REPORT ON THE GEOARCHAEOLOGICAL BOREHOLE INVESTIGATIONS AT PRIORY ROAD, DARTFORD, KENT

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INTRODUCTION

This report summarises the findings arising out of the geoarchaeological investigations undertaken by Quaternary Scientific (University of Reading) in connection with the proposed development at Priory Road, Dartford, Kent (National Grid Reference: TQ 5391 7492; OASIS ID: quaterna1-193393; Figure 1). The site is on the floodplain of the River Darent, to the west of the river and over 3km from its confluence with the River Thames. The site is approximately 1.29ha in size, and its eastern boundary lies adjacent to the present-day channel of the Darent.

The British Geological Survey (http://mapapps.bgs.ac.uk/geologyofbritain/home.html) shows the site underlain by Alluvium, described as comprising silty, sandy, clayey and peaty deposits, resting on Chalk bedrock. In fact, the Holocene alluvium of the Lower Thames and its tributaries is almost everywhere underlain by Late Devensian Late Glacial Gravels (in the Thames valley, the Shepperton Gravel of Gibbard, 1985, 1994), and this gravel is widely recorded in the geotechnical boreholes already put down across the site. Three geotechnical boreholes and seven window samples put down within the main part of the site by K F Geotechnical (2014; Figure 1) showed that the Gravel surface lies at between 3.2 and 4.0m below ground surface (bgs). Above this, a thick horizon of Peat is recorded, varying between 1.5 and 3m thick on the western side of the site (BHA, WS1, WS2, WS3, WS4, WS6, WS9), becoming thinner towards the east, and closer to the River Darent (1m in BHB & 1.2m in BHC). The Peat is capped by Made Ground in all boreholes which ranges between 0.7 and 2.5m in thickness.

Whilst thick horizons of Peat appear to be present on the site, its age is unknown. Previous work carried out at the Unwins Distribution Centre to the south-east of the site also identified organic alluvium and peat beds up to 20cm in thickness, but was not processed or dated due to contamination and truncation (Wessex Archaeology, 2009; Archaeology South East, 2010). It is highly likely however that the Peat is of Holocene age, and most likely prehistoric. Furthermore, it is possible that up to 3000 years-worth of peat may be present on the site, on the very approximate calculation that 1m of peat = 1000 years of accumulation. On this

basis, the Peat has the potential to provide a reconstruction of the environmental history of the site and its environs over multiple cultural periods.

Borehole core samples were not collected during the recent geotechnical investigations. These are required for: (1) detailed laboratory based lithostratigraphic description and the production of a deposit model for the site, and (2) assessment and analysis of the archaeobotanical and zooarchaeological remains (if necessary). These aspects of work are vital in order to increase knowledge and understanding of the environmental history of this part of River Darent Valley, as well as to discharge the planning condition on the site.

Four significant research aims were proposed within the geoarchaeological Written Scheme of Investigation (WSI; Batchelor, 2014) for the site which were as follows:

1. To carry out geoarchaeological borehole investigations to clarify the nature of the sub-surface stratigraphy across the site;
2. To assess the potential of the borehole sequences for reconstructing the environmental history of the site and its environs;
3. To provide recommendations for further work at the site (if necessary);
4. To integrate the new geoarchaeological record with other recent work in the local area for publication in an academic journal.

This report seeks to achieve the first of these aims by fulfilling the following objectives (as also outlined in Batchelor, 2014): (1) to obtain a maximum of three geoarchaeological boreholes from selected locations at the site, and (2) to use the stratigraphic data from the new locations, and existing records to produce a new deposit model of the major depositional units across the site. In addition, this report will provide recommendations for further work (if necessary).

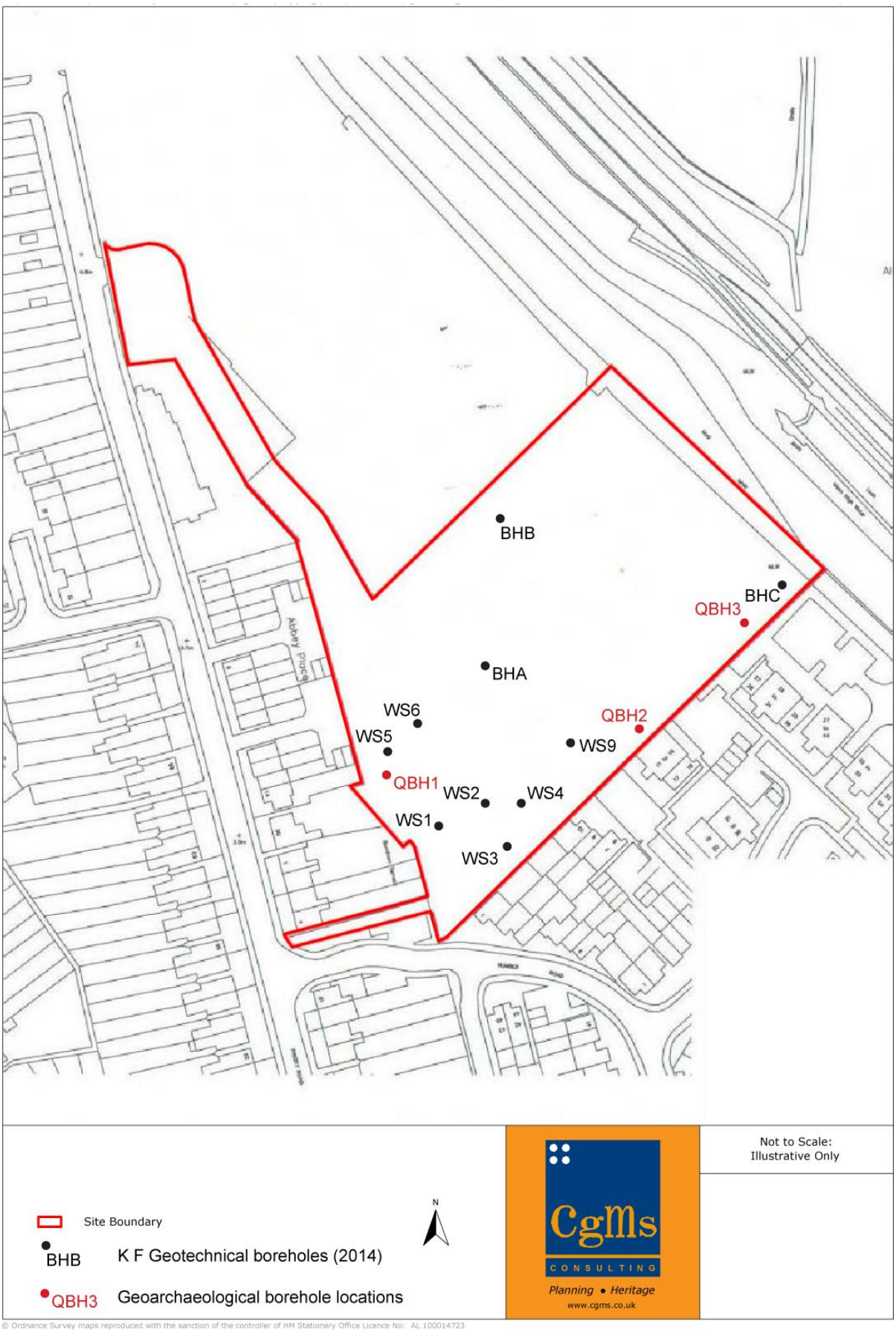

Figure 1: Location of the geoarchaeological and geotechnical boreholes at Priory Road, Dartford, Kent

METHODS

Field investigations

Three geoarchaeological boreholes (<QBH1> to <QBH3>) were put down within the site in October 2014. These locations were chosen so as: (1) to provide a south-west to north-east transect of boreholes across the site, towards the position of the River Darent, and (2) to confirm the expected sedimentary sequences recorded across the site. Within the WSI, the positions of QBH2 & QBH3 were towards the centre of the site, however, these had to be moved to the southern margins of the site because of thick horizons of concrete, and demolition works taking place in this area. Despite this, a south-west to north-east transect of boreholes was achieved.

Borehole core samples were recovered using an Eijkelkamp windowless sampler and gouge set using an Atlas Copco TT 2-stroke percussion engine. This coring technique is a suitable method for the recovery of continuous, undisturbed core samples and provides sub-samples suitable for not only sedimentary and microfossil assessment and analysis, but also macrofossil analysis. The recovered core samples were wrapped in clear plastic to prevent moisture loss, labelled with the depth (metres from ground surface) and orientation (top and base) and returned to Quaternary Scientific for storage in a purpose built facility at 2^{o}C. This temperature prevents fungal growth on the core surface, which may lead to anomalous radiocarbon dates, and moisture loss. The spatial attributes of each borehole were recorded using a Leica DGPS (Figure 1; Table 1).

Lithostratigraphic descriptions

The lithostratigraphy of the boreholes was described in the field and laboratory using standard procedures for recording unconsolidated sediment and organic sediments, noting the physical properties (colour), composition (gravel, sand, clay, silt and organic matter) and inclusions (e.g. artefacts) (Tröels-Smith, 1955). The procedure involved: (1) cleaning the samples with a scalpel to remove surface contaminants; (2) recording the physical properties, most notably colour using a Munsell Soil Colour Chart; (3) recording the composition; gravel (Grana glareosa; Gg), fine sand (Grana arenosa; Ga), silt (Argilla granosa; Ag) and clay (Argilla steatoides); and (4) recording the unit boundaries e.g. sharp or diffuse. The results are displayed in Tables 2 to 4.

Table 1: Spatial data for the new geoarchaeological boreholes at Priory Road, Dartford, Kent

Borehole number	Easting	Northing	Elevation (m OD)
<QBH1>	553872.981	174894.620	3.174
<QBH2>	553942.396	174909.576	3.391
<QBH3>	553975.176	174936.786	3.564

Deposit modelling

The reconstruction of the sedimentary architecture beneath the site was undertaken using records from the geoarchaeological and geotechnical investigations. No British Geological Society (BGS) boreholes are available in the area of the site. Due to the limited number of records, and lack of OD heights for the geotechnical boreholes, it is not possible to produce topographic models for the surface of each major stratigraphic unit. Instead, a west-east transect comprising the geoarchaeological boreholes is provided in Figure 2.

RESULTS, INTERPRETATION AND DISCUSSION OF THE GEOARCHAEOLOGICAL BOREHOLE INVESTIGATIONS

The results of the geoarchaeological borehole investigations are recorded in Tables 2 to 4, and plotted as a south-west to north-east transect in Figure 2. A summary of the stratigraphic information derived from the K.F. Geotechnical borehole and window sample logs is recorded in Table 5. As outlined in the methodology, it was not possible to place the boreholes in the positions outlined in the WSI (Batchelor, 2014). This was for two reasons: (1) previous development across much of the site left substantial thicknesses of concrete truncating the sedimentary sequence, and (2) the position of plant and demolition rubble on site created a health and safety concern in these areas. Nevertheless, a transect of boreholes was achieved and sedimentary sequences obtained.

The results of the investigations indicate a sequence of Sands and Gravels overlain by a complex sequence of Alluvial deposits and Peat. The Sands and Gravels are interpreted as representing the Shepperton Gravel surface, laid down under high energy conditions during the Late Glacial. Within the three boreholes, the surface of these deposits varies between 0.76 and -0.52m OD (2.40 to 3.69m bgs). Unfortunately it is not possible to map the surface of the Shepperton Gravel across the entire site due to both a lack of location data for the K.F. Geotechnical boreholes, and the distribution of these boreholes across the site. Nevertheless, these records indicate the surface ranges between 2.8 and 4.0m bgs, thus correlating well with the new geoarchaeological borehole records. It is important to note however that demolition and levelling works have taken place on the site since the K.F. Geotechnical boreholes were put down, and thus the below ground surface depths may no

longer be correct.

The Alluvial sediments overlying the Shepperton Gravel consist of: (1) fine-grained mineral-rich deposits (clays, silts and sands); (2) organic-rich clay, and (3) moderate to well-humified wood and herbaceous Peat. The fine-grained mineral-rich sediments are indicative of deposition within slow to moderately fast moving water. The organic-rich clay is indicative of deposition within a semi-aquatic environment, and the Peat is indicative of accumulation within a semi-terrestrial environment supporting the growth of trees, shrubs and/or herbs. The varying distribution of the different Alluvial sediments in the three boreholes indicates both spatial and temporal variations in environmental conditions across the site, which are fairly typical of a small floodplain valley.

The thickness of the Alluvial sediments (and certainly the Peat) is however markedly less than that indicated by the K.F Geotechnical Records (see Table 5). This could be due to one or more of the following: (1) the varying nature of truncation across the site by previous development/demolition; (2) differences in the coring and descriptive methodology, and (3) the spatial distribution of the two sets of boreholes across the site.

Table 2: Lithostratigraphic description of borehole <QBH1>, Priory Road, Dartford, Kent

Depth (m OD)	Depth (m bgs)	Composition
3.17 to 0.59	0 to 2.58	Made Ground
0.59 to 0.17	2.58 to 3.00	2.5YR 2.5/1; Sh3 Tl^{3}1, Th+; Humo 2; Reddish black well humified wood peat with herbaceous peat inclusions; diffuse contact into:
0.17 to -0.43	3.00 to 3.60	No recovery
-0.43 to -0.52	3.60 to 3.69	10YR 2/1; Sh3 Tl^{2}1, Th+ As+; Humo 3-4; Black well-humified wood peat with herbaceous peat and clay inclusions; sharp contact into:
-0.52 to -0.53	3.69 to 3.70	10YR 5/1; Gg2, Ga2; Grey sandy gravel.

Table 3: Lithostratigraphic description of borehole <QBH2>, Priory Road, Dartford, Kent

Depth (m OD)	Depth (m bgs)	Composition
3.39 to 1.77	0 to 1.62	Made Ground
1.77 to 1.63	1.62 to 1.76	10YR 5/1; As3, Ag1; Grey silty clay; diffuse contact into:
1.63 to 1.39	1.76 to 2.00	10YR 4/3; Sh2, Ag2; Humo 4, Th+, Gg+, Ga+; Brown well humified very organic-rich silt with herbaceous peat, sand and gravel inclusions; diffuse contact into:
1.39 to 1.34	2.00 to 2.05	10YR 3/2; Sh3, Th31; Humo 3-4; Very dark greyish brown well humified herbaceous and unidentifiable peat; diffuse contact into:
1.34 to 1.29	2.05 to 2.10	10YR 3/2 to 10YR 4/2; As2, Ag1, Sh1, Dh+, Dl+; Very dark greyish brown organic-rich silty clay with detrital

		wood and plant inclusions; diffuse contact into:
1.29 to 1.02	2.10 to 2.27	10YR 5/1; Ag2, As2, Gg+, Dl+; Grey silty clay with traces of gravel and detrital wood; sharp contact into:
1.02 to 0.97	2.27 to 2.42	Gley 1 10Y/7; Ag2, Ga1, As1, Gg+; Light bluish grey clayey sandy silt with gravel inclusions; diffuse contact into:
0.97 to 0.76	2.42 to 2.63	Gley 1 10Y/7; Ag2, Ga1, As1, Gg+; Light bluish grey clayey sandy silt with gravel inclusions and routes traversing vertically through the sediment; diffuse contact into:
0.76 to 0.58	2.42 to 2.81	10YR 5/1; Ga2, Gg2, Dh+; Grey sandy gravel with detrital plant remains and
0.58 to 0.39	2.81 to 3.00	10YR 6/6; Ga2, Gg2; Brownish yellow sandy gravel.

Table 4: Lithostratigraphic description of borehole <QBH3>, Priory Road, Dartford, Kent

Depth (m OD)	Depth (m bgs)	Composition
3.56 to 1.14	0 to 2.42	Made Ground
1.14 to 0.69	2.42 to 2.87	10YR 5/1; As3, Ag1, Sh+, Mollusca+, Dl+, Dh+; Grey silty clay with traces of organic remains, Mollusca, detrital wood and plant remains; sharp contact into:
0.69 to 0.60	2.87 to 2.96	10YR 6/1; As3, Ag1; Grey silty clay; very sharp contact into:
0.60 to 0.56	2.96 to 3.00	10YR 2/1; Sh3, Tl31; Humo 4; well humified herbaceous and unidentifiable peat; sharp contact into
0.56 to 0.46	3.00 to 3.10	10YR 3/1; As3; Sh1; Very dark grey organic-rich clay; sharp contact into:
0.46 to 0.22	3.10 to 3.34	10YR 6/1; As2, Ag2, Ga+, Dl+; Grey silty clay with sand and detrital wood inclusions; sharp contact into:
0.22 to 0.14	3.34 to 3.42	10YR 6/1; Gg2, Ga1, As1; Grey clayey sandy gravel; diffuse contact into:
0.14 to -0.44	3.42 to 4.00	10YR 6/6; Ga2, Gg2; Brownish yellow sandy gravel.

Table 5: Summary stratigraphic information from the K.F. Geotechnical borehole and window sample logs (2014), Priory Road, Dartford, Kent

Borehole/Window sample number	Top of Peat / Clay and Peat (m BGL)	Thickness of Peat / Clay and Peat	Top of Sands and Gravels (m BGL)
BHA	>1.0	3m	>4.0
BHB	>2.5	1m	>3.5
BHC	>2.0	1.2m	>3.2
WS1	>0.8	2.4m	>3.6
WS2	>1.5	2m	>3.5
WS3	>1.5	2.3m	>3.8
WS4	>1.6	1.7m	>3.3
WS5	Borehole abandoned		
WS6	>0.7	2.1m	>3.8
WS9	>1.0	2.8m	>2.8

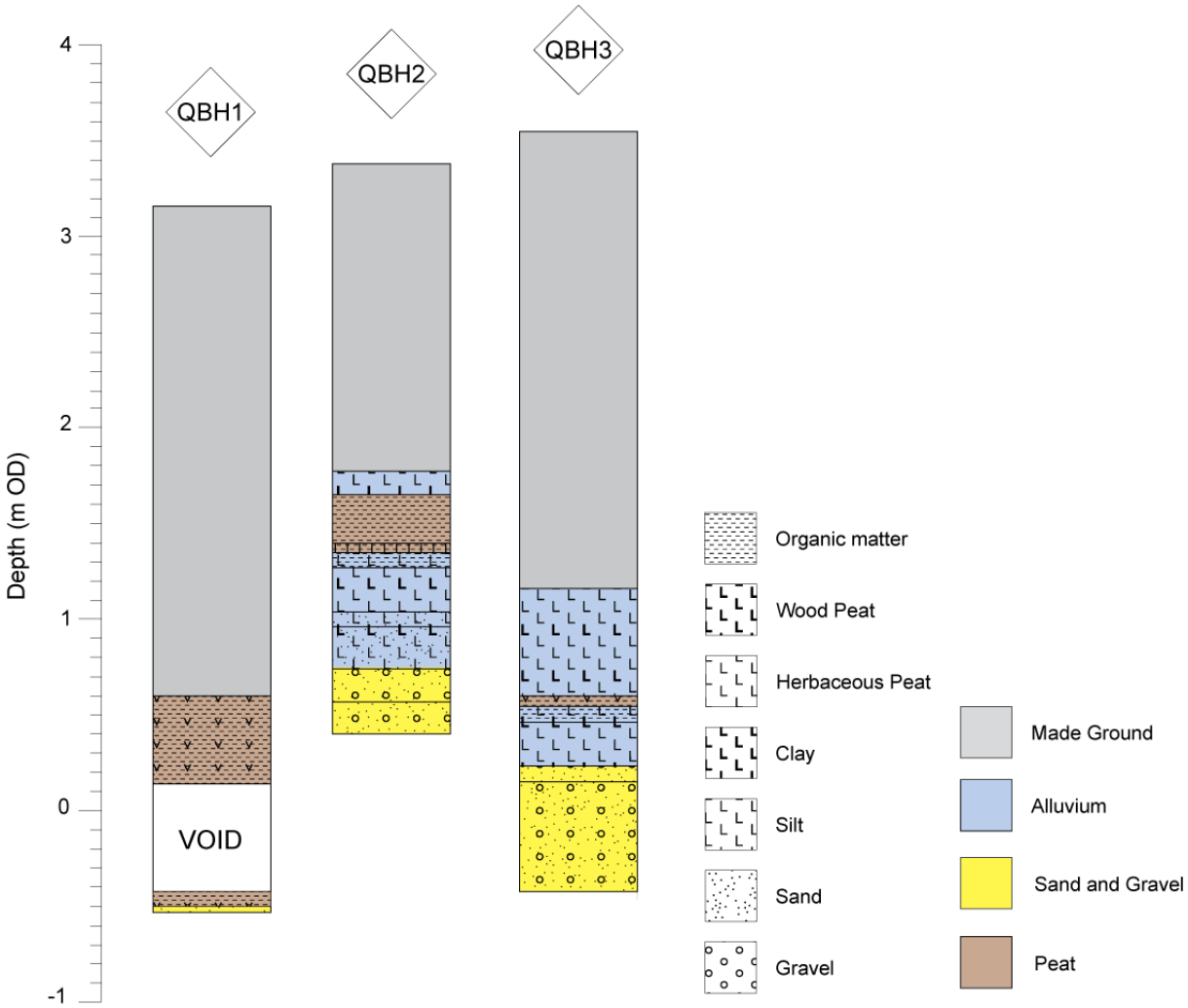

Figure 2: West-east borehole transect across the Priory Road site

CONCLUSION AND RECOMMENDATIONS

The aim of the geoarchaeological borehole investigations was to clarify the nature of the sub-surface stratigraphy across the site. This was achieved by putting down three boreholes at selected locations, and using the stratigraphic data from the new locations and existing records to produce a deposit model of the major depositional units across the site.

The results of the investigations indicate a sequence of Late Glacial Shepperton Gravel overlain by a complex sequence of Alluvial deposits and Peat. The Shepperton Gravel surface appears to undulate, resting between approximately 2.8 and 4.0m BGL (between at least 0.76 and -0.52m OD). The Alluvial sediments resting on the Shepperton Gravel surface are indicative of deposition within slow to moderately fast moving water, semi-aquatic, and semi-terrestrial environments. Spatial and temporal variations between these environments are indicated by the complex distribution of the Alluvial sediments; these variations are fairly typical of a small floodplain valley.

Organic-rich sediments (in particular Peat) have high potential to provide a detailed reconstruction of past environments through the assessment/analysis of palaeoecological remains (e.g. pollen, plant macrofossils and insects) and radiocarbon dating. Unfortunately, the thickness of the Peat is markedly less than that indicated by the K.F Geotechnical Records. As such, the potential for providing a detailed reconstruction of the environmental conditions over multiple cultural periods as outlined within the WSI (Batchelor, 2014) is substantially diminished. However, since the age of the Peat and its palaeoecological potential is unknown in this part of the Darent Valley, a limited programme of assessment is recommended incorporating radiocarbon dating and evaluation of the concentration and preservation of micro and macrofossil content. Not only would this provide further information about the site, but it would also provide valuable information for future investigations within the local area.

REFERENCES

Batchelor, C.R. (2014) *Written Scheme of Investigation for the geoarchaeological investigation of land At Priory Road, Dartford, Kent*. Quaternary Scientific (QUEST) Unpublished Report September 2014; Project Number 193/14.

Butler, C. (2014) Priory Road, Dartford, Kent: Archaeological Desk Based Assessment. CgMs Consulting Unpublished Report.

Gibbard, P.L. (1985) *Pleistocene History of the Middle Thames Valley*. Cambridge University Press, Cambridge.

Gibbard, P.L. (1994) *Pleistocene History of the Lower Thames Valley*. Cambridge University Press, Cambridge.

K F Geotechnical (2014) *Geotechnical borehole logs, Dartford Paper Mill, Dartford*. Unpublished report.

Tröels-Smith, J. (1955) Karakterisering af løse jordater (Characterisation of unconsolidated sediments), *Danm. Geol. Unders., **Ser IV*** **3**, 73.