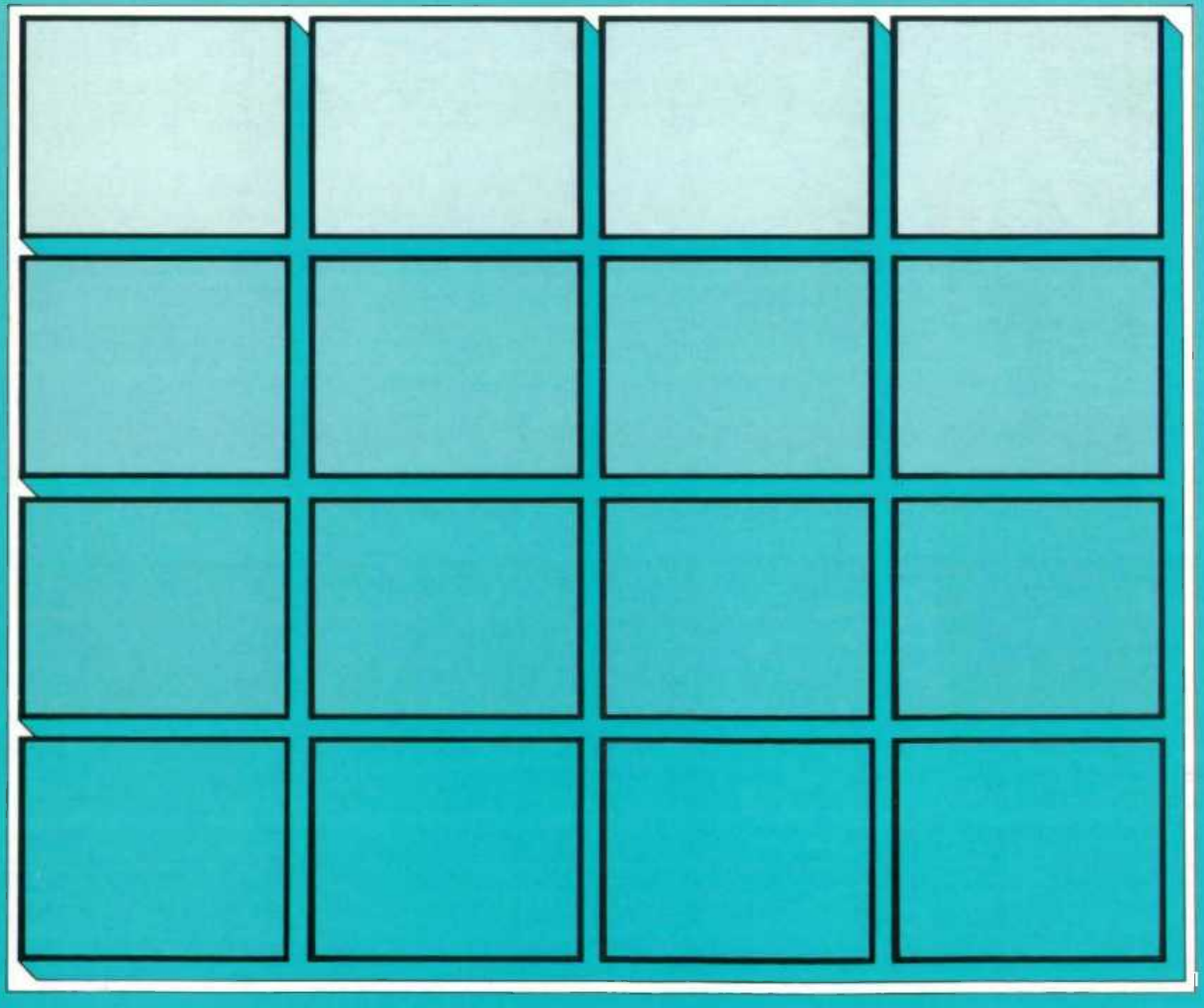
INSTITUTE of HYDROLOGY

GROBY POOL SSSI, LEICS

Hydrological Impact Study
Preliminary Report

June 1989



DRAFT

GROBY POOL SSSI, LEICS

Hydrological Impact Study
Preliminary Report

Institute of Hydrology
June 1989

Contents

1. Background

1.1 INTRODUCTION

Amey Roadstone Company (ARC) have commissioned the Institute of Hydrology (IH) to undertake a hydrological study of a Site of Special Scientific Interest (SSSI) adjacent to a proposed quarry development at Groby Pool in Leicestershire. The study will form part of a series of related studies intended to provide an independent assessment of the likely environmental impact of the proposed development.

The SSSI includes Groby Pool and the lower parts of the Bradgate Brook and Slate Brook, as shown in Figure 1. Part of the proposed development lies within the Bradgate Brook catchment. This area contains a complex of mixed habitats representative of slightly acid to neutral soils in the North Midlands. There are examples of alder woods, marsh and reedswamp, and dry and wet grassland.

The Nature Conservancy Council (NCC) have expressed particular concern regarding the impact of the proposed development on the following hydrological conditions of the SSSI:

(i) whether the flow and quality of the Bradgate Brook will be reduced thereby adversely affecting the water levels and water quality of Groby Pool

(ii) whether the hydrological conditions of the SSSI in the lower part of the Bradgate Brook will be altered with detrimental effects on the plant communities

In addition, it was felt that the amount of hydrological information was insufficient to properly establish the impact of the scheme.

This report, which is based mainly on a brief reconnaissance of the site and on the existing available data, presents a preliminary appraisal of the hydrological conditions within that part of the SSSI likely to be affected by the development. Outline proposals are given for a more detailed study, including a hydrological monitoring network, to provide a more detailed assessment of the impact of the proposed development.

1.2 SOURCES OF INFORMATION

The main sources of information made available for this preliminary study were as follows:

ARC site investigation maps at 1:2500 scale (presented as part of the original planning application in 1987)

- Sediment Stratigraphy of Groby Pool. Loughborough University, Oct 1988

- Soil Survey and Agricultural Land Classification- Groby Pool, Leics. Soil Survey, Rothamstead, Feb 1987

- Geology of Sheet SK 50 NW at 1:10000. British Geological Survey, 1975

- SSSI Notification for Groby Pool, NCC 1983.

An initial visit to the site was made on 1 June 1989 accompanied by ARC staff. A further meeting with ARC and a second site visit accompanied by an ecological consultant from Anderson and Associates was made on the 6 June, 1989.

1.3 RAINFALL

The mean annual rainfall (1941-70) at Newton Linford, which is located just north-east of the proposed development (Severn Trent/Meteorological Office station 114839), is 675 mm.

1.4 TOPOGRAPHY

Elevations range from about 95m at Groby Pool to about 120m on the ridges either side of the Bradgate valley. Bedrock is exposed on the ridge crests.

The valley sides north-east of the SSSI have an average gradient of 1 in 28. The upper part of the slope has an average gradient of 1 in 12.5, whilst the lower slope within the SSSI has an average gradient of about 1 in 18.5.

The average gradient is about 1 in 50 along the line of the valley within the SSSI. Breaks of slope were observed near the track bordering the north-eastern side of the SSSI and about midway between the edge of Lady Hay Wood and Bradgate Brook on the south-western side of the valley.

There are minor topographic variations within the SSSI which are characterised by different plant communities. Wet areas are mainly associated with minor depressions in this surface.

1.5 SUBCATCHMENT BOUNDARIES

Sub-catchment divides within the proposed development are shown in Figure 1. Four minor catchments can be defined on the north-eastern side of the SSSI, of which three lie within the Bradgate Brook catchment.

Subcatchments 1, 2 and 4 are wooded areas whilst subcatchment 3 is an open field. The proposed development will remove a substantial part of subcatchments 1, 2 and 3. These have a combined area of some 6 ha upslope of the SSSI, of which 4 ha lie within sub catchment 3.

1.6 SOILS

A survey of the soils within the development site was undertaken in February 1987. Five sampling sites were located within the SSSI in the lower part of the Bradgate Brook Type 3c soils (moderate limitations for cultivation), being affected by local seepages and high stone content.

Shallow, stony soils (Iveshead Series) occur on the bedrock formations of the valley sides, which are more easily drained due to the steeper gradients. Wetter soil types (Clavely and Salop Series) occur on the slopes in a thick, locally derived Head deposit overlying and intermixed with reddish Boulder Clay. The Salop series has a clay sub-soil which is only slightly permeable causing waterlogging of the upper layers.

Soils of the Clifton and Brockhurst series occur within the SSSI. These are described as being poorly drained, clay loam to clay soils. The Brockhurst Series generally has an upper clay loam layer of less than 0.5m thickness with a lower layer of dense clay or silty clay, which is only slightly permeable. For the most part the soils within the valley floor are rather variable.

1.7 GEOLOGY

The general geology consists of the Mercia Mudstone Group (MMG, or Keuper Marl) overlying granodiorite.

There are two small disused quarries adjacent to the SSSI. The spoil heaps (now overgrown) from these quarries intrude into the SSSI itself. Other larger quarries, such as Bluebell Quarry, occur nearby and throughout the general area.

Investigation holes (7 open hole and 1 cored borehole within the SSSI) and EM geophysical surveys have been used to define the thickness of the MMG. This indicates a variable base with the greatest thicknesses of 25 to 30m occurring in the Bradgate valley. A small buried valley trending south-west also extends upslope on the eastern side of the SSSI. The present topography also seems to follow this buried surface.

For the most part the MMG can be considered as impermeable. However, weathered and jointed/fractured zones as well as minor sandstone or siltstone bands occur in this formation and may allow some groundwater movement. The SSSI is also situated in a topographic low in both the present surface and the base of the MMG, such that any groundwater within the MMG may

tend to move towards this area.

The granodiorite would appear to contain negligible amounts of groundwater as usually only a limited amount of dewatering is required prior to excavation. Any groundwater would be contained in joints and fractures.

Three cored boreholes (C14 to 16) have been drilled near the edge of the woods adjacent to Groby Pool. Two of these, C15 and C16, were drilled at the same location. Basic information provided from these site is as follows:

	C14 (45 deg)	C15 (Vert)	C16 (45 deg)
Depth	34.5	60.8	65.1
Casing	9	39	33
Water level bgl	0.65	0.15	0.4
OD	96.41	95.42	95.16

All three penetrated MMG and granodiorite. The water levels are shallow, but whether these represent the granodiorite is uncertain as the casing may not have sealed off the overlying sequence of MMG and superficial deposits and no records were maintained of where water was encountered.

The geological map indicates alluvium in the central part of the SSSI along Bradgate Brook. However, this would appear to be limited to fine grained deposits along the brook close to Groby Pool. Most of the shallow deposits are probably Boulder Clay. The earlier drilling in 1987 did not record the thickness of the deposits overlying the MMG, but these could be perhaps 3m thick in the valley floor.

2. Groby Pool

Groby Pool covers an area of some 12 ha and is perhaps the largest natural expanse of water in Leicestershire. It has an average depth of only 1.3m and an approximate volume of 156000 m^3. The lake was created by a rock barrier but may have been in creased in size by a weir prior to the mid-1750's.

The catchment area of Groby Pool is about 8.37 km^2 but is served by two main catchments: Slate Brook to the south-west, with a catchment area of some 3 km^2, and Bradgate Brook to the north-west, with a catchment area of some 2 km^2.

The Bradgate Brook is about 1 to 2m wide with a gravel bed incised to about 1m depth. Whilst seepages along its course are likely to provide a small baseflow component, it is expected that rainfall run-off would provide most of the total flow.

ARC report that the natural flow of the Bradgate Brook contributes only about 15% of the combined inflow to Groby Pool from Slate Brook and Bradgate Brook. This needs to be confirmed by further flow measurements.

At present, clean water from two disused quarries in the upper part of the Bradgate Brook catchment is being pumped under an existing licence into the Bradgate Brook and thus into Groby Pool. This flow, estimated as about 5 to 10 l/s, will continue for at least several more months and may prevent a reliable estimate of the natural flow regime of this brook until after this pumping has ceased.

Aerial photographs indicate that the lower parts of both streams have silted-up in the area covered by woodland adjacent to Groby Pool. This would suggest a change in the base level of these streams, perhaps associated with the artificial changes to Groby Pool.

Thick silts form the base of the lake which would suggest that any direct contribution from groundwater to the lake is negligible compared to surface water inflow.

The proposed development will remove about 12 ha of the catchment, or about 5% of the total catchment area of Bradgate Brook. The part of the catchment involved is not believed to make an important contribution to the flow of Bradgate Brook. Consequently, it is unlikely that the proposed development will have a significant effect on the flow of Bradgate Brook and hence on water levels in Groby Pool.

If necessary, appropriate engineering works could be undertaken to maintain the flow of Bradgate Brook. This would need to simulate the total quantity and variations throughout the year and would need also to provide water of the same composition. This aspect might become more important if the main wet area in the SSSI is related to recharge from the Bradgate Brook.

The outlet weir from Groby Pool is also in poor condition. This could be improved to maintain the present, natural range of water levels in Groby Pool.

3. Seepages

3.1 DISTRIBUTION OF SEEPAGE AREAS

Seepages observed during the site visit on 7 June 1989 are indicated in Figure 1. The general distribution of seepages recorded during the two site visits are as follows:

(a) East of Bradgate Brook

a wet area occurs within the exit of the small disused quarry at the

north-eastern corner of the SSSI. A small wet area occurs just downdip of this location.

there would appear to be an old drainage ditch, now largely obscured, extending along the track adjacent to the wooded area in subcatchments 1 and 2 and some 5m inside the SSSI. This is probably an old field boundary and extends along the track between the two small quarries. No drainage ditches were observed leading from the adjacent slopes.

the area of meadow between the track and the Bradgate Brook south-east to borehole 87/41 lacks any seepages, except adjacent to the brook.

a small spring was observed near borehole 87/45 adjacent to the east bank of the brook arising from an indentation of the channel. Several similar seepages were noted adjacent to the channel as far as about borehole 87/41.

the main wet area occurs on the left bank of the brook between elevations of about 95.5 and 97m but is separated from the stream channel by a dry area. The main seepage area occurs at the northern end of this wet area at an elevation of about 98m near borehole 87/41.

(b) **West of Bradgate Brook**

- very localised wet areas occur at a break of slope at an elevation of about 101m just west of the brook and give rise to minor seepages adjacent to the brook. The slope this side of the brook is steeper than on the east and reaches closer to the brook.

a drainage ditch emerges from Lady Hay Wood near borehole 87/43. This was flowing at the time of the second field visit which had been preceded by a period of rainfall. This ditch continues south along the boundary of the wood and then turns west up through the wood. It drains into the Bradgate Brook near the main wet area.

at least 6 to 7 further indistinct ditches occur between this ditch and the fish pond area. These may predate the interceptor ditch along the edge of Lady Hay Wood.

(c) **Northern edge of Groby Pool**

- no seepages were observed within the meadow between the larger of the old quarries and the woods at the edge of Groby Pool.

- further wet areas occur along the edge of the woods in the area of cored boreholes C15 and C16 at an elevation of about 95 to 95.5m, with minor seepages close to the edge of the lake just east of these boreholes. This general area would be served by subcatchment 4.

3.2 SEEPAGE RATES

No direct measurements of the amount of seepage have been made. The field reconnaissance suggests that the flows are barely perciptible.

The topographic map has been used to provide a preliminary indication of the directions of sub-surface flow within the superficial deposits from the valley sides into the Bradgate valley, as shown in Figure 3. This suggests that most of the subsurface flow is concentrated into the main wet area at an elevation of about 98m. However this is also served by the largest of the adjacent subcatchments (subcatchment 3), which may have thicker soils.

The maximum contribution from sub-catchments 1, 2 and 3 to the Bradgate valley is estimated to be about 1.5 l/s based on an annual rainfall of 675mm. About two-thirds of this could enter the main seepage zone, based on the area of subcatchment 3. This takes no account of losses from evapotranspiration or deeper percolation and thus the actual amount of seepage will almost certainly be much less than this estimate.

It is apparent that the quantities of water involved are small. Their combined flow does not make a significant contribution to the flow of Bradgate Brook.

3.3 ORIGIN OF THE SEEPAGES

The wet areas are localised and apparently permanent features. They occur mainly within about 10m of the Bradgate Brook along both banks. This would suggest that they are not derived from groundwater within the MMG but instead are almost certainly associated with water draining from the superficial deposits on the valley slopes, perhaps emerging at some change in these deposits and/or breaks of slope.

At this stage it seems unlikely that any of the seepages are due to deeper groundwater emerging from the MMG.

The largest seepage zone emerges some 25 to 30m away from the brook but would appear to be situated adjacent to an abandoned course of the brook. It is also served by a larger subcatchment. A buried valley with a thicker sequence of MMG also intersects the Bradgate valley close to this location, but it seems unlikely that these particular seepages are directly related to this geological feature.

The catchment area of the seepages is likely to extend to the catchment divide to the north-east rather than be limited to the SSSI. The proposed development will remove about 75% of the catchment area serving the seepages found on the eastern side of Bradgate Brook and would therefore have a significant impact on these seepages, particularly on the largest seepage zone adjacent to borehole 87/41. This would apply whether these particular seepages are related to shallow or deeper groundwater.

The seepages on the western side of the brook, which are fed from the Lady

Hay Wood area, would not be affected by the development since these are associated with a separate system.

There is also some evidence from the available topographic maps (2m contour interval) that the lower course of the Bradgate Brook may have been diverted to serve the fish pond just west of Groby Pool. The largest wet area within the SSSI appears to occupy the low ground associated with the original channel, which is now obscured. At the time of the site visit water from the brook was being rediverted at the edge of the wood back into the main channel passing through the woods into Groby Pool. There was also some evidence of an historical channel, now infilled, at this location.

The largest wet area, which contains one of the more important plant communities, may not be the direct result of seepage from the valley sides. The topographic map suggests that this area occupies the true line of the valley and consequently most of the water entering this particular area may be derived from the Bradgate Brook rather than seepage from the valley slopes.

This particular area may be a wet meadowland equivalent of the wooded area at the southern end of this wet area from which it is separated by an ancient dry stone wall (ie, a field boundary). Hence, the main wet area could be simply the upper part of the wet area which passes through the wooded area along the course of Bradgate Brook to Groby Pool and is probably caused by *impeded drainage*.

If the main wet area is associated with the course of the Bradgate Brook then it is less likely to be affected by the proposed development. Nonetheless, this should be confirmed by further investigation, particularly to determine the contribution from the seepages near borehole 87/41 which would be affected by the proposed development.

The wet areas near cored boreholes C15 and C16 are considered to be derived from water draining from the superficial deposits within subcatchment 4. Only a small part of this catchment lies within the revised limits of the proposed development and consequently, it is unlikely that they will be significantly affected by the development.

Conclusions

The following preliminary conclusions are drawn from the reconnaissance study:

1. The proposed development is unlikely to affect water levels in Groby Pool.

2. The seepages are considered to be derived from the valley sides from water draining through the superficial deposits.

3. Those seepages on the eastern side of Bradgate Brook are likely to be affected by the proposed development, whereas those on the west will not be affected.

4. The ecological importance of the seepages on the eastern side of the Bradgate Brook needs to be established.

5. The main wet area would appear to be associated with the Bradgate Brook and is unlikely to be affected by the proposed development, provided the natural flow regime of this stream is maintained.

6. A programme of further work is required to investigate the lower part of Bradgate Brook in more detail and to monitor the existing, natural situation. This should commence as soon as possible. A suggested programme of further work is given in Annex A.

No 9 WARD

Topography, Catchment Boundaries and Seepage areas
Figure 1

- Limit of proposed development
- SSSI boundaries
- Subcatchment boundaries
- Seepages and wet areas
- Possible directions of flow in superficial deposits
- Spoil tips

Groby Pool

Groby Pool

Annex A Proposals for further investigation and monitoring

OBJECTIVES

The field reconnaissance suggests that the proposed development will have the greatest hydrological impact on the seepages on the eastern side of Bradgate Brook. The botanical importance of these minor seepages to the overall ecology of the SSSI needs to be established.

The most important seepage area occurs adjacent to the main wet area. Further investigations should be concentrated in and around this particular part of the SSSI to establish its origin.

It will also be necessary to link the hydrological regime to the distribution of the plant communities and to monitor the existing natural regime to provide the necessary background against which any changes that might be due to the proposed development can be assessed.

A monitoring period of two years would normally be the minimum required to include a reasonably representative range of seasonal variations. However, an initial period of monitoring which included seasonally high and low water level conditions should first be undertaken to establish whether a longer period of monitoring would be required. This would include a period of 6 to 9 months depending on the time of year the monitoring programme is initiated.

PROPOSED PROGRAMME OF FURTHER WORK

It is suggested that the collection of further data is undertaken at two levels:

- a low density of observation points throughout and around the SSSI within the lower part of Bradgate Brook

- a more detailed survey in key areas that are likely to be affected by the proposed development, primarily the main wet area.

The investigation techniques employed should cause minimal disturbance to the SSSI. The longer term monitoring network would be selected from the preliminary investigation sites. Preliminary locations are shown in Figure 2.

The main hydrological activities would be as follows:

* a detailed topographic survey.

* monitoring of lake levels in Groby Pool

* monitoring of flow and quality of Bradgate Brook

* installation of piezometers and neutron access tubes

* monitoring of groundwater levels

* sampling for groundwater chemistries

Figure 2 indicates the preliminary choice of investigation and monitoring sites. The presence of stones within the superficial deposits may restrict the installation of piezometers and neutron access tubes.

It is anticipated that rainfall records will be available from a local rainfall station, but if not then it will be necessary to establish a raingauge within the SSSI.

(a) **Levelling**

- topographic survey to provide 0.25m contour intervals in and around the main wet area and 0.5m contour interval over the rest of the SSSI in the lower part of Bradgate Brook

- levelling of all investigation and monitoring points

(b) **Surface Water**

stage marker in Groby Pool

- point discharge measurements of Slate Brook and Bradgate Brook in their lower reaches to compare their relative contribution to Groby Pool

monitoring of the flow of Bradgate Brook, either with a weir plate (if flows are small) or by periodic current metering with an automatic stage recorder

records of pumping by ARC into Bradgate Brook

water samples for chemical and stable isotope analysis from Bradgate Brook (initial sample then every 2 months) and the ditch draining Lady Hay Wood (initial sample then seasonally)

(c) **Soil Survey**

- additional soil investigation and the installation of neutron access tubes at 6 locations

(d) **Shallow Groundwater**

EM geophysical survey to determine the thickness of the superficial deposits overlying the MMG

- installation of piezometers by augering or manual percussion at 20 locations (including a paired shallow/fully penetrating piezometers at 2 locations within the main wet area), each finished flush to ground level, to provide information on water level depths, elevation and fluctuations

- sampling from each piezometer and 5 seepages for full chemical analyses

isotopic analyses of 3 seepages, 3 piezometers and the main wet area

- input or output tests, preferably on each piezometer to provide estimates of hydraulic conductivity

water level monitoring of all piezometers, initially monthly

- estimates of seepage rates (if possible)

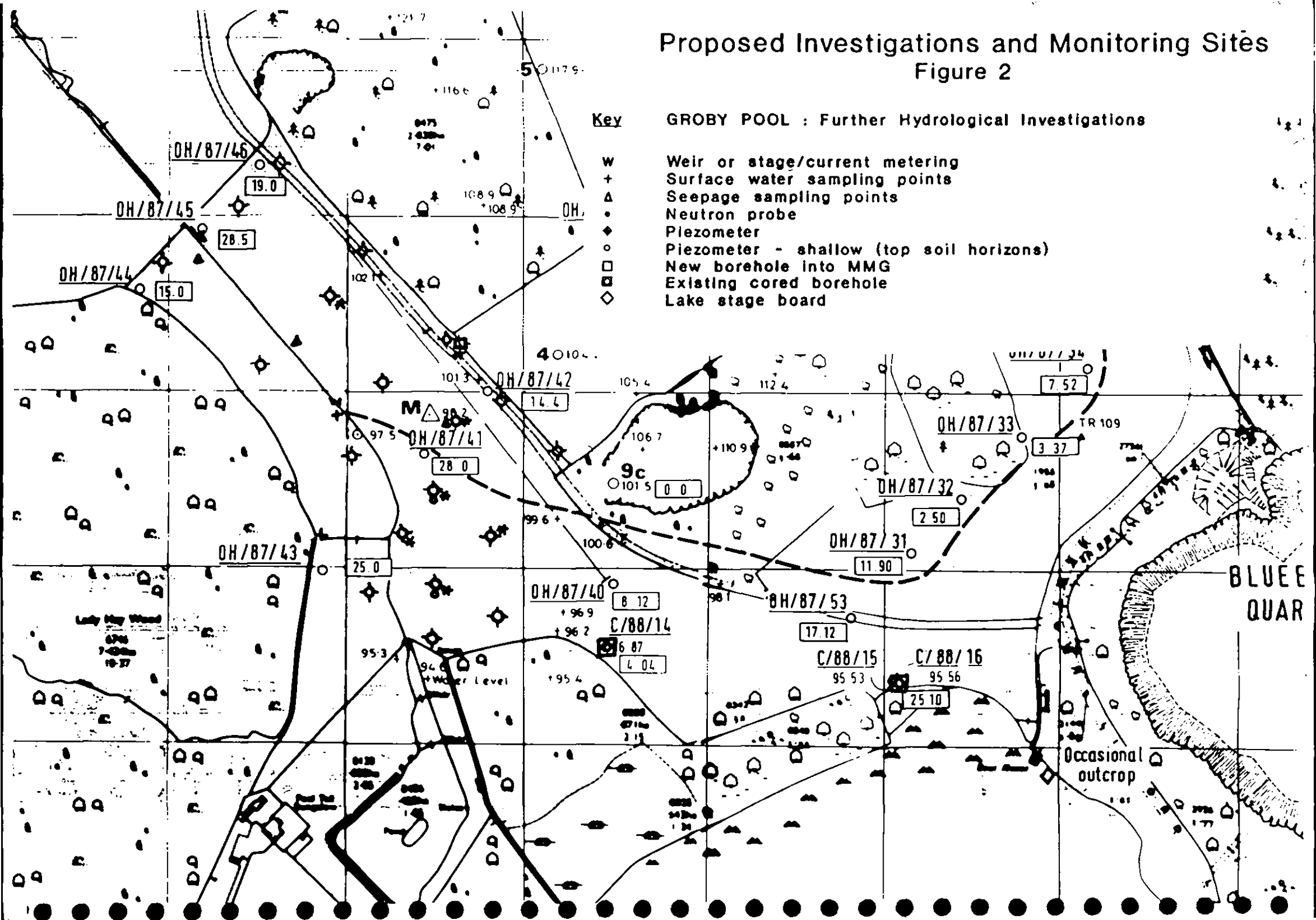
seasonal mapping of the occurrence of seepage/wet areas

(d) Deeper Groundwater

new borehole cased through the superficial deposits drilled to the base of the MMG updip of the main seepage area and adjacent to a shallow piezometer to show the presence of water in the MMG, water level elevation and water sampling (chemistry and isotopes) and to monitor water level fluctuations

monitoring of water levels in cored boreholes C14 to C16, initially monthly, and samples for chemical and isotope analysis

Proposed Investigations and Monitoring Sites
Figure 2



The demand for long-term scientific capabilities concerning the resources of the land and its freshwaters is rising sharply as the power of man to change his environment is growing, and with it the scale of his impact. Comprehensive research facilities (laboratories, field studies, computer modelling, instrumentation, remote sensing) are needed to provide solutions to the challenging problems of the modern world in its concern for appropriate and sympathetic management of the fragile systems of the land's surface.

The **Terrestrial and Freshwater Sciences** Directorate of the Natural Environment Research Council brings together an exceptionally wide range of appropriate disciplines (chemistry, biology, engineering, physics, geology, geography, mathematics and computer sciences) comprising one of the world's largest bodies of established environmental expertise. A staff of 550, largely graduate and professional, from four Institutes at eleven laboratories and field stations and two University units provide the specialised knowledge and experience to meet national and international needs in three major areas.

★

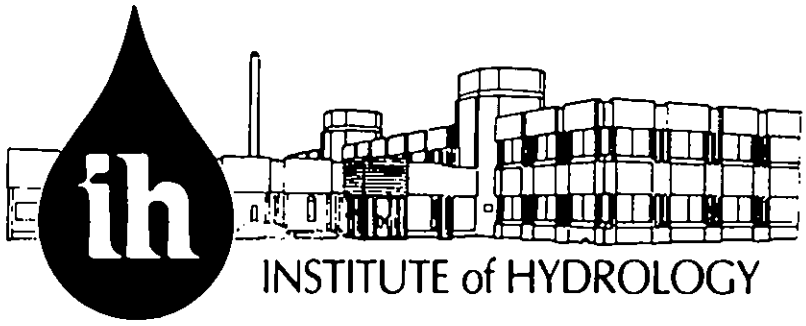
Land Use and Natural Resources

★

Environmental Quality and Pollution

★

Ecology and Conservation



The **Institute of Hydrology** is a component establishment of the UK Natural Environment Research Council, grant-aided from Government by the Department of Education and Science. For over 20 years the Institute has been at the forefront of research exploration of hydrological systems within complete catchment areas and into the physical processes by which rain or snow is transformed into flow in rivers. Applied studies, undertaken both in the UK and overseas, ensures that research activities are closely related to practical needs and that newly developed methods and instruments are tested for a wide range of environmental conditions.

The Institute, based at Wallingford, employs 140 staff, some 100 of whom are graduates. Staff structure is multidisciplinary involving physicists, geographers, geologists, computer scientists, mathematicians, chemists, environmental scientists, soil scientists and botanists. Research departments include catchment research, remote sensing, instrumentation, data processing, mathematical modelling, hydrogeology, hydrochemistry, soil hydrology, evaporation flux studies, vegetation-atmospheric interactions, flood and low-flow predictions, catchment response and engineering hydrology.

The budget of the Institute comprises £4.5 million per year. About 50 percent relates to research programmes funded directly by the Natural Environment Research Council. Extensive commissioned research is also carried out on behalf of government departments (both UK and overseas), various international agencies, environmental organisations and private sector clients. The Institute is also responsible for nationally archived hydrological data and for publishing annually HYDROLOGICAL DATA: UNITED KINGDOM.