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Land West of Church Lane, Climping: appraisal of hydrogeological impact

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EXECUTIVE SUMMARY

This report has been written to explore the potential impacts on local water table levels as a result of development at the application site at Climping. Historic England has requested that the impact of potential changes to the hydrological regime be considered in the light of the proximity of a scheduled ancient monument.

Near-surface geological deposits are variable: in the west they are sandy and in the east they are clayey. Below these is a chalk aquifer that conveys groundwater from the South Downs to discharge at the coast, or to the River Arun. The water table level in the near-surface deposits is expected to be controlled by the balance of water levels in the Chalk aquifer.

Groundwater lies at a shallow depth below Climping and the scheduled ancient monument. Depth to the water table is expected to be around 2.0 to 2.5 m but the typical range of fluctuation may be 2.0 to 2.5 m. During periods of very wet weather the water table may rise to the ground surface in places.

Potential changes in the hydrogeological regime as a result of the development have been considered. If there is to be any off-site impact on the level of the water table, it is anticipated that the improved site drainage may lead to a lowering of the water table during periods of very wet weather. This may result in protection of the scheduled ancient monument from potential damage from extremely high groundwater levels. This could also lead to less waterlogging in local gardens.

If there are any changes in water table level, they are expected to be minor and local to the application site. Groundwater in the chalk aquifer will tend to flow towards the site to compensate for any changes in water table level by increased flow from the South Downs.

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1. Glossary of Terms and Abbreviations
2. Borehole Logs

1. Introduction

1.1 Background

This report explores the potential impacts on the local water table as a result of development at a site in Climping, West Sussex (national grid reference of the site centroid is c. TQ 0005 0200). The local planning authority is Arun District Council.

An outline planning application was made in January 2017 (planning reference: CM/1/17/OUT) for the following development.

Outline application for the erection of up to 300 dwellings & ancillary development comprising open space, a building within use class D1 (Non- Residential Institutions) of up to 875 square metres net, a building for A1 (Shops) use having a floor area of up to 530 sq. metres net, together with open space & ancillary works, including car parking & drainage arrangements, with appearance, landscaping, layout & scale wholly reserved for subsequent approval. The access detail, showing the points of access to the development, & indicated on Bellamy Roberts drawings numbered 4724/004 & 4724/005 are access proposals to be determined at this stage of the application. For the avoidance of doubt all other access detail within the site is to be determined as a reserved matter at a later stage.

The application was refused in September 2017, and the decision is to be appealed. The Planning Inspectorate reference for the appeal is APP/C3810/W/17/3187601.

During the application process Historic England requested that the impact of potential changes to the hydrological regime be considered in the light of the proximity of a scheduled ancient monument.

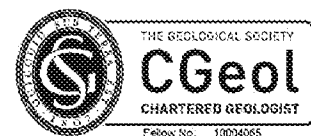
The principal document that was submitted for planning that has been referred to in writing the present report is the Surface Water Drainage Strategy, produced by Ambiental in December 2016. It indicates that the site drainage strategy relies on attenuation ponds discharging to local drains. No soakaways are intended to be used.

1.2 Scope of Report

This report presents a hydrogeology-focused basement impact assessment for the development. Its aim is to meet Historic England's request for a more detailed study on the local hydrogeology. This is to indicate whether the proposed development will change groundwater flow patterns around the site, to an extent that puts the scheduled ancient monument, 'Medieval earthworks E and SE of St Mary's Church, Climping', at risk.

1.3 Authorship of Report

Stephen Buss Environmental Consulting Ltd was instructed in May 2018 to complete this report. This report has been prepared by Dr Stephen Buss MA MSc CGeol. Dr Buss is a UK-based independent hydrogeologist with more than 18 years' consulting experience in solving groundwater issues for regulators, water companies and other private sector organisations. **Dr Buss is a Chartered Geologist with the Geological Society of London.** Dr Buss's CV and publications list is available at www.hydro-geology.co.uk.



A site visit was undertaken by Dr Buss on the 4 June 2018.

2. Environmental Setting

2.1 Geology and Hydrogeology of Climping

Site geology can be interpreted from the geological mapping of the British Geological Survey (Sheet 317/332: Chichester and Bognor). Generic comments on the hydrogeology of each of these strata are interpreted here from the survey of the hydrogeology of the South Downs by Jones and Robins (1999).

Beneath Climping the bedrock comprises chalk (stratigraphically part of the White Chalk Group, formerly known as the Upper Chalk). Chalk is a white, fractured, limestone that readily transmits groundwater. The chalk stratum forms an aquifer that stretches from the South Downs to the coast. This aquifer provides much of the water supply for the district, though there are no water supplies in the immediate area around Climping.

Overlying the chalk is a layer of raised beach deposits (primarily sand and gravel) and overlying these on higher ground to the west (including the western half of the application site) are river terrace deposits which may comprise clay, silt and/or sand. To the east, nearer the River Arun, the raised beach deposits grade into raised marine deposits, which have a more variable composition including clay, silt, sand and/or gravel. These were all formed in interglacial periods when the sea levels and river levels were higher. The ability of groundwater to flow readily through these near-surface deposits will be variable. It flows more readily through sandy materials than clayey materials. Jones and Robins (1999) indicate that these do tend to be quite permeable in general, though there will be local heterogeneity.

Every winter, rain falling on the South Downs infiltrates through the soil and reaches the chalk aquifer which underlies the whole area. From the South Downs, this groundwater flows roughly southwards, towards the coast. Infiltration causes a rise in water table level beneath the South Downs that then recedes through spring and summer. The water table beneath Climping also rises as a result. Having flowed southwards, groundwater finally discharges to the coast and to the tributaries of the River Arun. Around Climping there is an easterly component of flow towards the River Arun itself.

The Environment Agency regularly measures water table elevation in a borehole at Climping Ryebank. The borehole is located 800 m to the south west of the centre of the application site, adjacent to a small watercourse called Ryebank Rife. Ground level at the borehole is 4.98 m AOD but the water level in Ryebank Rife is rather lower (estimated at about 3.0 m AOD, based on observation from Climping Street on 4 June 2018). The borehole was constructed in May 1979 and is 250 m deep (Appendix 2). Over the part of the borehole that is nearest the ground surface it has been lined with solid steel casing to 30 m depth. Below this the borehole is unsupported and open to the aquifer.

Historical water level data from the Environment Agency borehole is shown on Figure 2.1. This shows that the water table elevation rises and falls on an annual cycle, with peak levels occurring in winter. The annual range is typically 2.5 m. Water level rarely rises above 0.75 m below ground level, but it rose to 0.5 m below ground level (4.5 m AOD) in November 2001 and January 2014.

A further borehole¹ named ‘Tortington Test’ is located 5.6 km north of the application site and is located next to the A27 near Binstead. Ground level is 29.05 m AOD. Here the range in groundwater level is much more variable than at Climping, and there is not a typical annual maximum level (Figure 2.1). Peaks in November 2001 and February 2014 exceeded 13.4 m AOD but in most years the level does not exceed 12.0 m AOD.

Several other boreholes have been drilled at and around Climping although these do not have time series data available. Key geological and water level information from their logs are summarised in Table 2.1. Their locations are mapped on Figure 2.2.

Table 2.1 Local borehole geology and groundwater observations

ID ²	Geological observations	Groundwater observations
SU90SE38	Topsoil and silt (‘brickearth’) to 1.7 m Clayey sand & gravel (raised beach deposits) to 6.1 m Soft rubbly chalk to base of borehole at 7.8 m	Water struck at 2.0 m (3.7 m AOD)
TQ00SW120	Sandy silty clay to 1.6 m Soft chalk, getting harder, to base of borehole at 6.0 m	Water struck at 3.0 m, rose to 2.4 m overnight (2.5 m AOD)
TQ00SW121	Sandy silty clay to 3.4 m Soft chalk, getting harder, to base of borehole at 4.4 m	Groundwater not encountered at 0.0 m AOD
TQ00SW122	Silty clay to 2.6 m with 0.2 m peat below, Chalky clay and chalk to base of borehole at 4.7 m	Groundwater not encountered at -3.5 m AOD

Geological information from the local boreholes shows that the deposits to the west (borehole SU90SE38) tend to have a higher component of sandy/gravelly material than the others which are to the east. This corresponds to the location of the raised beach deposits in the east, and the raised marine deposits in the west.

Where it was measured the groundwater level around Climping was typically about 2.0 to 2.5 m below ground level. In the boreholes where water was not encountered it does not necessarily mean that the natural water table was below the base of the borehole. Many boreholes, especially in clayey strata, are dry after drilling but water levels gradually rise over the following days and weeks.

Fluctuations in water level in the River Arun, caused by tidal and/or rainfall amounts, can propagate from the river through permeable near-surface geological deposits. At periods of high flows (caused by high rainfall) and high tides, these can combine to raise groundwater levels

¹ http://scans.bgs.ac.uk/sobi_scans/boreholes/434117

² Data sources are:

SU90SE38: http://scans.bgs.ac.uk/sobi_scans/boreholes/434416

TQ00SW120: http://scans.bgs.ac.uk/sobi_scans/boreholes/569845

TQ00SW121: http://scans.bgs.ac.uk/sobi_scans/boreholes/569846

TQ00SW122: http://scans.bgs.ac.uk/sobi_scans/boreholes/569847

adjacent to the river. The significance and impact of this effect diminishes with distance from the River Arun. If these high levels back up along tributaries of the river, the same effect may be seen near these watercourses.

Water levels in the River Arun fluctuate with the amount of river flow and with the tides. The Environment Agency operates a gauge at Littlehampton that measures water level. The normal range³ is between -1.59 m AOD and 3.29 m AOD and the highest level recorded is 3.76 m AOD, on 6 December 2013 at 01.30.

There are several smaller watercourses between the River Arun and the application site (seen on Figure 2.2). To the east of the application site, and near the scheduled ancient monument, are two sets of ditches that drain roughly eastwards and south eastwards. The southernmost ditch - about 200 m south of the scheduled ancient monument - was observed on 4 June 2018 to have clear water, about 20 cm deep, flowing slowly eastwards. The water level, observed from a bridge over the ditch, was estimated at about 0.2 m AOD. The ditch to the north (adjacent to the south east corner of the scheduled ancient monument) could not be accessed from public paths.

2.2 Vulnerability of Receptors Potentially at Risk

A scheduled ancient monument is located to the east of St. Mary's Parish Church. This comprises a deserted medieval village. As well as the topographic features there may be buried structural remains, pits and ditches, likely filled with local soils and possibly skeletal remains (for more detail refer to the citation at Historic England⁴ and complementary evidence to this appeal by Syann Brooks).

Buried archaeological materials degrade, over time, without any change in the hydrogeological regime due to development. The water table in the vicinity of the scheduled ancient monument is shallow and varies seasonally. Continuation of the current levels of stability of the buried archaeological materials at the site is therefore dependent on the continuation of the current hydrogeological regime. i.e. any shallow materials should remain mostly above the water table, and any deeper materials should remain mostly below the water table.

High groundwater levels may cause or exacerbate flooding when either: the water table rises to the ground surface and emerges, or the water table rises close to the ground surface, thus filling the aquifer, so that flooding by other causes cannot drain away and so the severity and duration of the flooding may be increased (Robins and Finch, 2012).

It is reasonable to expect that observations of historical surface water ponding within and adjacent to the application site are as a result of high groundwater levels. For instance, the photographs of flooding presented by Clymping Parish Council in their representation to the appeal are dated January 2014. This was a period of very high groundwater levels beneath Climping (Figure 2.1). It is not clear whether this surface water was, in fact, emergent groundwater or whether it was rain water that could not soak into the ground.

There is no data that describes the baseline variability of groundwater level beneath the scheduled ancient monument, not the residential properties of Climping.

³ www.riverlevels.uk/arun-littlehampton

⁴ <https://historicengland.org.uk/listing/the-list/list-entry/1005828>

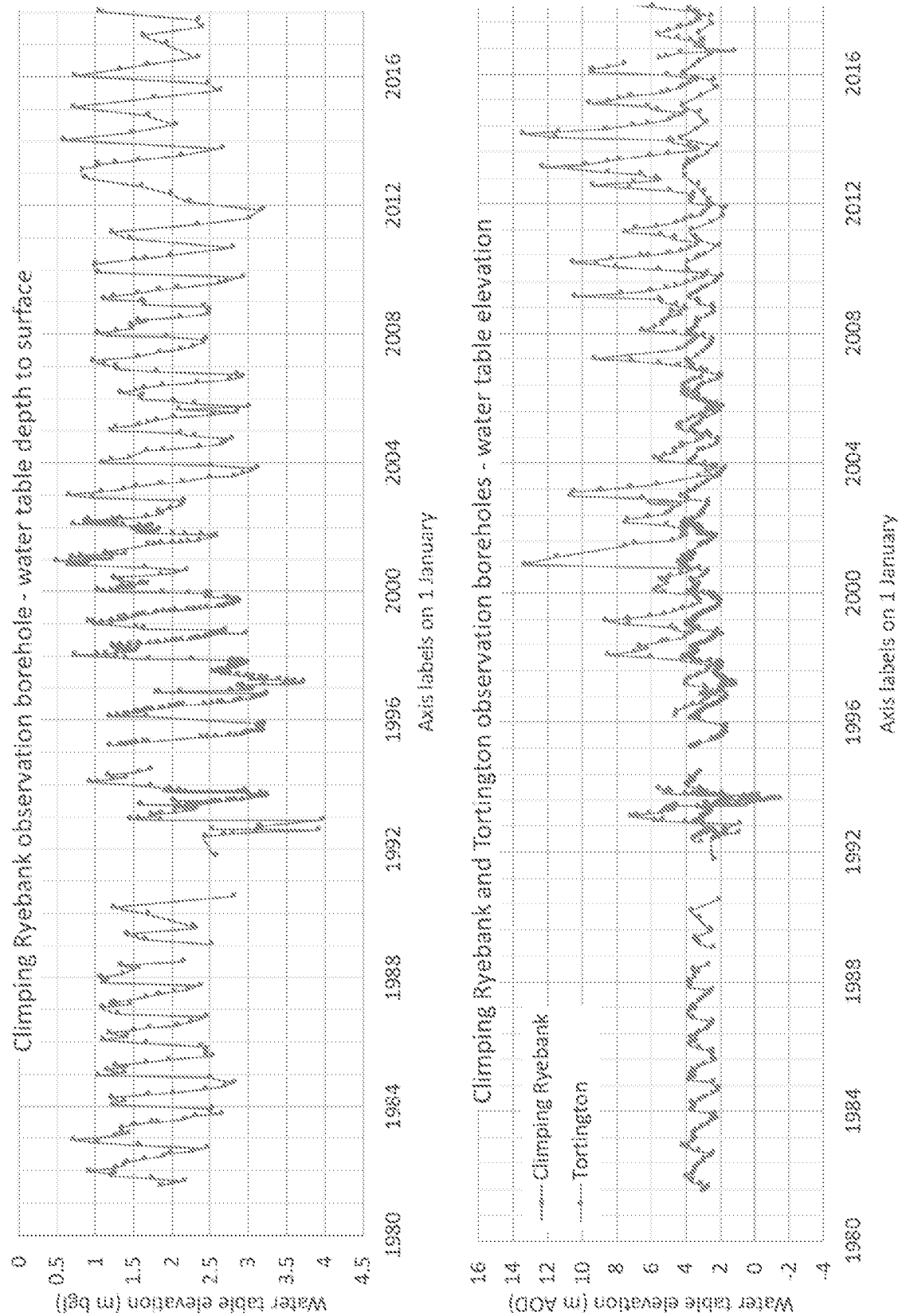


Figure 2.1 Local groundwater levels

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3. Interpretation and Risk Assessment

3.1 Conceptual Understanding of Groundwater Flow

Groundwater levels at Climping are controlled by the balance of recharge over the South Downs, and discharge to the River Adur and the English Channel. Sometimes there may be inflows of water due to high river levels in the River Arun and its tributaries.

There is no evidence that there are vertically separated aquifer units in the area of Climping. Hence the elevation of the water table level in near-surface deposits will most likely reflect the piezometric level in the chalk aquifer. i.e. the chalk and overlying deposits act as one aquifer unit (as indicated by Jones and Robins, 2012).

Because of the low permeability of the clayey near-surface deposits to the east of Climping, around the scheduled ancient monument, fluctuations in groundwater level are likely to be subdued compared to the range of fluctuations in the chalk. However, the average level is expected to be similar to that in the chalk aquifer (which is unknown at that location).

Groundwater discharge from the chalk aquifer will be to the River Arun itself, to its tributaries, and to the coast. There are two locations near, and adjacent to, the scheduled ancient monument, where groundwater is expected to discharge: the two ditches to the south and east (the clarity of water observed on 4 June 2018 suggests a groundwater source). Near these locations the water table level is likely to be controlled by the level of the ditches.

3.2 Impact of the Proposed Development on Groundwater Flow Patterns

There are four broad potential impacts of the proposed development that might affect the water table level nearby. These are discussed in the following section.

A relative rise in the average water table would be the result of a discharge of water to ground in addition to the current level of recharge. On the development roofs and roads collect rainwater to be disposed of. If that disposal route was to be via soakaway then there could be an increase in water table level. However, the ground is likely to be insufficiently permeable, and the water table is certainly too near the surface, for a soakaway to operate properly. Soakaways are not proposed to be used on the development so there is considered to be no risk of increased recharge to ground.

Interception of rainfall and its collection in attenuation ponds may result in a decrease in recharge to the area, as 100% of rainfall on roofs and roads will be diverted to the drainage system. Currently some proportion of rainfall does form recharge to the ground on the site. If necessary this may be mitigated by the use of installations such as porous paving, which would be used to balance out the impact of impermeable surfaces. A relative drop in the water table is therefore possible but could be avoided.

Installation of impermeable structures below the water table can lead to backing-up of groundwater up-gradient of the structure. Deep foundations have not been proposed for the site, so it is not anticipated that the water table will be intercepted by any structures. Any potential effect can be mitigated by installation of high-permeability drainage around the structures.

Underground services (sewers, drainage, water pipes, cables) are typically installed in trenches that are back-filled with gravel. If this intercepts the water table these can act as high permeability conduits for flow, leading to lowered water tables. Under normal conditions, when the water table is likely to be 2.0 to 2.5 m below ground level this is not likely to occur. However,

when groundwater levels are high the gravel-filled service trenches are likely to act as drains and should locally lower the water table.

3.3 Risk to Scheduled Ancient Monument

The scheduled ancient monument, at its nearest point, is to be at a distance of 70 m from the development. (For perspective the eastern end of the monument is 110 m from the River Arun, in which the water level fluctuates by about 4.9 m twice daily.)

It seems most likely that, if there was to be any hydrogeological impact of the development, there might be a decrease in recharge. This could lead to a drop in water table level in an isolated groundwater system.

However, the development site and scheduled ancient monument are to be built above a thick layer of permeable chalk aquifer. The near-surface groundwater is in continuity with the deeper groundwater so any reduction in recharge at the site will be compensated for by additional flow from the South Downs. Hence the balance is expected to be maintained, within the wider aquifer, between groundwater levels on the South Downs and the groundwater levels at discharge points (watercourses and the coast).

Gravel-filled service trenches offer the benefit of locally lowering the water table during periods of high rainfall / recharge. Hence these should be seen as a potential benefit to ameliorate the potential impacts of high groundwater levels on the scheduled ancient monument. Regardless, any impact outside of the boundary of the site is still expected to be minor.

3.4 Risk to Local Residential Properties

There is no indication that the development would lead to a rise in the water table. Furthermore, local properties are not likely to suffer from the potential for a slight lowering of the water table, if that were to occur.

Installation of site drainage and the incorporation of gravel-filled service trenches offer the benefit of locally lowering the water table during periods of high rainfall / recharge. Hence these should be seen as a benefit to ameliorate the potential impacts of shallow groundwater levels and flooding on neighbouring properties.

Laura Gibbons (drainage engineer at Arun District Council) states in an email to the planning department, of 8 May 2018, that soakaways must be considered, and tests undertaken during winter conditions. It seems unlikely that soakaways will be feasible given the high groundwater levels, but if they are to be used, a stand-off distance from neighbouring properties may be specified to ensure that there is no change in groundwater level off-site. Once soakaway tests have been undertaken the results would provide adequate evidence to enable specification of the stand-off distance.

4. Conclusions

The physical, hydrological, geological and hydrogeological setting of the proposed development site and the scheduled ancient monument at Climping has been described in Section 2.1. Based on these facts, a conceptual understanding of the hydrogeology has been developed and described in Section 3.1.

Potential mechanisms that might lead to a change in the average level or range of groundwater levels below the scheduled ancient monument have been considered in Section 3.2. Assessments in Sections 3.3 and 3.4 show that there are no feasible impacts of the development that might lead to a significant change in the groundwater regime below the scheduled ancient monument.

In the light of the above there is no need to consider effects on groundwater flow or levels, nor hydrological impact on the scheduled ancient monument, as a reason for refusal of the application.

References

Jones, H.K. and Robins, N.S., 1999. The Chalk Aquifer of the South Downs. British Geological Survey Hydrogeological Report SD/99/001.

Robins, N.S. and Finch, J.W., 2012. Groundwater flood or groundwater-induced flood? Quarterly Journal of Engineering Geology and Hydrogeology 45, 119-122.

Appendix 1. Glossary of Terms and Abbreviations

Aquifer	A permeable geological stratum or formation that is capable of both storing and transmitting water in significant amounts
Borehole	Drilled hole made in soil or rock.
Groundwater	The mass of water in the ground below the unsaturated zone occupying the total pore space in the rock and moving slowly down the hydraulic gradient in accordance with the permeability The water contained in interconnected pores located below the water table in an unconfined aquifer or located in a confined aquifer.
m AOD	metres above Ordnance Datum Newlyn
m bgl	metres below ground level
Recharge	Water that percolates downward from the ground surface to become groundwater.
Water Table	The surface in an unconfined aquifer at which the pore water pressure is atmospheric. This represents the level to which water will rise in a piezometer.

Environment Agency reference: Climping Ryebank observation borehole

BGS reference: SU90SE9 Coordinates: 499760, 101230

Web link: http://scans.bgs.ac.uk/sobi_scans/boreholes/434387

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SU90SE/9

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GEOLOGICAL CLASSIFICATION	NATURE OF STRATA (and any additional remarks)	THICKNESS	DEPTH
		METRES	METRES
		3.00	3.00
Balkingham	Sandy loess	13.00	16.00
	Soft chalk	101.00	117.00
Upper	Chalk and flints	22.00	139.00
2. Middle	Middle chalk	44.00	183.00
Chalk	Lower chalk	6.00	189.00
	Lower chalk, getting darker grey in colour	20.00	209.00
	Lower chalk, very dark grey.		
			(820 ft. 3 in.)
B.T.	25/10/74		