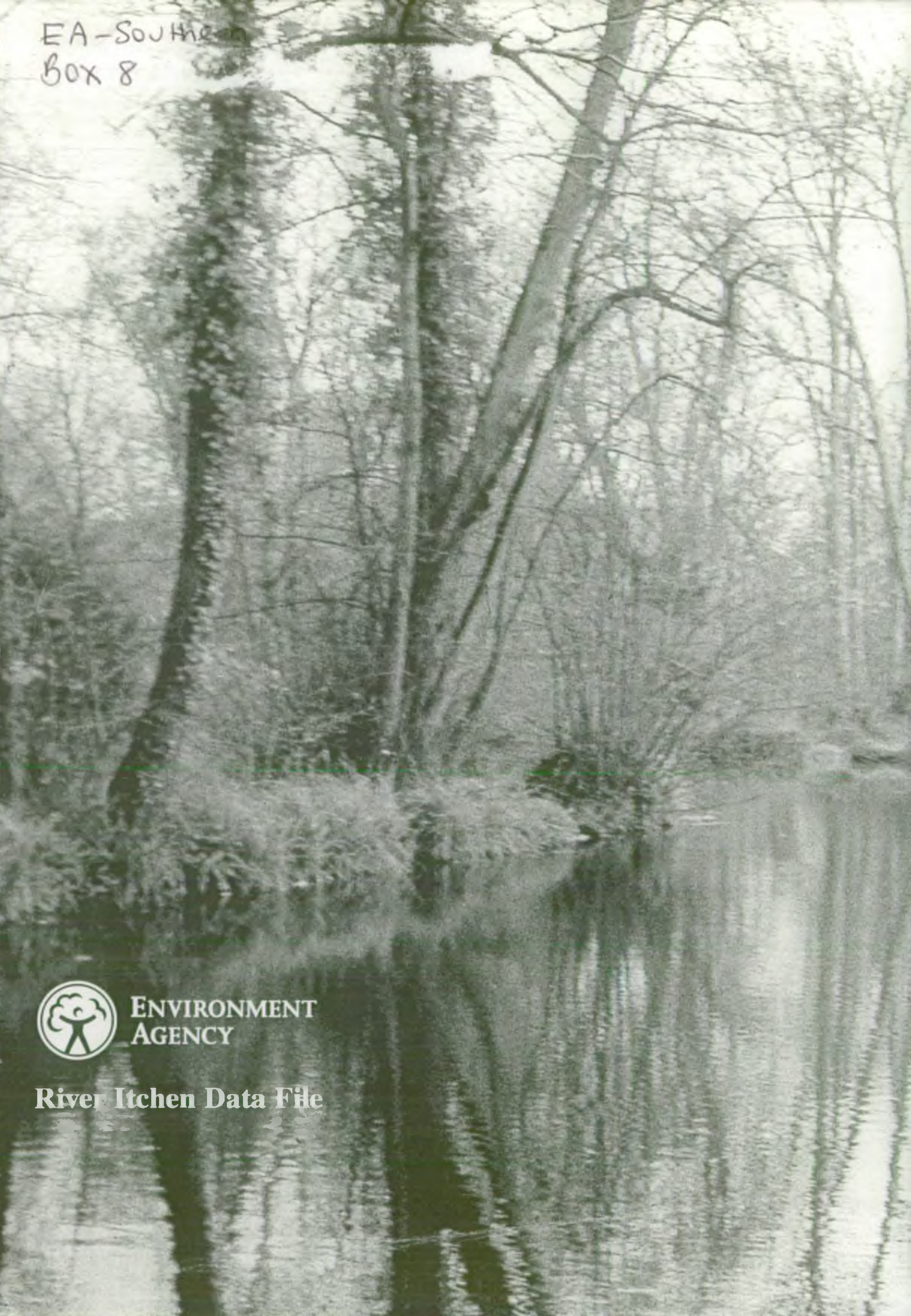


ENVIRONMENT AGENCY

River Itchen Data File

ENVIRONMENT AGENCY

RIVER ITCHEN DATA FILE

WOODMILL, SWAYTHLING
FLEMING PARK, EASTLEIGH
MONMOUTH CLOSE, CHANDLERS FORD

CONTENTS:

1. INTRODUCTION

Background

This Agency Data File (ADF) folder contains data sheets, field work and classroom exercises, interpretative text and teaching notes that describe the state of the environment at three specially selected sites on the River Itchen. These sites are Woodmill, Swaythling, Southampton at the confluence of the River Itchen and the Monks Brook and two sites on the Monks Brook tributary at Fleming Park, Eastleigh and Monmouth Close, Chandlers Ford. The notes have been designed and compiled by the Environment Agency with the particular interests of schools and colleges in mind, but will also be of relevance to undergraduate and postgraduate studies that are concerned with or include the River Itchen catchment.

Layout of the ADF Folder

The folder is arranged in ten sections. These are the introduction, background to the River Itchen, Monks Brook study site at Fleming Park, Monks Brook study site at Monmouth Close, River Itchen study site at Woodmill, Swathling, site comparisons, how do we do that, factsheets, the Environment Agency functions and the Environment Agency publications list / further reading.

Format of the ADF Folder

This folder has been designed as a central resource and is provided on a school by school basis. Topic sheets, data tables and maps have all been designed to fit the A4 format to allow study materials to be selected at the discretion of teachers and photocopied to tailor information to classroom and field work.

In addition to the A4 data sheets that are designed for students, each section includes advice and guidance to teachers in leading classroom and field work discussions on the concepts and issues that are raised by the information.

The information in this folder reflects the environmental issues that relate to the three specially selected study sites providing in each case detailed and relevant data. The content of the folder therefore reflects the issues that are relevant to these three sites and as such is designed to augment existing textbooks rather than replace them. Consequently it is recommended that teachers adapt the information and suggestions contained in the folder to individual school or class requirements.

There are many features to see at each of the study sites and the supporting data is quite extensive. In compiling the notes attention has been given to the need to support successive visits throughout a year's cycle. It is envisaged that visits could be made during double lessons but single lesson visits may well also be appropriate if the sites can be reached quickly from school. In either case, a visit to the site by the teacher prior to the class visit, is advisable in order to plan the site visit, determine the location of the key features, and to determine where to park and how to reach each of the sites.

The Woodmill Canoeing and Outdoor Activity Centre use much of the Woodmill site, and are part of Southampton City Council. The Activity Centre provides by appointment, guided tours of the environmental features of the site including pond dipping. Access to the Salmon Pool and the Fishpond is across land owned by the Centre and therefore contact with the Centre is advisable before visiting the site.

Application to the National Curriculum and Educational Standards

The notes have been written with college and "A" level students in mind and it is intended that teachers will adapt the material for younger age groups. However the material naturally falls into three categories that can be used to convey concepts to the three main age groups as follows:

Pre–GCSE: At this level students are essentially required to gain an understanding of environment building blocks such as what a habitat is, what weirs and meteorological stations are, why data is collected, and what techniques are used to appreciate broad principals of complex environmental concepts like ecology. Many of the site-based activities fall into this category.

GCSE: At this level students learn how human activity affects the environment, how environmental management is undertaken, and gain an introduction to how decisions are made. These topics are neatly summarised in the section describing what the Environment Agency does, why they do it and how they carry out their work. Consequently, an examination of the Environment Agency and each of it's functions can provide a conceptual framework to which students will be able to relate study work on each of the topics and functions. This is a valuable approach, as the complexity and interplay of environmental processes is difficult to grasp at any stage of learning.

College and "A" level: In general terms, this level deals with how environmental management decisions are made and how management methods have been developed in response to improvements in environmental techniques, environmental awareness, the public's increasing demand for higher standards and an increasing willingness to pay for the additional cost. It requires an appreciation of how decisions are made and requires a detailed understanding of the interplay and complexity of environmental processes, awareness of best practice, development of new methods, competing demands, how environmental standards are set and how it is decided who pays for environmental improvement and enhancement.

2. BACKGROUND TO THE RIVER ITCHEN

2.1 The Natural Environment

Course and Geology

The River Itchen is one of the best examples of a chalk groundwater fed river in Europe. It rises on the Upper Chalk as three spring-fed tributaries; the Candover Stream, the River Alre and the Cheriton Stream. These flow from three points of the compass to unite just West of New Alresford. The upper catchment is entirely within the Chalk, the lower and southern half of the catchment is underlain by successively younger Woolwich and Reading Beds, London Clay and the Barton and Bagshot beds all of which overlie the Chalk. The geology of the River Itchen is summarised on the catchment geology map on page 4.

For additional information regarding geology see:
Section 8 – factsheet 2

Hydrology and Water Resources

The underlying rocks of the River Itchen catchment form part of the northern flank of the geological structure known as the Hampshire Basin. It's rocks slope gently, or dip, from the North to the South. The oldest rock is the Cretaceous Chalk, a porous, fine grained limestone which outcrops over the whole of the valley to the North of Eastleigh. Rain soaks into the Chalk rock rather than running off, then gradually percolates down to the water table, it then flows through the pores or small fissures in the Chalk under the influence of gravity until it issues from springs in the valley. The Chalk thus forms a massive natural underground reservoir or aquifer.

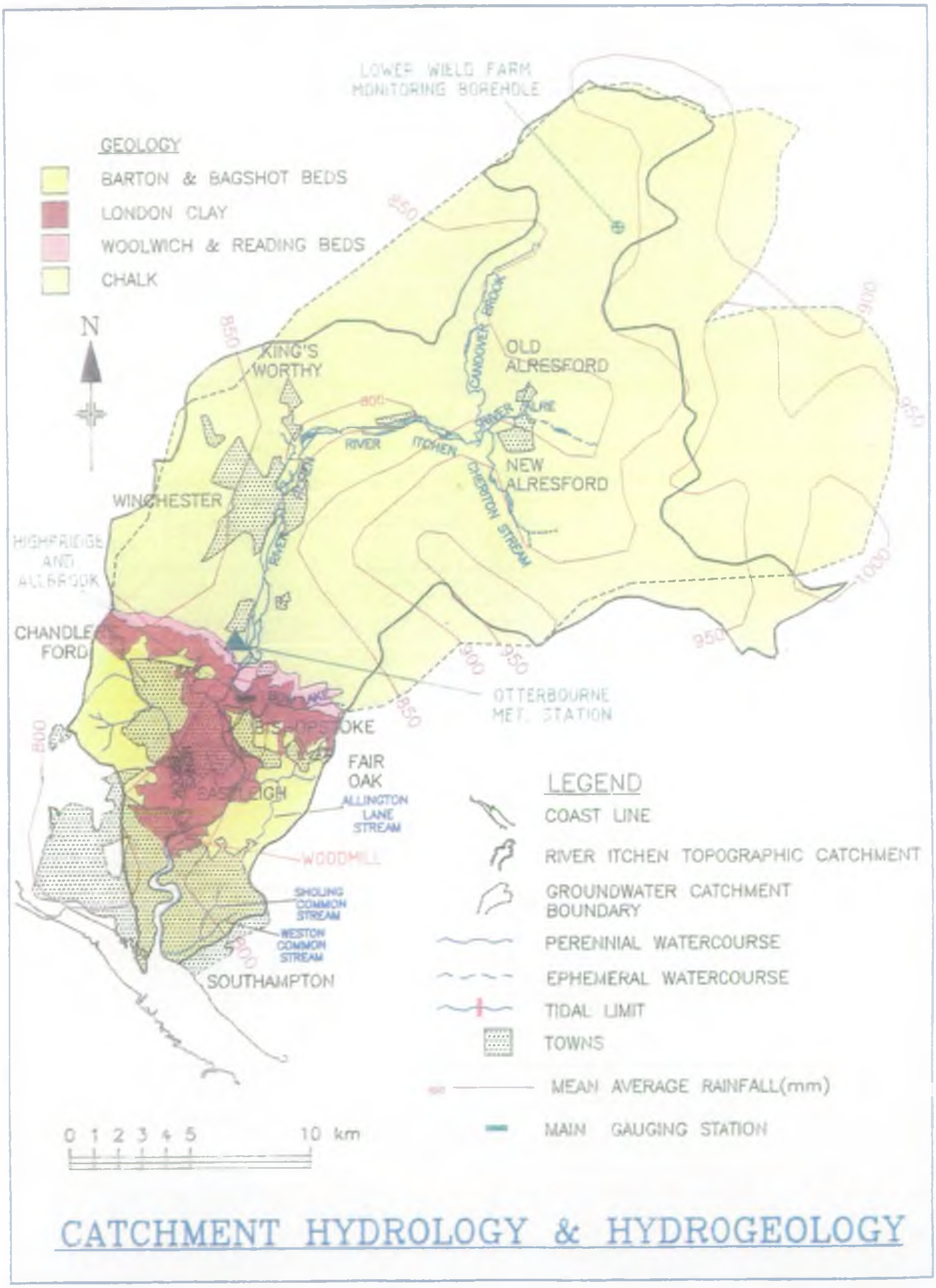
For additional information regarding hydrology and geomorphology see:
Section 8 - factsheets 3 & 4

Ecology

Ecology is the study of organisms in relation to their environment and surroundings. This is sometimes called the study of ecosystems. Each ecosystem is made up of two parts: a non-living part called a habitat and a living part called a community. Chalk streams are renowned for their abundance and diversity of water life, the River Itchen being a prime example. Perhaps most importantly, the River Itchen provides the life – support for both animals and plants of economic value, such as trout and salmon fisheries, and also others of conservation importance such as the otter and the water vole.

For additional information regarding ecology and habitats see:
Section 8 - factsheet 5

Catchment Hydrology and Hydrogeology



Flood Defence

For much of it's length, the River Itchen is not one stream but two, three or even four separate channels running parallel to each other. These interconnected channels have a considerable number of structures to regulate flows and levels. This results in a controlled river with maintained high river levels and a high degree of water retention and storage behind each of the flow control structures. Many sluices are operated by riparian owners, though some, such as the automatic outfall sluice at Woodmill are owned and operated by the Environment Agency. River levels and flow in the River Itchen catchment are not significantly affected by rainfall events, since the Chalk is the predominant rock type in the catchment and flow is mostly controlled by the steady release of baseflow into the river from water stored in the Chalk aquifier. Historic flooding occurred in Winchester in 1852, 1903, 1928 and 1947. Allbrook and Bishopstoke flooded in 1891 and 1928 and Kingsworthy in 1935. More recently some urban areas have flooded, particularly on the Monks Brook which drains mainly from sand and clay soils. As a result of the serious flooding in Chandlers Ford and Swaythling in 1960, a scheme was carried out to improve the flood carrying capacity of the Brook.

For additional information on flood defence see:
Section 8 - factsheets 4 & 20

2.2 Human Influences on the Environment

Land Use

Within the River Itchen catchment land use can be divided into a number of categories. These include: arable and livestock farming, aquaculture (water cress and fish farms), urban areas including industrial, residential and business areas, waste disposal sites, transportation including roads, motorways, railways and an airport, conservation sites and recreation and leisure sites. Each land use has an associated economic or lifestyle value but also may have an associated adverse impact on the environment. A map indicating the location of fisheries within the catchment is located on page 8.

For additional information regarding land use see:
Section 8 - factsheet 6

Water Quality

Chalk-streams usually have high water quality, however their natural hardness and alkalinity increases their tendency to assimilate effluents and makes them particularly vunerable to pollution. This tendency is important in South Hampshire where there has been continuing development based on good communication links. Increases in population have resulted in three large sewage treatment works discharging directly to the lower and tidal reaches of the river. The largest is the Chickenhall sewage treatment works at Eastleigh which has a consented dry weather flow discharge of up to 30,000 m^3/d. Consequently the Environment Agency sets stringent conditions on the quality and quantity of discharged effluents and only permits discharges that ensure the river and groundwater quality are preserved to high standards.

For additional information regarding water quality see:
Section 8 - factsheets 7, 10 & 19

Monitoring

In order to protect the environment it is essential to be able to assess the state of the environment effectively. This can be achieved by environmental monitoring. Water and sediment sampling identifies chemical pollutants that have accidentally or deliberately been introduced into the river, whilst habitat monitoring determines the well-being of the environment. Monitoring provides the essential data base resource from which the state of the environment is assessed and management decisions are made to achieve the right balance between the needs of the environment and those making use of the environment. A map indicating water quality sampling sites is located on page 7.

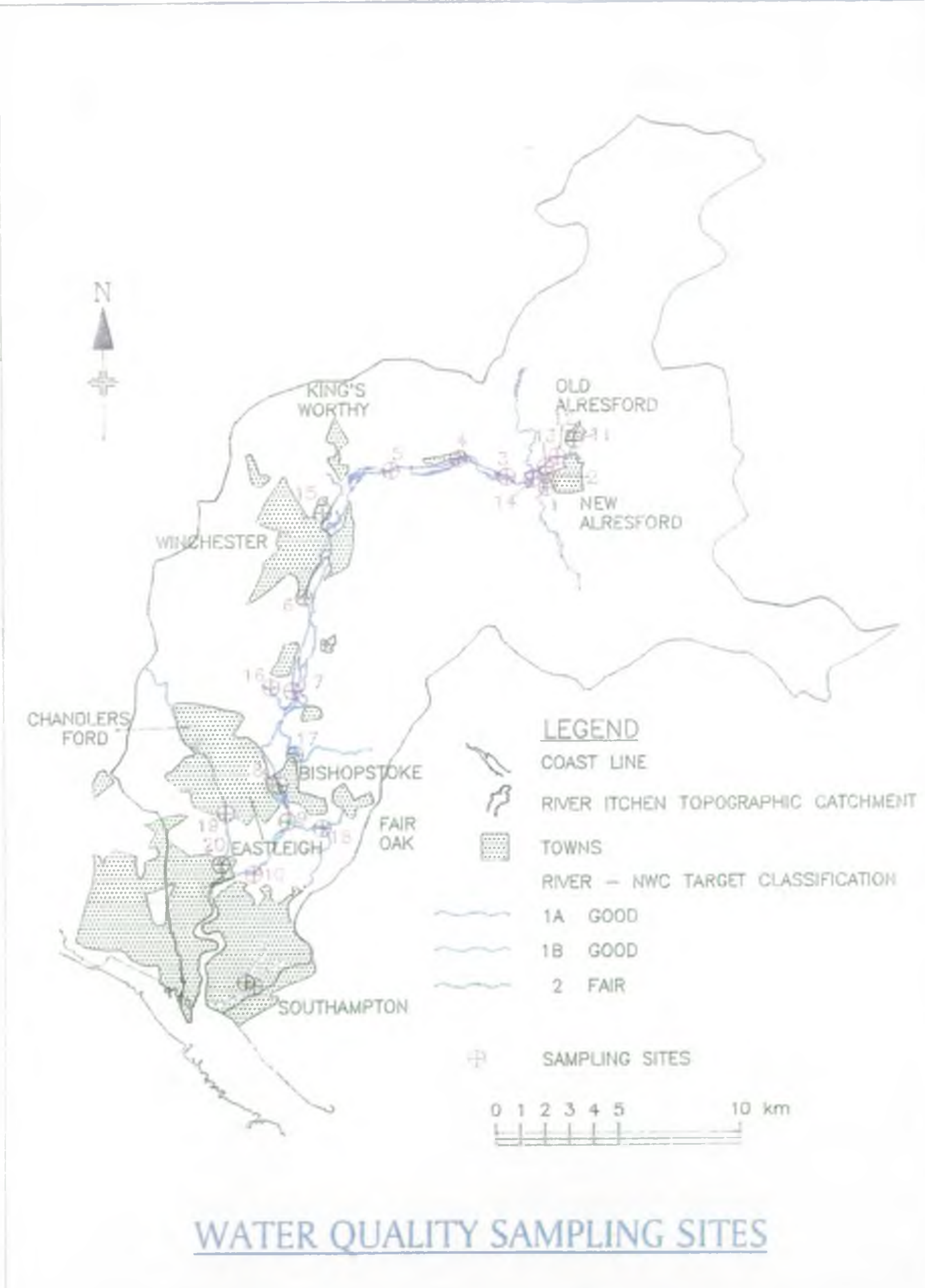
For additional information regarding monitoring water quality, monitoring fisheries and ecology, monitoring water resources and collection, treatment of sewage and disposal of treated water see:
Section 8 - factsheets 7 to 10

Site Pressures

Pressures on the environment at individual sites predominantly come from human activity but natural processes such as climate and rising seawater levels can also have important repercussions. The human pressures may be accidental, or arise from processes associated with intentional or planned activities that in many cases are unavoidable because of their economic or lifestyle importance. In densely populated regions such as Southern England, it is inevitable that competition for land space occurs. River environments are at a particular premium as they are of economic value, aesthetic value, and lifestyle value.

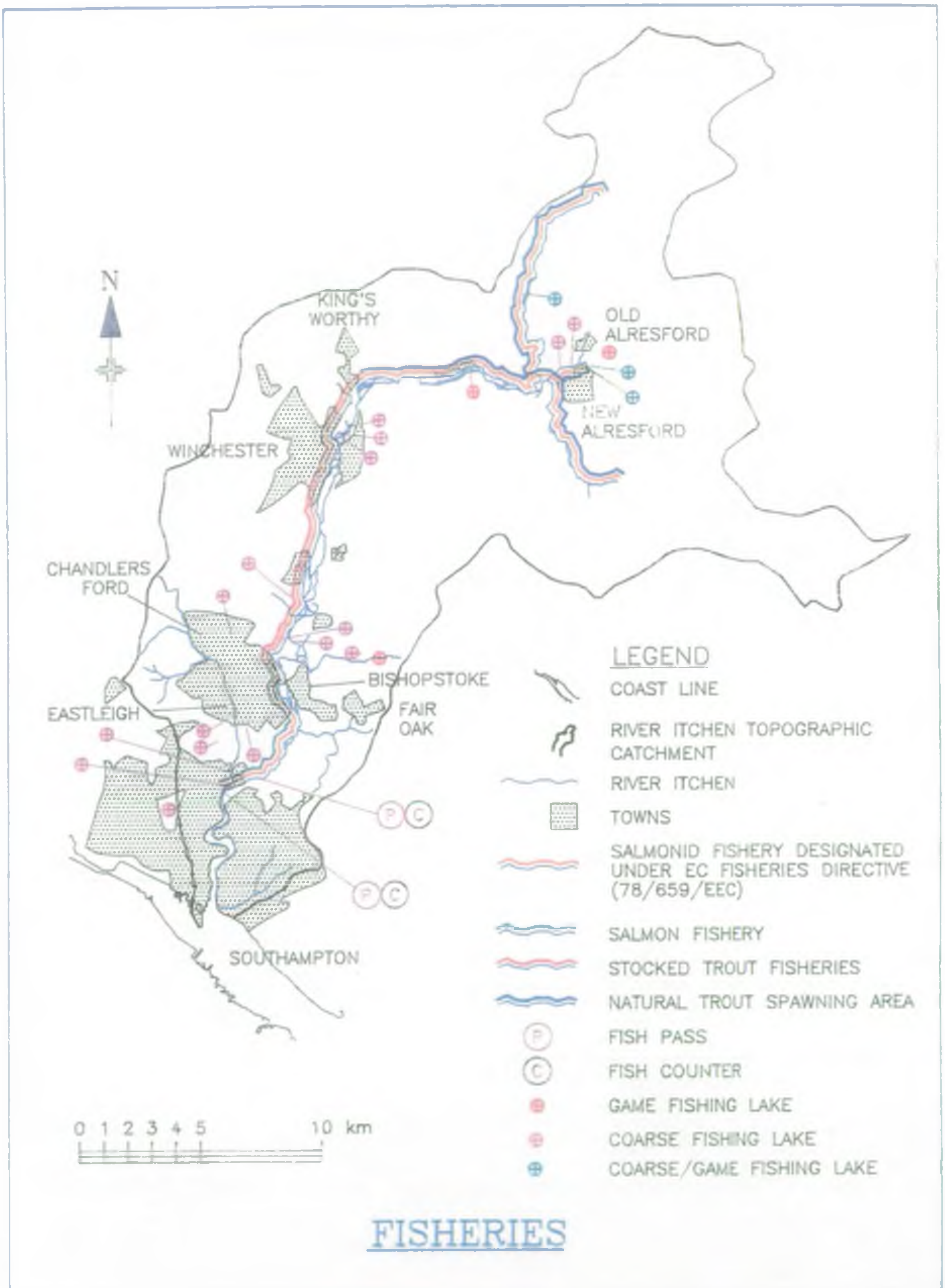
For additional information regarding site pressures see:
Section 8 - factsheets 11 to 13

Map of Water Quality Sampling Sites

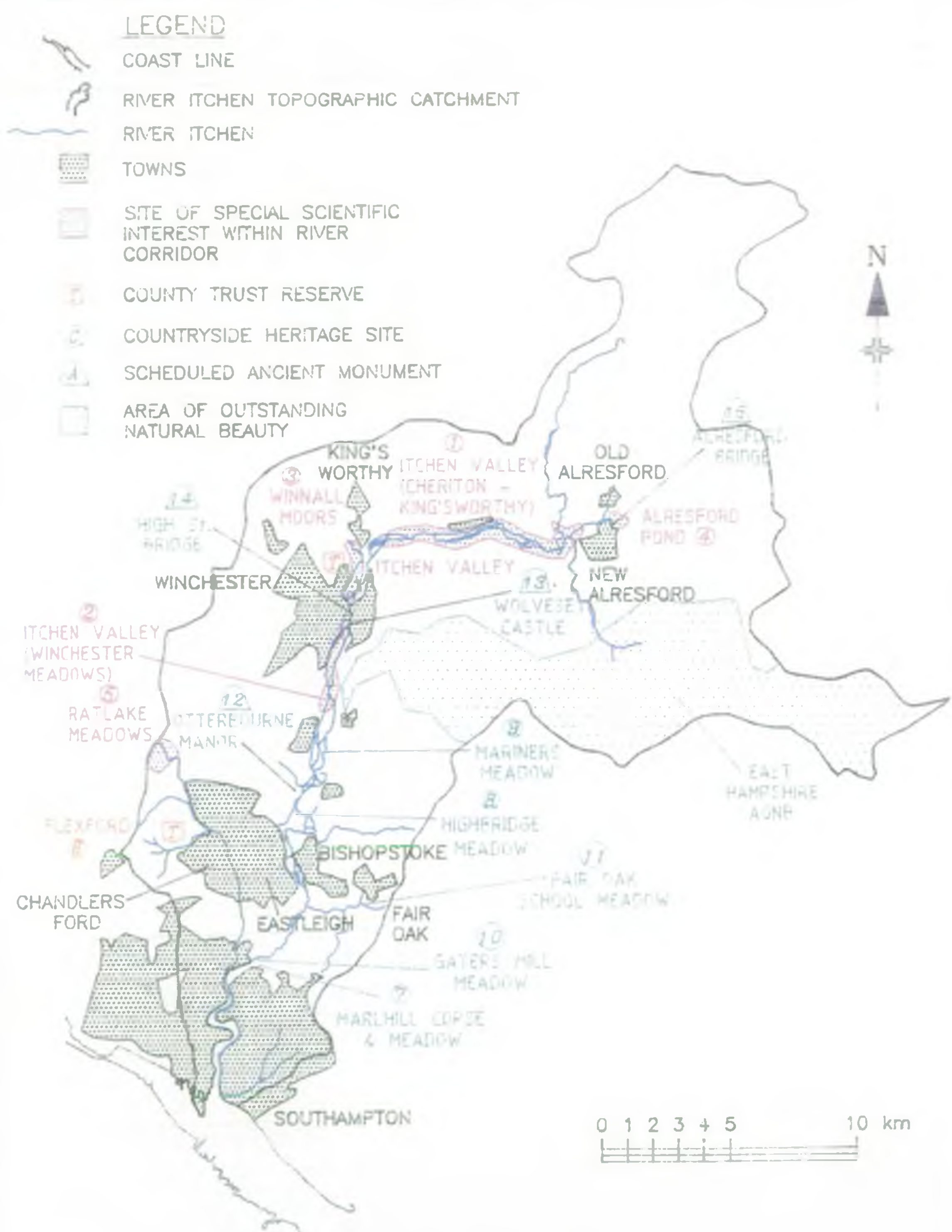


WATER QUALITY SAMPLING SITES

Map of Fisheries



Map of Conservation



CONSERVATION

2.3 The Changing Environment

Historical Perspective

The River Itchen has experienced a number of changes in use over the years that reflect the changing social and economic demands placed on the river. The three historic uses of the river; water meadows, water mills and barge transport, have resulted in a highly altered river with a multiplicity of channels. Conversely some demands have remained unchanged for many years such as the Salmon fisheries on the river which are probably more than one thousand years old.

For additional information regarding the historical perspective see:
Section 8 - factsheet 14

Climate Change

It is very difficult to demonstrate or prove that climate change has occurred or will occur in the future in response to human influences. However what is certain is that there have been a much higher than average group of dry years during the past 20 years and a greater seasonal variability.

For additional information regarding climate change see:
Section 8 - factsheet 15

2.4 Environmental Management

The Importance of Planning the Environment

Many of our economic and lifestyle activities have an impact on the environment through competing demands for land space, utilisation of resources, production of pollutants and alteration of natural habitat although the degree of impact varies from activity to activity. Therefore it is becoming increasingly important to plan and manage the environment to control issues associated with water supply, farming, urban development, waste disposal, air pollution, transport, industry, navigation and recreational and leisure activities.

For additional information regarding planning the environment see: Section 8 - factsheet 16a and 16b

Management of Competing Demands

Effective river management has to take account not only of the linkage between natural processes but also the demands and expectations of the people that use a river for a diverse range of lifestyle and recreational activities, businesses that rely on a river for its economic value (i.e. for water supply, fisheries, water power and water transport) and the need to protect and conserve the environmental value of a rivers natural habitat, wildlife and plants.

To achieve effective river management a decision process has to be employed in order to identify which uses of the river take precedence at any point. This involves managing each of the uses of the river and undertaking consultation with local planning authorities, river users and conservation groups to develop consensus with development or conservation plans. Thereby incorporating controls to protect and conserve the river environment for future generations. A map indicating the location of conservation sites is located on page 9.

For additional information regarding management of competing demands see: Section 8 - factsheet 17

Management of Recreation and Conservation

The River Itchen has been recognised as an area of natural beauty and as one of the finest examples of a Chalk river not only in the U.K. but also within a European context. For some years now it has been designated as a site of Special Scientific Interest (SSSI) and more recently, the river has been designated a Special Area of Conservation (SAC). In the River Itchen Catchment considerable effort is put into the protection and conservation of fisheries to preserve the quality of fishing on the river. In addition to conserving fisheries, the Agency has an active otter and water vole conservation program. A map indicating sites of recreation and amenity is located on page 13.

For additional information regarding Management of Recreation and Conservation see:
Section 8 - factsheet 18

Ensuring Environmental Protection

There has been a steady improvement in the environment and water quality standards since Victorian times. The change in standards has largely been achieved through the progressive improvement of environmental planning, design, management methods and technical instruction coupled with an increasing demand from the public for higher standards and a willingness to pay for the additional cost. The river water quality of the River Itchen Catchment is excellent. In fact it meets the highest *water quality objectives (WQOs)* and is abstracted for drinking water supply throughout the length of the river. In contrast the Monks Brook is often thought of as the poor water quality river. However despite repeated pollution events, this river also has very good water standards, supports important protected populations of river vole and otter and provides a very pleasant environment for walkers, cyclists and conservation activities.

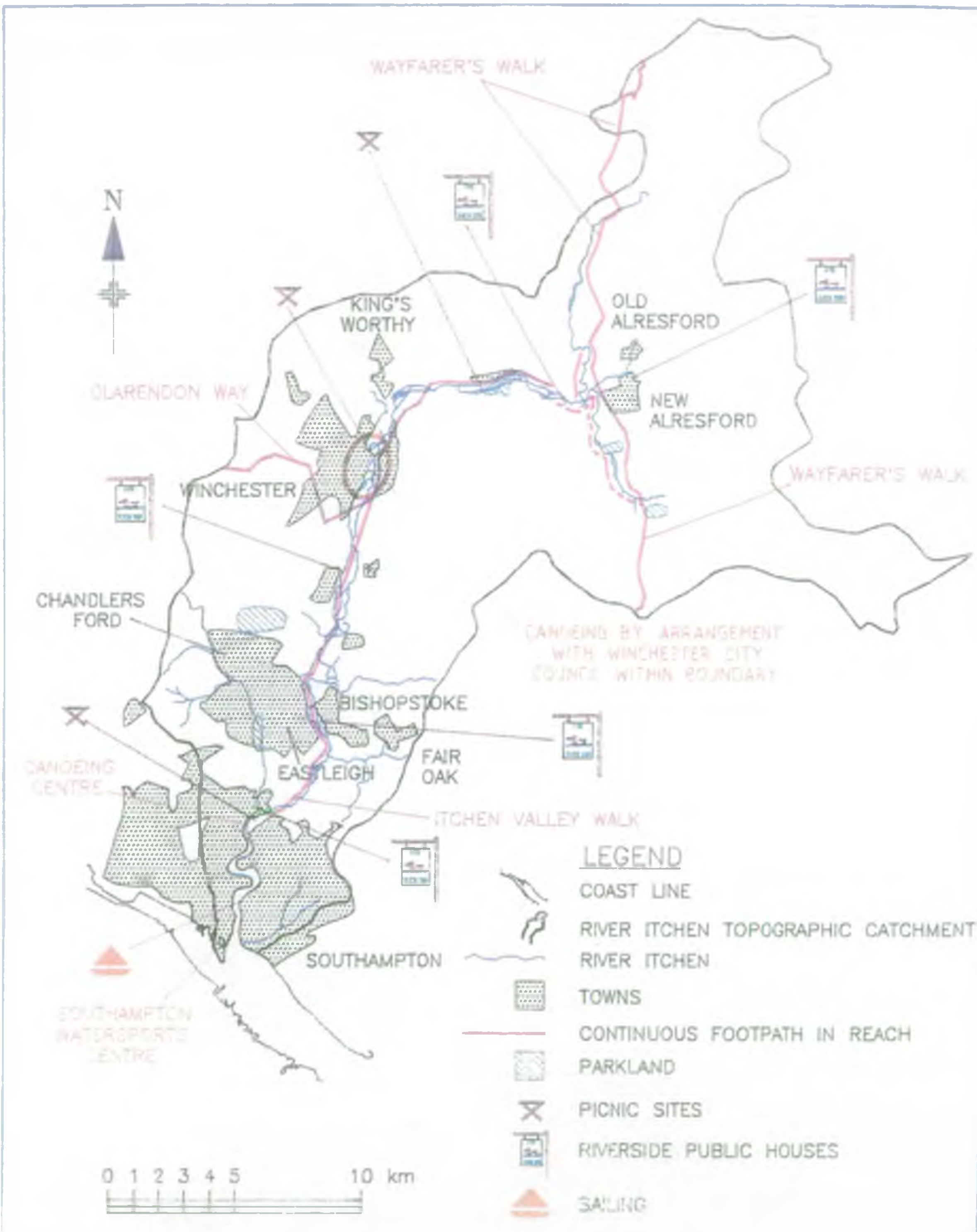
For additional information regarding ensuring environmental protection see:
Section 8 - factsheet 19

Management of Flood Defence and Land Drainage

The Agency has responsibilities for providing an efficient and effective flood defence and land drainage service that involves; managing watercourse maintenance programmes, the implementation of flood alleviation schemes on rivers and sea defences along the coast, together with the provision of a flood forecasting and warning service.

For additional information regarding management of flood defence and land drainage see:
Section 8 - factsheet 20

Map of Recreation and Amenity



RECREATION AND AMENITY

3. THE MONKS BROOK STUDY SITE AT FLEMING PARK

3.1 Introduction

The Monks Brook is a tributary of the River Itchen that begins in springs near Hursley and flows in a southerly direction via Chandlers Ford and Eastleigh to Southampton where it joins the River Itchen at Swaythling. Two of the ADF study sites are located on the Monks Brook, the first at the restored section close to Monmouth Close in Chandlers Ford and the second at Fleming Park in Eastleigh.

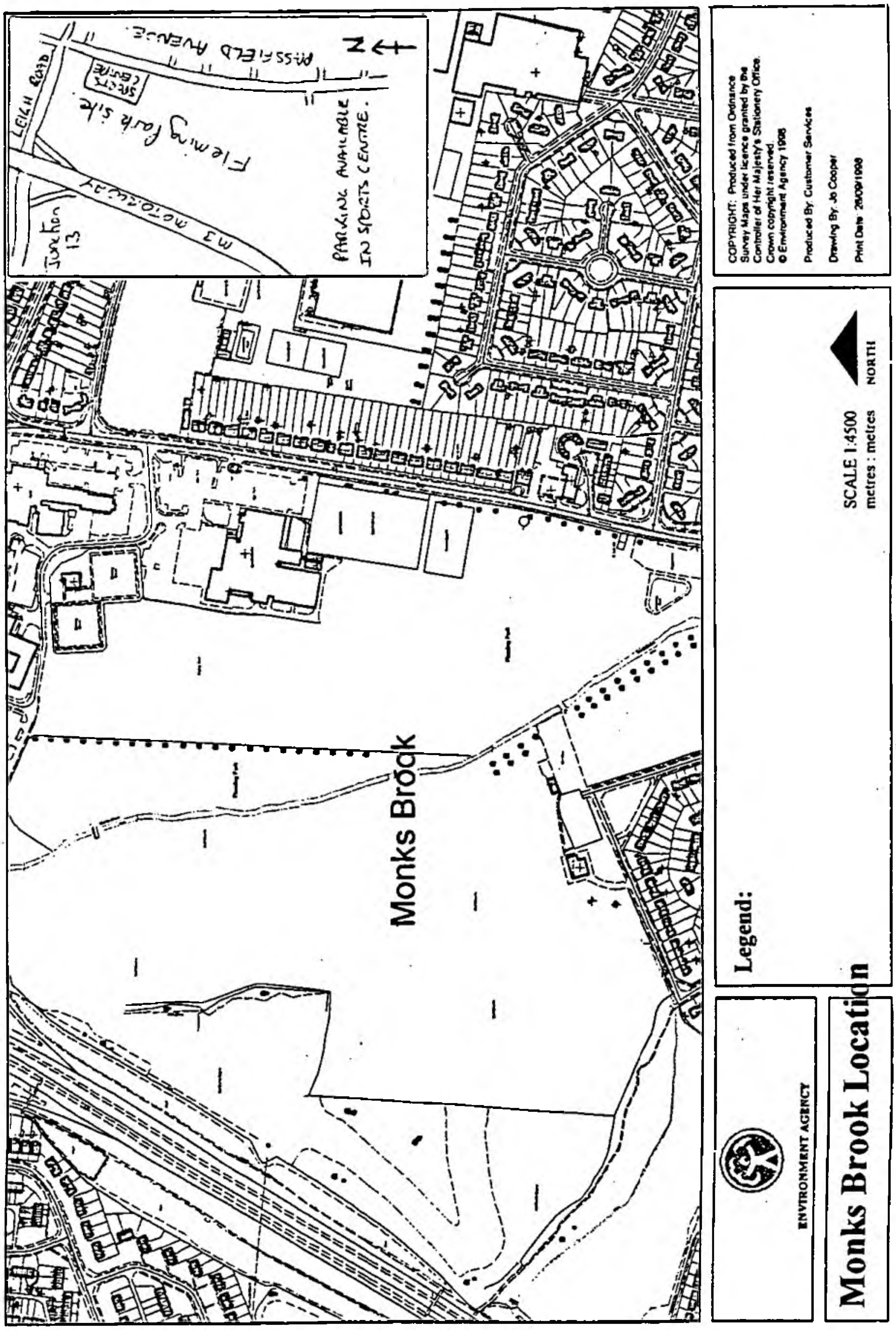
The Monks Brook and each of its tributaries at and above the Monmouth Close site are gaining sections of the river as these sections of the Brook gain groundwater from the Barton and Bagshot Beds that underlie the site and the catchment upstream from the site. The aquifier terminates within Eastleigh close to the route of the M3, so does not reach the Fleming Park site, which is instead underlain by London Clay which is impermeable. The combination of larger areas of urban paved surfaces and underlying impermeable clay in the catchment draining to Fleming Park causes the Brook to have rapid, high flow immediately after rainfall events interspersed with much reduced flow and lower stream levels during the intervening dry periods.

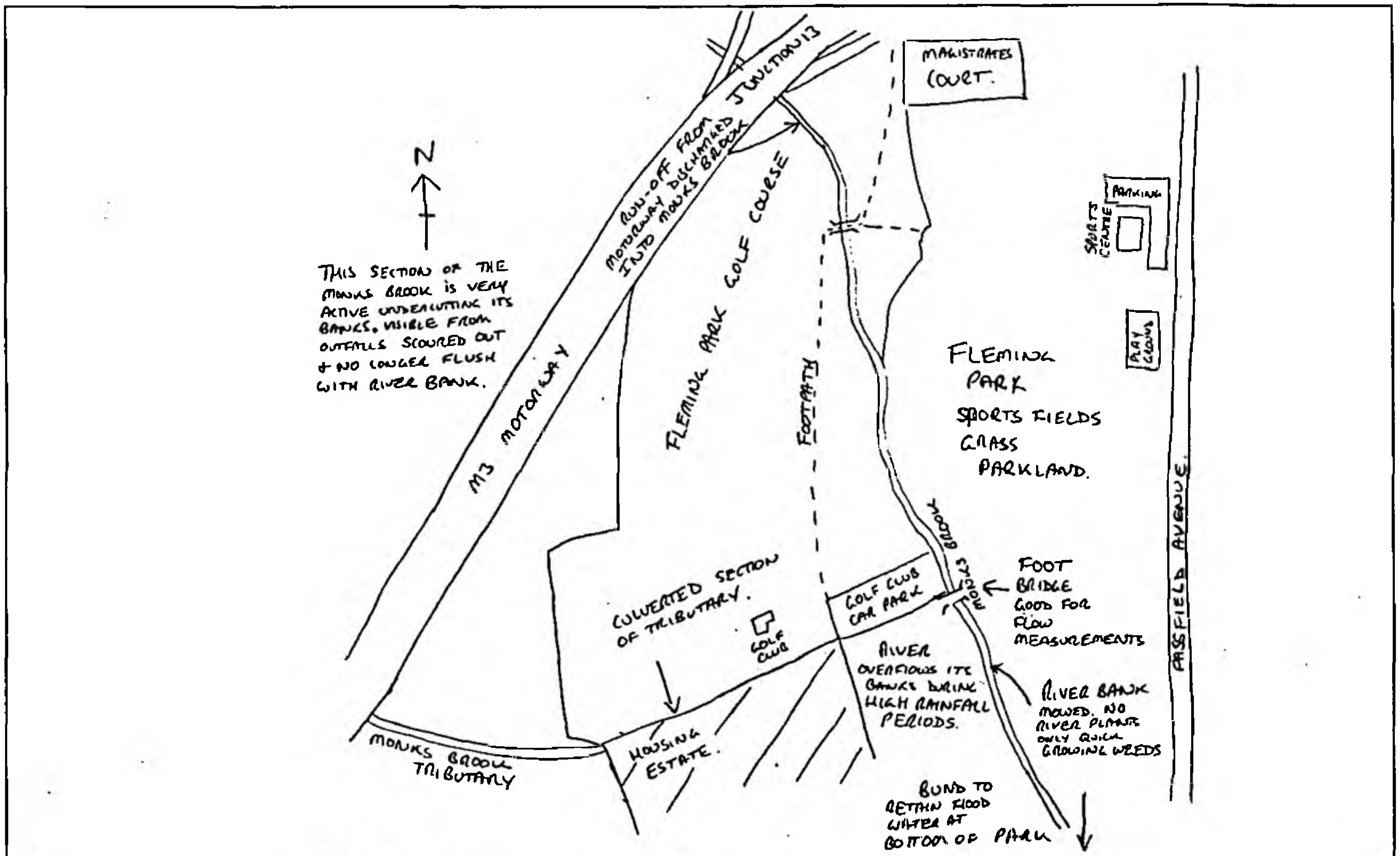
Fleming Park is used as the site of a leisure complex, playing fields, and a small separate golf course. The site is close to the geographic centre of Eastleigh and is surrounded by a large built-up area. Therefore it's value as an open green space for walkers, dog owners, and haven from the activity of the town is at a premium.

The west side of the park is bounded by the M3 motorway and the Monks Brook enters the site through a series of culverts under the motorway. Run-off into the stream occurs from the motorway, the surrounding urban areas and from industrial estates on the west side of the motorway.

The original route of the river has been straightened to increase the stream flow and thereby minimise the risk of flooding to the parkland and surrounding urban land.

Fleming Park Study Site Location Map





Simpson & Partners *Water and Environmental Consultants* Alexandra House, Alexandra Terrace, Guildford, Surrey GU1 3DA Tel: 01483 454647 Fax 01483 454648	Revisions	Client: Environment Agency Project: River Itchen ADFs	Drawing title: Fleming Park Study Site Sketch Map

Prepared by	Drawn by	Checked by	Revision	Scale	Date	Job no.	Drawing no.
MA	MA	RWS	.	-	23/12/98	367	

3.3 List of Issues and Items of Interest at the Fleming Park Site

Land Use

1. Urban planning.
2. Increase from 1960 to 1990 in urban pavement.
3. Use of site e.g. golf course, leisure centre, recreation ground, playing fields, green field amenity for walking and other leisure pursuits.
4. River banks mown by park mowers. Aquatic plants destroyed.
5. Steep banks provide habitat for water vole but frequent high storm water levels make water vole vulnerable.

Water Resources and Water Quality

1. River flow (Flow measurement using a float timed over a measured distance and cross-section.
2. Outfalls and discharge consents.
3. Poor water quality arising from frequent point source, often oil based, accidental and intentional spillages and illegal connections carried by urban run-off through outfalls into the Brook.
4. Water quality measurement (Electrical Conductivity (EC), pH and other paper based test parameters.

Flood Defence

1. Brook canalisation.
2. Peaky flood flow due to urban run-off.
3. Active stream channel with bank erosion (visible from eroded margins of outfall pipes).
4. Flood containment berm located at the southern end of the Park.

3.4 Site Activities at the Fleming Park Study Site

1. Measure streamflow under bridges measuring the wetted cross-sectional area and the water velocity using a float timed over a measured distance. The flow is the area times the velocity. Bridges are good locations as the bridge pillars provide a constant cross-section, and the bridge deck a good observation platform.

2. Measure water chemistry including Electrical Conductivity (EC), pH, dissolved oxygen (DO), and Temperature with paper tests or instruments if you have them. Compare this site with the water chemistry at Woodmill and Monmouth Close. Why is the water chemistry and the pH likely to be distinctly different at the Woodmill canal? Are there any differences with Monmouth Close? Might these differences have an effect on water quality?

3. Observe and record the effect of mowing on river bank vegetation and habitat. Compare notes with visits on previous occasions.

4. Observe and make a map of features of soil and rock type. London Clay is beneath the soil layer at this site.

5. Observe and make a map of site uses. What pollution problems can be expected in this section of the river? Don't forget the land uses upstream of Fleming Park

6. Carry out random and transect quadrant surveys to determine species diversity. Compare results with those obtained from the Monmouth Close site.

7. Notice eroded outfalls that indicate an active channel that has changed since construction of the outfall and the berms constructed downstream to contain local flooding. Try carrying out a river survey creating a map indicating areas of erosion and deposition.

8. Include steps 1 to7 in a site assessment survey and compare with assessments from previous visits.

3.5 Teachers Guide to the Fleming Park Site

Fleming Park and Monmouth Close

The Fleming Park site has been chosen because it is the most accessible site for schools in Eastleigh. The Monmouth Close site has been chosen because it provides a vital contrast to Fleming Park and has a number of features that illustrate environmental management techniques.

Fleming Park

1. Measure and compare the stream flow along the Brook. The bridge sections are often the best locations. To do this measure the cross-sectional area of the stream and determine the stream velocity. The flow is the area multiplied by the velocity. Use a tape measure for the width, a metre stick for the depth and measure the mean time an orange flows along a measured distance to determine the stream velocity. Use units of litres/sec or m^3/sec.

2. Measure the flow velocity close to the centre of the channel and compare it with the velocity at the sides of the channel. The central flow should be faster. It will be significantly faster if the banks are roughened by pebbles and stones, or is of variable width and depth or the banks are covered by vegetation. Discuss how river flows are best measured when the velocity is so dependant on bank morphology and bank plants. The Agency uses weirs with engineered concrete approach and cross-sections that remove many of the channel complications and calibrate the weir with detailed measurements to construct flow tables for height on the weir.

3. Measure rainfall in mm at your school at the same time as measuring daily stream flows and keep daily records. Relate the increases in river flow to the rainfall events. Rainfall is an event based data set. It is often easier to see volumes over a period of time if you calculate a moving average of the rainfall, then the rainfall peaks should lead river flow peaks. Discuss these techniques with the students. It should be noted that hydrology is a natural science and natural conditions often make measurements difficult. Consequently experience with data interpretation is invaluable and the Agency employs many specialist hydrologists and hydrogeologists to assess the data they collect.

4. Sand and gravel aquifers usually have a neutral pH of 6.5 to 7.5. Sands and gravels are chemically inert aquifers and therefore tend to have low concentrations of dissolved minerals unless the aquifer is still being flushed after emergence from the sea or contains mineralised water at depth. Chalk aquifers often have a higher pH of 7.5 to 8.5 and contain high concentrations of carbonate (CO_3^{2-}) and hydrogen carbonate (HCO_3^-) dissolved from the Chalk. The high residence time of Chalk groundwater means that chalk water entering streams and springs is saturated in (CO_3^{2-}) and (HCO_3^-) which buffer the dissolved CO_2 in the water. This gives chalk water a tendency for higher pH's. Point out to the students that these are natural mineralisation differences that do not significantly change the quality of the water but do have an effect on water hardness and nuisances such as iron staining.

5. It is difficult to take pollution based chemical measurements on site but discoloration, turbidity and the presence of foam and oil may be observed. However by examining the site, students can anticipate the problems that arise from the surrounding land uses and anticipate the problems. The most influential are storm drains from the high percentage of paved areas which will contain a high range of pollutants including oil and salt from the roads, herbicides from road and rail systems, organic detritus, sediments and anything else which is spilt or deliberately dumped into the drain's catchment. However others include the storm overflow of sewage treatment works, accidental spillages from industrial, agricultural, road and rail uses or the diffuse movement of agricultural chemicals from land to groundwater and surface waters.

6. The random and transect quadrant surveys should highlight the sharply improved diversity in habitat and ecology that is evident at the Monmouth Close Site and particularly along the restored section in comparison to the relatively sterile environment of Fleming Park. Ask the students how Fleming Park could be improved whilst maintaining or improving it's amenity value. What would be the most cost effective options? Where do the funds come from? Would the local residents be prepared to pay? Who else might pay for the improvements? Take into account that increased taxes are unpopular.

7. Draw a cross-section of the river to identify the different habitats relative to the river. These include the open channel, river bed, river bank, flood terraces, the levee and the land behind the terraces and the levees.

4. THE MONKS BROOK STUDY SITE AT MONMOUTH CLOSE

4.1 Introduction

The Monks Brook is a tributary of the River Itchen that begins in springs near Hursley and flows in a southerly direction via Chandlers Ford and Eastleigh to Southampton where it joins the River Itchen at Swaythling. Two of the ADF study sites are located on the Monks Brook, the first at the restored section close to Monmouth Close in Chandlers Ford and the second at Fleming Park in Eastleigh.

The Monks Brook and each of its tributaries at and above the Monmouth Close site are gaining sections of the river as these sections of the Brook gain groundwater from the Barton and Bagshot Beds that underlie the site and the catchment upstream from the site. The aquifier terminates within Eastleigh close to the route of the M3, so does not reach the Fleming Park site, which is instead underlain by London Clay which is impermeable. The combination of larger areas of urban paved surfaces and underlying impermeable clay in the catchment draining to Fleming Park causes the Brook to have rapid, high flow immediately after rainfall events interspersed with much reduced flow and lower stream levels during the intervening dry periods.

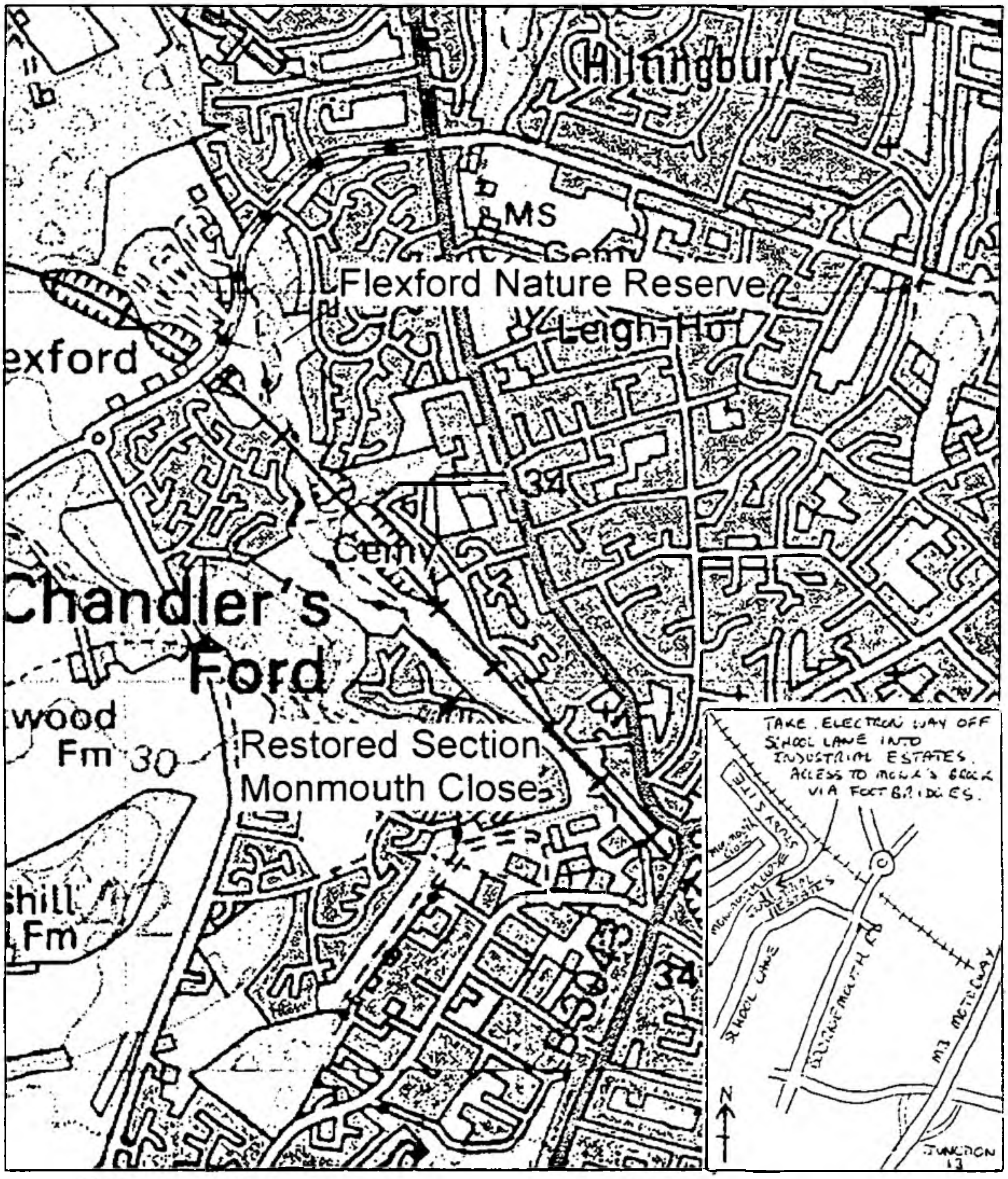
The Monmouth Close Study Site on the Monks Brook is used for a diverse range of activities that include residential housing, industrial activities, rail and road transport, a cycle track, footpath access between the industrial and housing estates, walking, and conservation activities.

Like Fleming Park, the Monks Brook and its minor tributaries close to Monmouth Close were straightened during the 1960s to improve peak flow run-off and so reduce flooding. However this has proved to be detrimental to the environment, destroying important aquatic habitats and disrupting the plant and animal ecology resulting in marked population reductions of animal and plant species and most notably endangered animals such as the otter and the water vole.

Consequently a short section of the Brook close to Monmouth Close in Chandlers Ford has been recently returned to it's original condition. This type of improvement is called *river restoration* and is intended to enhance the quality of the environment. This is achieved by the artificial restoration of the Brook to a more natural river environment through the introduction of bends to the river channel, wood baffles and alteration of the channel slope to control the stream flow, creating areas of faster flowing water and deeper quiescent conditions elsewhere.

These alterations may increase the frequency of local flooding. Consequently the restored section sits within a two stage channel with successively higher river terraces that contain the higher river flow in a channel centred on the Brook during flood flow conditions. The terraces are also bounded by a single levee as a final protection against flooding of the surrounding houses and industrial estate.

Monmouth Close Study Site Location Map

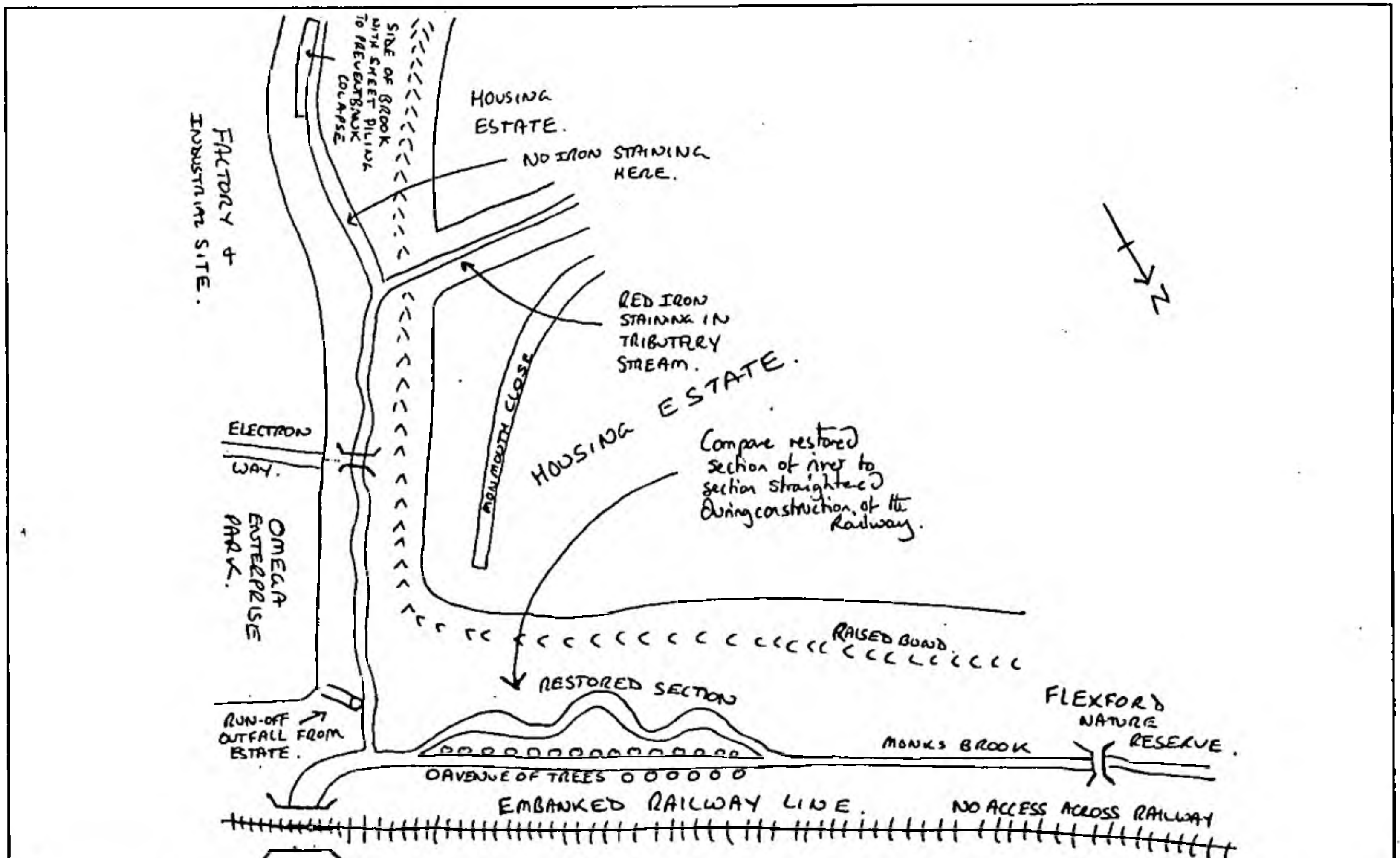


Monks Brook Restoration

SCALE 1:13900
metres : metres
NORTH

Produced By: Customer Contact
Drawing By: Jo Cooper
Print Date: 23/12/1998

Monmouth Close Study Site Sketch Map



Simpson & Partners
Water and Environmental Consultants

Alexandra House, Alexandra Terrace, Guildford, Surrey GU1 3DA
Tel: 01483 454647 Fax: 01483 454648

Revisions

Client	Project	Drawing title
Environment Agency	River Itchen ADFs	Monmouth Close Study Site Sketch Map

Prepared by	Drawn by	Checked by	Revision	Scale	Date	Job no.	Drawing no.
MA	MA	RWS		-	23/12/98	367	

Monk Brook Restoration Program Leaflet

4.3 List of the Issues and Items of Interest at the Monmouth Close Site

Land Use

1. Urban planning.
2. Increase from 1960 to 1990 in urban pavement.
3. Use of site e.g. green field amenity for walking and other leisure pursuits, Flexford Nature Reserve, flood plain, aesthetic boundary to hide industrial estate from residents living in the housing estate.
4. River banks not mown by park mowers. Good habitat for aquatic plants.
5. Steep banks provide habitat for water vole but frequent high storm water levels make water vole vulnerable.

Water Resources and Water Quality

1. River Flow (Flow measurement using a float timed over a measured distance and cross-section.
2. Outfalls and discharge consents.
3. Poor water quality arising from frequent point source, often oil based, accidental and intentional spillages and illegal connections carried by urban run-off through outfalls into the Brook. Most problems coming from local industrial estates.
4. Water Quality Measurement (Electrical Conductivity (EC), pH and other paper based test parameters.

Flood Defence

1. River restoration.
2. Brook canalisation.
3. Less pronounced peaky flood flow due to urban run-off than Fleming Park site.
4. Active stream channel with bank erosion (visible from eroded margins of outfall pipes).

4.4 Site Activities at the Monmouth Close Study Site

1. Observe and map features of soil and rock type where visible (Barton and Bagshot Beds). Why are there so many tributaries close to Monmouth Close and only one in the whole of Fleming Park? What effect might urbanisation and the construction of storm sewer drains have on the Brook?

2. Determine the water chemistry by measuring EC, pH, DO and Temperature parameters. Compare the main brook with its tributaries. Observe the Fe^{3+} staining in one of the tributaries and absence in each of the other streams. What does this indicate about water chemistry processes?

3. Observe and map site uses. Based on land uses around the site, what pollution problems can be expected in this section of the Brook?

4. Observe and map storm water drains. Where are they coming from?

5. Is the Brook in flood flow or are you observing the aquifer base flow? If the river was in flood and the Brook level rose further, would the stream be contained. What river features contain the river as the storm water level rises?

6. Measure streamflow under bridges using a measured stream cross-section and a float timed over a measured distance to determine the stream velocity. Average measurements are more accurate.

7. Carry out random and transect quadrant surveys. Compare the ecology found in each type of habitat and determine if diversity is better than at Fleming Park.

8. Observe effect of mowing only grassland areas on river bank vegetation and habitat. To do this, compare with Fleming Park river banks and identify plant species. You don't need to know their names to work out the species diversity, but it is worth trying to identify the ones that favour wetland habitats such as silver birch and willow trees.

9. Record the effect on the ecology of the restored river section by measuring the plant species diversity (and animals if you have time).

10. Carry out a river corridor survey by dividing the Brook into sections and recording the details of the aquatic habitat and ecological features of interest along each section. Use the surveys provided and conducted by the Environment Agency as an example of the kind of information to record, it is not exhaustive, any relevant information can be recorded.

4.5 Teachers Guide to the Monmouth Close Site

Monmouth Close

The Monmouth Close site has been chosen because it provides a vital contrast to Fleming Park and has a number of features that illustrate environmental management techniques.

1. Measure and compare the stream flow along the Brook. The bridge sections are often the best locations. To do this measure the cross-sectional area of the stream and determine the stream velocity. The flow is the area multiplied by the velocity. Use a tape measure for the width, a metre stick for the depth and measure the mean time an orange flows along a measured distance to determine the stream velocity. Use units of litres/sec or m^3/sec.

2. Measure the flow velocity close to the centre of the channel and compare it with the velocity at the sides of the channel. The central flow should be faster. It will be significantly faster if the banks are roughened by pebbles and stones, or are of variable width and depth or are covered by vegetation. Discuss how river flows are best measured when the velocity is so dependant on bank morphology and bank plants. The Agency uses weirs with engineered concrete approach and cross-sections that remove many of the channel complications and calibrate the weir with detailed measurements to construct flow tables for height on the weir.

3. Measure rainfall in mm at your school at the same time as measuring daily stream flows and keep daily records. Relate the increases in river flow to the rainfall events. Rainfall is an event based data set. It is often easier to see volumes over a period of time if you calculate a moving average of the rainfall, then the rainfall peaks should lead river flow peaks. Discuss these techniques with the students. It should be noted that hydrology is a natural science and natural conditions often make measurements difficult. Consequently experience with data interpretation is invaluable and the Agency employs many specialist hydrologists and hydrogeologists to assess the data they collect.

4. One of the tributaries at Monmouth Close has a very red channel from the precipitation of iron oxides. Groundwater in sand and gravel aquifers like the Barton and Bagshot Beds often contain iron, but because aquifers are not exposed to the atmosphere, groundwater is normally depleted in dissolved oxygen and there is a chemical oxygen demand. Consequently the iron dissolves in the groundwater as Fe^{2+} OH^- which is highly soluble. When the groundwater flows into a stream through the river bed, the tumbling action of the river oxygenates the water and the Fe^{2+} converts to Fe^{3+} OH^-. This hydroxide has a very low solubility and has a dark red colour and the process occurs rapidly. Consequently the iron hydroxide precipitates as a red solid that is easily identified by sight and confirms that this tributary is a *gaining stream section* supplied by water from the Barton and Bagshot Beds aquifer. Equally the high frequency of tributaries is also a general indicator of groundwater being drained by the stream channels, as are marsh grass and other wetland plant species.

5. Sand and gravel aquifers usually have a neutral pH of 6.5 to 7.5. Sands and gravels are chemically inert aquifers and therefore tend to have low concentrations of dissolved minerals unless the aquifer is still being flushed after emergence from the sea or contains mineralised water at depth. Chalk aquifers often have a higher pH of 7.5 to 8.5 and contain high concentrations of carbonate (CO_3^{2-}) and hydrogen carbonate (HCO_3^-) dissolved from the Chalk. The high residence time of Chalk groundwater means that chalk water entering streams and springs is saturated in (CO_3^{2-}) and (HCO_3^-) which buffer the dissolved CO_2 in the water. This gives chalk water a tendency for higher pH's. Point out to the students that these are natural mineralisation differences that do not significantly change the quality of the water but do have an effect on water hardness and nuisances such as iron staining.

6. It is difficult to take pollution based chemical measurements on site but discoloration, turbidity and the presence of foam and oil may be observed. However by examining the site, students can anticipate the problems that arise from the surrounding land uses and anticipate the problems. The most influential are storm drains from the high percentage of paved areas which will contain a high range of pollutants including oil and salt from the roads, herbicides from road and rail systems, organic detritus, sediments and anything else which is spilt or deliberately dumped into the drain's catchment. However others include the storm overflow of sewage treatment works, accidental spillages from industrial, agricultural, road and rail uses or the diffuse movement of agricultural chemicals from land to groundwater and surface waters.

7. Get the students to discuss pollution prevention measures. The following excerpt from the Agency's River Itchen Conservation Strategy may be a good starting point. "High risk areas need to be identified and precautionary measures taken". For example, it is possible to install systems which catch and hold contaminated run-off where it can be removed or neutralised by natural processes before entering the river.

8. The random and transect quadrant surveys should highlight the sharply improved diversity in habitat and ecology that is evident at the Monmouth Close Site and particularly along the restored section in comparison to the relatively sterile environment of Fleming Park. Ask the students how Fleming Park could be improved whilst maintaining or improving it's amenity value. What would be the most cost effective options? Where do the funds come from? Would the local residents be prepared to pay? Who else might pay for the improvements? Take into account that increased taxes are unpopular.

9. Use this opportunity to introduce students to species and genera. Plants, birds and fish are the most visible species. Ecology and habitat studies require detailed knowledge of individual species. Encourage the students natural interest to learn the names of plants, birds and animals that you encounter. This is the starting point for the study of zoology and botany and some students may develop these interests into pastimes such as ornithology or pond dipping, fishing etc.

10. Draw a cross-section of the river to identify the different habitats relative to the river. These include the open channel, river bed, river bank, flood terraces, the levee and the land behind the terraces and the levees.

5. THE RIVER ITCHEN STUDY SITE AT WOODMILL, SWAYTHLING

5.1 Introduction to the Woodmill Site

Woodmill is at the *confluence* of the Monks Brook and the River Itchen and is also at the *tidal limit* of the River Itchen. The river flow of the Itchen arrives at Woodmill in the River Itchen Navigation which was constructed as a canal to transport heavy goods during the 18th Century. It is no longer used as a canal but remains as the artificial channel of the Itchen at Woodmill.

The majority of the flow in the River Itchen is derived from groundwater draining the Chalk hills to the north of Eastleigh and east of Winchester and the river water has a typical Chalk aquifer water chemistry. The Monks Brook originates in springs around Hursley south of Winchester and drains the Barton and Bagshot Beds minor aquifer. The Monks Brook has water chemistry typical of sand and gravel aquifers.

Woodmill is used by the Woodmill Canoeing and Outdoor Activity Centre that organises canoeing, fishing, climbing and environmental activities such as pond dipping. In addition to the activities available at the centre, there are other features nearby that include a pitch and putt course, a river side walk along the side of the canal following the original tow path and the urban area surrounding the site.

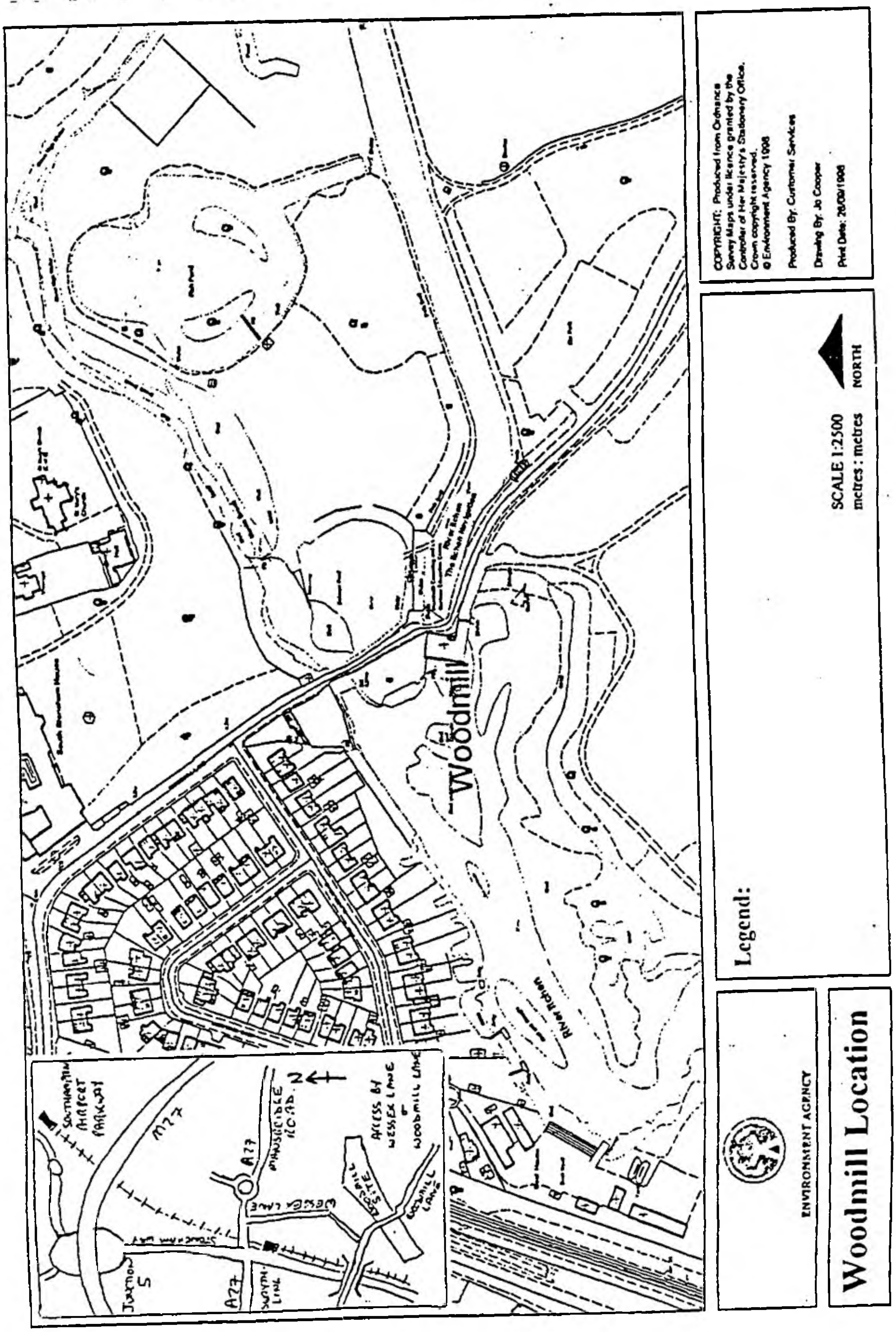
The site has a number of important aquatic habitats. Perhaps the most important site is the salmon pool which provides a resting location for *migratory fish* during their annual migrations up and down the river. This is a brackish pool with access to the tidal river estuary and the River Itchen via a *fish ladder* located next to the canal outflow. The salmon pool provides a resting location where fish make the transition from salt water to fresh water. This transition requires the fish to alter their *metabolism* to compensate for the change in salt concentrations before ascending the fish ladder or entering the tidal estuary.

Other important *aquatic habitats* are the Monks Brook watercourse, the canal bottom, the canal bank opposite the riverside walk, the fish pond and wetlands between the Navigation and the Monks Brook. Each provide important and different aquatic habitats for fish, plants, mammals and birds.

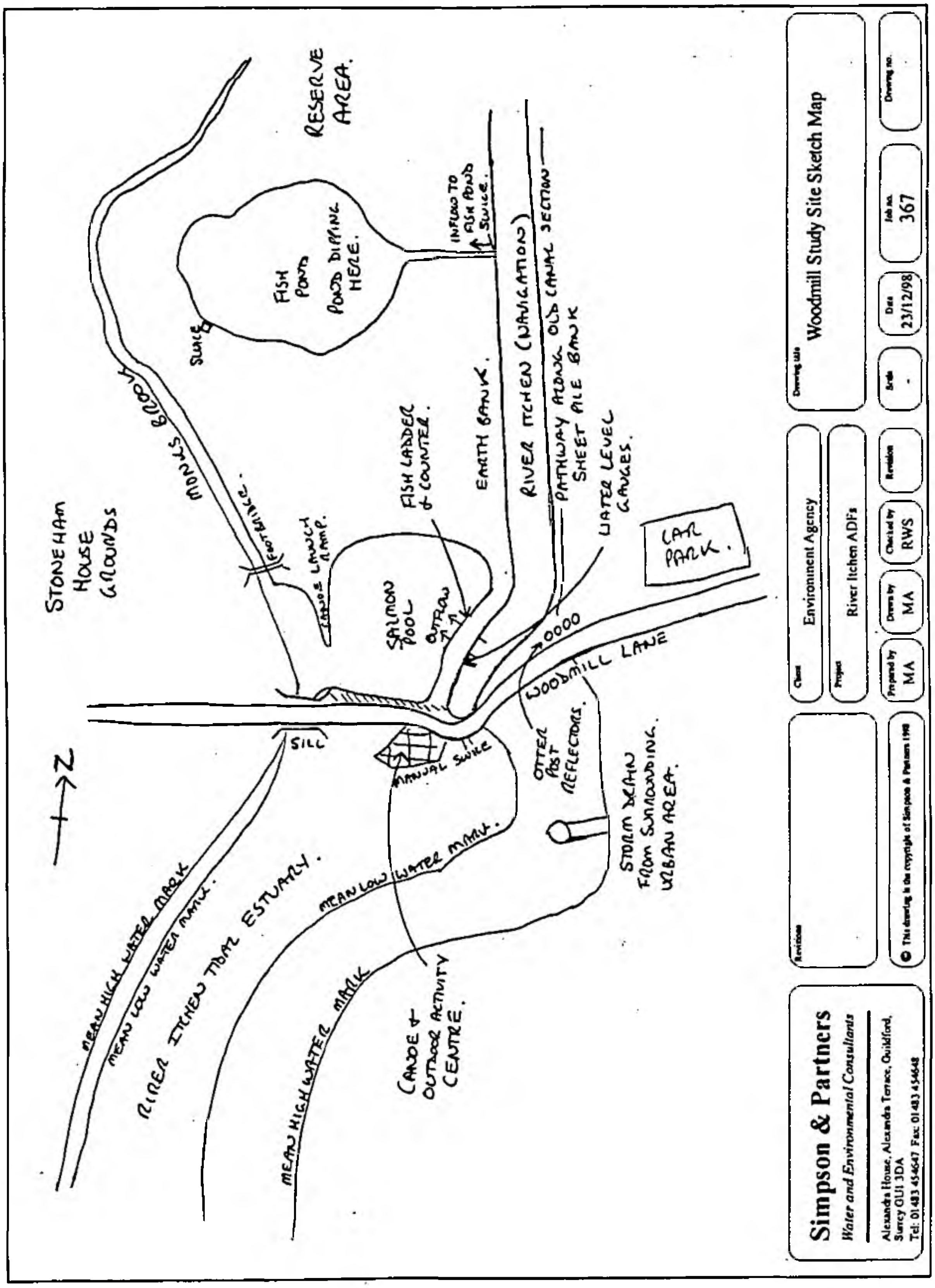
The Woodmill site is largely *artificial* having been altered to construct the River Itchen Navigation to provide a constant flow to the old mill, in which the Outdoor Education Centre is now housed, and to create ornamental grounds which the centre now uses. The eastern bank of the canal contains sheet piling to stabilise the bank and to permit the construction of the permanent paved riverside walk.

Other engineering structures include a *flood sluice gate* to lower water levels in the Navigation during flood events, and two *flow controls* between the Navigation and tidal sections and between the Navigation and the salmon pool.

Woodmill Study Site Location Map



Woodmill Study Site Sketch Map



Woodmill Outdoor Centre

Woodmill has an exceptionally long history of offering outdoor activity courses. At weekends and evenings the Centre has an extensive programme of courses for adults, during term-time the facilities are available to schools. Woodmill was one of the first specialist Centres to open in the Country over 40 years ago. More recently the Centre has been extensively refurbished. Together with the installation of a residential unit and the acquisition of the Salmon Pool and grounds adjacent to the Centre, Woodmill has been able to extend still further the number and range of opportunities available.

Activities available include: canoeing; kayaking; dragon boating; mountain biking; archery; artificial wall rock climbing; orienteering; camping; environmental studies; raft building; problem solving activities; fishing and low rope course.

Facilities include: an extensive range of activity equipment; 2 classrooms; self contained 18 bed residential unit complete with kitchen and dining area; 14 acres of grounds; secure camp site; sheltered lake; white water facility; canoe and outdoor activity equipment shop.

For adults and holiday courses at evening and weekends, phone for the centre's activity course brochure.

For schools, single or multi activity courses are available in a variety of formats from a "one-off" taster session to a five day course or weekly programme of activities. Most courses are available on a residential or non-residential basis.

The senior members of staff at Woodmill are qualified teachers and are always willing to discuss individual school requirements to ensure that these are reflected in the programme agreed for each group. As a City Council, Woodmill Centre works entirely within the guidelines, recommendations and regulations of the County Hazardous Pursuit Regulations and always uses qualified instructors. Woodmill is a centre approved by the British Canoe Union and British Orienteering Federation.

Undoubtedly the best way to appreciate the facilities is to visit the Centre. Please feel free to phone Phillip Quill of John Smith at Woodmill to arrange this or to discuss options that may be available for your school.

Woodmill Outdoor Centre, Woodmill Lane, Swaythling, Southampton, Hampshire, SO18 2JR - Tel No 01703 555993 Fax 01703 556641
Website: www.woodmill.co.uk email: courses@woodmill.co.uk

5.3 List of Issues and Items of Interest at the Woodmill Site

Land Use

1. Competing demands for site use.
2. Site pressures.
3. Use of site e.g. pitch and putt course, outdoor activity centre, canoeing, recreation facilities, green field amenity for walking and other leisure pursuits, important wetland habitat and strategic habitat for animals, particularly the otter.
4. One of the Navigation banks is a paved path preventing growth of bank plants.
5. Steep banks provide important habitat for the water vole but control of water levels in the navigation means the water vole is much less vulnerable at this site.
6. Fish Ladder.
7. Pond dipping in fish pond.
8. Salmon fishing in salmon pool.

Water Resources and Water Quality

1. Outfalls and discharge consents.
2. Excellent water quality arising from exceptional nature of a Chalk river. Abstraction for water supply occurs just upstream from Woodmill at Gaters Mill.
3. Water Quality Measurement (Electrical Conductivity (EC), pH and other paper based test parameters).

Flood Defence

1. Artificial channels of both the Navigation and the Monks Brook.
2. Peaky flood flow on the Monks Brook due to urban run-off, steady, relatively high flow rate through the Itchen Navigation.
3. Controlled stream channel with little bank erosion.
4. Flood control gates and sluices.
5. Water level measurement instruments.

5.4 Site Activities at the Woodmill Site

1. Measure water quality. Electrical Conductivity (EC), pH, dissolved oxygen (DO) and temperature with paper tests or instruments if you have them. Compare the water quality in the Monks Brook with the water quality in the River Itchen Navigation. Why is the water chemistry and the pH likely to be distinctly different in the Woodmill canal from the Monks Brook. Does this mean that the two water features have different water quality or do they just have different water chemistry.

2. Visit the Woodmill Outdoor Education Centre. Why was the mill located at this site?

3. Visit the Outdoor Activity Centre for a guided tour including environment features, the salmon pool and pond dipping in the fish pond.

4. Carry out random and transect quadrant surveys. Compare the ecology found in each type of habitat and determine which habitats have the greatest species diversity. You don't need to know the species names to work out the species diversity, but it is worth trying to identify the ones that favour wetland habitats such as willow trees.

5. Observe the effect on the ecology of each of the different habitats around the site. Use the river survey provided to assess the aquatic habitat and ecological features of the rivers.

6. The Environment Agency surveys species diversity mostly using worms that live in the river bottom to gauge the state of the river environment. Worms have been chosen because they are common, are site specific (i.e. they don't wander away from the river) and several species of worms are sensitive to pollutants. It is not possible to wade about in the canal or the Monks Brook to collect worms so what other common species are visible at the river site? Plants have a much greater degree of resistance to pollutants than animals higher up the food chain. Most animals are not easily visible as they skulk in the undergrowth. Birds are highly mobile, but many are territorial. Consequently, bird species could also be surveyed to assess the state of the environment. Frequent visits are required to assess the influence of changing environment on *biodiversity*. Population surveys can also be useful. A list of aquatic birds is included in the data section on pages 60-63. See also the suggested field exercise "Species diversity surveys" on page 91, and factsheet 8 "Monitoring fisheries and ecology" on page 108.

7. Many hydraulic features are visible at Woodmill. See if you can find the following:

    i. *A sluice*. This is a spillway that carries water away from a watercourse. If the weather has been dry then sluices may not be in operation and will be harder to find.

    ii. *A sluice gate*. This is an adjustable structure that is opened to adjust flows through a sluice or to control levels upstream in the water course. The simplest gates are lifted vertically like a portcullis. Small ones can be lifted by hand. Larger ones require a power drive and may be sectional.

    iii. *A sill*. A sill is a structure that maintains a depth of water behind the sill or a flow over it. This is important during low flow conditions or at low tide. To find the sill, work out which area needs a sill. It may be visible at low tide.

    iv. A *storm water outfall*. This drains water from the surrounding paved areas. Note the line of gulls that sometimes wait for food scraps coming down the sewer into the river via the outfall.

    v. The *water level recording station* comprising a stilling tube (containing a float), electronic level recorder and telemetry equipment to measure and transmit water levels back to the Agency's flood control unit. The unit uses the levels to decide when to adjust the sluice gate.

    vi. Identify the flow direction in each channel section of the site. Which part of the site has two flow directions? Work out where any pollution to the Woodmill site might come from.

5.5 Teachers Guide to the Woodmill Site

The Woodmill site has been selected because it is an outstanding study site where many environmental features occur in close proximity and because it is the most accessible site on the River Itchen for schools in Southampton. The site is also supported by the activities of the Outdoor Activity Centre run by Southampton City Council.

1. Sand and gravel aquifers usually have a neutral pH of 6.5 to 7.5. Sands and gravels are chemically inert aquifers and therefore tend to have low concentrations of dissolved minerals unless the aquifer is still being flushed after emergence from the sea or contains mineralised water at depth. Chalk aquifers often have a higher pH of 7.5 to 8.5 and contain high concentrations of carbonate (CO_3^{2-}) and hydrogen carbonate (HCO_3^-) dissolved from the Chalk. The high residence time of Chalk groundwater means that Chalk water entering streams and springs is saturated in (CO_3^{2-}) and (HCO_3^-) which buffer the dissolved CO_2 in the water. This gives chalk water a tendency for higher pH's.

2. The site is not suitable for taking pollution based chemical measurements. However by examining the site, students can evaluate the problems that arise from the land uses surrounding each site and anticipate the problems. The most influential are storm drains from the high percentage of paved areas which will contain a broad range of pollutants including oil and salt from the roads, herbicides from road and rail systems, organic detritus, sediments and anything else which is spilt or deliberately dumped into the drain's catchment. Other sources of pollution include the continuous treated sewage discharge, accidental industrial, agricultural, road airport and rail spillages or the diffuse movement of agricultural chemicals from land to groundwater and surface waters. Contrast these results with those obtained for the Monks Brook sites. The key difference is that the Woodmill site is at the downstream end of both the River Itchen and Monks Brook catchments and will feature all the persistent accumulated pollution problems. The site is also at the tidal limit and therefore a good location for pollutants to deposit from all areas of the Solent, in particular, the major industrial sites along Southampton water.

3. The random and transect quadrant surveys should highlight the differences in diversity in habitat. Note how sterile the parkland can be, even though this is public "Green Space".

4. The resident populations of fish, birds, otters and water voles provide ample evidence of the sites importance to these animals.

5. Use the site to identify the hydraulic structures that have been constructed for the purpose of power generation, navigation, creation of fisheries and water meadows, the management of water flows and quality, flood control and enhancement of the water based recreation and riverside amenities.

6. Ask the students to assess the Woodmill site and how it might be improved. Start by assessing the amenity uses and the economic uses. It is not anticipated that the amenity and economic value of the site can be substantially improved, but the students may come up with some ingenious solutions. Any solutions must take cost into account. What are the most cost effective options? Where do the funds come from? Would the local residents be prepared to pay? Who else might pay for the improvements?

7. Introduce the students to the concepts of recreation and amenity management

8. Use this opportunity to introduce the students to species and genera. Plants, birds and fish are the most visible species. Ecology and habitat studies require detailed knowledge of individual species. Encourage the students natural interest to learn the names of plants and birds and other animals that you encounter. This is the starting point for the study of zoology and botany and some students may develop these interests into pastimes such as ornithology or pond dipping, fishing etc. Use the bird species list on pages 60-63 to help with these exercises.

6. SITE COMPARISONS

6.1 Introduction to the Data Sheets

This section contains a set of data sheets containing supporting data and information for the Woodmill site on the River Itchen and the Fleming Park and Monmouth Close sites on the Monks Brook. The sheets are intended to provide information for classroom activities either in support of site visits or for individual class based discussions on broader environmental topics contained within the sheets.

The data sheets contain information on the following topics:-
Rainfall
Run-off
River Water Quality
River Corridor Surveys
Bird Species
Conservation sites and projects
Fisheries
Waste Disposal Sites
River pollution Incidents
Flood Defence

Whereas the selected sites have several interesting features and illustrate many important aspects of the Environment Agency's work, evidence of some issues are not apparent at the chosen sites and in an attempt to redress this balance, some additional classroom exercises are included to cover these topics.

A teacher's guidance note has been included with each data sheet to provide suggestions on how each exercise might be utilised in the classroom.

CONSERVATION DESIGNATIONS APPLYING TO THE ITCHEN

River Itchen Special Area of Conservation (SAC)

- Ordnance Survey Sheet: (1:50,000) 185, 196.
- Length of River: 42km (approx)
- Date notified 1998. The designation covers bank top to bank top in each channel.
- Special Areas of Conservation (SACS) are sites that support the best examples of habitats listed in Annex I and species listed in Annex 11 of the EC Habitats and Species Directive. The purpose of SACs is to form a network of sites (the NATURA 2000 network) whose nature conservation importance is recognized at a European level. The Itchen SAC has been designated on the basis of its floating vegetation *of Ranunculus* (water crowfoots) of plain and sub-mountainous rivers. This designation has significant implications for the Agency, as the regulating body for land drainage, water abstraction, discharge and waste regulation operations, and who must review authorisation consents likely to damage the special interest of the SAC.
- The SAC designation will seek to maintain the quality and diversity of the River Itchen's characteristic features and associated habitats. The characteristic flora and fauna and overall diversity are largely dependent on features such as water chemistry, geomorphology, flow dynamics and substrate type. In these respects the River Itchen is largely typical of Chalk streams. However, elements of particular interest have been, and still are, vulnerable to change, and it must be recognised that the river we see today is the result of extensive management. Its physical chemical and biological make-up have been significantly altered through human intervention, and, in some respects, it does not resemble a "classic" Chalk stream.

Sites of Special Scientific Interest (SSSI)

- Some parts of the river and additional areas within the corridor already have SSSI status. These include, Alresford Pond, Itchen Valley (Cheriton to Kings Worthy), Itchen Valley (Winnall Moors), Itchen Valley (Winchester Meadows) and Ratlake Meadows.

Species and habitats listed in EC Habitats & Species Directive which occur in the Itchen valley.

- In addition to being a SAC for its water crowfoot habitats, the River Itchen also supports a number of Annex I habitats and Annex II species which remain of European importance despite not actually being selected to be represented in the NATURA 2000 network. A third Annex within the Directive is of significance here where Annex V lists species whose exploitation should remain compatible with their maintenance at a favourable conservation status. These habitats and species, and the Annex in which they appear, are therefore listed below.

Molinia meadows on chalk and clay. Annex I

Alkaline Fen Annex I

Atlantic salmon *(Salmo salar)* Annex II and V

Grayling *(7hymallus thymallus)* Annex V

Bullhead *(Cottus gobio)* Annex II

Sea lamprey *(Petromyzon marinus)* (occasional) Annex II

Brook lamprey *(Lampetra planeri)* Annex II

White-clawed crayfish *(A ustropotamobious pallipes)* Annex III

Southern damselfly *(Coenagrian mercuriale)* Annex II

Otter *(Lutra lutra)* Annex II

'Salmonid Fishery'.

- The whole of the Itchen is designated a salmonid fishery under the EC Freshwater Fisheries Directive (78/695/EEC). The implications of this relate to the responsibilities of several Agency Functions (e.g. Fisheries, Water Quality and Water Resources) whose duties directly effect the quality and management of salmonid habitat.

County Heritage Area and Sites of Interest for Nature Conservation (SINCs).

- The whole of the Itchen Valley has been designated one of 12 County Heritage Areas in the county. The boundary of this designation also encompasses important landscape features such as St. Catherine's Hill. The aim of this is to help conserve its special and distinctive character. Within this designation there are 5 Sites of Interest for Nature Conservation (SINCS) designated by Hampshire County Council, being Marlhill Copse and Meadow, Gaters Mill Meadow, Fair Oak School Meadow, Highbridge Meadow and Mariners Meadow.

Area of Outstanding Natural Beauty (AONB).

- The East Hampshire AONB runs approximately from the eastern side of Winchester east to the county boundary.

Hampshire Wildlife Trust Nature Reserves.

- Two reserves situated at the head waters of Monks Brook and on the northern edge of Winchester City.

Globally threatened and declining species recognised by the UKs Biodiversity Action Plan.

- Species which are globally threatened, or are rapidly declining in the UK, (by more than 50% in last 25 years), and which require immediate conservation action, are short-listed in "Biodiversity: The UK Steering Group Report", (1995). The River Itchen is important for a number of these species that are listed below. (This list is not exhaustive).

Water vole *(Arvicola terrestria)*

Pipistrelle bat *(Pipistraellus pipistraellus)*

White-clawed crayfish *(Austropotamobious pallipes)*

Southern damselfly *(Coenagrian mercuriale)*

Freshwater snail *(Pisidium tenuilineatuym)*

Species specially protected by the 1981 Wildlife & Countryside Act

- The following species occur in the Itchen valley and are given special protection by The 1981 Wildlife and Countryside Act. (i.e. birds listed in Schedule 1, and animals listed in Schedule 5).

Kingfisher *(Alcedo atthis)*

Osprey *(Pandion haliaetus)*

Hobby *(Falco subbuteo)*

Green sandpiper *(Tringa ochropus)*

Cettis warbler *(Cettia cetti)*

Bittern *(Botaurua stellaris)*

Barn owl *(Tyto alba)*

White-clawed crayfish *(Austropotamobious pallipes)*

Otter *(Lutra lutra)*

Water vole (*Arvicola terrestris*)

Table 1: River Water Quality (1995)

CLASS	Proportion of River (%)
A	56%
B	32%
C	8%
D	4%

Upstream of Eastleigh the whole of the River Itchen and the Monks Brook are within Class A. In the reaches through Eastleigh and Bishopstoke to the tidal limit at Woodmill, the water quality of the main river and its tributaries is generally designated as both Class A and Class B. Lower class values are found in the lower reaches of the small tributaries such as the Allington Lane Stream (Northwood, Southampton) an the Sholing Common Stream (East Central Southampton) and Western Common Stream (Southeast Southampton).

The present classification scheme is currently under review to include a wider range of parameters, especially biological indicators.

Table 2: Minimum Five-Month Rainfall Totals for England & Wales, 1850 - 1995

Rank	Cumulative Rainfall (mm)	Percentage of average	End month	Year
1	149	43.1	08	1995
2	155	44.8	08	1976
3	159	50.7	06	1921
4	184	58.7	06	1938
5	185	59.0	06	1929
6	186	59.3	06	1887
7	187	52.5	04	1854
8	188	57.6	07	1870
9	191	51.2	09	1959

(a) The averages are not in the same rank order because they are dependent on end dates.

Reference : Water Resources and Supply, Agenda for Action, HMSO, 1996

Table 3: Standard period average rainfall for England and Wales (mm)

Month	**1916-1950**	**1914-1970**	**1961-1990**
January	92	86	88
February	66	65	63
March	57	59	72
April	60	58	60
May	63	67	64
June	55	61	65
July	79	73	62
August	81	90	76
September	76	83	77
October	92	83	85
November	95	97	90
December	88	90	94
Annual Average	904	912	895

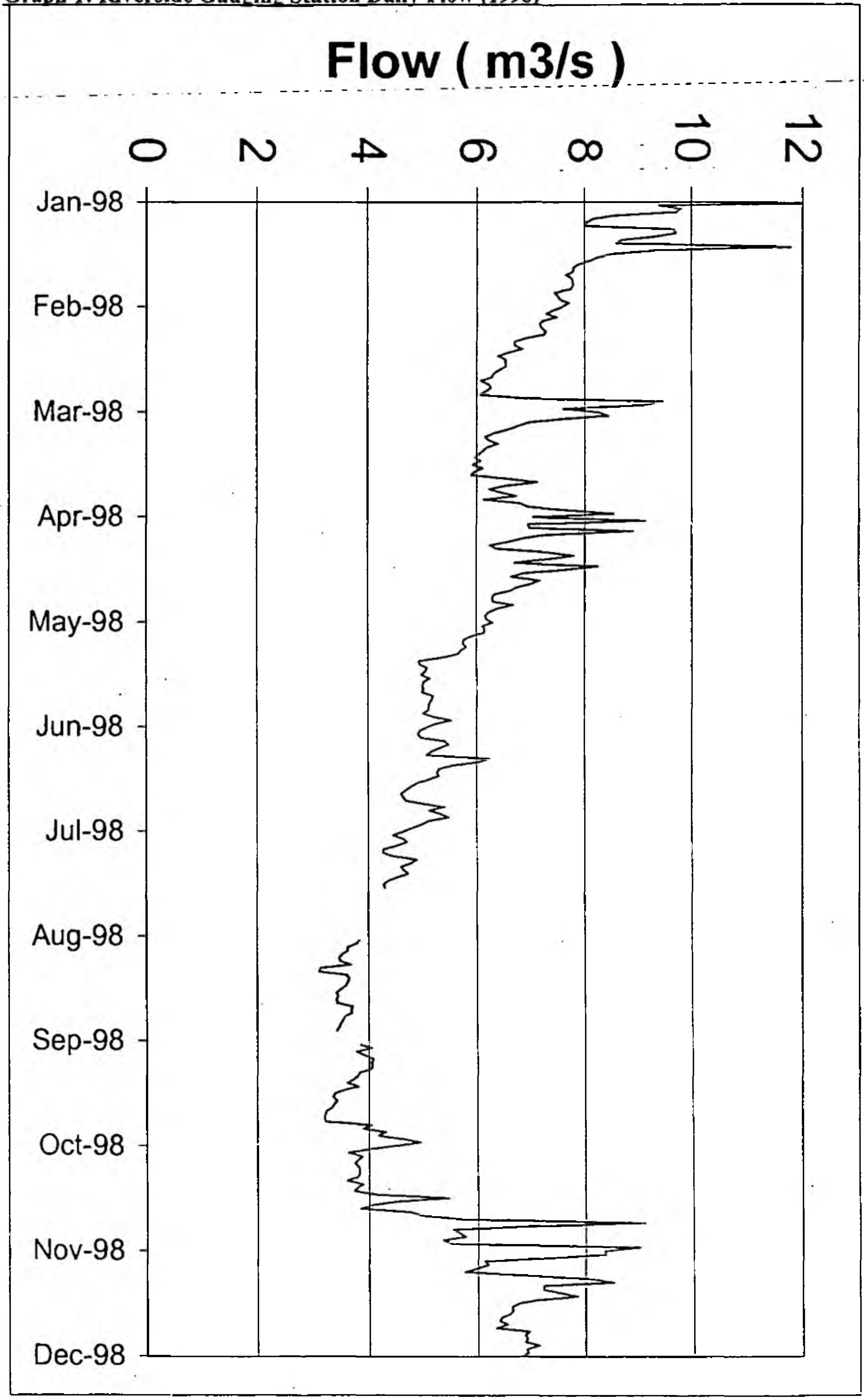
Reference : Water Resources and Supply, Agenda for Action, HMSO, 1996

Table 4: Water put into public supply in England and Wales
Annual averages in Megalitres per day (Ml/d)

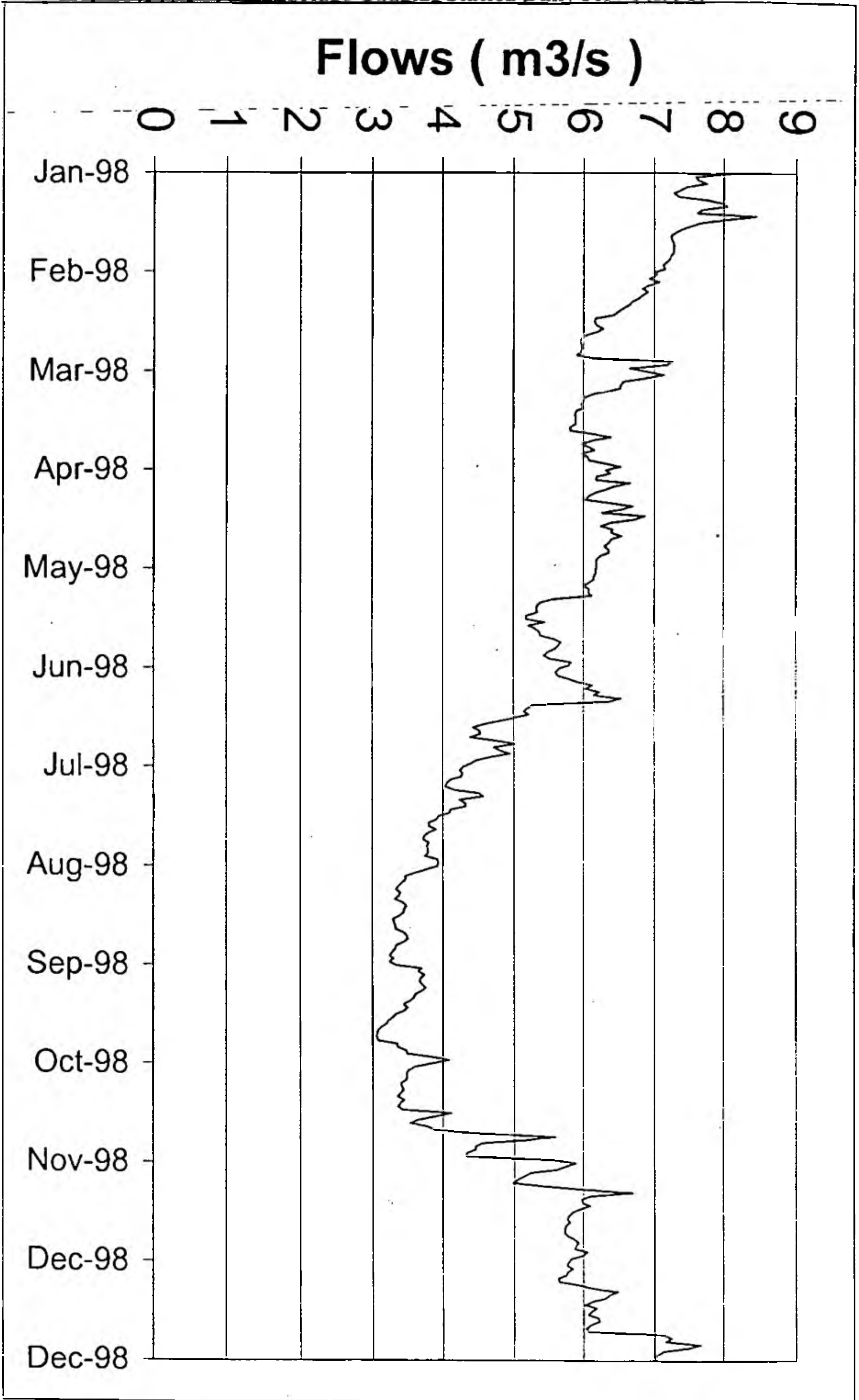
Year	Unmetered	Metered	Total
1974/75	9555	4801	14356
1975/76	9907	4668	14575
1976/77	9519	4359	13878
1977/78	9961	4211	14172
1978/79	10407	4352	14759
1979/80	10961	4490	15451
1980/81	11083	4247	15330
1981/82	11224	4029	15253
1982/83	11548	4106	15654
1983/84	11842	3996	15838
1984/85	11956	3990	15946
1985/86	12036	3965	16001
1986/87	12195	4088	16283
1987/88	122216	4059	16275
1988/89	12177	4114	16291
1989/90	12424	4135	16559
1990/91	12549	4256	16805
1991/92	12399	4258	16657
1992/93	11669	4457	16126
1993/94	11999	4034	16033
1994/95	12350	4139	16489

Reference : Water Resources and Supply, Agenda for Action, HMSO, 1996

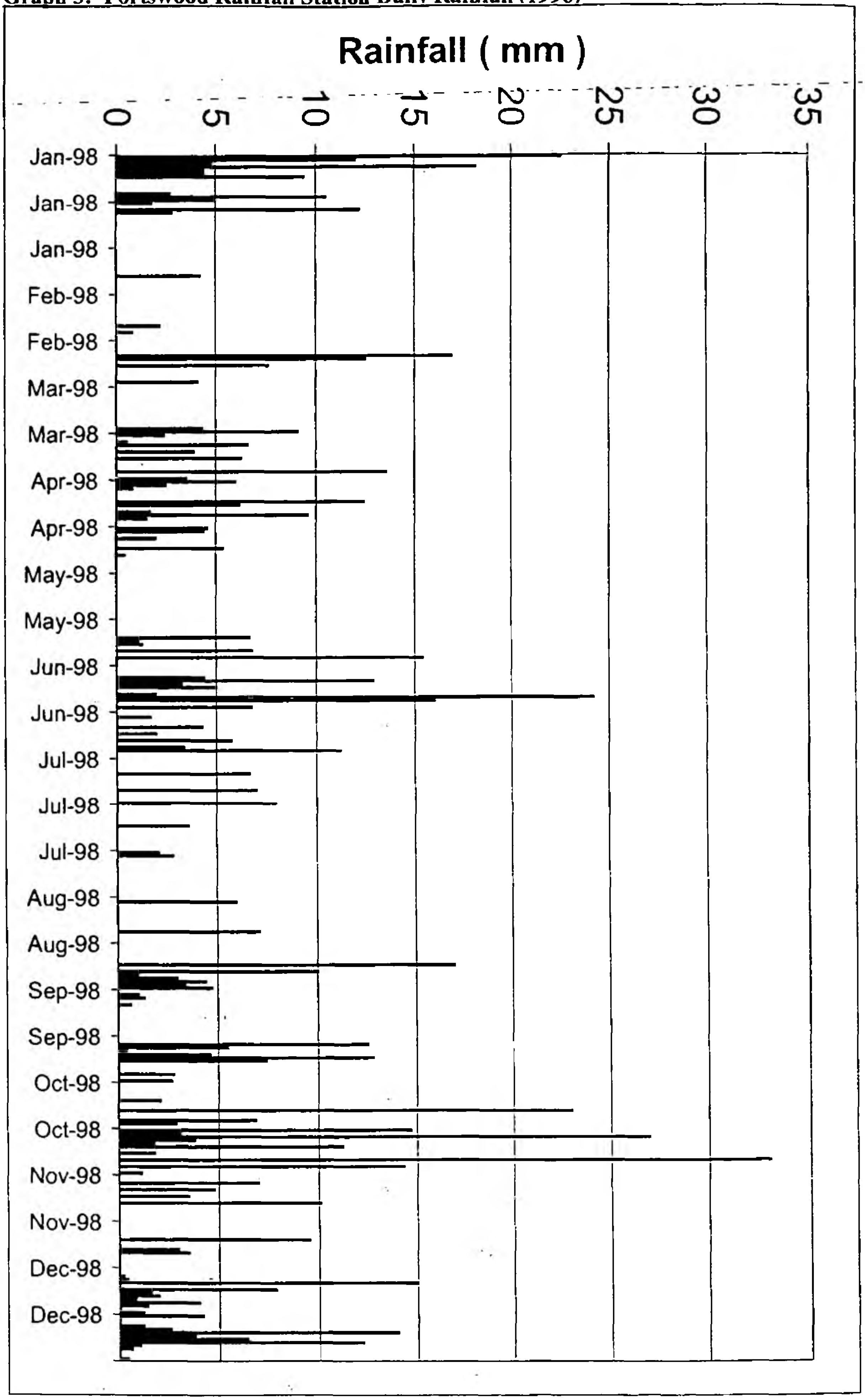
Graph 1: Riverside Gauging Station Daily Flow (1998)



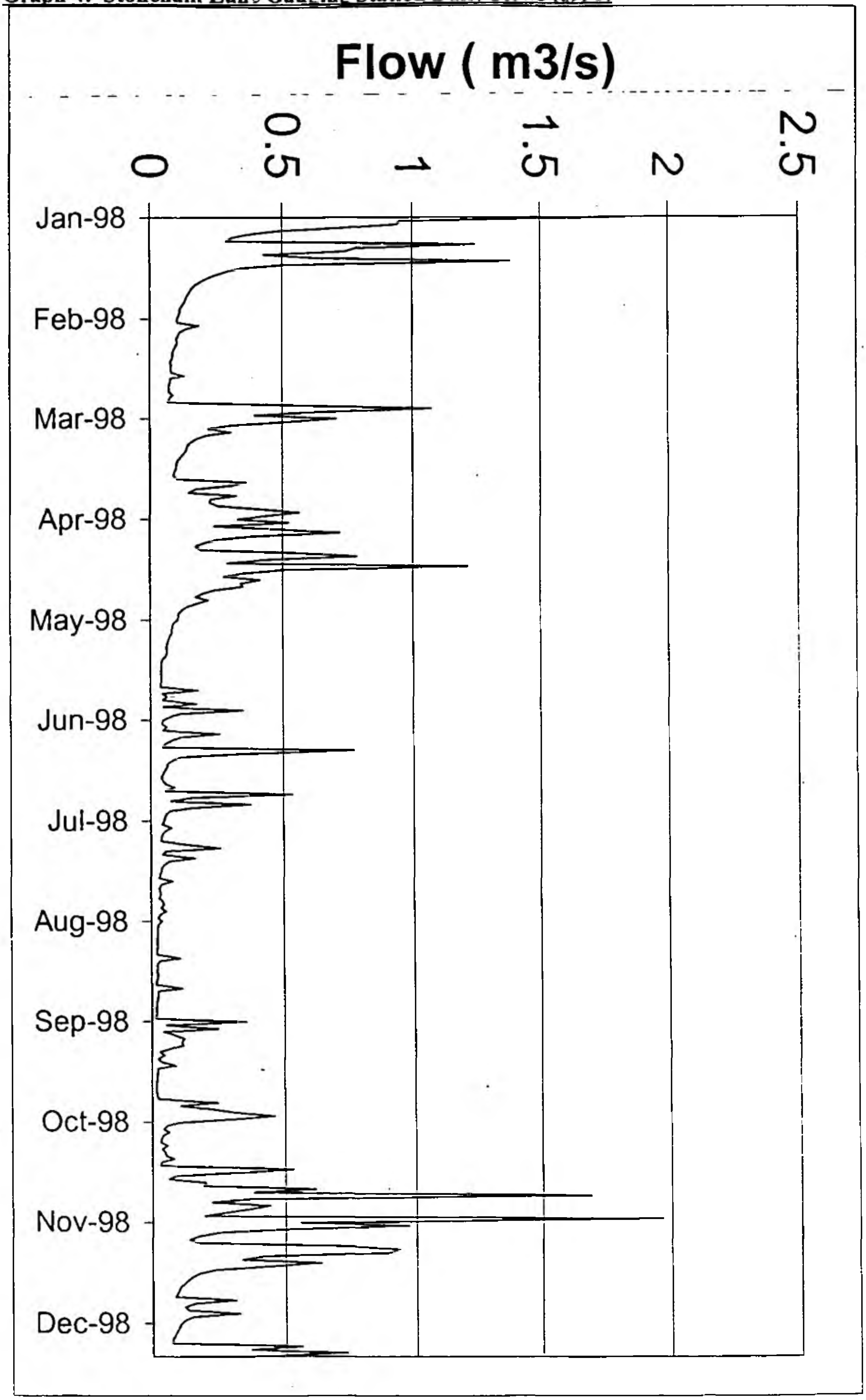
Graph 2: Allbrook and Highbridge Gauging Station Daily Flows (1998)



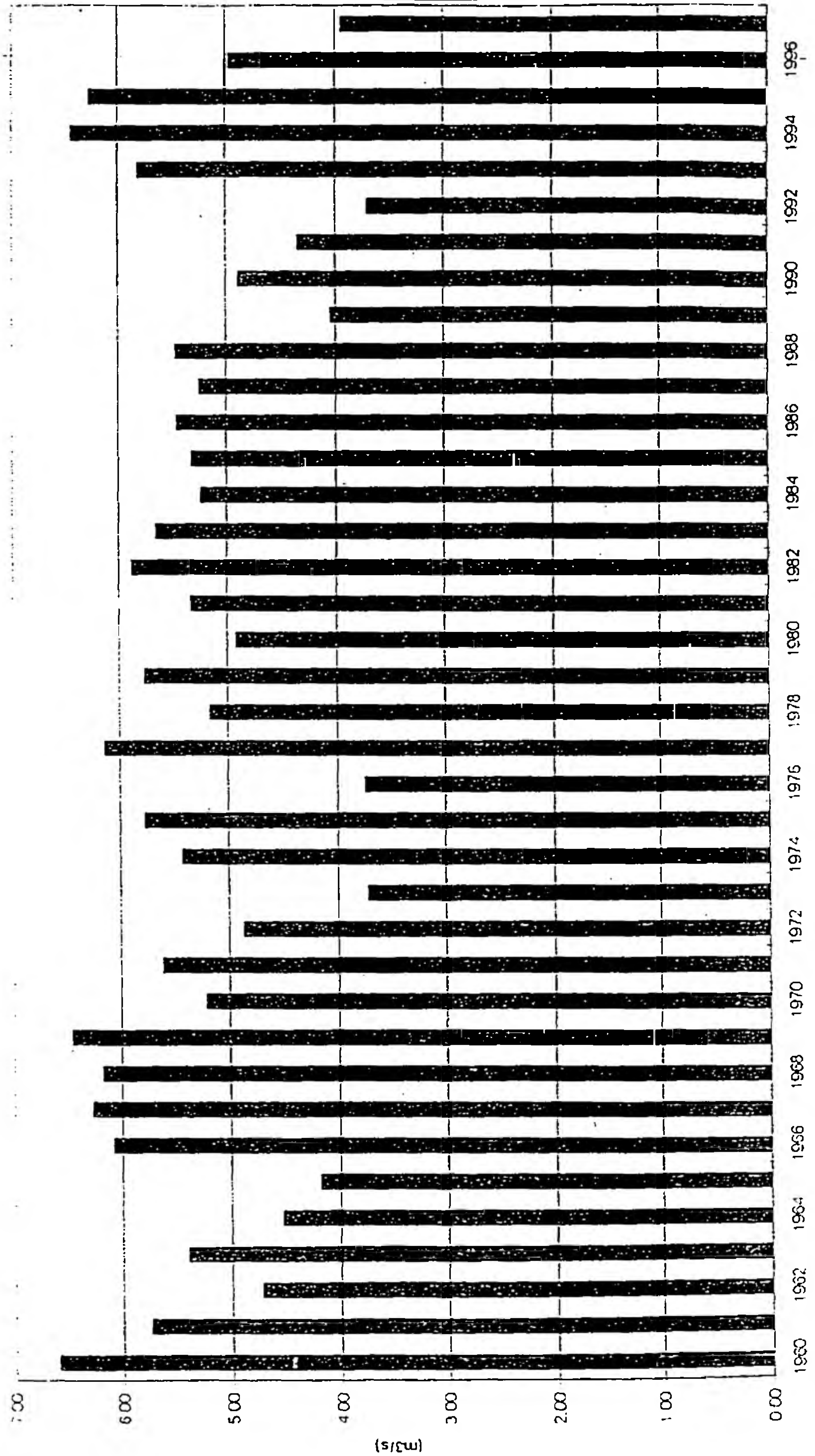
Graph 3: Portswood Rainfall Station Daily Rainfall (1998)



Graph 4: Stoneham Lane Gauging Station Daily Flows (1998)



Graph 5: Allbrook and Highbridge Annual Run-off



Graph 6: Otterbourne Rainfall Station Annual Rainfall (1960-1997)

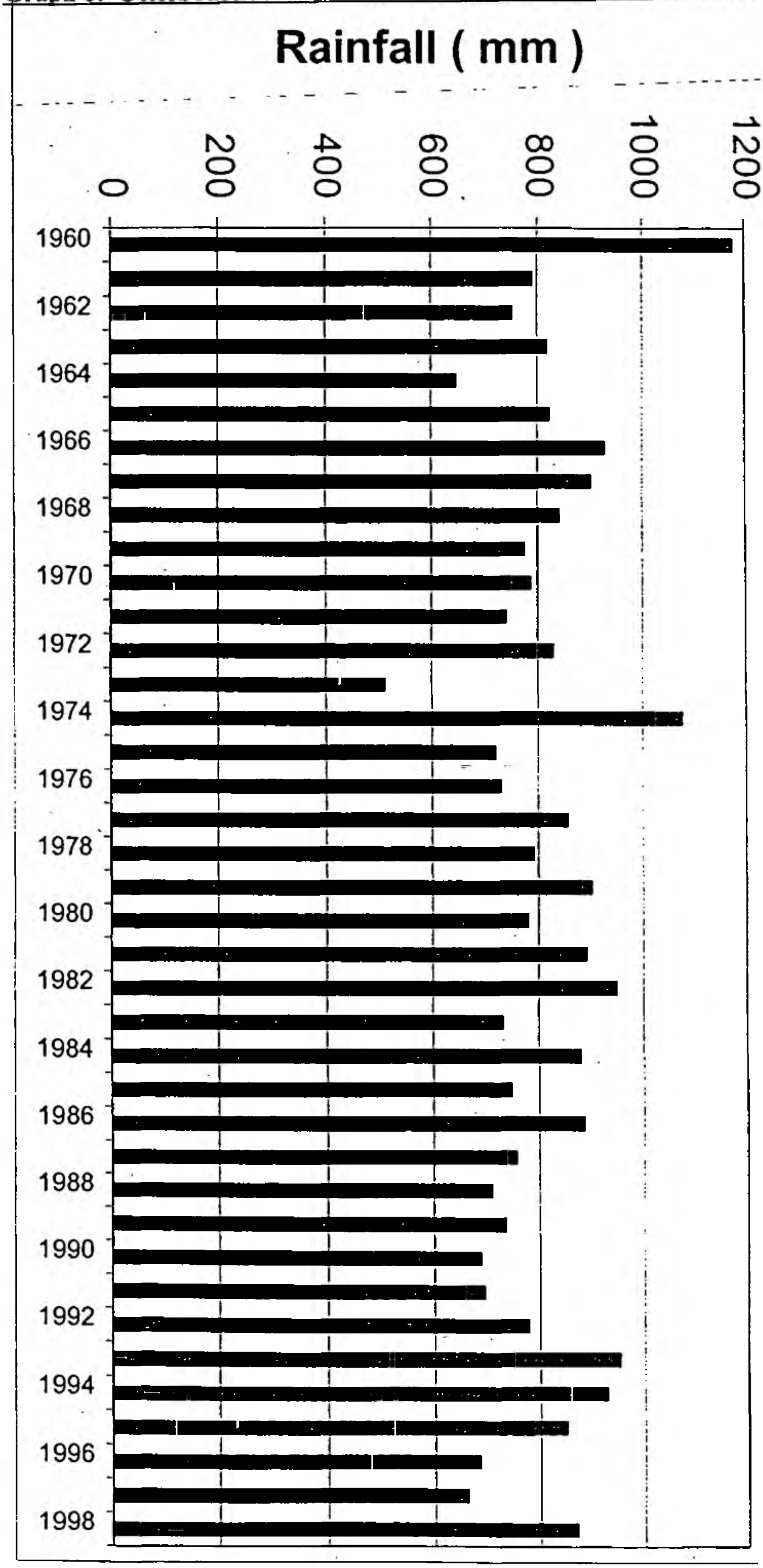


Table 5: Inorganic Water Mineral Chemistry Information

Determinand	Symbol	Typical Chalk Groundwater	Mol. Weight	Typical Sources
Anions :				
Carbonate	CO_3^{2-}	30 mg/l	60	Limestone rocks such as the Chalk. Some carbonate derived from solution of CO_2 gas in falling rain droplets.
Hydrogen Carbonate	HCO_3^-	268 mg/l	61	
Sulphate ion	SO_4^{2-}	34 mg/l	96.1	Often present in marine clays or clays derived from igneous rocks. High concentrations in the Gault Clay
Chloride ion	Cl^-	72 mg/l	35.5	Typical of sea water. Present in river water from tidal mixing but also low concentrations derived from aquifers.
Cations:				
Calcium	Ca^{2+}	52 mg/l	40	Limestone rocks such as the Chalk. Mg^{2+} higher in dolomite limestones
Magnesium	Mg^{2+}	10 mg/l	24.3	
Potasium	K^+	5 mg/l	39.1	In natural environment derived from micaceous clays. Also from road salt.
Sodium	Na^+	80 mg/l	14	Typical of sea water but also derived from road salt. Present in river water from road run-off, tidal mixing. Low concentrations derived from aquifers.
Ferric ion	Fe^{2+}	0.07 mg/l	55.8	Typical of sandstones such as the lower greensand. Fe^{2+} is very soluble, Fe^{3+} mostly insoluble. Fe^{2+}converts to Fe^{3+} when oxygen available.
Ferrous ion	Fe^{3+}	Mostly insoluble	55.8	
Manganese	Mn	0.003 mg/l	54.9	Typical of igneous rock areas, but also from human activity.

Table 6: Water Chemistry Information related to Human Activity

Information on some inorganic determinands linked to human activity :

Determinand	Symbol	Typical Chalk Groundwater	Mol. Weight	Typical Sources
Nitrate	NO_3^-	< 1 mg/l	62	NO_3^- applied as fertiliser on fields whilst NH_3 derived from breakdown of plants and leaf litter and from sewage treatment effluent.
Ammonia	NH_3	Very low	17	

Information on some organic determinands linked to human activity:

Determinand	**Detectable Limit (ng/l)**	**Likely Source**
Benzo-a-pyrene	About 1 ng/l	Polyaromatic hydrocarbons found in coal tar, oils and bitumen. Likely to come from road surface run-off.
Flouranthene	About 1 ng/l	Polyaromatic hydrocarbons found in coal tar, oils and bitumen. Likely to come from road surface run-off.
PCB	About 1 ng/l	One of several polychlorinated bi-phenyls used up to the 1970s in electrical equipment. Typical former use as electrical transformer coolant
2Tributyl tin	1 ng/l	Anti-foul paint compound used on boat hulls to prevent weed and barnacle growth.
DDT	About 1 ng/l	Very persistant insecticide used worldwide until the late 1960s
Atrazine	About 2 ng/l	Herbicide widely used by municipal authorities for weed control. Widespread former use on rail tracks to kill weeds.
Simazine	2 ng/l	Herbicide widely used by municipal authorities for weed control. Widespread former use on rail tracks to kill weeds.
1,2,3 trichloroethane	2 ng/l	Degreasing metal cleaning solvent used in manufacturing and industrial processes.

Table 7: Sample Summary data from Gaters Mill between 1 Jan 97 and 1 Jan 98

Table 7a: Physical Chemistry Determinands

Determinand	Unit	Max.	Min.	Mean	Sample Count	<'s	Date of Max.
General :							
Temperature	°C	18.2	3.8	9.7	25	0	14-8-97
Conductivity	µS/cm	548	480	526	25	0	9-1-97
PH (lab)	Ph	8.4	8.1	8.2	24	0	28-1-97
PH (field)	units	8.6	7.9	8.3	10	0	4-12-97
Turbidity	FTU	10	1.8	4.6	11	0	9-1-97
Suspended Solids	mg/l	28	3.5	13.2	25	0	12-2-97
Colour	Hazen	13	< l.d.	n.d.	24	12	12-2-97

Table 7b: Oxygen Chemistry Determinands

Determinand	Unit	Max.	Min.	Mean	Sample Count	<'s	Date of Max.
Oxygen (sol)	%	114	81	96	25	0	14-4-97
BOD ATU	mg/l	2.6	1.3	2.0	24	0	5-3-97
COD as O	mg/l	16.2	< l.d.	n.d.	11	7	19-6-98
Organic C	mg/l	3.6	1.2	1.9	24	0	12-2-97

Table 7c: Major Ion Chemistry Determinands

Determinand	Unit	Potable Limit (E.U.)	Max.	Min.	Mean	Sample Count	<'s
Ca^{2+}	mg/l	200	115	93	107	25	0
Mg^{2+}	mg/l	50	2.9	2.2	2.4	25	0
Na^{+}	mg/l	150	18	13	16	11	0
K^{+}	mg/l	12	3.3	2.1	2.6	11	0
Tot.Hardness	mg/l	No p.l.	298	244	278	24	0
Alkalinity	mg/l	No p.l.	254	160	234	24	0
SO_4^{2-}	mg/l	200	25.0	14.0	17.2	11	0
Cl^{-}	mg/l	250	28.0	20.9	24.5	24	0
NO_3^{-}	mg/l	50	6.7	4.3	5.8	24	0
NO_2^{-}	mg/l	0.03	0.1	0.04	0.06	24	0
Total N	mg/l	11.3	6.8	4.4	5.8	24	0

Table 7: Sample Summary data from Gaters Mill between 1 Jan 97 and 1 Jan 98								
Determinand	Unit	Potable Limit (E.U.)	Max.	Min.	Mean	Sample Count	<'s	Limit of detection (l.d.)
Table 7d: Minor Chemistry Inorganic Determinands :								
Pb (aq.)	μg/l	50	< l.d	< l.d.	n.d.	11	11	.2
Total Pb	μg/l	50	5	< l.d.	n.d.	11	9	.2
Hg (aq)	μg/l	1	.05	< l.d.	n.d.	11	10	.01
Total Hg	μg/l	1	.08	< l.d.	n.d.	11	9	.01
Cd (aq.)	μg/l	5	< l.d.	< l.d.	n.d.	11	9	.1
Total Cd	μg/l	5	.2	< l.d.	n.d.	11	9	.1
Total B	mg/l	2	< l.d.	< l.d.	n.d.	11	11	.1
Total V	mg/l	None	< l.d.	< l.d.	n.d.	11	11	.002
Total Mn	mg/l	0.05	.017	< l.d.	n.d.	11	5	.01
Total Ag	μg/l	10	< l.d.	< l.d.	n.d.	11	11	1
Total As	μg/l	50	4.5	< l.d.	n.d.	11	10	1
Total Se	μg/l	10	< l.d.	< l.d.	n.d.	11	11	1
Total Ba	μg/l	500	21	16	17	11	0	1
Total Cu	μg/l	500	19	1.9	46	14	0	1
Total Zn	μg/l	300	68	4	14	14	0	1
Total Ni	μg/l	50	33	3	8.5	10	0	1
o-Phosphate	mg/l	5 (.2)	.53	.27	.37	24	0	0.01
Table 7e: Minor Chemistry Organic Determinands :								
Benzo-a-pyrene	ng/l	10	18.2	1.1	4.6	11	0	~ 1 ng/l
Detergents	mg/l	0.2	< l.d.	< l.d.	n.d.	11	11	.05
Hydrocarbon	mg/l	0.01	.24	< l.d.	n.d.	11	10	.06
Flouranthene	μg/l	n.d.	25	6	n.d.	11	6	6
PCBs	μg/l	n.d.	< l.d.	< l.d.	n.d.	14	14	~ 10 ng/l
Tributyl tin	μg/l	n.d.	< l.d.	< l.d.	n.d.	2	2	About 100 ng/l
DDT	ng/l	100	< l.d.	< l.d.	n.d.	11	11	~ 10 ng/l
Atrazine	ng/l	100	31.9	< l.d.	n.d.	11	10	~ 10 ng/l
Simazine	ng/l	100	.14	< l.d.	n.d.	11	10	~ 5 ng/l
1,2,3, tri-chloroethane	μg/l	30	< l.d.	< l.d.	n.d.	11	11	~ 10 ng/l
Polycyclic aromatic HC	ng/l	200	88.5	17.8	32.4	11	0	~ 1 ng/l
Trichloro-methane	μg/l	3	.3	< l.d.	n.d.	11	10	About 100 ng/l
Tetrachloro-ethene	μg/l	10	< l.d.	< l.d.	n.d.	11	11	About 100 ng/l

Figures in brackets denote river water quality limits where they exceed potable limits.

Graph 7: Preston Candover Groundwater levels (1975-98)

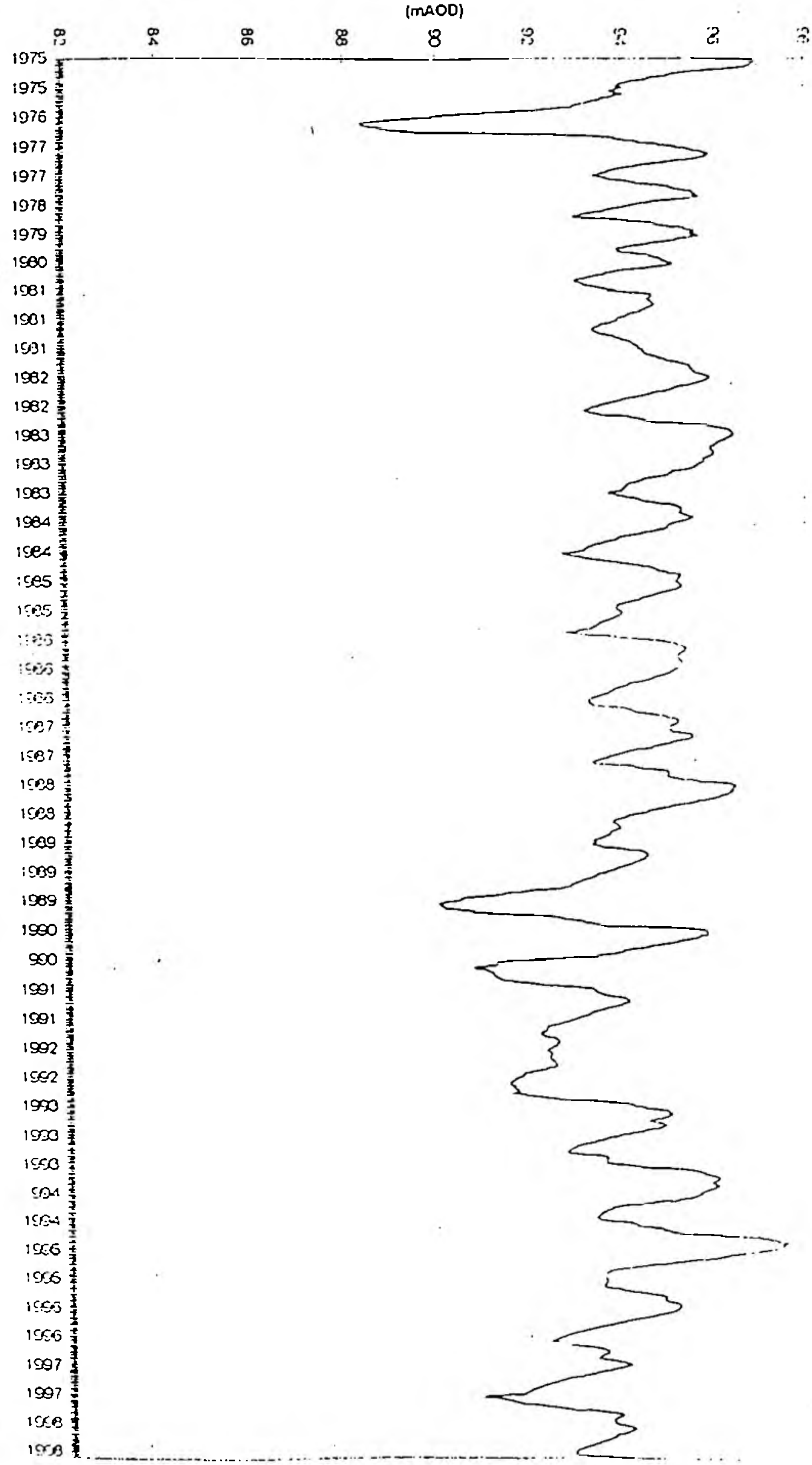


Table 8: Monk's Brook Rainfall and Run-off (1988 - 1997)

Year	Portswood STW Annual Rainfall (mm)	Stoneham Lane GS (49 km^2) Annual Runoff (m^3/s)	Stoneham Lane GS (49 km^2) Annual Runoff (mm)	Catchment Annual Runoff/ Rainfall (%)
1988	675.6	0.206	132.7	19.6
1989	671.0	0.170	109.5	16.3
1990	696.5	0.196	126.2	18.1
1991	692.0	0.148	95.3	13.8
1992	755.0	0.155	99.8	13.2
1993	968.9	0.302	194.5	20.0
1994	934.2	0.325	209.3	22.4
1995	856.0	0.309	199.0	23.2
1996	657.1	0.208	134.0	20.4
1997	515.5	0.175	112.7	21.8

Table 9: River Itchen Rainfall and Run-off (1988 - 1997)

Year	Otterbourne STW Annual Rainfall (mm)	Allbrook & Highbridge GS ($320\ km^2$) Annual Runoff (m^3/s)	Allbrook & Highbridge GS ($320\ km^2$) Annual Runoff (mm)	Catchment Annual Runoff/ Rainfall (%)
1988	710.6	5.47	539.4	75.9
1989	736.8	4.04	398.4	54.1
1990	692.5	4.88	481.3	69.5
1991	695.5	4.33	427.0	61.4
1992	779.9	3.70	364.9	46.8
1993	969.0	5.81	573.0	59.1
1994	920.8	6.43	634.1	68.9
1995	850.9	6.26	617.3	72.5
1996	685.7	4.96	489.1	71.3
1997	730.0	3.94	388.6	53.2

Table 12: Household Water Use in England & Wales

Year	Per capita consumption (litres/head/day)
1961	85
1971	108
1981	123
1991	140

Reference : Water Resources and Supply, Agenda for Action, HMSO, 1996

Table 13: List of Aquatic Birds and Environment Information

No.	Bird Name	Group & Diet	Habitat & aquatic association
1	Heron	Herons: Aquatic animals e.g. Fish, frogs and crustaceans	Resident. Common. Seen on lakes, seashores, lagoons, rivers and wetlands.
2	Bittern		Resident. Elusive. Favours and hides in reed beds. Most active at night
3	Little Egret		Rare summer visitor from Brittany. Favours salt & aquatic marshes
4	Mute Swan	Swans: Grass and river bed vegetation	Resident. Common. Nests on rivers, lakes and ponds
5	Bewick's or Whooper Swans		Winter Visitors. Not common. On large rivers and sheltered bays in winter
6	Canada Goose	Geese: Feed on grain, vegetation and grass in fields	Resident. Often seen in aquatic habitats but also in fields & non aquatic habitats
7	Greylag Goose		Winter visitor. Prefers salt & freshwater marshes, pastures and stubble fields.
8	Brent Goose		Winter visitor. Favours seashores and coastal bays.
9	Mallard	Surface Feeding ducks: Up ending and dabbling to sieve pond life	Resident. Common on rivers
10	Gadwall		Winter visitor. Uncommon. Found on lakes and rivers but rarely in salt water.
11	Pintail		Resident or winter visitor. Common. Found on lakes, ponds and bays
12	Wigeon		Common winter visitor on lakes, lagoons and bays. Often grazes on land
13	Teal		Common resident. Ponds, lakes, bogs and marshes. Prefers fresh water
14	Garganey		Summer visitor. Not commn. Lakes and flooded meadows with rich shore plants
15	Shoveler		Common resident. Found on ponds and flooded marshes
16	Shelduck		Common on coastal flats and estuaries. During winter also on inland wetlands
17	Great Crested Grebe	Grebes. Feed on small aquatic animals	Resident. Common on lakes and bays with reed cover
18	Little Grebe		Resident. Common on lakes and rivers with dense vegetation.
19	Scaup	Bay ducks: Dive and swim underwater to feed	Winter visitor along coasts. Often in deeper water
20	Tufted Duck		Common resident. Favours lakes, bays estuarys and seashores
21	Pochard		Common resident. Favours lakes, bays, estuarys and seashores.
22	Goldeneye		Winter visitor. Good diver and favours deeper water of coasts, rivers and lakes.

Table 13: List of Aquatic Birds and Environment Information (cont)

No.	Bird Name	Group & Diet	Habitat & aquatic association
23	Smew	Mergensers: Fish-eating diving ducks	Winter visitor. Locally common. Favours lakes and rivers with trees
24	Red-breasted mergenser		Common winter visitor. Favours fresh and saltwater shorelines
25	Goosander		Common winter visitor on lakes and rivers with wooded shores
26	Water rail	Rails and crakes: Aquatic animals	Common resident. Favours swamps and ponds in dense vegetation. Secretive
27	Spotted Crake		Summer visitor. Favours swamps and ponds in dense vegetation. Secretive
28	Moorhen	Moorhen Aquatic animals	Common resident. Favours ponds, lakes and rivers with shore vegetation.
29	Coot	Coot : Eggs and aquatic animals	Common resident. Favours ponds, lakes and rivers with shore vegetation.
30	Wading Birds	Worms, shellfish crustaceans and insects	See list of resident wading bird habitats
31	Swift	Swallows and Swifts :	Drink from water on the wing and to make mud for nests
32	Swallow		Drink from water on the wing and to make mud for nests
33	House Martin		Drink from water on the wing and to make mud for nests
34	Sandmartin	Insects taken on the wing	Common along river banks and gravel pits. Often seen near water
35	Kingfisher	Small fish	Fairly common resident along streams and ponds well stocked with fish
36	Grey wagtail	Wagtails : Insects	Common resident alongside water in streams, sewage farms and even towns
37	White wagtail		Common resident in towns and open country, often alongside water
38	Dipper	Aquatic animals and insects	Fairly common resident favours fast flowing streams and shores in winter
39	Sedge Warbler	Warblers: Favour and nest in aquatic reed beds. Eat insects	Common summer visitor in reed beds, swamps and dense vegetation.
40	Marsh Warbler		Common summer visitor in dense, low shrubbery in swamps and wetlands
41	Reed Warbler		Very common summer visitor in reed beds and other water edges.
42	Reed Bunting	Buntings Eat seeds	Common resident in and near reed beds in water
43	Marsh Harrier	Birds of prey	Common resident. Nests in large dense reed beds and hunts over wetlands.
44	Hen Harrier	Prey on aquatic animals that live in reed beds and wetlands.	Common winter visitor. Hunts over marshes and swamps and open land
45	Montagu's Harrier		Summer visitor found in marshes, moors and heaths.

Table 14: List of habitats favoured by native Shore Birds

Habitat	In Breeding Season	Outside Breeding Season
Open Sea		Grey Phalarope
		Red-necked Phalarope
Sandy Beaches	Kentish Plover	Oystercatcher
		Ringed Plover
		Kentish Plover
		Grey Plover
		Knot
		Sanderling
		Common Sandpiper
Stoney or rocky Beaches	Lapwing	Turnstone
	Oystercatcher	Purple Sandpiper
	Ringed Plover	Common Sandpiper
	Turnstone	Redshank (Locally)
	Grey Phalarope	
Marshes with Mud-flats	Lapwing	Golden Plover
	Dunlin	Lapwing
	Redshank	Temnick's Stint
	MarshSandpiper	Little Stint
	Terek Sandpiper	Dunlin
	Black-tailed Godwit	Curlew Sandpiper
	Curlew	Redshank
	Snipe	Marsh Sandpiper
	Great Snipe	Broad billed Sandpiper
	Black-winged Stilt	Greenshank
	Avocet	Green Sandpiper
	Pratincole	Wood Sandpiper
		Common Sandpiper
		Black tailed Godwit
		Snipe
		Jack Snipe
		Black winged Stilt
Inland fields	Little ringed Plover	Dotteral
	Lapwing	Golden Plover
	Stone Curlew	Lapwing
		Curlew
		Whimbrel
		Great Snipe
		Stone Curlew

Table 14: List of habitats favoured by native Shore Birds (cont)

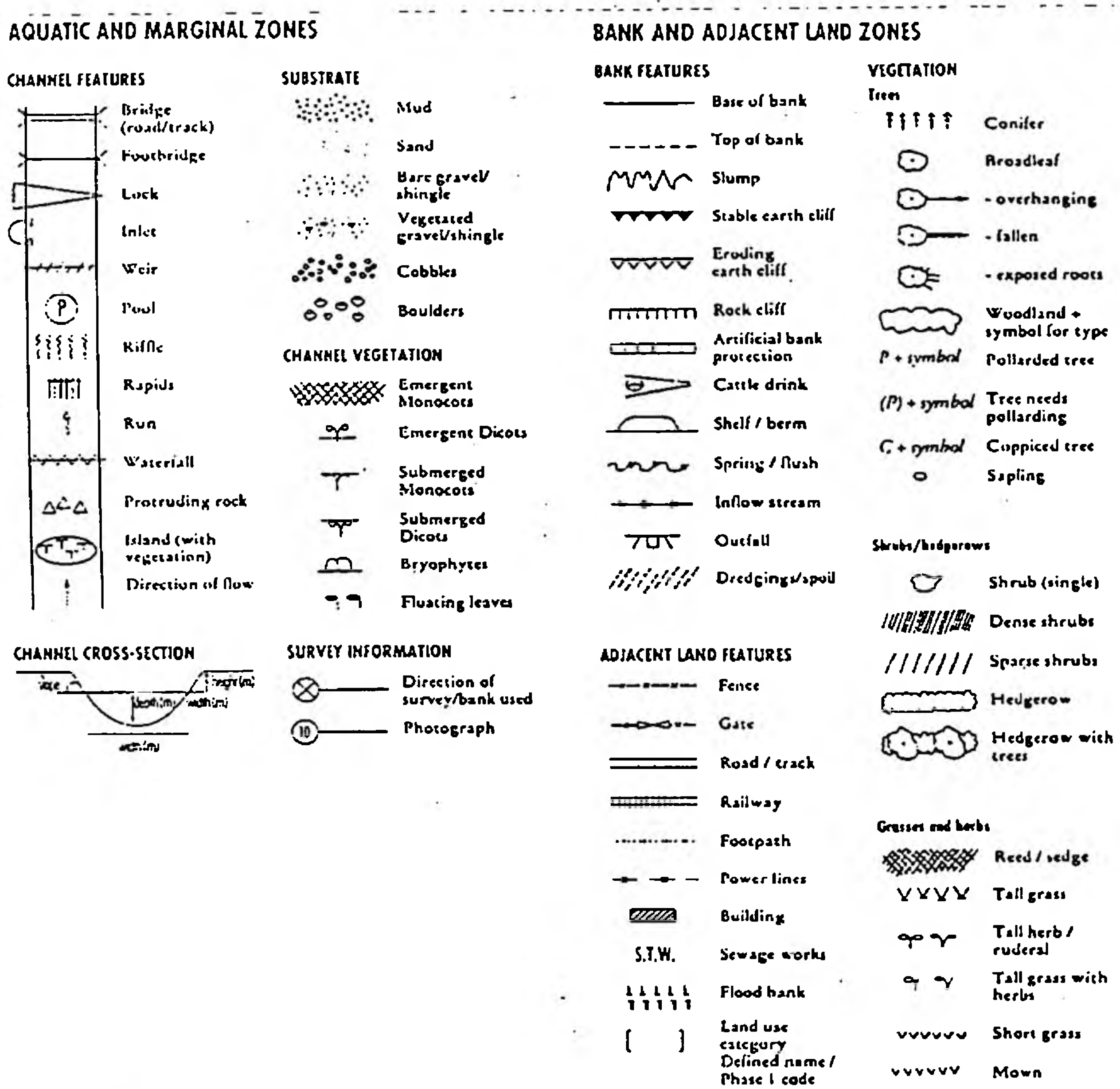
Habitat	**In Breeding Season**	**Outside Breeding Season**
Along lakes and rivers	Common Sandpiper	
Upland Moors and Tundra for breeding season column *Coastal mud-flats for non-breeding season column*	Oystercatcher	Oystercatcher
	Dotterel	Ringed Plover
	Golden Plover	Golden Plover
	Grey Plover	Grey Plover
	Lapwing	Lapwing
	Dunlin	Dunlin
	Temnick's Stint	Little Ringed Plover
	Little Stint	Little Stint
	Purple Sandpiper	Kentish Plover
	Knot	Knot
	Sanderling	Curlew Sandpiper
	Broad-billed Sandpiper	Broad-billed Sandpiper
	Greenshank	Greenshank
	Wood Sandpiper	Redshank
	Bar-tailed Godwit	Bar-tailed Godwit
	Curlew	Curlew
	Whimbrel	Whimbrel
	Grey Phalarope	Spotted Redshank
	Red necked Phalarope	Common Sandpiper
		Terek Sandpiper
		Avocet
Marshes and bogs in woods and forests	Common Sandpiper	
	Spotted Redshank	
	Greenshank	
	Wood Sandpiper	
	Terek Sandpiper	

Reference:

The Hamlyn Guide to Birds of Britain and Europe, by Bertel Braun
Published by the Hamlyn Publishing group. 1974

For field identification information, see Hamlyn Guide or similar Guide also from Collins and available in most large bookshops

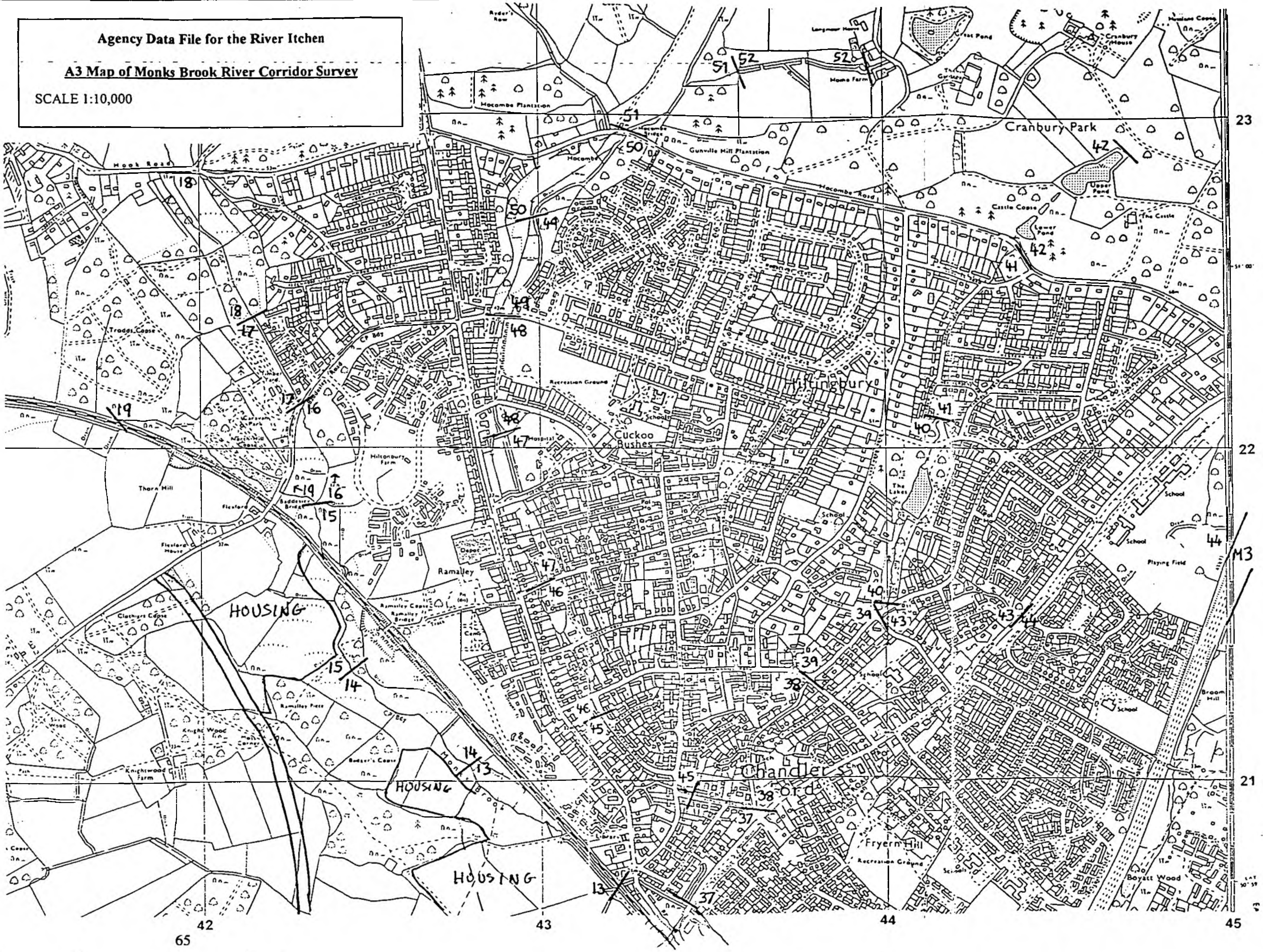
Table 15: Standard Symbols used in River Corridor Surveys



Agency Data File for the River Itchen

A3 Map of Monks Brook River Corridor Survey

SCALE 1:10,000



MONKS BROOK RIVER CORRIDOR SURVEY 1996

Section 15
SU423218 (upper Flexford NR) to SU424213 (lower Flexford NR)

Date of survey: 31.7.96 Photos: 45, 46

Survey conditions
Weather: Warm, cloudy, recent rain. Water level: Low.

Description
A continuation of section 16 beyond the confluence with section 19. The start of the section has a well-developed series of meanders, with some riffle sections. It then follows a straightened course alongside a railway line, before passing through a tunnel under the railway to continue as a gently winding channel. Some more prominent shoals and riffles occur just beyond the railway.

Before the railway line, the stream is flanked by tall, mature alder woodland, with wet unimproved meadows on both sides. After the railway the left bank is adjacent to woodland and the right bank to houses.

Management
The section runs through Flexford Nature Reserve, and is managed by Hampshire Wildlife Trust. The area is designated as a Countryside Heritage Site and proposed SINC. The meadows are grazed by cattle. No management would be required along the channel or adjacent alder woodland. The current management appears to be satisfactory.

Species list

<u>Trees & shrubs</u>
Alnus glutinosa A
Corylus avellana
Fraxinus excelsior
Hedera helix
Ilex aquifolium
Quercus robur
Rosa arvensis
Rubus fruticosus
Salix cinerea

<u>Herbs, ferns & horsetails</u>
Athyrium filix-femina A
Circaea lutetiana
Dryopteris filix-mas
Geranium robertianum
Mercurialis perennis
Oenanthe crocata R
Urtica dioica

<u>Grasses, rushes & sedges</u>
Brachypodium sylvaticum
Carex pendula O
Carex remota

MONKS BROOK RIVER CORRIDOR SURVEY 1996

Species list (Section 16 in upper Flexford Nature Reserve, including part of sections 15 and 19)

Trees & shrubs

Alnus glutinosa	A/D
Betula pubescens	R
Corylus avellana	
Fraxinus excelsior	
Hedera helix	
Ilex aquifolium	
Ligustrum vulgare	
Prunus spinosa	
Prunus spinosa	
Quercus robur	
Ribes rubrum	
Rosa arvensis	
Rubus fruticosus	
Salix cinerea	
Taxus baccata	R
Viburnum opulus	

Herbs, ferns & horsetails

Allium ursinum	
Apium nodiflorum	R
Athyrium filix-femina	
Chrysosplenium oppositifolium	LA
Circaea lutetiana	
Cirsium palustre	
Filipendula ulmaria	
Geum urbanum	
Iris pseudacorus	
Oenanthe crocata	
Polygonatum multiflorum	
Ranunculus repens	
Scrophularia auriculata	R
Senecio aquaticus	R
Stachys palustris	
Urtica dioica	

Grasses, rushes & sedges

Brachypodium sylvaticum
Carex acutiformis
Carex pendula
Carex remota
Deschampsia cespitosa
Juncus effusus

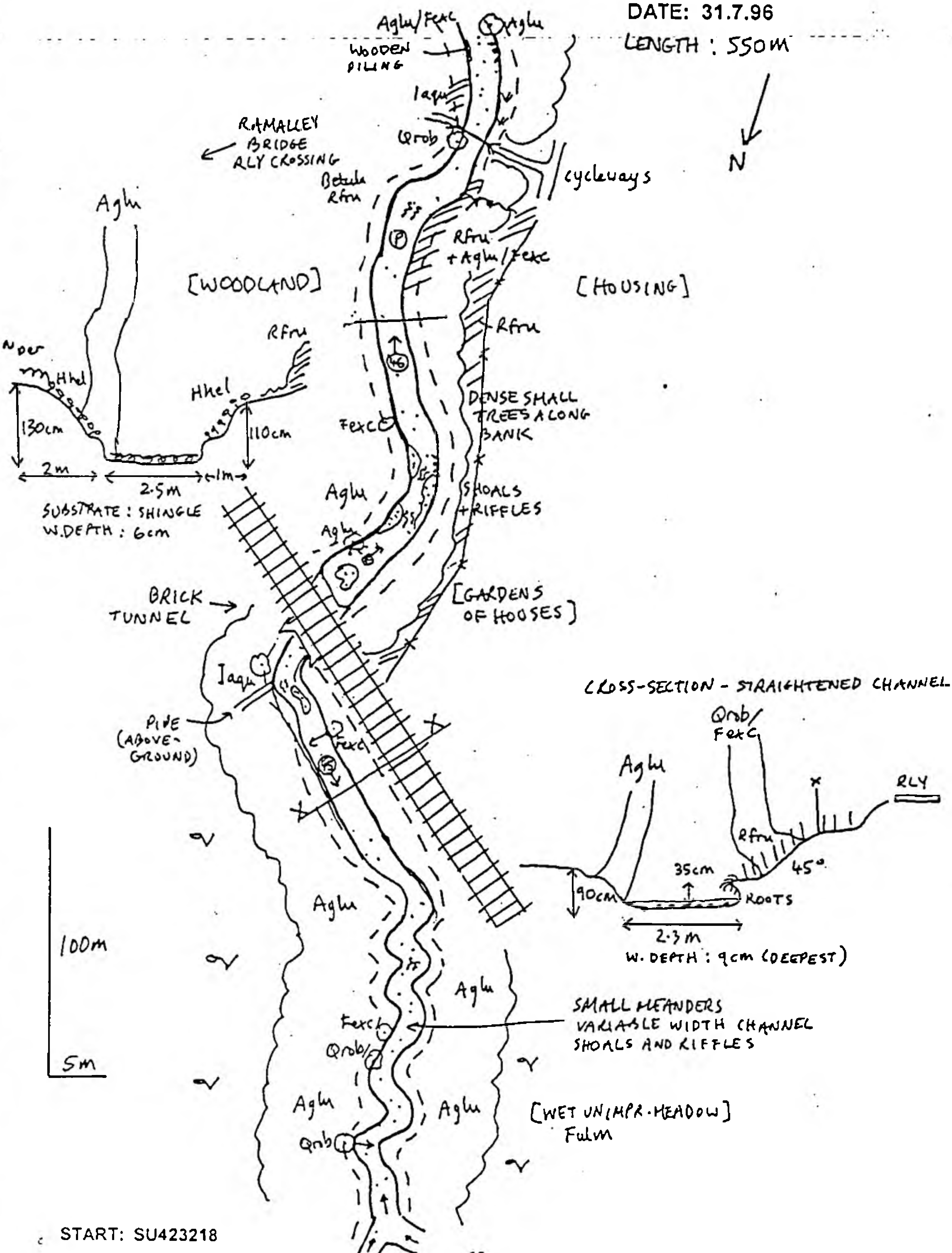
MONKS BROOK: 15

END: SU424213

SURVEYOR: J NORTON

DATE: 31.7.96

LENGTH : 550M



START: SU423218

MONKS BROOK RIVER CORRIDOR SURVEY 1996

Section 14
SU424213 (lower Flexford NR) to SU428210 (Shannon Way)

Date of survey: 31.7.96 Photo: 47

Survey conditions
Weather: Warm, cloudy, recent rain. Water level: Low.

Description
The stream continues from section 15 as a fairly broad (2-3m wide) and shallow (1-1.5m deep) channel with gravel/shingle substrate. It has some small kinks and a relatively large looping bend with shoals. Some portions were quite deep and have been marked as pools. A small weir, built of stones had been constructed.

The stream is flanked by alder, oak and hazel woodland and partly by dense blackthorn scrub on the right bank. Beyond this is mown amenity grassland and pavement/cycleway. The railway is adjacent to the left bank, with some unimproved grassland between.

Management
The left bank is adjacent to Hampshire Wildlife Trust's Flexford Nature Reserve. The grassland areas are managed by grazing. Little or no management would be required along the stream channel or adjacent alder woodland. The current management is satisfactory.

Species list

Trees & shrubs
Alnus glutinosa
Corylus avellana
Crataegus monogyna
Fraxinus excelsior
Hedera helix
Ilex aquifolium
Prunus spinosa
Quercus robur
Rosa arvensis
Rubus fruticosus

Herbs, ferns & horsetails
Athyrium filix-femina
Circaea lutetiana
Dryopteris filix-mas
Geum urbanum
Urtica dioica

Grasses, rushes & sedges
Brachypodium sylvaticum
Carex pendula
Carex remota

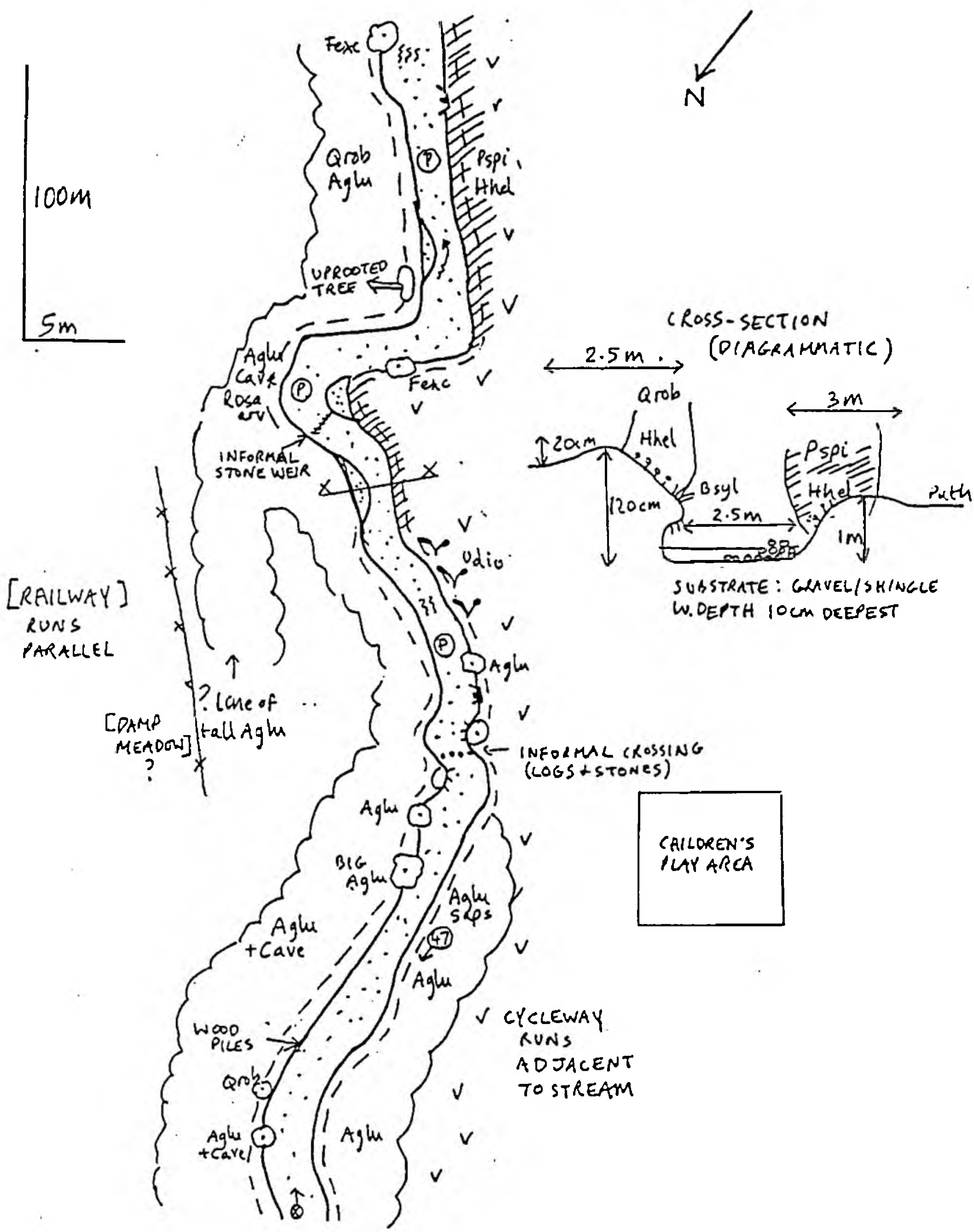
MONKS BROOK: 14

END: SU428210

SURVEYOR: J NORTON

DATE: 31.7.96

LENGTH: 500m



START: SU424213

MONKS BROOK RIVER CORRIDOR SURVEY 1996

Section 13
SU428210 (Shannon Way) to SU432206 (Hursley Road railway tunnel)

Date of survey: 31.7.96 Photos: 48, 49

Survey conditions
Weather: Warm, cloudy, recent rain. Water level: Low.

Description
A continuation of section 14, with railway close to the left bank and mown amenity grassland on the right bank. Part of the stream is straightened along the railway, and this section supported lines of very tall, thin alder, shown in photo 49. The uniformity of the alder is also apparent from photo 48 taken outside the stream. The tributary ending with section 20 meets Monks Brook before it passes through a railway tunnel at the end of this section.

Management
The left bank is adjacent to Hampshire Wildlife Trust's Flexford Nature Reserve. The grassland areas are managed by grazing. Little or no management would be required along the stream channel or adjacent alder woodland.

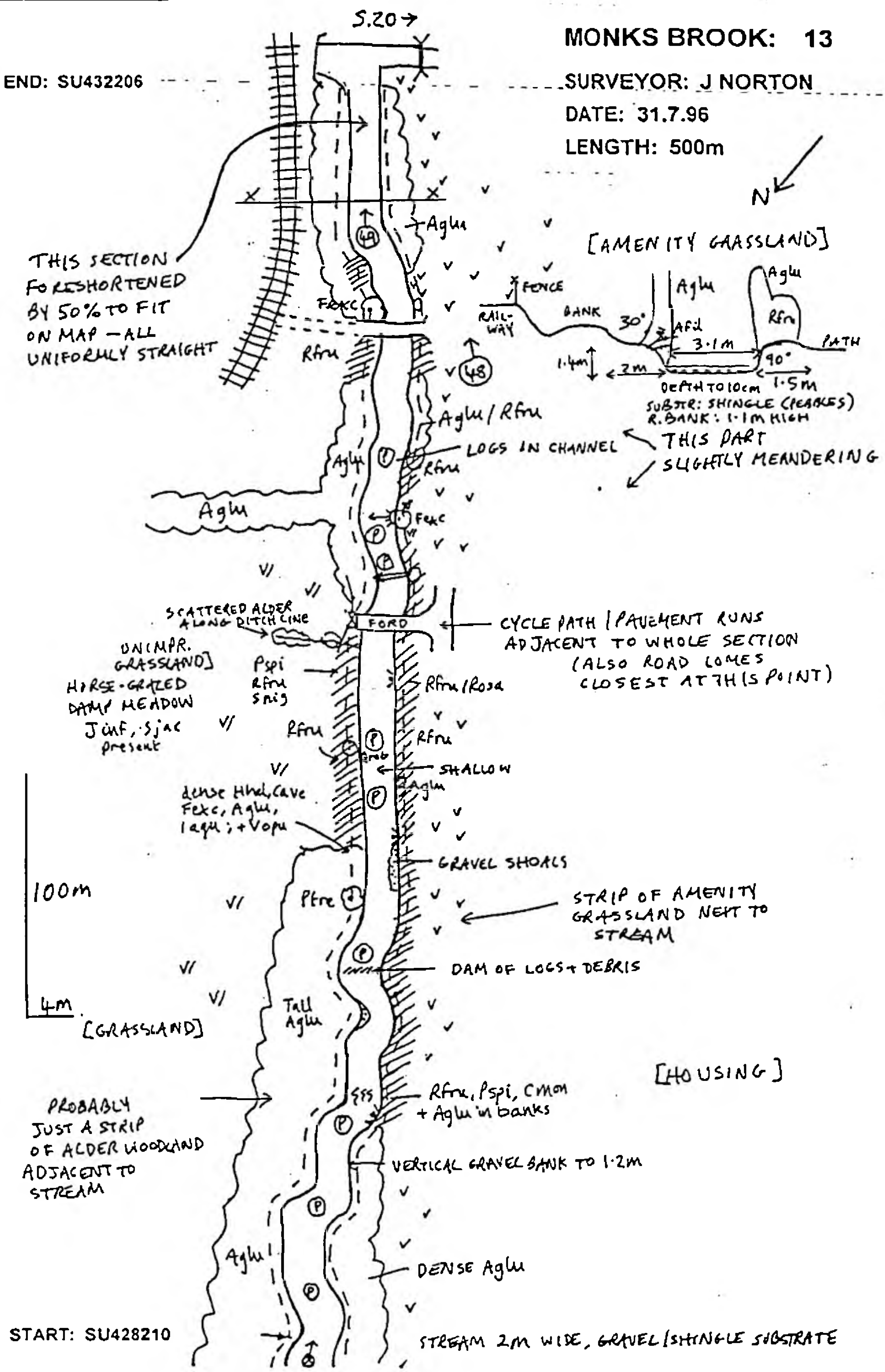
Proposed restoration options for the end of this section, next to the railway, are discussed in the Monks Brook Design Options report (Reaches 2b and 3). It is suggested that the straight channel is replaced by a meandering reach, by cutting gaps in the trees on the right bank. It is also proposed that a wetland area be constructed by excavation near to the stream.

MONKS BROOK RIVER CORRIDOR SURVEY 1996

Species list (Section 13)

Species	Abundance	Species	Abundance
Trees & shrubs		*Allium ursinum*	
Alnus glutinosa		*Athyrium filix-femina*	
Corylus avellana		*Circaea lutetiana*	
Crataegus monogyna		*Cirsium palustre*	
Crataegus monogyna	F	*Dryopteris filix-mas*	O
Fraxinus excelsior		*Galium palustre*	
Hedera helix		*Geum urbanum*	
Ilex aquifolium		*Mentha aquatica*	
Populus alba		*Mercurialis perennis*	O
Prunus spinosa		*Oenanthe crocata*	F
Quercus robur		*Pulicaria dysenterica*	
Rosa sp.		*Ranunculus flammula*	
Rubus fruticosus			
Viburnum opulus	O	Grasses, rushes & sedges	
		Carex pendula	R
Herbs, ferns & horsetails		*Carex remota*	
Achillea ptarmica		*Juncus acutiflorus*	
Alliaria petiolata			

Section 13 Sketch Map



Otter Log Pile Holts

R · S · N · C
The Wildlife Trusts
PARTNERSHIP

ROYAL SOCIETY FOR NATURE CONSERVATION

Vigilant House . 120 Wilton Road . London . SW1V 1JZ Tel (071) 931 0601 . Fax (071) 873 8585

OTTERS AND RIVERS PROJECT

LOG PILE HOLTS

The information in this leaflet sets out practical details for the construction of log pile holts using materials readily available with an indication of time and labour required.

INTRODUCTION

The European otter, Lutra lutra, is largely nocturnal in England and Wales, and usually spends the day in secure lying-up sites close to water. A home range (territory) may consist of up to 40 km of waterway, and an individual otter will regularly use more than 20 resting sites. The three most common places used by otters are bankside tree roots, dense scrub and piles of bankside timber debris, along with reedbeds in parts of the country such as East Anglia.

Land drainage schemes, bankside clearance and river regulation, road schemes and other developments have resulted in the loss of many resting sites over the last 40 years. For otters to make use of these impoverished rivers, and to enable the otter population to expand, work must include the recreation of resting sites by tree and scrub planting along with fencing to keep out livestock. However, this takes time to become effective.

Surveys have shown that log pile holts are well used, and are a quick and effective way of providing immediate resting sites for otters. They also provide places for other animals.

Log pile holts are usually more cost effective than other artificial holts.

Please contact your local Otters and Rivers Project run by the Wildlife Trust (see above) if you are considering building a holt. Project staff may be able to provide additional advice, visit the site and help decide on a location as well as advise on an after care and monitoring programme. In some instances fencing and tree planting will be necessary - grant aid is often available for this work.

Otter Log Pile Holts (cont)

REQUIREMENTS

- Time (for 5 - 10 people)

Approximately half a day for chainsaw work (only to be undertaken by a qualified chainsaw operator), trimming poles and brashing.

Approximately half a day for holt construction with pre-cut materials.

- Tools

Chainsaw, bowsaws, billhooks, scythe, heavy duty gloves. If the area is liable to flooding then sheep or wire netting, wooden stakes and a mallet will be necessary.

- Location

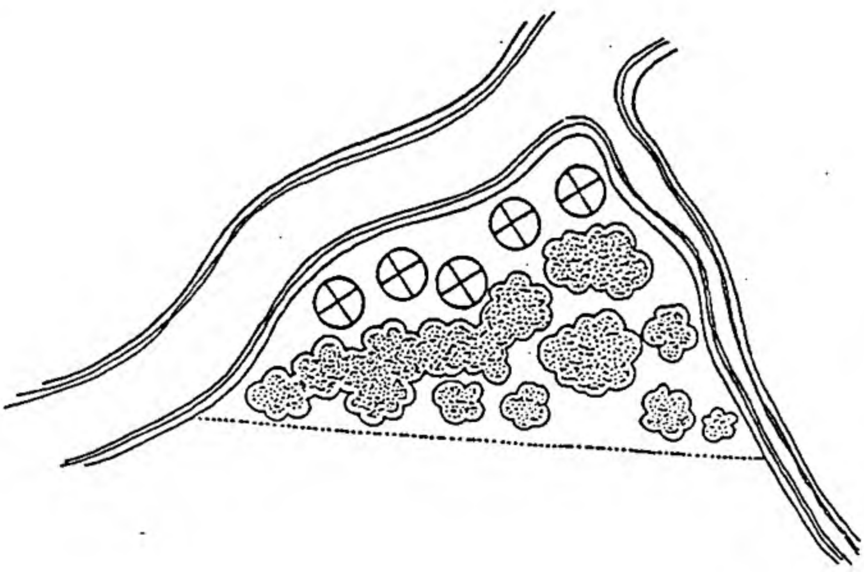
Build the log pile holt as close to the water's edge as possible and where otters can climb the bank.

As long as the site has minimal disturbance from humans and particularly dogs, the log pile holt can be built anywhere along rivers, streams, lakes and ponds, in meanders, field corners, riverside woodlands, islands, and stream confluences.

If possible, fence off the patch of land particularly if livestock is present, and either plant with species typical of the locality, or leave it to develop scrub cover naturally. A large area is not necessarily required.

- Suggested spacing for tree planting

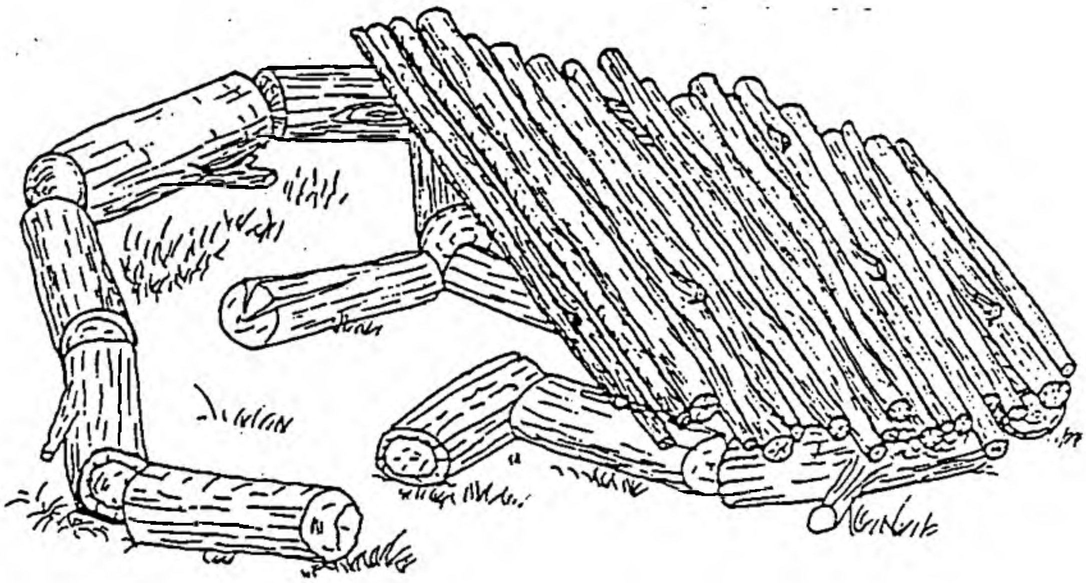
Plant blackthorn or hawthorn whips at 20 cm intervals adjacent to the holt, and alder, ash or willow whips at two to three metre intervals on the periphery of the area.



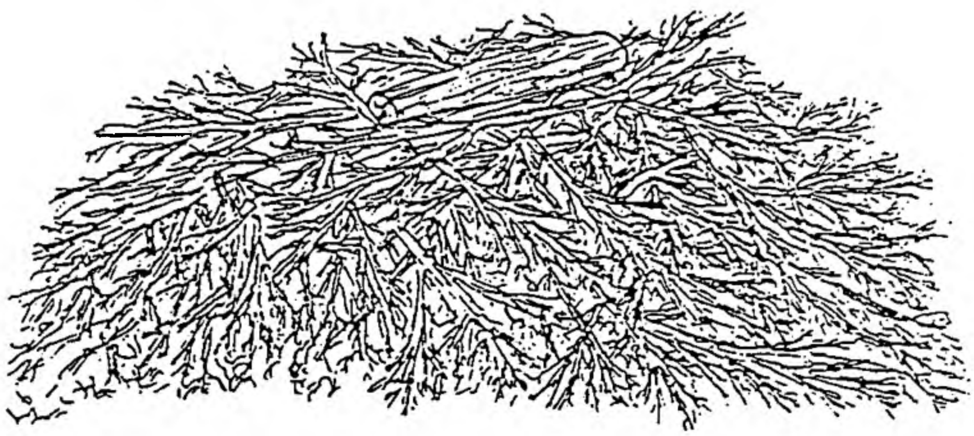
1 Holt site with tree planting and fencing to deter livestock

Otter Log Pile Holts (cont)

STAGE 2. Use poles across the logs and chambers to form the roof. Small pieces of wood can be used to fill the gaps to make the chambers darker and more water resistant.



STAGE 3. Pile the brashings on top of the structure to completely hide the logs and poles and make the chambers dry and dark. It is best to break or saw branches so that they lay flat and pack down. Lay branch stems inwards, with smaller branches and and fronds overlapping logs and poles to form an outer fringe.



If the site is liable to flooding, stretch sheep netting over the brashings and stake netting down on both sides of the holt. Wooden stakes can be made on site. Place more brashings on top to hide the wire.

The Otters and Rivers Project is coordinated by the Wildlife Trusts Partnership throughout the UK and is working for a better future for otters and their wetland habitats. For further information contact:

Otter Log Pile Holts (cont)

- Timber requirements

Timber can be used from fallen trees, and poles and brashing. from a dense hedgeline. Products from woodland or general management work can also be used. Any species can be used, but hardwoods tend to decompose less easily than softwoods in a holt structure and therefore last longer.

Logs - ideally these should be about 1 m long and 30 - 40 cm in diameter.

Poles - use stout fairly straight tree branches of 3 - 10 cm in diameter and cut to lengths of 3 - 4 m. Shorter poles can be used to infill gaps.

Brashings - use large quantities of small branches (trimmings from the poles above), hedge brashings or conifer plantation trimmings.

CONSTRUCTION

The aim is to try and provide a number of interconnecting chambers which are dark and reasonably dry.

The shape of the holt is determined by the location and can be rectangular, square or round.

Construction is in three stages forming three layers:

STAGE 1. Place logs to form chambers of about 1 metre square. Two to eight chambers should be included. Leave gaps of about 15 - 20 cm round as entrances: One or two entrances should be immediately on the river or water's edge, with other entrances onto the land.

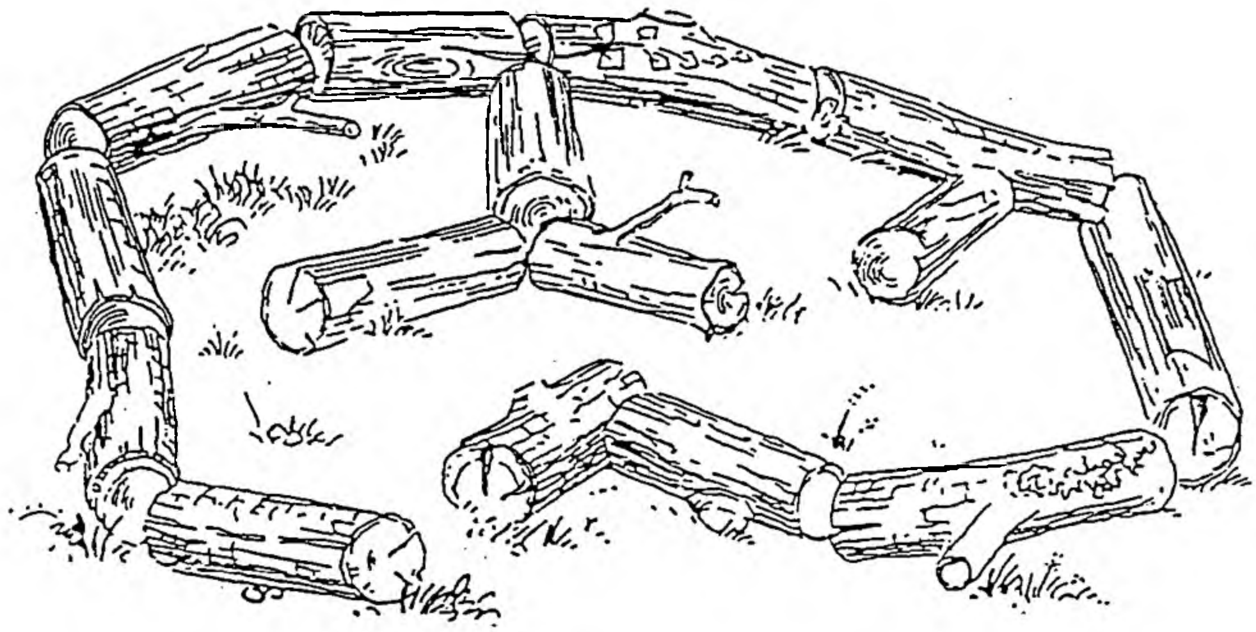
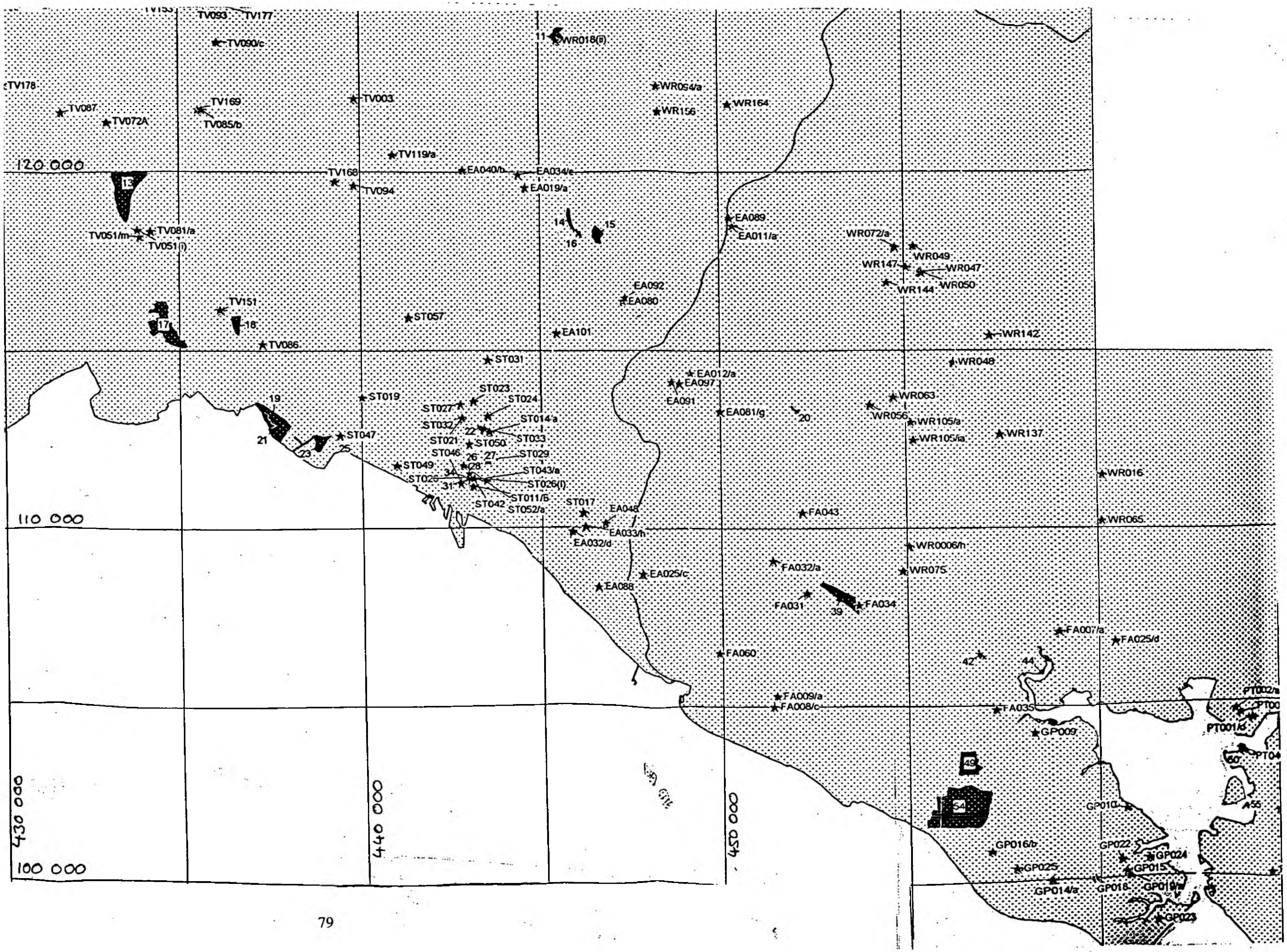


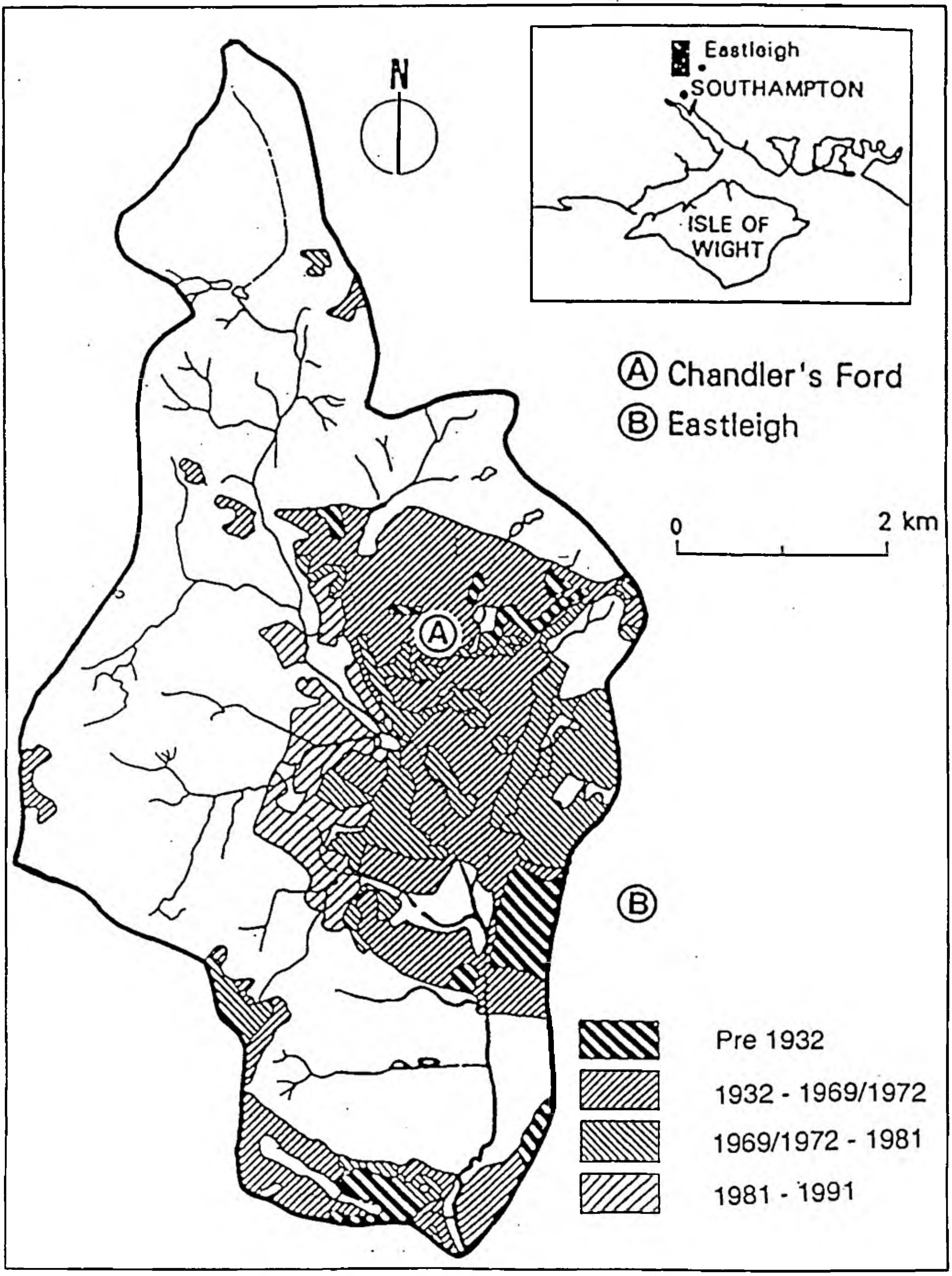
Table 16: Waste Handling Sites and Operators in the Lower Itchen Catchment

SIT	DIS	SITEID	SITENAME	OPERATOR	ADDRESS	PHONENUMB	FACILITY T.
33	TV	119/a	Manor Farm	J & W Ltd	Manor Farm, North Baddesley, Hampshire	017032624	Landfill
45	WR	156	Wessex Park	PHS Ltd	Unit 1, Wessex Park, Wessex Way, Colden Common, Nr Winchester, Hampshire	01222 8510	Storage on Produc
70	ST	011/B	Floating Bridge Road	Biffa Waste Services	Floating Bridge Road, Southampton, Hampshire	01703 7707	Transfer Station
71	ST	026	Town Depot	Southampton City Council	Land at Town Depot, Albert Road North, Southampton	01703 2240	Transfer Station
72	ST	027	Rentokil	Rentokil Ltd	Land at Dukes Road, Southampton	01342 3271	Transfer Station
73	ST	029	Willments Shipyard	McNicholas Construction Co Lt	Land at Unit E, Willments Shipyard, Woolston, Southampton	0181 95341	Transfer Station
74	ST	031	Portswood Waste	Southern Water Services	Land at Portswood Waste, Treatment Works, Kent Road, Southampton, Hampshire	01962 7145	Storage on Produc
75	ST	033	Drivers Wharf	BFI Ltd	Land adj. to Drivers Wharf, Millbank Street, Northam, Hampshire	01753 6627	Transfer Station
76	ST	042	Itchen Marine (Towage)	Itchen Marine (Towage) Ltd	Land at American Wharf, Millbank Street, Northam, Hampshire	01703 6325	Processing / Treat
77	ST	046	A & B Oil	A & B Oil	Royal Crescent Road, Southampton, Hampshire	01703 3392	Processing / Treat
85	EA	032/d	Abbey Fruit Farm	Leigh Environmental Ltd	Land at Abbey Fruit Farm, Woolston Road, Hound	01705 6999	Inert Landfill
86	EA	033/h	Netley Farm	Leigh Environmental (Southern)	Land at Netley Farm, Hound, Southampton, Hants	01705 6999	Landfill
87	EA	040/b	Cannon Hygiene	Cannon Hygiene Ltd	Unit 6 Speedwell Close, Chandlers Ford, Eastleigh	015 246089	Transfer Station
89	EA	088	Netley Abbey	Mr I P Wood	Unit 7, The Sidings Ind. Estate, Netley Abbey	017 034521	Transfer Station
02	WR	018(ii)	Otterbourne Incinerator	Onyx (Hants) Ltd	Former Baling Shed, Otterbourne Incinerator, Poles Lane, Winchester.	01962 7640	Transfer Station
02	WR	020/a	Garnier Road HWRC	Hopkins Recycling	Garnier Road, Winchester, Hampshire	01962 8685	Recycling Site
02	WR	021/a	Prospect Road HWRC	Hopkins Recycling	Prospect Road, Alresford, Hampshire	01962 7989	Recycling Site
02	WR	052/a	Land at the Laurels	Mr A R Wilson	Land at the Laurels, Alersford Road, Winchester, Hampshire	01962 8660	Scrapyards & Met
02	WR	054/b	Winchester Recycling	Winchester Recycling Ltd	Land at Barfield Close, Winchester, Hampshire	01962 8447	Scrapyards & Met
02	WR	094/a	Advanced Vehicle Spares	Mr B Dunford	Main Road, Colden Common, Nr Winchester, Hampshire	01962 7142	Scrapyards & Met
02	WR	136/a	Land at Bushfield Farm	DoE	Land at Bushfield Farm, Compton, Winchester, Hamsphire	01962 8437	Inert Landfill
02	WR	139/a	Morestead Farm	Gough Partners	Morestead Farm, Nr Winchester, Hampshire	01962 7120	Scrapyards & Met
02	WR	140/a	Morestead WWTW	Southern Water Services	Morestead Road, Nr Winchester, Hampshire	01962 8437	Inert Landfill
02	WR	164	Land at Marwell Zoo	Marwell Presentaion Trust Ltd	Marwell Zoological Park, Colden Common, Winchester, Hampshire	01962 7774	Storage on Produc
02	WR	166	Crowhurst Kennels	L A Poupart	Land off Sutton Wood Lane, Ropley, Alresford, Hampshire	01962 7732	Landfill
02	ST	014/a	Land at Princes Street	Shepperd (Group) Ltd	Land at Princes Street, Northam, Southampton, Hampshire, SO9 4EB	01703 3362	Scrapyards & Met
02	ST	017	Land at Ashley Cresent	Huntley Brothers Ltd	Land at Ashley Cresent, Sholing, Southampton, Hamsphire	01703 4473	Scrapyards & Met
02	ST	021	Bevois Valley Sidings	W Forfar Ltd	Bevois Park Sidings, Empress Road, Southampton, Hampshire	01703 2270	Scrapyards & Met
02	EA	019/a	Woodside Avenue HWRC	Hopkins Recycling	Land at Woodside Avenue, Eastleigh, Nr Southampton, Hampshire	01962 7989	Recycling Site
02	EA	034/e	Saftey Kleen UK Ltd	Saftey Kleen UK Ltd	Land at 4/5 Peacock Trading Estate, Eastleigh, Hampshire	01703 6413	Storage on Produc
02	EA	048	Grange Road HWRC	Clark Bros. Recycling Ltd	Land at Grange Road, Netley, Southampton, Hampshire	01703 4061	Recycling Site
02	EA	080	Land at Roddington Forge	JMA Salvage Ltd	Land at Roddington Forge, Allington Lane, West End, Southampton, Hampshire	01703 4207	Scrapyards & Met
02	EA	092	Roddington Forge	R W Wright	Roddington Forge, Allington Lane, West End, Southampton, Hampshire	01703 4730	Scrapyards & Met
02	ST	023	Land at 44 Priory Road	Belsize Boatyard Ltd	Land at 44 Priory Road, St Denys, Southampton, Hampshire	01703 6713	Scrapyards & Met
02	ST	024	Land at Quayside Road	T Holden	Land at Quayside Road, Bitterne Manor, Southampton, Hampshire, SO2 4AD	01703 2253	Scrapyards & Met
02	ST	026(I)	Land at Town Depot	N Berry	Land at Town Depot, Albert Road North, Southampton; Hamsphire, SO14 5AT	01703 2240	Transfer Station
02	ST	032	Bevois Park Sidings	W & S Smith	Bevois Park Sidings, Empress Road, Southampton, Hampshire	01703 6325	Scrapyards & Met
02	ST	043/a	Chapel Depot HWRC	Onyx (Hampshire) Ltd	Chapel Depot, Endle Street, Southampton, Hampshire	01962 7640	Recycling Site
02	ST	050	Cable Street	L Povey & Son Ltd	Cable Street, Northam, Southampton, Hampshire	01703 2220	Scrapyards & Met
02	ST	052/a	Land at 65-69 Melbourne Stre	A M Thery	Land at 65-69 Melbourne Street, Central Trading Estate, Chapel, Southampton, Ham	01703 2237	Scrapyards & Met
02	EA	101	Hamilton House	Solvay Health Care	Hamilton House, West End, Southampton, Hampshire	01703 4722	Storage on Produc
02	BA	105	Little Bushy Warren Copse	Onyx (Hampshire) Ltd	Land at Little Bushy Warren Copse, Herriard	01962 7640	Materials Reclaima
02	HV	038	Havant Lorry Park	Hughes Waste Management Lt	Havant Lorry Park, Southmoor Lane, Havant	01329 2233	Transfer Station

Map of Waste Handling Sites



Growth in Urban Area in Monks Brook Catchment



Suggested Classroom Exercise - 1

Flood Control and Rainfall/Run-off Relationships

River flow data from the gauging station at Allbrook & Highbridge on the River Itchen in the northern outskirts of Eastleigh and at Stoneham Lane on the Monks Brook at the southern boundary of Eastleigh are provided in this data section together with their respective nearby rain gauges at Otterbourne and Portswood on pages 46 – 51.

Problem

Plots of the daily 1998 rainfall and daily 1998 river flow data from the Itchen and the Monks Brook sites are provided with the same time scale along the bottom of each graph. If you are able to superimpose the plots on one graph then this will aid comparison of the plots. Starting with flow data from the Stoneham Lane river gauging station, which is situated on the Monks Brook just downstream of the Fleming Park site, compare the spikes on the river flow graph with the rainfall data. Is there a correlation? How does the paved area in Eastleigh influence this result?

Now compare the river flows during periods of no or little rainfall. Note that the reduction in flow follows a steady exponential reduction curve whereas the rise in flow is rapid. Where is the flow in the Brook coming from during dry periods? Now compare the percentage difference between maximum daily flow for the year with the minimum daily flow value.

Secondly, carry out the same exercise on the 1998 data from the Allbrook & Highbridge river flow gauging station on the River Itchen which is located just upstream of Eastleigh at the downstream end of the Chalk part of the catchment. What is the percentage difference between the maximum and minimum daily flows on the River Itchen? Why are the proportions of flows on the two rivers so different? Also compare the total annual run-off per Km^2 for the two stations. Why are they so different?

Teachers Guide

The reducing flow represented by the recession curve on the Monks Brook is derived from drainage or baseflow from the Barton and Bagshot Beds aquifer combined with other flow components that also drain stored water, for instance water stored in the river banks whilst the water level in the river was high during the storm flow period. On the River Itchen, the Chalk aquifer has a much larger volume of storage than the aquifers on the Monks Brook and the proportion of built-up area pavement is much smaller so that baseflow is a dominant component of the total river flow.

The small amount of direct run-off occurs because the Chalk is highly porous and permeable. It should be noted that the Monks Brook and the River Itchen are exceptional examples of the extremes of river flow characteristics. Most rivers fall somewhere between these two extremes. Finally this difference has a practical corollary. Flooding on the Monks Brook begins just *two hours* after very heavy rainfall events whilst flooding on the River Itchen occurs during the winter months after *three months or longer* of persistently high rainfall.

Suggested Classroom Exercise - 2

Discussion of Natural Mineral Water Chemistry

Bottled water has become very popular in recent years and is obtained from groundwater either from a spring or borehole abstraction. All groundwater contains to varying degrees minerals dissolved from the rocks through which the water has passed. Some water is referred to as "pure", whilst other manufacturers proclaim their product as "mineral" water. Do you know what they mean by this? Have a look at the label of some well-known brands and compare the water mineral chemistry information contained on them. British law requires the manufacturers to declare the mineral contents. Are the manufacturers being misleading when they state their water is pure or mineralised? Compare the analyses with tap water or the mineral content of the water abstracted at Gaters Mill, 1½ Km upstream from Woodmill. Data are provided on pages 52 and 54. Are some bottled waters any different to tap water?

Use the table of water mineral chemistry data provided to identify the main mineral constituents. You can check that the analysis has been declared correctly as the total charge of the anions and the total charge of cations must be equal. An error of 5 to 10% is acceptable. To calculate the total charge, multiply each individual mineral ion concentration by the charge of the ion (either 1, 2 or 3) and divide by the molecular weight. Then sum the anion molar charges and the cation molar charges seperately and work out the percentage difference of the two totals.

Teachers Guide

Rainfall combines with CO_2 from the atmosphere to form a weak carbonic acid that helps leach minerals that are contained in the soil layer and underlying aquifers. Some minerals such as silica are more or less chemically inert and more or less insoluble in water. In contrast, carbonate minerals are both reactive and soluble. Consequently the concentration of minerals dissolved in groundwater is dependent on the minerals of the rock through which the water passes.

Sand grains are usually composed of silica and hence clean sandstones (with little or no clay content) are almost exclusively comprised of silica. Consequently, sandstone aquifers yield very pure, low mineral content groundwater. In extreme cases, if an aquifer is inert, e.g. a quartz arenite (more than 95% silica sand by composition) and it has been fully flushed by groundwater since it last emerged from below sea-level, the aquifer may produce water that has such low mineral concentrations that it is not too different from distilled water. In contrast, Chalk is comprised of 99% carbonate minerals and is highly susceptible to dissolution of the carbonate and Chalk water is therefore saturated in this mineral.

Pure bottled water should strictly mean that it has a very low mineral content, say 100 to 200 mg/l total dissolved solids (this is the total of all the minerals contained in the water). However some manufacturers might call a water pure because it comes from a natural source not necessarily because it has low mineralisation. Other water is sold as "mineral" water. This often just means it has minerals dissolved in it. Tap water often has the same concentrations of minerals as the bottled water. This is not surprising as the source of the water may often be the same, for instance, about 90% of tap water supply in the South of England comes from groundwater abstracted from boreholes and springs. Note that although minerals dissolved in drinking water are beneficial to balanced nutrition, very high concentrations of mineral ions can be detrimental or harmful. The E.U. drinking water limits are presented in the Gaters Mill data.

Suggested Classroom Exercise - 3

Assessment of river water quality data at the Gaters Mill abstraction site

A summary of the results of water quality chemistry analyses taken during 1997 from the River Itchen at Gaters Mill, 1½ Km upstream from Woodmill, are presented in table format in the data section on pages 52 to 55. These samples are regularly taken to monitor the water quality of the river upstream of the large abstraction for water supply at this site.

The information has been presented in terms of physical, major mineral ion, metal ion, and organic determinands. The original data contains many more test determinands so examples have been chosen to illustrate the types of test undertaken and the results obtained.

Water quality classification based on chemistry tests is dependent on the concentations of the determinand in the water. If a determinand has a concentration below the potable (drinking water) concentration limit, then that determinand has an acceptable concentration. Indeed in the case of mineral ions, the presence of some minerals in appropriate concentrations is beneficial to general health. However as the concentrations approach or exceed the potable limit, the chemical or mineral becomes increasingly harmful or may have other associated problems, for instance high iron concentrations cause iron staining.

Exercise

First of all, identify what each determinand is, and why the test has been taken. Use the table of water chemistry information related to human activity to identify some of the more common possible contaminants and how the contaminants might get into the water supply. Note that Gaters Mill is the site of an abstraction for raw water that is treated in the works prior to being put into water supply. Work out which if any of the analyses exceed the potable or recommended limit. The <'s column (means less than) identifies the number of analyses where the concentration of the determinand was below the limit of detection (l.d.) of the test. Assume the test has been appropriately selected and that the limit of detection is less than the potable limit for that determinand. (n.d. stands for no data.)

On how many occasions do determinand tests demonstrate that the raw river water is already suitable for use as a potable water supply? Note that if no treatment of the water were being undertaken, (this is not the case) and water quality just exceeds the potable limit on may be one occasion each year, it is not particularly significant. However frequent failures or large excess concentrations are likely to be harmful. You can make an assessment of the number by comparing the maximum figure with the mean, minimum and less than figures.

Teachers Guide

You should find that one or two determinands just exceed potable limits. The raw river water at Gaters Mill is therefore of exceptionally good quality and nearly fit for supply without treatment. However since this is a river abstraction it is vulnerable to contamination throughout the catchment from accidental spills and chemicals arising from local land use practices such as farming and the motorway network. Consequently the raw river water abstracted at Gaters Mill is treated as a matter of routine prior to supply and the quality or raw water intake is continuously monitored by "on-line" "real-time" instruments that allow the operators to shut down the river intake both manually and automatically as soon as a contaminant is detected.

Suggested Classroom Exercise - 4

A discussion of the relative merits of "hard" and "soft" Engineering

To alleviate the risk of local flooding the channel of the Monks Brook was modified during the 1960s and 1970s. A number of engineering works were undertaken to improve the hydraulic efficiency of the river channel in order to transmit the flood peak volume more quickly downstream away from the urban areas towards the estuary. These works included the straightening, re-alignment and lining of the channel and the removal of obstructions.

In the 1980s and 1990s an alternative approach to flood alleviation has been introduced which involves the construction of local flood storage ponds. It is now possible to restore the downstream channels to their previous natural condition and improve the riverside habitats.

Similarly a new approach is being considered for coastal defence works which involves the concept of "soft" engineering rather than "hard" engineering. Rather than constructing expensive permanent sea walls to protect the coast in non-urban areas and creating an artificial environment, consideration is being given to creating a more natural interface between the land and the sea.

Discussion Problem

Discuss as a class the relative merits of "hard and "soft" engineering solutions to river and sea flood defence strategies.

Teachers Guide

To carry out the exercise, ask the class to tabulate the advantages and disadvantages of carrying out "soft" engineering solutions and contrast these with the disadvantages and advantages of "hard" engineering solutions. This topic relates particularly to the Monmouth Close site and the old canalised and newly restored river sections. The answer to the question "Why are hard engineering solutions preferred to protect urban areas and soft solutions preferred for non-urban areas?" is that soft engineering solutions like beaches are mobile environments and cannot protect coastal buildings with any degree of confidence over a period of time. In fact at locations of sea erosion, this management option entails a steady loss of land. Economics are an important consideration. For instance, where the substantial cost of undertaking coastal defence operations or installing coastal defence infrastructure such as walls and groynes exceeds resulting costs e.g. the cost of land loss, soft engineering options are preferred. Consequently concrete coastal defences are used along promenades and urban areas to protect property as this affords more reliability, whilst soft solutions afford a more natural environment and are preferred in non-urban environments where flooding from the sea is less important or is beneficial through improvement of the beach habitat.

Suggested Classroom Exercise - 5

Drought Management and Climate Change

Water Resources

Within the last thirty years there have been three major drought events in southern England in 1995/97, 1988/92 and 1975/76. During these events the water supply systems were severely affected in their ability to satisfy demands, river flows were significantly depleted and groundwater levels fell sharply.

Surface water sources are more at risk of failure than groundwater sources where the amount of water in storage in aquifers is generally larger than that held in river systems, even those with impounding reservoirs.

Climate Change

An examination of long-term rainfall records over the last seventy years (Table 3, page 44) indicates that rainfall has tended to increase in March and decrease in July and August.

Exercise

Using the groundwater level record at the Agency's observation borehole at Preston Candover for the period 1975 to 1998 on page 56 observe the seasonal fluctuation of water levels each year and identify the drought sequences described above.

Compare these drought events with rainfall data for the same period at Otterbourne, Table 9, page 58 and note the statistical significance of the drought periods in Table 2, page 43.

Observe the evidence for climate change in the monthly extreme rainfall data in Table 3, page 44.

Teachers Guide

Draw the students attention to the difference between global warming and climate change. Whereas recent summers (July 1998 was the hottest month recorded over the whole globe since records began) have been much hotter than average, it is not yet evident that this is in response to global warming or is merely a cyclical change in the world's climate.

However it is apparent that climate change is occurring and this is taking place in the British Isles. This has been apparent in an increase in extremes. That is to say, the average rainfall has remained more or less constant when averaged over a number of years, however the summers have been hotter and drier whilst the winters have been markedly wetter although the rainfall has been within a shorter period of time. This suggests that we are getting more of a Mediterranean climate although the changes have not been over a sufficiently long enough period to be certain of this and these changes may still be part of a natural cycle.

Suggested Classroom Exercise - 6

Water Demand Management

Humans use water for a variety of purposes, some of which are essential for human life and some of which, though not essential, enhance the quality of life.

Water is also essential for animals and plants and the character of many natural ecosystems is determined principally by the particular characteristics of the water environment whether or not it is influenced by human beings.

Problem

Water in its natural state is a renewable resource. However demand for water supplies is growing and in order to meet the objectives of sustainable development what measures can be taken to avoid or defer the use of new or additional water resources?

Discuss such issues as the willingness of customers to:
- Use less water and to install water efficient equipment
- Pay more for water or have more frequent restrictions to their supply
- Have their supplies metered

Teachers Guide

Water put into public water supply over the last twenty years show a 15% increase from 1974/75 to 1994/95 but only a 3% increase in 1984/85 to 1994/95 see Table 4, page 45. The cause of the change in demand is not fully understood but studies are underway to assess the economic, lifestyle and cultural changes that are taking place within the community of customers. Also under investigation is the possible effect of climate change.

To maximise the economic beneficial use of existing water supplies in order to reduce the need for new resources there are a number of available demand management options to consider:

1. Efficient use by Consumers
   (a) Provision and installation of more water-efficient equipment and fittings
   (b) Reduction of leakage and other wastage from customers pipes and existing fittings
   (c) Promotion of efficient use by users (employ water conservation measures, introduce water recycling systems, use water wisely)

2. Charging arrangements by water companies
   (a) Introduction of metering
   (b) Change of tariff structures

3. Leakage from water company's supply systems
   (a) Replace old pipes and tanks
   (b) Reline pipework
   (c) Reduce water pressures

4. Reduce level of service security from water company's supply systems
   (a) More frequent use of hose-pipe bans
   (b) More frequent curtailment of non-essential use

Suggested Classroom Exercise -7

Management of the Environment and Canvassing Public Opinion

Discussion

What are the main environmental issues globally, nationally and locally?

In recognition of the public debate on the environment that has highlighted the need to improve the environment in accordance with principles of *sustainable development,* and the need to tailor the environmental effort to issues that relate to the local situation in accordance with *local Agenda 21,* how can the public's opinion best be canvassed and how can they best be represented.

Teachers Guide

The Environment Agency is pioneering Local Environment Action Plans (LEAPs) to provide a mechanism whereby local environment issues may be identified and prioritised through discussions with local environment groups and organisations and with the local planning authorities such as the local Borough and County Councils. The extent of each LEAP is determined by major river catchment boundaries. Each LEAP entails collection of data and discussions with personnel from local environment groups and planning organisations in order to determine the state of the local environment along with environmental pressures and competing demands for sites within the LEAP catchment.

This management tool was implemented in the mid-1990s and the first complete set of LEAPs for England and Wales will be completed by the Year 2000. At this point it will be possible to determine the environmental issues that are important across the nation and the issues that are important in each area. In addition, a LEAP also provides a management mechanism through frequent LEAP reappraisal every five years, at which point, progress (or the lack of progress) is identified. This allows the managers of the Agency to determine the effectiveness of environmental policy and allows early implementation of any necessary remedial action as new environment issues develop.

Suggested Classroom Exercise - 8

Industrial Process Control

Within the catchment of the Monks Brook there are a number of industrial sites that represent a potential contamination risk to the river. Although some businesses have consents to discharge to water courses licensed and managed by the Agency, accidental spillages occur and have caused occasional pollution events by entering the Monks Brook via storm sewers carried in the run-off from rainfall events.

Problem

Identify the possible sources of contamination by locating the industrial sites and the type of industrial processes taking place on a catchment map? A list of IPC category businesses is available from the Agency. Smaller firms may be identified by a walk-over survey of the businesses on any industrial estate or by a review of the local Thompson or Yellow Pages Directories.

Can the sources of contamination be located precisely? If not, why is it difficult to pinpoint the source of the contamination? Given the state of knowledge, what is the best strategic policy to reduce accidental or illegal disposal of contaminants?

Teachers Guide

Most of the pollution events on the Monks Brook may be linked to one or two particular industrial estates. However, chemical sampling is the only method available to determine the presence of contaminants in a river. This samples all the water arriving at the sampling location from upstream and any contamination arriving may arrive from any number of outfalls or tributaries. It is therefore very difficult to prove an offence has occurred and prosecute the offender. However the sampling does indicate who the most likely offenders might be.

Given the difficulty of prosecuting the law, it is often much more effective to encourage a business to utilise *best practice*, perhaps by installation of on-site storage and settlement tanks that remove or retain pollutants before discharge to a water course. New discharge consents are usually now authorised with the condition that the discharge is monitored and the data supplied to the Agency. If frequent pollution is occurring, the Agency may target a particular estate with leaflets and visits by Agency personnel to encourage implementation of best practice. However it should be noted that the management of many businesses are concerned about the effect of their business on the environment and in recent years many have engaged environmental consultants and implemented best practice techniques without encouragement from the Agency. It is hoped that the number of pollution incidents on the Monks Brook will decline in the future as best practice is implemented.

The type of pollution that a business might produce can be anticipated from the type of business, i.e. is it an office, warehouse, workshop or factory, or by what is done on the site i.e. is it an assembly factory, processing factory or a packaging factory. The key issues to look for are use of cooling water (major consumption of water resources), storage and production of harmful chemicals and wastes (e.g. hospitals) or utilisation of substantial process water (food and paper mill factories). Large factories tend to be responsible and operate BATNEEC principles (see factsheet 19).

Suggested Classroom Exercise - 9

The Salmon Action Plan

The River Itchen is of national and international conservation importance with 42 Km of the river (of its total 97 Km length) being classified as a riverine European Special Area of Conservation (SAC) with ten sites of Special Scientific Interest (SSSIs). These classifications are respectively the highest in Europe and England and Wales.

The majority of the River Itchen and its tributaries has been designated "Salmonid Fisheries" under the EC freshwater Fisheries Directive (78/659/EEC) which relates to water quality standards. It consists of the whole length of the main river from Woodmill upstream to the headwaters that include the River Alre, Cheriton Stream and the Candover Brook but excludes all the tributaries south of Winchester such as the Monks Brook. The freshwater life phases of salmon within the river are critically influenced by the maintenance of adequate seasonal flow regimes but recent low rainfall years have resulted in seasonal reductions in the flow of the river. This has increased the magnitude and number of in-river obstructions to fish migration and have also increased the deposition rate of silt and the dilution of urban discharges to the river hence reducing the quality of water in the river. These factors impact upon the Itchen brown trout, eels and salmon by hampering the migration of adults (exposing them to greater exploitation and predation) and by reducing the egg and fry survival rates.

The Chalk aquifer in the upper part of the catchment provides a consistently high flow of alkaline water in the river which has led to the development of the excellent brown trout Chalk stream fisheries that have become internationally renowned and the salmon fishery is one of only six remaining in English Chalk streams. The River Itchen is world class for its trout fisheries with the upper reaches above Winchester being predominantly for wild trout Those fisheries downstream of Winchester are stocked with trout to supplement natural production.

The catchment also provides suitable habitat for a variety of course fish that include pike, perch, roach, chub, gudgeon, carp, eel and grayling. The eel population is exploited commercially by the river's game fishery managers and they are perceived as competitors to trout and salmon.

Problem

How might the river be managed in the best interests of each of the competing demands?

Teachers Guide

Measures might include the following:

(a) The control of siltation through catchment management involving promotion of soil conservation, the cleaning and rehabilitation of spawning gravel, the restoration of river banks and establishment of minimum acceptable river flows.

(b) Reduced over-exploitation by encouraging the release of rod catch, reducing poaching and influencing the type of marine fishing practices and lobbying international fisheries policy.

(c) Improved fisheries management by increasing consultation with riparian owners, the salmon fisheries and the Hampshire Salmon Trust.

(d) Improved understanding of the salmon fisheries of the River Itchen by increased monitoring and the initiation of specific research programmes.

Suggested Classroom Exercise - 10

Managing Waste Disposal

The local Borough Councils are responsible for planning, organising and managing refuse and waste collection, waste disposal, incineration and recycling. Solid and liquid wastes are disposed of in carefully managed and monitored refuse and waste disposal sites that are categorised according to the mobility and potential environmental risk from the waste. Statutory regulation requires refuse sites to operate to strict procedures that include the maintenance of careful disposal records, separation and disposal of wastes into different locations, authorisation of waste sites to dispose of defined categories of wastes and cover-up of the refuse or wastes each day with impermeable membranes to prevent harmful chemicals being leached by percolating rainfall.

Problem

A list of some of the currently active waste handling and disposal sites in the River Itchen catchment is included in the data section on page 79. This data includes information on organisations that handle wastes such as scrap merchants as well as waste disposal sites. Compare the location (gained from the grid references) of the landfill sites with the catchment geology map. Note the rock type on which most of the landfill sites are located. Why is this rock type favoured? Why are landfill sites required to take measures to reduce percolating rainfall? What measures are necessary to reduce environmental contamination from landfill sites?

Since the 1960s there has been substantial housing development in the Itchen Catchment. This process continues and an extra 12,450 homes were planned for the period from 1990 to 2001. This will entail about a 5% increase in domestic refuse production. How might waste disposal be reduced and how might additional sites be found?

Teachers Guide

Many noxious contaminants enter the environment through landfill sites and this is most likely to occur from leaching of contaminants by percolating rainfall into the groundwater of underlying aquifers and thereby into water courses. Up to the mid-1980s waste was tipped indiscriminately and many waste organisations did not keep accurate records of waste storage. Consequently it is now often difficult for specialists to anticipate environmental problems from a landfill site. Therefore monitoring of sites and if necessary, carrying out environmental clean-up operations as the monitoring programs detect unacceptable levels of contamination is the appropriate method of environmental protection.

Clay has been excavated for a number of centuries to supply industry and brick manufacturers and the resulting clay pits provide good landfill sites. Clay is relatively impermeable and restricts contaminant leakage getting into underlying aquifers such as the Chalk. Suitable landfill sites are becoming an increasingly rare commodity as the remaining clay pits and alternative landfill sites are filled up. Since effective waste disposal sites must have a large volume that is surrounded by an impermeable seal to stop rainfall leaching chemicals from stored wastes, new sites are hard to locate or expensive to engineer. The cost of waste disposal is likely to increase in the coming decades. Incineration is one option if the waste does not produce noxious gas emissions. Recycling is another option but is currently sub-economic. This situation is subject to change. Increasing waste disposal costs are likely in the early part of the 21st century. Economic recycling would allow substantial reductions in waste disposal.

Suggested Field Exercise - 1

Species Diversity Surveys

The number of species at any one location is referred to as the *species diversity* and it is a good measure of the value of a particular habitat or environment. Species exploiting a niche habitat are very sensitive to reduction in habitat or habitat changes. Consequently as river habitats contain many niche habitats, effective river management is required to ensure that human intervention resulting from increased access, or alteration of the environment for economic and lifestyle reasons causes minimal loss in diversity.

The vulnerability of aquatic species to environmental change can be put to good use because their sensitivity to specific habitats makes them excellent indicator species to monitor a river environment. Reduction in species diversity at any location indicates that pressures on the site environment are probably occurring and these may be caused by increased human access, alteration of land use, pollution from persistent chemicals or frequent low risk spillages which when combined together become important. Monitoring of every species in a habitat is very time consuming and prohibitively expensive. Consequently, it is necessary to compromise and choose a number of good indicator species that are both common, sensitive to the environment in question and are immobile. Animals lower down the *food chain* are often numerous but not environment specific. Animals high up the food chain are much less common and are often also mobile. Consequently, the Environment Agency assesses the state of the river environment and water quality by surveying the diversity of worm populations resident in the river bottom which are the best group of species that satisfy the survey criteria. Sometimes alternative species may be used if appropriate.

Problem

What species other than worms would be good indicators of the state of the environment? What are the criteria for selecting appropriate species? Which species could you identify? How could you carry out a species diversity survey?

Teachers Notes

The surveys of worm species diversity consist of a list of worms found at a particular date and locality. The river quality classification is based on the community of worms found. This type of data has not been included in the notes as they require specialist knowledge to identify the worm species and it is inappropriate for students to search for worm species at the study sites.

However a similar survey can be carried out by identifying bird species diversity. A list of birds that prefer river and estuary habitats is included in the data section on pages 60 - 63. However it should be noted that in many species, the birds do not fulfil the requirement for immobility, so are less effective local environment indicators. However they are very sensitive to general environmental factors whilst many birds are territorial, and others rely on the river habitat for food e.g. the Kingfisher. Since birds are much more readily identified, students will benefit from carrying out a bird species diversity survey. Initially they will need to learn identification skills, but this will reap dividends as they get to know the behaviour of each bird type, and will also significantly improve a students awareness of the environment even if it is an urban one. Many naturalists began by learning to identify mammels, birds, butterflies, and dragonflies. You will probably find that the students require little encouragement with this exercise. Good field guides are available in most good bookshops.

Suggested Field Exercise - 2

River Corridor Surveys

In any river environment there are a number of distinct habitats. These include the associated wetlands and marshes, the river margins comprising the river terraces, flood plain water meadows and levees, the river banks, the river channel margins and the river channel itself. Within these habitats relief, channel shape and behaviour such as meanders, river water chemistry, the reliability of stream flow and the type of river bed (i.e. gravel or mud) are controlled by the rocks of the catchment aquifer. Consequently rivers provide a highly varied range of habitats within a small space. This allows an extremely diverse fauna and flora to flourish in association with each other because each organism is able to exploit a particular *niche* in the environment rather than having to compete for space with winners and losers.

River habitats and the need for river management at each location is assessed by carrying out a *river corridor survey.* In carrying out such surveys it is necessary to assess each of the wide variety of habitats associated with rivers in turn, identifying the species that are present in those habitats and what habitat modifications are necessary to enhance each river habitat. This survey records the species and habitats present along a sequence of river sections called *reaches.*

Field Exercise

Using sketch maps, notes and annotations produce river corridor surveys for separate reaches of the river at the Study sites. Compare these with previous corridor surveys taken in past years or at different times of the year. What has changed? What hasn't changed? Determine what changes and improvements might be made to your surveyed reach. Estimate what the cost of these improvements might be. What are the most cost effective and beneficial exercises?

Teachers Notes

River Corridor survey data for the Monks Brook at Monmouth Close has been included in the data section on pages 64 – 73. These can be used as data or textbook examples as required.

The River Corridor Survey encourages students to sketch the environment at each site annotating the sketches with comments and environmental observations. It also provides the opportunity to develop journal skills and record information that may be compared with surveys conducted at other times of the year allowing students to identify seasonal changes at a site and the effect this has on the habitat, species diversity and species populations.

Suggested Field Exercise - 3

Otter Holt Construction

Enclosed in the data section, pages 74 – 77, are details on the construction of artificial holts to provide "resting-up" sites for otters during the day where they will not be disturbed by human activity. Otters are largely *nocturnal*, and are mostly active between dusk and dawn although they may also be seen during the daytime.

The notes included explain how artificial holts may be constructed and who to contact if you are interested in carrying out this kind of activity. In addition, the Environment Agency Conservation Officer at the Winchester Area Office, carries out otter holt construction on an occasional basis and would welcome participation of interested parties. He may be contacted to discuss details.

7. HOW DO WE DO THAT

7.1 Measuring Flow Rate

(What you need: 'Pooh' stick, stopwatch and measuring tape)

Expensive flow meters can be used to measure the flow rate of a stream. However, a simple method of doing the same thing is to use a 'Pooh' stick, a stopwatch, and a measuring tape. The tape is laid down along the bank, the 'Pooh' stick is placed in the water at 0 metres, or equivalent, and using the stopwatch, the length of time it takes for the stick to travel one metre or so is measured, repeat several times and take the mean.

$$\text{Flow rate} = \frac{\text{Distance travelled}}{\text{time}}$$

Another method is to use a plastic bag meter (after Hynes, The Ecology of Running Waters, Liverpool University Press, 1970), which is cheap and fairly accurate and is more useful for microhabitat work. It consists of a glass tube of known diameter with a plastic bag attached to one end. The meter is put into position with your thumb over the hole. The thumb is removed and water is allowed into the bag for a fixed period of time; the thumb is then replaced, and the meter is removed from the water. Next the water is poured from the meter into a measuring cylinder and the volume noted.

The results can be calculated using the formula below.

$$\frac{\text{Water in bag}}{\text{Cross-sectional diameter of tube}} = \text{Flow rate per unit time period}$$

7.2 Measuring Depth

(What you need: a large pole with measurements marked along it)

The depth of a river, stream or pond can be measured. However, care must be taken as it is easy to lean out too far and fall in. Ideally, measurements should be taken from a bridge or a boat, by using a long pole with measurements marked along it.

7.3 Measuring pH levels

(What you need: test tubes with rubber bungs, pH indicator, BDH soil indicator chart, bottle of barium sulphate, spatula, test tube brush)

The pH of water depends on a variety of factors, an important one being the nature of the rock it flows over. A high pH of water in a stream or pond may indicate that it has drained from a limestone area, and be associated with a large mollusc population. These animals, which require calcium to form their shells, are often absent from acid water. It is the source of the water which matters.

The pH of water is important because many biological activities can occur only within a narrow range, so any variation from the range could be fatal to a particular organism.

The easiest way to test pH is to add some universal indicator to a 10ml water sample, or a pH meter can be used.

7.4 Measuring Temperature levels

(What you need: thermometer)

The solubility of oxygen decreases with increasing temperatures, and this leads to environmental stress. Water at high altitude will, however, contain a range of organisms that are adapted to lower temperatures. There are, of course, seasonal and diurnal changes, and if a maximum and minimum temperature can be recorded then some idea of the range of temperatures between which the organisms have to live can be obtained.

Field temperature measurements can be taken by placing the thermometer directly in the water and taking the reading off the scale. When making a series of determinations, all recordings must be made at constant depth.

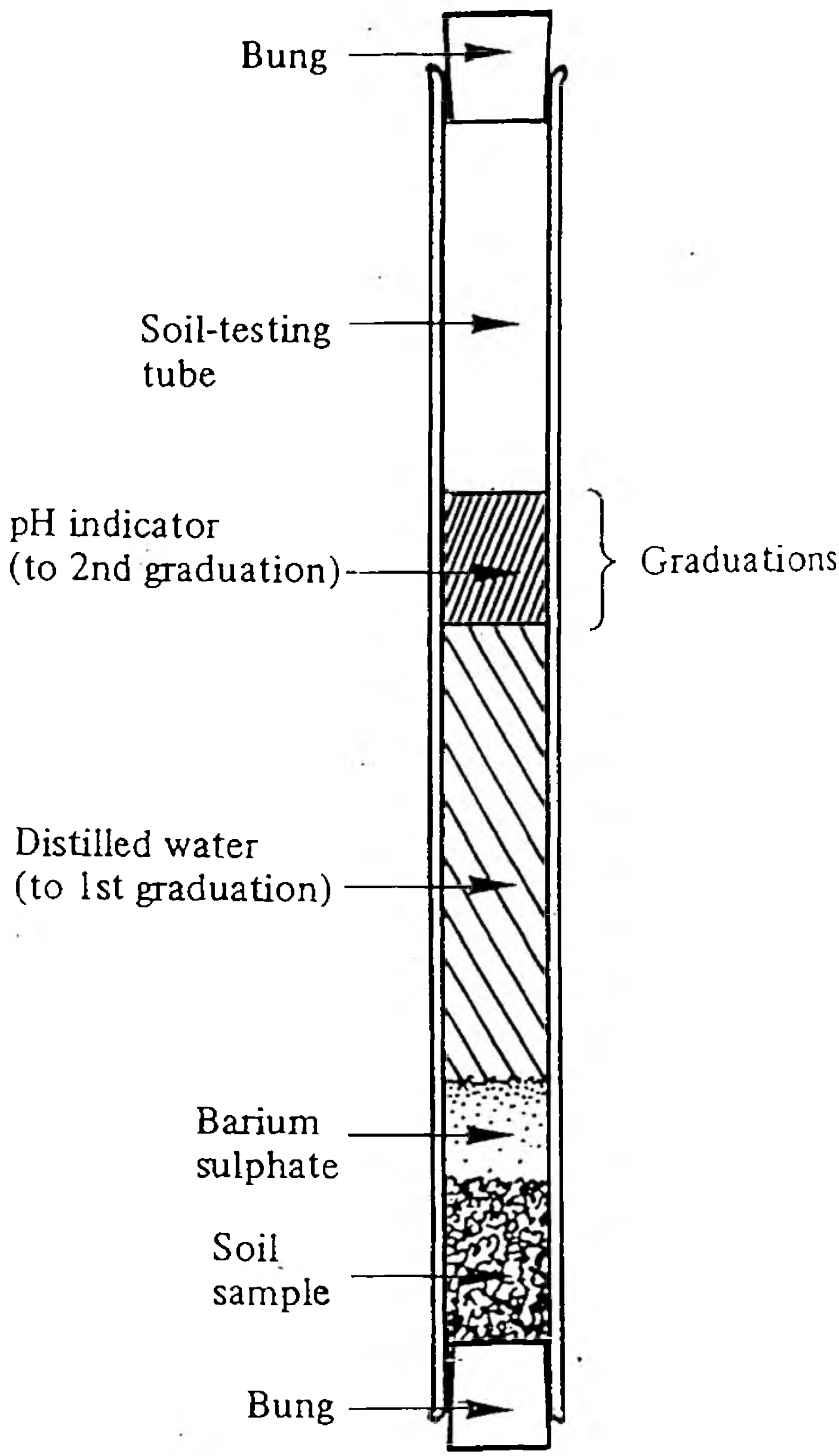
To do this, measure the distance (for example, 0.5m) from the sensor at the end of the probe back along the pole, and then mark this with a waterproof pen. Now all that needs to be done is to lower the probe into the water until the mark touches the surface of the water.

7.5 Measuring the Turbidity of Water

(What you need: glass/plastic tube 2.5cm diameter 1m long, piece of plane glass glued to the bottom which has a black cross painted on with lines 1mm in width and 250 cm^3 beaker)

Turbidity is the name given to the clarity of the water, which is affected by the amount of suspended solids present in it. High turbidity often accompanies organic pollution.

Measuring Soil pH using Indicator



Measuring soil pH using indicator

The more turbid the water is, then the greater the level of organic pollution such as sewage. Turbidity reduces the depth to which light can penetrate, and hence reduces the growth of plants. As plants are the primary producers of the ecosystem and the main source of oxygen, this also has a detrimental effect on the animal life. Sometimes the main source of turbidity is the very plant life itself, as with algal blooms.

A water sample must be obtained and this is then poured into the tube until the cross can no longer be seen when looking straight down the tube. Next, measure the depth of water in the tube and record the measurement. This can be repeated with water from different ponds, or different regions along a stream which receives effluent at one point – for example, a farm drainage outfall pipe.

The measurements can be classified as follows:

Good waters	-	above 600mm
Satisfactory	-	about 300mm
Poor waters	-	less than 100mm

7.6 Recording Quadrants

A quadrant is a small area of ground marked out for the purpose of making a detailed description and recording numerical data, and usually acting as a sample of a larger area. As the name implies, a quadrant is usually square or rectangular, but it can be round or take some different form. They are used to sample objects which do not move, at least during the sampling, such as plants. Quadrants can be any size, but commonly they are 1 x 1 m or smaller. Quadrants can be marked out by knocking pegs in the ground, alternatively you can make your own quadrant frame.

For example, when recording the frequency of the species present in a study area, it is only necessary to record whether each species is present or absent. You can, of course, treat other forms of quadrant data from a frequency point of view; for example, if you have recorded density, zero means 'absent' and anything else means 'present'. Frequency estimations are affected by quadrant size. You can express species frequency as follows:

$$\text{Frequency of species } x \text{ (per cent)} = \frac{\text{No.of quadrants with } x \text{ present}}{\text{Total no.of quadrants in sample}} \times 100$$

Sample of recording sheet (species, by percentage cover)

Name: Site:

	Percentage cover of quadrant no.										Cover		Frequency	
Species	1	2	3	4	5	6	7	8	9	10	Total	%	Total	%
Daisy	15	5	4	18	20	3	1	0	0	20	86	8.6	8	100
Buttercup	20	30	31	20	5	5	5	4	4	0	124	12.	9	90
Dandelion	2	5	5	5	2	2	5	5	18	4	53	4	10	100
Self-heal	4	5	0	0	20	30	5	5	0	2	71	5.3	7	70
Bent grass	40	70	80	85	90	70	70	40	65	45	655	7.1	10	100
												65. 5		

7.7 Some of the Indicators of Water Quality

One of the best indicators of a rich supply of nutrients from sewage is sewage fungus, which grows on the surface of stones. The name 'sewage fungus' usually refers to one species if filamentous bacterium, *Sphaerolitus natans,* but it is also referred to as a complicated community of fungi, algae bacteria and protozoans.

If sewage fungus is present with a little oxygen, then it is likely that there will be a population of sludge worms (*Tubifex*). These live in the mud and can reach vast numbers (for example 420,000 per m^3) if there is no competition from other animals.

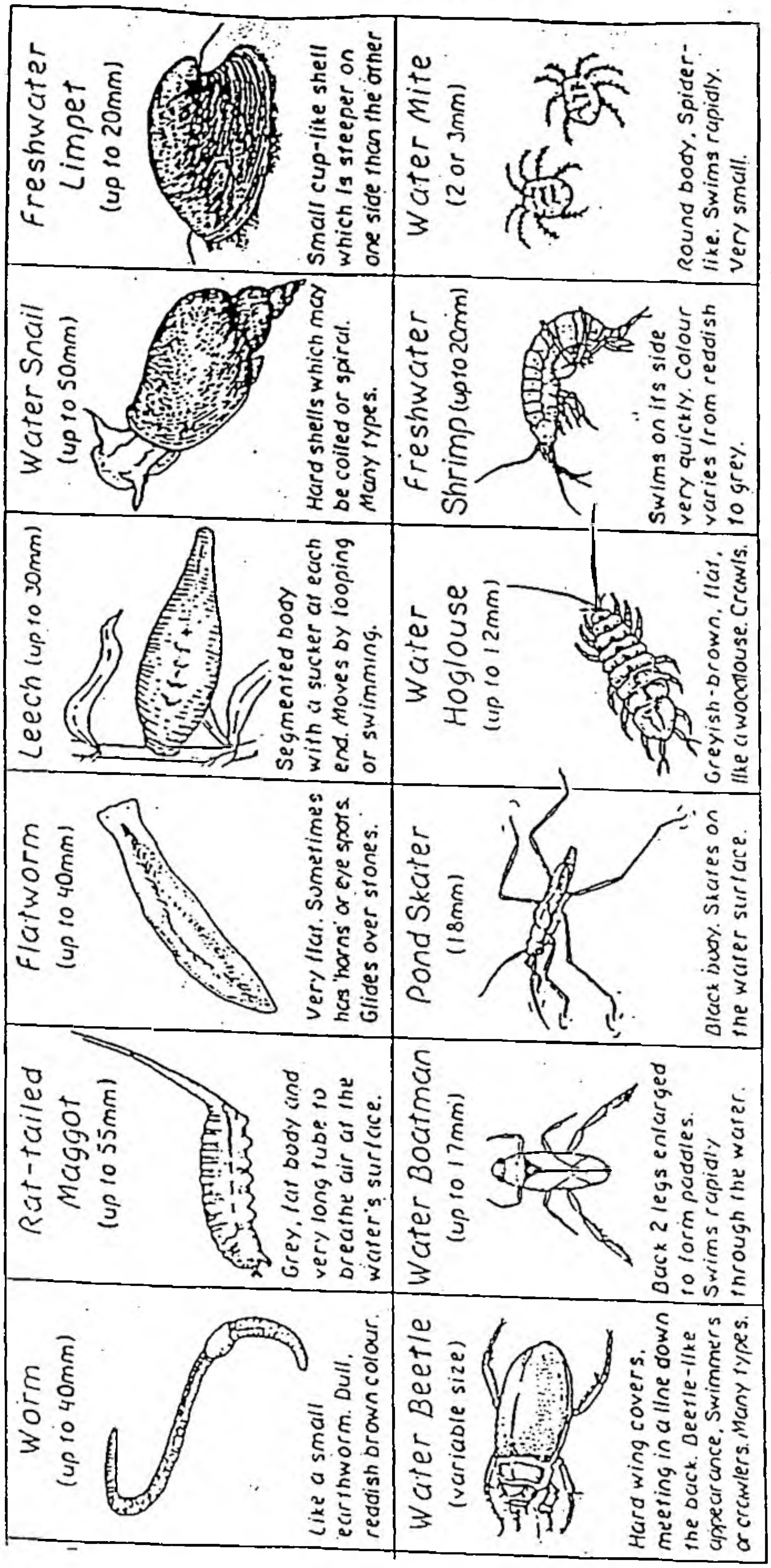
If there is no dissolved oxygen, then this is due to a high level of organic pollution which prevents the larger invertebrates surviving, as these need high oxygen levels to survive. If there is a low level of organic pollution and low oxygen level, then the sewage fungus will be sparse and the sludge worm (*Tubifex*) may be joined by the less tolerant red fly larvae (*Chironomids*), which can survive in high concentrations of salts and ammonia.

Once the water becomes clean then Mayfly (baetis) that are tolerant of mild pollution may appear. However, Mayfly with three tail cerci and especially stonefly with two tail cerci are good indicators of clean water. The table below lists some of the commoner indicator species.

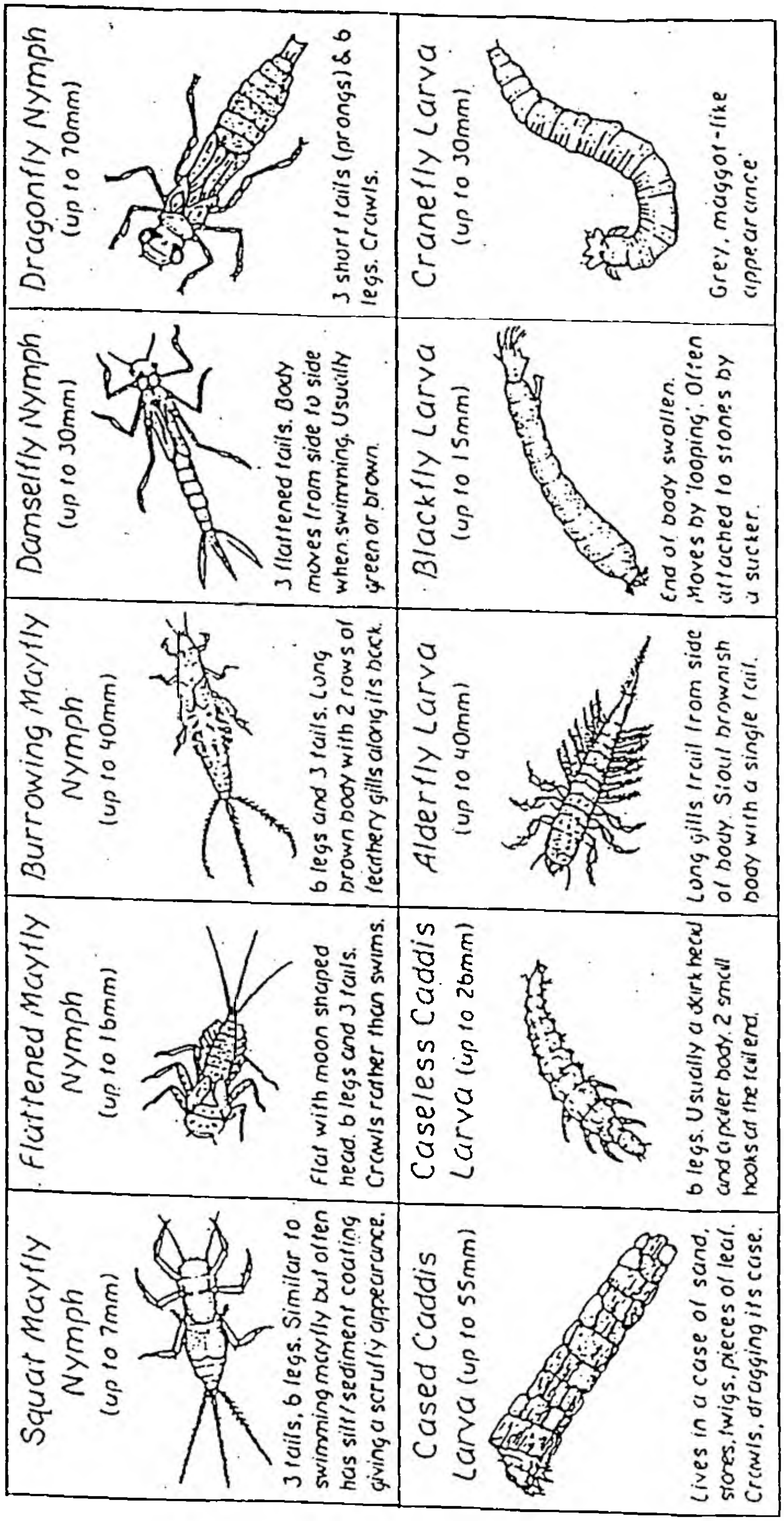
Animals found in water of very high quality only	Animals tolerating water of moderate quality	Animals tolerating water of poor quality (recovering from pollution)	Animals found in water of very poor quality (polluted)
Mayfly larvae [H] Stonefly larvae [C] Freshwater shrimp [F] Caddis larvae [H] Flatworms [C] Newts [C] Frogs [C] Toads [C] Sponges [F]	Jenkin spire shell [F] Limpet [H] Damselfly larvae [C] Beetles [C] Beetle larvae [C] Mites [C] Fish [C] Pea shell [F] Greater waterboatman [C]	Pond snails Waterlouse [F] Alderfly larvae [F] Water fleas [F] Leeches [C] Water cricket [C] Pond skater [C]	Sludge worms [F] Fly larvae [F]

[C] = carnivores, [H] = herbivores, [F] = filterfeeders
Using the total number of carnivores and herbivores in your sample, you can work out the ratio of each.

Swimming Mayfly



Non – Biting Midge Larva



8. FACTSHEETS

Factsheet 1 - Introduction to the Natural Environment

The River Itchen is recognised within Europe as one of Britain's finest examples of a Chalk river environment and supports a very diverse range of quality environmental activities. It has been recently designated as a Special Area of Conservation (SAC), awarded by the European Community Habitats Commission, in addition to its long standing status as a Site of Special Scientific Interest (SSSI). Both designations entail statutory regulation and management of the river environment.

The complex natural environment

The variety of natural river environments arises from a delicate balance between a diverse range of natural processes. Most natural systems, like rivers, are continuously changing in response to the complex interplay of natural processes. Therefore the ability to distinguish between cause and effect is important in the environment. Natural processes can be subdivided into processes that are largely constant and unchanging and those that are dependent on a number of causal processes. Although there are few truly constant natural processes, in the case of *geomorphology*, the processes are very slow, and can be thought of as almost constant. In particular, the natural environment of a river catchment is dependent in many ways on the rock types through which the river flows. Hence the River Itchen is known as a *Chalk river*.

The influence of rocks on the natural environment

Hard rocks are able to resist *erosion* and form plateaus, highland, hills or mountains forming river valleys with high topography and fast flowing, energetic mountain streams. This kind of environment is typical of Welsh and Scottish mountain streams and rivers. Soft rocks are rapidly eroded forming flat, lowland regions with slow, gently flowing streams that flood frequently and are often surrounded by extensive *wetlands* and *marshes*, this kind of environment is typical of the lower half of the River Itchen catchment. In contrast the Chalk found in the upper half of the catchment is a moderately hard rock forming relatively high hills.

The *altitude* of a region affects the *climate*, which in turn has a profound impact on habitat. In Britain, trees struggle to survive above about 300 m. Consequently hill tops and mountains provide a distinct moorland habitat characterised by grassland, heather and gorse. In contrast, prior to the roman period, the lowland areas below 300 m, were characterised by forests. Soil is formed through *weathering* of the underlying rocks. Plants rely on soils to provide essential nutrients and store rainwater. Sands and gravels often weather to form acidic, sandy soils with low nutrient value and poor water retention, and are typically associated with *Heathland* habitats. Chalk weathers to produce mildly alkaline, soils with good water retention characteristics that are ideal for plant growth.

The value of the natural environment

River environments are valued because they are locations enjoyed for their tranquillity, beauty or recreational facilities. Hence when considering the aesthetics of the environment it is important to remember the delicate interplay between the natural processes that underpin and provide value to the environment being considered.

Factsheet 2 - Geology of the River Itchen

The geology of the River Itchen catchment is summarised on the catchment geology map on page 4. The upper catchment is entirely comprised of Chalk. In the lower and southern half of the catchment, the successively younger Woolwich and Reading Beds, London Clay and the Barton and Bagshot beds overlie the Chalk.

The Chalk was formed during the *Cretaceous* period when a shallow sea covered south and central England and much of northern Europe and is made up the fragments and spheres of calcareous algae, called *Coccoliths,* which were abundant in the sea at that time. As the Coccoliths died, the algae decomposed leaving their spherical skeletons to form a chalk sediment on the seabed. The absence of rivers nearby resulted in a very low supply of other sediment. Consequently, except for the lower horizons of the Chalk, which is not present in the River Itchen valley, the Chalk is a very pure limestone comprised of 99% $Ca\ CO_3$. The Cretaceous geological environment can be inferred from the fossils of shallow sea animals that include *Micraster,* an early genus of sea urchin, *Belemintella,* animals similar to cuttlefish, *Ammonites,* early animals similar to *Nautilus,* and *Rhynconnella* and *Terebratula,* animals similar to modern shellfish.

At the beginning of the *Eocene* period, sediment was increasingly transported by rivers into the shallow Chalk Sea, creating the silty sand and clay beds that comprise the Woolwich & Reading Beds. In many areas, the beds were deposited in estuaries or deltas and hence the sea level must have been much shallower during this period. Prior to the deposition of the London Clay, the land was covered by sea again, but the dominant material deposited was clay although there must have been sediment filled rivers on land close by to supply clay sediments. The London Clay is rich in fossil mollusc shells, many of which are very similar to modern species. The fauna and particularly the flora from this period were distinctly sub-tropical so the environment must have been much warmer than it is today.

The Barton and Bagshot Beds were formed in the late Eocene period and consist of fluviatile sands and gravels therefore the environment must again have been on the margins of the land surfaces. The Barton and Bagshot Beds overlie the other rock layers. They must therefore be the youngest rocks. All the rock layers are gently folded so the folding must have occurred since the youngest beds were deposited. This occurred during the *Miocene,* a period from about 5 to 10 million years ago.

The Woolwich and Reading Beds, London Clay and the Barton and Bagshot Beds have been compacted to some degree by being overlain by other rocks since they were laid down. They are all poorly cemented rocks. In contrast to the Chalk, they are not hard or strong rocks. The Chalk is older and underlies the other rocks, in the northern half of the catchment, it has been gently folded upwards to form higher ground. The younger rocks initially overlaid the Chalk, but because these rocks are softer, they were more easily eroded to expose the Chalk at ground surface. The Chalk is the major aquifier in the catchment and the water stored in it supplies the baseflow in the River Itchen.

The younger weaker beds occur in the southern half of the catchment. The Woolwich and Reading Beds are exposed in a very narrow localised area. Thus the River Itchen flows over the impermeable London Clay and this part of the catchment is therefore flat, with frequent sinuous meanders across a wide flood plain. In the south-western quarter of the catchment the Barton and Bagshot Beds are a good minor aquifer and the water stored in these beds supplies the baseflow of the Monks Brook tributary.

Factsheet 3 - The Hydrogeology of the River Itchen

The Hydrological Cycle

Rain falling on land surfaces is a component process of the hydrological cycle, a well known group of water based processes that occur within the environment and in which, rivers play an important role. Simply described, water is drawn into the atmosphere by *evaporation* from open water surfaces such as the sea and *evapotranspiration* from plants and trees on land. Consequently air above the oceans is close to 100% *humidity*. As warm, humid air is forced to rise over land, or encounters cold airflows in weather systems, the air becomes *supersaturated* with water, condensing water droplets, which then fall as rain or as other forms of precipitation. The rainfall then either runs off the land surface directly or passes slowly through water bearing rocks (*aquifers*) before being discharged directly into the sea or indirectly via rivers.

Hydrology and Hydrogeology

Hydrology and *hydrogeology* are the respective natural and engineering sciences of water occurring on the land surface and the subsurface. Rain either falls on to *permeable* soils, such as sands through which it *infiltrates,* or on to *impermeable* soils such as clays, in which case some of the water is absorbed by surface clays and the remainder flows across the ground surface as *run-off* until it reaches a water course or is itself absorbed by unwetted clay. Clays therefore provide a water storage process that retains water in the soil layer between rainfall events. This process is important for plants as they require water to *transpire*. In fact the ideal soil contains some clay for water storage, some *humus* that provides nutrients and some coarse particulate material such as sand to enhance drainage and prevent salt build-up.

In some localities where permeable soils are underlain by layers with less permeability, the infiltrating rainfall is unable to descend any further and *throughflow* occurs horizontally through the soil layer before reaching a nearby watercourse. However in cases where permeable soils are underlain by permeable rocks and soils, infiltrating water descends into the underlying aquifer.

Based on their hydraulic properties there are three types of aquifer. *Porous aquifers* such as sands and gravels, transmit and store water in the pore spaces between the contacts of each sand and gravel particle. *Fractured aquifers,* such as lavas, transmit water through connected fractures, are unable to absorb water and have very little open space volume in which to store water. They are therefore usually minor aquifers as they are unable to store water for supply during summer months. *Hybrid aquifers* are porous *and* fractured. They often are the best aquifers as they have high porous storage and enhanced flow characteristics from the fracture system. The Chalk which supplies the baseflow of the River Itchen and the Triassic Sandstone are the UK's two principal aquifers and they are both hybrid aquifers.

The Chalk is a very good aquifer with high storage and permeability characteristics, providing most of the flow in the River Itchen. The flow comes from the Chalk aquifer via springs and indirect flow from the aquifer by seepage into the river bed. The River Itchen is a perennial river that flows throughout the year. The Chalk aquifer is the only water input to the river during dry periods, and at these times the flow from the aquifer is reduced as groundwater levels fall. Groundwater levels are at a minimum at the end of the summer and early autumn. This reduction in river flow has a big impact on the river ecology and consequently river low flows are a primary consideration in the assessment of water resource availability.

Factsheet 4 - The Hydrology and Geomorphology of the River Itchen

In Britain the landscape has been shaped over millions of years by the action of ice and water to create many different types of scenery. Although the River Itchen valley was south of the southerly extent of the ice age glaciers, the ice ages were often also associated with periods of high rainfall called *pluviatiles.* The pluviatiles were characterised by high groundwater levels that fed streams and rivers that created the typical rounded Chalk valleys. Since the last Ice Age rainfall has been lower and groundwater levels have dropped. In some valleys, groundwater levels have fallen below the valley floor and these are known as *dry valleys.*

Although the Chalk is a hard rock, it is porous and susceptible to weathering by *frost shattering* or *ground heave*, it is also susceptible to *chemical weathering* by solution of the calcium carbonate minerals of which it is principally comprised. However, the Chalk contains frequent layers of flint nodules that are chemically inert, impermeable and resist weathering. Thus erosion through weathering by ice and *dissolution* by percolating water removes the $CaCO_3$ component leaving a residue of flint. The flints are transported along the Chalk stream river beds during flood flows and are a typical feature of Chalk river beds.

In contrast to the Chalk, the London Clay and the Barton and Bagshot Beds are chemically inert and do not suffer from chemical erosion. However they are comparatively soft and suffer physical erosion consequently the land in the southern half of the river catchment is relatively flat and low lying.

The River Itchen has two distinct river morphologies. In the Chalk of the northern half of the catchment, there is high relief and the river gradients and flows are moderate. The river has moderately high energy and is capable of transporting its flint bed load, so is slowly eroding the chalk along these sections and sediments are being transported instead of being deposited. This results in relatively narrow, eroding valleys. The river follows the natural weaknesses in the Chalk and has a distinctly orthogonal channel pattern, which approximate to the fracture directions generated during folding since the Chalk was formed during the Cretaceous. This preferred alignments of the river valleys are clearly visible on an Ordnance Survey map. The coincidence of springs and fractures in the river valley bottom enhances water flow along fissures by opening and connecting fractures by *solution widening*, these areas of enhanced permeability are the most productive sites for water abstraction boreholes in the Chalk.

The southern half of the river catchment is characterised by low relief and weak rocks providing silt and clay from weathering and transport processes. In these reaches of the river, the low energy results in a slower, *depositional* environment. Consequently the river forms sinuous meanders across a wide flat flood plain that are independent of the underlying geology. The point of change in river morphology is quite marked and occurs at Shawford close to the Chalk outcrop boundary with the Woolwich and Reading Beds.

In most catchments flooding occurs in the lower reaches of a river where a flood plain has developed and shallow gradients prevent rapid drainage. The River Itchen is prone only to mild flooding events because rainfall is absorbed by, and percolates into the Chalk, thereby reducing rapid run-off to the river system. Consequently river flows, even during high rainfall periods, are moderated by the natural storage of the Chalk. In the case of the Monks Brook tributary similar processes affect the flows out of the Barton and Bagshot Beds but in this case, the Beds have a much smaller storage and man-made pavement covers more than 50% of the sub-catchment. Consequently very high but short duration flood flows occur on this river.

Factsheet 5 - Ecology and Habitats

Ecology is the study of organisms in relation to their environment or surroundings. This is sometimes called the study of *ecosystems.* For example, a pond is an ecosystem.

Each ecosystem is made up of two parts: a non-living part called a *habitat* where organisms live and a living-part called a *community* which is the group of plants and animals that live in the habitat.

Each community is made up of different *populations* of plants and animals. A population is a group of individuals of the same species. For example, the stream community of the Monks Brook contains a population of Kingfishers, a population of dragonflies, and a population of willows.

Environmental Factors

Each ecosystem has a particular set of conditions or *environmental factors* such as water, temperature and light. Plants and animals must adapt to these conditions if they are to survive.

Water is needed for all life to survive. In streams such as the Monks Brook, plants and animals also have to withstand fast flowing and occasionally polluted water. Few living organisms can grow outside the *temperature range* of 0-40°C. Some stream organisms prefer warmer shallower water, whilst others prefer cooler deeper water.

Light is needed by plants for *photosynthesis.* Some plants are adapted to live in the shade, whilst others grow best in full sunlight. The *turbidity* of water is a measure of its cloudiness. Few plants are able to live in cloudy water as the cloudiness reduces the light available. Typical of Chalk rivers, the River Itchen has consistently clear water even during heavy rainfall and high run-off periods. Consequently it provides an exceptionally good habitat for channel and channel margin plants.

Few organisms can live without *oxygen.* Aquatic organisms for example, take oxygen out of the water. Plants also take in *carbon dioxide* (CO_2) for photosynthesis and give out oxygen. Animals use oxygen for respiration and give out carbon dioxide.

In any habitat there is a limit to the food, light, water and space available. Therefore plants and animals have to *compete* for these resources. Some individuals will be better adapted to compete than others. Plants and animals that are not well adapted may not survive or suffer greatly reduced populations. However if conditions change, for instance a dominant species may contract a virulent disease, as happened with the house sparrow a few years ago, then other organisms may utilise the free resources. Consequently the populations in a community may change proportions, sometimes dramatically. However if the community species are well adapted, they are often able to recover quickly when favourable conditions return.

The influence of Human Activity

Human activity has become in many cases the most significant factor that affects the survival of living species. Industry, forestry, farming, transport and housing all dramatically change the natural environment and frequently affect the survival of organisms by altering their habitats.

Factsheet 6 - Land Use

Within the River Itchen catchment land use can be divided into a number of categories. These include: arable and livestock farming, aquaculture of water cress, fish farms, urban areas including industrial, residential and business areas, waste disposal sites, transportation including roads, motorways, railways and an airport, conservation sites and recreation and leisure sites. Each land use has an associated economic or lifestyle value but also may have an associated adverse impact on the environment. The table below summarises some of the benefits and adverse impacts associated with each kind of land use in the lower River Itchen catchment.

Land Use	Benefit to the Community	Adverse Environmental impact
Arable agriculture	Provision of food, work and economic value	Some contamination of rivers and groundwater from use of pesticides, fertilisers and soil erosion.
Livestock agriculture	Provision of food, work and economic value	Some contamination of rivers and groundwater from silage, animal waste and insecticides.
Urban - Housing	Provision of shelter and quality of life	Few. Production of waste water sewage.
Urban – Industrial	Manufacture of essential and lifestyle goods and economic value.	Hospital waste, accidental and intentional chemical spills, contamination of water, and ground, air pollution.
Urban – Offices	Government and management of lifestyle. Economic value.	Few. Production of waste water and waste paper.
Transport – Road, rail, and airports.	Economic and lifestyle value from rapid access, transport and communication.	Accidental spillage of fuel. Herbicide contamination of groundwater. Air pollution.
Parkland	Sports and recreation. Lifestyle value	Grassland only, therefore poor plant habitat and no cover for animals. Use of fertilisers and fungicides etc.
Waste Disposal	Disposal of harmful and bulky wastes. Economic and lifestyle value.	Contamination of soil and groundwater. Significant contamination from poorly managed historic waste sites.
National Trust and nature conservancy land	Conservation of the general environment, plants, animals and historic buildings. Lifestyle and economic value	Few. Land unavailable for alternative uses.
Private Estates	Excellent conservation of natural habitats due to lack of access to the public. Economic value.	Few. Poor access to national environmental and heritage sites. Poor amenity value. Contamination from animal waste, fertiliser and pesticides

Factsheet 7 - Monitoring Water Quality

Human activity has an adverse impact on the natural environment that takes place in four principal ways. These are alteration of the natural environment to provide land use for human activity; use of harmful chemicals such as pesticides and herbicides; spillage and disposal of chemical, biological and bulk wastes (e.g. builders rubble) into waste disposal sites, rivers and the atmosphere; and environmental interference (e.g. increased human access or water sports).

Alteration of the natural environment is necessary, either to provide land use for human activity or to provide resources. Development need not have an adverse impact if it is well managed but can have severe consequences if it is inappropriate. Even innocuous activities such as groundwater abstractions can be detrimental. Groundwater abstractions reduce groundwater levels, causing low river flows that concentrate pollutants in the river, or in severe cases, cause rivers to dry up altogether with a drastic impact upon the river habitat and ecology.

In order to protect the environment it is essential to be able to assess the state of the environment effectively. This can be achieved by environmental monitoring. Traditionally this has been accomplished by periodically sampling soil, water and air at standard locations and testing the samples to determine the concentration of the chemicals contained within them. Chemical testing is expensive and consequently extensive parameter testing, such as the data obtained at Gaters Mill, is only carried out at a few sites and only where necessary on a periodic basis.

In order to pinpoint sources of contamination and activities that regularly pollute the river, routine samples are also taken at other monitoring sites throughout the catchment. Pollution from landfill leachates, air emissions and sewage treatment plants must all be monitored by the Environment Agency to ensure compliance with discharge and emission consents.

At river monitoring sites the usual principal objective is to determine if treated sewage effluent discharges are complying with their discharge consents, that suitability for downstream abstraction is maintained and that the river water quality is maintained at a potable or similar high standard in accordance with the national river water quality classification. This is based on an assessment of the suitability of river water for the uses for which it is required. Effluent is continuously discharged into and diluted by the flow of river water in the Monks Brook and the River Itchen south of Eastleigh and it alters the water temperature, dissolved oxygen, BOD (Biological Oxygen Demand) and ammonia concentrations in the water. Consequently, these four selective tests are usually undertaken for water samples from the river monitoring sites.

Monitoring through the collection and testing of samples allows the Environment Agency to determine or check if the water companies are operating their sewage treatment plants efficiently or in compliance of their consents. However although water sample monitoring is extremely accurate it is unable to determine water quality in between sampling. Due to the expense and logistics of sampling, water samples are rarely collected at frequencies greater than once a month. Consequently, water sampling is only effective at identifying contamination that occurs frequently or has released chemicals that are *persistent* (i.e. remain for long times without breaking down). Consequently, the state of the environment is now also assessed by monitoring environment specific species. On the River Itchen this is carried out doing *surveys* of the worms living in the river bed and river corridor surveys. Biological surveys cannot match the accuracy of chemical surveys but complement the snapshot water chemistry method by indicating harmful contamination of the environment.

Factsheet 8 - Monitoring Fisheries and Ecology

In any river environment there are a number of distinct habitats. These include the flood plain, associated wetlands and marshes, the river margins comprising the river terraces, flood plain water meadows and levees, the river banks, the river channel margins and the river channel itself. Within these habitats relief, channel shape and behaviour such as meanders, river water chemistry, the reliability of stream flow and the type of river bed (i.e. gravel or mud) are controlled by the rocks of the catchment aquifer. Consequently rivers provide a highly varied range of habitats within a small space. This allows an extremely diverse fauna and flora to flourish in association with each other because each organism is able to exploit a particular *niche* in the environment rather than having to compete for space with winners and losers.

The number of species at any one location is referred to as the *species diversity* and it is a good measure of the value of a particular habitat or environment. However species exploiting a niche habitat are very sensitive to reduction in habitat or habitat changes. Consequently river habitats in particular require effective river management to ensure that human intervention resulting from increased access, or alteration of the environment for economic and lifestyle reasons is carried out in an appropriate manner.

The *vulnerability* of aquatic species to environmental change can be put to good use because their sensitivity to specific habitats makes them excellent indicator species to monitor a river environment. Reduction in species diversity at any location indicates that pressures on the site environment are probably occurring and these may be caused by increased human access, alteration of land use, pollution from persistent chemicals or frequent low risk spillages which when combined together become important. For instance many animals and plants are sensitive to changing pressures according to the stage of their life-cycle. For instance, fish may require a gravel river bottom during spawning to protect their eggs from river bottom currents and predation.

Water and sediment sampling identifies chemical pollutants that have accidentally or deliberately been introduced into the river environment. However the time and cost necessary to identify every chemical in the environment by this method is prohibitive. Habitat monitoring determines the well-being of the environment more effectively. Consequently both techniques are currently used to monitor the state of the environment.

River habitats and the need for river management at each location is assessed by carrying out a *river corridor survey*. In carrying out such surveys it is necessary to assess each of the wide variety of habitats associated with rivers in turn, identifying the species that are present in those habitats and what modifications are necessary to enhance each river section. This survey records the species and habitats present along a sequence of river sections called *reaches*.

Species diversity monitoring is a good measure of the state of the environment. Monitoring of every species in a habitat is very time consuming and prohibitively expensive. Consequently, it is necessary to compromise and choose a number of good indicator species that are both common, sensitive to the environment in question and are immobile. Animals lower down the *food chain* are often numerous but not environment specific. Animals high up the food chain are much less common and are often also mobile. Consequently, the Environment Agency assesses the state of the river environment and water quality by surveying the diversity of worm populations resident in the river bottom which are the best group of species that satisfy the survey criteria. However alternative species may be used if appropriate.

Factsheet 9 - Monitoring Water Resources

The Agency is responsible for planning resources to meet the water needs of the area, licensing water companies, organisations and individuals to abstract water and monitoring the licences.

In managing water resources to achieve the right balance between the needs of the environment and those of the abstractors, it is necessary to estimate the available resources to meet present and future demands. This is achieved by monitoring the changes that occur spatially and over periods of time in the principal components of the water cycle so that they can be analysed to determine the amount of water that can be allocated to permit sustainable development.

To do this the Agency has established a number of monitoring sites to measure directly or remotely, either continuously or occasionally such parameters as rainfall, river flow and groundwater levels. Other important hydrological parameters such as humidity, wind, sunshine radiation, and evaporation are measured by the meteorological office and provided to the Agency on request. Thus groundwater (level and quality) including deep wells and springs, surface water (level, flow and quality) including streams, rivers, drains, lakes, wetlands, estuaries and reservoirs are all effectively monitored by the Agency. The data may be compiled in the form of paper records, magnetic or digital data and is processed and compiled in a variety of ways that are appropriate for the proposed methods of analysis or storage.

Thus the staff of the Agency are involved in significant amounts of fieldwork, data processing and analysis so that a variety of plans and scenarios can be prepared for water resources assessment. To enable the assessments to be completed, it is also necessary to measure the abstractions from and the discharges into the water resource. The abstractions comprise those licensed for public water supply, industry and agriculture, together with the releases or maintained flows that are required to sustain water levels or water flows within the catchment to meet the needs of water quality, ecology, recreation, power generation and navigation. Discharges into the system include those consented such as sewage effluent, industrial effluent, mine drainage, storm water and field drainage and cooling water discharges from factories and power stations.

A water balance is established for each water resource unit, be it an aquifer or river catchment by assessing the total inputs, outputs and change of storage so that an agreed available resource can be used for planning and management purposes.

Factsheet 10 - Collection, Treatment of Sewage and Disposal of Treated Water

Since the importance of hygiene was first recognised and the Victorians began to build municipal sewerage systems, one of the principal environmental problems associated with rivers has been the disposal of sewage. Prior to the construction of treatment works, raw untreated sewage was often thrown out of town houses from where it drained through the sewers into open water courses, creating an ideal environment for black rats. Black rats carry many known virulent diseases including the black death. Therefore as urban populations increased during the Middle Ages, so did the rat population and so did the incidence of potentially lethal diseases such as cholera, black death and weils disease.

The Romans were one of the first civilisations to recognise two thousand years ago that sewage not only had to be removed from the urban environment to improve *public health*, but it also had to be prevented from contaminating water supplies. They used slave labour to design huge water engineering projects and constructed *aqueducts, canals, water tunnels and piped water systems* that provided plentiful water supplies to Roman cities. Water was re-used in a strict order. It was first used in fountains and water features throughout each city to demonstrate publicly roman wealth, skill and ingenuity, before being piped to hot and cold roman baths and then to continuously flushed communal city toilets. From the toilets the water was then piped to the fields where the water and sewage fertilised and irrigated the crops and where exposure to the sun quickly destroyed the *pathogens* contained in the water. It is remarkable that this was all accomplished without the aid of pumps. Water was supplied under gravity only. Careful surveying, design and planning was essential to achieve this level of engineering which took many years to construct.

However it was not until the Victorians developed large pumps powered by steam that *environmental engineering* and a piped water supply could be provided cheaply. Consequently the Victorians not only provided a piped wholesome water supply to each home, they also built sewers to transport the waste water out of the city. The large volumes of sewage were dumped into water courses downstream from the cities. Unfortunately the bacteria breaking the sewage down and the natural chemicals contained in sewage have a large oxygen demand and once added to water, quickly use up the dissolved oxygen. Therefore the water courses rapidly became *anoxic*, killing all the natural plant and animal life. By the end of the Victorian era, many of Britain's rivers and most notably the Thames had become smelly and lifeless and Victorian engineers deliberately kept people away from the Thames by building large river embankments in central London to hide the oderous Thames.

During the twentieth century successive measures were taken to improve river environments, including the treatment of sewage. The solid component is first removed by *primary treatment* in settling ponds before *secondary treatment* of the water component. The secondary treatment is carried out either by transfer through reed beds, or percolation through a soil layer or by passing the water slowly through special gravel beds. In all the methods *anoxic bacteria* decompose the sewage water naturally. Once the sewage has been treated, the oxygen demand, ammonia content and other water quality parameters are dramatically improved. Small volumes can be percolated through the soil layer that is a natural filter of biogenic material, however disposal of the large volumes of water is a problem, pumping of the treated water to the sea is prohibitively expensive. Therefore the only feasible solution is to dilute the sewage works effluent by combining it with river water. This practice continues today but requires careful monitoring to ensure river water quality is maintained. Sewage sludge disposal from the primary treatment process is yet to be resolved. Use as an agricultural fertiliser is one option.

Factsheet 11 - Site Pressures and Competing Demands

Pressures on the environment at individual sites usually come from human activity but natural processes such as climate change and rising seawater levels can also have some impact. The human pressures may be accidental or arise from processes associated with intentional or planned activities. In many cases the activities are unavoidable because the activity is of economic or lifestyle importance.

In densely populated regions, such as southern England, it is inevitable that competition for land space occurs. River environments are at a particular premium as they are of economic value, aesthetic value, and lifestyle value. The Tables below list the site pressures and competing demands at each of the study sites.

Fleming Park, Monks Brook.

Site Features and Competing Demands
Parkland with facilities for recreational sports.
Access for walkers.
Golf course.
River provides aesthetic feature through centre of park and golf course water features.
Park provides storage of local flooding at southern end of the park.

Site Pressures
Poor water quality arising from accidental and repeated discharges of oil based chemicals from upstream industrial site.
Mowing of parkland destroys river-bank vegetation and habitat.
Stream has been canalised to prevent peak storm flows flooding parkland with loss of natural habitat. Stream channel is actively eroding its banks.
Steep channel sides provide habitat for endangered water vole. However the rapid rise of water levels during rainfall periods means voles have high risk of being flooded out. Rapid flows prevent effective growth of stream vegetation. Therefore it is a poor site for aquatic plant, otter and water vole conservation.
Motorway along west side and industrial estates upstream of Fleming Park cause regular oil based spills into the Monks Brook.

Factsheet 12 - Site Pressures and Competing Demands (Continued)

Woodmill, Swaythling

Site Features and Competing Demands
Canoeing.
Walking.
Outdoor activity centre.
Parkland including small golf course.
Important site for aquatic plants, animals and birds.
Strategic site for the otter in order to expand otter distribution to other Solent rivers.
Resting location for salmon making the transition from salt to fresh water.
Historic uses: Itchen Navigation Canal and Old Mill.
Pond dipping in fish pond.
Effluent disposal from Portswood sewage treatment works.
Commercial rod fishery.
Commercial historic salmon net.

Site Pressures
Control of flood water outflow into estuary. High flows required to encourage salmon into the River Itchen (Navigation). Also provides white water conditions for canoe school.
Control of water levels in canal.
Control of water level in salmon pool.
End of Itchen river and Monks Brook Tributary. Any contaminants and discharges in either rivers pass through this site.
End of tidal estuary. Any contaminants and discharges into the lower estuary may reach site on flood flow up the estuary.
Fish pass required upstream to provide access from Monks Brook to the River Itchen for migrating salmon that miss the salmon pool fish ladder choosing to swim up the Monks Brook instead.
Maintenance of good water quality for fish and other river and pond life. The River Itchen is very vulnerable to pollution spills, although pollution is a very rare occurrence on this river.
Storm water effluent outfall from surrounding urban area.
Illegal poaching of salmon and sea trout.

Factsheet 13 - Site Pressures and Competing Demands (Continued)

Monmouth Close, Monks Brook

Site Features and Competing Demands
River Restoration of old canalised section of river along railway line to restore the Brook to a more natural habitat.
Amenity for walking, cycling and leisure activities.
Flexford Nature Reserve. Preservation of natural habitat, flora and fauna.
River flood plain to store and provide second stage channel for peak flood flows.

Site Pressures
Poor water quality discharges through sewer system from adjacent industrial estates.
Reduced access to the Brook and the flood plain during high rainfall events.

Teachers Notes

Human influences on the environment are always hard to quantify without prolonged and laborious monitoring of data from individual sites. It is therefore difficult to illustrate this feature apart from anecdotal information. However the "Growth in urban area in Monks Brook catchment" map on page 80 in the data and catchment maps section shows some features particularly well.

Firstly the map indicates the steady growth in urbanisation since the 1930s. The change in percentage of developed area compared to the total catchment size is dramatic. Suggest the students trace the areas onto grided paper and calculate the successive increases in the percentage of developed surface area to the total catchment area. Note that by 1991 the total area covered is of the order of 40% and development is continuing in the catchment.

This has obvious implications in terms of flood flows and run-off as the increased surface area covered by urban pavement increases the rain catch flowing as run-off. Land underlain by the London Clay had high run-off before urbanisation but land on the Barton and Bagshot Beds covered by the development will change from percolation and storage in the groundwater system following a rainfall event to more or less instantaneous run-off. The dramatic increase in urbanisation therefore helps to explain why the Monks Book has such a high run-off component of stream flow as demonstrated by the 1998 stream flow data from the Stoneham Lane gauging station on page 49 in the data section.

These effects are the measurable physical effects. From a biological and recreation point of view, the urbanisation has caused dramatic reductions of natural habitat in the catchment and made green space a rare commodity within the developed areas.

Factsheet 14 – The Historical Perspective

The River Itchen has experienced a number of changes in use over the years that reflect the changing social and economic demands placed on the river, such as it often having more than one channel, particularly in the lower catchment. Three historic uses gave rise to this multiplicity of channels which were the harnessing of water power for milling, the use of water meadow systems to promote the early growth of pasture, and the development of the river for navigation between the tidal section and Winchester.

Traditional water based industries included wool processing, paper making, tanning, flour and grist milling, as well as the generation of electricity. The last working mill ceased operation in the 1960s.

The valley floor contains evidence of extensive systems of surface irrigation that provided water to *water meadows.* A complex system of terraces, water level control structures, channels, aqueducts and drains ensured the water meadows were flooded for several months each year. For many reasons, including the reduced demand for early pasture and its labour intensive management system, the water meadows have now become derelict. Besides the creation of water meadows there has been a long tradition of growing water cress that is an important present day economic activity.

The salmon fisheries are probably more than one thousand years old with private fishing rights predating the Magna Carta. It is believed that the Salmon Pool at Woodmill dates from at least this period. Since then, the salmon runs have been protected and managed by riparian owners for hundreds of years and more recently many fish farms have been built especially in the upper reaches of the river.

The River Itchen Navigation dates from Charles IIs reign when he passed an Act for making the river from Woodmill to Winchester navigable for barges and boats. The river may also have been navigable for small boats up as far as Alresford from at least the 12th Century onwards but details are uncertain. New channels were cut under the new Acts of 1795, 1792, 1811 and 1822. The navigation fell into disuse many years ago but although partially filled in some places, it can still be traced on large scale maps.

These industries illustrate how our use of the environment has changed dramatically particularly since the start of the industrial period and this change continues apace. Public perception of the environment comes largely from news items in the press and media, as awareness is restricted to newsworthy items such as summer low river flows or pollution incidents it is easy to gain a perceive the environment purely in terms of the problems industrial processes and urbanisation have caused. However there has also been a steady improvement in the environment and water quality standards since Victorian times that are only apparent through comparison of longer periods of time. The change in standards has largely been achieved through a combination of the progressive improvement of environmental management techniques, the public's increasing demand for higher standards and an increasing willingness to pay for the additional cost.

Factsheet 15 - Climate Change

It is very difficult to demonstrate or prove that climate change has occurred or will occur in the future in response to human influences. It is not known whether the changes in rainfall and temperatures experienced in the UK over the past 20 years are the result of a natural cycle or have been caused by human intervention. However what is certain is that there have been a much higher than average group of dry years during the past 20 years and a greater seasonal variability.

The Agenda for Action on Water Resources and Supply published by the Department of the Environment in 1996 makes the following comments "The droughts of 1995/96, 1988-92, 1984 and 1975/76 may be considered as exceptionally rare events for specific time spans and for specific parts of England and Wales. For each the rainfall was of sufficient magnitude and duration to affect water resources over a wide areas, and to test severely the ability of water supply systems to satisfy demand. The effects on climate change may become increasingly significant on rainfall patterns and hence on water resource availability"

Low rainfall years experienced in the catchment since the 1970s and especially during the 1980s have resulted in the progressive seasonal emptying of the Chalk aquifers and thereby similar seasonal reductions in the flows of the Itchen River and the Monks Brook. On the River Itchen, low flows have a large impact on salmon as the low flows mean that treated sewage effluent is less diluted, markedly reducing the river water quality. Simultaneously the low water levels increase the number of obstructions to fish movements, reduce the protection of fish from predators and increase the deposition of silt which then covers the gravel beds that are necessary for effective egg laying and spawning. It is likely that variable river flows may occur in the future in response to climate cycles or climate changes and that effective river flow management, including river augmentation and other methods, will become increasingly necessary.

Although it is difficult to demonstrate climate change is occurring on a global scale, it is apparent in the local River Itchen Catchment. Longterm rainfall records over the last seventy years indicate that rainfall in the River Itchen Catchment has tended to increase in March and decrease in July and August.

For additional information and a discussion of climate change issues in the River Itchen Catchment see: Suggested Classroom Exercise 5, on page 85

Factsheet 16a - The Importance of Planning the Environment

Many of our economic and lifestyle activities have an impact on the environment through competing demands for land space, utilisation of resources, production of pollutants and alteration of natural habitat although the degree of impact varies from activity to activity. Therefore it is becoming increasingly important to manage the environment to control issues associated with water supply, farming, urban development, waste disposal, air pollution, transport, industry, navigation and recreational and leisure activities.

The choice between competing demands for resources is a difficult and often contentious exercise. Consultation, discussions and liaison with appropriate organisations is both necessary and time consuming and is organised by local government in consultation with statutory organisations such as the Agency. Planning is a complex area with many separate issues. Waste disposal sites and sewage effluent treatment are good illustrations of some of the issues that affect planning.

The problems associated with sewage disposal from our modern cities arise because of their large scale. At an individual scale, houses in the country sometimes utilise soak-aways that allow household sewage to percolate slowly through the soil layer so that bacteria and chemical reactions in the ground purify the water as it passes through. Such a process has only a very minor impact on the environment and in dispersed populations has no significant impact. The Romans were able to dispose of their sewage on fields because even their largest cities had relatively small populations. Today cities are much larger, usually with a high population density where small scale engineering solutions are not feasible. Thus population density is one of the most significant influences on environmental pollution. As in Roman times, planning of our modern cities to minimise environmental pollution and maximise lifestyle enhancements is an essential component of environmental management.

The planning role in the River Itchen catchment is carried out on a county level by Hampshire County Council but the detailed municipal planning is conducted at a local level by Winchester City Council, Eastleigh Borough Council and Southampton City Council. Although for historic and engineering reasons, sewerage and sewage treatment is undertaken by the local water supply company, the local councils are responsible for planning, organising and operating refuse and waste collection, recycling, and disposal in carefully managed and monitored refuse and waste disposal sites that are categorised according to the mobility and potential environmental risk from the waste.

Many noxious contaminants enter the environment through landfill sites. Up to the mid-1980s waste was tipped indiscriminately and many waste organisations did not keep accurate records of the wastes stored at any site. Consequently it is now often difficult for specialists to anticipate environmental problems from a landfill site. Therefore environmental protection is only possible by monitoring sites and if necessary, carrying out environmental clean-up operations as the monitoring programs detect unacceptable levels of risk from the contaminants. Unfortunately, the lack of sufficient information can also make the monitoring of old landfill difficult.

Today statutory regulation requires landfill and refuse sites to operate to strict procedures that include the maintenance of careful disposal records, separation and disposal of wastes into different locations, authorisation of landfill sites to dispose of defined categories of wastes and cover-up of the refuse or wastes each day with clay and or plastic membranes to prevent harmful chemicals being leached by percolating rainfall.

Factsheet 16b - The Importance of Planning the Environment

Teachers Notes and Suggested Exercises relevant to factsheet 16a

A list of the historic and currently active waste disposal sites is on page 79 in the data section. Ask the students to compare the location (gained from the grid references) of the of the landfill sites with the catchment geology map on page 4. Note that clay is the soil/rock type most of the disposal sites are located on.

Clay has been excavated for a number of centuries to supply industry and brick manufacturers and the resulting clay pits provide good disposal sites. Clay is relatively impermeable and restricts contaminant leakage getting into underlying aquifers such as the Chalk.

Suitable landfill sites are becoming an increasingly rare commodity as the remaining clay pits and alternative landfill sites are filled up. Since effective landfill sites must have a large volume that is surrounded by an impermeable seal to stop rainfall leaching chemicals from waste disposal sites, new sites are hard to locate or expensive to engineer. The cost of waste disposal is likely to increase in the coming decades. Engineering options include using thick plastic matting referred to as *geomembranes* to contain the waste leachates within the waste disposal site where clays are absent or clay permeabilities are not low enough to meet design specifications.

Another increasingly important option is to increase incineration and recycling; 50% recycling doubles the life span of available waste disposal sites. Ultimately, unless a solution is found, the cost of waste disposal will increase in the early part of the 21st century making alternative technologies increasingly cost effective. Clearly these are important considerations in the planning process.

Factsheet 17 - Management of Competing Demands

Effective river management has to take account not only of the linkage between natural processes but also the demands and expectations of the people that use a river for a diverse range of lifestyle and recreational activities, businesses that rely on a river for its economic value (i.e. for water supply, fisheries, water power and water transport) and the need to protect and conserve the environmental value of a rivers natural habitat, wildlife and plants.

Many of the river uses derogate the value of the river for others. For instance, the over-abstraction of groundwater in the upper catchment for water supply could reduce the flow in the river downstream, thereby diminishing the aesthetic amenity and reducing the water dilution of treated sewage effluent. The consequence would be a reduction in the river water quality affecting the animals and plants that live in or depend on the river for food.

Therefore to achieve effective river management a decision process has to be employed in order to identify which uses of the river take precedence at any point. This involves managing each of the uses of the river and the inclusion of consultation with local planning authorities, river users and conservation groups to develop consensus with development or conservation plans, followed by incorporation of the controls to protect the river environment to conserve it for future generations. This decision process normally functions on the basis of at least achieving the status quo and in many cases achieving improvements and enhancements. In other words, the current uses of the river take precedence over any new planned uses. Alteration of the status quo is undertaken where current practices are detrimental to the environment and this applies particularly to environmental protection but also to abstraction rights and licences.

The Environment Agency is pioneering a new approach to river management that continuously develops and enhances the environment for future generations. For each area, the Agency is producing a local environment action plan or LEAP. LEAPs are based on river catchments so that the River Itchen and Monks Brook catchment are included in a single LEAP. The LEAP identifies all the pressures on the environment, the competing demands and the projected demands that are expected in the future from say anticipated increases in housing which has been an issue in the Itchen catchment. In addition to identifying pressures, the LEAP also provides a management tool to canvass all the environmental stakeholders with interests in a river catchment from waste disposal to flood control to provide the Agency with an overview of the expectations and demands from the public and industry regarding relevant issues.

Once LEAPs have been completed for all of England and Wales, the Agency will have a complete perspective of the state of the Environment, and financial resources will then be provided on a local basis to target the most pressing issues identified in each area through the LEAP process.

The LEAPs process also has the additional benefit of giving the Agency a greater incentive to be proactive in conservation, pollution prevention and local environmental initiatives. These are key areas that the Agency wishes to develop in the future since in most cases, co-operation and improving the public's awareness of the environment is often much more effective then enforcement. In addition, the public expectations of the condition and status of the environment are also continuously evolving. Canvassing of opinion is vital to achieve appropriate and effective river management and LEAPs provide this process.

Factsheet 18 - Management of Recreation and Conservation

The River Itchen has been recognised as an area of natural beauty and as one of the finest examples of a Chalk river not only in the U.K. but also within a European context. For some years now it has been designated as a site of Special Scientific Interest (SSSI) that recognises the special value of the river and affords a legal process to protect the river channel, its immediate river banks and the flora and fauna found in these locations from other activities that derogate the natural beauty, interfere with the ecosystem and the quality of the environment. More recently, the river has been designated a Special Area of Conservation (SAC) under the Habitats Commission of the European Union Directive that protects many of the features of the environment beyond the immediate banks of the river.

In addition to its traditional role of protecting and managing the environment, the Agency has a new role to encourage and enhance the activities of conservation groups within any river catchment or management area. It has a general policy of promoting water based recreation where it is appropriate on the basis of permitting the harmonious enjoyment of the environment.

In the River Itchen Catchment considerable effort is put into the protection and conservation of the wild brown trout fisheries to preserve the quality of fishing on the river both for riparian owners and recreational fishermen. The effort is concentrated on wild trout fishing as these fish are of economic value but other species of fish also survive in the river and may be caught by anglers. Illegal fishing of salmon is a persistent problem and the agency monitors and enforces correct practice to ensure poaching is kept to minimum.

The key fish features are the salmon pool at Woodmill that provides a resting location for fish as they change their metabolism to adjust from a salt to fresh water environment and the fish ladders and structures that provide routes for the salmon, trout and eels to swim up the River Itchen to their traditional spawning grounds. Fish are counted at Gaters Mill only as the Woodmill fish counter is not currently operated.

In addition to conserving fisheries, the Agency has an active otter and water vole conservation program. Both are endangered species that have been in serious decline nationally throughout the 20th Century. However, the recent initiatives introduced by the Agency to conserve these animals have resulted in support of the Hampshire and Isle of Wight Wildlife Trust Otter Conservation Officer whose role is to conserve these beautiful animals. Both the Monks Brook and the Itchen provide ideal habitat for the otter and many of the steep banks of the Monks Brook offer suitable habitat for the water vole.

Woodmill is an important location for the otter as it provides access via the River Itchen estuary and Southampton water to the many other rivers flowing into the Solent, many of which provide excellent habitat for the otter. Therefore Woodmill is an important strategic location for the otter to provide the access route to other habitats where it is hoped it will expand its distribution.

In addition to the conservation of animals and plants, attention is also given to the conservation of habitats. The restored section of the Monks Brook at Monmouth Close has been undertaken to improve the habitat which had been derogated by realignment of the channel during construction of the adjacent railway. The restored section is adjacent to and compliments the purpose of the Flexford Nature Reserve which conserves a small section of the natural habitat of the Monks Brook and this is operated by the Hampshire and Isle of Wight Wildlife Trust.

Factsheet 19 - Ensuring Environmental Protection

Our use of the environment has changed dramatically since the start of the industrial period and this change continues apace. Public perception of the environment comes largely from news items in the press and media, as awareness is restricted to newsworthy items such as summer low river flows or pollution incidents it is easy to gain a perceive the environment purely in terms of the problems industrial processes and urbanisation have caused. However there has also been a steady improvement in the environment and water quality standards since Victorian times that are only apparent through comparison of longer periods of time. The change in standards has largely been achieved through a combination of the progressive improvement of environmental management techniques, the public's increasing demand for higher standards and an increasing willingness to pay for the additional cost.

Thus environmental managers are now required to instigate continuous improvement of monitoring and processing techniques to reduce pollution, improve installations to protect the environment from accidental spillages, improve environmental laws to aid enforcement of environmental standards, improve methods of monitoring and assessment of the state of the environment, provide more investment in conservation and rehabilitation of the river environment and provide greater access to the public to the river environment amenity.

The river water quality of the River Itchen Catchment is excellent. In fact it meets the highest *water quality objectives (WQOs)* and is so good that water is abstracted for drinking water supply at Gaters Mill which is at the bottom of the catchment. It follows therefore that the River Itchen meets drinking water quality standards throughout much of the catchment.

In contrast, the Monks Brook is often thought of as the poor water quality river. However despite repeated pollution events, this river also has very good water standards, supports important protected populations of river vole and otter and provides a very pleasant environment for walkers, cyclists and conservation activities. However the river remains vulnerable to accidental and deliberate illegal discharges containing oil based pollution. The large pavement area of the catchment results in rapid run-off, flushing any pollutants that might have been spilled on paved areas into the Brook. This includes the M3 motorway that is a consented discharge that drains into the Brook, the railway that runs close to the Monks Brook at Monmouth Close and the industrial estate also associated with this site. The pollution risk has been identified and campaigns to increase awareness and improve environmental protection measures at factory sites in the catchment have recently been undertaken.

Environmental accreditation has had a big impact in this catchment and in particular, many big companies have made large strides in applying best practicable environmental options (BPEOs) and reducing disposal of pollutants. However in a catchment that has a high proportion of domestic housing improved practice in homes is also an important target of the Agency. Many household chemicals, such as bleach, are very destructive to the environment, many of which are disposed down the drain via sewage treatment works. Improving public awareness of these chemicals, their best use, and the disposal and the recycling of household wastes remain important targets within the catchment.

Finally, the monitoring and management of sewage treatment works remains a priority since the principle of best available techniques not engendering excessive cost (BATNEEC) necessitates disposal of treated effluent into rivers and dilution of the treated water in conjunction with regular monitoring to ensure river water quality standards are maintained.

Factsheet 20 - Management of Flood Defence and Land Drainage

The Agency has powers for providing an efficient and effective flood defence and land drainage service that involves managing watercourse maintenance programmes, the implementation of flood alleviation schemes on rivers and sea defences along the coast together with the provision of a flood forecasting and warning service.

Because most of the River Itchen catchment is underlain by porous Chalk rock, storm rainfall is able to infiltrate into the subsurface and does not create storm run-off. Consequently there is little surface water flooding risk in the catchment. However, very occasionally after a prolonged period of continuous rain, the groundwater level in the Chalk may rise substantially resulting in increased baseflow into the river causing river water levels to rise and flooding of riverside properties.

In the Monks Brook catchment the underlying strata are clays, sands and gravels with low combined storage capacity and therefore surface water flooding occurs after each storm rainfall event. This is exacerbated by the increasing amount of paved area in the catchment that results from urban development in Chandlers Ford and Eastleigh reducing the opportunity for storm rainfall to infiltrate into the soil and underlying sediments so that the flood run-off peaks become more severe.

To alleviate the risk of local flooding the channel of the Monks Brook was modified during the 1960s and 1970s. A number of engineering works were undertaken to improve the hydraulic efficiency of the river channel in order to transmit the flood peak volume more quickly downstream away from the urban areas towards the estuary. These works included the straightening, re-alignment and lining of the channel and the removal of obstructions.

In the late 1990s an alternative approach to flood alleviation has been introduced which involves the construction of local flood storage ponds. It is now possible in some cases to restore the downstream channels to their previous natural condition and improve the riverside habitats.

Similarly a new approach is being considered for coastal defence works which involves the concept of "soft" engineering rather than "hard" engineering. Rather than constructing expensive permanent sea walls to protect the coast in non-urban areas creating an artificial environment, consideration is being given to creating a more natural interface between the land and the sea, of which natural shingle beaches are a very good example.

9. THE ENVIRONMENT AGENCY

9.1 Formation of the Agency

The Environment Agency came into being following Royal Assent to the 1995 Environment Act in August 1995. It was formed by amalgamating the National Rivers Authority (NRA), Her Majesty's Inspectorate of Pollution (HMIP), 83 Waste Regulation Authorities (WRAs), and parts of the Department of the Environment (DoE) and the Agency took up statutory duties to protect and enhance the environment across England and Wales on 1 April 1996.

The principal functions of the Agency are pollution prevention and control, water resources, flood defence, fisheries, conservation, navigation and recreation. All the functions have responsibility and authority across England and Wales but the pollution control and fisheries responsibilities extend to three and six nautical miles from the coast respectively.

9.2 Statutory Responsibilities

The Agency has a wide range of statutory duties and powers related to its functions. Many of these are unchanged from those carried out by its predecessors the NRA, HMIP and WRAs. Although the 1995 Environment Act consolidated and amended inherited duties, it also added new duties. The legislation enforced by the Agency includes all the following Acts :

- Environment Act 1995;
- Control of Pollution Act 1974, Environmental Protection Act 1990;
- Radioactive Substances Act 1993;
- Water Act 1989, Water Resources Act 1991, Water Industry Act 1991;
- Land Drainage Act 1991;
- Salmon and Freshwater Fisheries Act 1975, Diseases of Fish Act 1983, Salmon Act 1986;
- Wildlife and Countryside Act 1981;
- Health and safety at work Act 1990;
- Police and Criminal Evidence Act 1984

The Agency has also been designated as a competent authority for some thirty EC Environmental Directives, many of which have a significant impact on the management of the environment and policing the standards required to meet objectives such as river water quality.

9.3 The Organisation of the Environment Agency

The Environment Agency is organised into a Head Office, 8 Regions and 26 Area offices. The Head Office is primarily concerned with forward planning, policy development and performance monitoring. Some of the Head Office science and technical services are organised as National Centres based in one region, and some business service activities are organised as National Services. The role of the National Centres is to develop excellence through research and review of best practice and to disseminate this information throughout the Agency.

The Regions and Areas implement policy and organise the daily operational activities dealing with the general public and industry. Many of the Agency's functions are related to river basin management and consequently, in general, the major regional boundaries follow those of the river catchments with some exceptions following river boundaries. Each Region is divided into three or four Areas to implement daily operations and to control those activities such as monitoring, licensing and regulation that are most effectively carried out at a local level.

9.4 Assessing the State of the Environment

Developing a clear understanding of the state of the environment and how it responds to the different pressures placed upon it is fundamental to effective environmental management. This provides the basis for decisions on what actions are necessary and how they should be prioritised. The achievement of the Agency's principal aim of protecting and enhancing the environment, requires a knowledge of what the state of the environment is now, how it is changing both over time and across the Agency's different Regions and Areas, and what as a consequence, are the priority issues to be addressed. This area of the Agency's work therefore provides a vital input into the corporate planning process to ensure that resources are properly targeted across England and Wales to address environmental priorities.

The Agency has inherited duties to assess the states of water resources, water quality, flood defences, and freshwater fisheries, plus a new and specific duty under the Environment Act of 1995 to compile information, either derived from our own work or obtained in other ways, in order to:

- facilitate the carrying out of its pollution prevention and control functions; or
- enable it to form an opinion of the general state of pollution of the environment.

To form an opinion of the state of pollution of the environment, or other features of the living and man-made environment, it is necessary to develop an understanding of the many and varied pressures on the environment and how they influence environmental processes. Some of these pressures are controllable by the Agency; others are not. Many environmental pressures are outside anyone's direct control. It is essential in assessing the consequent state of the environment that it is taken as a whole because of the effects which pressures on one sector of the environment can have on another.

LEAPs Consultation in the Corporate Planning Process

In order to achieve its stated goal of "a better environment in England and Wales for present and future generations", the Agency is continually evolving its long term strategy. The strategy is based on the Agency's individual assessments of the state of the environment, competing demands and site pressures gained from local environment action plans (LEAPs) across England and Wales. LEAPs are updated regularly and cover a specified area. For instance the River Itchen is covered by the River Itchen LEAP. Since LEAPs and the inherent consultation process are a key new objective, the Agency is still in the process of developing LEAP consultation reports and every area in England and Wales, many for the first time, will have a LEAP by 2000.

The aim of introducing the LEAPs is to produce a local agenda of integrated action for environmental improvement so that resources can be deployed locally to best effect and optimise benefit for the local environment. Essentially this is achieved by assessing competing demands and environmental pressures throughout a local area. This in turn requires the Agency to consult with the business community, local government, the media, the public and environmental interests such as conservation groups, environmental organisations and leisure organisations.

9.5 The Individual Functions of the Agency

The Agency has two main roles: environmental protection and environmental management. The Agency's environmental protection role is essentially one of pollution prevention and control whilst its environmental management role is predominantly river basin management in its widest sense. Thus the environmental protection role includes integrated pollution control, radioactive substances and water quality functions whilst the environmental management role includes water resources, flood defence, fisheries, conservation, navigation and recreation functions.

Water Resources

The primary aim of the water resources function of the Agency is to ensure proper use of water resources. Water resources personnel monitor river flows, groundwater levels and rainfall and manage river water and groundwater abstraction licences. The Agency is required by law to manage the River Itchen catchment with the objective of achieving enhancement of the environment through *sustainable development*. Water abstractions reduce river flows. Thus abstraction licences must be managed in such a way that sufficient flow rates and water velocities are maintained in the River Itchen and Monks Brook to ensure that the river habitats are sustained or enhanced and so that all the conservation, fishing rights and recreational uses of the river are preserved.

The demand for water supplies exceed the water resources available in the River Itchen Catchment. This is a common situation in England although the opposite is true in some regions such as Wales. Consequently the Agency manages new licences according to their benefit. The water resources required to sustain river flows and the water supplies for drinking water are both essential uses and have to be guaranteed. Within the next most beneficial category are non-consumptive uses (i.e. the majority of the water is returned to the river and is available for alternative uses), such as fish and water cress farming, whilst others such as spray irrigation and factory cooling water are almost totally consumptive and have the lowest priority in the catchment.

Climate change has been evident during the past thirty years so that on average, the past ten summers have been hotter and dryer whilst winters have been wetter although with a shorter winter groundwater recharge period. Consequently climate change has had some impact in recent years on available water resources and is considered one of the key pressures on this function of the Agency in the River Itchen catchment. In response to this, Parliament is reviewing the possibility of giving the Agency increased powers to regulate all existing licences including licences of right where, every licence is for a set time period only, not exceeding fifteen years. It should be noted that many water licences are *licences of right* and have no time limit (these apply to water that was being abstracted for supply before the licensing system was begun in 1966). This new legal authorisation would give the water resources function of the Agency the necessary power to tackle the problems caused by climate change if or as it occurs by adjusting water abstractions and licences accordingly.

Flood Defence

The Agency's flood defence function aims to reduce risks to people and the developed and natural environment from flooding from the rivers and the sea. It has powers to provide an efficient and effective flood defence service including accurate and timely flood warnings to alert people of impending risks. In addition, the Agency manages watercourse maintenance programmes and implementation of flood alleviation schemes. The Agency is also required to assess applications for new construction projects or discharge consents, including the potential impact of the proposal on the relevant river catchment or sea defences.

The course of the River Itchen flood plain is almost entirely artificial having been altered in the past by the construction of mills, the Itchen Navigation and water meadows. The river is less subject to storm floods than most other rivers because the Chalk aquifer absorbs rainfall and delays discharge for sufficient time to reduce storms to very small peak flow. It is therefore exceptionally reliable and has a small flood plain with a small *freeboard*. The freeboard is the extra height above the normal river level, through which a river can rise before it overtops the river banks and enters the flood plain.

There are three types of flooding: storm peak flows, excessively high groundwater and baseflows, and estuarine flooding of high river storm flows superimposed on high tides. The most risky period for the latter are the spring high tides. These occur every fourteen days but are highest at the Spring and Autumn Equinox. The Monks Brook has very rapid run-off occurring within two hours of a storm event leading to very high storm flows consequently floods on the Monks Brook occur in response to heavy rainfall. The opposite is true on the River Itchen, as the Chalk aquifer prevents storm floods but it floods instead when groundwater levels are high. Unlike the two hour peak of the Monks Brook, the Itchen floods in response to two or three months of steady rainfall, despite the low freeboard of the river, the artificially altered channels and the heavier and more prolonged winter rainfall in response to climate change all contributing to the risk of flooding on the Itchen, it remains an uncommon event.

Any development in a flood plain is at risk from flooding. The management of the development of flood plains, such as new housing and industrial estates, is undertaken by local planning authorities. However the Agency, is a statutory consultee on development plans and many aspects of development control. The Agency provides constant advice to avoid building on the *flood plain*, but inevitably, commercial interests encourage encroachment of property development onto flood plains. Serious flooding tends to be about a once in thirty year event, as this is the time span of a generation and it appears, the time span of human memory. As time passes since the last major flooding event, flooding concerns are increasingly forgotten, and result in encroachment of the flood plain until an exceptional storm event occurs and people are reminded of the vulnerability of buildings to floods. For a time development is directed elsewhere until once again, past flooding is forgotten and encroachment begins again. This process is exacerbated when climate change increases the frequency of high rainfall events. As part of the Environment Agency's flood warning role it provides constant advice to the public and businesses located within the flood plain of each river so that timely warning is given to mitigate flood damage and prevent human and livestock mortalities.

Fisheries, Ecology and Recreation

The River Itchen is an SSSI and a SAC with riparian fishing rights. The Agency is responsible for the fisheries and conservation interests in the River Itchen catchment and maintains, improves and develops fisheries, enforces fishery legislation and promotes and implements conservation activity. In addition, the Agency is also responsible for developing and promoting the recreational use of water and associated land and for the liaison with River Use groups.

Within any area there is a conflict between conservation and recreation, as increased access to natural habitats can increase disturbance and have a detrimental effect on wildlife. The Agency's management policy is to promote water based recreation only where it is appropriate in line with "quiet enjoyment of the environment". For example, opening a jet ski centre on the River Itchen would not be appropriate. Equally, since canoeing already exists, new canoeing sites would not be promoted. However development of access and increased protection or enhancement of wildlife habitats would be key objectives.

The SSSI and SAC designations of the River Itchen Catchment are the key to the management policy. The River Itchen is now designated as one of the best example of a Chalk river in Europe requiring the highest standards of environmental preservation. Consequently the environment is managed to meet these high objectives and standards.

Although the Monks Brook falls outside these designations, recent activities on this river illustrate the role of the Agency. At Monmouth Close, the Environment Agency in co-operation with Eastleigh Borough Council has begun to restore sections of the Monks Brook to enhance the natural habitat. In addition, the same site has enhanced the environmental value of Flexford Nature Reserve at the northern end of the restored river section which is managed by the Hampshire and Isle of Wight Wildlife Trust. This is an important habitat for the water vole which maintains a presence on the Monks Brook.

Secondly, the Agency manages the environment on a strategic basis. In the case of fisheries, the riparian owners are best placed to alert the Agency to activities that affect their commercial interests such as the discharge of effluents or the reduction of river flows. Consequently, the Agency is able to direct its activities towards protecting fishing activities through management of fish licences and response to alerts rather than day to day policing although it also undertakes this duty.

In the case of ecology, strategic management of wildlife is particularly important. Both the water vole and otter are endangered and protected species that have key habitats on the River Itchen. The management policy associated with these animals is not only to increase the habitat in which these animals are able to live but also to encourage an increased distribution onto other Solent rivers. Management of the river corridor is also a key aim and objective. River corridor surveys provide detailed information and monitor the natural habitat along each stretch of the river. Comparison of successive surveys provides the data from which river management and enhancement plans are drawn up.

Environmental Protection and Planning

The Environmental Protection and Planning function of the Agency brings together control of major industrial processes, water quality regulation and management and waste regulation and management that were enforced previously by disparate predecessors before the formation of the Environment Agency. This allows the Agency to develop an integrated approach to environmental protection for the first time, building on the concept of Best Practicable Environmental Option (BPEO).

In many cases, a choice can be made to discharge a pollutant either to land, air or water or to a combination of them. This was recognised by the Royal Commission on Environmental Pollution in 1976, that incorporated the concept of BPEO, recommending that each industrial process be looked at as a whole and that a pattern of discharges should be selected to ensure the best overall outcome for the environment. This might, for instance, involve an increase in emissions to air to avoid a much more damaging discharge to water or vice versa.

The system of Integrated Pollution Control (IPC) was established under the Environmental Protection Act 1990 and is administered by the Agency. In granting and reviewing authorisation, the Agency enforces any existing release limits or environmental quality standards and requires the application of "best practice not entailing excessive cost" (BATNEEC) to minimise the impact of the applicant industry. The Agency considers different disposal options to establish what is best for environmental protection; requires operators to pay for authorisation as part of the "polluter pays" principle; and keeps a register of compliance and enforcement available for public inspection.

The pollution prevention and control function of the Agency is also responsible for the regulation and management of water quality and the disposal of wastes. This includes monitoring and archiving water quality records from observation boreholes, consented discharges to water courses, river sampling stations and waste disposal sites. These records are kept to identify any accidental spillage or illegal dumping of pollutants.

The second aspect of water quality and waste disposal involves the management of waste disposal and discharge consents to water courses. The Agency examines each request individually and specifies the conditions under which a consent may be operated and monitors activities to ensure that consents are adhered to. The consent conditions applied are dependant on the quality of the discharge water and the prevailing environmental conditions relevant at the discharge point or waste disposal site. The level of conditions applied is dependant on the principle of BATNEEC and the Agency charges for the consent under the polluter pays principle. The charge increases according to the degree of environmental pollution caused by the intended waste disposal or water discharged.

Finally, the Agency employs tactical planning to identify and target the persistent polluters of the environment, and works alongside these industries to reduce pollution through identification of better techniques or installations to retain pollutants on site e.g. pollutants mobilised by run-off.

Customer Services

Examination of the competing demands at each of the sites in this Agency Data File highlights the pressures currently being placed on environmental resources at most locations in Britain. Consequently it has become fundamentally important to plan development effectively. This requires significant consultation and collaboration with local government institutions, environmental organisations and the general public to determine the expectations and options for not only protecting, but also enhancing the environment in pursuit of the Agencys objective of sustainable development and local Agenda 21.

With the establishment of the Agency in 1996 a more comprehensive approach to dealing with the protection of the environment was introduced. By combining the responsibilities of the NRA, HMIP, the Waste Regulation Authorities with some of those of the DoE, together with the introduction of new duties, the Agency can now be considered to be one of the most powerful in the world.

The establishment of one national organisation dedicated to management of the environment not only allows more effective environmental protection but also allows customers such as industries, environmental organisations, farmers, riparian owners, conservation groups, students, teachers and the general public to deal with just one office. Customers need to contact the Agency to obtain environmental information, abstraction licences, discharge consents, opinion and advice on proposed developments, particularly if they are in flood plains whilst the Agency must also liaise with other statutory and planning organisations such as local Borough Councils and County Councils.

The Customer Services Department within each Area Office not only deals with incoming enquiries but also co-ordinates the marketing and planning functions of the Agency so that its influence upon public opinion and its participation in the wider planning process is strengthened and managed in a clear and professional way. Much of this activity is focused into management and continual revision of LEAPs. However the Agency also has additional objectives including increased transparency and a commitment to improve public awareness of environmental issues. In practice this means providing information to external requests for environmental information, liaising with schools and presenting the work and role of the Agency at strategic public meetings and shows. In addition, the Agency continuously updates its internet site with current data and relevant information and a visit to this site is recommended.

10. SOUTHERN REGION PUBLICATIONS LIST

As at January 1999

Ref	Publication
CORPORATE / GENERAL	
cor.1	**Guardians of the Environment** A4 Brochure detailing the work of the Agency
cor.2	**A Better Environment for England and Wales** Environment Agency - National Guide
cor.3	**The Environment of England and Wales - A Snapshot**
cor.4	**An Environmental Strategy for the Millennium and Beyond**
cor.5	**Customer Charter Booklet**
cor.6	**Helping Your Environment - complete the picture** (DoE)
cor.7	**Environment Agency 0800 Card with Leaflet**
cor.8	**An Introduction to Southern Region**
cor.9	**Hampshire and IoW Area Directory**
cor.10	**Kent Area Directory**
cor.11	**Sussex Area Directory**
cor.12	**A Guide to Information Available to the Public** What's on the Public Register
cor.13	**Our Complaint and Commendation Procedure**
cor.14	**Regional Review and Forward Look - Southern Region**
cor.15	**Corporate Plan 1999-2000 / Our Forward Look to 2002**
cor.16	**Corporate Plan 1999 / 2000 Summary**
cor.17	**Annual Report and Accounts 1997 - 98**

Ref	Publication Title
cor.18	**Annual Review 1997 - 1998**
cor.19	**Annual Environmental Report for the Agency's Own Activities 1997/98**
cor.20	**Annual Environmental Report for the Agency's Own Activities 1997/98 - Summary**
cor.21	**Partnerships In Action** Guidance on managing partnership projects
cor.22	**Local Agenda 21 leaflet**
cor.23	**Sustainable Development** Introductory Guidance to Sustainable Development
cor.24	**Managing the Environmental Impacts of the Agency's Own Activites**
cor.25	**Environmental Policy for the Agency's Own Activities**
cor.26	**Data & Information Policy Handbook**
cor.27	**Your Rights when Agency warranted officers take action**
cor.28	**All you ever wanted to know about Agency Publishing**
cor.29	**A guide to Exhibitions and Events**
cor.30	**An Action Plan for Flood Defence**
cor.31	**An Action Plan for Water Resources**
cor.32	**An Action Plan for Fisheries**
cor.33	**An Action Plan for Recreation**
cor.34	**An Action Plan for Conservation**
cor.35	**An Action Plan for Navigation**
cor.36	**An Action Plan for Water Quality**
cor.37	**An Action Plan for Process Industries Regulation**
cor.38	**An Action Plan for Radioactive Substances Regulation**

Ref	Publication Title
cor.39	**An Action Plan for Waste Management and Regulation**
cor.40	**Recruitment Information**

EDUCATIONAL

edu.1	**Green shoots** (Our vision for Environmental Education)
edu.2	**In Depth - River Flooding** (1) Number one in the series of education factsheets called 'In Depth' suitable for Geography students/teachers at Key Stages 3 and 4 of the National Curriculum
edu.3	**In Depth - Coastal Flooding** (2) 2nd in the series of 'In Depth' factsheets
edu.4	**In Depth - The Water Cycle** (3) 3rd in the series of 'In Depth' factsheets
edu.5	**In Depth - Pollution** (4) 4th in the series of 'In Depth' factsheets
edu.6	**In Depth - Uses of the Water Environment** (5) 5th in the series of 'In Depth' factsheets
edu.7	**In Depth - Environmental Management** (7) 6th in the series of 'In Depth' factsheets
edu.8	**In Depth - Conservation** (8) 7th in the series of 'In Depth' factsheets
edu.9	**In Depth - Life in the Rivers** (9) 8th in the series of 'In Depth' factsheets
edu.10	**In Depth - Taking Care of Waste from Industry** (10) 9th in the series of 'In Depth' factsheets
edu.11	**In Depth - Managing Waste** (11) 10th in the series of 'In Depth' factsheets
edu.12	**In Depth - Drought in the South** Educational factsheet
edu.13	**Drought - The Dry Facts** Leaflets describing the drought in Southern Region and what can be done

Ref	Publication Title
edu.14	**Environment Agency Activity Book**
edu.15	**Environment Research Challenge** Environmental research projects for young people
edu.16	**Eco-Schools** Towards a sustainable lifestyle
edu.17	**What is in the Water** (poster)
edu.18	**Water Facts** Are you a water watcher or a water waster?

REGIONAL RIVER LEAFLETS

riv.1	**River Adur** Factsheet covering the same as below and giving a brief history of the River Adur
riv.2	**River Arun** Leaflet covering the same as above and giving a brief history of the River Arun
riv.3	**River Ouse** Factsheet covering the same as above and giving a brief history of the River Ouse
riv.4	**Cuckmere River** Leaflet covering the same as above and giving a brief history of the River Cuckmere
riv.5	**River Medway** Factsheet covering the same as above and giving a brief history of the River Medway
riv.6	**River Stour** Factsheet covering the same as above and giving a brief history of the River Stour
riv.7	**Eastern Rother** Factsheet covering the same as above and giving a brief history of the Eastern Rother
riv.8	**The River Darent Action Plan**
riv.9	**River Itchen** Factsheet covering the same as above and giving a brief history of the River Itchen
riv.10	**River Meon** Factsheet covering the same as above and giving a brief history of the River Meon

Ref	Publication Title
riv.11	**River Test** Factsheet covering the same as above and giving a brief history of the River Test
riv.12	**Rivers of the Isle of Wight** Factsheet covering the same as above and giving a brief history of the Rivers of the IoW
riv.13	**New Life for Hermitage Stream and Questionnaires** A5 leaflet detailing Hermitage Stream Restoration Project
riv.14	**River Medway Navigation Leaflet** Booklet giving advise to river users
riv.15	**River Medway Navigation Leaflet** Detailed guide for navigation licence holders
riv.16	**Mariners Guide to Rye** Booklet outlining Rye's History, map of Harbour of Rye and information
riv.17	**Rivers of the New Forest Fact File**
riv.18	**The River Hamble Fact File**

LOCAL ENVIRONMENT AGENCY PLANS (LEAPS)

lea.1	**River Catchment Data Report**
lea.2	**New Forest Leap - Consultation Draft April 1998**
lea.3	**New Forest Leap - Consultation Draft Summary**
lea.4	**New Forest Leap - Environmental Overview 1998**
lea.5	**Cuckmere and Pevensey Levels Leap - Consultation Draft November 1998**
lea.6	**Cuckmere and Pevensey Levels LEAP - Consultation Draft Summary**
lea.7	**Cuckmere and Pevensey Levels Leap - Environmental Overview November 1998**

WATER RESOURCES

Ref	Publication Title
wr.1	**Policy & Practice for the Protection of Groundwater** Summary and Regional Appendix
wr.2	**Groundwater Vulnerability Maps**
wr.3	**Abstraction Licensing and Water Resources** A Brief guide for potential abstractors
wr.4	**The State of the Environment of England and Wales: Freshwaters** A Summary Report 1998
wr.5	**Sustaining our resources - The Way forward** (NRA) Southern Region water resources strategy main and summary document
wr.6	**Sustaining our Resources - Update 1997** (Agency)
wr.7	**Saving Water** The NRA's Approach to Water Conversation and Demand Management September 1995
wr.8	**Saving Water: Taking Action**
wr.9	**Saving Water - On the Right Track**
wr.10	**Using water wisely**
wr.11	**Water Wise** A water saving guide for Agency employees
wr.12	**Water Wise** Are you pouring money down the drain?
wr.13	**New Life for Swanbourne Lake**
wr.14	**Enjoy Your Garden**
wr.15	**Making your home and garden more water efficient**
wr.16	**Water Alert**
wr.17	**Progress in Water Supply Planning** The Environment Agency's review of water company resources plans A submission to Government October 1998
wr.18	**A Price Worth Paying** The Environment Agency's proposals for the National Environment Programme for Water Companies 2000-2005 A submission to Government May 1998

Ref	Publication Title
FLOOD DEFENCE	
fd.1	**High and Low Tide Tables for 1999 (Southern Region)**
fd.2	**Policy and Practice for the Protection of Floodplains**
fd.3	**River Lavant Flood Investigation July 1994** Volume 1 Summary Report by Posford Duvivier
fd.4	**River Lavant Flood Investigation July 1994** Volume 2 Main Report
fd.5	**River Lavant Flood Investigation Phase III July 1996** Options Appraisal Report
fd.6	**River Lavant Flood Investigation Phase III July 1996** Summary Report
fd.7	**Chichester Flood Review** The Chichester Flood Relief Scheme
fd.8	**When the Rains Came**
fd.9	**Chichester to Pagham Harbour Flood Relief Scheme - Factsheet** Your key questions answered
fd.10	**The Environment Agency and the Selsey Sea Defences - Factsheet**
fd.11	**Shoreham and Lancing Sea Defences**
fd.12	**Lymington Estuary Tidal Defences Scheme**
fd.13	**Hayling Island Coastal Defences Strategy**
fd.14	**Milford on Sea Flood Alleviation Scheme**
fd.15	**Storrington Flood Alleviation Scheme**

Ref	Publication Title
FLOOD WARNING	
fw.1	**Flood Watch Newsletter**
fw.2	**Flood Warning Information (East Sussex)**
fw.3	**Flood Warning Information (South Kent and East Sussex Coast)**
fw.4	**Flood Warning Information (East Kent Coast)**
fw.5	**Flood Warning Information (North Kent Coast)**
fw.6	**Flood Warning Information (River Medway)**
fw.7	**Flood Warning Information (Great Stour)**
fw.8	**Flood Warning Information (Swale Area)**
fw.9	**Flood Warning Information (West Sussex)**
fw.10	**Flood Warning Information (Test Valley and Southern Hampshire)**
fw.11	**Flood Warning Information (River Rother)**
fw.12	**Flood Warning Information (Isle of Wight)**
fw.13	**Flood Warning Information (River Darent)**
PIR/PSR	
ep.1	**Pollution Prevention Guidelines** Guidelines - 1to 18
ep.2	**Pollution Prevention Pays** National leaflet produced for industry
ep.3	**Pollution Prevention Pays** with postage paid card
ep.4	**River Pollution** and how to avoid it
ep.5	**Home Pollution** and how to avoid it
ep.6	**Making the Right Connection** - avoiding water pollution
ep.7	**Solvent Pollution** and how to avoid it

Ref	Publication Title
ep.8	**Silage Pollution** and how to avoid it
ep.9	**Silt Pollution** and how to avoid it
ep.10	**Farm Waste Regulations**
ep.11	**Farm Waste Management Plans**
ep.12	**Farm Waste Minimisation**
ep.13	**Farm Pollution** and how to avoid it
ep.14	**Agricultural Pesticides and Water** A4 leaflet detailing pesticide pollution
ep.15	**Blue-Green Algae**
ep.16	**Algae or Sewage** - helping you tell the difference National Leaflet
ep.17	**Marine Algae** National leaflet
ep.18	**The Quality of Rivers and Canals in England and Wales 1995**
ep.19	**Looking after our Rivers**
ep.20	**Water Pollution Incidents in England and Wales 1996** (Report Summary)
ep.21	**Water Pollution Incidents in England and Wales 1997** (Report Summary)
ep.22	**Bathing Water Quality in England and Wales in 1996**
ep.23	**Bathing Water Quality in England and Wales in 1997**
ep.24	**Bathing Water Quality Results 1996** Southern Region information leaflet
ep.25	**Safeguard the Environment** A Guide for Developers
ep.26	**Less Waste More Value** Consultation paper on the waste strategy for England and Wales
ep.27	**Natures Way** A guide to surface water best management practice, the effective and economical answer to non-point source pollution

Ref	Publication Title
ep.28	**Building a Cleaner Future** Leaflet and video giving advise to the construction industry on reducing pollution
ep.29	**Money for Nothing your waste tips for free**
ep.30	**Are your profits going . . .**
ep.31	**Duty of Care - Waste** (DoE) Introduction to Duty of Care
ep.32	**The Registration of Waste Carriers** A5 leaflet explaining who needs to register, how to apply and how much it costs
ep.33	**Cut Waste Save Money** How your business can get ahead with waste minimisation
ep.34	**A new waste licensing system** (DoE) A5 leaflet explaining what it means and how it affects you
ep.35	**Special Waste Regulations 1996** (DoE) How the controls on special waste affect you
ep.36	**New Packaging Regulations**
ep.37	**Waste Minimisation and Recycling Directory for Businesses in Sussex** Cut Waste, Save Money . . .
ep.38	**Waste Minimisation and Recycling Directory for Hampshire**
ep.39	**Waste Minimisation and Recycling Directory for Isle of Wight**
ep.40	**The Medway & Swale Waste Minimisation Project - Report**
ep.41	**The Medway & Swale Waste Minimisation Project - Newsletter**
ep.42	**What a Waste!** Recycle, Reduce, Reuse
ep.43	**Groundwater Pollution** Evaluation of the extent and character of groundwater pollution from point sources in England and Wales
ep.44	**Endocrine-disrupting substances in the environment - What Should be Done?** Consultative Report
ep.45	**Hormone Disruption in Wildlife**

Ref	**Publication Title**
ep.46	**Nitrate Vulnerable Zones**
ep.47	**Your Recycling Pack** Reduce, reuse, recycle - what you can do
ep.48	**The Environment Agency and Land Contamination**
ep.49	**Integrated Pollution Control** An introductory guide
ep.50	**Regional Environmental Protection Directory - Southern Region**
ep.51	**Mobile Sheep Dipping** A guide to reducing pollution risks
ep.52	**Sheep Dipping** Leaflet to help farmers and others involved in sheep dipping to protect their health and the environment
ep.53	**Irrigation Scheduling** (MAFF) Uses and Techniques
ep.54	**Oil and Gas in the Environment**
ep.55	**Tyres in the Environment** The Agency examines one of the issues arising from transport and waste management - tyres
ep.56	**Tyres in the Environment** A Summary 1998
ep.57	**The Environment Agency and Canterbury Mills Rendering Plant** - Factsheet
ep.58	**How safe are our beaches** - Factsheet UWWT and its affect on sewage discharges into the sea
ep.59	**Southern Region Bathing Water Quality Results 1996** - Factsheet
ep.60	**Assessing Water Quality** - Factsheet General Quality Assessment (GQA) scheme for Biology
ep.61	**The Environment Agency and the Portsmouth Incinerator** - Factsheet

Ref	Publication Title
FISHERIES	
fis.1	**Fishing in the South 1998/99** Guide to fishing locations in Sussex, Kent and Hampshire
fis.2	**Southern Region & National Fisheries Byelaws** Revised April 1998
fis.3	**Anglers and the Environment Agency 1998-99**
fis.4	**Beware of Poached Salmon**
fis.5	**Newsreels - Summer 1998** Fisheries Magazine
fis.6	**"Buyers Beware" - Your guide to stocking fish** A4 leaflet explaining rules on fish introduction & advice on buying/stocking fish
fis.7	**Fisheries Factsheets** 19 information sheets on creating and managing fisheries
fis.8	**Freshwater Fisheries and Wildlife Conservation - A Good Practice Guide**
fis.9	**Freshwater Fisheries and Wildlife Conservation Guidelines**
fis.10	**A Guide to Careful Salmon Handing**
fis.11	**Code of Conduct for Specialist Coarse Anglers (1997)**
fis.12	**Useful Information for Angling Clubs**
fis.13	**Management of Specialist Stillwater Coarse Fisheries**
fis.14	**Fisheries Habitat Improvement**
fis.15	**Environments for Fish**
fis.16	**Desiliting Stillwater**
fis.17	**Water Plants - their function and management**
fis.18	**Keep Fish Diseases Out** (MAFF) A guide to protecting freshwater fish stocks from gyrodactylosis and other fish diseases
fis.19	**Identifying Freshwater Invertebrate Life**

Ref	Publication Title
CONSERVATION	
con.1	**Annual Conservation Access & Recreation Report**
con.2	**Ponds and Conservation** A guide to pond restoration, creation and management
con.3	**Phytophthora Disease of Alder**
con.4	**Mink** A4 brochure giving general information on the mink species
con.5	**Guidance for the Control of Invasive Plants near Watercourse** Japanese Knotweed, Giant Hogweed, Himalayan Balsam
con.6	**Understanding Buffer Strips**
con.7	**Managing Maize** A guide to profitable maize growing and safeguarding the environment
con.8	**Ponds in the Weald** The conservation and management of ponds in the Weald of Kent, Sussex and Surrey
con.9	**Pond Heaven**
con.10	**Source to Sea - Tales of the Riverbank**
con.11	**River Life - From Source to Sea**
con.12	**Aquatic Weed Control Operation - Best Practice Guidelines**
con.13	**Riverside Owners Guide** also contains Land Drainage and Sea Defence Byelaws
con.14	**Living on the Edge** A guide to the rights and responsibilities of a riverside owner
con.15	**The Pevensey Levels Newsletter - Spring 1998**
con.16	**Controlling Soil Erosion (MAFF)** An advisory booklet for the management of agricultural land
con.17	**Understanding Riverbank Erosion**

Ref	**Publication Title**
RECREATION	
rec.1	**Water Related Recreation Strategy for the Southern Region - Draft 1997**
rec.2	**Water Related Recreation Strategy for the Southern Region - Summary 1997**
rec.3	**Have Fun Have a Care** Information for river canoeists
MISC	
mis.1	**Channel Tunnel Rail Link in Kent**
mis.2	**Working together to protect our Environment** Take action in Hampshire and the Isle of Wight

ENVIRONMENT AGENCY SOUTHERN REGION
PUBLICATIONS ORDER FORM

Please fill in this form and fax or send to the address below to order copies of the publications listed

Name			
Address			
Ref.	Title	Pub. code (if applicable)	No of Copies

Please fax this form to Public Relations Department on (01903) 214298.

Alternatively return this form by post to:
Regional Public Relations Department
Environment Agency
Guildbourne House
Chatsworth Road
Worthing
West Sussex BN11 1LD

11. Glossary

Abstraction	Removal of water from surface water or groundwater; usually by pumping.
Abstraction Licence	Licence issued by the Agency under Section 38 of the Water Resources Act 1991 to permit water abstraction.
Aquifer	A layer of underground porous rock which contains water and allows water to flow through it.
Biochemical Oxygen Demand	A measure of the amount of oxygen in water during the breakdown of organic matter.
Catchment	The total area of land which contributes surface water to a specified watercourse or water body.
Coastal Protection	Natural or man made features protecting land above 5m AOD contour.
Combined Sewer Overflow	An overflow structure which allows discharge from the sewerage system to a watercourse during wet weather.
Controlled Water	Defined by the Water Resources Act 1991 Section 104, including groundwaters, inland waters and estuaries.
Discharge Consent	A statutory consent issued by the Agency under Schedule 10 of the WRA 91 to indicate any limits and conditions on the discharge of effluent to controlled water.
Dissolved Oxygen	The amount of oxygen dissolved in water. This measurement is an important, but highly variable, indicator of the "health" of a water.
Effective Rainfall	The rain remaining as runoff after losses by evaporation, interception and infiltration have all been allowed for.
Environmentally Sensitive Area	An area defined by MAFF for which grant aid is available for appropriate agricultural and water/land management.
Eutrophication	Presence of nutrients in aquatic systems leading to excessive growth of algae and other aquatic plants.
Floodplain	All land adjacent to a watercourse over which water flows or would flow, but for flood defences, in times of flood.

Flytipping	The unregulated and, hence, illegal, dumping of waste.
Green Belt	A zone of designated countryside immediately adjacent to a town or city, defined in development plans for the purpose of restricting outward expansion of the urban areas, and preventing the coalescence of settlements.
Groundwater	Water which is contained in aquifers.
Hydrograph	Graph of groundwater levels, river levels, or river flow.
Landfill Tax	A levy per tonne or cubic metre of waste sent to landfill, to encourage recycling and waste minimisation.
Littoral (and sub littoral)	The zone at the edge of a lake or estuary which is periodically exposed to the air. The sub littoral zone is continuously submersed.
Main River	All watercourses which contribute significantly to a catchment's drainage. The Agency has powers to carry out works to protect land and property from flooding by improving drainage of Main Rivers only, under the WRA 91.
mg/l	Milligrams per litre.
National Nature Reserve	Land designated by English Nature under Section 35 of the Wildlife and Countryside Act 1981, managed by, or on behalf of, English Nature for nature conservation.
Potable Water	Water of suitable quality for drinking.
Ramsar Sites	Internationally important wetland sites adopted from the Ramsar Convention on Wetlands of International Importance especially as waterfowl habitats (1971) and ratified by the UK government in 1976.
Riparian Owner	A person or organisation with property rights on a river bank.
River Corridor	Land which has visual, physical or ecological links to a watercourse and which is dependent on the quality or level of the water within the channel.
River Quality Objective	The water quality that a river should achieve in order to be suitable for its agreed uses.

Salmonid	Game fish of the salmon family, - Salmon, trout / sea trout.
Sea Defences	Natural or man-made features protecting land below 5 m AOD contour.
Special Areas of Conservation	Internationally important nature conservation sites designated under the EC Habitats Directive. All SACs are also SSSIs.
Special Protection Areas	Internationally important nature conservation sites designated under the EC Wild Birds Directive. All SPAs are also SSSIs.
Statutory Water Quality Objectives	Water Quality objectives set by the Secretary of State for the Environment, in relation to controlled waters.
Strata	Layers of rock, including unconsolidated materials.
Sustainable development	'Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs'
Swale	A shallow ditch containing vegetation that intercepts surface run-off from roads and removes suspended solids and other pollutants.