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GORESBROOK PARK, LONDON BOROUGH OF BARKING AND DAGENHAM

Environmental Archaeological Assessment Report

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1. NON-TECHNICAL SUMMARY

An environmental archaeological assessment of two sequences was carried out at the Goresbrook Park site in order (1) to establish the age of the peat recorded at the site; (2) to assess the palaeoenvironmental potential of the sequence; (3) to highlight any indications of nearby human activity, and (4) to provide recommendations for further analysis.

The Shepperton Gravel (and occasional sand) at the site is overlain by a tripartite sequence of Lower Alluvium, Peat and Upper Alluvium. The Peat generally ranges between 1 and 2m in thickness, and lies at elevations of between *ca*. -1 and -5m OD. The results of the radiocarbon dating indicate that peat accumulation began towards the southeast of the site during the Early to Middle Neolithic, and towards the northwest, during the Late Neolithic. Peat accumulation continued at the site until the Iron Age, and towards the southeast, the Roman period. The results of the palaeobotanical assessment are indicative of a peat surface dominated by alder and willow, with an understorey of grasses, sedges and occasional aquatics, with mixed deciduous woodland on the dryland including oak and lime. No definitive indicators of human activity were recorded during the assessment. However, both lime and oak decline in the upper half of both sequences, and this is matched by an expansion in the diversity of herbs and an increase of microcharcoal. This most likely indicates late prehistoric woodland clearance for settlement and/or agricultural purposes. In addition, of particular note are the high values of both micro- and macrocharcoal towards the base of both sequences; this is suggestive of nearby or in situ burning, though whether this was of natural or anthropogenic origin is not possible to state at this time. In QBH2 this horizon of charcoal occurs just above the wooden branch/timber identified at the base of this borehole, and not far from the structure identified by Divers (1996) *ca*. 100m to the northeast.

The sequence from the Goresbrook Park site provides a unique opportunity to investigate the vegetation history of this part of the Lower Thames Valley, where prehistoric human activity is known to have taken place. Analysis of the pollen assemblages in both sequences is therefore recommended, along with identifications of the charcoal present towards the base of both boreholes. The diatom assemblages in borehole QBH1 should also be analysed, in order to investigate in more detail the transition from peat to alluvium towards the top of the sequence. Two additional radiocarbon dates for each sequence are also recommended, in order to provide a better chronological framework that can be used to compare and integrate the data with other sites in this area.

2. INTRODUCTION

2.1 Site context

This report summarises the findings arising out of the environmental archaeological assessment undertaken by Quaternary Scientific (University of Reading) in connection with the proposed development of land at Goresbrook Park, London Borough of Barking and Dagenham (National Grid Reference: centred on TQ 48432 83233; Figures 1 & 2). Quaternary Scientific were commissioned by CgMs Consulting to undertake the investigations. The site lies on the floodplain of the Lower Thames Valley, to the west and north of the Gores Brook tributary; the northern boundary of the site borders the edge of the floodplain. The modern course of the River flows broadly north-west to south-east *ca*. 1km to the south of the site. The British Geological Survey (BGS) show the site underlain London Clay bedrock, with Lambeth Group deposits, described as 'clay, silt and sand' outcropping just beyond the southern border of the site. The bedrock is overlain by Holocene alluvium across the vast majority of the site (described as 'clay, peaty, silty, sandy'), with deposits of the Wolstonian (Marine Isotope Stages (MIS) 6-10) Taplow Gravel terrace towards its northern border. In fact, the alluvial deposits of the Lower Thames and its tributaries are almost everywhere underlain by Late Devensian (MIS 2) Late Glacial Gravels (in the Thames valley, the Shepperton Gravel of Gibbard, 1985, 1994), and this gravel is widely recorded in boreholes in the vicinity of the site.

A recent desk-based deposit modelling exercise (Batchelor, 2017), and subsequent geoarchaeological field investigations (Young & Batchelor, 2017a) at the site indicate that the sediments present are similar in character to those recorded elsewhere in the Lower Thames Valley; the Shepperton Gravel is overlain by a sequence of Holocene alluvial sediments, including peat, buried beneath modern Made Ground. The surface of the Shepperton Gravel generally rests between -3 and -4.5m OD across the majority of the site, rising to 2m OD on the northern most part of the site, representative of the Taplow Gravel terrace and floodplain edge. A similar sequence of deposits is recorded across the neighbouring Beam Park (Young & Batchelor, 2017a) and Former Ford Stamping Factory (Batchelor, 2017b) sites to the east. The Shepperton Gravel (and occasional sand) is overlain by a tripartite sequence of Lower Alluvium, Peat and Upper Alluvium. The peat is generally present in thicknesses of between 1 and 2m, and is recorded at between *ca*. -1 and -4m OD (Young & Batchelor, 2017a).

2.2 Palaeoenvironmental and archaeological significance

The existing deposit model for the site, based on both geoarchaeological and geotechnical borehole records, indicates considerable variation in the height of the Gravel surface, and the type, thickness and age of the subsequent Holocene deposits within the vicinity of the site. Such variations are significant as they represent different environmental conditions that would have existed in a given location. For example: (1) the varying surface of the Gravel may represent the location of pre-Holocene river terraces, former channels and bars; (2) the presence of peat represents former terrestrial or semi-terrestrial land-surfaces, and (3) the various alluvial units represent periods of changing hydrological conditions. Thus by studying the sub-surface stratigraphy across the site in greater detail, it will be possible to build an understanding of the former landscapes and environmental changes that took place across space and time.

Organic-rich sediments (in particular peat) also have high potential to provide a detailed reconstruction of past environments on both the wetland and dryland. In particular, they provide the potential to increase knowledge and understanding of the interactions between hydrology, human activity, vegetation succession and climate. Significant vegetation changes include the Mesolithic/Neolithic decline of elm woodland, the Neolithic colonisation and decline of yew woodland; the Late Neolithic/Early Bronze Age growth of elm on Peat, and the general decline of wetland and dryland woodland during the Bronze Age. Such investigations are carried out through the assessment/analysis of palaeoecological remains (e.g. pollen, plant macrofossils & insects) and radiocarbon dating. For example, at Hornchurch Marshes, <2km to the southeast (Batchelor, 2009; Branch *et al*., 2012) analysis of fine-grained mineral-rich sediments and peat revealed the presence of freshwater during the Late Mesolithic, at which point peat accumulation began, corresponding to a regional reduction in sea level. Significant changes in both the wetland and dryland environment were recorded here, including the establishment of alder carr woodland, yew; the decline of both elm during the Neolithic, and decline of lime during the Neolithic & Bronze Age. A subsequent transition to estuarine conditions was dated to *ca*. 3900 cal BP, coinciding with a decline in woodland cover and the expansion of plant communities typically found within reed swamp. Analysis of borehole sequences from Barking Riverside, *ca*. 2km to the southwest (see Figure 1), indicated that peat accumulation began at *ca*. 6000 cal BP (late Mesolithic), and continued until at least *ca*. 3500 cal BP (Bronze Age) (Green *et al*., 2014). The peat at Bridge Road meanwhile, >3km to the east, was found to be of Late Neolithic to Bronze Age date (Meddens & Beasley, 1990). Palaeoenvironmental analysis here revealed that during its accumulation, dense alder carr woodland dominated the wetland, with oak, lime and hazel on the surrounding dryland (Meddens & Beasley, 1990). Palaeoenvironmental assessment carried out immediately to the west of the site at New Road, Rainham revealed a thin sequence of peat and alluvial deposits dating to the Bronze Age. This indicated similar vegetation communities, but the local environment became more open in response to wetter conditions and clearance (Krawiec, 2014). Peat deposits have also been recorded accumulating from the Late Mesolithic to the Iron Age East of Ferry Lane on the High Speed 1 route (Bates & Stafford, 2013).

Finally, areas of high gravel topography, soils and peat represent potential areas that might have been utilised or even occupied by prehistoric people, evidence of which may be preserved in the archaeological (e.g. features and structures) and palaeoenvironmental record (e.g. changes in vegetation composition). This is of particular significance at the present site, as a 4m wide Bronze Age causeway, constructed of gravel and burnt flint (MLO59097, TQ 4850 8320 was identified at Hays Storage Dagenham immediately adjacent to the eastern part of the site (Divers, 1996; Figures 1 & 2), Radiocarbon dating of the causeway at Hays Storage Service Ltd. suggested that the causeway was in use for over 100 years between 1520 and 1400 BC (Divers, 1996). The trackway was orientated NNE/SSW and recorded at a depth of -1.70m OD, and traced for 23m within the upper level of a peat deposit also dated to the Bronze Age. The Dagenham Idol, a Neolithic wooden figurine, was also discovered during the installation of sewer pipes in 1922, approximately 200m to the east of the site. In addition, a series of prehistoric archaeological features were identified less *ca*. 3km to the east at Bridge Road (Meddens & Beasley, 1990; Beasley, 1991), whilst. The features recorded at Bridge Road included stake holes and spreads of fire-cracked pebbles associated with the foreshore of a former channel, and later, stakes, wattling and a brushwood trackway associated with peat formation (Meddens & Beasley, 1990; Beasley, 1991). Further important prehistoric and historic archaeological remains in the nearby area are highlighted in the Archaeological Desk-Based Assessment for the site (CgMs Consulting, 2016).

The potential of identifying archaeological remains at the Goresbrook Park site, particularly towards the northern edge is therefore significant, though it is highlighted that a recently completed archaeological evaluation (PCA, 2017) and ongoing watching brief (Mayo, pers. comm.) are yet to identify any prehistoric remains. It is of note that during the previous geoarchaeological investigations (Young & Batchelor, 2017a) a large, horizontal piece of wood was recorded at the base of borehole QBH2, between -3.16 and *at least* -3.82m OD; it is uncertain at this stage what this piece of wood may relate to. Interestingly, Divers (1996) noted that fallen yew and alder trees were recorded lower down in the peat sequence at the Hays Storage site, below the causeway identified there. Perhaps significantly, a large charred wood fragment (20x20mm) was identified just above this wood, at between -2.86 to -2.88m OD; again, it is unclear if this charcoal is a result of human activity or a natural fire event.

2.3 Aims and objectives

Following the results of the geoarchaeological field investigations and subsequent deposit modelling, it was recommended that a full environmental archaeological assessment was undertaken on borehole QBH1, with a limited programme of assessment and radiocarbon dating of borehole QBH2. The aims of the assessment were (1) to establish the age of the peat recorded at the site; (2) to assess the palaeoenvironmental potential of the sequence; (3) to highlight any indications of nearby human activity, and (4) to provide recommendations for further analysis (if necessary).

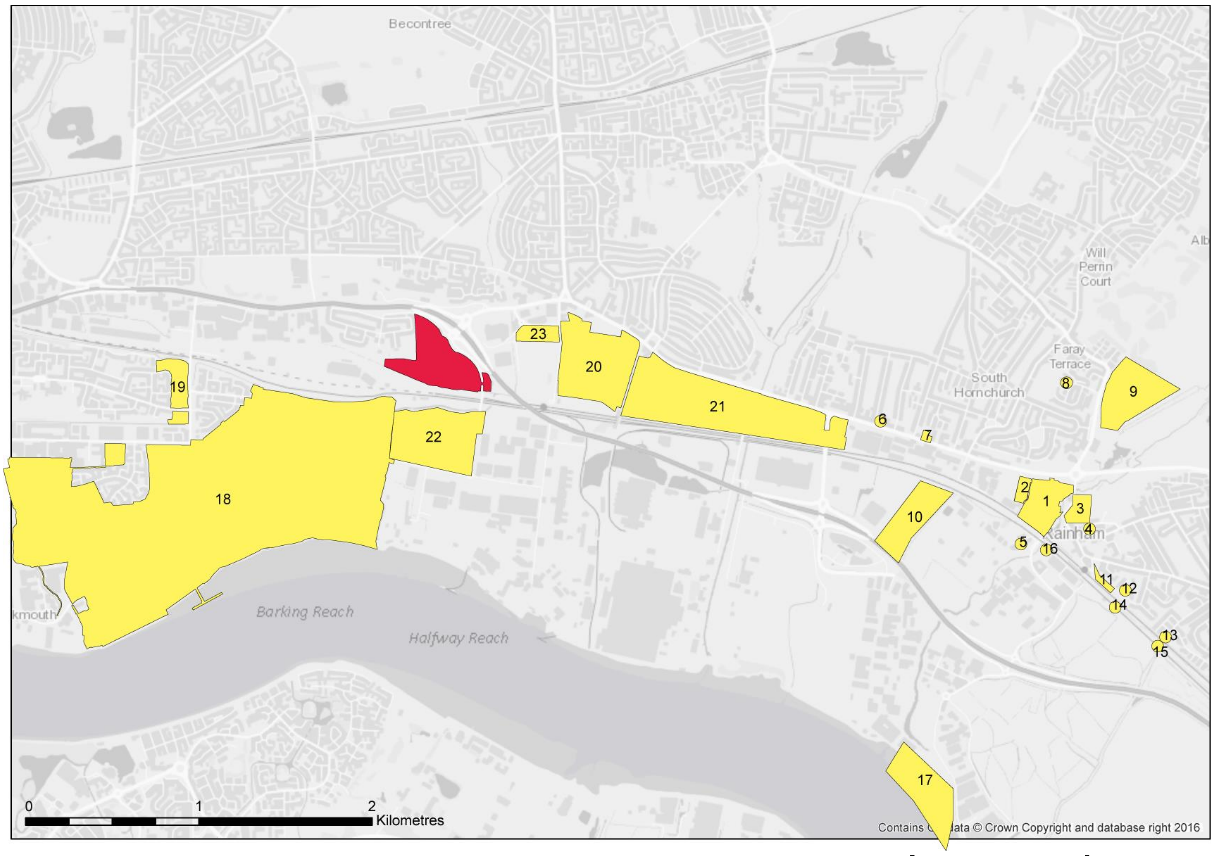

Figure 1: Location of Goresbrook Park / Hays Storage Dagenham (Divers, 1996), London Borough of Barking and Dagenham (highlighted in red) and selected other archaeological and palaeoenvironmental sites: (1) Dovers Corner (Batchelor & Young, 2016); (2) the Passivhaus Housing Development (NRD13; Dyson, 2013); (3) Bridge Road (RA-BR89; Meddens & Beasley, 1990; Beasley, 1991); (4) Viking Way (RA-VW 96; Beasley, 1996); (5) Union Railways (URA97; MoLAS, 1997); (6) the former Manser Works (MNM03; Potter, 2003); (7) 155-163 New Road (NRI07; Pre-Construct Archaeology, 2007); (8) the Lessa Sports Ground (LSA98; MoLAS, 1998, 2001); (9) Scott & Albyn's Farm, Rainham Road (RNH96; HO-CP95; Hertfordshire Archaeological Trust, 1995, 2000); (10) Hornchurch Marshes (MOY03; Branch et al., 2012; Batchelor 2009), (11) the former Rainham Squash and Snooker Club (RSQ04; Archaeological Solutions Ltd, 2005); (12) the former Rainham Football Club (RA-FG95; Thames Valley Archaeological Society, 1995); (13) Brookway Allotments (RA-BA92; Newham Museum Service, 1992); (14) 24.455, East of Ferry Lane, HS1 (Bates & Stafford 2013); (15) 24.755, East of Ferry Lane, HS1 (Bates & Stafford 2013); (16) Rainham Creek (Bates & Stafford 2013); (17) Frog Island (MER11; Batchelor *et al.*, 2011); (18) Barking Riverside (Green *et al.*, 2012); (19) Renwick Road (Green et al., 2012); (20) Former Ford Stamping Factory (Young *et al.*, 2017); (21) Beam Park (Young & Batchelor, 2017a); (22) London Sustainable Industries Park (MoLA, 2010); (23) Merrielands Crescent (Batchelor *et al.*, 2017).

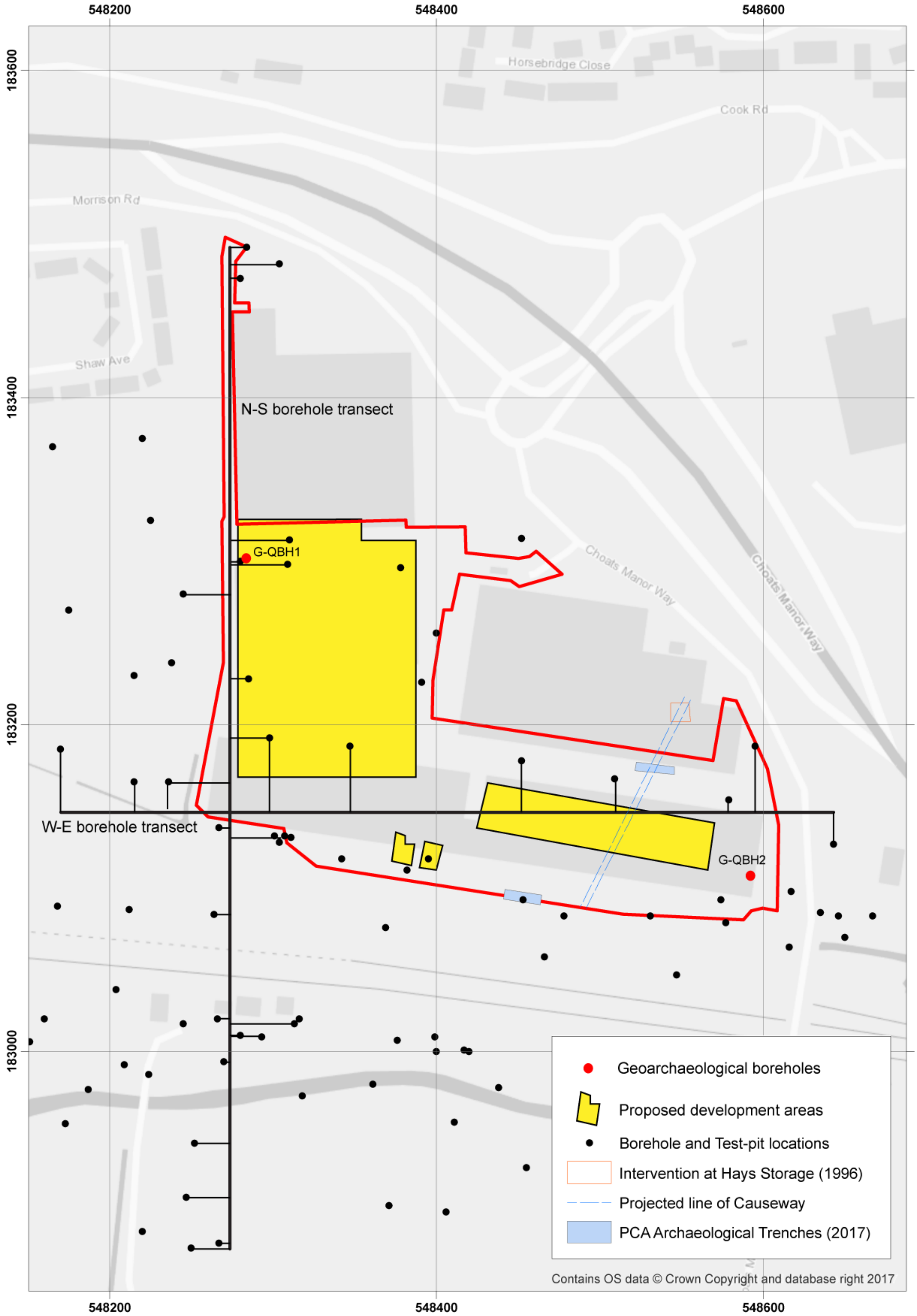

Figure 2: Location of the geoarchaeological and geotechnical boreholes and test-pits across the Goresbrook Park site. Also displayed is the location of the causeway discovered at Hays Storage Dagenham, and its projected orientation (Divers, 1996).

3. METHODS

3.1 Previous investigations (Field investigations, lithostratigraphic descriptions and deposit modelling)

Two geoarchaeological boreholes (boreholes QBH1 and QBH2) were put down at the site in July 2017 by Quaternary Scientific (Figure 2). The borehole core samples were recovered using an Eijkelkamp window sampler and gouge set using an Atlas Copco TT 2-stroke percussion engine. This coring techniques provide 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. Spatial co-ordinates for each borehole were obtained using a Leica Differential GPS (see Table 1). It was not possible to record the entire Holocene alluvial sequence in QBH2, due to the presence of a thick (≥0.66m) layer of wood at between 4.34 to 5.00m bgl which prevented drilling beyond this depth (see Young & Batchelor, 2017a).

A combination of laboratory- and field-based lithostratigraphic descriptions of the new borehole samples was carried out using standard procedures for recording unconsolidated sediment and peat, noting the physical properties (colour), composition (gravel, sand, clay, silt and organic matter) and inclusions (e.g. artefacts). The procedure involved: (1) cleaning the samples with a spatula or scalpel blade and distilled water to remove surface contaminants; (2) recording the physical properties, most notably colour; (3) recording the composition e.g. gravel, fine sand, silt and clay; (4) recording the degree of peat humification, and (5) recording the unit boundaries e.g. sharp or diffuse. The results are displayed in Tables 2 and 3.

The deposit model for the site was based on a review of 143 borehole records, including the two new geoarchaeological records. Sedimentary units from the boreholes were classified into six groups: (1) Bedrock (London Clay / Lambeth Group), (2) Gravel, (3) Lower Alluvium. (4) Peat, (5) Upper Alluvium and (6) Made Ground. In addition, 743 geoarchaeological, archaeological and geotechnical records were collated to examine key deposits across the wider area. The classified data for groups 1-6 were then input into a database within the RockWorks 16 geological utilities software, the output from which was displayed using ArcMAP 10. Models of surface height were generated for the Gravel, Lower Alluvium, Peat and Upper Alluvium using an Inverse Distance Weighted algorithm (Figures 3-5, 7 and 9). Thickness of the Peat, total Holocene alluvium (incorporating the Lower Alluvium, Peat and Upper Alluvium) and Made Ground (Figures 6, 8 and 10) were also modelled (also using an Inverse Distance Weighted algorithm). Borehole transects are displayed in Figures 11 (north-south) & 12 (west-east).

As reported by Young & Batchelor (2017a), in general, both the distribution and density of boreholes across the site is good; however, not all boreholes record the entire Holocene alluvial sequence, and thus for selected stratigraphic units the reliability is better in certain areas of the site. The reliability of the models generated using RockWorks is therefore variable. In general, reliability improves from outlying areas where the models are largely supported by scattered archival records towards the core area of boreholes. Because of the 'smoothing' effect of the modelling procedure, the modelled levels of stratigraphic contacts may differ slightly from the levels recorded in borehole logs and section drawings. As a consequence of this the modelling procedure has been manually adjusted so that only those areas for which sufficient stratigraphic data is present will be modelled. In order to achieve this, a maximum distance cut-off filter equivalent to a 50m radius around each record is applied to all the site-wide deposit models, and 100m for the wider gravel surface model. In addition, it is important to recognise that multiple sets of boreholes are represented, put down at different times and recorded using different drilling/descriptive terms and subject to differing technical constraints in terms of recorded detail including the exact levels of the stratigraphic boundaries.

3.2 Organic matter determinations

A total of 13 subsamples from borehole QBH1 were taken for determination of the organic matter content (Table 4; Figure 14). These records were important as they can identify increases in organic matter possibly associated with more terrestrial conditions. The organic matter content was determined by standard procedures involving: (1) drying the sub-sample at 110^{0}C for 12 hours to remove excess moisture; (2) placing the sub-sample in a muffle furnace at 550°C for 2 hours to remove organic matter (thermal oxidation), and (3) re-weighing the sub-sample obtain the 'loss-on-ignition' value. The samples were then re-weighed after 2 hours at 950°C for determination of the calcium carbonate content (see Bengtsson & Enell, 1986).

3.3 Radiocarbon dating

Two subsamples were extracted from the base and top of the peat in each of boreholes QBH1 and QBH2 for radiocarbon dating. In borehole QBH2, the basal sample was extracted from just above the large, horizontal piece of wood recorded at the base of borehole QBH2. The samples were submitted for AMS radiocarbon dating to the BETA Analytic Radiocarbon Dating Facility, Miami, Florida. The results have been calibrated using OxCal v4.2 (Bronk Ramsey, 1995; 2001 and 2007) and the IntCal13 atmospheric curve (Reimer *et al*., 2013). The results are displayed in Figure 14 and in Tables 5 and 6.

3.4 Pollen assessment

Seven subsamples from borehole QBH1 and five from QBH2 were extracted for an assessment of pollen content. The pollen was extracted as follows: (1) sampling a standard volume of sediment (1ml); (2) adding two tablets of the exotic clubmoss *Lycopodium clavatum* to provide a measure of pollen concentration in each sample; (3) deflocculation of the sample in 1% Sodium pyrophosphate; (4) sieving of the sample to remove coarse mineral and organic fractions (>125µ); (5) acetolysis; (6) removal of finer minerogenic fraction using Sodium polytungstate (specific gravity of 2.0g/cm^3); (7) mounting of the sample in glycerol jelly. Each stage of the procedure was preceded and followed by thorough sample cleaning in filtered distilled water. Quality control is maintained by periodic checking of residues, and assembling sample batches from various depths to test for systematic laboratory effects. Pollen grains and spores were identified using the University of Reading pollen type collection and the following sources of keys and photographs: Moore *et al* (1991); Reille (1992). The assessment procedure consisted of scanning the prepared slides, and recording the concentration and preservation of pollen grains and spores, and the principal taxa on four transects (10% of the slide) (Table 7).

3.5 Diatom assessment

A total of four samples from borehole QBH1 were submitted for an assessment of diatom presence. 0.5g of sediment was required for the diatom sample preparation. All samples were first treated with sodium hexametaphosphate and left overnight, to assist in minerogenic deflocculation. Samples were then treated with hydrogen peroxide (30% solution) to remove organic material. Samples were finally sieved using a 10μm mesh to remove fine minerogenic sediments. The residue was transferred to a plastic vial, from which a slide was prepared for subsequent assessment. A minimum of four slide traverses were undertaken across each slide sample. When encountered, diatom species ware identified with reference to van der Werff and Huls (1958-74), Hendy (1964) and Krammer & Lange-Bertalot (1986-1991). However, due to the nature of the rapid assessment, many taxa were only identified to genera level. The results of the assessment are shown in Table 8.

3.6 Macrofossil assessment

A total of five samples from QBH1 and six from QBH2 were extracted and processed for the recovery of macrofossil remains, including waterlogged plant macrofossils, wood, insects and Mollusca (Tables 9 and 10). The samples were focussed on the peat horizons in both boreholes, in QBH2 extending down to the surface of the timber recorded at the base of this borehole. The extraction process involved the following procedures: (1) measuring the sample volume by water displacement, and (2) processing the sample by wet sieving using 300μm and 1mm mesh sizes. Each sample was scanned under a stereozoom microscope at x7-45 magnifications, and sorted into the different macrofossil classes. The concentration and preservation of remains was estimated for each class of macrofossil (Tables 9 and 10). Preliminary identifications of the waterlogged seeds (Table 11) have been made using modern comparative material and reference atlases (e.g. NIAB, 2004; Cappers *et al.* 2006). Nomenclature used follows Stace (2005).

Table 1: Spatial attributes and lithostratigraphic data for the new geoarchaeological boreholes at Goresbrook Park, London Borough of Barking and Dagenham.

Borehole	Easting	Northing	Elevation (m OD)	Total Depth (m)	Upper Alluvium surface (m bgl)	Peat surface (m bgl)	Lower Alluvium surface (m bgl)	Sand surface (m bgl)	Gravel surface (m bgl)
QBH1	548282.99	183301.78	2.41	6.0	2.45	3.69	4.63	5.76	5.87
QBH2	548595.65	183105.09	1.18	5.0	2.75	3.00	Not reached	Not reached	Not reached

4. RESULTS, INTERPRETATION & DISCUSSION OF THE GEOARCHAEOLOGICAL FIELD INVESTIGATIONS, DEPOSIT MODELLING & RADIOCARBON DATING

The results of the lithostratigraphic descriptions and deposit modelling were reported previously (Young & Batchelor, 2017a) and are shown in Tables 2 and 3, with the results of the deposit modelling displayed in Figures 3 to 13. Figures 3 to 11 are surface elevation and thickness models for each of the main stratigraphic units, whilst Figures 12 and 13 are two-dimensional transects across the site. The results of the deposit modelling indicate that the number and spread of the logs is sufficient to permit modelling with a high level of certainty across the vast majority of the site.

The full sequence of sediments recorded in the boreholes comprises:

Made Ground
Upper Alluvium – widely present
Peat – widely present
Lower Alluvium – widely present
Sand – present across the south-western part of the site
Gravel – widely present

4.1 Gravel

Gravel was present in all the boreholes that penetrated to the bottom of the Holocene sequence. The modelling exercise indicates that the surface of the Gravel falls from the northern most part of the site, where it is recorded at around 2m OD to between -3 and -4.5m OD across much of the rest of the site (Figures 3 & 12-13). The surface of the Gravel was reached in only one of the new geoarchaeological boreholes; in QBH1 it is recorded at -3.46m OD.

Across much of the site, this unit most likely represents the Shepperton Gravel deposited during the Devensian Late Glacial (MIS2; 15,000 to 10,000 BP) and comprises the sands and gravels of a high-energy braided river system which, while it was active would have been characterised by longitudinal gravel bars and intervening low-water channels in which finer-grained sediments might have been deposited. Such a relief pattern would have been present on the valley floor at the beginning of the Holocene when a lower-energy fluvial regime was being established. The rise in Gravel surface to 2m OD towards the northern most part of the site is consistent with the position of the site on the edge of the floodplain. Indeed, this elevation is indicative of the older Wolstonian Taplow Gravel terrace (MIS 6-10; 352,000 to 130,000 BP) which in this area forms the edge of the floodplain; Gibbard (1994) shows the surface of the Mucking (Taplow) Gravel falling to around 1m OD in the area of South Hornchurch (p 54). However, it is difficult to differentiate the deposits of the Taplow and Shepperton Gravel on the basis of elevation alone.

Beyond the margins of the site, the surface of the Taplow Gravel can also confidently recognised, where it reaches between *ca*. 1.5 and -1m OD on the northern part of the Beam Park site (Young & Batchelor, 2017a; Figure 4), and along Ripple Road where it reaches between 0 and 3m OD to the west and east. From the terrace edge, the Gravel surface generally falls to between -3 and -6m OD representative of the Shepperton Gravel. Particularly deep depressions are recognised however, towards the south-west of Beam Park where the Gravel surface is consistently recorded at between *ca*. -7.5 and -9.58m OD. Although the extent and orientation of this depression is not yet fully understood, due to the absence of data to the south, it is possible that this feature represents a former channel. In addition, towards the north-west of Beam Park, three borehole records indicate thick alluvial deposits resting directly on Bedrock at up to -14m OD. It is possible that these records are erroneous, but it is of note that similarly deep depressions are recorded adjacent to the terrace edge at Barking Riverside (Green *et al*., 2014). Higher gravel surfaces above -2m OD can also be recognised across the wider area, including on the southern part of Barking Riverside, and to the south of Choats Road.

4.2 Sand

A horizon of sand is the lowest unit in the Holocene alluvial sequence, and where present, it rests directly on the surface of the underlying Shepperton Gravel. Where it is identified, it can be interpreted as being deposited under low to moderate energy fluvial conditions, most likely within former channel features. On the present site, Sand is recognised in 23 sequences, varying in thickness between 0.2 and at least 2m (Figures 5 & 12-13). In borehole QBH1, it was recorded overlying the Gravel at between -3.35 to -3.46m OD. The Sand appears to be present mainly in the southwestern area of the site. However, its absence in the other sequences does not necessarily mean it is not present as an individual unit; it is rarely possible to confidently separate Sand from Shepperton Gravel or indeed the silty sandy deposits of the Lower Alluvium, due to the nature of the coring methods and less precise method of geotechnical description. In the case of the modelling exercise, differentiation between the Sand and Gravel is made based upon the presence of more than rare occurrences of Gravel within the sediment.

4.3 Lower Alluvium

The Lower Alluvium rests directly on either the Shepperton Gravel or Sand and was recorded in the majority of those records that penetrated sufficiently deeply across the site. The surface of the Lower Alluvium (Figures 6 & 12-13) is relatively even, ranging between -2 and -3.5m OD. It is however absent towards the very north of the site, probably as a consequence of its location above the floodplain edge.

The deposits of the Lower Alluvium are described as a predominantly silty or clayey, tending to become increasingly sandy downward in most sequences, and occasionally organic. The Lower Alluvium frequently contains detrital wood or plant remains, and in many cases is described as organic and with occasional Mollusca remains. In borehole QBH1 the Lower Alluvium was recorded between -2.22 and -3.35m OD, the results of the loss-on-ignition analysis (Table 4) indicating that the Lower Alluvium is generally less than 15% organic. However, a richly organic unit (32% organic) is recorded between -2.22 and -2.37m OD at the interface between this unit and the overlying Peat.

The sediments of the Lower Alluvium are indicative of deposition during the Early to Mid-Holocene, when the main course of the Thames was probably confined to a single meandering channel. During this period, the surface of the Shepperton Gravel was progressively buried beneath the sandy and silty flood deposits of the river. The richly-organic nature of the Lower Alluvium suggests that this was a period during which the valley floor was occupied by a network of actively shifting channels, with a drainage pattern on the floodplain that was still largely determined by the relief on the surface of the underlying Shepperton Gravel.

4.4 Peat

Overlying the Lower Alluvium / Sand or in some cases Shepperton Gravel in the vast majority of the boreholes is a unit of Peat. The peat is indicative of a transition towards semi-terrestrial (marshy) conditions, supporting the growth of sedge fen/reed swamp and/or woodland communities across the floodplain. The results of the loss-on-ignition analysis of samples from QBH1 (see Table 4 and Figure 14) indicate that this unit is consistently between 75 and 80% organic, indicative of occasional flood events bringing minerogenic material on to the surface of the peat during its accumulation.

The Peat generally varies in thickness between 1 and 2m across the vast majority of the site (Figure 7). In geoarchaeological borehole QBH1 it was recorded at between -1.28 and -2.22m OD, and below -1.82m OD in borehole QBH2 (the base of the Peat in this borehole was not reached, but it lies at *at least* -3.16m OD). The Peat has the potential to contain archaeological remains as demonstrated by significant trackway/causeway findings at both Hays Storage Dagenham (Divers, 1996) and Bridge Road, Rainham (Meddens & Beasley, 1990; Beasley, 1991). Generally, these remains have been recorded towards the top of the Peat, and relatively close the floodplain edge. In QBH2 a large, horizontal piece of wood was recorded between -3.16 and *at least* -3.82m OD. It is uncertain at this stage what this piece of wood may relate to. It is of note that a large charred wood fragment (20x20mm) was identified just above this wood, at between -2.86 to -2.88m OD.

As might be expected given the lower elevation of the peat in QBH2, the results of the radiocarbon dating indicate that peat accumulation began earlier here; accumulation began some time prior to 5325-5580 cal BP (3375 to 3635 cal BC; Early-Middle Neolithic), indicating that the wood recorded at the base of this sequence (whatever its origin) pre-dates this. In borehole QBH1 peat accumulation began at around 4250-4430 cal BP (2300 to 2480 cal BC; Late Neolithic). The peat appears to have continued accumulating until later in QBH2; in QBH1 peat cessation occurred at around 2490-2740 cal BP (540 to 790 cal BC; Early-Middle Iron Age), whilst in QBH2 peat accumulation continued until at least 1870-1995 cal BP (80 cal AD to 45 cal BC; Roman). Nearby sites such as Hornchurch Marshes (Batchelor, 2009; Branch et al., 2012), Barking Riverside (Green et al., 2014), Bridge Road (Meddens & Beasley, 1990; Beasley, 1991) and the Former Ford Stamping Factory (Young *et al*., 2017) have all recorded Peat accumulation from the late Mesolithic to Bronze Age; the later date for the upper surface of the peat (Iron Age/Roman) at the present site therefore represents a later record of peat formation than has previously been recorded in this area.

The Peat is absent on the northern most part of the site, and an isolated few other sequences (TQ48SE1238, 1363, 1237, 1242, 1162, 1092) all of which are beyond the margins of the site. Within these sequences, mineral-rich deposits were recorded ranging in size from clay to gravel sized clasts. The surface of the Peat is relatively even, generally lying between -1 and -2m OD (Figure 8 & 12-13).

4.5 Upper Alluvium

The Upper Alluvium generally rests directly Peat, and was recorded in all records across the site with the exception of those in the northern most part. The deposits of the Upper Alluvium are described as predominantly silty or clayey which are very occasionally organic-rich. The results of the loss-on-ignition analysis indicate that this unit is generally less than 10% organic (see Table 4). The surface of the Upper Alluvium is relatively even, generally lying at between *ca*. -1.5 and 2m OD (Figure 9 & 12-13); in boreholes QBH1 and QBH2 it is recorded at -0.04 and -1.57m OD respectively. The sediments of the Upper Alluvium are indicative of deposition within low energy fluvial and/or semi-aquatic conditions during the Holocene. The high mineral content of the sediments may reflect increased sediment loads resulting from intensification of agricultural land use from the later prehistoric period onward, combined with the effects of rising sea level.

The combined Holocene alluvial sequence, incorporating the Sand, Lower Alluvium, Peat and Upper Alluvium ranges between 2 & 4m in thickness, and is generally thicker where the Shepperton Gravel surface is lower towards the south of the site (Figure 10). It is worth noting however, that the thickness of the Total Alluvium noted on the northern most part of the site, likely represents Pleistocene sands resting on the Taplow Terrace, rather than Holocene floodplain deposits.

4.6 Made Ground

Between 1 & 3m of Made Ground caps the Holocene alluvial sequence across the vast majority of the site.

Table 2: Lithostratigraphic description of borehole QBH1, Goresbrook Park, London Borough of Barking and Dagenham.

Depth (m OD)	Depth (m bgl)	Description	Stratigraphic group
2.41 to -0.04	0.00 to 2.45	Made Ground of concrete hardstanding over concrete and brick rubble in a matrix of brown silty clay.	MADE GROUND
-0.04 to -0.59	2.45 to 3.00	As3 Ag1; blue grey silty clay with frequent worm/root hollows. Diffuse contact in to:	UPPER ALLUVIUM
-0.59 to -0.82	3.00 to 3.23	As3 Ag1; dark olive grey silty clay with some vertical rooting. Rare iron staining Diffuse contact in to:	
-0.82 to -0.97	3.23 to 3.38	As3 Ag1 Sh+; dark greyish brown silty clay with a trace of organic matter. Some structure/colouration indicative of soil formation. Diffuse contact in to:	
-0.97 to -1.28	3.38 to 3.69	Ag3 As1; grey silty clay. Sharp contact in to:	

Depth (m OD)	Depth (m bgl)	Description	Stratigraphic group
-1.28 to -1.59	3.69 to 4.00	Sh3 Th^{3}1; humo. 3; well humified dark reddish brown herbaceous peat. Diffuse contact in to:	PEAT
-1.59 to -2.22	4.00 to 4.63	Sh2 Tl^{2}1 Th^{2}1; humo. 2; moderately humified dark reddish brown herbaceous and wood peat. Diffuse contact in to:	
-2.22 to -2.37	4.63 to 4.78	Ag2 Sh2 Th+; dark greyish brown very organic silt with a trace of herbaceous material (in situ). Diffuse contact in to:	LOWER ALLUVIUM
-2.37 to -2.59	4.78 to 5.00	Ag2 As1 Ga1 Dh+; dark olive grey sandy clayey silt with a trace of detrital herbaceous material. Some vertical sedge rooting. Diffuse contact in to:	
-2.59 to -3.23	5.00 to 5,64	Ag2 Ga1 As1 Dl+; grey sandy clayey silt with a trace of detrital wood. Diffuse contact in to:	
-3.23 to -3.35	5.64 to 5.76	Ga3 Ag1 Gg+; grey silty sand with occasional gravel clasts (flint). Diffuse contact in to:	
-3.35 to -3.46	5.76 to 5.87	Ga3 Gg1; orange gravelly sand. Clasts are flint, sub-angular to rounded, up to 20mm in diameter. Diffuse contact in to:	SAND
-3.46 to -3.59	5.87 to 6.00	Gg3 Ga1; orange sandy gravel. Clasts are flint, sub-angular to well-rounded, up to 30mm in diameter.	GRAVEL

Table 3: Lithostratigraphic description of borehole QBH2, Goresbrook Park, London Borough of Barking and Dagenham.

Depth (m OD)	Depth (m bgl)	Description	Stratigraphic group
1.18 to -0.82	0.00 to 2.00	Made Ground of concrete hardstanding over concrete and brick rubble.	MADE GROUND
-0.82 to -1.40	2.00 to 2.58	Made Ground of concrete and brick rubble; frequent glass.	
-1.40 to -1.57	2.58 to 2.75	As3 Ag1; blue grey silty clay with frequent worm/root hollows. Possibly reworked. Diffuse contact in to:	
-1.57 to -1.82	2.75 to 3.00	As3 Ag1; greyish brown silty clay. Some structure/colouration indicative of soil formation. Diffuse contact in to:	UPPER ALLUVIUM
-1.82 to -3.16	3.00 to 4.34	Sh3 Th^{2}1 Tl+ Ag+; humo. 3; dark reddish brown well humified herbaceous peat with traces of woody material and silt. Charcoal fragment (20x20mm) at -2.86 to -2.88m OD. Sharp contact in to:	PEAT
-3.16 to -3.82	4.34 to 5.00	Large wood branch/timber. Not possible to core beyond 5.00m bgl.	WOOD

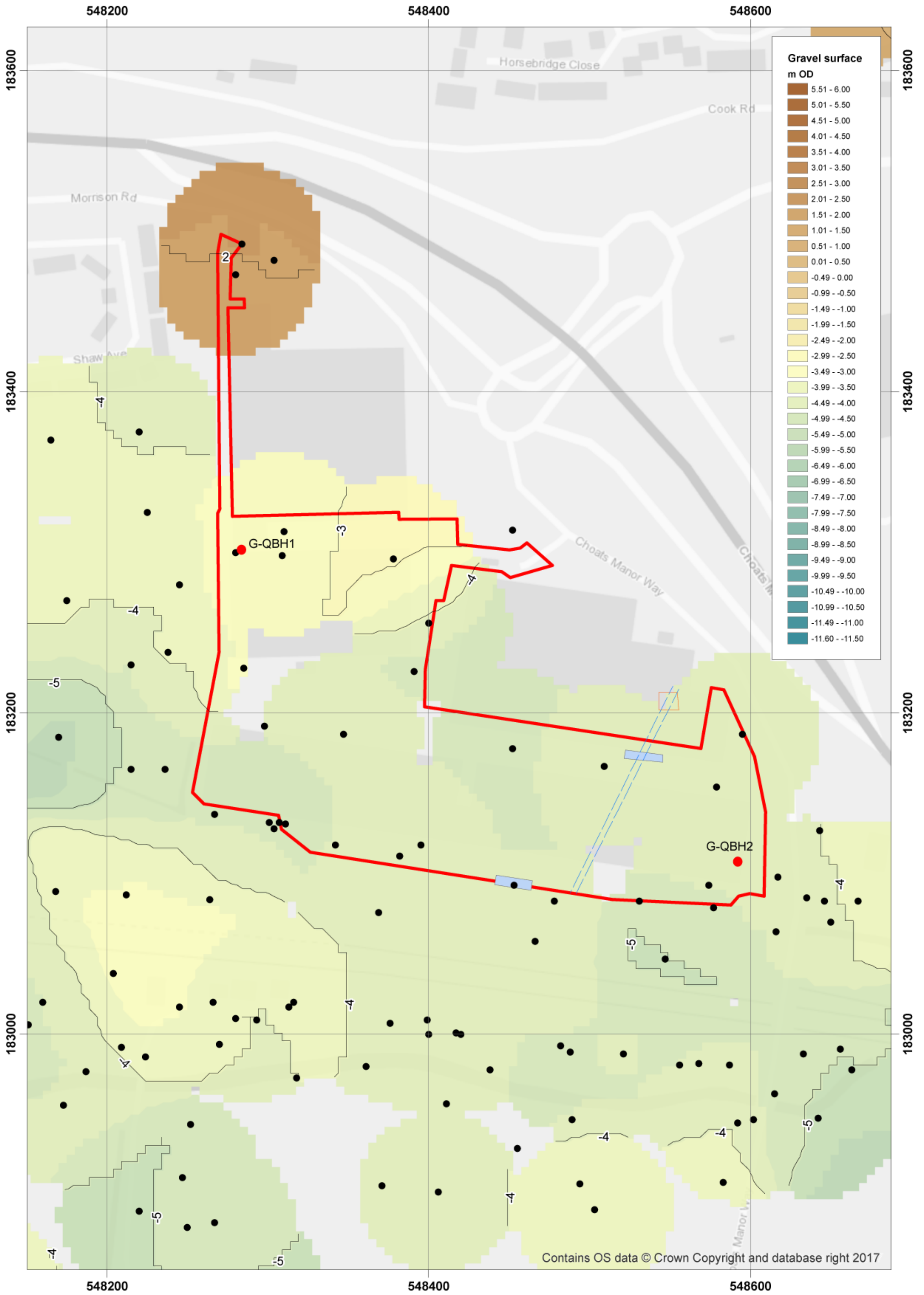

Figure 3: Top of the Gravel (m OD)

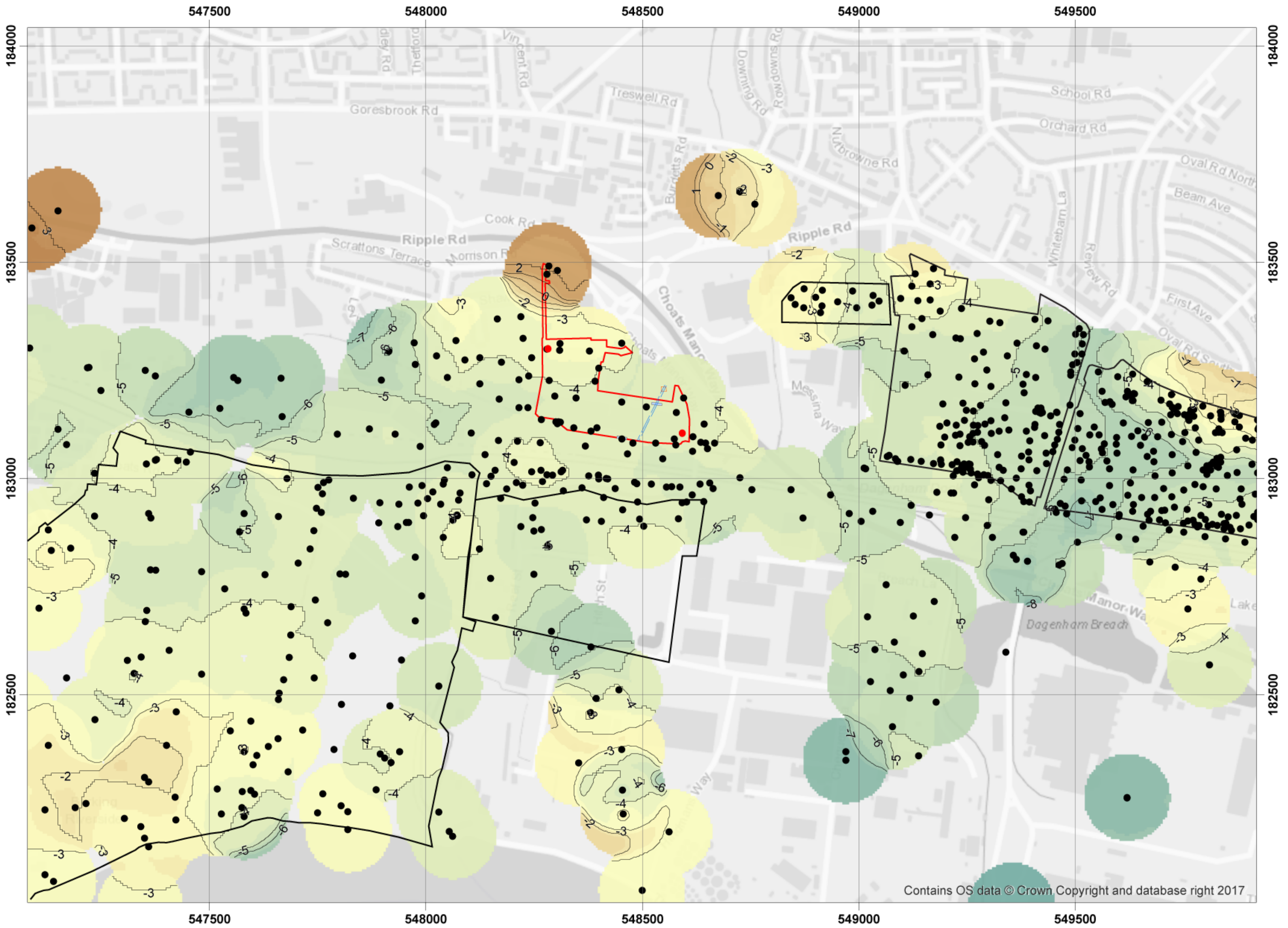

Figure 4: Top of the Gravel across the wider area (m OD) (site outline in red)

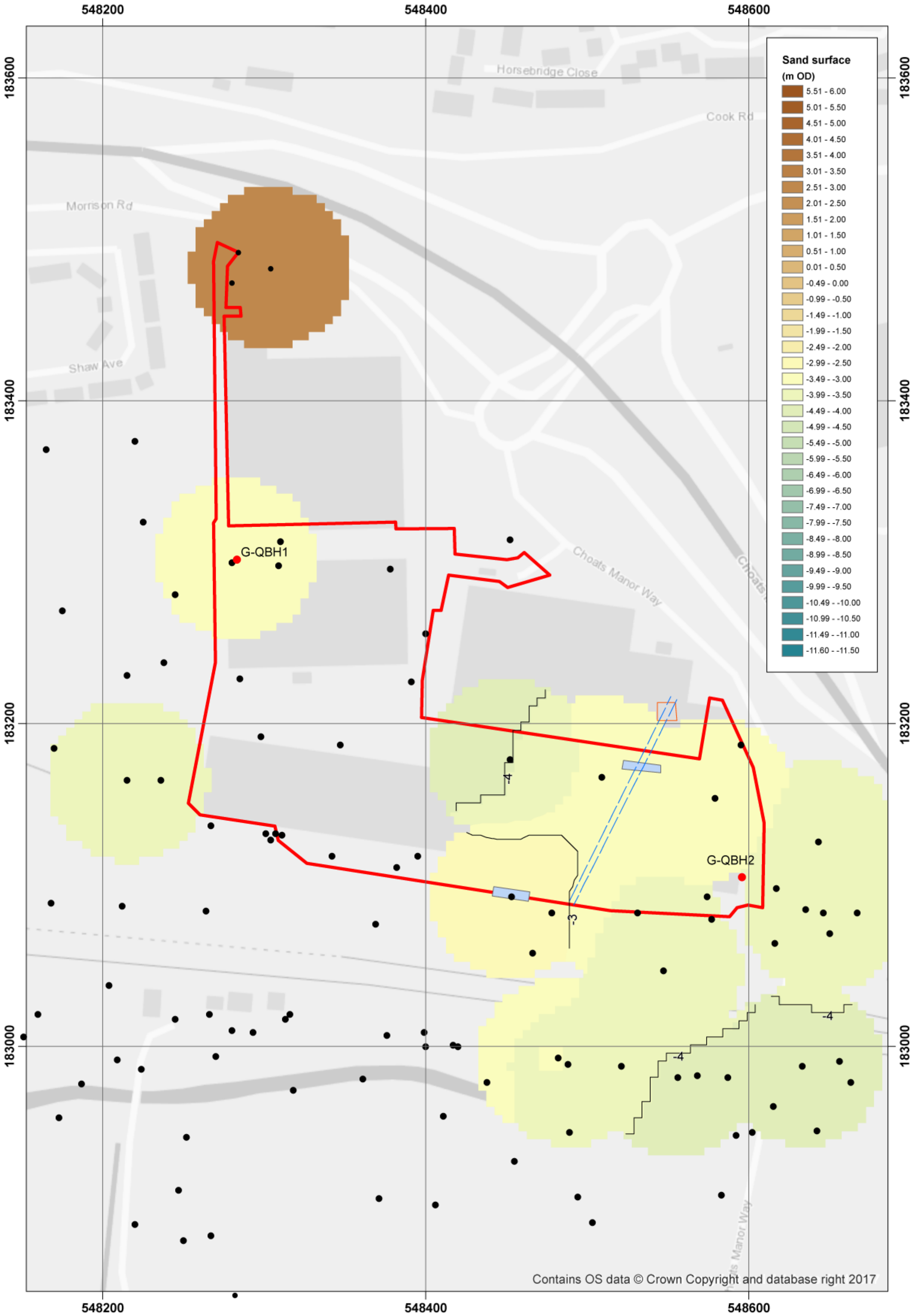

Figure 5: Top of the Sand (m OD)

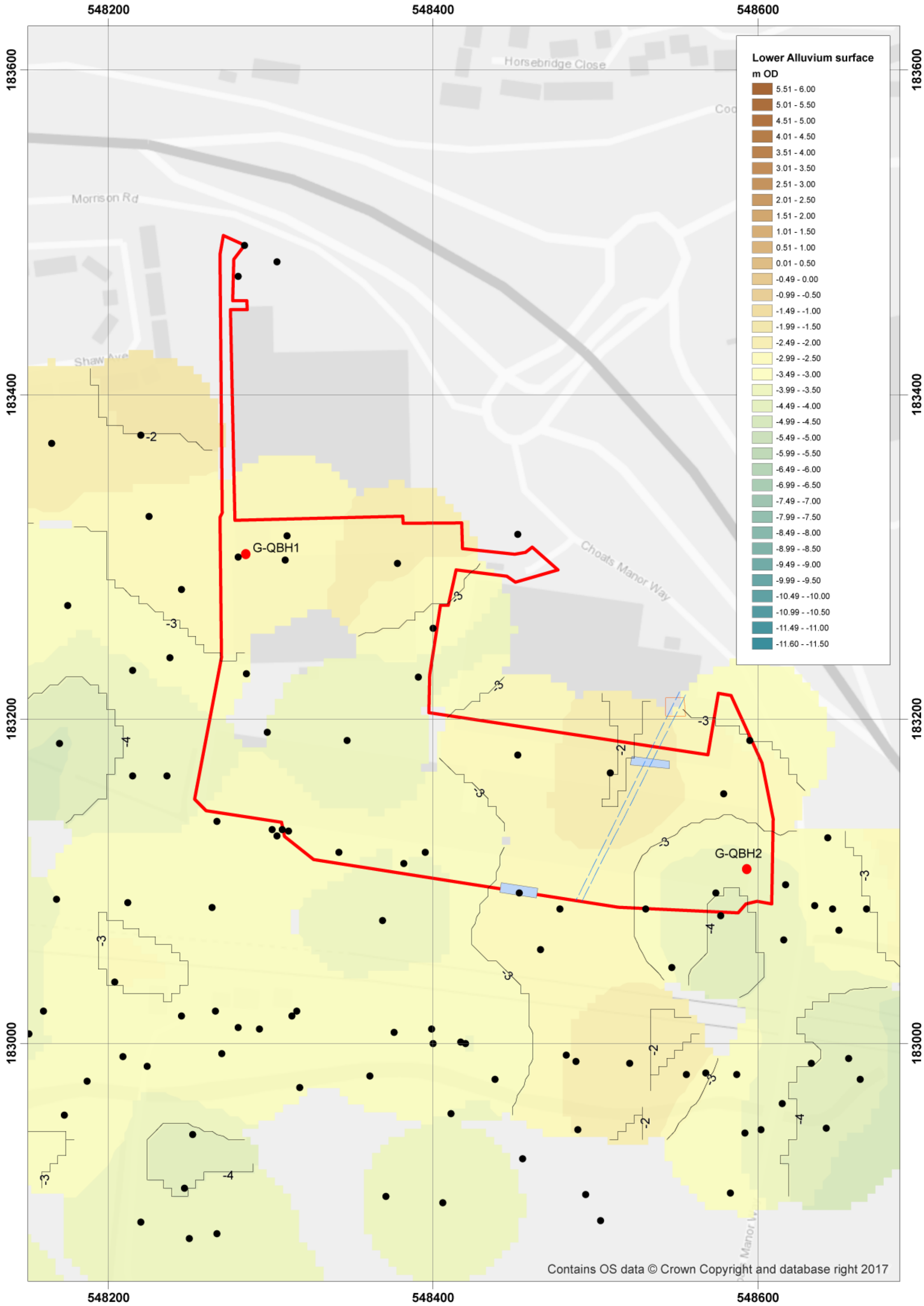

Figure 6: Top of the Lower Alluvium (m OD)

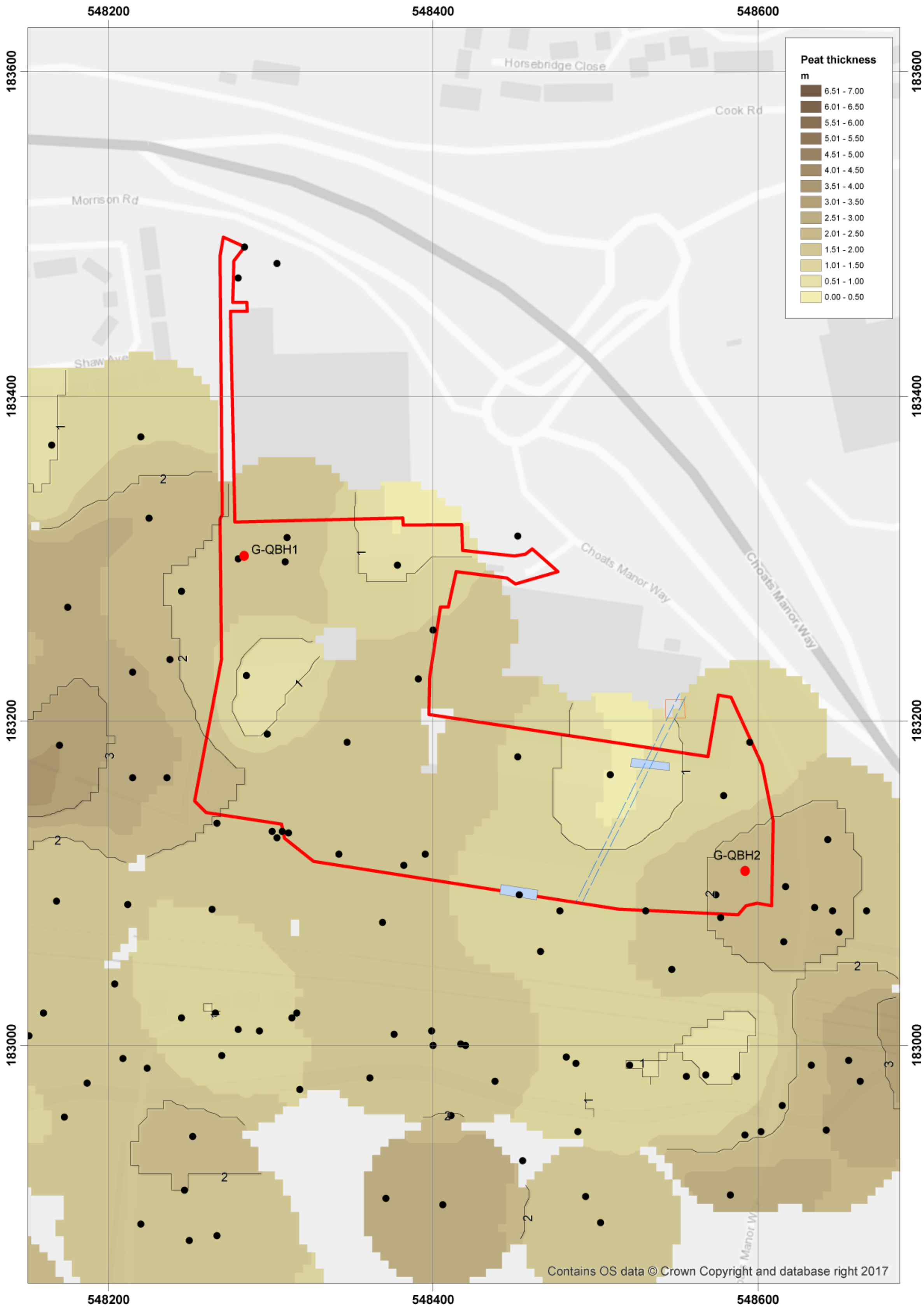

Figure 7: Thickness of the Peat (m)

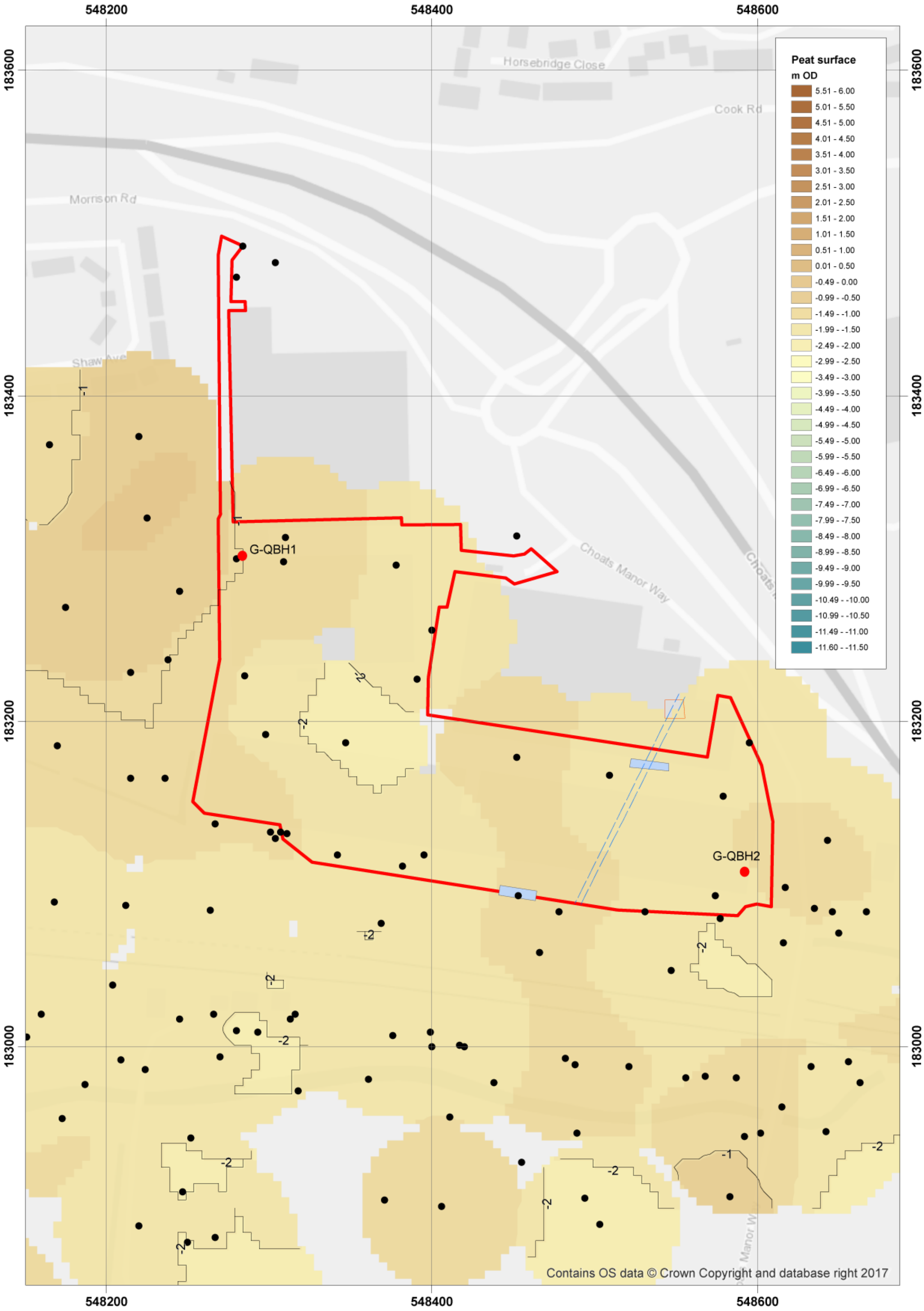

Figure 8: Top of the Peat (m OD)

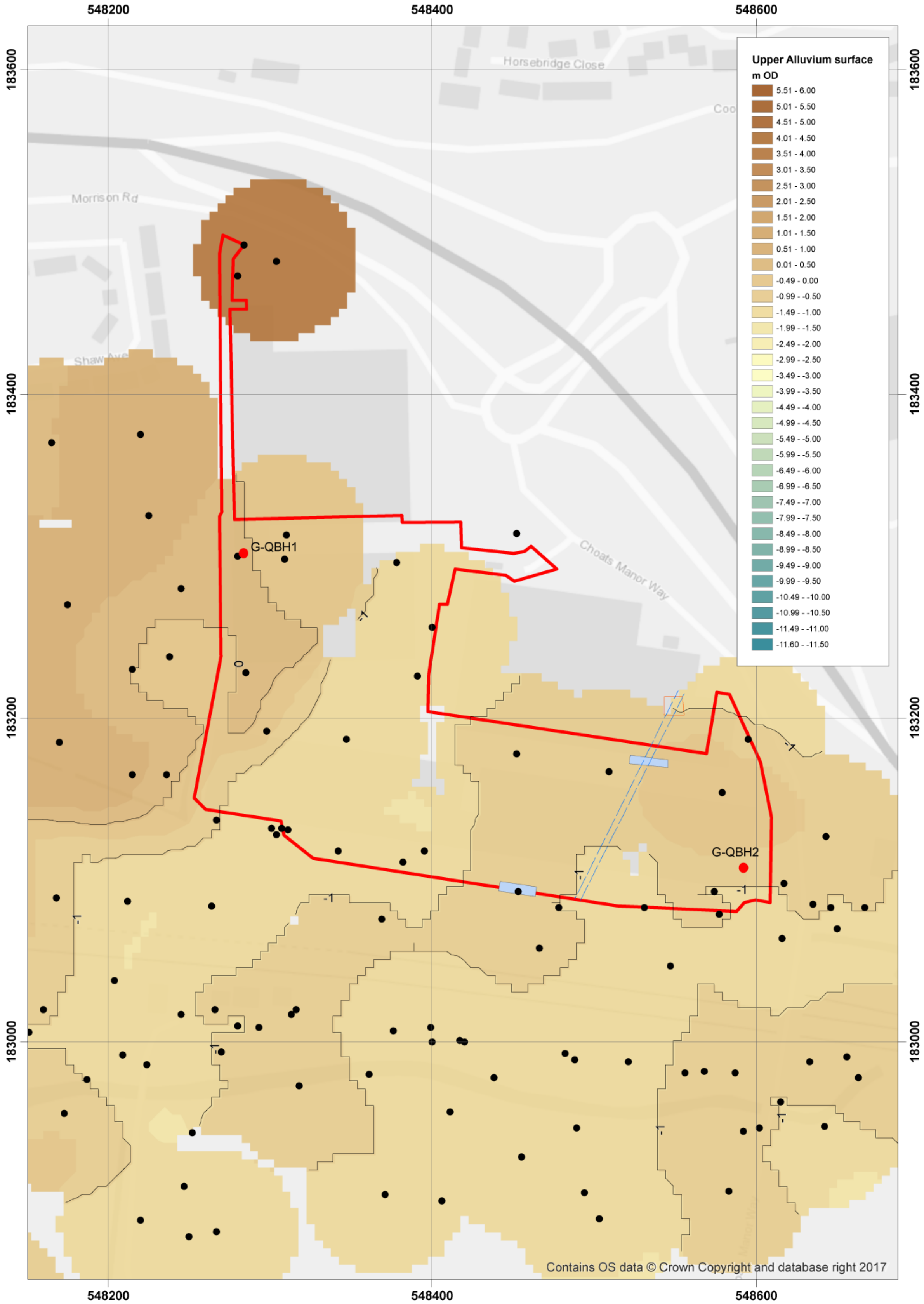

Figure 9: Top of the Upper Alluvium (m)

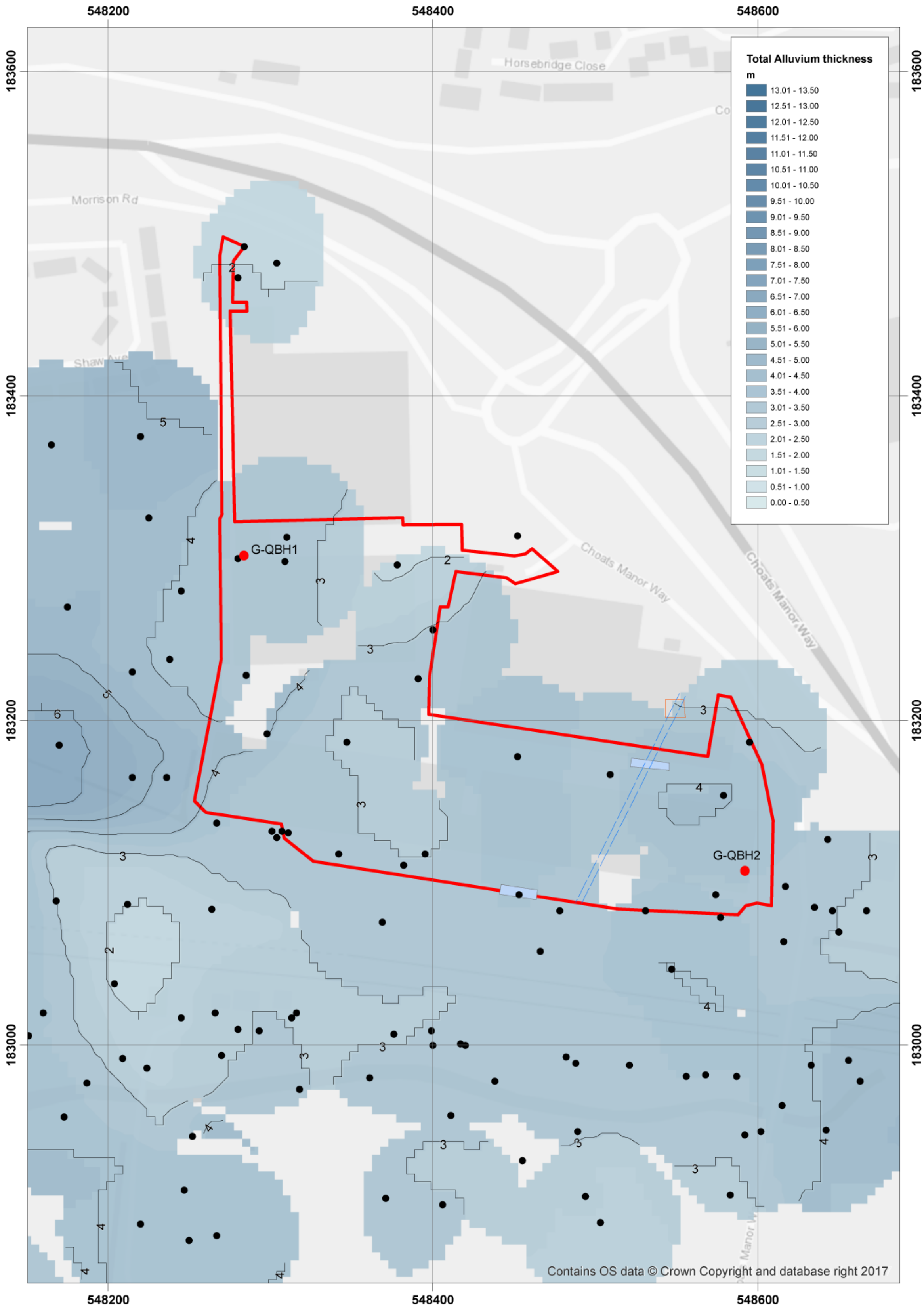

Figure 10: Thickness of the Total Alluvium (Lower Alluvium, Peat and Upper Alluvium) (m)

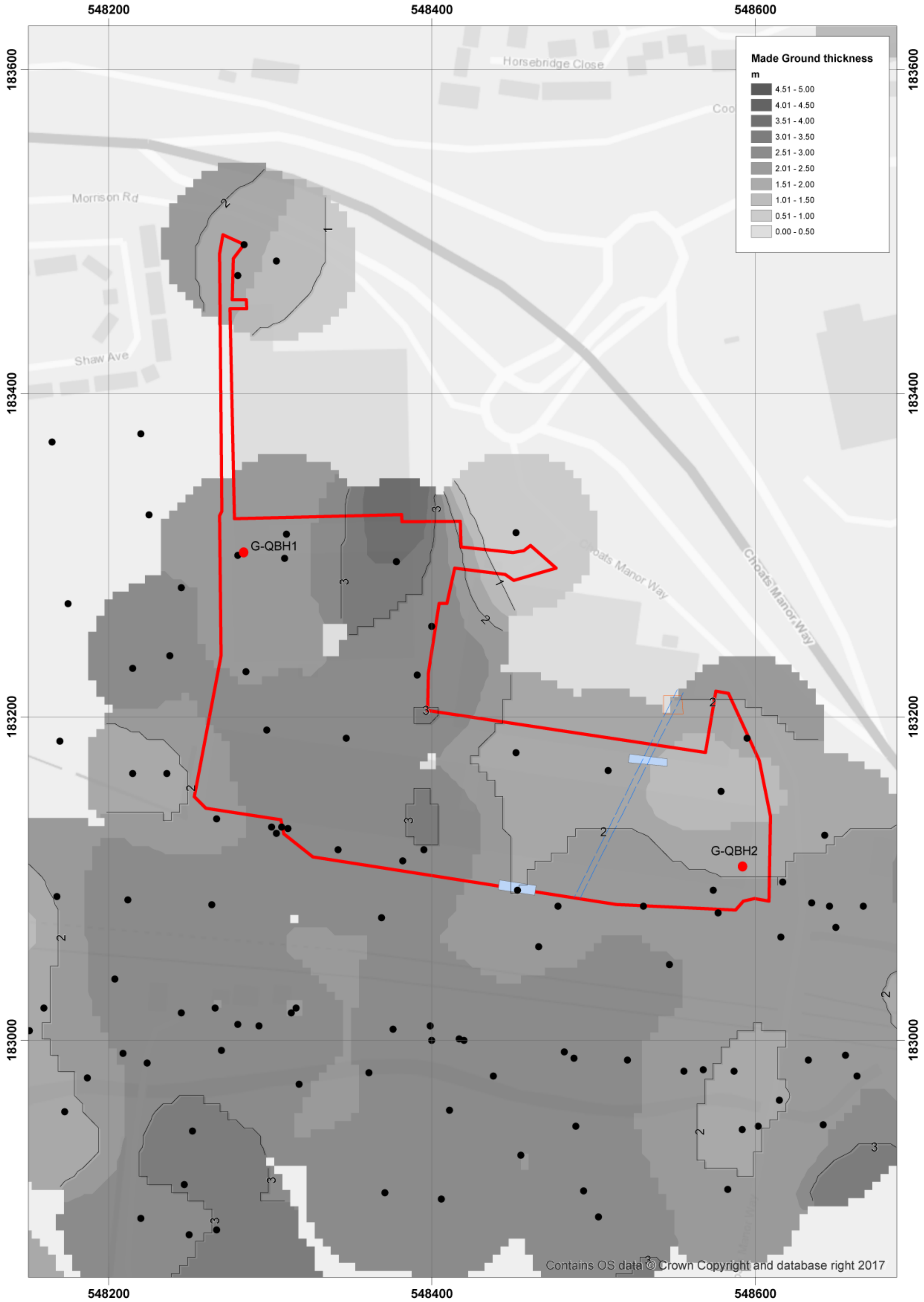

Figure 11: Thickness of Made Ground (m)

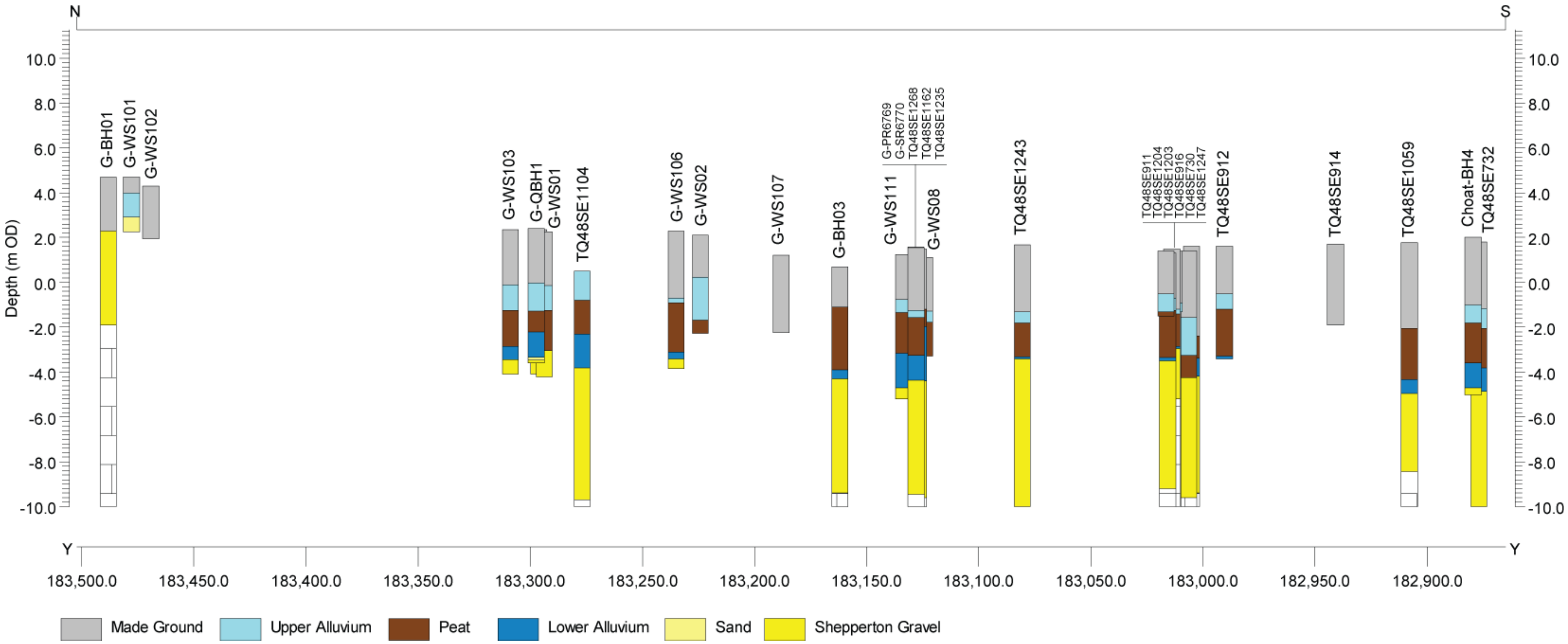

Figure 12: Site-wide north-south borehole transect

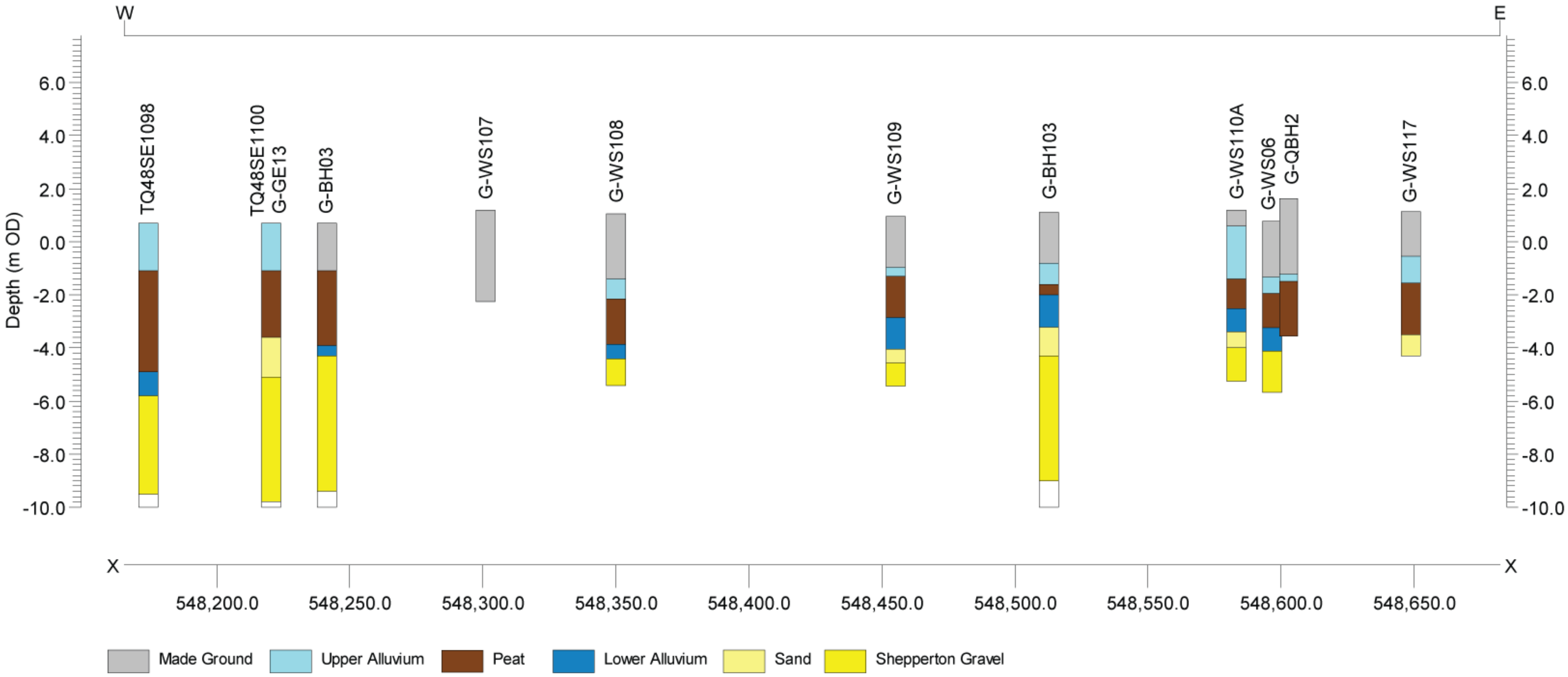

Figure 13: Site-wide west-east borehole transect

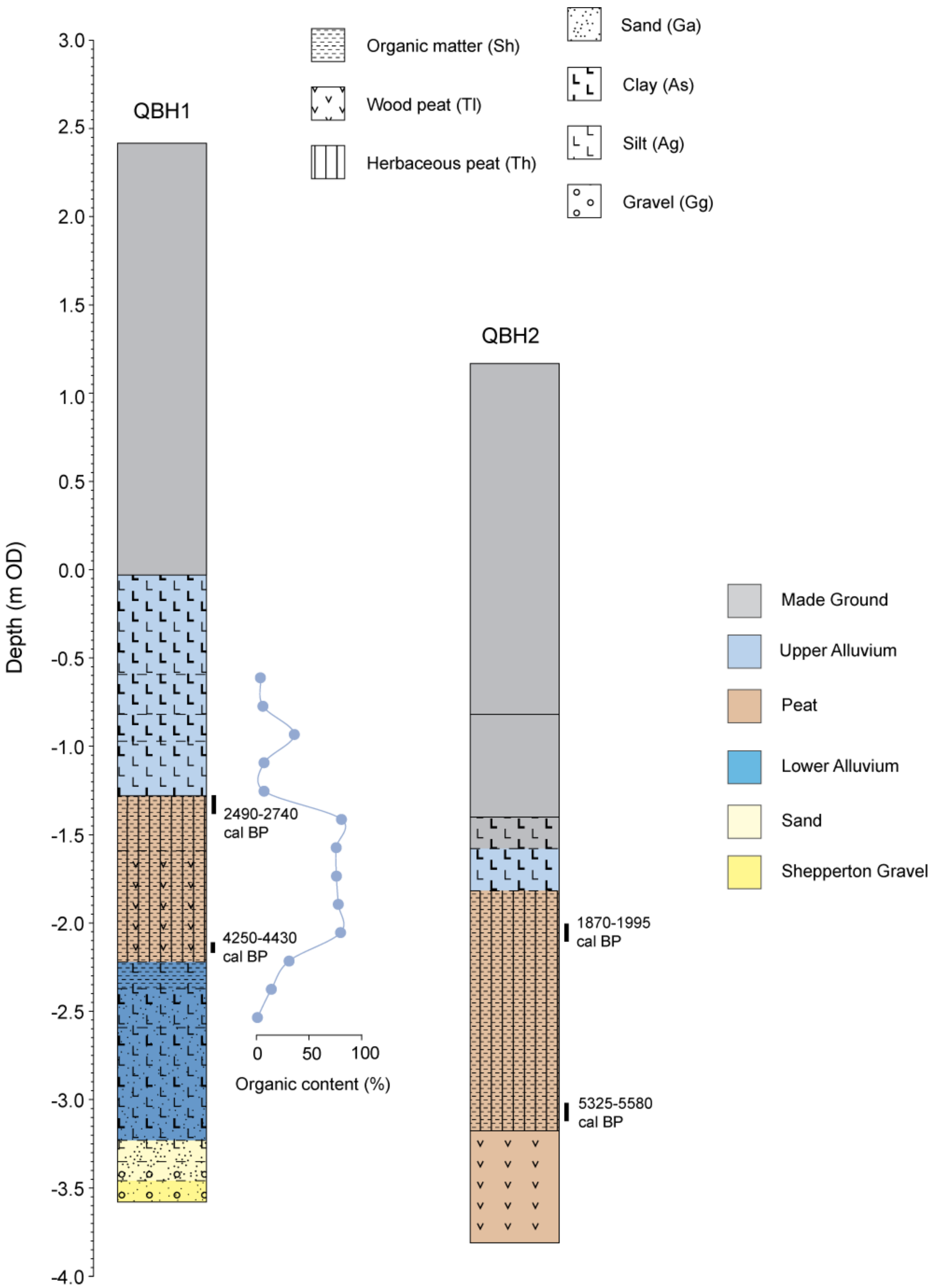

Figure 14: Results of the lithostratigraphic descriptions, organic content determinations and radiocarbon dating of boreholes QBH1 and QBH2 at Goresbrook Park, London Borough of Barking and Dagenham.

Table 4: Results of the borehole QBH1 organic matter determinations, Goresbrook Park, London Borough of Barking and Dagenham.

Depth (m OD)		Organic matter content (%)
From	To	
-0.62	-0.63	5.01
-0.78	-0.79	7.33
-0.94	-0.95	36.65
-1.10	-1.11	8.48
-1.26	-1.27	8.28
-1.42	-1.43	80.90
-1.58	-1.59	75.88
-1.74	-1.75	76.09
-1.90	-1.91	77.88
-2.06	-2.07	80.05
-2.22	-2.23	31.79
-2.38	-2.39	15.15
-2.54	-2.55	2.16

Table 5: Results of the borehole QBH1 radiocarbon dating, Goresbrook Park, London Borough of Barking and Dagenham.

Laboratory code / Method	Material and location	Depth (m OD)	Uncalibrated radiocarbon years before present (yr BP)	Calibrated age BC/AD (BP) (2-sigma, 95.4% probability)	δ13C (‰)
BETA 478986 AMS	Twig wood/aerial sedge remains; top of peat	-1.28 to -1.33	2510 ± 30	540 to 790 cal BC (2490 to 2740 cal BP)	-26.0
BETA 478987 AMS	Twig wood; base of peat	-2.12 to -2.17	3920 ± 30	2300 to 2480 cal BC (4250 to 4430 cal BP)	-27.9

Table 6: Results of the borehole QBH2 radiocarbon dating, Goresbrook Park, London Borough of Barking and Dagenham.

Laboratory code / Method	Material and location	Depth (m OD)	Uncalibrated radiocarbon years before present (yr BP)	Calibrated age BC/AD (BP) (2-sigma, 95.4% probability)	δ13C (‰)
BETA 478988 AMS	Aerial sedge remains; top of peat	-2.01 to -2.11	1980 ± 30	80 cal AD to 45 cal BC (1870 to 1995 cal BP)	-24.7
BETA 478989 AMS	*Alnus glutinosa* catkins; above wood	-3.02 to -3.12	4720 ± 30	3375 to 3635 cal BC (5325 to 5580 cal BP)	-27.7

5. RESULTS & INTERPRETATION OF THE POLLEN ASSESSMENT

Samples were prepared for pollen assessment from the peat horizons of QBH1 and QBH2. The results indicate a moderate to high concentration and preservation of remains in all of the samples assessed (Table 7).

The majority of both sequences are characterised by high values of tree and shrub pollen: alder (*Alnus*) dominates with oak (*Quercus*), hazel (*Corylus* type), birch (*Betula*), willow (*Salix*) and more sporadic values of lime (*Tilia*), elm (*Ulmus*) and yew (*Taxus*). Oak declines in the uppermost sample(s) of both boreholes. The herbaceous assemblage is relatively limited in number and diversity, dominated by grasses (Poaceae) and sedges (Cyperaceae). The uppermost sample(s) assessed in both QBH1 and QBH2 contained a more diverse range of herbs however, including cereals (*Cereale* type), dandelions (Lactuceae), ribwort plantain (*Plantago lanceolata*), goosefoot (*Chenopodium* type), mugwort (*Artemisia*), daisies (Asteraceae) and Brassicaceae (*Sinapis* type). The aquatic assemblage consists of sporadic occurrences of bur-reed (*Sparganium* type), water-lily (*Nuphar* type) and bulrush (*Typha latifolia*); at the top of QBH1 however, high numbers of bur-reed pollen are recorded. Spores are dominated by ferns (*Filicales*) which reach especially high values at -1.74m OD in QBH1. Microcharcoal concentrations are generally negligible to low, but are higher towards the top and base of each sequence (especially in QBH2).

The results of the assessment indicate a peat surface dominated by alder and willow, with an understorey of grasses, sedges and occasional aquatics. The high values of ferns, particularly towards the middle of the QBH1 sequence suggests these also formed an important component of the floodplain vegetation. Also of note are the high values of microcharcoal towards the base of both sequences; particularly in QBH2. This is suggestive of nearby or in situ burning, though whether this was of natural or anthropogenic origin is not possible to state at this time.

Hazel, ash and birch may have occupied the peat surface with alder and willow, but are more likely to grown on the dryland forming mixed deciduous woodland with oak and lime. Sporadic occurrences of elm suggest that both sequences post-date the well documented elm decline which is consistent with the results of the radiocarbon dating. Lime and oak both decline in the upper half of both sequences, and is matched by an expansion in the diversity of herbs (including the individual occurrence of cereal pollen) and increase of microcharcoal. This most likely indicates late prehistoric woodland clearance for settlement and/or agricultural purposes.

Table 7: Results of the pollen assessment from QBH1and QBH2, Goresbrook Park

		QBH1							QBH2				
	Depth (m OD)	-1.26	-1.42	-1.58	-1.74	-1.90	-2.06	-2.52	-1.88	-2.20	-2.22	-2.84	-3.16
Latin name	Common name												
Trees													
Alnus	alder	19	4	32	20	12	5	4	12	13	21	10	7
Quercus	oak	4	2	11	10	8	6	3	5	9	11	7	3
Pinus	pine				1				3				
Ulmus	elm	1			1			1	1				
Tilia	lime				6	4		2	1		7	3	
Taxus	yew		1	2									
Betula	birch	2	1	1	5	2		1		1			
Fraxinus	ash			1		2				2			
Shrubs													
Calluna vulgaris	heather									1			
Corylus type	e.g. hazel	6		9	7	5	3	1	5	6	5	7	1
Salix	willow		2	1	2	1	8			3		10	5
Herbs													
Cyperaceae	sedge family	2	4		2	5	28		6	2	9	7	2
Poaceae	grass family	8	4	1					10	7	1		1
Cereale type	e.g. barley								1				
Asteraceae	daisy family									2			
Artemisia type	mugwort								1				
Lactuceae	dandelion family	3							2	5			
Plantago lanceolata	ribwort plantain	4											
Chenopodium type	goosefoot family	5							1	3			
Rumex acetosa/acetosella	sorrel		1										
Apiaceae	carrot family	1										4	
Sinapis type	brassica family								2				
Potentilla type	cinquefoil												1
Aquatics													
Nuphar type	water-lily		2				1						1
Sparganium type	bur-reed	32							2			4	1
Typha latifolia	bulrush		1									1	
Spores													
Pteridium aquilinum	bracken								2				
Filicales	ferns	5	37	8	463	67	25	4	14	13	34	47	9
Polypodium vulgare	polypody				3	1							1

		QBH1							QBH2				
	Depth (m OD)	-1.26	-1.42	-1.58	-1.74	-1.90	-2.06	-2.52	-1.88	-2.20	-2.22	-2.84	-3.16
Latin name	Common name												
Total Land Pollen (grains counted)		54	20	58	54	34	50	12	50	54	54	48	20
Concentration*		5	2	5	5	5	5	2	5	5	5	5	3
Preservation**		4	4	4	4	4	3-4	3	3	4	4	4	4
Microcharcoal Concentration***		2-3	1	1	2	2	2	2-3	3-4	2	1-2	3-4	0
Suitable for further analysis		YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

*Key: *Concentration: 0 = 0 grains; 1 =1-75 grains, 2 = 76-150 grains, 3 =151-225 grains, 4 = 226-300, 5 =300+ grains per slide; **Preservation: 0 = absent; 1 = very poor; 2 = poor; 3 = moderate; 4 = good; 5 = excellent; ***Microcharcoal Concentration: 0 = none, 1= negligible, 2 = occasional, 3 = moderate, 4 = frequent, 5 = abundant*

6. RESULTS & INTERPRETATION OF THE DIATOM ASSESSMENT

A total of four samples from borehole QBH1 were submitted for an assessment of diatom presence, located at the interface between the Lower Alluvium/Peat and Peat/Upper Alluvium. A summary of the main diatom presence-absence assessment results are provided in Table 8. Diatoms were absent in the basal two samples (-2.18 to -2.19 and -2.22 to -2.23m OD) but encountered in abundance in the uppermost samples -1.26 to -1.27 and -1.30 to -1.31m OD. The most typical diatoms encountered in each sample are listed, and are arranged in order of abundance (most common at the top of each sample list). If a particular diatom was found to be super abundant relative to other taxa within a sample, the species is highlighted in bold, to assist subsequent palaeoenvironmental discussions.

The samples in which diatoms were absent were those that were most organic rich. In contrast, the minerogenic upper samples were those in which diatoms were found to be present in abundance and diversity. Where diatoms were present, both planktonic and benthic taxa were encountered. Overall, benthic taxa dominated in terms of abundance and diversity, with the most typical species throughout the upper samples including *Nitzschia navicularis, Gyrosigma sp., Delphineis sp, Cocconeis sp., and Navicula sp.* Numerous other benthic species were also encountered, with these subordinate taxa varying in diversity between samples. Planktonic diatoms were also present in samples, typified by *Cyclotella striata* and *Thalassiosira* sp. Many of the benthic and planktonic taxa encountered are most often associated with marine and brackish conditions, although taxa more associated with low salinity conditions were also present.

Table 8: Results of the diatom assessment of samples from QBH1, Goresbrook Park, London Borough of Barking and Dagenha.m.

Depth (m OD)	Diatom concentration	Main taxa
-1.26 to -1.27	3	***Cyclotella striata*** *Cocconeis sp.* *Nitzschia navicularis* *Pinnularia sp* *Navicula sp* *Diploneis interrupta* *Gyrosigma sp.* *Thalassiosira sp.*
-1.30 to -1.31	3	***Nitzschia navicularis*** ***Cyclotella striata*** *Gyrosigma sp.* *Cocconeis sp.* *Delphineis amphiceros* *Amphora sp.* *Nitzschia sigma* *Navicula sp.* *Thalassiosira sp.*
-2.18 to -2.19	0	-
-2.22 to -2.23	0	-

7. RESULTS & INTERPRETATION OF THE MACROFOSSIL ASSESSMENT

A total of five samples from QBH1, and six from QBH3, were extracted and processed for the recovery of macrofossil remains, including waterlogged plant macrofossils, wood, insects and Mollusca (Tables 9 and 10). The samples were focussed on the peat horizons in both boreholes, in QBH2 extending down to the surface of the timber recorded at the base of this borehole.

At the base of the peat in borehole QBH1 the sample from -2.12 to -2.17m OD is dominated by high quantities of waterlogged wood; low quantities were also recorded in the samples from -1.28 to -1.33, -1.70 to -1.80 and -1.90 to -2.00m OD, although wood was absent in the sample from -1.49 to -1.59m OD. The upper part of the sequence is dominated by waterlogged sedge remains, generally lacking the diagnostic epidermal tissue necessary for identification; particularly high quantities were recorded in the samples from -1.49 to -1.59 and -1.70 to -1.80m OD. Notably, charred wood was identified in high quantities in the sample from -1.90 to -2.00m OD. No bone, Mollusca or insects were recorded in this sequence.

A very similar sequence of macrofossil remains was identified in borehole QBH3, albeit with the equivalent horizons occurring at a lower elevation. In the basal samples from the peat in this borehole, waterlogged wood was present in high concentrations in the sample from -3.02 to -3.12m OD, and was recorded in low concentrations in the samples from -2.51 to -2.61 and -2.90 to -3.00m OD; the samples from -2.01 to -2.80m OD were dominated by waterlogged sedge remains, again lacking the diagnostic epidermal tissue necessary for identification. Waterlogged seeds were recorded in the uppermost (-2.01 to -2.11m OD) and at the base of the peat sequence (-3.02 to -3.12m OD), including *Rubus* cf. *fruticosus* (e.g. bramble) and *Alnus glutinosa* (alder) respectively. This assemblage is too small to attempt a full environmental interpretation, but these taxa are consistent with alder carr/sedge fen environments. A very similar assemblage of charred remains to that in borehole QBH1 (-1.90 and -2.00m OD) was identified in the sample from -2.90 to -3.00m OD; here, high concentrations of charcoal was recorded, including specimens greater than 4mm in diameter. No Mollusca, bone or insects were identified in the samples from QBH2.

Table 9: Results of the macrofossil assessment of samples from borehole QBH1, Goresbrook Park, London Borough of Barking and Dagenham.

				Charred					Waterlogged			Mollusca		Bone			
Depth (m OD)	Unit	Volume processed (ml)	Fraction	Charcoal (>4mm)	Charcoal (2-4mm)	Charcoal (<2mm)	Seeds	Chaff	Wood	Seeds	Sedge remains (e.g. stems/roots)	Whole	Fragments	Large	Small	Fragments	Insects
-1.28 to -1.33		0.05	>300µm	-	-	1	-	-	1	-	1	-	-	-	-	-	-
-1.49 to -1.59		0.10	>300µm	-	-	-	-	-	-	-	5	-	-	-	-	-	-
-1.70 to -1.80	Peat	0.10	>300µm	-	-	-	-	-	1	-	4	-	-	-	-	-	-
-1.90 to -2.00		0.10	>300µm	2	3	2	-	-	1	-	-	-	-	-	-	-	-
-2.12 to -2.17		0.05	>300µm	-	-	-	-	-	4	-	-	-	-	-	-	-	-

Key: 0 = Estimated Minimum Number of Specimens (MNS) = 0; 1 = 1 to 25; 2 = 26 to 50; 3 = 51 to 75; 4 = 76 to 100; 5 = 101+

Table 10: Results of the macrofossil assessment of samples from borehole QBH2, Goresbrook Park, London Borough of Barking and Dagenham.

				Charred					Waterlogged			Mollusca		Bone			
Depth (m OD)	Unit	Volume processed (ml)	Fraction	Charcoal (>4mm)	Charcoal (2-4mm)	Charcoal (<2mm)	Seeds	Chaff	Wood	Seeds	Sedge remains (e.g. stems/roots)	Whole	Fragments	Large	Small	Fragments	Insects
-2.01 to -2.11		0.05	>300µm	-	-	-	-	-	-	1	3	-	-	-	-	-	-
-2.30 to -2.40		0.10	>300µm	-	-	-	-	-	-	-	1	-	-	-	-	-	-
-2.51 to -2.61	Peat	0.05	>300µm	-	-	-	-	-	1	-	3	-	-	-	-	-	-
-2.70 to -2.80		0.05	>300µm	-	-	-	-	-	-	-	5	-	-	-	-	-	-
-2.90 to -3.00		0.05	>300µm	2	2	3	-	-	1	-	-	-	-	-	-	-	-
-3.02 to -3.12		0.05	>300µm	-	-	-	-	-	4	1	-	-	-	-	-	-	-

Key: 0 = Estimated Minimum Number of Specimens (MNS) = 0; 1 = 1 to 25; 2 = 26 to 50; 3 = 51 to 75; 4 = 76 to 100; 5 = 101+

Table 11: Results of the seed identifications of samples from borehole QBH2, Goresbrook Park, London Borough of Barking and Dagenham.

Depth (m OD)	Unit	Seed identification		Quantity
		Latin name	Common name	
-2.01 to -2.11	Peat	*Rubus* cf. *fruticosus*	e.g. bramble	1
-2.30 to -2.40		-	-	-
-2.51 to -2.61		-	-	-
-2.70 to -2.80		-	-	-
-2.90 to -3.00		-	-	-
-3.02 to -3.12		*Alnus glutinosa* (catkin)	alder	2

8. DISCUSSION & CONCLUSIONS

The aims of the environmental archaeological assessment at Goresbrook Park were (1) to establish the age of the peat recorded at the site; (2) to assess the palaeoenvironmental potential of the sequence; (3) to highlight any indications of nearby human activity, and (4) to provide recommendations for further analysis (if necessary). In order to achieve this aim, a full environmental archaeological assessment was undertaken on borehole QBH1, with a limited programme of assessment and radiocarbon dating of borehole QBH2.

The results of the previous geoarchaeological field investigations and deposit modelling (Young & Batchelor, 2017a) indicated that the sediments present beneath the site are similar to those recorded elsewhere in the Lower Thames Valley. The Shepperton Gravel is overlain by a sequence of Holocene alluvial sediments, including peat, buried beneath modern Made Ground. The surface of the Shepperton Gravel generally rests between -3 and -4.5m OD across the majority of the site, rising to 2m OD on the northern most part of the site, representative of the Taplow Gravel terrace and floodplain edge. A similar sequence of deposits is recorded across the neighbouring Beam Park (Young & Batchelor, 2017a) and Former Ford Stamping Factory (Young *et al.*, 2017) sites to the east. The Shepperton Gravel (and occasional sand) is overlain by a tripartite sequence of Lower Alluvium, Peat and Upper Alluvium.

The Peat generally varies in thickness between 1 and 2m across the vast majority of the site, and is generally recorded at elevations between *ca*. -1 and -5m OD. In geoarchaeological borehole QBH1 it was recorded at between -1.28 and -2.22m OD, and below -1.82m OD in borehole QBH2 (the base of the Peat in this borehole was not reached, but it lies at *at least* -3.16m OD). The Peat has the potential to contain archaeological remains as demonstrated by significant trackway/causeway findings at both Hays Storage Dagenham (Divers, 1996) and Bridge Road, Rainham (Meddens & Beasley, 1990; Beasley, 1991). Generally, these remains have been recorded towards the top of the Peat, and relatively close the floodplain edge.

As might be expected given the lower elevation of the peat in QBH2, the results of the radiocarbon dating indicate that peat accumulation began earlier here; accumulation began some time prior to 5325-5580 cal BP (Early-Middle Neolithic), indicating that the wood recorded at the base of this sequence (whatever its origin) pre-dates this. In borehole QBH1 peat accumulation began at around 4250-4430 cal BP (Late Neolithic). The peat appears to have continued accumulating until later in QBH2; in QBH1 peat cessation occurred at around 2490-2740 cal BP (540 to 790 cal BC; Early-Middle Iron Age), whilst in QBH2 peat accumulation continued until at least 1870-1995 cal BP (80 cal AD to 45 cal BC; Roman). Nearby sites such as Hornchurch Marshes (Batchelor, 2009; Branch et al., 2012), Barking Riverside (Green et al., 2014), Bridge Road (Meddens & Beasley, 1990; Beasley, 1991) and the Former Ford Stamping Factory (Young *et al.*, 2017) have all recorded Peat accumulation from the late Mesolithic to Bronze Age; the later date for the upper surface of the peat (Iron Age/Roman) at the present site therefore represents a later record of peat formation than has previously been recorded in this area.

The results of the palaeobotanical assessment (seeds and pollen) of the peat in borehole QBH1 are indicative of a peat surface dominated by alder and willow, with an understorey of grasses, sedges and occasional aquatics. Hazel, ash and birch may have occupied the peat surface with alder and willow, but are more likely to grown on the dryland forming mixed deciduous woodland with oak and lime. No definitive indicators of human activity were recorded during the assessment. However, both lime and oak decline in the upper half of both sequences, and this is matched by an expansion in the diversity of herbs (including the individual occurrence of cereal pollen) and increase of microcharcoal. This most likely indicates late prehistoric woodland clearance for settlement and/or agricultural purposes. Also of note is the increase of sedges, grasses and bur-reed in the uppermost sample of QBH1, which is indicative of a much wetter environment on the floodplain. As reported in other sequences across the Lower Thames Valley, the near contemporaneous nature of vegetation change on the floodplain and dryland is striking and suggests a strong link between the two environments and possible causes. In addition, of particular note are the high values of both micro- and macrocharcoal towards the base of both sequences; a high concentration of charcoal was identified in the macrofossil assessment at between -1.90 to -2.00m OD in QBH1 and -2.90 to -3.00m OD in QBH2. Along with the microcharcoal, this is suggestive of nearby or in situ burning, though whether this was of natural or anthropogenic origin is not possible to state at this time. In QBH2 this horizon of charcoal occurs just above the wooden branch/timber identified at the base of this borehole, and not far from the structure identified by Divers (1996) *ca*. 100m to the northeast (see below and Figure 2).

The record of vegetation history provided by the assessment of the sequences from Goresbrook Park shows some similarities with those of other sites in this area, albeit at this site continuing later, in to the Iron Age/Roman periods. At the Former Ford Stamping Factory site *ca*. 300m to the east (Young *et al*., 2017) the peat surface was dominated by alder, with an understorey of sedges and occasional grasses and aquatics. A similar mosaic of dryland woodland was present, with hazel, ash and birch possibly occupying the peat surface with alder, but perhaps more likely to grown on the dryland forming mixed deciduous woodland with oak and lime (Young *et al*., 2017). At Merrielands Crescent, *ca*. 200m to the northeast (Batchelor *et al*., 2017) the results of the assessment indicated a very similar peat surface occupied by alder and willow, forming carr woodland, with an understorey of sedges and grasses. No definitive evidence of human activity was recorded here or at the Former Ford Stamping Factory site; however, similar to the present site, high levels of microcharcoal were recorded towards the base of the sequence, and a decline in oak was apparent towards the top (Batchelor *et al*., 2017). At Hornchurch Marshes, *ca*. 2km to the southeast (Batchelor, 2009; Branch *et al*., 2012) analysis of fine-grained mineral-rich sediments and peat revealed the presence of freshwater during the Late Mesolithic, at which point peat accumulation began, corresponding to a regional reduction in sea level. Significant changes in both the wetland and dryland environment were recorded here, including the establishment of alder carr woodland, the presence of yew, the decline of elm during the Neolithic, and decline of lime during the Neolithic & Bronze Age. A subsequent transition to estuarine conditions was dated to *ca*. 3900 cal BP, coinciding with a decline in woodland cover and the expansion of plant communities typically found within reed swamp. Analysis of borehole sequences from Barking Riverside meanwhile, *ca*. 2km to the southwest (see

Figure 1), indicated that peat accumulation began at *ca*. 6000 cal BP (late Mesolithic), and continued until at least *ca*. 3500 cal BP (Bronze Age) (Green *et al*., 2014). The peat at Bridge Road, *ca*. 3km to the east, was found to be of Late Neolithic to Bronze Age date (Meddens & Beasley, 1990). Palaeoenvironmental analysis here revealed that during its accumulation, dense alder carr woodland dominated the wetland, with oak, lime and hazel on the surrounding dryland (Meddens & Beasley, 1990). Palaeoenvironmental assessment carried out immediately to the west of the site revealed a thin sequence of peat and alluvial deposits dating to the Bronze Age. This indicated similar vegetation communities, but the local environment became more open in response to wetter conditions and clearance (Krawiec, 2014). Peat deposits have also been recorded accumulating from the Late Mesolithic to the Iron Age East of Ferry Lane on the High Speed 1 route (Bates & Stafford, 2013).

Significant prehistoric archaeological remains have been found towards the top of the Peat (at *ca*. -1.6m OD) close to the floodplain/dryland edge at Hays Storage (Divers, 1996) immediately adjacent to the present site. Further remains have been found at Bridge Road, Rainham (Meddens & Beasley, 1990; Beasley, 1991) and more recently within brickearth, and peat, in the north-eastern corner of Beam Park (PCA, in press). At Bridge Road, these included a Bronze Age causeway, constructed of gravel and burnt flint, stakes, spreads of fire-cracked pebbles, wattling and a brushwood trackway. The potential of identifying such remains at the Goresbrook Park site, particularly towards the northern edge therefore exists, though it is highlighted that a recently completed archaeological evaluation (PCA, 2017) and ongoing watching brief (Mayo, pers. comm.) are yet to identify any prehistoric remains. It is of note that in borehole QBH2 a large, horizontal piece of wood was recorded between -3.16 and *at least* -3.82m OD; it is uncertain at this stage what this piece of wood may relate to. Interestingly, Divers (1996) noted that fallen yew and alder trees were recorded lower down in the peat sequence at the Hays Storage site, below the causeway identified there.

At the interface between the peat and the overlying Upper Alluvium both planktonic and benthic diatom taxa were encountered, most of which are associated with marine and brackish conditions, although taxa more associated with low salinity conditions were also present. There is therefore tentative evidence for an increase in salinity contemporaneous with the transition from peat formation to the deposition of the Upper Alluvium here, although further investigation of the diatom assemblages is required in order to provide a better understanding of this process.

9. RECOMMENDATIONS

The sequence from the Goresbrook Park site provides a unique opportunity to consider the vegetation history of this part of the Lower Thames Valley, where prehistoric human activity is known to have taken place: the results can be integrated with other sites being investigated along an east-west transect close to the floodplain edge, including investigations at the Former Ford Stamping Plant site (Young *et al*., 2017), Hays Storage Services Ltd. (Divers, 1996), Hornchurch Marshes (Batchelor, 2009; Branch *et al*., 2012), Beam Park (Young & Batchelor, 2016), and Merrielands Crescent (Batchelor *et al*., 2017) (see Figure 1). For the present site, further analysis is recommended on both sequences from borehole QBH1 and QBH2 due to the different chronologies of the upper parts of the sequence. These sequences post-date other records of vegetation history in this area, and can provide additional records of environmental change for the Iron Age and Roman periods.

Analysis of the pollen assemblages in both sequences is therefore recommended, along with identifications of the charcoal present towards the base of both. The diatom assemblages in borehole QBH1 should also be analysed, in order to investigate in more detail the transition from peat to alluvium towards the top of the sequence. Two additional radiocarbon dates for each sequence are also recommended, in order to provide a better chronological framework that can be used to compare and integrate the data with other sites in this area. This work should contribute to a future publication of the results of geoarchaeological/palaeoenvironmental investigations in this area.

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11. APPENDIX 1: OASIS FORM

OASIS ID: quaterna1-295975

Project details

Project name	Goresbrook Park
Short description of the project	An environmental archaeological assessment of two sequences was carried out at the Goresbrook Park site. The Shepperton Gravel at the site is overlain by a tripartite sequence of Lower Alluvium, Peat and Upper Alluvium. The Peat generally ranges between 1 and 2m in thickness, and lies at elevations of between ca. -1 and -5m OD. Peat accumulation began towards the southeast of the site during the Early to Middle Neolithic, and during the Late Neolithic towards the northwest. Peat accumulation continued at the site until the Iron Age, and towards the southeast, the Roman period. The results of the assessment are indicative of a peat surface dominated by alder and willow, with an understorey of grasses, sedges and occasional aquatics, with mixed deciduous woodland on the dryland including oak and lime. No definitive indicators of human activity were recorded during the assessment. However, there are indicators of late prehistoric woodland clearance towards the top of the sequence, and evidence for burning, particularly towards the base of the peat. Analysis of the pollen assemblages in both sequences is recommended, along with identifications of the charcoal present towards the base of both. The diatom assemblages in borehole QBH1 should also be analysed, in order to investigate in more detail the transition from peat to alluvium towards the top of the sequence. Two additional radiocarbon dates for each sequence are also recommended, in order to provide a better chronological framework that can be used to compare and integrate the data with other sites in this area.
Project dates	Start: 15-07-2017 End: 08-12-2017
Previous/future work	No / Yes
Type of project	Environmental assessment
Significant Finds	PEAT Early Neolithic
Significant Finds	PEAT Iron Age
Significant Finds	PEAT Roman
Survey techniques	Landscape

Project location

Country	England
Site location	GREATER LONDON BARKING AND DAGENHAM DAGENHAM Goresbrook Park
Postcode	RM9 6RS
Site coordinates	TQ 48432 83233 51.527966794075 0.140026310543 51 31 40 N 000 08 24 E Point

Project creators

Name of Organisation	Quaternary Scientific (QUEST)
Project brief originator	CgMs Consulting
Project design originator	Dr C.R. Batchelor
Project director/manager	C.R. Batchelor
Project supervisor	D.S. Young
Type of sponsor/funding body	Developer

Project archives

Physical Archive Exists?	No
Digital Archive Exists?	No
Paper Archive recipient	LAARC
Paper Contents	"Environmental","Stratigraphic"
Paper Media available	"Report"

Entered by	Daniel Young (d.s.young@reading.ac.uk)
Entered on	8 December 2017

