PIRELLI WORKS, CHURCH MANORWAY, ERITH (SITE CODE: PWR12): ENVIRONMENTAL ARCHAEOLOGICAL ASSESSMENT REPORT

D.S. Young, C.R. Batchelor, C.P. Green and R.A. Braithwaite
Quaternary Scientific (QUEST), School of Human and Environmental Sciences, University of Reading, Whiteknights, PO Box 227, Reading, RG6 6AB, UK

INTRODUCTION

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 at Pirelli Works, Church Manorway, Erith, DA8 1HS (National Grid Reference: centred on TQ 50463 79542; site code: PWR12; Figure 1). The site is located on the floodplain of the Estuarine Thames adjacent to the modern waterfront, and less than 0.5km north of the floodplain edge and the rising ground of the valley side. Previous geoarchaeological investigations at the site carried out by Museum of London Archaeological Service (MoLAS; Halsey, 2007; site code: PWR12) consisted of two borehole transects located: (1) on the eastern side of the site and orientated south-west to north-east (Transect 1) and (2) on the western side of the site and orientated north-south (Transect 2; Figure 6). These investigations revealed a pre-Holocene gravel surface that varies between *ca.* -7.0m OD (BH15) and *ca.* -9.8m OD (BH10), overlain by a sequence of coarse and fine mineral-rich deposits (alluvium) and peats of varying thicknesses (up to *ca.* 5m in BH5) and depths.

The grain of the Shepperton Gravel relief is west-north-west to east-south-east, which is broadly parallel with the margin of the floodplain to the south. The existing borehole evidence show an unusually level surface of the Shepperton Gravel across most of the site, rising to a high point in the extreme north-east and with a slight rise in the extreme south. Between these two areas there is a broad depression, arguably a channel, running approximately west-north-west to east-south-east. The presumed Late Pleistocene/Early Holocene sand that overlies the Shepperton Gravel is thin across the fairly level floor of this channel, but thicker towards its margins. Resting above these deposits with a broadly similar distribution - thicker towards the margins of the channel and thinner in the middle – is a thin horizon of 'Mesolithic' peat.

The Lower Alluvium that overlies this Early Holocene sequence is thickest in the north-east and in the south. MoLAS (Halsey, 2007) suggests that these two thick accumulations of

Lower Alluvium represent part of a continuous palaeochannel infill. They show 'Course of possible Early to Mid Holocene channel' trending west-south-west to east-north-east across the southern part of the site. This course seems to be counterintuitive: (1) the site as a whole is in a position where the Thames must throughout the Holocene have had a broad north-west to south-east alignment, determined by the distribution of the higher ground to the south; (2) there is no tributary stream flowing from the higher ground onto the floodplain from the south-west that might encourage a trend across this broad alignment, and (3) the topography of the underlying Shepperton Gravel and the distribution of the Late Pleistocene/Early Holocene sand and the Mesolithic peat can all be explained in terms of west-north-west to east-south-east trending relief.

As an alternative to the MoLAS west-south-west to east-north-east trending channel, we therefore suggest that the two thick Lower Alluvium sequences are quite separate. If as MoLAS suggests, they are channel infill, then we would argue that they represent two separate channels, both trending west-north-west to east-south-east with peat accumulating in the intervening areas, possibly contemporaneously, as MOLAS suggests. The age relationship between the Lower Alluvium and the peat may however be rather different. Elsewhere in the Lower Thames area, e.g. in Barking Riverside (Batchelor *et al.*, 2011), Quest has argued that peat-filled depressions in the Lower Alluvium may represent peat accumulation in depressions cut into the Lower Alluvium (probably formed as palaeochannels), and that upstanding areas of Lower Alluvium are unconsumed remnants of a once more continuous Lower Alluvium cover. In this case, the whole of the peat sequence is later than the Lower Alluvium rather than in part contemporaneous with it.

In addition to the sediments themselves having the potential to increase our knowledge and understanding of Holocene landscape evolution at the Pirelli Works site, the archaeobotanical (pollen, diatoms, waterlogged wood and seeds) and zooarchaeological (insects, Mollusca, Foraminifera, Ostracoda) remains contained in the alluvial and peat deposits have the potential to provide data contributing to the reconstruction of past environments on both the wetland and dryland, from the Mesolithic to Late Bronze Age cultural periods. In particular, there is the potential to increase knowledge and understanding of the interactions between relative sea level, human activity, vegetation succession and climate in this area of the Lower Thames Valley. 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. It is also highlighted

significant evidence of prehistoric activity have been recorded locally to the Pirelli Works site including a Mesolithic flint scatter at Erith Spine Road / Bronze Age Way (Sidell *et al.*, 1996) and Bronze Age trackeways at both Erith Spine Road / Bronze Age Way and on the Erith Foreshore (Sidell pers. comm.) (Figure 1).

The aim of the environmental archaeological assessment was to evaluate the potential of the sedimentary sequences at the Pirelli Works site for reconstructing the environmental history of the site and its environs. In order to achieve this aim, the geoarchaeological deposit modelling and environmental archaeological assessment consisted of the following techniques, as stated in the written scheme of investigation for this site (Batchelor and Green, 2012):

1. Recording the lithostratigraphy of the new borehole sequences to clarify the nature of the subsurface stratigraphy at the site and to provide a preliminary reconstruction of the sedimentary history of the site
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
3. Carrying out organic matter content determinations on selected boreholes to enhance the results of the sedimentary descriptions
4. Radiocarbon dating of selected boreholes to provide a provisional geochronological framework for the natural stratigraphic sequences
5. Assessment of the preservation and concentration of pollen grains and spores in selected boreholes to provide a preliminary reconstruction of the vegetation history, and to detect evidence for human activities e.g. woodland clearance and cultivation
6. Assessment of the preservation and concentration of diatom frustules in selected boreholes
7. Assessment of the preservation and concentration of macroscopic plant, insect and Mollusca remains from small bulk samples from selected boreholes to provide a preliminary reconstruction of the vegetation history and general environmental context of the site.

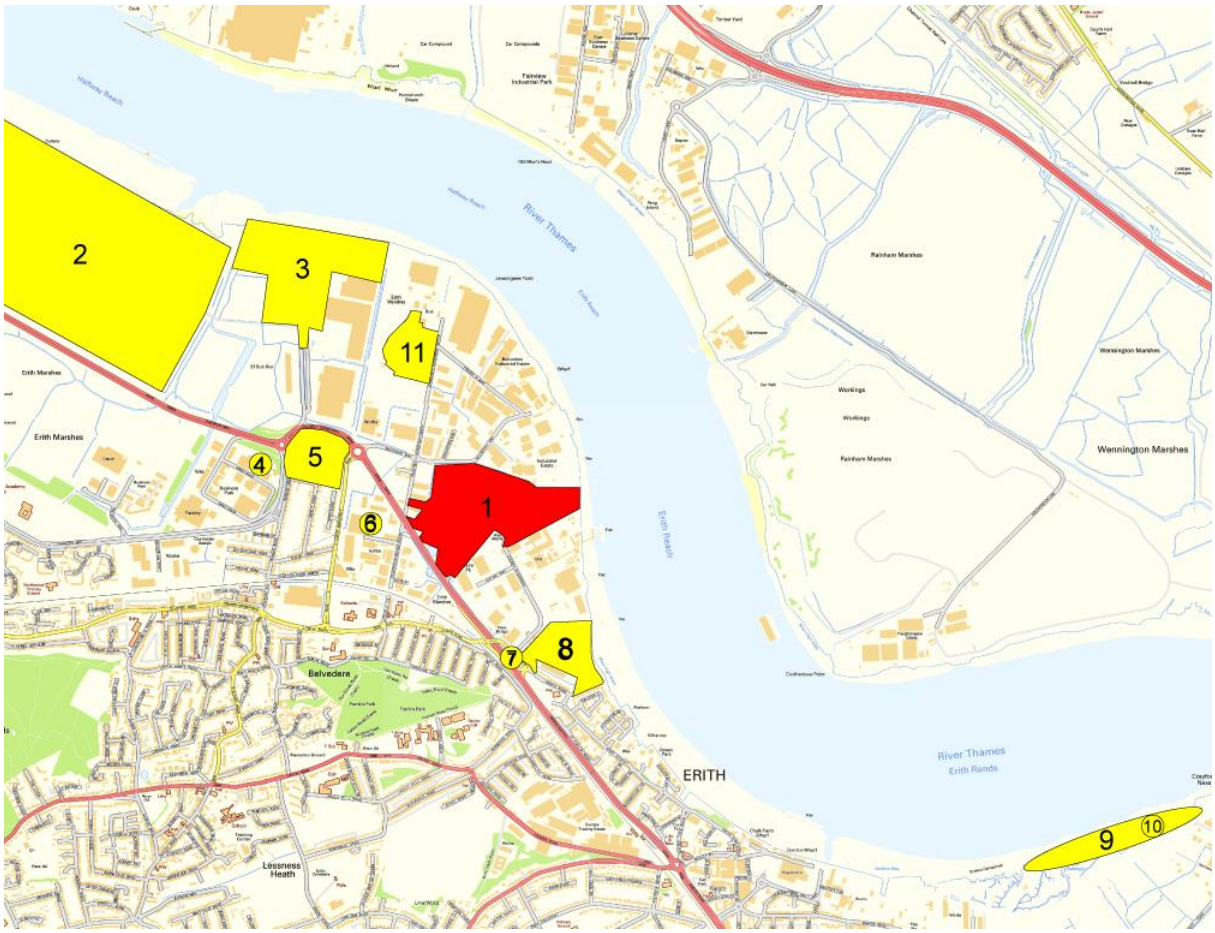

Figure 1: Location of the Pirelli Works site (PWR12) (1) and other selected local sites: (2) Crossness (Devoy, 1979) / Crossness Sewage Works (EAW06 - Batchelor *et al.*, 2007a; CXS07 - Batchelor *et al.*, 2007b; CRO11 - Green *et al.*, 2011) (3) Norman Road (NNB06; Batchelor *et al.*, 2008a) (4) North Bexley Drainage Improvements (EWY01; Branch *et al.*, 2004) (5) Imperial Gateway (Batchelor *et al.*, 2008b) (6) Crabtree Manorway South (CXN05; Askew and Spurr, 2006) (7) Erith Spine Road / Bronze Age Way (Sidell *et al.*, 1996) (8) Corinthian Quay (Corcoran & Lam, 2002) (9) Erith Forest (Seel, 2001) (10) Erith Forest (Sidell, pers. comm.) (11) Former NuFarm Site (Young *et al.*, in prep.). *Contains Ordnance Survey data © Crown copyright and database right [2012]*

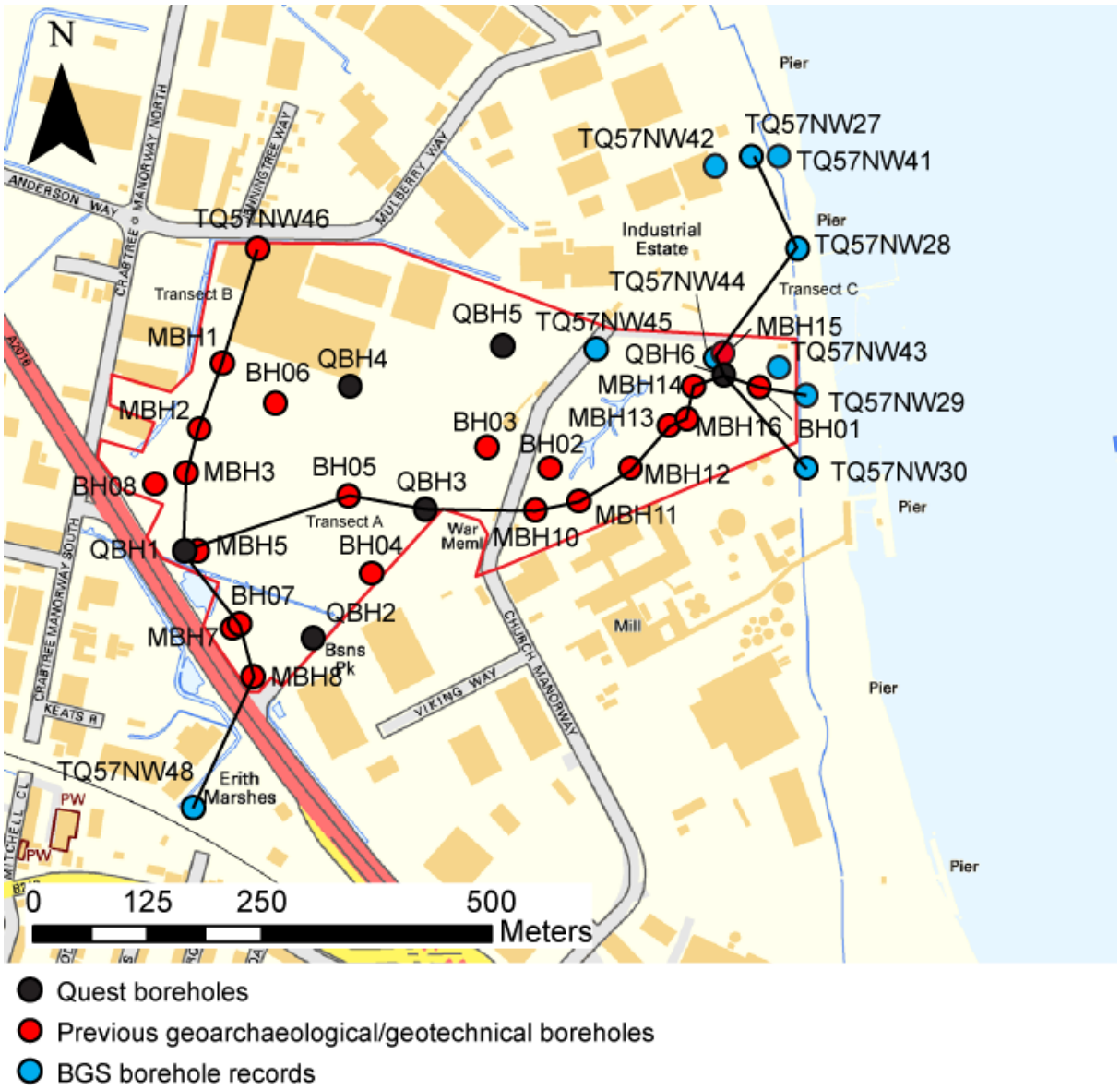

Figure 2: Detailed site map incorporating the location of the previous geotechnical and geoarchaeological boreholes, existing BGS borehole records and new Quest boreholes. Pirelli Works, Church Manorway, Erith (Site Code: PWR12). ***Contains Ordnance Survey data © Crown copyright and database right [2012]***

METHODS

Field investigations

Six boreholes (Boreholes <QBH1> to <QBH6>) were put down at the site in August 2012 (Figure 2). Borehole core samples were recovered using an Eijkelkamp window 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°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 (Table 1 and Figure 2).

Table 1: Borehole attributes, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Borehole number	Easting	Northing	Elevation (m OD)
Quest geoarchaeological boreholes			
<QBH1>	550200.9	179399.6	1.116
<QBH2>	550341.3	179304.5	0.751
<QBH3>	550464.2	179445.6	0.982
<QBH4>	550381.8	179579.3	1.007
<QBH5>	550548.0	179624.0	-0.114
<QBH6>	550789.5	179592.0	0.824
BGS borehole records *Based upon records provided by British Geological Survey (NERC).*			
TQ57NW28	550870	179730	3.5
TQ57NW29	550880	179570	0.7
TQ57NW41	550820	179830	1.83
TQ57NW43	550850	179600	1.32
TQ57NW45	550650	179620	0.74
TQ57NW46	550280	179730	0.67
TQ57NW42	550780	179820	2.01
TQ57NW44	550780	179610	0.76
TQ57NW47	550920	178860	2.61
TQ57NW48	550210	179120	1.73
TQ57NW26	550770	179990	5.7
TQ57NW27	550850	179830	2.3
TQ57NW30	550880	179490	0.2
Geotechnical/geoarchaeological boreholes			
MBH1	550242	179605	1.21
MBH2	550217	179533	1.14
MBH3	550202	179485	1.12
MBH5	550215	179400	1.09
MBH7	550253	179315	0.77
MBH8	550275	179263	0.7

MBH10	550584	179445	0.75
MBH11	550631	179454	0.98
MBH12	550688	179490	1.04
MBH13	550730	179536	1.05
MBH14	550756	179579	0.89
MBH15	550789	179616	0.85
MBH16	550749	179544	0.95
BH01	550828	179578	1.86
BH02	550599	179490	0.94
BH03	550531	179513	0.77
BH04	550405	179375	1.24
BH05	550380	179460	1.18
BH06	550300	179561	1.18
BH07	550261	179320	0.68
BH08	550168	179473	0.91

Lithostratigraphic descriptions

The lithostratigraphy of boreholes <QBH1> to <QBH6> was described in the 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 spatula or scalpel blade and distilled water 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); (4) recording the degree of peat humification and (5) recording the unit boundaries e.g. sharp or diffuse. The results are displayed in Figure 3 and Tables 2 to 7. Two-dimensional deposit models comprising a west-east transect (Transect A) and north-south transects across the western (Transect B) and eastern (Transect C) parts of the sites are shown in Figures 4 to 6.

Deposit modelling

The deposit model was based on a review of 40 borehole records (Table 1), incorporating the six new Quaternary Scientific geoarchaeological boreholes, 21 existing geotechnical boreholes (Halsey, 2007), and 13 BGS borehole records (Based upon records provided by British Geological Survey (NERC)) (see Table 1 for summary data).

Sedimentary units from the boreholes were classified into five groupings: (1) Shepperton Gravel (incorporating Basal Sands); (2) Lower Alluvium (incorporating the Lower Organic Horizon); (3) Peat; (4) Upper Alluvium, and (5) Made Ground. For the purposes of the deposit model, where the Basal Sands were recorded these were incorporated in to the Shepperton Gravel; where the Lower Organic Horizon was recorded this was incorporated in

to the Lower Alluvium. The classified data for groups 1-5 were then input into a database with the RockWorks 2006 geological utilities software. Models of surface height (using a nearest neighbour routine) were generated for each of these stratigraphic groups (Figures 7 and 9 to 11). Thickness of the peat and combined alluvial units was also modelled (also using a nearest neighbour routine) (Figures 12 and 13). Because the boreholes are not uniformly distributed over the area of investigation, the reliability of the models generated using RockWorks is variable. In general, reliability improves from outlying areas where the models are largely supported by scattered archival records towards the core area of commissioned 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.

In addition, the reliability of individual models is affected by the quality of the stratigraphic records which in turn are affected by the nature of the sediments and/or their post-depositional disturbance during previous stages of development on the site. In particular, it is important to recognise that several sets of boreholes are represented, put down at different times and recorded using different descriptive terms and subject to differing technical constraints in terms of recorded detail including the exact levels of the stratigraphic boundaries. The cores from the six new boreholes (<QBH1> to <QBH6>) represent the most detailed record of the sediment sequences.

Organic matter determinations

69 sub-samples from borehole <QBH1>, 63 from <QBH5> and 55 from <QBH6> were taken for determination of the organic matter content (Tables 8 to 10; Figure 3). 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 110^0C 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 (see Bengtsson and Enell, 1986).

Radiocarbon dating

Six sub-samples of twig wood or terrestrial waterlogged seeds were extracted for radiocarbon dating: from the base (indeterminate twig wood, *ca.* 2-3 years old) and top (indeterminate twig wood, *ca.* 2-3 years old) of the peat in borehole <QBH1>; from the base of the lower organic horizon (*Alnus glutinosa* catkins) and top of the main peat unit

(indeterminate twig wood, *ca.* 2-3 years old) in borehole <QBH5> and from the lower organic horizon (indeterminate twig wood, *ca.* 2-3 years old) and top of the main peat unit (indeterminate twig wood, *ca.* 2-3 years old) in borehole <QBH6>. The six samples were submitted for AMS radiocarbon dating to Beta Analytic INC, Radiocarbon Dating Laboratory, Florida, USA. The results have been calibrated using OxCal v4.0.1 Bronk Ramsey (1995, 2001 and 2007) and IntCal04 atmospheric curve (Reimer *et al.*, 2004). The results are displayed in Figure 3 and Table 11.

Pollen assessment

18 sub-samples (six from each of boreholes <QBH1>, <QBH5> and <QBH6>) 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) (Tables 12 to 14).

Diatom assessment

12 sub-samples (four from each of boreholes <QBH1>, <QBH5> and <QBH6>) were extracted for the assessment of diatoms. The diatom extraction involved the following procedures (Battarbee *et al.,* 2001):

1. Treatment of the sub-sample (0.2g) with Hydrogen peroxide (30%) to remove organic material and Hydrochloric acid (50%) to remove remaining carbonates
2. Centrifuging the sub-sample at 1200 for 5 minutes and washing with distilled water (4 washes)
3. Removal of clay from the sub-samples in the last wash by adding a few drops of Ammonia (1%)

4. Two slides prepared, each of a different concentration of the cleaned solution, were fixed in mounting medium of suitable refractive index for diatoms (Naphrax)

Duplicate slides each having two coverslips were made from each sample and fixed in Naphrax for diatom microscopy. The coverslip with the most suitable concentration of the sample preparation was selected for diatom evaluation. A large area of this coverslip was scanned for diatoms at magnifications of x400 and x1000 under phase contrast illumination using a Leica microscope. The results are displayed in Tables 15 to 17.

Macrofossil assessment

A total of eighteen small bulk samples (seven from borehole <QBH1>, five from borehole <QBH5> and six from borehole <QBH6>) were extracted for the recovery of macrofossil remains including waterlogged plant macrofossils, waterlogged wood, insects and Mollus*ca.* The extraction process involved the following procedures: (1) removing a sample up to 10cm in thickness; (2) measuring the sample volume by water displacement, and (3) 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 18 to 20).

Preliminary identifications of the waterlogged seeds have been made using modern comparative material and reference atlases (e.g. Cappers *et al.* 2006). The nomenclature used follows Stace (2005) (Tables 21 to 23).

RESULTS AND INTERPRETATION OF THE LITHOSTRATIGRAPHIC DESCRIPTIONS AND ORGANIC MATTER CONTENT DETERMINATIONS

The results of the lithostratigraphic descriptions for boreholes <QBH1> to <QBH6> are displayed in Tables 2 to 7 and Figures 3 to 6. The combined results of the geoarchaeological borehole investigation have enhanced the previous geotechnical investigations and permitted a programme of deposit modelling of the surface elevation and thickness of each major stratigraphic unit (Figures 7 to 13).

The majority of boreholes bottomed in sand and gravel or coarse sands considered to represent the Shepperton Gravel or the Late Pleistocene/Early Holocene 'Basal Sands' (Figure 7). These sediments were deposited during the Late Glacial, within a high energy braided river system (Shepperton Gravel), or the Early Holocene, followed by a gradual reduction in flow rate (Basal Sands). The new geoarchaeological boreholes and the results

of the deposit modelling of the Shepperton Gravel/Basal Sands surface indicate a highly variable surface that may represent two separate channels, both trending roughly north-north-west to south-south-east, one to the far west and one traversing the centre of the site. Towards the base of these possible channels the gravel surface lies at maximum depths of -9.73m OD (western channel; MBH7) and -9.65m OD (central channel, MBH10) (Figures 4 and 7); away from the channels, the gravel/sand surface rises in the far eastern part of the site to -6.41m OD (borehole <QBH6>), and to -7.2m OD (BH05) towards the centre of the site, representing a relief amplitude of *ca.* 2-3.0m. The BGS borehole records to the north-east of the site and towards the modern course of the River Thames indicate that the gravel surface falls in this direction, to -8.5m OD in borehole TQ57NW42, -8.53m OD in TQ57NW41, -9.8m OD in TQ57NW28, and -12.0m OD in TQ57NW27 (Figure 7). *Ca.* 400m to the west of the site at Imperial Gateway (Batchelor *et al.*, 2008b; Figure 1) the surface of the Shepperton Gravel was variable, generally between -5.0 and -9.0m OD. At the Former NuFarm Site *ca.* 500m to the north-west of the Pirelli Works site (Figure 1) the surface of the Shepperton Gravel is fairly uniform, recorded in the most recent investigation at the site (Young *et al.*, in prep.) at between -7.82 and -9.17m OD. Further north-west, at the Norman Road (Batchelor *et al.*, 2008a) site the gravel surface was recorded at between -9.2m and -6.7m OD, with a higher gravel surface to the south of the site up to -2.8m OD. West of here, at the Crossness Sewage Treatment Works (Batchelor *et al.*, 2007a), *ca.* 1500m north-west of the Pirelli Works site and bordering the southern bank of the Thames, the gravel surface is variable, recorded between *ca.* -5.0 to -11.0m OD.

At the Pirelli Works site, succeeding the Shepperton Gravel/Basal Sands in some boreholes (Figures 4 to 6 and 8) was an organic-rich horizon (the Lower Organic Horizon) generally between 0.2m and 1.0m thick (but to a maximum of 2.0m in borehole MBH12). This horizon (referred to as the Mesolithic Peat' by MoLA) was composed of organic-rich (sometimes peaty) silty clay, with varying quantities of wood remains, and significantly, would have represented a semi-terrestrial land surface that might have been utilised by prehistoric people. This organic horizon is generally thicker towards the centre and east of the site, and appears to have accumulated in both the channels between *ca.* -9.0 and -8.0m OD and on the gravel highs between *ca.* -7.0 and -6.0m OD. There is therefore no specific pattern to the distribution of boreholes across the site that contain the Lower Organic Horizon and those which do not. It is speculated that the absence could be attributed to one or more of the following: (1) the sediment did not accumulate in these areas; (2) the sediment was eroded from these areas by subsequent processes (see below), or (3) the method of coring and/or description carried out previously across the site did not permit the identification of the

sediment.

Overlying the Lower Organic Horizon (and the Shepperton Gravel where the Lower Organic Horizon is not present) was the Lower Alluvium, the sediments of which were deposited during the Early to Mid-Holocene as the energy of flow decreased and the Thames probably became confined to a single meandering channel. The upper surface of the Lower Alluvium is generally recorded between -4.0 and -2.0m OD (Figure 9), with the deepest areas in the far western part of the site, in the region of boreholes MBH2 (-6.86m OD) and MBH3 (-4.88m OD) and shallowest in the eastern part of the site, in the area of boreholes MBH13 (-1.95m OD), MBH12 (-2.71m OD) and <QBH6> (-2.83m OD).

The Lower Alluvium is overlain in the majority of boreholes by generally well-humified, sometimes woody Peat (the 'main' Peat unit), indicative of a transition towards a semi-terrestrial environment supporting the growth of wetland woodland. Throughout the course of Peat accumulation, is a constant supply of fine grained mineral-rich sediment (as indicated by the results of the organic matter content determinations; Figure 3, Tables 8 to 10). This supply indicates that the Peat surface was prone to flooding (perhaps on a seasonal basis), but that this varied across the site and over time – for example, the Peat surface was inundated more often towards the base in boreholes <QBH5> and <QBH6>, whilst QBH1 remained relatively dry; conversely the opposite was true towards the top of the Peat. The upper surface of the Peat is fairly uniform across the site at between -0.5 and -2.0m OD (Figure 10). The thickness of peat is variable across the site, generally between 2.0 and 4.0m in thickness and thicker within the two north-north-west to south-south-east channels (Figures 4 and 12). The greatest thickness of peat is recorded in the far western part of the site, in the area of boreholes MBH2 (4.0m) and MBH3 (3.9m); and in the central part of the site in the area of MBH10 (3.1m). Outside of the present site and to the north-east, the deposit model indicates that the peat thickness increases in this area, to a maximum thickness of 6.5m in borehole TQ57NW27. Similarly to the Lower Organic Horizon, this Peat would have represented a semi-terrestrial land surface that might have been utilised by prehistoric people.

The Upper Alluvium overlies the surface of the Peat, and is representative of inundation of the wetland environment. The surface of the Upper Alluvium generally lies between 0.0m and -1.0m OD (Figures 4 to 6 and 11). In most cases the surface of the Upper Alluvium appears to be truncated by the overlying Made Ground, which caps the majority of boreholes to the current surface height within the site of between *ca.* 1.0 and 0.0m OD.

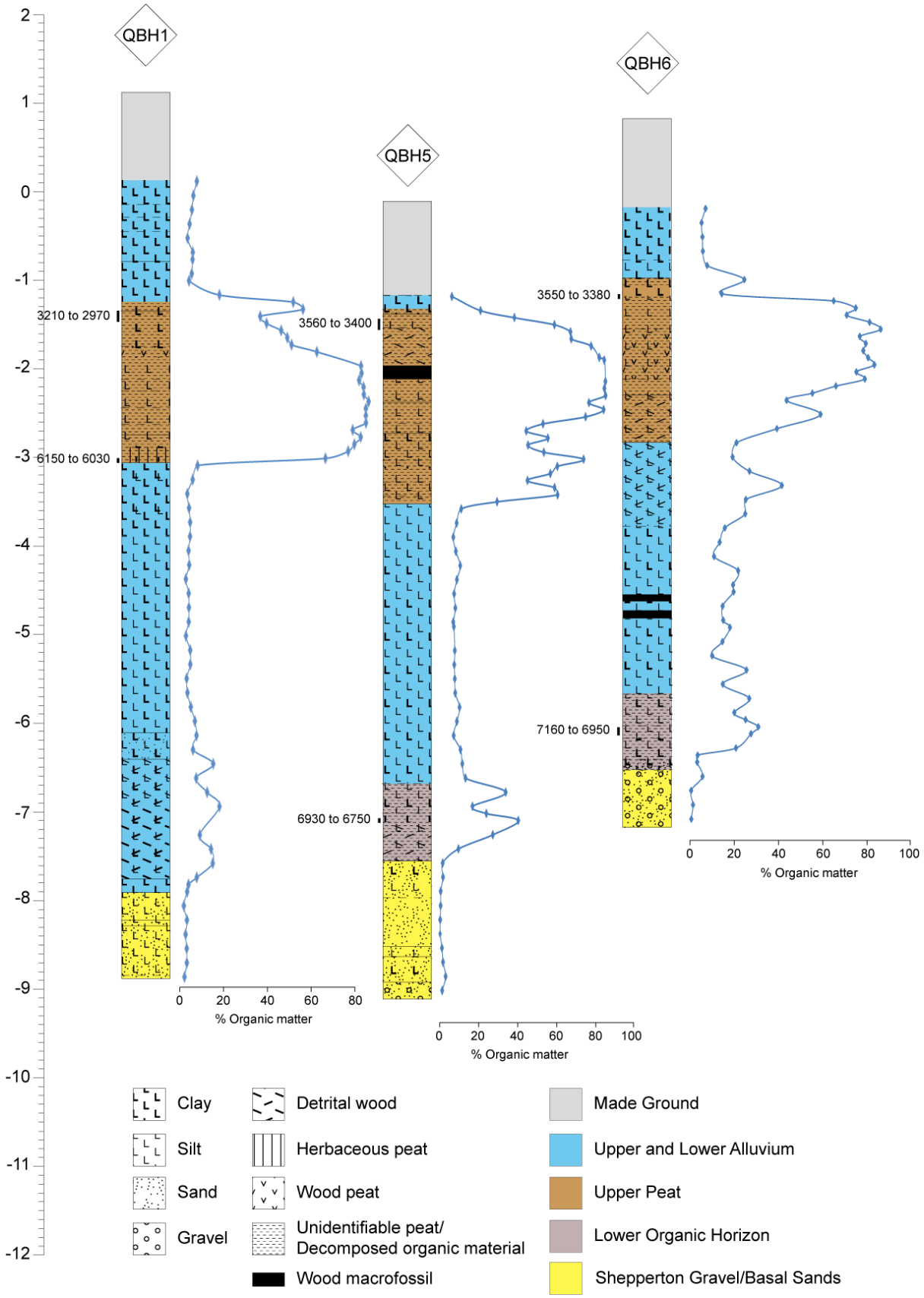

Figure 3: Results of the borehole <QBH1>, <QBH5> and <QBH6> lithostratigraphic analysis, incorporating lithostratigraphic descriptions and organic matter content, plotted with associated radiocarbon dates (calibrated years BP). Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

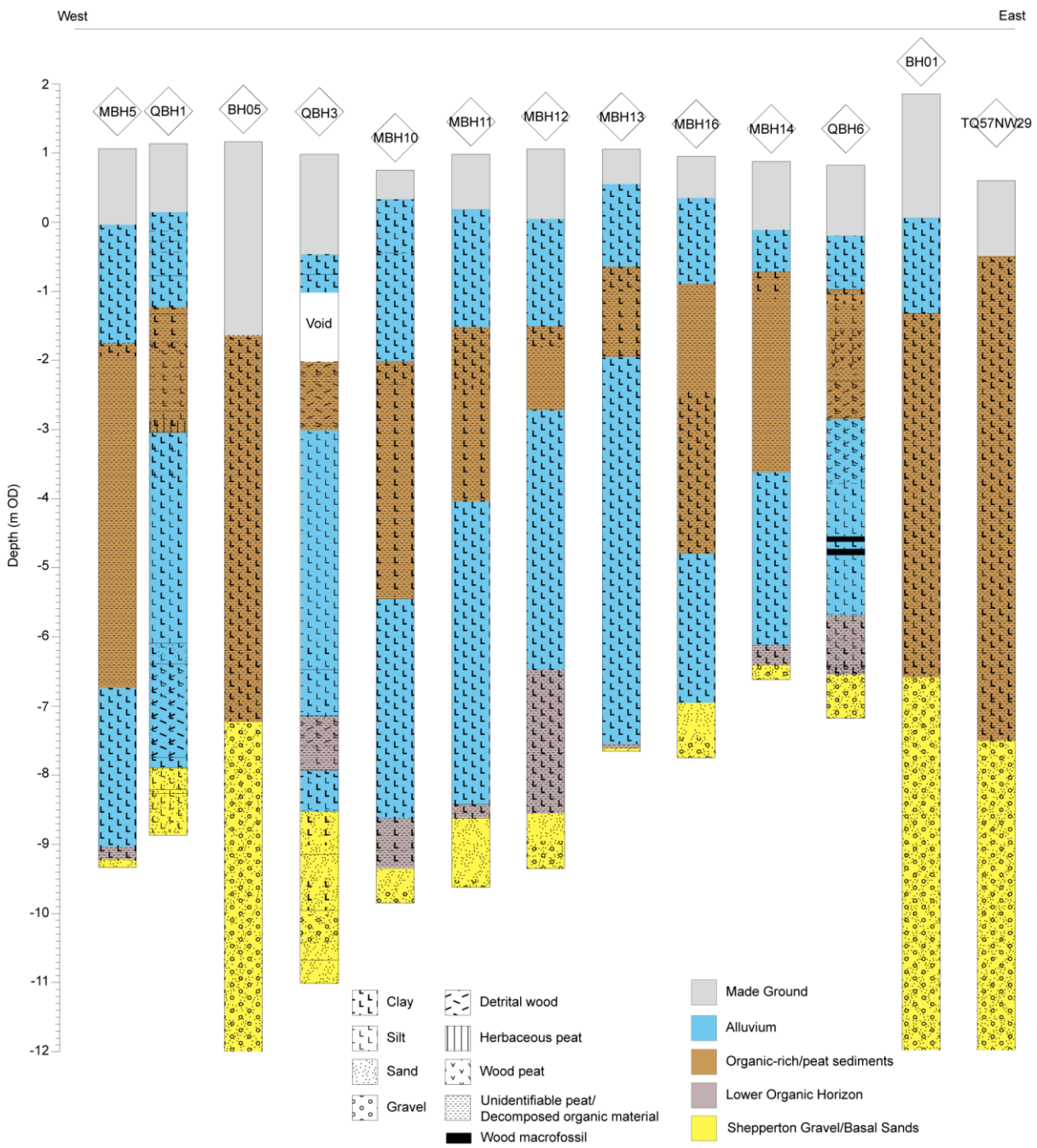

Figure 4: West-east transect (Transect A) of boreholes across Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

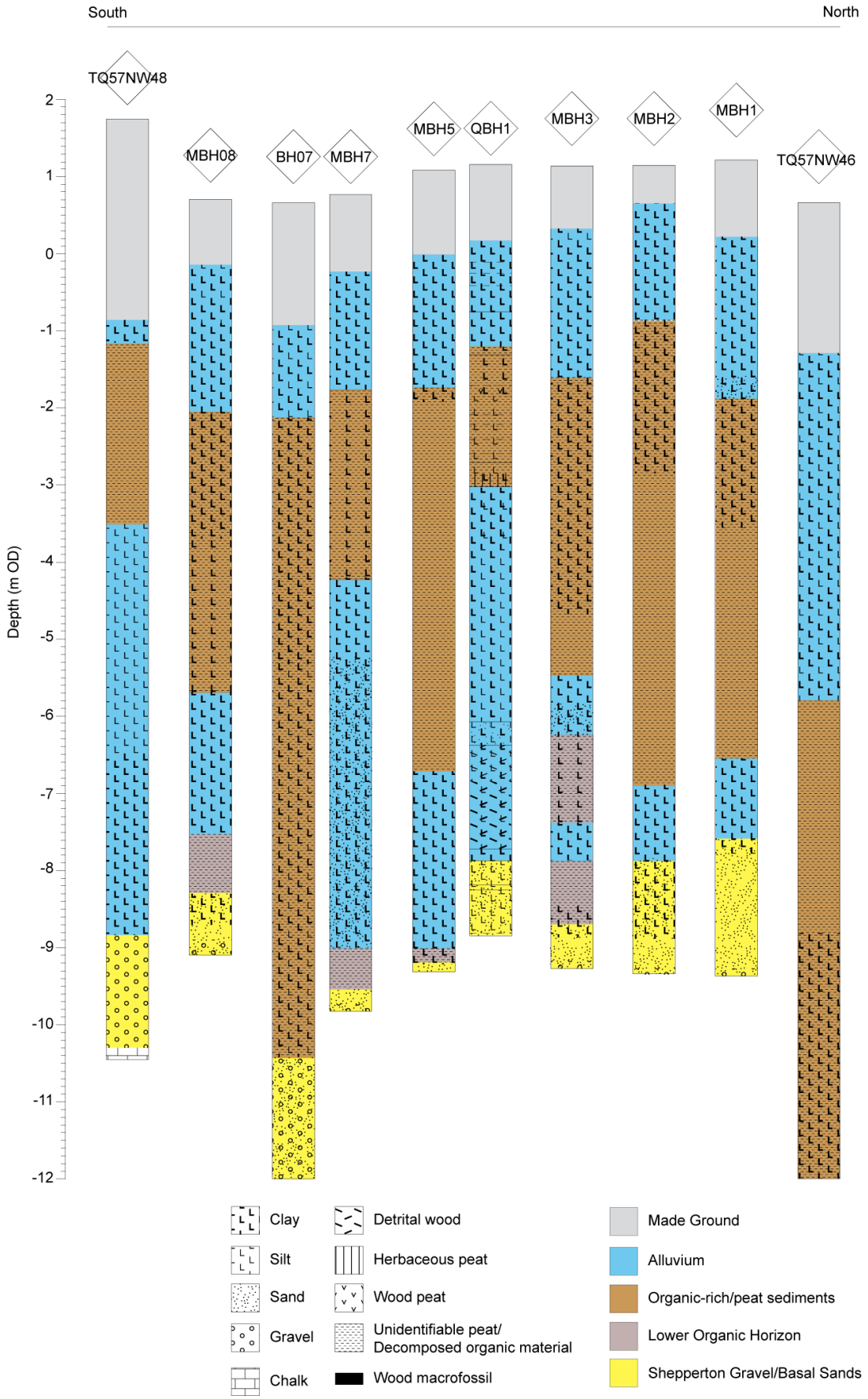

Figure 5: Western south-north transect (Transect B) of boreholes across Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

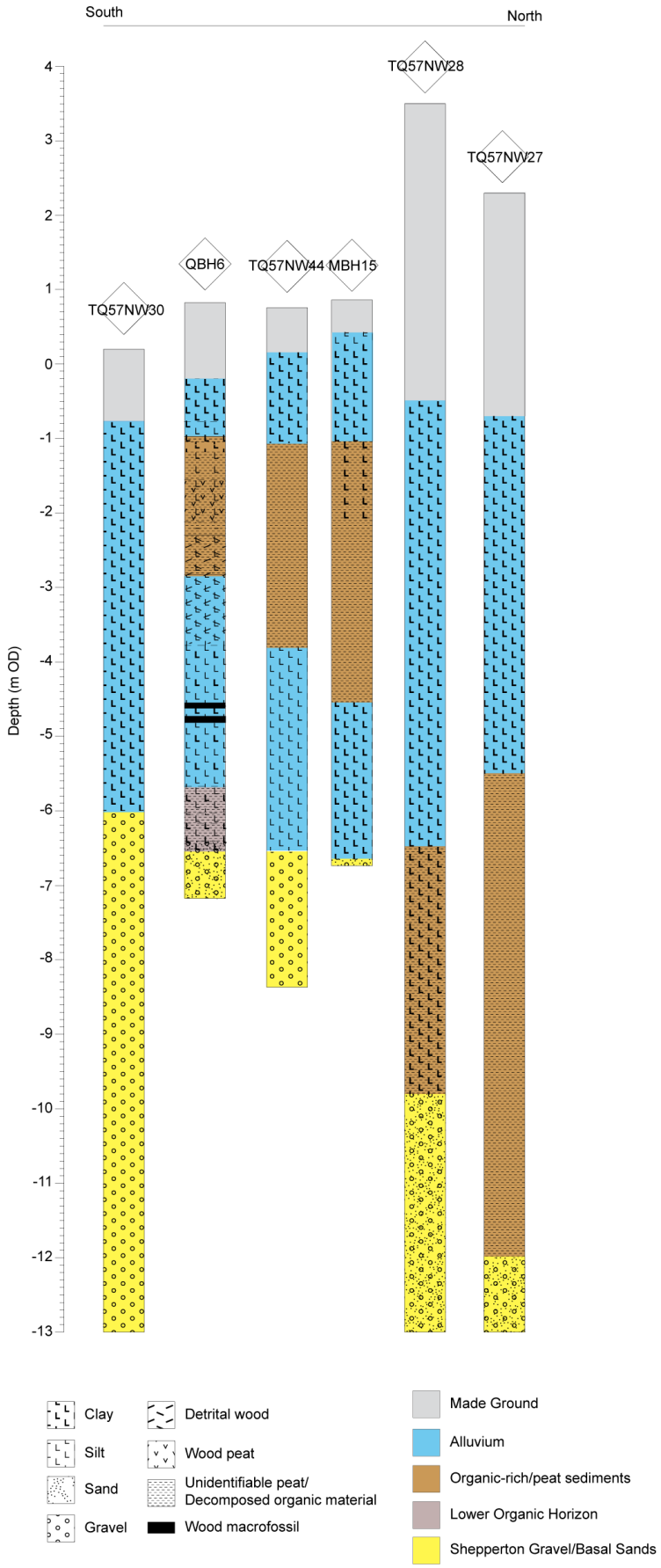

Figure 6: Western north-south transect (Transect C) of boreholes across Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Table 2: Lithostratigraphic description of borehole <QBH1>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)	Depth (m BGS)	Composition
1.12 to 0.12	0.00 to1.00	Made ground
0.12 to -0.14	1.00 to 1.26	7.5YR 4/1; As4; dark grey clay; diffuse contact into:
-0.14 to -0.29	1.26 to 1.41	10YR 4/1; As4; dark grey clay; diffuse contact into:
-0.29 to -0.45	1.41 to 1.57	2.5Y 3/1; As4 Ag+ Dh/Dl+; very dark grey clay with a trace of silt and detrital herbaceous material/wood; diffuse contact into:
-0.45 to -0.79	1.57 to 1.91	10YR 4/1; As4 Ga+; dark grey clay with a trace of sand; sharp contact into:
-0.79 to -0.88	1.91 to 2.00	10YR 5/1; As4; grey clay.
-0.88 to -1.24	2.00 to 2.36	2.5Y 6/3; As4; light yellowish brown clay; uneven contact into:
-1.24 to -1.35	2.36 to 2.47	5YR 3/2; Sh3 As1 Tl+; Humo 3; dark reddish brown silty well humified peat with a trace of wood peat; sharp contact into:
-1.35 to -1.74	2.47 to 2.86	5YR COLOUR; Sh3 As1 Tl+; Humo 4; very dark grey silty well humified peat with a trace of wood peat; diffuse contact into:
-1.74 to -1.88	2.86 to 3.00	7.5YR 2.5/1; Sh2 As1 $Tl^2$1; black clayey well humified wood peat.
-1.88 to -2.12	3.00 to 3.24	10YR 2/2; Sh3 Ag1 Tl+; Humo 3; very dark brown silty well humified peat with a trace of wood peat; diffuse contact into:
-2.12 to -2.25	3.24 to 3.37	7.5YR 2.5/1; Sh3 Ag1 Th+; Humo 4; black silty well humified peat with a trace of herbaceous peat; diffuse contact into:
-2.25 to -2.44	3.37 to 3.56	5YR 3/1; Sh3 Ag1 Th/Tl+; Humo 4; very dark grey silty well humified peat with a trace of herbaceous/wood peat; diffuse contact into:
-2.44 to -2.63	3.56 to 3.75	7.5YR 2.5/1; Sh3 Ag1 Th+ Humo 4; Black silty well humified peat with a trace of herbaceous peat; diffuse contact into:
-2.63 to -2.75	3.75 to 3.87	5 YR 3/1; Sh3 Ag1 Th/Tl+; Humo 4; very dark grey silty well humified peat with a trace of herbaceous/wood peat; diffuse contact into:
-2.75 to -2.88	3.87 to 4.00	7.5YR 3/1; Sh2 Ag1 $Th^3$1; Humo 4; very dark grey silty well humified herbaceous peat.
-2.88 to -3.06	4.00 to 4.18	2.5YR 2.5/1; $Th^2$2 Sh1 As1; Humo 3; reddish black clayey well humified herbaceous peat; Sharp contact into:
-3.06 to -3.88	4.18 to 5.00	2.5YR 4/1; As3 Ag1 Dl+; dark grey silty clay with a trace of detrital wood; laminations occur throughout.
-3.88 to -4.88	5.00 to 6.00	10YR 4/1; As2 Ag2; dark grey clay and silt; laminations occur throughout.
-4.88 to -6.12	6.00 to 7.24	10YR 4/1; As2 Ag2 Ga+; dark grey clay and silt with a trace of sand; sharp contact into:
-6.12 to -6.41	7.24 to 7.53	7.5YR 4/1; Ag2 As1 Ga1 Dl+; dark grey sandy clayey silt with a trace of detrital wood; sharp contact into:
-6.41 to -6.88	7.53 to 8.00	2.5Y 2.5/1; Ag2 As1 Dl1 Sh+; black clayey silt with detrital wood and a trace of organic material.
-6.88 to -7.74	8.00 to 8.86	10YR 3/1; Dl2 As1 Ag1 Ga+ Sh+; very dark grey

		detrital wood, clay and silt with a trace of sand and organic material; sharp contact into:
-7.74 to -7.91	8.86 to 9.03	10YR 4/1; As4; dark grey clay; sharp contact into:
-7.91 to -8.23	9.03 to 9.35	2.5Y 4/1; Ag3 Ga1 As+; dark grey sandy silt with a trace of clay; sharp contact into:
-8.23 to -8.29	9.35 to 9.41	2.5Y 6/2; Ag3 Ga1 Gg+; light yellowish grey sandy silt with a trace of gravel; unit possibly contains calcareous material; sharp contact into:
-8.29 to -8.87	9.41 to 9.99	2.5Y 5/1; Ag3 Ga1 Gg+; grey sandy silt with gravel inclusions; 9.61 to 9.64 as 9.35 to 9.41; diffuse contact into:
-8.87 to -8.88	9.99 to 10.00	2.5Y 5/1; Ga4; grey sand.

Table 3: Lithostratigraphic description of borehole <QBH2>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)	Depth (m BGS)	Composition
0.75 to -0.38	0.00 to1.13	Made ground
-0.38 to -0.78	1.13 to 1.53	7.5YR 4/1; As3 Ag1; dark grey silty clay; vertical rooting; diffuse contact into:
-0.78 to -1.08	1.53 to 1.83	7.5YR 4/1; As2 Ag2; dark grey silt and clay; vertical rooting; diffuse contact into:
-1.08 to -1.25	1.83 to 2.00	7.5YR 2.5/1; Sh2 As1 Ag1; Humo 4; black clayey silty well humified peat.
-1.25 to -2.00	2.00 to 2.75	7.5YR 2.5/1; Sh2 Ag2 Dl/Tl+; Humo 3; black silt and well humified peat with a trace of detrital wood/wood peat; sharp contact into:
-2.00 to -2.25	2.75 to 3.00	10YR 2/1; Tl/Dl2 Sh1 Ag1; Humo 2; black wood peat/detrital wood with well humified peat and silt.
-2.25 to -2.71	3.00 to 3.46	5YR 2.5/2; Sh3 Ag1 Tl+; Humo 3; dark reddish brown silty well humified peat with a trace of wood peat; diffuse contact into:
-2.71 to -3.25	3.46 to 4.00	10YR 2/1; Sh4 Th+; Humo 4; black well humified peat with a trace of herbaceous peat
-3.25 to -3.35	4.00 to 4.10	7.5YR 2.5/2; Ag2 Sh1 Tl^2/Dl1; Humo 3; very dark brown organic silt with wood peat/detrital wood; diffuse contact into:
-3.35 to -3.77	4.10 to 4.52	10YR 2/2; Ag3 Sh1; Humo 4; very dark brown organic silt; sharp contact into;
-3.77 to -4.08	4.52 to 4.83	5YR 3/2; Sh2 Tl^2/Dl1 Ag1; Humo 3; dark reddish brown silty well humified peat with wood peat/detrital wood; sharp contact into:
-4.08 to -5.25	4.83 to 6.00	10YR 4/1; Ag3 As1 Dl+; dark grey clayey silt with a trace of detrital wood.
-5.25 to -6.25	6.00 to 7.00	VOID
-6.25 to -6.43	7.00 to 7.18	10YR 3/1; Ag2 Sh1 As1; very dark grey organic clayey silt; diffuse contact into:
-6.43 to -6.71	7.18 to 7.46	5YR 2.5/1; Sh3 $Tl^4$1 Ag+; Humo 4; black well humified wood peat with a trace of silt; diffuse contact into:
-6.71 to -7.16	7.46 to 7.91	10YR 4/1; As4; dark grey clay; diffuse contact into:
-7.16 to -7.25	7.91 to 8.00	10YR 4/1; As4 Ga+ Ag+; dark grey clay with a trace of sand and silt.
-7.25 to -7.44	8.00 to 8.19	2.5Y 5/1; As3 Ag1 Ga+; grey silty clay with a trace of sand; diffuse contact into:
-7.44 to -7.97	8.19 to 8.72	2.5Y 5/1; As2 Ag 1 Ga1; grey silty sandy clay; diffuse

		contact into:
-7.97 to -8.96	8.72 to 9.71	2.5Y 5/1; Ga4 Ag+; grey sand with a trace of silt; diffuse contact into:
-8.96 to -9.03	9.71 to 9.78	2.5Y 3/1; Ga3 As1; very dark grey clayey sand; diffuse contact into:
-9.03 to -9.25	9.78 to 10.00	2.5Y 5/4; Ga4 Ag+; light olive brown sand with a trace of silt.
-9.25 to -9.84	10.00 to 10.59	2.5Y 5/2; Ga4 Gg+; greyish brown sand with a trace of gravel; clay inclusions at 10.46, 10.50 and 10.53m; sharp contact into:
-9.84 to -9.94	10.59 to 10.69	2.5Y 6/4; Ga4; light yellowish brown sand; sharp contact into:
-9.94 to -10.25	10.69 to 11.00	2.5Y 5/6; Ga2 Gg2; light olive brown sand and gravel.

Table 4: Lithostratigraphic description of borehole <QBH3>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)	Depth (m BGS)	Composition
0.98 to -0.46	0.00 to 1.44	Made ground
-0.46 to -0.76	1.44 to 1.74	2.5Y 3/1; As4 Ag+; very dark grey clay with a trace of silt; sharp contact into:
-0.76 to -1.02	1.74 to 2.00	10YR 3/2; As4 Dl+; very dark greyish brown with a trace of detrital wood.
-1.02 to -2.02	2.00 to 3.00	VOID
-2.02 to -2.24	3.00 to 3.22	7.5YR 3/1; Ag2 Sh1 Tl^3/Dl1; very dark grey organic silt with wood peat/detrital wood; diffuse contact into:
-2.24 to -2.51	3.22 to 3.49	10YR 2/1; Sh3 Ag1 Th+; Humo 4; black silty well humified peat with a trace of herbaceous material; diffuse contact into:
-2.51 to -2.96	3.49 to 3.94	5YR 2.5/1; Sh3 $Tl^2$1 Ag+; Humo 3; black well humified wood peat with a trace of silt; diffuse contact into:
-2.96 to -3.02	3.94 to 4.00	7.5YR 3/1; Ag3 Sh1; very dark grey organic silt.
-3.02 to -6.02	4.00 to 7.00	7.5YR 3/1; Ag4 As+ Dl+; dark grey silt with a trace of clay and detrital wood.
-6.02 to -6.49	7.00 to 7.47	2.5Y 3/1; Ag3 As1; very dark grey clayey silt; laminations throughout; sharp contact into:
-6.49 to -7.02	7.47 to 8.00	2.5Y 2.5/1; Ag3 As1 Dl+; black clayey silt with a trace of detrital wood; laminations throughout.
-7.02 to -7.15	8.00 to 8.13	2.5Y 4/1; As2 Ag2 Dl+; dark grey clay and silt with a trace of detrital wood; sharp contact into:
-7.15 to -7.58	8.13 to 8.56	10YR 2/1; Ag2 Sh1 Dl1; black organic silt with detrital wood; diffuse contact into:
-7.58 to -7.94	8.56 to 8.92	7.5YR 2.5/1; Sh3 Ag1; Humo 4; black silty well humified peat; mollusc inclusions throughout; sharp contact into:
-7.94 to -8.02	8.92 to 9.00	10YR 3/1; As4; very dark grey clay.
-8.02 to -8.53	9.00 to 9.51	5Y 5/1; As3 Ag1 Ga+; grey silty clay with a trace of sand; diffuse contact into:
-8.53 to -9.02	9.51 to 10.00	5Y 5/1; As2 Ga2; grey clay and sand.
-9.02 to -9.16	10.00 to 10.14	2.5Y 5/4; Ga4; light olive brown sand; sharp contact into:
-9.16 to -9.50	10.14 to 10.48	2.5Y 4/1; Ga4 Ag+; dark grey sand with a trace of silt; diffuse contact into:
-9.50 to -9.96	10.48 to 10.94	2.5Y 5/1; Ga2 As2; grey sand and clay; sharp contact into:

-9.96 to -10.02	10.94 to 11.00	2.5Y 5/3; Ga4 Ag+; light olive brown sand with a trace of silt.
-10.02 to -10.43	11.00 to 11.41	2.5Y 5/1; Ga3 Gg1; grey sand and gravel; diffuse contact into:
-10.43 to -10.68	11.41 to 11.66	2.5Y 5/1; Ga4; grey sand; sharp contact into:
-10.68 to -10.86	11.66 to 11.84	2.5Y 5/6; Ga4 Ag+; light olive brown sand with a trace of silt
-10.86 to -11.02	11.84 to 12.00	2.5Y 4/3; Ga4; olive brown sand.

Table 5: Lithostratigraphic description of borehole <QBH4>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)	Depth (m BGS)	Composition
1.01 to -0.99	0.00 to 2.00	Made ground
-0.99 to -1.13	2.00 to 2.14	2.5Y 4/1; As3 Ag1; dark grey silty clay; sharp contact into:
-1.13 to -1.56	2.14 to 2.57	7.5YR 2.5/1; Sh3 Ag1; Humo 4; black silty well humified peat; sharp contact into:
-1.56 to -1.77	2.57 to 2.78	7.5YR 3/1; Ag2 As1 Sh1; Humo 4; very dark grey organic clayey silt; sharp contact into:
-1.77 to -1.99	2.78 to 3.00	10YR 2/1; As2 Sh2 Dl/Tl+; Humo 4; black well humified peat and clay with a trace of wood.
-1.99 to -2.05	3.00 to 3.06	7.5YR 2.5/1; Sh3 Ag1; Humo 4; black silty well humified peat; sharp contact into:
-2.05 to –2.85	3.06 to 3.86	5YR 2.5/1; Sh4 Ag+ Tl+; Humo 4; black well humified peat with a trace of silt and wood; wood macrofossil inclusion from 3.36 to 3.43m; sharp contact into:
-2.85 to -2.99	3.86 to 4.00	10YR 2/2; Sh2 Ag2; Humo 4; very dark brown silt and well humified peat.
-2.99 to -3.14	4.00 to 4.15	7.5YR 3/1; Sh3 Ag1; Humo 4; very dark grey silty well humified peat; diffuse contact into:
-3.14 to -3.30	4.15 to 4.31	10YR 2/2; Sh2 Ag1 Dl/Tl1; Humo 3; very dark brown silty well humified peat with wood; sharp contact into:
-3.30 to -3.37	4.31 to 4.38	10YR 3/2; Sh2 Ag2 Tl/Dl+; Humo 4; very dark greyish brown well humified peat and silt with a trace of wood; sharp contact into:
-3.37 to -3.69	4.38 to 4.70	7.5YR 2.5/1; Sh3 Ag1 Tl+; Humo 4; black silty well humified peat with a trace of wood; diffuse contact into:
-3.69 to -3.75	4.70 to 4.76	10YR 2/1; Sh3 Ag1; Humo 3; black silty well humified peat; sharp contact into:
-3.75 to -3.80	4.76 to 4.81	10YR 2/2; Ag3 Sh1; Humo 4; very dark brown organic silt; diffuse contact into:
-3.80 to -3.99	4.81 to 5.00	2.5Y 3/1; Ag3 As1 Sh+ Tl/Dl+; very dark grey clayey silt with a trace of wood.
-3.99 to -4.88	5.00 to 5.89	2.5Y 4/1; As3 Dl1; dark grey clay with detrital wood; wood macrofossil inclusion from 5.36 to 5.48m; diffuse contact into:
-4.88 to -4.99	5.89 to 6.00	2.5Y 2.5/1; As4 Dl+; black clay with a trace of detrital wood.
-4.99 to -5.30	6.00 to 6.31	2.5Y 2.5/1; Ag2 As2 Dl+; black clay and silt with a trace of detrital wood; diffuse contact into:
-5.30 to -5.37	6.31 to 6.38	10YR 3/1; As3 Ag1 Sh+ Dl+; very dark grey silty clay

		with a trace of organic material and detrital wood; diffuse contact into:
-5.37 to -5.50	6.38 to 6.51	7.5YR 2.5/1; Sh3 As1 Ag+ Dl+; Humo 4; black clayey well humified peat with a trace of silt and detrital wood; diffuse contact into:
5.50 to -5.99	6.51 to 7.00	2.5Y 4/1; As1 Ag2 Ga1 Dl+; dark grey sandy clayey silt with a trace of detrital wood.
-5.99 to -6.06	7.00 to 7.07	2.5Y 3/1; Ag2 Ga2; very dark grey silt and sand; diffuse contact into:
-6.06 to -6.99	7.07 to 8.00	2.5Y 4/1; As2 Ga2; dark grey clay and sand; sandy inclusions from 7.59 to 7.68m and 7.95 and 7.96m; possible calcareous material with detrital wood from 7.76 to 7.82m.
-6.99 to -7.64	8.00 to 8.65	2.5Y 4/1; Ga4; grey sand; sandy clay inclusion from 8.48 to 8.50m; diffuse contact into:
-7.64 to -7.71	8.65 to 8.72	2.5Y 5/1; Ga2 As2; grey sand and clay; diffuse contact into:
-7.71 to -7.80	8.72 to 8.81	2.5Y 5/1; Ga4 Ag+; grey sand with a trace of silt; diffuse contact into:
-7.80 to -7.89	8.81 to 9.00	2.5Y 5/4; Ga2 Gg2; Light olive brown sand and gravel.

Table 6: Lithostratigraphic description of borehole <QBH5>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)	Depth (m BGS)	Composition
-0.11 to -1.17	0.00 to 1.06	Made ground
-1.17 to -1.32	1.06 to 1.21	10YR 3/4; As4 Ag+; dark yellowish brown clay with a trace of silt; diffuse contact into:
-1.32 to -1.39	1.21 to 1.28	7.5YR 3/2; As3 Sh1 Dl+; Humo 4; dark brown organic clay with a trace of detrital material; sharp contact into:
-1.39 to -1.54	1.28 to 1.43	10YR 2/2; Ag2 Sh2 Tl/Dl+; Humo 4; very dark brown silt and well humified peat with a trace of wood; diffuse contact into:
-1.54 to -1.98	1.43 to 1.87	7.5YR 2.5/1; Sh3 $Tl^2$1; Humo 3; black well humified wood peat.
-1.98 to -2.11	1.87 to 2.00	Wood macrofossil.
-2.11 to -2.39	2.00 to 2.28	7.5YR 2.5/2; Sh3 Ag1 Th+; Humo 4; very dark brown silty well humified peat with a trace of wood peat; sharp contact into;
-2.39 to -2.61	2.28 to 2.50	10YR 3/4; Ag2 Sh2 Th/Tl+; Humo 4; dark yellowish brown silt and well humified peat with a trace of herbaceous/wood peat; diffuse contact into:
-2.61 to -2.73	2.50 to 2.62	10YR 4/2; Ag2 As1 Sh1; dark greyish brown organic clayey silt; sharp contact into:
-2.73 to -3.04	2.62 to 2.93	10YR 3/3; As2 Ag1 Sh1 Dl+; dark brown organic silty clay with a trace of detrital wood; diffuse contact into:
-3.04 to -3.11	2.93 to 3.00	10YR 2/2; Sh3 Ag1 Tl/Th+; Humo 3; black silty well humified peat with a trace of wood/herbaceous peat.
-3.11 to -3.27	3.00 to 3.16	10YR 3/3; Sh2 Ag2 Tl/Dl+; Humo 4; dark brown well humified peat and silt with a trace of wood; diffuse contact into:
-3.27 to -3.44	3.16 to 3.33	10YR 4/2; Ag3 Sh1 Dl+; dark greyish brown organic silt with a trace of detrital wood; diffuse contact into:
-3.44 to -3.51	3.33 to 3.40	10YR 3/4; Sh2 Ag1 As1 Dl/Tl+; dark yellowish brown clayey silty well humified peat with a trace of detrital

		wood/wood peat; sharp contact into:
-3.51 to -4.11	3.40 to 4.00	2.5Y 4/1; Ag4 As+ Dl+; dark grey silt with a trace of clay and detrital wood.
-4.11 to -6.69	4.00 to 6.58	2.5Y 4/1; As1 Ag3 Dl+; dark grey clayey silt with a trace of detrital wood; mollusc inclusions from 5.00 to 6.58m; diffuse contact into:
-6.69 to -7.01	6.58 to 6.90	10YR 3/1; Ag2 As1 Sh1 Dl+; very dark grey organic clayey silt with a trace of detrital wood; mollusc inclusions throughout; diffuse contact into:
-7.01 to -7.11	6.90 to 7.00	10YR 2/1; Sh2 As1 Ag1; Humo 4; black clayey silty well humified peat; mollusc inclusions throughout.
-7.11 to -7.55	7.00 to 7.44	7.5YR 2.5/1; Ag2 Sh1 Dl1; black organic silt with detrital wood; wood macrofossil inclusion from 7.05 to 7.13m; frequent mollusc inclusions throughout; sharp contact into:
-7.55 to -7.96	7.44 to 7.85	10YR 4/1; Ga2 As1 Ag1; dark grey clayey silty sand; diffuse contact into:
-7.96 to -8.51	7.85 to 8.40	2.5Y 5/3; Ga4 Ag/As+; light olive brown sand with a trace of silt/clay; sharp contact into:
-8.51 to -8.62	8.40 to 8.51	2.5Y 5/3; Ga2 As1 Ag1; light olive brown clayey silty sand; sharp contact into:
-8.62 to -8.91	8.51 to 8.80	2.5Y 5/2; Ga2 As1 Ag1; greyish brown clayey silty sand; clay/silt inclusions from 8.52 to 8.55m, at 60m and 72m; sharp contact into:
-8.91 to -9.11	8.80 to 9.00	2.5Y 4/3; Ga2 Gg2; olive brown sand and gravel.

Table 7: Lithostratigraphic description of borehole <QBH6>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)	Depth (m BGS)	Composition
0.82 to -0.18	0.00 to 1.00	Made ground
-0.18 to -0.76	1.00 to 1.58	7.5YR 5/3; As4 Dl+; brown clay with a trace of detrital wood; diffuse contact into:
-0.76 to -0.97	1.58 to 1.79	7.5YR 4/2; As3 Ag1; brown silty clay; sharp contact into:
-0.97 to -1.07	1.79 to 1.89	7.5YR 3/1; As3 Sh1; very dark grey organic clay.
-1.07 to -1.08	1.89 to 1.90	VOID
-1.08 to -1.18	1.90 to 2.00	7.5YR 3/2; As4; dark brown clay
-1.18 to -1.55	2.00 to 2.37	10YR 2/2; Sh3 Ag1 Tl+; Humo 4; very dark brown silty well humified peat with a trace of wood peat; diffuse contact into:
-1.55 to -2.11	2.37 to 2.93	7.5YR 2.5/2; Sh2 $Tl^2$1 Ag1 Th+; Humo 3; very dark brown silty well humified wood peat with a trace of herbaceous peat; diffuse contact into:
-2.11 to -2.18	2.93 to 3.00	10YR 2/1; Sh4; Humo 4; black well humified peat
-2.18 to -2.30	3.00 to 3.12	10YR 2/2; Sh2 Ag2 Tl/Dl+; Humo 4; very dark brown silt and well humified peat; wood macrofossil inclusion at top of unit; sharp contact into:
-2.30 to -2.83	3.12 to 3.65	10YR 2/2; Ag2 Dl1 Sh1 As+; very dark brown organic silt with detrital wood and a trace of clay; sharp contact into:
-2.83 to -3.77	3.65 to 4.59	10YR 3/2; Ag3 Dl1 Sh+ As+; very dark greyish brown silt with detrital wood with a trace of clay and organic material; diffuse contact into:
-3.77 to -4.73	4.59 to 5.55	10YR 4/1; Ag3 As1 Dl+; dark grey clayey silt with a

		trace of detrital wood; wood macrofossil inclusion from 5.37 to 5.46m.
-4.73 to -4.81	5.55 to 5.63	Wood macrofossil.
-4.81 to -5.68	5.63 to 6.50	2.5Y 2.5/1; Ag3 As1 Sh+ Dl+; black clayey silt with a trace of organic material and detrital wood; diffuse contact into:
-5.68 to -6.03	6.50 to 6.85	10YR 3/1; Ag2 As1 Sh1 Dl+; very dark grey organic clayey silt with a trace of detrital wood; diffuse contact into:
-6.03 to -6.18	6.85 to 7.00	10YR 2/1; Sh2 Ag2; Humo 4; black well humified peat and silt.
-6.18 to -6.41	7.00 to 7.23	10YR 2/1; Sh2 As1 Ag1; Humo 4; black clayey silty well humified peat; mollusc inclusions throughout; diffuse contact into:
-6.41 to -6.53	7.23 to 7.35	10YR 2/1; Sh1 As1 Ga1 Gg1 Ag+; black organic clay, sand and gravel with a trace of silt; diffuse contact into:
-6.53 to -7.18	7.35 to 8.00	10YR 4/2; Ga2 Gg2; dark greyish brown sand and gravel.

Table 8: Results of the borehole <QBH1> organic matter determinations, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)		Organic matter content %
From	**To**	
0.10	0.09	7.96
-0.06	-0.07	6.37
-0.22	-0.23	5.70
-0.38	-0.39	4.65
-0.54	-0.55	3.74
-0.70	-0.71	6.12
-0.78	-0.79	6.01
-0.94	-0.95	5.64
-1.02	-1.03	4.39
-1.18	-1.19	18.29
-1.26	-1.27	52.00
-1.34	-1.35	56.44
-1.42	-1.43	36.89
-1.50	-1.51	39.80
-1.58	-1.59	46.47
-1.66	-1.67	49.27
-1.74	-1.75	51.23
-1.82	-1.83	62.76
-1.98	-1.99	82.92
-2.06	-2.07	83.18
-2.14	-2.15	82.03
-2.22	-2.23	84.09
-2.30	-2.31	84.21
-2.38	-2.39	86.37
-2.46	-2.47	85.11
-2.54	-2.55	85.13
-2.62	-2.63	85.18
-2.70	-2.71	79.14
-2.78	-2.79	82.77

-2.86	-2.87	79.91
-2.94	-2.95	77.08
-3.02	-3.03	66.67
-3.10	-3.11	8.32
-3.26	-3.27	6.06
-3.42	-3.43	3.63
-3.58	-3.59	4.39
-3.74	-3.75	4.91
-3.90	-3.91	4.86
-4.06	-4.07	4.19
-4.22	-4.23	4.48
-4.38	-4.39	2.95
-4.54	-4.55	4.26
-4.70	-4.71	4.36
-4.86	-4.87	4.26
-5.02	-5.03	2.98
-5.18	-5.19	4.92
-5.34	-5.35	4.98
-5.50	-5.51	3.31
-5.66	-5.67	3.66
-5.82	-5.83	5.20
-5.98	-5.99	7.06
-6.14	-6.15	7.80
-6.30	-6.31	6.19
-6.46	-6.47	15.43
-6.62	-6.63	7.65
-6.78	-6.79	12.67
-6.94	-6.95	18.29
-7.26	-7.27	9.33
-7.42	-7.43	14.44
-7.58	-7.59	15.23
-7.74	-7.75	7.91
-7.82	-7.83	4.16
-7.90	-7.91	3.54
-8.06	-8.07	2.02
-8.22	-8.23	3.44
-8.38	-8.39	2.84
-8.54	-8.55	3.33
-8.70	-8.71	3.39
-8.86	-8.87	2.34

Table 9: Results of the borehole <QBH5> organic matter determinations, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)		Organic matter content %
From	**To**	
-1.19	-1.20	6.44
-1.35	-1.36	21.24
-1.43	-1.44	38.64
-1.51	-1.52	59.28
-1.59	-1.60	67.58
-1.67	-1.68	67.99
-1.75	-1.76	78.22
-1.88	-1.89	82.44

-1.91	-1.92	85.00
-2.15	-2.16	85.59
-2.23	-2.24	85.05
-2.31	-2.32	85.68
-2.39	2.40	77.09
-2.47	-2.48	84.67
-2.55	-2.56	75.37
-2.63	-2.64	53.44
-2.71	-2.72	44.76
-2.79	-2.80	55.91
-2.87	-2.88	45.70
-2.95	-2.96	53.86
-3.03	-3.04	74.35
-3.11	-3.12	60.84
-3.19	-3.20	57.24
-3.27	-3.28	45.42
-3.35	-3.36	59.38
-3.43	-3.44	60.92
-3.51	-3.52	29.72
-3.59	-3.60	11.28
-3.75	-3.76	8.91
-3.91	-3.92	7.17
-4.07	-4.08	8.48
-4.23	-4.24	10.74
-4.39	-4.40	9.00
-4.55	-4.56	7.59
-4.71	-4.72	8.20
-4.87	-4.88	7.14
-4.92	-4.93	7.45
-5.19	-5.20	7.96
-5.35	-5.36	7.69
-5.51	-5.50	7.96
-5.67	-5.68	8.17
-5.83	-5.84	10.38
-5.99	-6.00	9.00
-6.15	-6.16	7.36
-6.31	-6.32	10.87
-6.47	-6.48	11.82
-6.63	-6.64	13.47
-6.79	-6.80	34.16
-6.95	-6.96	17.07
-7.03	-7.04	24.21
-7.11	-7.12	40.64
-7.27	-7.28	27.56
-7.43	-7.44	9.82
-7.59	-7.60	1.68
-7.75	-7.76	1.84
-7.91	-7.92	0.69
-8.07	-8.08	0.61
-8.23	-8.24	0.38
-8.39	-8.40	0.37
-8.55	-8.56	1.33
-8.71	-8.72	1.87

-8.87	-8.88	3.21
-9.03	-9.04	1.43

Table 10: Results of the borehole <QBH6> organic matter determinations, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)		Organic matter content %
From	To	
-0.20	-0.21	7.68
-0.36	-0.37	5.86
-0.52	-0.53	6.27
-0.68	-0.69	6.43
-0.84	-0.85	8.35
-1.00	-1.01	25.17
-1.16	-1.17	14.99
-1.24	-1.25	65.48
-1.32	-1.33	75.40
-1.40	-1.41	71.30
-1.48	-1.49	81.64
-1.56	-1.57	86.62
-1.64	-1.65	77.22
-1.72	-1.73	79.92
-1.80	-1.81	78.80
-1.88	-1.89	80.98
-1.96	-1.97	83.79
-2.04	-2.05	75.69
-2.12	-2.13	79.49
-2.20	-2.21	66.45
-2.28	-2.29	55.86
-2.36	-2.37	44.19
-2.52	-2.35	59.51
-2.68	-2.69	39.83
-2.84	-2.85	21.62
-3.00	-3.01	19.85
-3.16	-3.17	27.47
-3.32	-3.30	42.05
-3.48	-3.49	25.81
-3.64	-3.65	25.56
-3.80	-3.81	16.36
-3.96	-3.97	14.03
-4.12	-4.13	11.52
-4.28	-4.29	22.33
-4.44	-4.45	20.07
-4.52	-4.53	20.30
-4.68	-4.69	15.37
-4.84	-4.85	15.64
-4.92	-4.93	18.66
-5.08	-5.09	15.31
-5.24	-5.25	10.64
-5.40	-5.41	26.12
-5.56	-5.57	15.47
-5.72	-5.73	27.37
-5.88	-5.89	20.62

-5.96	-5.97	25.70
-6.04	-6.05	31.44
-6.12	-6.13	28.16
-6.28	-6.29	21.40
-6.36	-6.37	4.11
-6.44	-6.45	3.89
-6.60	-6.61	6.30
-6.76	-6.77	1.17
-6.92	-6.93	2.01
-7.08	-7.09	1.24

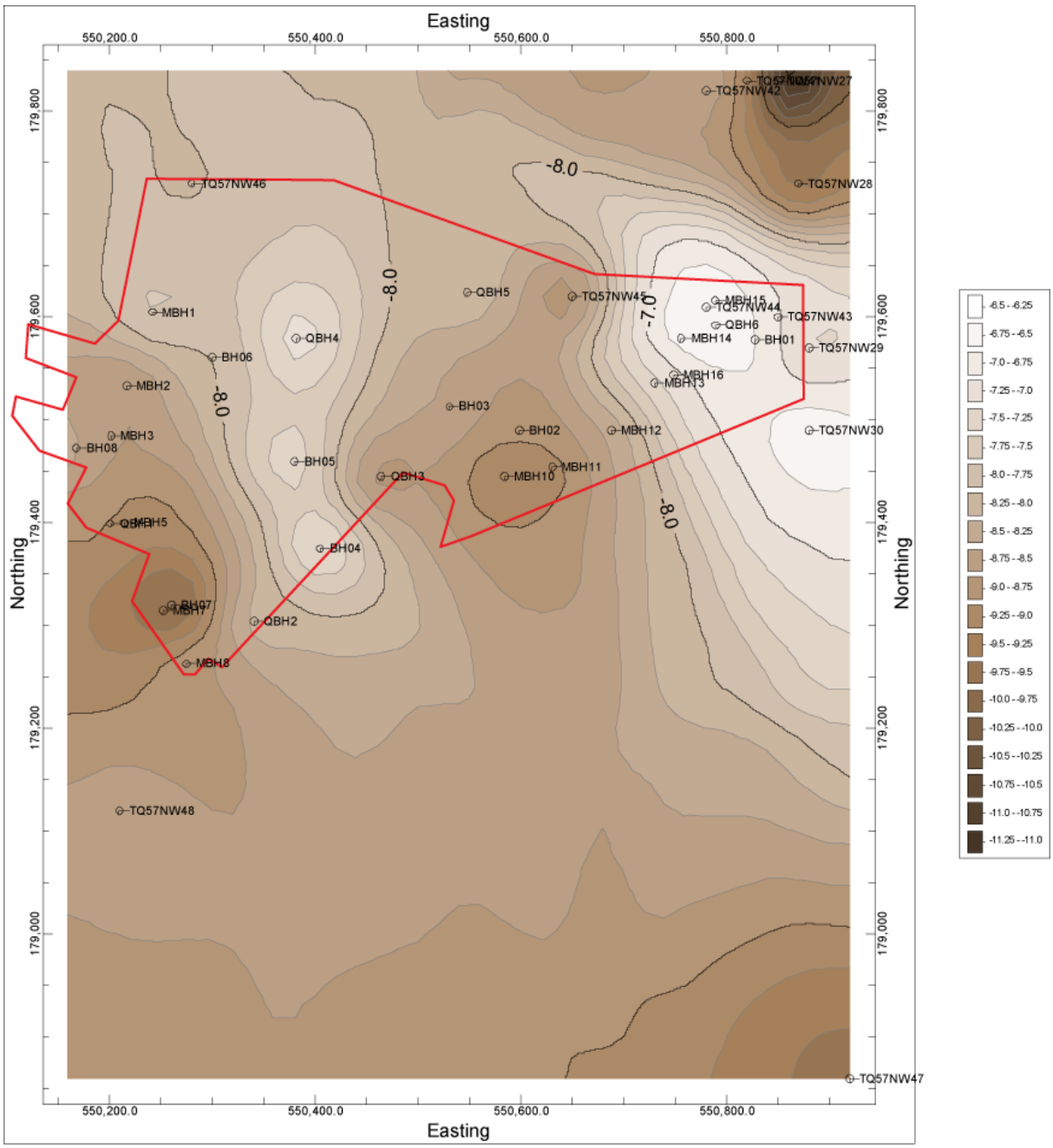

Figure 7: Top of the Shepperton Gravel (incorporating the Basal Sands) / Base of the Lower Alluvium (m OD), Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

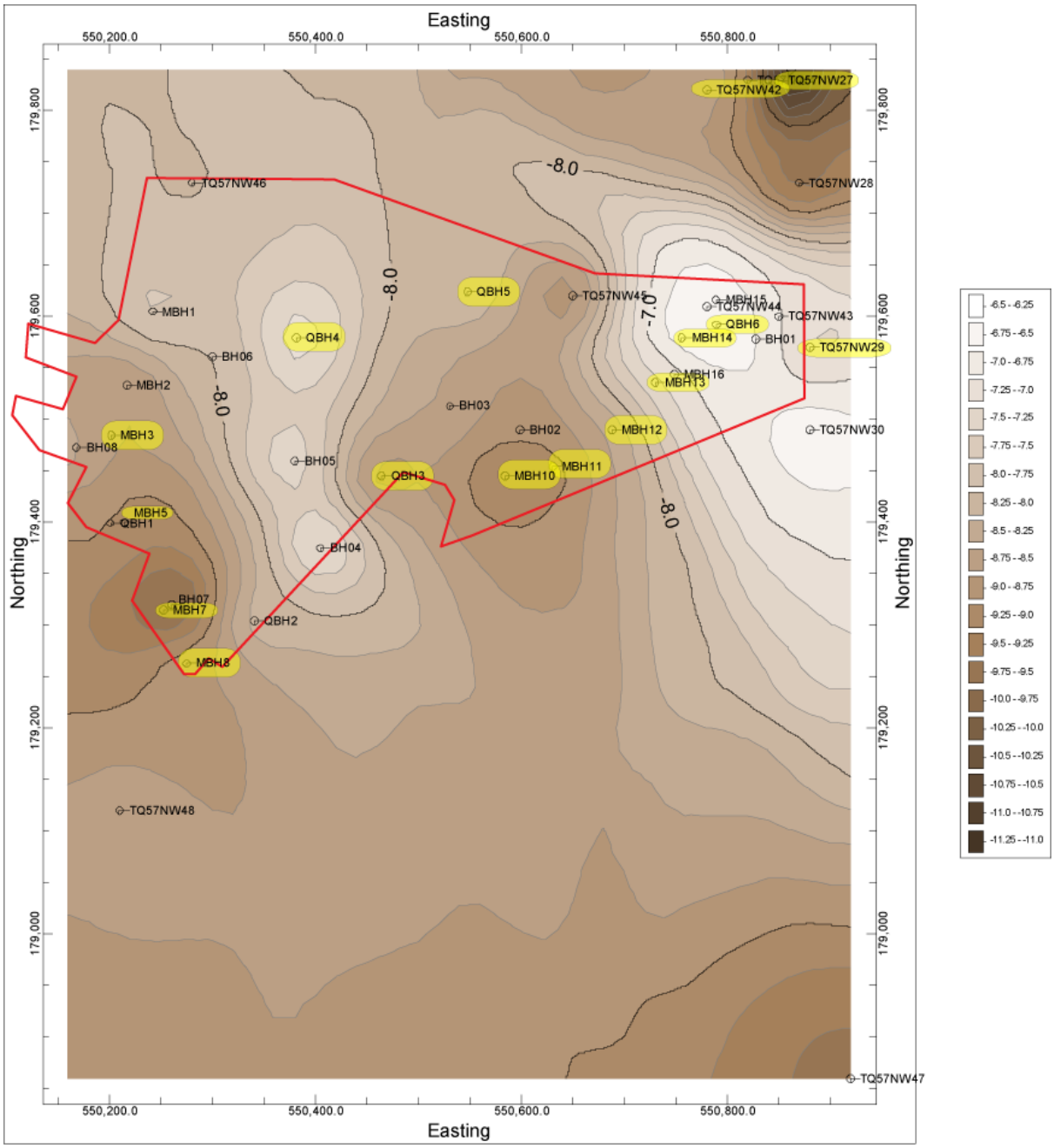

Figure 8: Top of the Shepperton Gravel (incorporating the Basal Sands) / Base of the Lower Alluvium (m OD), showing boreholes in which the Lower Organic Horizon is present (yellow). Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

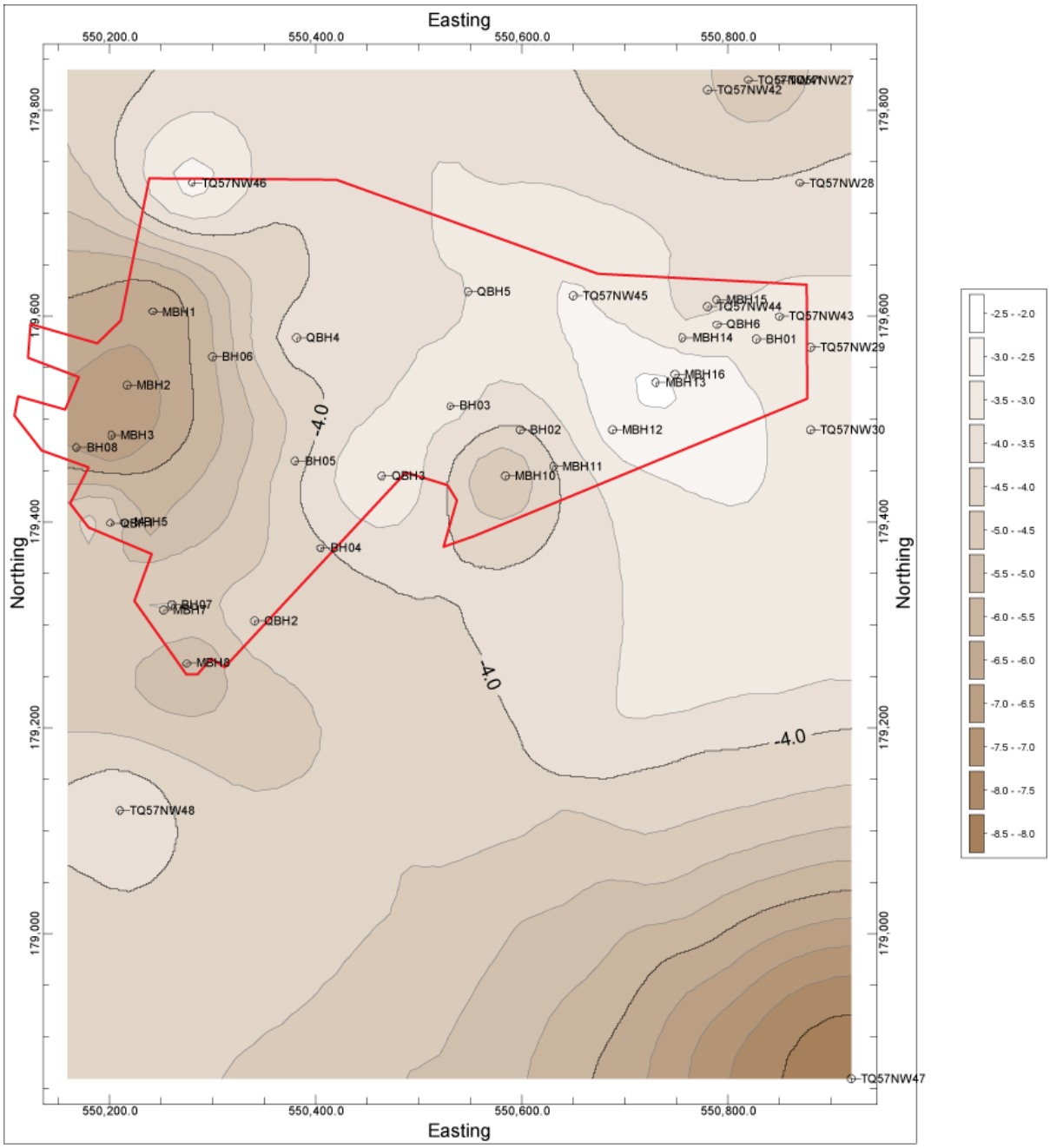

Figure 9: Top of Lower Alluvium / Base of the Peat (m OD), Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

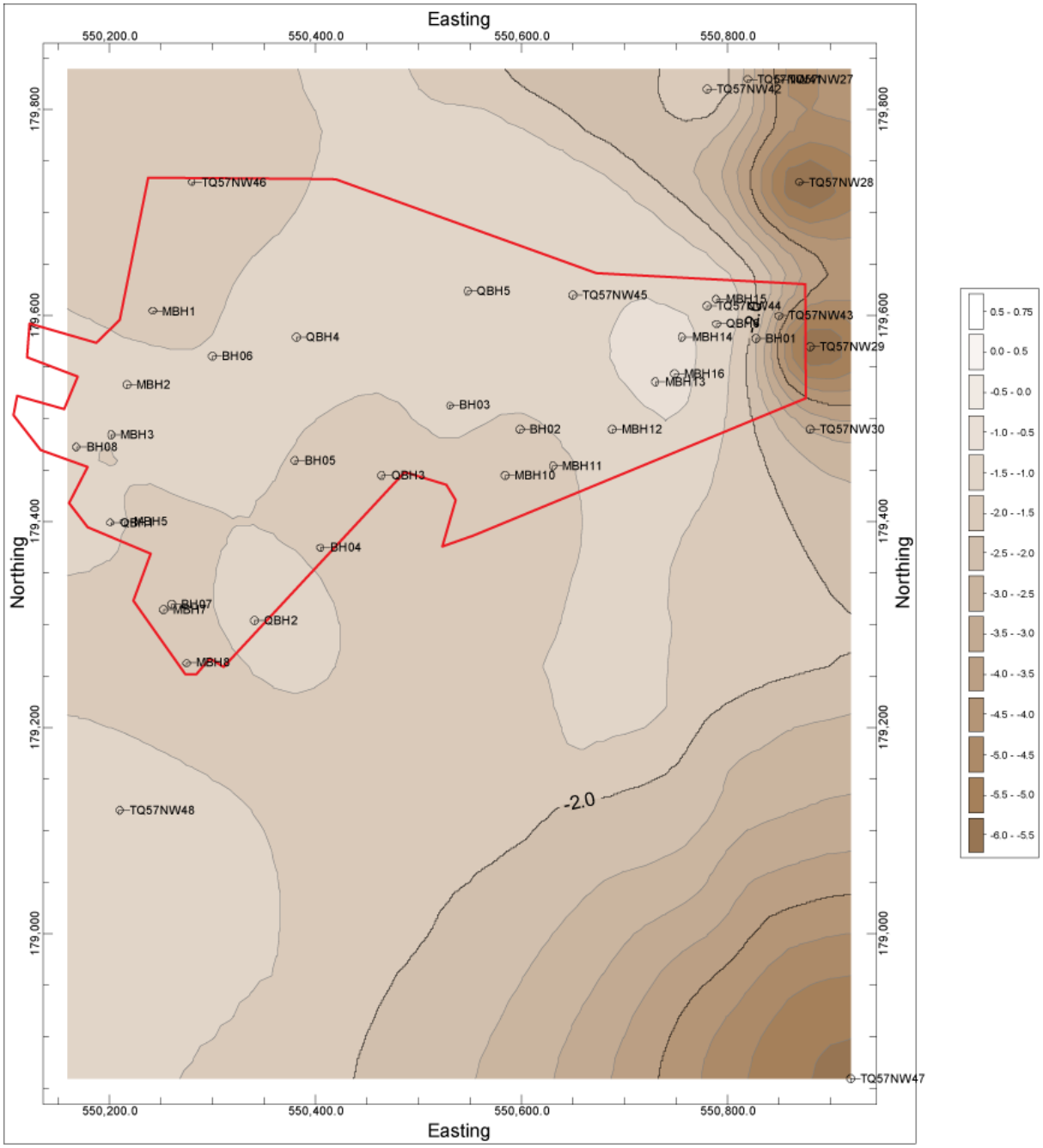

Figure 10: Top of Peat / Base of the Upper Alluvium (m OD), Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

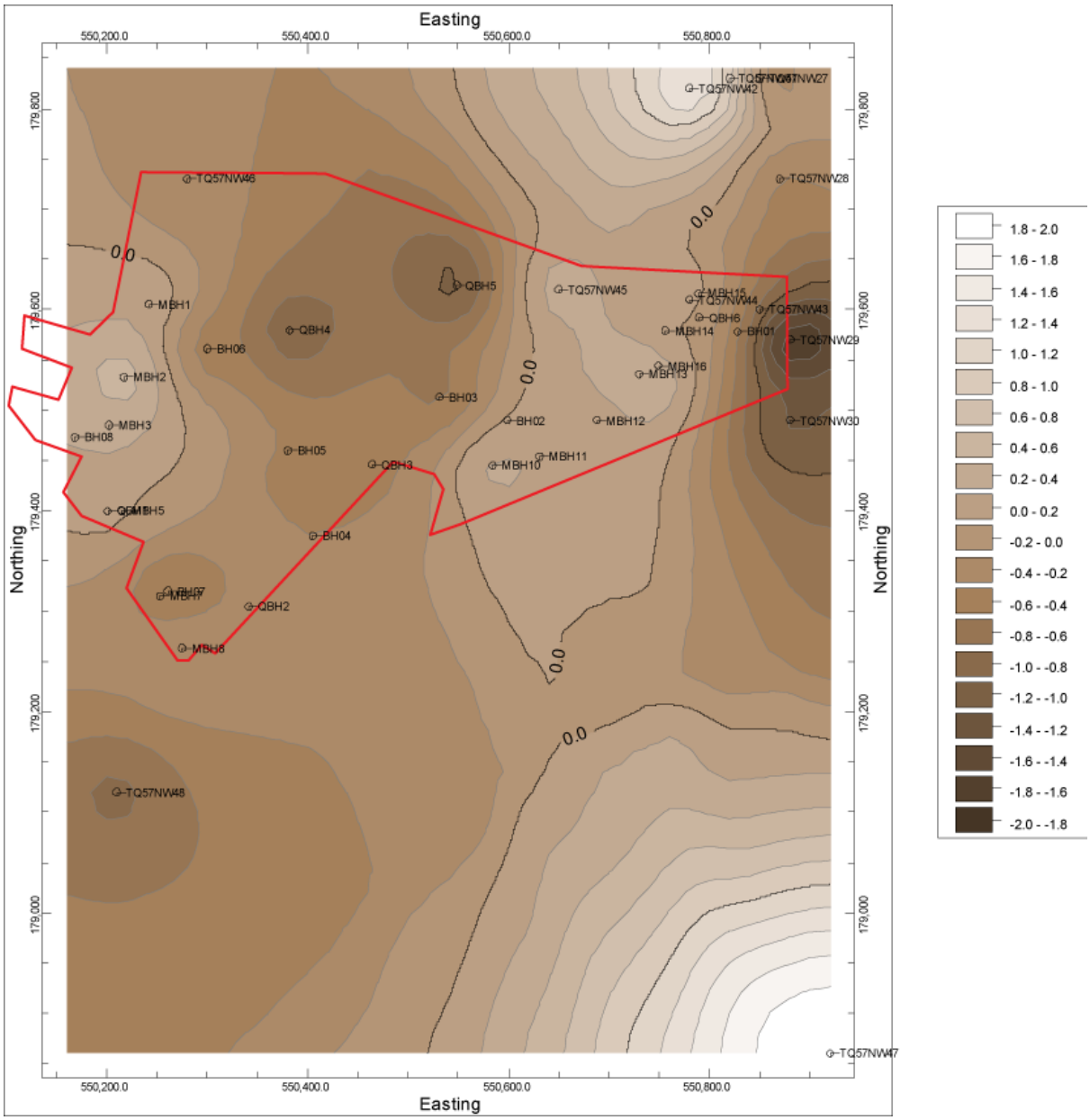

Figure 11: Top of Upper Alluvium / Base of Made Ground (m OD), Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

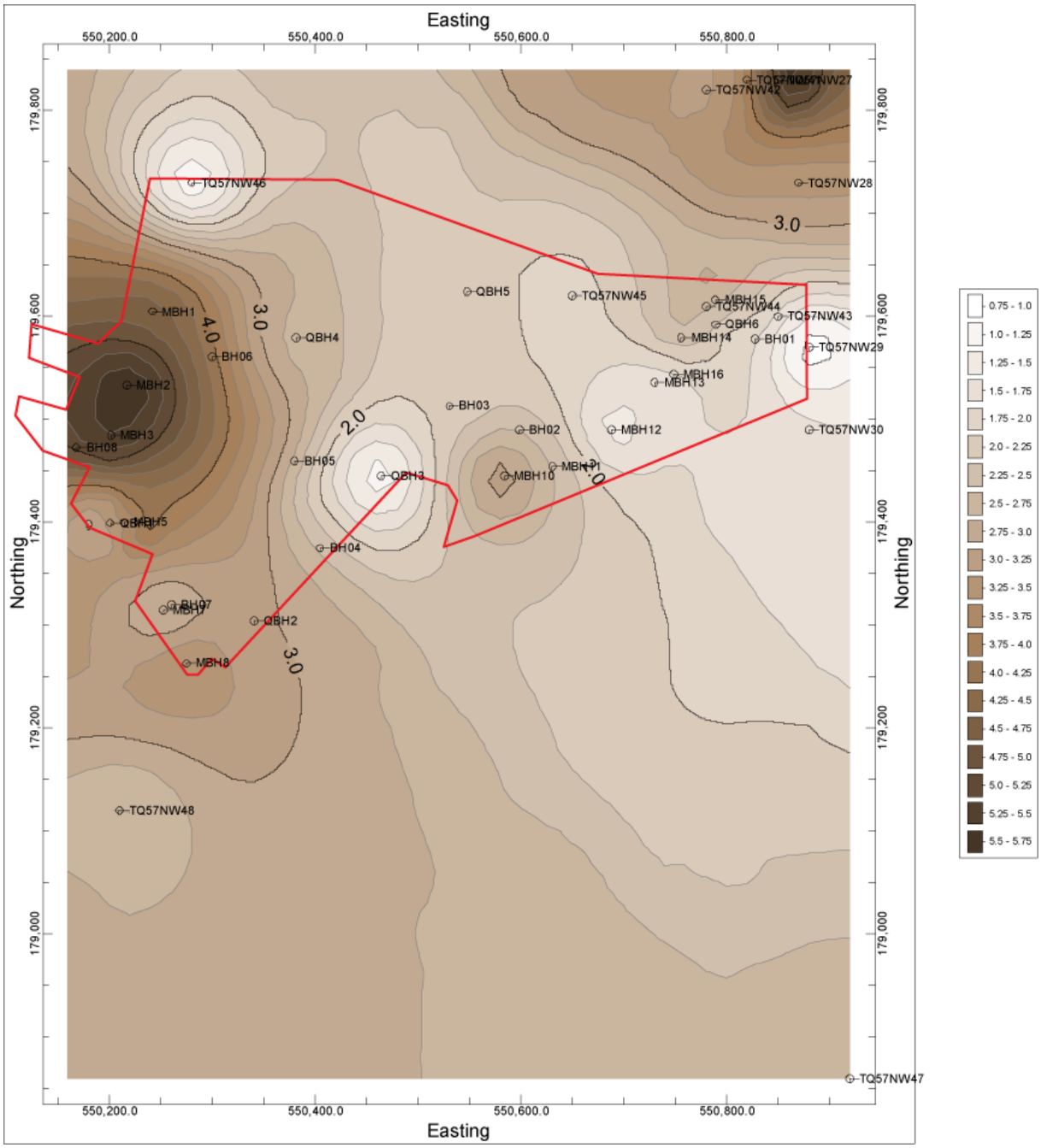

Figure 12: Thickness of the Peat (m), Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

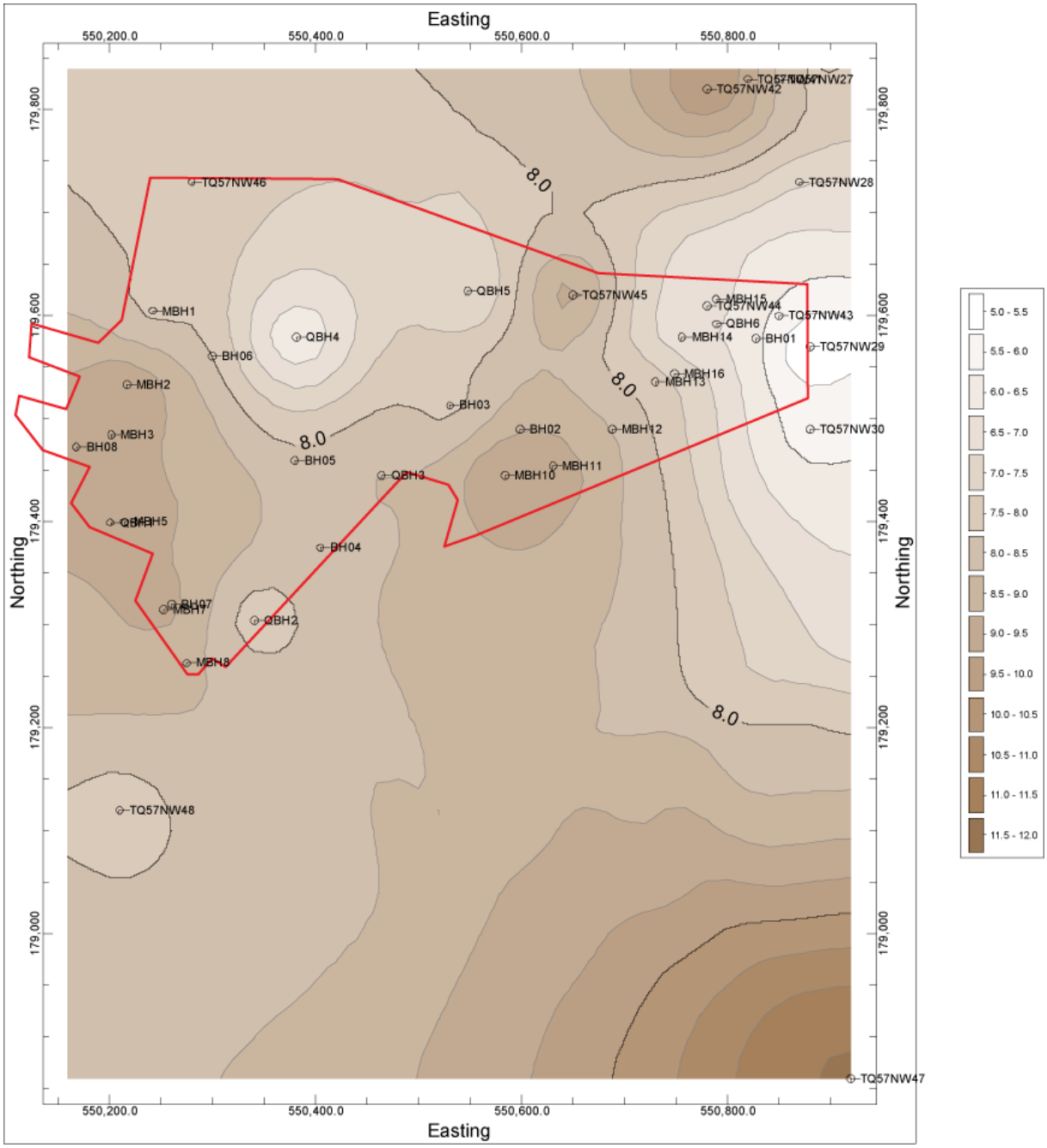

Figure 13: Thickness of Total Alluvium (m), Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

RESULTS AND INTERPRETATION OF THE RADIOCARBON DATING

Six sub-samples from boreholes <QBH1>, <QBH5> and <QBH6> were submitted for radiocarbon dating (Table 11). Indeterminate twig wood (*ca.* 2-3 years old) from the base of the peat in borehole <QBH1> (-3.02 to -3.06m OD) was radiocarbon dated to 6280 to 6030 cal BP (4330 to 4080 cal BC), and indeterminate twig wood (*ca.* 2-3 years old) from the top of the peat (-1.36 to -1.46m OD) in borehole <QBH1> was dated to 3210 to 2970 cal BP (1260 to 1020 cal BC). *Alnus glutinosa* catkins from the base of the lower organic horizon (-7.06 to -7.11m OD) in borehole <QBH5> were dated to 6930 to 6750 cal BP (4980 to 4800 cal BC), and indeterminate twig wood (*ca.* 2-3 years old) from the top of the main peat unit (-1.45 to -1.55m OD) in borehole <QBH5> was dated to 3560 to 3400 cal BP (1610 to 1450 cal BC). Indeterminate twig wood (*ca.* 2-3 years old) from the lower organic horizon (-6.06 to -6.16m OD) in borehole <QBH6> was dated to 7160 to 6950 cal BP (5210 to 5000 cal BC), and indeterminate twig wood (*ca.* 2-3 years old) from the top of the main peat unit (-1.18 to -1.20m OD) in borehole <QBH6> was dated to 1600 to 1430 cal BC (3550 to 3380 cal BP). The δ13C (‰) values are consistent with that expected for peat sediment, and there is no evidence for mineral or biogenic carbonate contamination.

The results of the radiocarbon dating therefore indicate that the accumulation of the lower organic horizon in boreholes <QBH5> and <QBH6> began at least during the late Mesolithic cultural period. The accumulation of the main Peat horizon began at least during the late Mesolithic/early Neolithic in borehole <QBH1>, and continued in all three boreholes until the Middle to Late Bronze Age.

Table 11: Results of the boreholes <QBH1>, <QBH5> and <QBH6> radiocarbon dating, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Laboratory code / Method	Borehole number	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-329217	<QBH1>	Indeterminate twig, *ca.* 2-3 years old; top of Peat	-1.36 to -1.46	2930 ± 30 BP	1260 to 1020 cal BC (3210 to 2970 cal BP)	-28.0
Beta-329218	<QBH1>	Indeterminate twig, *ca.* 2-3 years old; base of Peat	-3.02 to -3.06	5380 ± 30 BP	4330 to 4080 cal BC (6280 to 6030 cal BP)	-26.6
Beta-329219	<QBH5>	Indeterminate twig, *ca.* 2-3 years old; top of Peat	-1.45 to -1.55	3260 ± 30 BP	1610 to 1450 cal BC (3560 to 3400 cal BP)	-29.8
Beta-329220	<QBH5>	Alder catkins; lower organic horizon	-7.06 to -7.11	6000 ± 30 BP	4980 to 4800 cal BC (6930 to 6750 cal BP)	-27.2
Beta-329221	<QBH6>	Indeterminate twig, *ca.* 2-3 years old; top of Peat	-1.18 to -1.20	3230 ± 30 BP	1600 to 1430 cal BC (3550 to 3380 cal BP)	-25.9
Beta-329222	<QBH6>	Indeterminate twig, *ca.* 2-3 years old; lower organic horizon	-6.06 to -6.16	6160 ± 30 BP	5210 to 5000 cal BC (7160 to 6950 cal BP)	-28.3

RESULTS AND INTERPRETATION OF THE POLLEN ASSESSMENT

Eighteen sub-samples (six from each borehole) were extracted for an assessment of pollen content. The results are displayed in Tables 12 to 14.

Borehole <QBH1>

The results of the assessment indicate that the concentration and preservation of pollen is variable through the main peat horizon. In the samples assessed from the base of the peat at -2.94m and -2.62m OD, the concentration of pollen was very high and in an excellent state of preservation. Within these samples, *Alnus* (alder) dominated the assemblage with *Quercus* (oak), Cyperaceae (sedges) and *Dryopteris* type (buckler ferns). *Ulmus* (elm), *Tilia* (lime), *Corylus* type (e.g. hazel), Poaceae (grass family), *Typha latifolia* (bulrush) and *Polypodium vulgare* (polypody) were present in individual samples. This assemblage is indicative of wetland woodland dominated by alder with a ground flora of sedges, grasses, aquatics and ferns. Oak, hazel and elm may also formed part of this woodland, but were equally likely to have formed part of the dryland woodland with lime.

Between -2.30m and -1.34m OD, the concentration and preservation of pollen was poor to moderate. The presence of *Alnus*, *Quercus*, *Salix* (willow), *Corylus* type, Poaceae and Cyperaceae suggests a continuation of woodland growth on both the wetland and dryland, although the lower concentration and preservation of remains limits any further interpretation.

No palynological indicators of human activity were recorded during the assessment. However, a moderate concentration of microscopic charred particles were recorded at -2.30m OD suggesting an episode of burning which might be of natural or anthropogenic origin. In addition, the date of peat initiation (6150-6030 cal BP) and cessation (3210-2970 cal BP) in combination with the presence of both elm and lime means that there is potential to record both a Neolithic elm decline and the decline of woodland during the Bronze Age. Both these events have associations with human interference with the natural environment.

Borehole <QBH5>

With the exception of two samples, the concentration of pollen was excellent in borehole <QBH5> and in a moderate state of preservation. The single sample assessed from the lower organic horizon was dominated by *Alnus* with *Quercus*, *Tilia*, *Ulmus* and *Fraxinus*. This assemblage is indicative of a wetland woodland dominated by alder carr. Oak, elm and ash may also have grown within this alder carr woodland, or on the dryland with lime.

The samples assessed from the peat were of similar composition to those recorded in <QBH1>, the exception being that within the uppermost sample, the ratio of Poaceae and Cyperaceae to tree and shrub taxa, suggests that woodland was declining on the wetland and probably dryland surfaces.

Direct palynological evidence for human activity was not recorded during the course of the assessment. However, similarly to borehole <QBH1>, due to the chronology of the sequence (this time from 6930-6750 to 3560-3400 cal BP) and presence of both *Ulmus* and *Tilia* pollen grains, there is the potential to record evidence of the Neolithic elm decline and Bronze Age woodland clearance. Indeed, the decline of arboreal pollen towards the sequence is most likely to be attributed to a combination of inundation of the wetland (consequent of an increase in relative sea level rise), and Bronze Age woodland clearance. Finally, microscopic charred particles were recorded towards the base of the main peat sequence suggesting an episode of burning which might be of natural or anthropogenic origin.

Borehole <QBH6>

With the exception of two samples, the concentration of pollen was very high and in a generally good state of preservation. Similarly to borehole <QBH5> the main taxa recorded in the lower organic horizon was dominated by tree and shrub taxa representative of wetland woodland dominated by alder, and dryland woodland including lime. Also of note was the presence of microscopic charred particles within this horizon, suggesting burning that may have been of natural or anthropogenic origin.

The pollen assemblage from the main peat horizon was very similar in composition to that of boreholes <QBH1> and <QBH5>, indicating a continuation of wetland and dryland woodland through much of the horizon, with an increase of grasses and sedges towards the top suggestive of more open environments.

No direct palynological evidence for human activity was recorded during the course of the assessment. However, similarly to borehole <QBH1> and <QBH6>, due to the chronology of the sequence (this time from 7160-6950 to 3550-3380 cal BP) and presence of both *Ulmus* and *Tilia* pollen grains, there is the potential to record evidence of the Neolithic elm decline and Bronze Age woodland clearance.

Table 12: Results of the pollen assessment of borehole <QBH1>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)		Main pollen taxa			Concentration 0-5	Concentration grains/cm^3	Preservation 0- 5	Microcharcoal 0 - 5
From	**To**	**Latin name**	**Common name**	**Number**				
-1.34	-1.35	*Alnus*	alder	4	2	9121	2-3	0
		Quercus	oak	1				
		Corylus type	e.g. hazel	1				
		Salix	willow	1				
		Poaceae	grass family	3				
		Lactuceae	dandelion family	1				
		Chenopodium type	e.g. fat hen	1				
		Dryopteris type	buckler fern	5				
-1.66	-1.67	*Alnus*	alder	3	1	291,872	2	0
		Quercus	oak	1				
		Fraxinus	ash	1				
		Poaceae	grass family	2				
		Dryopteris type	buckler fern	9				
-1.98	-1.99	*Alnus*	alder	2	3	44,149	3	0
		Quercus	oak	2				
		Corylus type	e.g. hazel	1				
		Salix	willow	12				
		Poaceae	grass family	1				
-2.30	-2.31	*Alnus*	alder	2	2	11,582	3	3
		Pinus	pine	1				
		Corylus type	e.g. hazel	3				
		Poaceae	grass family	3				
		Cyperaceae	sedge family	1				
		Dryopteris type	buckler fern	175				
		Polypodium type	polypody fern	1				
-2.62	-2.63	*Alnus*	alder	26	5	115,466	4-5	0
		Quercus	oak	4				
		Corylus type	e.g. hazel	1				
		Poaceae	grass family	1				
		Cyperaceae	sedge family	5				
		Typha latifolia	bulrush	1				
		Dryopteris type	buckler fern	24				
-2.94	-2.95	*Alnus*	alder	18	5	37,628	4-5	0
		Quercus	oak	6				

		Ulmus	elm	1				
		Tilia	lime	2				
		Cyperaceae	sedge family	10				
		Dryopteris type	buckler fern	4				
		Polypodium vulgare	polypody fern	2				

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 = none, 1 = very poor, 2 = poor, 3 = moderate, 4 = good, 5 = excellent
Charcoal: 0 = none, 1= negligible, 2 = occasional, 3 = moderate, 4 = frequent, 5 = abundant

Table 13: Results of the pollen assessment of borehole <QBH5>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)		**Main pollen taxa**			**Concentration 0-5**	**Concentration grains/cm^3**	**Preservation 0- 5**	**Microcharcoal 0 - 5**
From	**To**	**Latin name**	**Common name**	**Number**				
-1.43	-1.44	*Alnus*	alder	10	5	25,603	3-4	0
		Quercus	oak	4				
		Pinus	pine	1				
		Tilia	lime	1				
		Corylus type	e.g. hazel	4				
		Sambucas	elder	2				
		Poaceae	grass family	5				
		Cyperaceae	sedge family	6				
		Chenopodium type	e.g. fat hen	1				
		Asteraceae	daisy family	1				
		Dryopteris type	buckler fern	1				
-1.75	-1.76	*Alnus*	alder	4	2	6294	2-3	0
		Corylus type	e.g. hazel	1				
		Salix	willow	1				
		Cyperaceae	sedge family	1				
		Dryopteris type	buckler fern	1				
		Nuphar type	water-lily	13				
-2.39	-2.40	*Alnus*	alder	13	5	171,996	4-5	0
		Quercus	oak	7				
		Ulmus	elm	2				
		Fraxinus	ash	3				
		Corylus type	e.g. hazel	3				
		Poaceae	grass family	1				
		Cyperaceae	sedge family	4				

		Nuphar type	water-lily	1				
		Dryopteris type	buckler fern	8				
-3.11	-3.12	*Alnus*	alder	7	2	10,877	3	1-2
		Quercus	oak	1				
		Ulmus	elm	1				
		Tilia	lime	1				
		Cyperaceae	sedge family	1				
		Typha latifolia	bulrush	1				
		Dryopteris type	buckler fern	4				
		Polypodium vulgare	polypody fern	2				
-3.47	-3.48	*Alnus*	alder	32	5	136,460	3-4	0
		Quercus	oak	1				
		Fraxinus	ash	1				
		Cyperaceae	sedge family	2				
-7.03	-7.04	*Alnus*	alder	25	5	101,262	3-4	0
		Quercus	oak	5				
		Tilia	lime	2				
		Ulmus	elm	1				
		Fraxinus	ash	1				

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 = none, 1 = very poor, 2 = poor, 3 = moderate, 4 = good, 5 = excellent
Charcoal: 0 = none, 1= negligible, 2 = occasional, 3 = moderate, 4 = frequent, 5 = abundant

Table 14: Results of the pollen assessment of borehole <QBH6>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)		**Main pollen taxa**			**Concentration 0-5**	**Concentration grains/cm^3**	**Preservation 0- 5**	**Microcharcoal 0 - 5**
From	**To**	**Latin name**	**Common name**	**Number**				
-1.24	-1.25	*Alnus*	alder	8	4	28,529	3-4	0
		Quercus	oak	1				
		Tilia	lime	1				
		Corylus type	e.g. hazel	4				
		Poaceae	grass family	4				
		Cyperaceae	sedge family	6				
		Asteraceae	daisy family	1				
		Sinapis type	e.g. charlock	1				
		Dryopteris type	buckler fern	6				
		Sphagnum	peat moss	1				

-1.56	-1.57	-			0	0	-	0
-1.88	-1.89	*Alnus* *Quercus* *Betula*	alder oak birch	30 5 1	5	107,218	4	0
-2.20	-2.21	*Alnus* *Quercus* *Tilia* *Ulmus* *Corylus* type *Dryopteris* type	alder oak lime elm e.g. hazel buckler fern	30 2 2 1 1 1	5	93,816	3	0
-6.12	-6.13	*Alnus* *Quercus* *Pinus* *Corylus* type *Hedera* *Sambucas*	alder oak pine e.g. hazel ivy elder	28 4 2 5 1 1	5	528,149	3-4	2
-6.28	-6.29	*Alnus* *Tilia* *Ulmus*	alder lime elm	1 2 1	4	4508	2	0

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 = none, 1 = very poor, 2 = poor, 3 = moderate, 4 = good, 5 = excellent
Charcoal: 0 = none, 1= negligible, 2 = occasional, 3 = moderate, 4 = frequent, 5 = abundant

RESULTS AND INTERPRETATION OF THE DIATOM ASSESSMENT

Four sub-samples from each borehole were extracted for the assessment of diatoms. The results are displayed in Tables 15 to 17. The results of the diatom assessment indicate a very limited concentration or absence of diatoms in the majority of the samples from all three boreholes. A number of factors influence diatom preservation, and it is probable that in the sediments examined here diatom concentrations were always low and that post-depositional destruction of the frustules has occurred due to drying-out, abrasion and possibly unfavourable chemical conditions. Dissolution of the diatom silica, for example, can occur as a response to the ambient dissolved silica concentration, the pH in open water, and the interstitial water in sediments. Using both fossil and modern diatoms, these and other environmental factors have been shown to affect the quality of preservation of assemblages (Flower, 1993; Ryves *et al.*, 2001).

Table 15: Summary diatom assessment results of borehole <QBH1>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)		Diatom concentration	Quality of preservation	Diversity
From	To			
-1.18	-1.19	Moderate	Poor	Low
-1.26	-1.27	Very low	Poor	Very low
-3.02	-3.03	None	-	-
-3.10	-3.11	None	-	-

Table 16: Summary diatom assessment results of borehole <QBH5>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)		Diatom concentration	Quality of preservation	Diversity
From	To			
-1.35	-1.36	Very low	Poor	Very low
-2.55	-2.56	None	-	-
-3.47	-3.48	None	-	-
-7.03	-7.04	Moderate	Poor	Moderate

Table 17: Summary diatom assessment results of borehole <QBH6>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)		Diatom concentration	Quality of preservation	Diversity
From	To			
-2.28	-2.29	None	-	-
-2.36	-2.37	None	-	-
-6.36	-6.37	Low	Moderate	Low
-6.44	-6.45	Moderate	Moderate	Moderate

RESULTS AND INTERPRETATION OF THE MACROFOSSIL ASSESSMENT

A total of eighteen small bulk samples (seven from borehole <QBH1>, five from borehole <QBH5> and six from borehole <QBH6>) were extracted for the recovery of macrofossil remains including waterlogged plant macrofossils, waterlogged wood, insects and Mollusca (Tables 18 to 20). The samples were focussed on the organic-rich sections of each borehole only. The results of the macrofossil rapid assessment indicated that waterlogged seeds were present in low quantities in three samples from borehole <QBH1> (-1.75 to -1.85, -3.02 to -3.06 and -2.88 to -2.98m OD), two samples from <QBH5> (-1.45 to -1.55 and -7.06 to -7.11m OD) and three from <QBH6> (-1.18 to -1.20, -6.06 to -6.16 and -6.28 to -6.33m OD). Waterlogged wood was present in low quantities in the majority of samples from boreholes <QBH1> and <QBH5>, and in two of the six samples from borehole <QBH6> (-1.24 to -1.34 and -2.18 to -2.28m OD). No insects, Mollusca, charred seeds or fragments of charcoal were found during the assessment.

Table 18: Results of the macrofossil assessment of borehole <QBH1>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

				Charred					Waterlogged		Mollusca		Bone			
Depth (m OD)	Volume sampled (l)	Volume processed (l)	Fraction (e.g. flot, residue, >300µm)	Charcoal (>4mm)	Charcoal (2-4mm)	Charcoal (<2mm)	Seeds	Chaff	Wood	Seeds	Whole	Fragments	Large	Small	Fragments	Insects
-1.24 to -1.26	<0.1	<0.1	>1mm	-	-	-	-	-	-	-	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-1.26 to -1.36	0.1	0.1	>1mm	-	-	-	-	-	-	-	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-1.36 to -1.46	0.1	0.1	>1mm	-	-	-	-	-	2	-	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-1.75 to -1.85	0.1	0.1	>1mm	-	-	-	-	-	3	1	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-2.30 to -2.40	0.1	0.1	>1mm	-	-	-	-	-	1	-	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-2.88 to -2.98	<0.1	<0.1	>1mm	-	-	-	-	-	2	1	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-3.02 to -3.06	0.1	0.1	>1mm	-	-	-	-	-	1	2	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	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 19: Results of the macrofossil assessment of borehole <QBH5>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

				Charred					Waterlogged		Mollusca		Bone			
Depth (m OD)	**Volume sampled (l)**	**Volume processed (l)**	**Fraction (e.g. flot, residue, >300µm)**	**Charcoal (>4mm)**	**Charcoal (2-4mm)**	**Charcoal (<2mm)**	**Seeds**	**Chaff**	**Wood**	**Seeds**	**Whole**	**Fragments**	**Large**	**Small**	**Fragments**	**Insects**
-1.39 to -1.43	0.1	0.1	>1mm	-	-	-	-	-	-	-	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-1.45 to -1.55	<0.1	<0.1	>1mm	-	-	-	-	-	1	1	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-2.47 to -2.57	<0.1	<0.1	>1mm	-	-	-	-	-	3	-	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-3.13 to -3.23	0.1	0.1	>1mm	-	-	-	-	-	3	-	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-7.06 to -7.11	0.1	0.1	>1mm	-	-	-	-	-	2	1	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-

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 20: Results of the macrofossil assessment of borehole <QBH6>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

				Charred					Waterlogged		Mollusca		Bone			
Depth (m OD)	**Volume sampled (l)**	**Volume processed (l)**	**Fraction (e.g. flot, residue, >300µm)**	**Charcoal (>4mm)**	**Charcoal (2-4mm)**	**Charcoal (<2mm)**	**Seeds**	**Chaff**	**Wood**	**Seeds**	**Whole**	**Fragments**	**Large**	**Small**	**Fragments**	**Insects**
-1.18 to -1.20	<0.1	<0.1	>1mm	-	-	-	-	-	-	-	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	1	-	-	-	-	-	-
-1.24 to -1.34	<0.1	<0.1	>1mm	-	-	-	-	-	2	-	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-2.18 to -2.28	<0.1	<0.1	>1mm	-	-	-	-	-	2	-	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-6.06 to -6.16	<0.1	<0.1	>1mm	-	-	-	-	-	-	1	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-6.28 to -6.33	<0.1	<0.1	>1mm	-	-	-	-	-	-	1	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-6.33 to -6.38	<0.1	<0.1	>1mm	-	-	-	-	-	-	-	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-

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+

RESULTS OF THE WATERLOGGED PLANT MACROFOSSIL ASSESSMENT (SEEDS)

The results of the macrofossil rapid assessment indicated that waterlogged seeds were present in low quantities in three samples from borehole <QBH1> (-1.75 to -1.85, -2.88 to -2.98 and -3.02 to -3.06m OD), two samples from <QBH5> (-1.45 to -1.55 and -7.06 to -7.11m OD) and three from <QBH6> (-1.18 to -1.20, -6.06 to -6.16 and -6.28 to -6.33m OD); these samples thus underwent a more detailed assessment. The results of the borehole <QBH1>, <QBH5> and <QBH6> waterlogged plant macrofossil (seeds) assessments are displayed in Tables 21 to 23.

Results and interpretation of the waterlogged seed assessment

Borehole <QBH1>

Waterlogged seeds were preserved in low quantities in three samples from borehole <QBH1>. The assemblage in the lowest sample in the sequence (-3.02 to -3.06m OD) contained seeds of *Ranunculus* cf. *repens* (cf. creeping buttercup), cf. *Carex* sp. (sedge) and cf. *Carex rostrata* (bottle sedge). The sample from -2.88 to -2.98m OD contained seeds of *Rubus* sp. (e.g. bramble), and the sample from -1.75 to -1.85m OD contained *Alnus glutinosa* (alder) catkins. Although the assemblage in borehole <QBH1> is limited, it is consistent with wetland fen vegetation.

Borehole <QBH5>

The lower sample in borehole <QBH5> (-7.06 to -7.11m OD) contained fruits and catkins of *Alnus glutinosa* (alder). The upper sample (-1.45 to -1.55m OD) contained fruits of *Alnus glutinosa* and *Ranunculus* cf. *repens* (cf. creeping buttercup). Again, the assemblage in borehole <QBH5> is limited, but is consistent with wetland fen vegetation dominated by alder.

Borehole <QBH6>

Waterlogged seeds were preserved in low quantities in three samples from borehole <QBH6>. Of these, the assemblage in the lowest sample in the sequence (-6.28 to -6.33m OD) contained seeds of *Rumex*/*Polygonum* sp. (dock/sorrel/knotweed) and an *Alnus glutinosa* (alder) catkin. Above this, the sample from -6.06 to -6.16m OD contained fruits and catkins of *Alnus glutinosa* and seeds of *Ranunculus* cf. *repens* (cf. creeping buttercup). The assemblage in the highest sample in the sequence (-1.18 to -1.20m OD) was limited to *Lycopus europaeus* (gypsywort). The assemblage from borehole <QBH6> is again limited, but is consistent with wetland fen vegetation, and in the samples below -6.06m OD, with the growth of alder carr woodland.

Table 21: Results of the waterlogged plant macrofossil (seeds) assessment of borehole <QBH1>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)	Waterlogged seeds		
	Latin name	**Common name**	**Number**
-1.75 to -1.85	*Alnus glutinosa* catkin	alder	2
-2.88 to -2.98	*Rubus* sp.	e.g. bramble	3
-3.02 to -3.06	*Ranunculus* cf. *repens* cf. *Carex* sp. cf. *Carex rostrata*	cf. creeping buttercup sedge cf. bottle sedge	1 5 1

Table 22: Results of the waterlogged plant macrofossil (seeds) assessment of borehole <QBH5>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)	Waterlogged seeds		
	Latin name	**Common name**	**Number**
-1.45 to -1.55	*Alnus glutinosa* fruit *Ranunculus* cf. *repens*	alder cf. creeping buttercup	1 1
-7.06 to -7.11	*Alnus glutinosa* catkin *Alnus glutinosa* fruit	alder alder	4 4

Table 23: Results of the waterlogged plant macrofossil (seeds) assessment of borehole <QBH6>, Pirelli Works, Church Manorway, Erith (Site Code: PWR12)

Depth (m OD)	Waterlogged seeds		
	Latin name	**Common name**	**Number**
-1.18 to -1.20	*Lycopus europaeus*	gypsywort	1
-6.06 to -6.16	*Alnus glutinosa* catkin *Alnus glutinosa* fruit *Ranunculus* cf. *repens*	alder alder cf. creeping buttercup	1 6 3
-6.28 to -6.33	*Rumex*/*Polygonum* sp. *Alnus glutinosa* catkin	dock/sorrel/knotweed alder	1 1

DISCUSSION AND CONCLUSIONS

The aim of the environmental archaeological assessment was (1) to clarify the nature of the sub-surface stratigraphy at the site, (2) to evaluate the potential of the borehole sequences for reconstructing the past environmental conditions of the site and its environs, and (3) to elucidate the ages of the peat horizons across the site. An assessment of three sequences was carried out from boreholes <QBH1>, <QBH5> and <QBH6> as they contained significant alluvial and organic-rich horizons, and were distributed evenly across the site.

The results of the lithostratigraphic descriptions and deposit modelling indicate that the deposits recorded at the Pirelli Works site are analogous to those recorded across much of the Lower Thames Valley, with a sequence of Shepperton Gravel overlain by Holocene Alluvium (including Peat), capped by Made Ground. On the basis of the previous investigations at the site, Halsey (2007) suggested that two thick accumulations of Lower Alluvium overlying the Shepperton Gravel in the north-east and in the south of the site represent part of a continuous palaeochannel infill; however, as an alternative to the MoLAS west-south-west to east-north-east trending channel, it was proposed that the two thick Lower Alluvium sequences are quite separate and represent two distinct channels, both trending west-north-west to east-south-east with peat accumulating in the intervening areas, possibly contemporaneously. The results of the new geoarchaeological boreholes and deposit modelling indicate that as suggested, there are two separate channels, both of which trend roughly north-north-west to south-south-east, one to the far west and one traversing the centre of the site. Towards the base of these possible channels the gravel surface lies at maximum depths of -9.73m OD (western channel) and -9.65m OD (central channel); away from the channels, the gravel surface rises in the far eastern part of the site to -6.41m OD (borehole <QBH6>), and to -7.2m OD (BH05) towards the centre of the site, representing a relief amplitude of *ca.* 2-3.0m.

A lower organic horizon, identified in the previous investigations and overlying the Shepperton Gravel and Late Glacial/Early Holocene sands between *ca.* -6.1 to -9.0m OD, was suggested by MoLAS (Halsey, 2007) to have accumulated sometime during the middle to late Mesolithic, and to equate to Devoy's (1979) Tilbury II regression event. The results of the radiocarbon dating of this lower organic horizon are consistent with this hypothesis, indicating that accumulation began in boreholes <QBH5> (6930 to 6750 cal BP) and <QBH6> (7160 to 6950 cal BP) at the latest during the late Mesolithic cultural period. The radiocarbon dates for the lower organic horizon are consistent with that from the lower peat at Imperial Gateway (Batchelor *et al.*, 2008b), where peat accumulation begin in the

lowermost peat unit at 7160-6900 cal BP. A slightly earlier date was established for the 'lower peat' recorded at *ca.* -8.0m OD at Corinthian Quay (*ca.* 500m to the south-east; Corcoran & Lam, 2002), dated to 7425-7240 cal BP.

Halsey (2007) suggested that accumulation of the lower organic horizon did not occur on the areas of higher gravel surface since they were not prone to waterlogging. The absence of the lower organic horizon in boreholes MBH1 and MBH2 (within MoLAS's 'area B') is consistent with the absence of this horizon in borehole <QBH1>; however, a lower organic horizon was recorded in borehole <QBH6> (close to boreholes MBH15 and MBH16, within MoLAS's 'area A'), and as stated above was dated to the late Mesolithic cultural period. The slightly later date for this organic horizon compared to that in borehole <QBH5> indicates that this lower organic horizon may have migrated up-slope (in this area of higher gravel surface) as it accumulated.

The pollen and waterlogged seed assemblages from the lower organic horizon in boreholes <QBH5> and <QBH6> are indicative of a wetland woodland dominated by alder carr. Oak, elm and ash were present, either within this alder carr woodland, or on the dryland with lime. These warmth-loving trees, especially elm and lime, became established during a period of Early Holocene climate warming, forming a mixed deciduous forest ecosystem. This forest would have been present throughout the Lower Thames Valley, and provided suitable areas human occupation and exploitation during the Mesolithic cultural period (*ca.* 11,500-6700 cal yr BP), with rich plant and animal resources, including hazel nuts and acorns, and probably *Cervus elaphus* (red deer) and *Bos primigenius* (auroch) (see Thomas and Rackham, 1996; Sidell *et al.,* 2002). Indeed, it is of note that a large Mesolithic flint scatter and possible hearth were found at the nearby Bronze Age Way site (Sidell, 1996), demonstrating nearby activity at this time. At the Pirelli site, no definitive evidence of human activity was recorded, but the presence of microscopic charred particles in the pollen record from <QBH6> does indicate burning of natural or anthropogenic origin. Significantly, the lower organic Mesolithic horizon in this borehole is located over the high Shepperton Gravel / Basal Sand surface towards the east of the site (-6.41m OD; Figure 8): a location which would have been more favourable for human activity.

Overlying the Lower Alluvium in the majority of boreholes and present between *ca.* -1.0 and -4.0m OD was a generally well-humified, sometimes woody Peat (the 'main' Peat unit), indicative of a transition towards a semi-terrestrial environment supporting the growth of wetland woodland. The accumulation of the main Peat horizon began at least during the late

Mesolithic/early Neolithic in borehole <QBH1> (6280 to 6030 cal BP), and continued in all three boreholes until the Middle to Late Bronze Age. The radiocarbon dates for this Peat horizon are consistent with Devoy's (1979) Tilbury III regressive event, and with those from peat horizons from sites nearby. The date for the beginning of peat accumulation in borehole <QBH1> is similar to that recorded at Imperial Gateway for the base of the 'middle' peat (6290-6120 cal BP), and peat cessation took place at a similar time (at 3840-3640 cal BP, during the Early to Middle Bronze Age). At Corinthian Quay (Corcoran & Lam, 2002) the onset of accumulation of the peat horizon recorded at *ca.* -3.0 to -1.0m OD was dated to 6300-6000 cal BP; at Crossness Sewage Works (Batchelor *et al.*, 2007a) a slightly earlier date for peat initiation was returned, the base of the peat radiocarbon dated to 6010-5870 cal BP, and an Iron Age date was returned (2720-2350 cal BP) for peat cessation. At Norman Road (Batchelor *et al.*, 2008a), where the base of the peat was recorded at a higher elevation (-2.45m OD), the modelled date for peat initiation was later than those recorded at Pirelli Works and elsewhere, at *ca.* 5320-4860 cal BP.

The combined results of the archaeobotanical (pollen and waterlogged seeds) records from borehole <QBH1> indicate that during the accumulation of the peat in this borehole the wetland was dominated by alder with a ground flora of bramble, sedges, grasses, aquatic taxa and ferns, while the dryland was dominated by oak, hazel, lime and elm. In all boreholes, no definitive palynological evidence of human activity was recorded (e.g. cereal pollen), however, similarly to the lower organic horizon, both the wetland and dryland environments would have represented very attractive areas for occupation and exploitation. Indeed, Bronze Age trackway structures at Erith Spine Road / Bronze Age Way (Sidell *et al.*, 1996) and on the Erith foreshore (Sidell, pers. comm.) clearly demonstrate that human activity was taking place nearby, and whilst no definitive indicators were recorded at Pirelli Works, microscopic charred particles were present at certain horizons within the Peat indicating that some form of burning (either natural or anthropogenic) did take place. Furthermore, due to the chronology of the sequences and preservation of the pollen, the sequences have the potential to provide important information on the Neolithic elm decline and Bronze Age decline of woodland – both of which have been attributed to human activity. Evidence for the latter is recognised within the Peat sequences from <QBH5> and <QBH6>. In addition, due to their chronology, the sequences will aid in the continued mapping of: (1) Taxus (yew) woodland, which colonised and declined from the Lower Thames Valley Peat surface between *ca*. 5000 and 4000 cal BP – the decline may have been influenced by human activity (Batchelor, 2009), and (2) the Bronze Age expansion of elm on the Peat surface after its Neolithic decline – an occurrence noted at Norman Road (Batchelor et al.,

2008a) and at Erith Forest (Seel, 2001).

RECOMMENDATIONS

The results of the environmental archaeological assessment have revealed that the archaeobotanical remains are sufficiently well preserved in the sedimentary sequences of boreholes <QBH5> and <QBH6> to reconstruct the environmental history of the site and its environs. In addition, whilst no definitive evidence of human activity at Pirelli Works was recorded during the assessment, the presence of significant archaeological remains nearby, a combination of: (1) the relief the Shepperton Gravel / Basal Sands, including channels and topographic high-points, (2) the chronology of the sequences, including the presence of Mesolithic and later Neolithic to Bronze Age semi-terrestrial land surfaces; (3) the recognition of microscopic charred particles, and (4) the unequivocal occupation of the nearby area during at least the Mesolithic Bronze Age periods, the new sequences clearly have the potential for recording evidence of human activity.

It is therefore recommended that further work is carried out on the <QBH5> and <QBH6> sequences. These sequences are recommended as they represent boreholes from different topographical settings on the site. Borehole <QBH5> is located over a depression (or possible palaeochannel) in the Shepperton Gravel surface, whilst <QBH6> is located over a topographic high point. Since prehistoric people are more likely to have made use of higher drier surfaces on the floodplain, we believe there is a greater potential for evidence of anthropogenic activity to be recorded in borehole <QBH6>.

It is therefore recommended that this environmental archaeological analysis should consist of:

(1) Pollen analysis on the <QBH5> and <QBH6> sequences to enhance our understanding of the environmental changes and elucidate evidence for human activity through the lower organic horizon and upper peat horizon;
(2) A maximum of six additional radiocarbon dates from boreholes <QBH5> and <QBH6> to provide a chronological framework for the palaeoenvironmental analysis;
(3) Identification of the waterlogged wood (where sufficient preservation was identified during the assessment) from boreholes <QBH5> and <QBH6>.

REFERENCES

Askew, P. & Spurr, G. (2006) *Crabtree Manorway South, Belvedere: an archaeological evaluation and geoarchaeological investigation report*. MoLAS Unpublished Report.

Batchelor, C.R. (2009) *Middle Holocene Environmental Changes and the History of Yew (Taxus baccata L.) Woodland in the Lower Thames Valley*. Department of Geography, Royal Holloway, University of London, Unpublished PhD thesis.

Batchelor, C.R., Branch, N.P., Elias, S., Green, C.P., Swindle, G.E., & Wilkinson, K.N. (2007a) *Thames Water Utilities LTD, tidal Thames quality improvements, Crossness, London Borough of Bexley: environmental archaeological analysis (site code EAW06)*. *ArchaeoScape* Unpublished Report.

Batchelor, C.R., Branch, N.P., Austin, P. (2007b) *Crossness Sewage Works, Crossness, London Borough of Bexley: Environmental archaeological analysis of waterlogged wood remains (site code: CXS07). ArchaeoScape* Unpublished Report.

Batchelor, C.R., Branch, N.P., Elias, S., Young, D., Austin, P., Green, C.P., Morgan, P. & K, Williams. (2008a). *Former Borax works, Norman Road, Belvedere, London Borough of Bexley: rapid environmental archaeological assessment (site code: NNB07).* ArchaeoScape Unpublished Report.

Batchelor, C.R., Branch, N.P., Christie, R., Elias, S. Young, D.S., Austin, P., Williams, K., & Wilkinson, K. (2008b) *Imperial Gateway, Belvedere: environmental archaeological assessment report.* Quaternary Scientific (QUEST) Unpublished Report December 2008; Project Number 056/08.

Batchelor, C.R., Green, C.P., Young, D.S., Brown, A., Austin, P., Cameron, N., & Elias, S. (2011) *A report on the geoarchaeological borehole investigations and deposit modelling on land at Barking Riverside (site code: RWC10).* Quaternary Scientific (QUEST) Unpublished Report December 2010; Project Number 002/10

Batchelor, C.R. and Green, C.P. (2012) *Written scheme of investigation for the geoarchaeological investigation of land at Pirrelli Works, Church Manorway, Erith, DA8 1HS*. Quaternary Scientific Written Scheme of Investigation.

Battarbee, R.W., Jones, V.J., Flower, R.J., Cameron, N.G., Bennion, H.B., Carvalho, L. & Juggins, S. (2001) *Diatoms.* In (J.P. Smol and H.J.B. Birks eds.), *Tracking Environmental Change Using Lake Sediments Volume 3: Terrestrial, Algal, and Siliceous Indicators*, 155-202. Dordrecht: Kluwer Academic Publishers.

Bengtsson, L. & Enell, M. (1986) Chemical Analysis. In (Berglund, B.E. ed.) *Handbook of Holocene palaeoecology and palaeohydrology,* 423-451. Chichester: John Wiley and Sons.

Branch, N.P., Silva, B. & Swindle, G.E. (2004) *An Environmental Archaeological Assessment: North Bexley Drainage Improvements, Belvedere, Kent (EWY01). ArchaeoScape* Unpublished Report, 2004.

Bronk Ramsey C. (1995) Radiocarbon Calibration and Analysis of Stratigraphy: The OxCal Program, *Radiocarbon* **37 (2)**, 425-430.

Bronk Ramsey C. (2001) Development of the Radiocarbon Program OxCal, *Radiocarbon* **43 (2a)**, 355-363.

Bronk Ramsey, C. (2007) Deposition models for chronological records. *Quaternary Science Reviews* (INTIMATE special issue; 27(1-2), 42-60.

Cappers, R.T.J., Bekker R.M. & Jans J.E.A. (2006) Digital Seed Atlas of the Netherlands. Groningen Archaeological Series 4. Barkhuis, Netherlands

Corcoran, J. & Lam, J. (2002) *Land at Project Alice, the former British Gypsum Site, Corinthian Quay, Church Manor Way, Erith: a report on the geoarchaeological evaluation*. MoLAS Unpublished Report.

Devoy, R.J.N. (1979) Flandrian sea-level changes and vegetational history of the lower Thames estuary. *Philosophical Transactions of the Royal Society of London,* **B285**, 355-410.

Flower, R.J. (1993) Diatom preservation: experiments and observations on dissolution and breakage in modern and fossil material, *Hydrobiologia* **269/270**, 473-484.

Halsey, C. (2007) *Pirelli Works, Church Manorway, Erith, DA8 7HS: Geoarchaeological Evaluation Report*. MoLAS unpublished report

Moore, P.D., Webb, J.A. and Collinson, M.E. (1991) *Pollen Analysis* (2nd Ed.). Oxford: Blackwell.

Reille, M. (1992) *Pollen et Spores d'Europe et d'Afrique du Nord*. Marseille : Laboratoire de Botanique Historique et Palynologie.

Reimer, P.J., Baille, M.G.L., Bard, E., Bayliss, A., Beck, J.W., Bertrand, Blackwell, P.G., Buck, C.E., Burr, G.S., Cutler, K.B., Damon, P.E., Edwards, R.L., Fairbanks, R.G., Friedrich, M., Guilderson, T.P., Hogg, A.G., Hughen, K.A., Kromer, B., McCormac, G., Manning, S., Bronk Ramsey, C., Reimer, R.W., Remmele, S., Southon, J.R., Stuiver, M., Talamo, S., Taylor, F.W., van der Plicht, J. and Weyhenmeyer, C.E. (2004) IntCal04 terrestrial radiocarbon age calibration, 0-26 cal kyr BP, *Radiocarbon* **46 (3),** 1029-1058.

Ryves, D.B., Juggins, S., Fritz, S.C. and Battarbee, R.W. (2001) Experimental diatom dissolution and the quantification of microfossil preservation in sediments, *Palaeogeography, Palaeoclimatology, Palaeoecology* **172**, 99-113.

Seel, S.P.S. (2001) *Late Prehistoric woodlands and wood use on the Lower Thames floodplain.* University College, London: Unpublished PhD thesis.

Sidell, E.J., Scaife, R., Wilkinson, K., Giorgi, J., Goodburn, D. & Gray-Rees, L. (1996) *Spine Road Development, Erith, Bexley (site 2649): a palaeoenvironmental assessment*: MoLAS Unpublished Report.

Sidell, J., Cotton, J., Rayner, L. and Wheeler, L. (2002) *The Prehistory and Topography of Southwark and Lambeth*. Museum of London Monograph 14. London, Museum of London.

Stace, C. (2005) *New Flora of the British Isles*. Cambridge: Cambridge University Press.

Thomas, C. and Rackham, J. (1996) Bramcote Green, Bermondsey: a Bronze Age trackway and palaeoenvironmental sequence. *Proceedings of the Prehistoric Society* **61**, 221-253.

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

Young, D.S., Batchelor, C.R., Green, C.P and Braithwaite, R.A. (in prep.) *The Former NuFarm Site, Church Manorway North, Belvedere: environmental archaeological assessment report.* Quaternary Scientific (QUEST) Unpublished Report, in prep.