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410511/01

SOUTH WEST BICESTER

OXFORDSHIRE

GROUND INVESTIGATION

FACTUAL AND INTERPRETATIVE REPORT

Revision Record

Revision	Date	Originator	Checked	Approved	Status
	October 2001	L Marshall	D Beaumont	R Fuller	Draft

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5. GEOLOGY AND HYDROGEOLOGY

5.1 Geology

Published geological information [1] indicates this area to be underlain by rocks of the Jurassic Period with limited overlying superficial deposits.

The superficial deposits, in the vicinity of the site, are recorded as Quaternary in age and comprise localised deposits of Alluvium, which generally follow the route of the local streams.

Based on the geological map of the area, the solid rocks under the site comprise the following (youngest first):

- Kellaways Clay
- Combrash
- Forest Marble Formations.

The Combrash Formation generally covers the northern areas of the site, with other smaller outcrops towards the south eastern boundary and typically comprises grey and yellow brown rubbly limestones. The Forest Marble Formation is present as a small outcrop in the north east corner of the site and generally comprises interbedded grey flaggy mudstone and sandy limestones. The Kellaways Clay Members present in the southern of the site comprises dark grey mudstones.

The ground investigation was able to penetrate the weathered upper surfaces of these formations, the Combrash being recovered as a sandy silty gravel, the Forest Marble Formations as either a coarse gravel (where limestone) or a stiff to very stiff clay (where mudstone) and the Kellaways Clays as a firm to very stiff clay.

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5.2 Hydrogeology

The Environment Agency classifies inland waterways (rivers and canals) according to the General Quality Assessment scheme (GQA). The GQA scheme is designed to provide an accurate and consistent assessment of the state of water quality changes over time. The chemistry GQA describes quality in terms of three chemical measurements, which detect the most common types of organic pollution.

The nearest surface watercourse to the site is Gagle Brook, which lies approximately 50 to 100m south of the site. There are also two on-site streams or drainage ditches, which drain into an off-site drain lying approximately 350m east of the site. Gagle Brook and the on-site drains are not classified, however the unnamed off-site drain to the east has a GQA of Grade D (Fair).

The Environment Agency (EA) Groundwater Vulnerability Map and Regional Appendices, which make up part of the published 'Policy and Practice for the Protection of Groundwater', divide the underlying strata in England and Wales into major, minor and non aquifers dependent upon their potential for potable water supply.

The underlying Combrash and Forest Marble Formations are classified as a minor aquifer with the Kellaways Clay Formation classified as a non-aquifer.

There are four licensed groundwater or surface abstractions located within 500m of the site, one being on the site adjacent to Whitelands Farm. Three of the abstractions are to provide water for general agricultural use in adjacent farms whilst the fourth is the water supply for the adjacent caravan site.

There are two consents to discharge, one in the north east corner of the site and the second approximately 750m east of the site adjacent to the sewage treatment works.

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7. GROUND CONDITIONS

7.1 Strata Encountered

A summary of approximate areas of the different soils and rocks encountered is given in **Figure 2**. These broadly follow the arrangement of the geological map for the area, although it should be noted that our site investigation does not represent a detailed mapping exercise and that a degree of simplification has been adopted, with conditions being considered primarily in engineering terms.

The boundaries given in **Figure 2** are generally estimated between widely spaced exploratory holes and should thus be regarded as only indicative. Further detailed investigation of individual plots would be required to confirm this initial estimate.

(i) Made Ground

The strata encountered generally confirmed the published geology of an area of made ground in the north west of the site, with the addition of made ground in the north eastern area of the site and other probably localised areas of fill in the central eastern area of the site.

Between 1.65m and 2.45m of granular made ground was identified in the north west of the site, predominantly comprising ash fill with much glass and metal fragments. Some larger pieces of metal were identifiably vehicle engine parts. The glass, including some intact bottles, showed some evidence of melting, indicating high temperature combustion in the past.

Made ground in the north eastern area of the site was largely a fine sandy silty clayey gravel, although a 1.3m thick layer of soft to firm cohesive material with plant remains was encountered in one trial pit, TP84.

Probable localised areas of fill were identified in the central eastern area of the site in Trial Pits 76 and 76B, comprised largely cohesive materials between 2.1m and 2.5m deep. Trial pit 76B was extended in a north east to south west direction and appeared to show a shallow channel in the underlying limestone, infilled by clay. This could represent either an infilled drainage ditch or formally unrecorded shallow limestone quarry, similar to those identified elsewhere on the site.

(ii) Alluvial Deposits

Alluvial deposits were encountered in the south eastern area of the site comprising predominantly sand between 1m and 1.8m thick, and in the north eastern corner as a thin layer of soft clay and peat to less than 1m depth below ground level.

(iii) Kellaways Clay

Kellaways Clay was encountered in much of the southern and south western area of the site. This comprised predominantly stiff clay (highly to completely weathered mudstone) between 0.5m and 2.5m thick, and either gradually becoming a weak to very weak mudstone with increasing depth or was underlain by limestone (the Combrash).

(iv) Combrash

Combrash was encountered in the much of the northern area of the site. This comprised predominantly coarse granular material (highly to completely weathered limestone) between 0.5m and 2.5m thick, and either was underlain by generally moderately weak to moderately strong limestone or a stiff to very stiff clay, this representing completely weathered mudstone of the Forest Marble Formation. Grading results for the Combrash identified a range from a silty sandy gravel to a very clayey very silty sandy gravel.

(v) Forest Marble

Forest Marble Formation was encountered in the north eastern area of the site and underlying the Combrash where the base of this layer was penetrated. The Forest Marble Formation comprised either a moderately strong light grey limestone, (weathered to a granular material on the upper surface) or a predominantly stiff to very stiff clay (highly to completely weathered mudstone). The clay was found to be between 0.5m and 2.5m thick, becoming a weak mudstone with increasing depth, with occasional beds of moderately weak siltstone. Grading results for the Combrash identified a range from a silty sandy gravel to a very clayey very silty sandy gravel.

7.2 Groundwater

Groundwater was encountered in a number of trial pits across the site, but its occurrence was intermittent, being present in some pits but absent in adjacent ones. Water inflow was generally restricted to a seepage and a delay of up to an hour was often required to allow sufficient water to collect to enable a sample to be obtained.

A very minor seepage (reported as the borehole becoming damp) was noted in made ground in Borehole 1. The majority of groundwater encountered was as seepages either within the Combrash or at the interface between this and the underlying Forest Marble mudstones.

Water in the form of both a seepage and a moderate inflow was encountered at the interface between the suspected clay fill and Combrash, in trial pits TP 76 and TP 76B

Both seepages and moderate inflows were noted in the weathered upper surface of the Forest Marble in the north east corner of the site, although this is considered to be a local feature, attributable to the proximity of drainage ditches in this area.

The water strikes are considered to represent perched water, generally within the Combrash.

It should be noted that groundwater levels may be subject to seasonal and other variation.

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A summary of groundwater strikes is tabulated below in Table 1:

Exploratory Hole	Depth Water Encountered (m)	Depth Water Rise (m)	Comments
BH1	1.3	None	Very minor seepage in made ground
BH2	3.0	None	Very minor seepage at interface Cornbrash and underlying Forest Marble clay
BH11	1.0	None	Seepage from Cornbrash
TP14A	1.8	None	Seepage at interface Cornbrash and underlying Forest Marble clay
TP15A	1.0	None	Seepage from Cornbrash
TP16	1.5	None	Seepage from sandy lenses in Forest Marble clay
TP17	1.1	None	Seepage at interface Cornbrash and underlying Forest Marble clay
TP36	0.5	None	Seepage from Cornbrash
TP47	1.0	None	Seepage from Cornbrash
TP52	2.0	None	Seepage from Cornbrash
TP59	1.8	None	Seepage from Cornbrash
TP71	0.9	None	Seepage from Cornbrash
TP76	2.5	1.7 after30 mins.	Moderate inflow at interface clay fill and underlying Cornbrash
TP76B	2.1	2.0 after 20 mins.	Seepage at interface clay fill and underlying Cornbrash
TP83	0.8	0.6 after 20 mins.	Moderate inflow close to interface of gravel and underlying Forest Marble limestone
TP89A	0.9	None	Seepage at interface clayey gravel and underlying Forest Marble limestone
TP89B	0.9	0.45m in 30 mins.	Moderate inflow close to interface of gravel and underlying Forest Marble limestone

Table 1 Groundwater Encountered by Exploratory Holes

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For the ash fill material, the sulphate results fall into Class 2 of BRE Digest 363, 1996 [2]. As discussed further in Section 10, the anomalous data from TP68 should be subjected to an additional limited site investigation. For the remainder of the site, the sulphate results fall into Class 1 of BRE Digest 363 in terms of soil and groundwater results.

9.7 Drainage

With respect to the excavation for site drains and other services, due regard should be given to the difficulties experienced by the excavator during the trial pitting exercise. Design should take account of the final levels identified in each of the logs. Attempting to dig below these levels may require the breaking out of rock.

It is understood that soak-away drainage is being considered for the site. To this end the permeability of the Combrash has been investigated using the laboratory grading data and a limited programme of soak-away tests in trial pits.

From the grading curves, a range of permeability has been calculated. For Combrash this varies from $1x10^{-5}$mm/s (typical of a silt) to $9x10^{-3}$mm/s (typical of a fine sand/coarse silt). This material would not be considered ideal for a soak-away drainage design, both in terms of performance and because of the risk of a loss of fines leading to silting up of the pit and even possible local subsidence.

The soakaway tests in trial pits are summarised overleaf in Table 2 with an average of the volume of water lost from each pit per minute:

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Exploratory Hole	Average Water Loss m^3/min.	Average Water Loss Litres/min (Approx.)
TP45	0.010	10
TP46	0.115	115
TP56	0.050	50
TP64	0.005	5
TP65	0.012	12
TP73A	0.010	10

Table 2 Summary of Soak-away Tests

We have reservations with regard to adopting soak-aways as the main method of drainage on the site.

Firstly, the layer for drainage to occur in is likely to be restricted to the relatively thin Cornbrash layer, this at least in part being bounded above and below by weathered mudstones, giving an essentially impermeable cap and base to this layer. The capacity of this layer could thus be severely restricted.

Secondly, it is understood that high groundwater levels can occur during the winter, based on discussions with the Farmer for the site, Mr Alan Woodley, who has observed water levels within approximately 0.5m below ground level during new drainage ditch excavation. This could in effect turn soak-aways into ponds during the period of maximum demand on the drainage system.

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11.0 RECOMMENDATIONS AND CONCLUSIONS

It is proposed to develop the site for a variety of end-uses including residential, leisure, business and light industrial.

The investigation has identified that the site is underlain by Combrash, Kellaways Clay and Forest Marble, with limited areas of alluvium and made ground. An indicative plan showing their possible distribution is given in **Figure 2**.

A preliminary assessment of foundation types has been given for the anticipated ground conditions. Shallow footings are considered suitable for the site, only limited areas of made ground and peat with soft clays may require excavation from beneath foundation footprints and replacement by suitable granular fill.

Assessment of the sulphate content of the near surface in situ deposits shows that they fall into Class 1 of Table 1 of BRE 363, 1996[2].

Soak-aways are considered unlikely to be a viable option as the main means of drainage for the site.

The majority of materials over the site are regarded as likely to be acceptable for re-use as general fill, with regard to the DTP Specification for Highway Works. Care will be needed to ensure moisture control is strictly adopted for the fill however, due to sensitivity to moisture content change.

For pavement design, a CBR of at least 15% is considered reasonable for the areas of the site underlain by Combrash and granular weathered Forest Marble, assuming proposed road levels remain close to existing. For areas underlain by Kellaways Clay, a CBR of 5% should be adopted for design.

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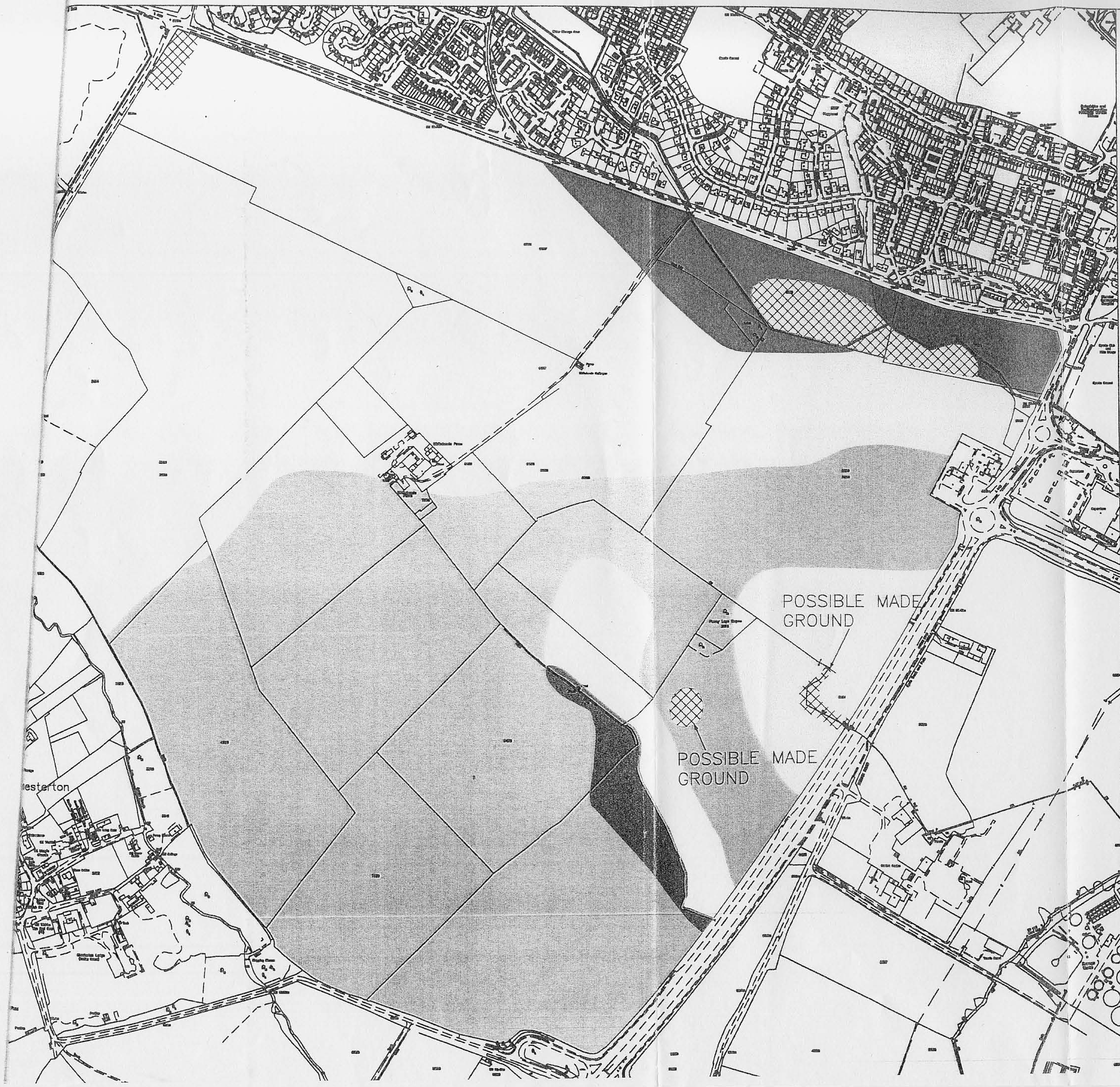
With respect to contamination, we do not consider that the site presents a significant hazard to the proposed end-uses. Other than the provision of a clean break layer for landscaping or cover by hardstanding in limited areas, we do not consider special measures will be required, although disposal off site may attract additional costs. Should significant quantities of material need to be taken off-site, it is advised that the relevant waste regulatory authority is contacted to ascertain the nearest suitable site and the premiums charged on these materials.

High results for arsenic, lead and phytotoxins within the quarry backfill were anticipated, elevated metals being common in ash fills.

The elevated levels of arsenic and sulphate in TP68 and of arsenic in TP75 are somewhat more problematic. These high results may only represent isolated 'hot spots' of contamination, but we would strongly recommend a further limited investigation of both these areas.

No significant contamination was noted throughout the remainder of the site.

There is no evidence of any significant concentrations of mobile contaminants on the site or from any off site source.



KEY

- CORNBRASH
- MADE GROUND
- FOREST MARBLE
- PEAT AND SOFT ORGANIC CLAY
- KELLAWAYS CLAY
- ALLUVIAL SANDS AND CLAY

REV	DATE	DRAWN	CHECKED	DETAILS OF REVISION

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CLIENT:- A D WOODLEY LTD

PROJECT TITLE:- SOUTH WEST BICESTER GROUND INVESTIGATION

DRAWING TITLE:- GROUND CONDITIONS ENCOUNTERED - INDICATIVE

A3	NAME	DATE
ORIGINATED	LM	22.10.01
CAD/DRAWN	GS	22.10.01
CHECKED	LM	25.10.01

SCALES (at A3):- 1:7500

PROJECT No.:- 410511
DRAWING No.:- FIGURE 2
REVISION:-

ENVIRONMENT AND HIGHWAYS BUSINESS UNIT
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