

## **50 LOMBARD WALL, CHARLTON, LONDON BOROUGH OF GREENWICH SE7 7SQ (SITE CODE: LBW11): ENVIRONMENTAL ARCHAEOLOGICAL ASSESSMENT REPORT**

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### **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 50 Lombard Wall, Charlton, London Borough of Greenwich SE7 7SQ (National Grid Reference: centred on TQ 4082 7900; site code: LBW11; Figure 1). The site is located on the floodplain of the Estuarine Thames adjacent to the modern waterfront, and less than 1km north of the floodplain edge. A geoarchaeological borehole investigation was recently carried out at the site, and the resultant sedimentary logs were integrated with previous geotechnical investigations carried out by RPS Health, Safety and Environment (Table 1 and Figure 2; Hawkins, 2011). The major stratigraphic units recorded within the new geoarchaeological boreholes (<QBH1> to <QBH4>; Tables 2 to 5) were broadly similar to those recorded during the previous geotechnical investigations. However, the depths at which each of these units were recorded varied considerably; both across the site in general, and between geoarchaeological and geotechnical boreholes put down in the same locations (Figures 3 to 5). The combined results suggest a highly variable sand and gravel topography across the site, with a west-east aligned gravel island towards its centre. Such islands may have been a foci for prehistoric activity (e.g. the Horsleydown and Bermondsey eyots in central London), and thus study of the environmental archaeological remains within these borehole sequences could provide important evidence of human activity in this area of the Lower Thames Valley.

The combined investigations (Figures 3 to 5) suggest that the surface of the sand and gravel is recorded around or below -2.00m OD in the northern area of the site (<QBH3>, BH1 & BH4). Further to the north and east of the site, this surface decreases further in height to between -3.94m and -6.28m OD (TQ47NW1629 to 31, TQ47NW74 & TQ47NW303). Immediately to the south of <QBH1>/BH3, the gravel surface rises steeply to -0.30m OD in BH2, and 0.15/-0.68m OD in BH3/<QBH4>; the surface may have been higher still in intervening <QBH2>, but the borehole was abandoned whilst in the overlying sands due to strong odours emitting from the borehole. In the southern area of the site, new borehole <QBH1> put down adjacent to WS6, suggests that the gravel surface dips to below -1.00m

OD. The arrangement of the topography appears to suggest a topographic high point (gravel eyot) centred on Lombard Wall on an east-west alignment between at least boreholes BH2 and <QBH4>. This interpretation is enhanced by a low gravel surface recorded to the south-west at Greenwich Industrial Estate (-4.00 to -7.50m OD; Morley, 2003; Figure 1). Similar gravel high points (of ca. -1.00 to -2.00m OD) are recorded on the opposite bank of the River Thames, centred on Royal Albert Dock/Royal Docks Community School (Batchelor, 2009/Holder, 1995) and Barking Riverside (Batchelor *et al.*, 2011b), both of which are surrounded by areas with a gravel surface ranging between -3.5m and >-5m OD.

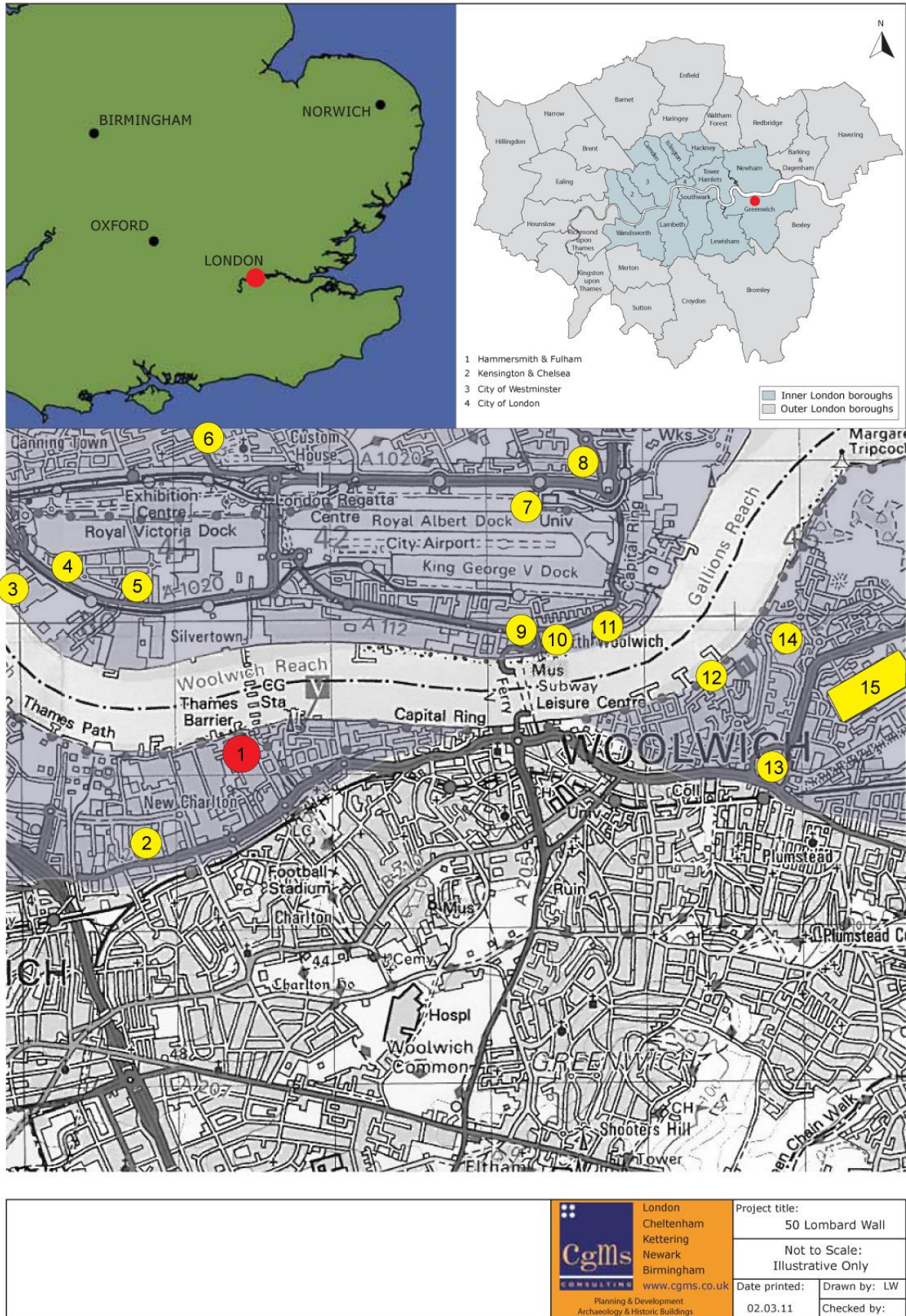
Alluvium and peat was recorded in all the new boreholes. In <QBH1> and <QBH2> the peat horizon was very thin (<10cm), prior to a transition to fine-grained organic-rich alluvium, and inorganic alluvium. In <QBH3> and <QBH4>, the sequence is similar, although the thicker and deeper peat is preceded by a thin horizon of organic-rich alluvium. The thickness of the peat appears proportional to the height of the underlying gravel surface as would be expected; i.e. thinner horizons of peat over areas with an elevated gravel surface and vice versa. The general sequence of organic-rich sands through peat formation, organic-rich alluvium and finally inorganic alluvium, is interpreted as representing a general transition from terrestrial and semi-terrestrial environments supporting woodland, to eventual inundation; a process of environmental changes possibly caused by rising relative sea level.

An environmental archaeological assessment of three boreholes was therefore recommended to elucidate the ages of the peat, and to evaluate the potential for reconstructing the past environmental conditions of the site and its environs. Environmental archaeological assessment was recommended on three boreholes: <QBH1>, <QBH2> and <QBH3> representing a north-south transect across the site, with the following objectives:

1. To carry out organic matter content determinations to enhance the results of the sedimentary descriptions
2. Rangefinder radiocarbon dating of identified plant macrofossils to provide an age for the peat in <QBH1> and <QBH2> (one date from each), and the onset and cessation of peat formation in <QBH3>;
3. To assess the preservation and concentration of pollen grains and spores to provide a preliminary reconstruction of the vegetation history, and to detect evidence for human activities e.g. woodland clearance and cultivation
4. To assess the preservation and concentration of diatom frustules to provide a preliminary reconstruction of the hydrological history e.g. water quality and depth

5. To assess the preservation and concentration of macroscopic plant, insect and Mollusca remains from small bulk samples to provide a preliminary reconstruction of the vegetation history and general environmental context of the site.

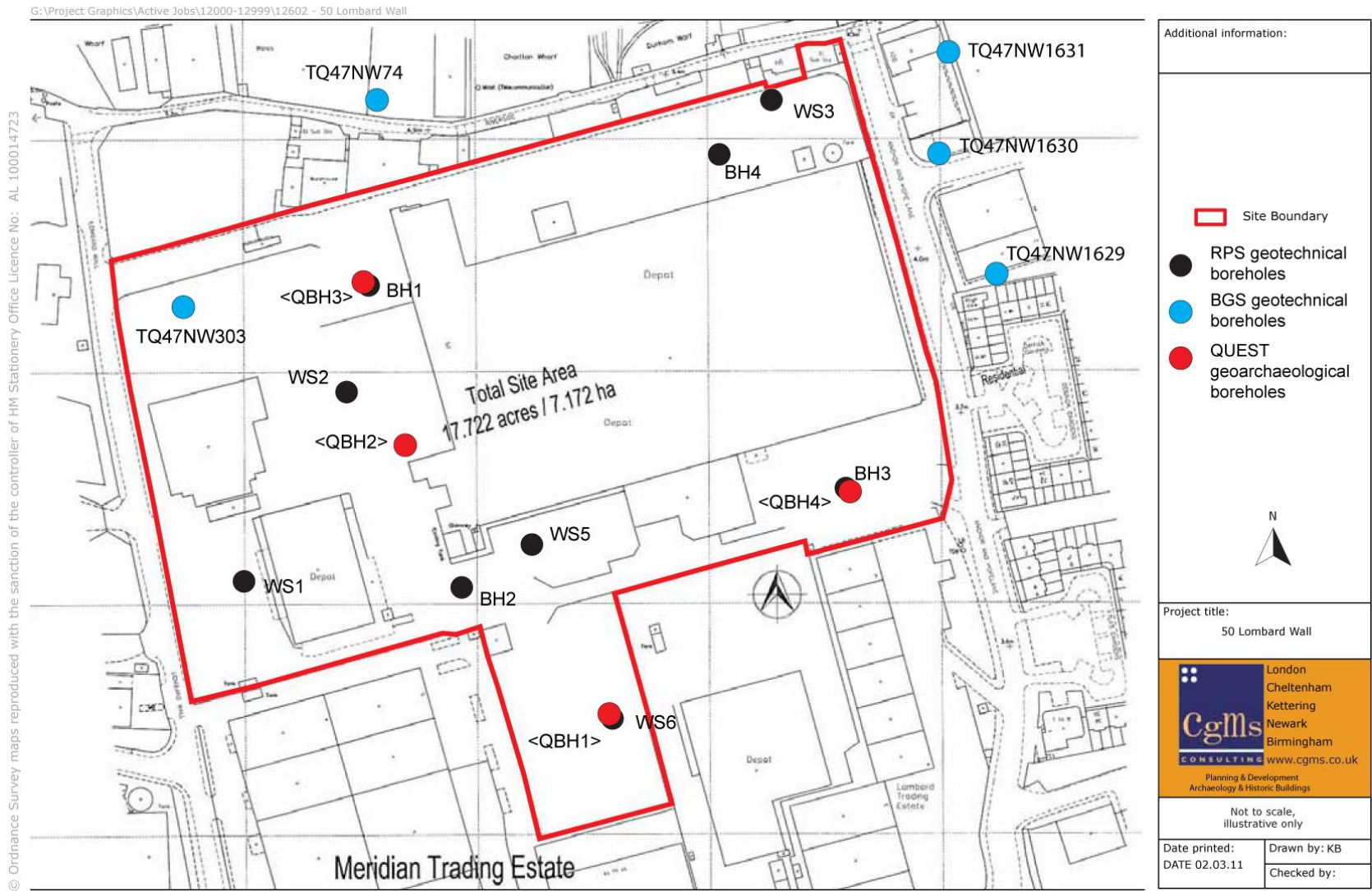
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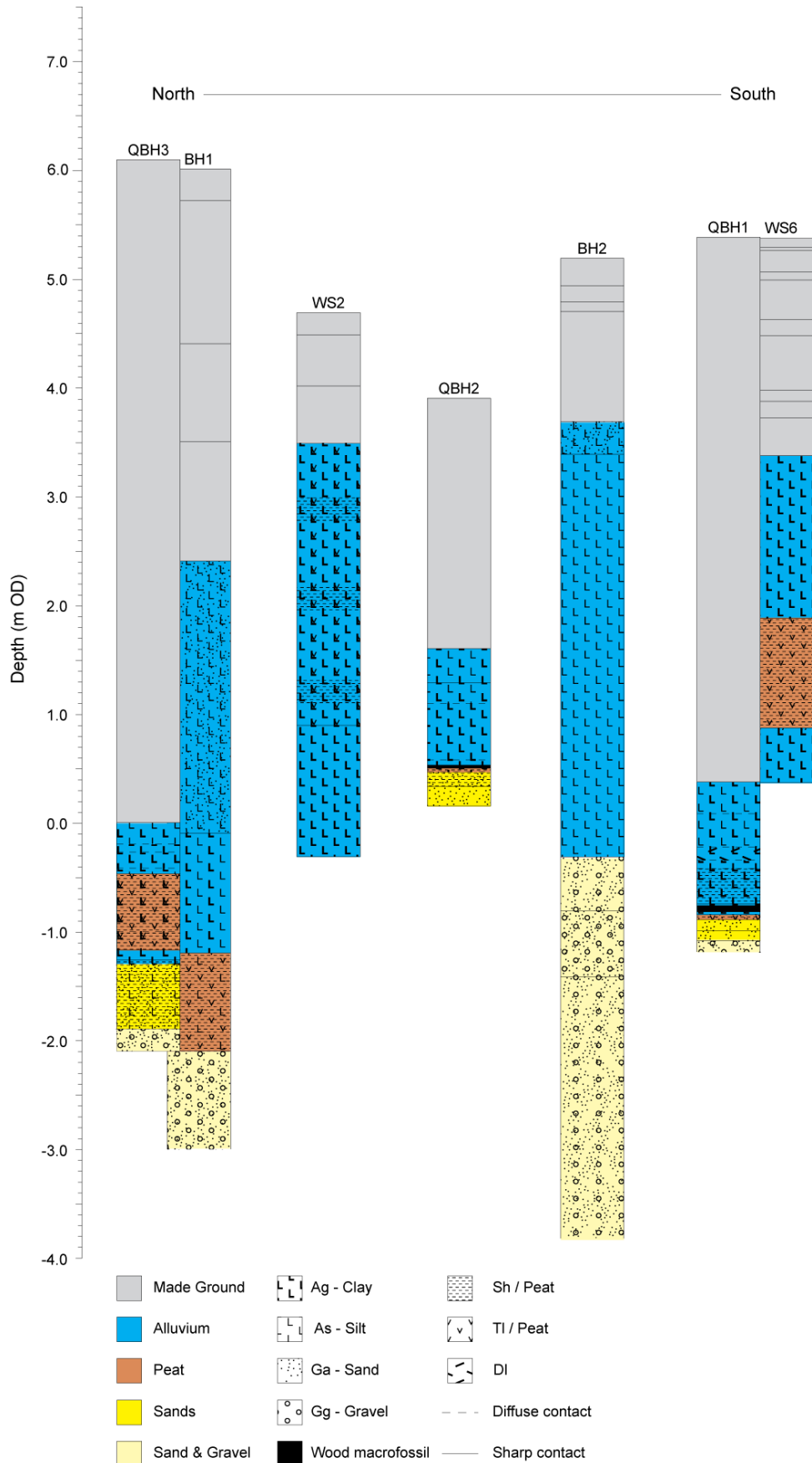
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**Figure 1: Location of 50 Lombard Wall, Charlton, London Borough of Greenwich (LBW11) (1) and other nearby sites: (2) Greenwich Industrial Estate (GIE02; Morley, 2003); (3) London Cable Car (CAB11; Batchelor *et al.*, 2011; in prep); (4) Silvertown (BWC96; Wilkinson *et al.*, 2000); (5) Fort Street (HW-FO94; Wessex Archaeology, 2000); (6) Royal Docks Community School (PRG97; Holder, 1995); (7) Royal Albert Docks (Batchelor, 2009); (8) Ferndale Street (HE-FE95; Divers, 1995); (9) Albert Road (AET01; Spurr *et al.*, 2001); (10) North Woolwich Pumping Station (WW-PS93; Sidell, 2003); (11) Barge House Road (BAJ00; Corcoran *et al.*, 2001); (12) Woolwich Arsenal DLR Extension (WWA02; Corcoran, 2003); (13) Woolwich Trade Park/Pettman Crescent (WTP03/PWO08; Batchelor, 2009; Batchelor and Young, 2009); (14) Gallions Reach (Sidell, 2003); (15) Belmarsh Prison (BLJ08 & BWQ08; Hart, 2009). Figure modified from Hawkins, 2011.**

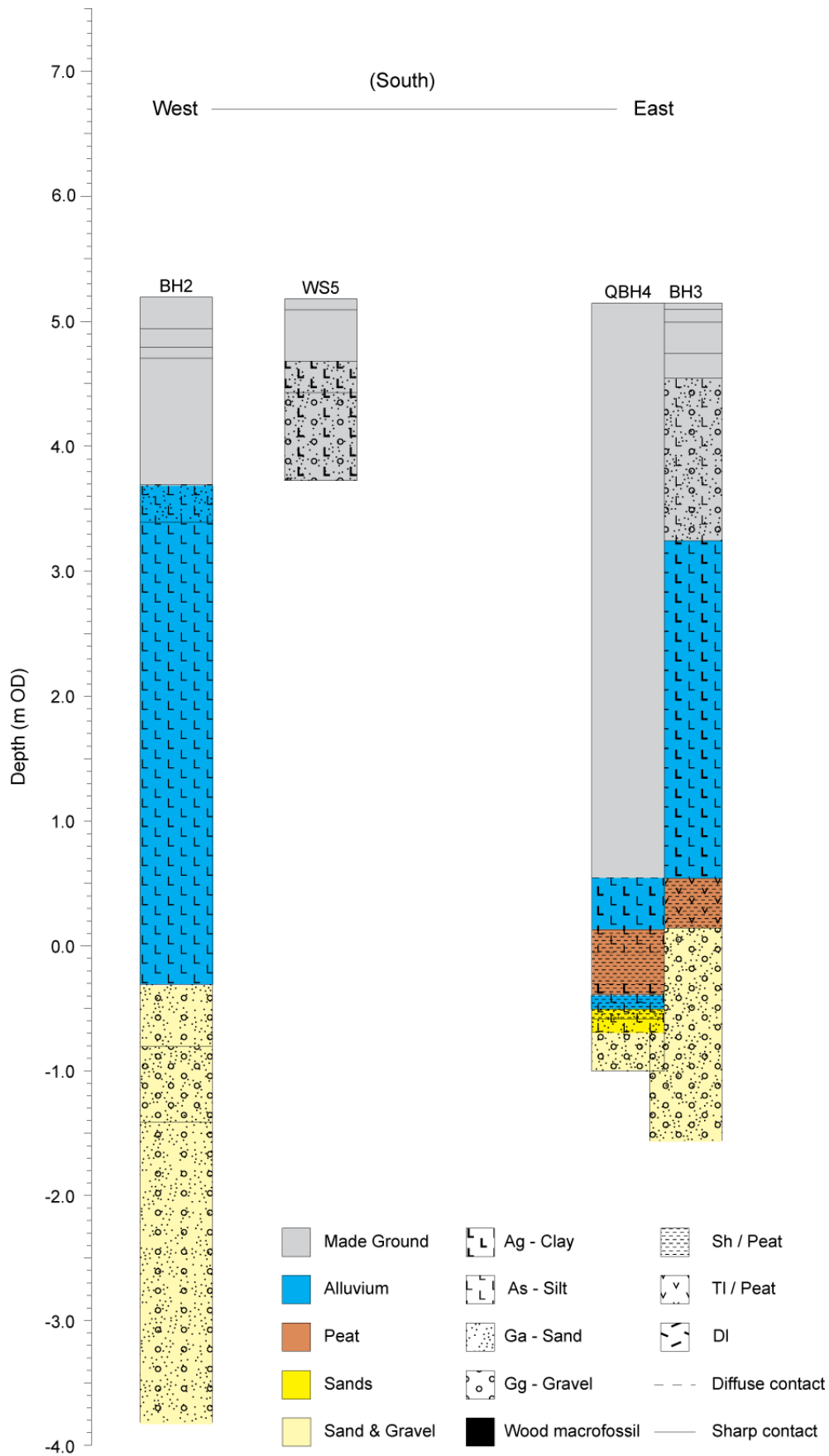




**Figure 2: Detailed site map incorporating the location of the previous geotechnical investigations and proposed geoarchaeological boreholes, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

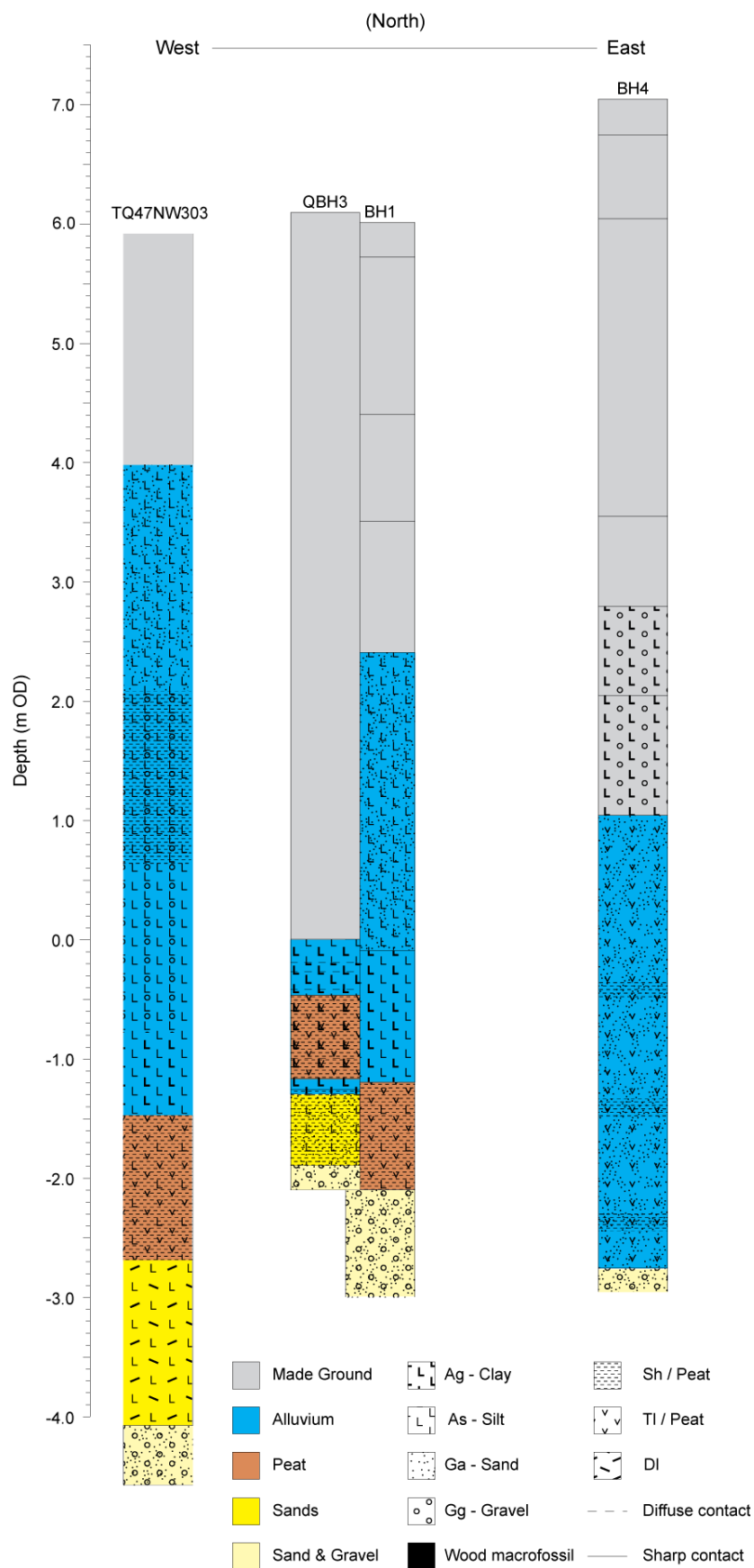


**Figure 3: North-south transect of boreholes across 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**



**Figure 4: Southern west-east transect of boreholes across 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**





**Figure 5: Northern west-east transect of boreholes across 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

## METHODS

### ***Previous investigations (field investigations; lithostratigraphic descriptions and deposit modelling)***

Four boreholes (Boreholes <QBH1> to <QBH4>) were put down at the site in November 2011 (Figure 2). Borehole core samples were recovered using cable percussion coring, carried out by Tony Bedford Drilling Services, and monitored by a member of Quaternary Scientific staff. The spatial attributes of each borehole were recorded (Table 1 and Figure 2). The spatial attributes for the original geotechnical boreholes are also shown (boreholes BH1-4, WS1-3 & 5-6) in Table 1 and Figure 2; these were not recorded during the original geotechnical works and thus were returned to during the geoarchaeological works.

**Table 1: Borehole attributes, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Borehole number	Easting	Northing	Elevation (m OD)
<i>Geoarchaeological boreholes</i>			
<QBH1>	540859.4640	178851.2290	5.38
<QBH2>	540771.4980	178966.2390	3.91
<QBH3>	540756.1060	179036.1170	6.01
<QBH4>	540928.7383	179115.0700	5.15
<i>Geotechnical boreholes</i>			
BH1	540756.1060	179036.1170	6.01
BH2	540795.4900	178905.1600	5.20
BH3	540962.5630	178946.8320	5.15
BH4	540905.3700	179091.8100	7.05
WS1	540702.030	178909.560	Unobtainable
WS2	540745.7170	178989.6390	4.70
WS3	540928.7383	179115.0700	6.78
WS5	540825.8670	178924.0190	5.19
WS6	540859.4640	178851.2290	5.38

The lithostratigraphy of boreholes <QBH1> to <QBH4> 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 Figures 3 to 6 and Tables 2 to 5.

### **Organic matter determinations**

Eighteen sub-samples from borehole <QBH3>, sixteen from <QBH2> and thirteen from <QBH1> were taken for determination of the organic matter content (Tables 6 to 8; Figure 6). 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°C for 12 hours to remove excess moisture; (2) placing the sub-sample in a muffle furnace at 550°C for 2 hours to remove organic matter (thermal oxidation), and (3) re-weighing the sub-sample obtain the 'loss-on-ignition' value (see Bengtsson and Enell, 1986).

### **Radiocarbon dating**

One sub-sample of waterlogged seeds from the base of the peat in borehole <QBH1> (*Alnus glutinosa* fruits/catkins), one sub-sample of waterlogged seeds from the base of the peat in borehole <QBH2> (indeterminate twig wood, ca. 2-3 years old) and sub-samples of waterlogged seeds (*Rubus* sp./*Ranunculus* cf. *repens*) from the top of peat and one sub-sample of waterlogged seeds (*Alnus glutinosa* catkins) from near the base of the peat in borehole <QBH3> were extracted for radiocarbon dating. All four 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 6 and Table 9.

### **Pollen assessment**

Twenty-two sub-samples (twelve from borehole <QBH3>, six from borehole <QBH2> and four from borehole <QBH1>) 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<sup>3</sup>); (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 10 to 12).

### ***Diatom assessment***

Four sub-samples from each borehole 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 13 to 15.

### **Macrofossil assessment**

A total of thirteen small bulk samples (9 from borehole <QBH3>, 2 from borehole <QBH2> and 2 from borehole <QBH1>) were extracted for the recovery of macrofossil remains including waterlogged plant macrofossils, waterlogged wood, insects and Mollusca. 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 16 to 18).

Preliminary identifications of the waterlogged seeds have been made using modern comparative material and reference atlases (Cappers *et al.* 2006, Schoch *et al.* 2004). Nomenclature used follows Stace (2005) (Tables 19 to 21).

A minimum of 10 waterlogged fragments per sample were assessed (Tables 19 to 21). The attributes and general quality of fragment preservation was noted. Preparation and examination of fragments follows standard practices as described in Hather (2000). Waterlogged wood fragments were thin sectioned using a hand held razor blade and mounted on a slide. Following preparation wood remains were examined at magnifications of up to x400. Specific attributes and features recorded during examination were the diameter of any twig wood and, as a means of determining relative maturity, the number of growth rings. Nomenclature follows Stace (2005).

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

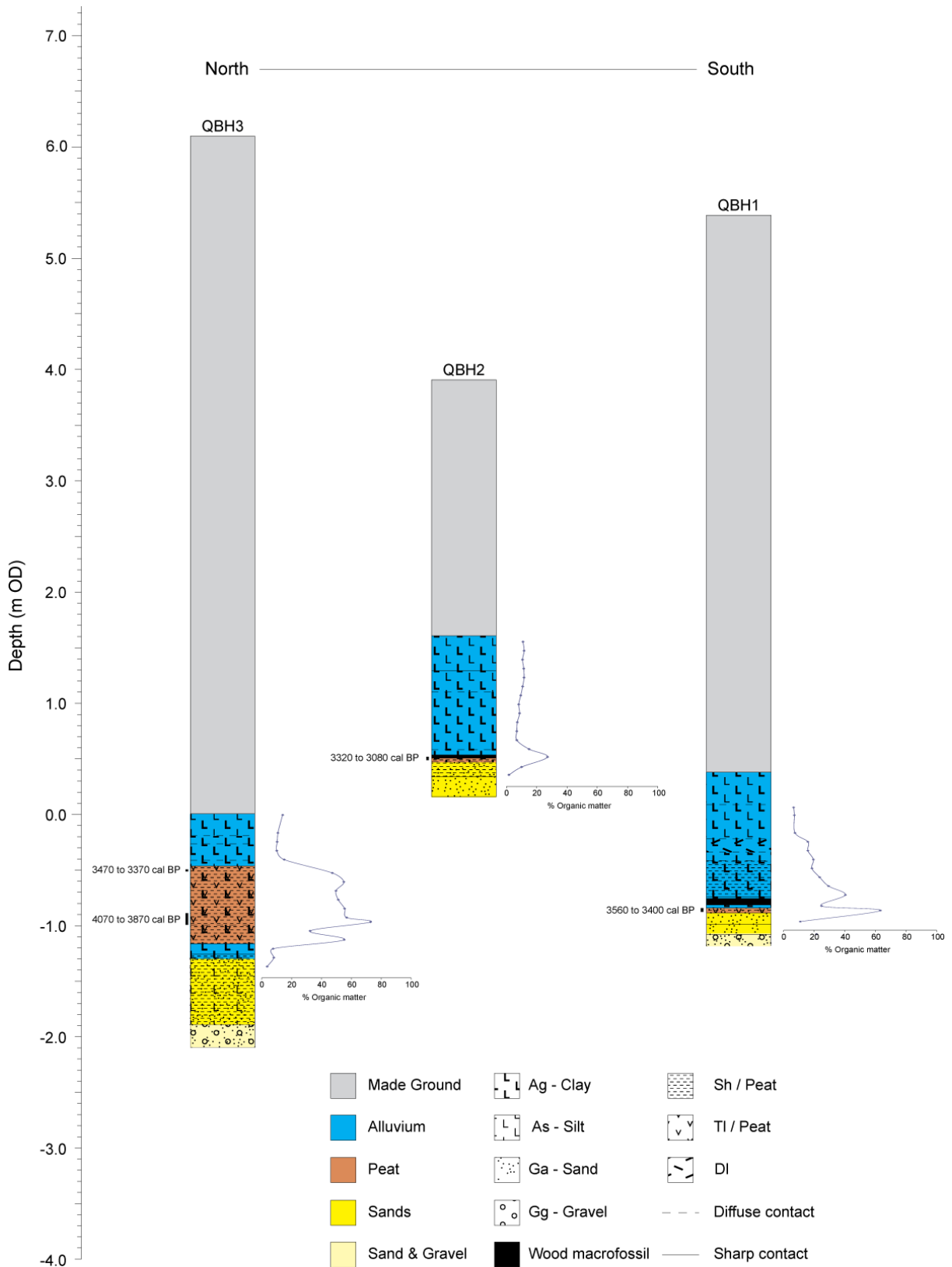
The results of the lithostratigraphic descriptions for boreholes <QBH1>, <QBH2> and <QBH3> (Tables 2 to 4, and Figure 6) have been reported previously (Batchelor and Young, 2011); quantification of the organic matter content by Loss-on-Ignition has allowed further detail to be added to the lithostratigraphic descriptions (Tables 6 to 8). As stated above the gravel surface at the site is representative of pre-Holocene river terrace gravels laid down within a high energy braided river environment. Within the previous geotechnical logs and Desk Based Assessment from Lombard Wall, this surface is referred to as the Kempton Park Gravel. However, Gibbard (1994) has a borehole transect along the line of the A102 (Blackwall Tunnel Approach Road), which is close to the Lombard Wall site. These boreholes show the Shepperton Gravel at ca. -2.0 to -3.0m OD and the Kempton Park Gravel at ca.

3.0m OD. This would suggest that the Lombard Wall site is underlain by Shepperton Gravel, but at a slightly elevated level in at least some areas of the site than observed on the A102 transect.

In all four of the geoarchaeological boreholes, the surface of the sand and gravel is overlain by coarse sands which frequently become increasingly organic (but generally less than 10% organic content) and contain wood remains upwards. This horizon is interpreted as deposition taking place during a decrease in fluvial energy during the Late Glacial, whilst the transition towards an organic-rich sand and wood macrofossils is thought to represent the development of more terrestrial conditions and establishment of woodland. This sand is not recorded within the previous geotechnical investigations, although borehole TQ47NW303 contains a thick horizon of 'silt with vegetation', which may be of similar origin to the sands and organic sands recorded in the new boreholes.

Above the sands, alluvium and peat is recorded in all the new boreholes. In <QBH1> and <QBH2> the peat horizon (20-30% organic content in <QBH2>, up to 65% in <QBH1>) is very thin (<10cm), prior to a transition to fine-grained organic-rich alluvium (ca. 20% organic content), and inorganic alluvium (generally less than 10% organic content). In <QBH3> the sequence is similar, although the thicker and deeper peat (generally 50-60% organic content) is preceded by a thin horizon of organic alluvium (ca. 10% organic content). The thickness of the peat appears proportional to the height of the underlying gravel surface as would be expected; i.e. thinner horizons of peat over areas with an elevated gravel surface and vice versa. The general sequence of organic-rich sands through peat formation, organic-rich alluvium and finally inorganic alluvium, is interpreted as representing a general transition from terrestrial and semi-terrestrial environments supporting woodland, to eventual inundation; a process of environmental changes possibly caused by rising relative sea level. In all boreholes, the alluvial sequence was overlain by a variable thickness of made ground to the present day surface of ca. 3 to 7m OD.





**Figure 6: Results of the borehole <QBH1>, <QBH2> and <QBH3> lithostratigraphic analysis, incorporating lithostratigraphic descriptions and organic matter content, plotted with associated radiocarbon dates. 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

**Table 2: Lithostratigraphic description of Borehole <QBH1>, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)	Depth (bgs)	Unit number	Description
5.38 to 0.38	0 to 5.00	11	Made Ground
0.38 to 0.08	5.00 to 5.30	10	10YR 2/1 mottled 10YR 4/1; As3, Ag1, Sh+, Ga+, Mollusca fragments+, mortar+, Gg+; Black mottled dark grey silty clay with organic, sand, gravel, mortar and Mollusca fragment inclusions. Gravel of various shapes, sizes and lithologies. diffuse contact into:
0.08 to -0.22	5.30 to 5.60	9	10YR 4/1; As3, Ag1, chalk nodules+; Dark grey stiff silty clay with chalk nodule inclusions; diffuse contact into:
-0.22 to -0.34	5.60 to 5.72	8	10YR 4/2 with 10YR 3/1; As3, DI1, Sh+; Dark greyish brown with very dark grey clay with detrital wood and traces of organic matter; diffuse contact into:
-0.34 to -0.42	5.72 to 5.80	7	10YR 4/1 mottled 10YR 2/1; As4, Sh+, DI+; Dark grey mottled black clay with organic matter and detrital wood inclusions; diffuse contact into:
-0.42 to -0.74	5.80 to 6.12	6	10YR 4/2; As3, Sh1, DI+; Dark greyish brown organic-rich clay with wood (detrital or <i>in situ</i> ) inclusions. Wood inclusions include towards the base of the unit.
-0.74 to -0.76	6.12 to 6.14	5	10YR 4/2; As4, Sh+, DI+; Dark greyish brown clay with inclusions of organic matter and detrital wood.
-0.76 to -0.82	6.14 to 6.20		Large wood macrofossil
-0.82 to -0.84	6.20 to 6.22	5	10YR 4/2; As4, Sh+, DI+; Dark greyish brown clay with inclusions of organic matter and detrital wood; sharp contact into:
-0.84 to -0.88	6.22 to 6.26	4	2.5YR 3/1; Sh2, TI <sup>4</sup> 1, Ga1; Humo 4; Reddish black very well humified, very organic-rich sandy wood peat; diffuse contact into:
-0.88 to -0.98	6.26 to 6.36	3	10YR 5/4; Ga4 alternating with and 10YR 3/1; Sh3, Ga1; Yellowish brown sand alternating with very dark grey very organic-rich sand. Contacts between the two units is sharp to diffuse. Diffuse contact into:
-0.98 to -1.07	6.36 to 6.45	2	10YR 5/4; Ga4, Sh+; Yellowish brown sand with organic-rich inclusions.
Below -1.07	>6.45	1	Sand and gravels recorded in the field but not recovered.

**Table 3: Lithostratigraphic description of Borehole <QBH2>, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)	Depth (bgs)	Unit number	Description
3.91 to 1.61	0 to 2.30	8	Made Ground
1.61 to 1.29	2.30 to 2.62	7	10YR 3/1 mottled 10YR 4/1; As3, Ag1; Very dark grey mottled with dark grey silty clay; sharp contact into:
1.29 to 1.11	2.62 to 2.80	6	10YR 3/1; As2, Ag2, Gg+, Ga+, rooting+, brick+; Very dark grey silty clay with gravel, sand, rooting and brick fragment inclusions; diffuse contact into:
1.11 to 0.58	2.80 to 3.33	5	10YR 5/1; As4; Grey clay; diffuse contact into:
0.58 to 0.54	3.33 to 3.37	4	10YR 4/1; As4, Sh+, DI+; Dark grey clay with detrital wood and organic-rich inclusions; sharp contact into:
0.54 to 0.51	3.37 to 3.40		Wood macrofossil
0.51 to 0.47	3.40 to 3.44	3	10YR 3/1; As2, Sh2, TI/DI+; Very dark grey very organic-rich clay with wood (detrital or in situ) inclusions; diffuse contact into:
0.47 to 0.34	3.44 to 3.57	2	10YR 3/1 to 10YR 5/4; Ga3, Sh1, DI+ / Sh3, Ga1, DI+; Very dark grey alternating with yellowish brown organic-rich sand to very organic-rich sand with wood inclusions (detrital or rooting); sharp contact into:
0.34 to 0.16	3.57 to 3.75	1	10YR 5/4; Ga4; Yellowish brown sand.
Below 0.16	>3.75		Borehole abandoned due to gaseous emissions.

**Table 4: Lithostratigraphic description of Borehole <QBH3>, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)	Depth (bgs)	Unit number	Description
6.01 to 0.01	0 to 6.00	11	Made Ground
0.01 to -0.19	6.00 to 6.20	10	10YR 3/1 mottled 10YR 5/1; As3, Ag1, brick fragments+, detrital wood+, Ga+; Very dark grey mottled with grey silty clay with inclusions of detrital wood, sand and brick fragments; diffuse contact into:
-0.19 to -0.26	6.20 to 6.27	9	10YR 4/1; As4; Dark grey clay; diffuse contact into:
-0.26 to -0.41	6.27 to 6.42	8	10YR 5/1 to 10R 4/1; As4, DI+; Grey to dark grey clay with detrital wood inclusions; diffuse contact into:
-0.41 to -0.46	6.42 to 6.47	7	10YR 4/2; As3, Ag1, DI+; Dark greyish brown silty clay with detrital wood inclusions; sharp contact

-0.46 to -0.99	6.47 to 7.00	6	into: 10YR 2/1; Sh2, TI <sup>3</sup> 1, As1; Humo 3-4; Black well humified, very organic-rich wood peat with clay; diffuse contact into:
-0.99 to -1.16	7.00 to 7.17	5	10YR 4/2 to 10YR 3/2; As2, Sh1, TI <sup>3</sup> 1; Humo 3-4; Very dark greyish brown to dark greyish brown highly organic-rich clay with well humified wood peat. A large wood macrofossil is present at the base of the unit; sharp contact into:
-1.16 to -1.25	7.17 to 7.26	4	10YR 5/1; As4, DI+; Grey clay with detrital wood inclusions; sharp contact into:
-1.25 to -1.28	7.26 to 7.29	3	10YR 4/2; As3, Sh1, DI/TI+; Dark greyish brown organic-rich clay with wood macrofossil inclusions (detrital or in situ); diffuse contact into:
-1.28 to -1.94	7.29 to 7.95	2	10YR 4/1 to 10YR 5/4; Ga2, Sh1, Ag1, DI+; Dark grey to yellowish brown organic-rich silty sand with detrital wood inclusions; diffuse contact into:
Below -1.94	>7.95	1	Sand and gravels recorded in the field but not recovered.

**Table 5: Lithostratigraphic description of Borehole <QBH4>, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)	Depth (bgs)	Unit number	Description
5.15 to 0.55	0 to 4.60	10	Made Ground
0.55 to 0.16	4.60 to 4.99	9	10YR 5/1; As3, Ag1, calcareous nodules+, Sh+; Grey silty clay with calcareous nodules from 4.75 to 4.80m BGS, and organic rich inclusions from 4.88 to 4.99m BGS; diffuse contact into:
0.16 to 0.09	4.99 to 5.06	8	2.5Y 3/1; Ag2, Sh1, As1; Very dark grey organic-rich clayey silt; sharp contact into:
0.09 to -0.05	5.06 to 5.20	7	2.5YR 2.5/1; Sh3, Ag1; Humo 3; Reddish black well humified, very organic-rich silt; diffuse contact into:
-0.05 to -0.30	5.20 to 5.45	6	2.5YR 2.5/1; Sh3, TI <sup>2</sup> 1, Ag+; Humo 3; Reddish black well humified highly organic-rich wood peat with silt inclusions; diffuse contact into:
-0.30 to -0.38	5.45 to 5.53	5	10YR 2/2; As2, Sh2, DI/TI+; Very dark brown very organic-rich clay with wood macrofossil (detrital or in situ) inclusions; sharp contact into:
-0.38 to -0.50	5.53 to 5.65	4	10YR 2/2; Ag3, Sh1, DI+; Very dark brown organic-rich silt with detrital wood inclusions; unknown contact into:
-0.50 to -0.58	5.70 to 5.78	3	10YR 2/1; Ga2, Ag1, Sh1; Black organic-rich silty sand; sharp contact into:
-0.58 to -0.68	5.78 to 5.83	2	10YR 3/2; Ag2, Ga2, Gg+; Very dark greyish brown silty sand with gravel inclusions; diffuse contact into:
-0.68 to -1.00	5.83 to 6.15	1	10YR 3/2; Ga2, Gg2; Very dark greyish brown sandy gravel.

**Table 6: Results of the borehole <QBH1> organic matter determinations, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)		Organic matter content %
From	To	
0.06	0.07	6.57
-0.01	-0.02	7.05
-0.17	-0.18	7.46
-0.25	-0.26	15.88
-0.33	-0.34	15.89
-0.41	-0.42	19.50
-0.49	-0.50	18.55
-0.57	-0.58	23.59
-0.65	-0.66	29.46
-0.73	-0.74	40.45
-0.83	-0.84	24.85
-0.87	-0.88	63.39
-0.97	-0.98	10.93

**Table 7: Results of the borehole <QBH2> organic matter determinations, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)		Organic matter content %
From	To	
1.55	1.54	11.03
1.47	1.46	11.77
1.39	1.38	10.73
1.31	1.30	11.53
1.23	1.22	11.72
1.15	1.14	10.78
1.07	1.06	9.53
0.99	0.98	8.20
0.91	0.90	8.74
0.83	0.82	7.24
0.75	0.74	6.91
0.67	0.66	6.89
0.59	0.58	15.06
0.52	0.51	27.29
0.43	0.42	10.11
0.36	0.34	1.67

**Table 8: Results of the borehole <QBH3> organic matter determinations, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)		Organic matter content %
From	To	
-0.01	-0.02	13.88
-0.09	-0.10	12.27
-0.17	-0.18	10.80
-0.25	-0.26	10.27
-0.33	-0.34	10.07
-0.41	-0.42	15.05
-0.53	-0.54	47.28
-0.61	-0.62	54.97
-0.69	-0.70	49.69

-0.77	-0.78	51.27
-0.85	-0.86	55.50
-0.93	-0.94	56.85
-0.97	-0.98	72.86
-1.05	-1.06	32.36
-1.13	-1.14	55.17
-1.21	-1.22	7.60
-1.29	-1.30	8.09
-1.37	-1.38	3.58

## RESULTS AND INTERPRETATION OF THE RADIOCARBON DATING

Identified waterlogged catkins and fruits of *Alnus glutinosa* from the base of the peat in borehole <QBH1> (-0.84 to -0.88m OD) were radiocarbon dated to 3560 to 3400 cal BP (1610 to 1450 cal BC); indeterminate twig wood (ca. 2-3 years old) from the base of the peat in borehole <QBH2> (0.47 to 0.51m OD) was radiocarbon dated to 3320 to 3080 cal BP (1370 to 1130 cal BC). *Alnus glutinosa* catkins from near the base of the peat in borehole <QBH3> (-0.89 to -0.99m OD) were radiocarbon dated to 4070 to 3870 cal BP (2120 to 1920 cal BC) and waterlogged seeds of *Rubus* sp. and *Ranunculus* cf. *repens* from the top of peat in borehole <QBH3> (0.49 to -0.51m OD) were radiocarbon dated to 3470 to 3370 cal BP (1520 to 1420 cal BC) (Table 9). The  $\delta^{13}C$  (‰) values are consistent with that expected for peat sediment, and there is no evidence for mineral or biogenic carbonate contamination. These results therefore indicate that peat accumulation began at least during the Late Neolithic/Early Bronze Age cultural periods in borehole <QBH3>, and began during the Early/Middle Bronze Age in boreholes <QBH1> and <QBH2>.



**Table 9: Results of the boreholes <QBH1>, <QBH2> and <QBH3> radiocarbon dating, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

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)	$\delta^{13}\text{C}$ (‰)
Beta-315450	<QBH1>	<i>Alnus glutinosa</i> fruits and catkins; base of peat	-0.84 to -0.88	3250 ± 30 BP	1610 to 1450 cal BC (3560 to 3400 cal BP)	-27.2
Beta-315451	<QBH2>	Indeterminate twig, ca. 2-3 years old; base of peat	0.47 to 0.51	3000 ± 30 BP	1370 to 1130 cal BC (3320 to 3080 cal BP)	-27.0
Beta-315452	<QBH3>	<i>Rubus</i> sp., <i>Ranunculus</i> cf. <i>repens</i> seeds; top of peat	-0.49 to -0.51	3200 ± 30 BP	1520 to 1420 cal BC (3470 to 3370 cal BP)	-27.7
Beta-315453	<QBH3>	<i>Alnus glutinosa</i> catkins; near base of peat	-0.89 to -0.99	3630 ± 30 BP	2120 to 1920 cal BC (4070 to 3870 cal BP)	-26.7

## RESULTS AND INTERPRETATION OF THE POLLEN ASSESSMENT

Twenty-two sub-samples (twelve from borehole <QBH3>, six from borehole <QBH2> and four from borehole <QBH1>) were extracted for an assessment of pollen content. The results are displayed in Tables 10 to 12.

### *Borehole <QBH1>*

The results of the pollen assessment indicate that the preservation and concentration of pollen grains in borehole <QBH1> was generally moderate to excellent. The assemblage is dominated by tree and shrub taxa including *Quercus* (oak), *Tilia* (lime), *Alnus* (alder), *Pinus* (pine), *Betula* (birch), *Corylus* type (e.g. hazel) and *Hedera* (ivy). Herbaceous taxa were present, and included Lactuceae (dandelion family), Poaceae (grass family), *Sinapis* type (mustard), *Chenopodium* type (e.g. fat hen), Cyperaceae (sedge family), *Cereale* (cereal), *Plantago lanceolata* (ribwort plantain) and *Plantago media/major* (plantain). The fern *Polypodium* (polypody) was also present. Aquatic taxa were rare, but included *Typha* (bulrush). This assemblage is indicative of woodland on the dryland dominated by lime, oak, pine, birch and hazel. The relatively high proportion of alder pollen indicates that the wetland is likely to have been a wooded fen dominated by alder (and possibly hazel and birch), with an understorey of shrubs including ivy, herbaceous and aquatic taxa. The presence of disturbed ground taxa and cereal pollen is indicative of human activity on the surrounding dryland.

### *Borehole <QBH2>*

The results of the pollen assessment indicate that the preservation and concentration of pollen grains in borehole <QBH2> was generally moderate to excellent, except in sample 0.35 to 0.34m OD which contained no pollen. The assemblage in borehole <QBH2> is largely dominated by tree and shrub taxa including *Quercus* (oak), *Alnus* (alder), *Pinus* (pine), *Betula* (birch), *Corylus* type (e.g. hazel) and *Hedera* (ivy). Herbaceous taxa were present, and included Lactuceae (dandelion family), Poaceae (grass family), *Sinapis* type (mustard), *Chenopodium* type (e.g. fat hen), Cyperaceae (sedge family), *Plantago lanceolata* (ribwort plantain), cf. *Polygonum aviculare* (knotgrass), cf. *Rumex* (dock/sorrel), *Cereale* (cereal) and Caryophyllaceae (pink family). The fern taxon *Polypodium* (polypody) was present in one sample (0.75 to 0.74m OD), as was the aquatic taxon *Sphagnum* (*Sphagnum* moss) (0.99 to 0.98m OD). This assemblage is indicative of woodland on the dryland dominated by oak, pine, birch and hazel. Alder pollen was dominant in the majority of samples, indicating that the wetland is likely to have been a wooded fen dominated by alder (and possibly hazel and birch), with an understorey of shrubs including ivy and herbaceous taxa. The presence of disturbed ground taxa and cereal pollen is indicative of human activity on the surrounding

dryland.

*Borehole <QBH3>*

The results of the pollen assessment indicate that the preservation and concentration of pollen grains in borehole <QBH3> was generally moderate to good, the assemblage dominated by tree and shrub taxa in the majority of samples, including *Quercus* (oak), *Tilia* (lime), *Alnus* (alder), *Ulmus* (elm), *Pinus* (pine), *Betula* (birch), *Corylus* type (e.g. hazel) and *Hedera* (ivy). cf. *Taxus/Juniperus* (yew/juniper) was present in one sample (-0.97 to -0.98m OD). Below -0.69m OD herbaceous taxa were rare, but above this included Lactuceae (dandelion family), Poaceae (grass family), *Sinapis* type (mustard), *Chenopodium* type (e.g. fat hen), Cyperaceae (sedge family) and cf. *Cirsium* (thistle). The ferns *Dryopteris* type (buckler fern), *Pteridium* (bracken) and *Polypodium* (polypody) were present. The assemblage in borehole <QBH3> is indicative of woodland on the dryland dominated by oak, pine, birch, hazel and yew/juniper. Alder pollen was dominant in the majority of samples, indicating that the wetland is likely to have been a wooded fen dominated by alder (and possibly hazel and birch) with an understorey of ferns and some herbaceous taxa. There is evidence for a more open environment dominated by herbaceous taxa in the uppermost sample in the sequence (-0.01 to -0.02m OD). There is no unequivocal evidence for human activity in the assemblage from borehole <QBH3>.

**Table 10: Results of the pollen assessment of borehole <QBH1>, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)		Main pollen taxa			Concentration 0 - 5	Preservation 0- 5	Microcharcoal 0 - 5
From	To	Latin name	Common name	Number			
-0.33	-0.34	<i>Quercus</i>	oak	4	4/5	3	-
		<i>Tilia</i>	lime	1			
		<i>Alnus</i>	alder	2			
		<i>Pinus</i>	pine	4			
		<i>Corylus</i> type	e.g. hazel	1			
		Lactuceae	dandelion family	2			
		Poaceae	grass family	1			
		<i>Sinapis</i> type	mustard	1			
		<i>Chenopodium</i> type	e.g. fat hen	5			
		Cyperaceae	sedge family	5			
		Cereale	cereal	1			
		<i>Plantago</i> type	plantain	2			
-0.57	-0.58	<i>Quercus</i>	oak	2	5	4/5	-
		<i>Alnus</i>	alder	19			
		<i>Corylus</i> type	e.g. hazel	3			
		<i>Chenopodium</i> type	e.g. fat hen	3			
		<i>Plantago lanceolata</i>	ribwort plantain	1			
		<i>Plantago media/major</i>	plantain	1			
		<i>Polypodium</i>	polypody	1			
		<i>Typha</i>	bulrush	1			
-0.84	-0.85	<i>Quercus</i>	oak	3	5	4	-
		<i>Alnus</i>	alder	14			
		<i>Betula</i>	birch	1			
		<i>Pinus</i>	pine	2			
		<i>Corylus</i> type	e.g. hazel	4			
		<i>Hedera</i>	ivy	1			
		<i>Ranunculus</i> type	e.g. creeping buttercup	1			
		<i>Plantago lanceolata</i>	ribwort plantain	2			
		Poaceae	grass family	3			
-0.86	-0.87	<i>Pinus</i>	pine	1	2	3/4	-

		<i>Alnus</i>	alder	3			
		<i>Corylus</i> type	e.g. hazel	3			
		<i>Tilia</i>	lime	6			

**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 11: Results of the pollen assessment of borehole <QBH2>, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)		Main pollen taxa			Concentration 0 - 5	Preservation 0- 5	Microcharcoal 0 - 5
From	To	Latin name	Common name	Number			
0.99	0.98	<i>Quercus</i>	oak	1	4	2/3	1
		<i>Alnus</i>	alder	5			
		<i>Pinus</i>	pine	2			
		Lactuceae	dandelion family	10			
		Poaceae	grass family	3			
		<i>Sinapis</i> type	mustard	2			
		Cyperaceae	sedge family	1			
		<i>Sphagnum</i>	<i>Sphagnum</i> moss	2			
0.75	0.74	<i>Alnus</i>	alder	2	2	3	-
		<i>Pinus</i>	pine	1			
		<i>Corylus</i> type	e.g. hazel	1			
		Lactuceae	dandelion family	5			
		<i>Polypodium</i>	polypody	1			
0.51	0.50	<i>Quercus</i>	oak	1	5	4/5	-
		<i>Alnus</i>	alder	25			
		<i>Corylus</i> type	e.g. hazel	1			
		Poaceae	grass family	3			
		cf. <i>Polygonum aviculare</i>	knotgrass	1			
		Unknown	-	1			
0.48	0.47	<i>Quercus</i>	oak	1	5	4/5	1
		<i>Alnus</i>	alder	27			
		<i>Corylus</i> type	e.g. hazel	2			

		<i>Hedera</i>	ivy	2			
		<i>Cereale</i>	cereal	1			
0.43	0.42	<i>Alnus</i>	Alder	22	5	4	-
		<i>Quercus</i>	oak	3			
		<i>Corylus</i> type	e.g. hazel	4			
		Poaceae	grass family	4			
		Cyperaceae	sedge family	2			
		cf. <i>Rumex</i>	dock/sorrel	1			
		Caryophyllaceae	pink family	1			
		<i>Plantago lanceolata</i>	ribwort plantain	3			
0.35	0.34	-	-	-	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

**Table 12: Results of the pollen assessment of borehole <QBH3>, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)		Main pollen taxa			Concentration 0 - 5	Preservation 0- 5	Microcharcoal 0 - 5
From	To	Latin name	Common name	Number			
-0.01	-0.02	<i>Pinus</i>	pine	1	4	3	3
		<i>Corylus</i> type	e.g. hazel	1			
		Poaceae	grass family	9			
		Lactuceae	dandelion family	8			
		Cyperaceae	sedge family	2			
		<i>Sinapis</i> type cf. <i>Cirsium</i>	mustard thistle	2 1			
-0.25	-0.26	<i>Pinus</i>	pine	1	1	2/3	4
		<i>Corylus</i> type	e.g. hazel	1			
		Cyperaceae	sedge family	2			
-0.53	-0.54	<i>Quercus</i>	oak	1	2	2/3	-
		<i>Alnus</i>	alder	3			
		<i>Pinus</i>	pine	1			
		<i>Corylus</i> type	e.g. hazel	1			



		Poaceae <i>Chenopodium</i> type <i>Polypodium</i>	grass family e.g. fat hen polypody	2 1 1			
-0.61	-0.62	<i>Chenopodium</i> type	e.g. fat hen	1	1	2	-
-0.68	-0.69	<i>Ulmus</i> <i>Quercus</i> <i>Pinus</i> <i>Tilia</i> <i>Alnus</i> <i>Corylus</i> type Poaceae Cyperaceae <i>Chenopodium</i> type	elm oak pine lime alder e.g. hazel grass family sedge family e.g. fat hen	1 2 2 1 6 6 3 3 1	4	3/4	-
-0.77	-0.78	<i>Ulmus</i> <i>Quercus</i> <i>Pinus</i> <i>Tilia</i> <i>Alnus</i> <i>Corylus</i> type <i>Hedera</i> <i>Polypodium</i>	elm oak pine lime alder e.g. hazel ivy polypody	3 5 1 1 8 3 1 1	3/4	3	-
-0.85	-0.86	<i>Fraxinus</i> <i>Quercus</i> <i>Tilia</i> <i>Alnus</i> <i>Corylus</i> type <i>Polypodium</i>	ash oak lime alder e.g. hazel polypody	1 4 1 10 2 1	3	3	-
-0.93	-0.94	<i>Quercus</i> <i>Alnus</i> <i>Corylus</i> type <i>Pinus</i> <i>Pteridium</i>	oak alder e.g. hazel pine bracken	7 14 3 1 1	4	4	-
-0.97	-0.98	cf. <i>Taxus/Juniperus</i> <i>Polypodium</i>	yew/juniper polypody	1 1	1	2	-
-1.05	-1.06	<i>Quercus</i>	oak	2	1/2	2/3	-

		<i>Alnus</i>	alder	2			
		<i>Corylus</i> type	e.g. hazel	1			
		<i>Tilia</i>	lime	1			
-1.13	-1.14	<i>Quercus</i>	oak	2	2	3/4	-
		<i>Tilia</i>	lime	2			
		<i>Alnus</i>	alder	3			
		<i>Chenopodium</i> type	e.g. fat hen	1			
		<i>Dryopteris</i> type	buckler fern	1			
		<i>Polypodium</i>	polypody	2			
-1.37	-1.38	-	-	-	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 13 to 15. 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 13: Summary diatom assessment results of borehole <QBH1>, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)		Diatom concentration	Quality of preservation	Diversity
From	To			
-0.73	-0.74	Very low	Very poor	Low
-0.83	-0.84	None	-	-
-0.87	-0.88	None	-	-
-0.97	-0.98	None	-	-

**Table 14: Summary diatom assessment results of borehole <QBH2>, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)		Diatom concentration	Quality of preservation	Diversity
From	To			
0.35	0.34	None	-	-
0.43	0.42	None	-	-
0.51	0.50	None	-	-
0.59	0.58	None	-	-

**Table 15: Summary diatom assessment results of borehole <QBH3>, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)		Diatom concentration	Quality of preservation	Diversity
From	To			
-0.41	-0.42	Low	Poor	Low
-0.53	-0.54	None	-	-
-1.13	-1.14	None	-	-
-1.21	-1.22	None	-	-

## **RESULTS AND INTERPRETATION OF THE MACROFOSSIL ASSESSMENT**

A total of thirteen small bulk samples (nine from borehole <QBH3>, two from borehole <QBH2> and two from borehole <QBH1>) were extracted for the recovery of macrofossil remains including waterlogged plant macrofossils, waterlogged wood, insects and Mollusca (Tables 19 to 21). 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 absent from the samples from borehole <QBH2>, but were present in both samples from borehole <QBH1> and five of the samples from borehole <QBH3>. Waterlogged wood was present in all thirteen samples. Fragments of insects were present in one sample from borehole <QBH2> (0.49 to 0.47m OD); however, these lacked the diagnostic features necessary for identification. Fragments of unidentifiable charcoal <2mm in diameter were present in one sample from borehole <QBH3> (-0.51 to -0.59m OD). No Mollusca remains were found in any of the samples.

**Table 16: Results of the macrofossil assessment of borehole <QBH1>, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)	Volume sampled (l)	Volume processed (l)	Fraction (e.g. flot, residue, >300µm)	Charred					Waterlogged		Mollusca	Bone				
				Charcoal (>4mm)	Charcoal (2-4mm)	Charcoal (<2mm)	Seeds	Chaff	Wood	Seeds	Whole	Fragments	Large	Small	Fragments	Insects
-0.84 to -0.86	0.1	0.1	>1mm	-	-	-	-	-	5	1	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-0.86 to -0.88	0.05	0.05	>300µm	-	-	-	-	-	3	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 17: Results of the macrofossil assessment of borehole <QBH2>, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)	Volume sampled (l)	Volume processed (l)	Fraction (e.g. flot, residue, >300µm)	Charred					Waterlogged		Mollusca	Bone				
				Charcoal (>4mm)	Charcoal (2-4mm)	Charcoal (<2mm)	Seeds	Chaff	Wood	Seeds	Whole	Fragments	Large	Small	Fragments	Insects
0.51 to 0.49	0.1	0.1	>1mm	-	-	-	-	-	1	-	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-

0.49 to 0.47	0.1	0.1	>300µm	-	-	-	-	-	2	-	-	-	-	-	1
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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 18: Results of the macrofossil assessment of borehole <QBH3>, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)	Volume sampled (l)	Volume processed (l)	Fraction (e.g. flot, residue, >300µm)	Charred					Waterlogged		Mollusca		Bone			
				Charcoal (>4mm)	Charcoal (2-4mm)	Charcoal (<2mm)	Seeds	Chaff	Wood	Seeds	Whole	Fragments	Large	Small	Fragments	Insects
-0.49 to -0.51	0.1	0.1	>1mm	-	-	-	-	-	5	1	-	-	-	-	-	-
-0.51 to -0.59	0.5	0.5	>1mm	-	-	1	-	-	5	-	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-0.59 to -0.69	0.4	0.4	>1mm	-	-	-	-	-	3	1	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	1	-	-	-	-	-	-
-0.69 to -0.79	0.3	0.3	>1mm	-	-	-	-	-	2	1	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	1	-	-	-	-	-	-
-0.79 to -0.89	0.3	0.3	>1mm	-	-	-	-	-	3	1	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-0.89 to -0.99	0.6	0.6	>1mm	-	-	-	-	-	3	1	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-0.99 to -1.09	0.5	0.5	>1mm	-	-	-	-	-	2	-	-	-	-	-	-	

			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-1.09 to -1.14	0.3	0.3	>1mm	-	-	-	-	-	3	-	-	-	-	-	-	-
			>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-
-1.14 to -1.16	0.1	0.1	>1mm	-	-	-	-	-	4	-	-	-	-	-	-	-

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

## **RESULTS OF THE WATERLOGGED PLANT MACROFOSSIL ASSESSMENT (SEEDS AND WOOD)**

The results of the macrofossil rapid assessment indicated that waterlogged wood was present in all sample assessed, and waterlogged seeds were present in seven of the samples from boreholes <QBH1> and <QBH3>; all samples thus underwent a more detailed assessment. The results of the borehole <QBH1>, <QBH2> and <QBH3> waterlogged plant macrofossil (seeds and wood) assessments are displayed in Tables 19 to 21.

### ***Results and interpretation of the waterlogged seed assessment***

#### *Borehole <QBH1>*

Waterlogged seeds were preserved in low quantities in both samples from borehole <QBH1> (Table 19). The assemblage in the lower sample (-0.86 to -0.88m OD) contained seeds of *Rubus* sp. (bramble), while the upper sample (-0.84 to -0.86m OD) contained fruits and catkins of *Alnus glutinosa* (alder). Although limited, the assemblage in this sequence is consistent with wetland fen vegetation.

#### *Borehole <QBH2>*

Waterlogged seeds were absent from the two samples from borehole <QBH2>.

#### *Borehole <QBH3>*

Waterlogged seeds were preserved in low quantities in five of the samples from borehole <QBH3>. Of the identifiable seeds, the assemblage was dominated by *Alnus glutinosa* (alder) fruits and catkins, and seeds of *Rubus* sp. (bramble) and *Ranunculus* cf. *repens* (creeping buttercup). Although relatively few waterlogged seeds were present in this assemblage, it is consistent throughout the sequence with a wetland fen environment.

### ***Results and interpretation of the waterlogged wood assessment***

A total of 120 fragments were examined of which 44 could not be positively identified. These fragments, recorded here as 'indeterminate', were mostly derived from bark. Alder was present in 10 of the samples and represented in each of the 3 boreholes (<QBH1>, <QBH2> and <QBH3>) by a total of 54 fragments; yew was present in 3 samples from <QBH3> only and represented by 15 fragments in total; ash was present in 2 samples, one from <QBH1> and one from <QBH3>, and represented by 7 fragments. All of the identified wood examined was derived from small roundwood, occasionally with bark still attached, or twig wood.

In general the quality of preservation of the fragments from each borehole was poor. Individual elements were small and, apart from the yew elements, all were soft and much



distorted from the round. The yew wood (and many bark fragments) was exceptionally hard and difficult to section, though it retained its original form better than the alder and ash elements. The apparent abundance of alder indicates some form of wetland habitat possibly associated with a watercourse, in which alder woodland was probably the most conspicuous component. The presence of ash and yew is not inconsistent with this view. Though often associated with dry alkaline soils, both taxa are tolerant of damp conditions. However, ash and yew were seemingly present in low quantities at the site and were almost certainly minor components of the local vegetation. That most of the fragments recovered were typically small branches or twigs, and the high incidence of bark, suggests that the material examined is the accumulated remains of woody debris shed naturally throughout the life of the plants represented.

**Table 19: Results of the waterlogged plant macrofossil (seeds and wood) assessment of borehole <QBH1>, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)	Waterlogged seeds		Waterlogged wood			
	Latin name	Common name	Latin name	Common name	Quantity	Comments
-0.84 to -0.86	<i>Alnus glutinosa</i> fruit	alder	<i>Alnus glutinosa</i>	alder	1	twig/small roundwood 8+ rings
	<i>Alnus glutinosa</i> catkin	alder	<i>Fraxinus excelsior</i>	ash	6	-
			Indeterminate	-	3	bark
-0.86 to -0.88	<i>Rubus</i> sp.	e.g. bramble	<i>Alnus glutinosa</i>	alder	8	-
			Indeterminate	-	2	-

**Table 20: Results of the waterlogged plant macrofossil (seeds and wood) assessment of borehole <QBH2>, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)	Waterlogged seeds		Waterlogged wood			
	Latin name	Common name	Latin name	Common name	Quantity	Comments
0.51 to 0.49	-	-	<i>Alnus glutinosa</i>	-	1	
			Indeterminate	-	9	
0.49 to 0.47	-	-	Indeterminate	all bark	10	all bark

**Table 21: Results of the waterlogged plant macrofossil (seeds) assessment of borehole <QBH3>, 50 Lombard Wall, Charlton, London Borough of Greenwich (site code: LBW11)**

Depth (m OD)	Waterlogged seeds		Waterlogged wood			
	Latin name	Common name	Latin name	Common name	Quantity	Comments
-0.49 to -0.51	<i>Rubus</i> sp.	e.g. bramble	<i>Alnus glutinosa</i>	alder	8	-
	<i>Ranunculus</i> cf. <i>repens</i>	creeping buttercup	Indeterminate	-	2	bark
-0.51 to -0.59	-	-	-	-	-	-
-0.59 to -0.69	Unidentified	-	<i>Alnus glutinosa</i>	alder	7	-
			<i>Fraxinus excelsior</i>	ash	1	-
			Indeterminate	-	2	bark
-0.69 to -0.79	<i>Ranunculus</i> cf. <i>repens</i>	creeping buttercup	<i>Alnus glutinosa</i>	alder	7	-
			Indeterminate	bark	3	bark
-0.79 to -0.89	<i>Alnus glutinosa</i> catkin	alder	<i>Alnus glutinosa</i>	alder	5	inc. twigwood
	<i>Ranunculus</i> cf. <i>repens</i>	creeping buttercup	Indeterminate	bark	5	-
-0.89 to -0.99	<i>Alnus glutinosa</i> catkin	alder	<i>Alnus glutinosa</i>	alder	7	-

	<i>Ranunculus cf. repens</i> Unidentified	creeping buttercup -	Indeterminate	bark	3	bark
-0.99 to -1.09	-	-	<i>Alnus glutinosa</i> <i>Taxus baccata</i> Indeterminate	alder yew -	3 3 4	Inc. twigwood bark -
-1.09 to -1.14	-	-	<i>Alnus glutinosa</i> <i>Taxus baccata</i>  Indeterminate	alder yew  -	7 2 1	inc. twigwood. twigwood/small roundwood bark
-1.14 to -1.16	-	-	<i>Taxus baccata</i>	yew	10	Small roundwood - 'knotty'

## **DISCUSSION AND CONCLUSIONS**

The aim of the environmental archaeological assessment was (1) to evaluate the potential for reconstructing the past environmental conditions of the site and its environs, and (2) to elucidate the ages of the peat horizons across the site. An assessment of three boreholes was carried out from boreholes <QBH1>, <QBH2> and <QBH3> as they contained significant alluvial and organic-rich horizons, and represented a north-south transect across the site.

The results of the lithostratigraphic descriptions indicate that in the four geoarchaeological boreholes, the surface of the Shepperton Sand and Gravel is overlain by coarse sands which frequently become increasingly organic and contain wood remains upwards; above the sands, alluvium and peat is recorded in all four boreholes. In <QBH1> and <QBH2> the peat horizon is very thin (<10cm), prior to a transition to fine-grained organic-rich alluvium, and inorganic alluvium. In <QBH3> and <QBH4>, the sequence is similar, although the thicker and deeper peat is preceded by a thin horizon of organic-rich alluvium. The thickness of the peat appears proportional to the height of the underlying gravel surface as would be expected; i.e. thinner horizons of peat over areas with an elevated gravel surface and vice versa. The results of the radiocarbon dating indicate that the peat horizons do not differ significantly in age, peat accumulation beginning at least during the Late Neolithic/Early Bronze Age cultural periods in borehole <QBH3>, and during the Early/Middle Bronze Age in boreholes <QBH1> and <QBH2>.

### *Boreholes <QBH1> and <QBH2>*

The combined results of the archaeobotanical (pollen, waterlogged wood and seeds) records from boreholes <QBH1> and <QBH2> indicate that during the accumulation of the peat in these boreholes, the woodland on the dryland was dominated by lime, oak, pine, birch and hazel. The wetland surface is likely to have been a wooded fen dominated by alder (and possibly hazel and birch), with an understorey of shrubs including bramble and ivy, herbaceous and aquatic taxa; ash was also present in the waterlogged wood assemblage from borehole <QBH1> indicating that it was growing on the wetland surface at this location. The presence of cereal pollen suggest nearby human activity since such grains do not travel far from source. Indeed, it might be speculated that the cereal pollen actually originates from the location of boreholes <QBH1> and <QBH2> since these represent topographic high points that might have been utilised by human groups during the Bronze Age cultural period. Gravel islands such as these have previously been identified as foci for prehistoric activity elsewhere in the Lower Thames Valley (e.g. the Horsleydown and Bermondsey eyots in central London). Diatoms were either absent or present in very low concentrations in the

alluvium underlying and overlying the peat in both boreholes.

#### *Borehole <QBH3>*

The combined results of the archaeobotanical (pollen, waterlogged wood and seeds) records from borehole <QBH3> are indicative of woodland on the dryland dominated by oak, pine, birch, hazel and yew/juniper. The wetland is likely to have supported a wooded fen dominated by alder (and possibly hazel and birch) with an understorey of shrubs, ferns and herbaceous taxa. There is evidence for a more open environment dominated by herbaceous taxa in the uppermost sample in the sequence (-0.01 to -0.02m OD); however, there is no unequivocal evidence for human activity in the assemblage from borehole <QBH3>. An absence of cereal pollen and disturbed ground taxa in the sequence from this borehole, despite their presence in the records from boreholes <QBH1> and <QBH2>, may be an indication of wetter and boggy (and therefore less suitable for human activities) conditions at the location of <QBH3> closer to the river channel.

The new stratigraphic record from borehole <QBH3> clearly post-dates the well documented elm decline; a near synchronous decline in elm populations across the British Isles around 6700 cal yr BP (Parker et al., 2002).

*Taxus baccata* (yew) was present in the three samples below -0.99m OD, indicating that this species was a component of the vegetation on the peat surface prior to 4070 to 3870 cal. BP. This is a new and potentially significant occurrence of this species during the Middle Holocene, which expands the present known range of *Taxus* in the Lower Thames Valley at this time (Batchelor, 2009). Previous work carried out on this topic (Batchelor, 2009) has highlighted an expansion of *Taxus* onto wetland surfaces, where it became a co-dominant component of the fen woodland with *Alnus* (alder), a vegetation community which has no known British modern analogue (Batchelor, 2009). *Taxus* growth in wetland environments has also been recorded in other areas of the British Isles, including the Somerset Levels (Beckett & Hibbert, 1979; Orme & Coles, 1989), the East Anglian Fens (Godwin *et al.*, 1935; Godwin, 1940; Waller, 1994a ) and Ireland (O'Connell & Molloy, 2001; Delahunty, 2002), and the Belgian coastal plains (Deforce & Bastiaens, 2004, 2007) during the Middle Holocene (Batchelor, 2009). Furthermore, the occurrence of yew at Lombard Wall supports the current model for its regional expansion and decline in the Lower Thames Valley ca. 5000 to 4000 cal. BP (Batchelor, 2009). In addition, the occurrence of elm within the pollen-stratigraphic record above the decline in yew may represent its expansion on the wetland and/or dryland surface nearby to the site. The increase of elm pollen and plant macrofossils has been noted at other sites within the Lower Thames Valley after 4000 cal. BP (e.g. Batchelor et al., 2009

(NORMAN ROAD) Seel, 2003).

## RECOMMENDATIONS

The results of the environmental archaeological assessment have revealed that the archaeobotanical remains are sufficiently well preserved in the sedimentary sequences of boreholes <QBH1>, <QBH2> and <QBH3> to reconstruct the environmental history of the site and its environs, and thus further work is justified. The sequence from borehole <QBH3> is of significance, since it contains evidence for the Middle Holocene colonisation of the peat surface by yew, and the later expansion of elm at the 50 Lombard Wall site, while the records from boreholes <QBH1> and <QBH2> contain possible evidence for human activity on their associated gravel islands. It is therefore recommended that this environmental archaeological analysis should consist of:

- (1) Pollen analysis on the <QBH1> and <QBH2> sequences to enhance our understanding of the environmental changes through the peat, and to confirm the identification of anthropogenic (disturbed ground taxa and *Cereale*) indicators
- (2) Pollen analysis on the <QBH3> sequence to enhance our understanding of the environmental changes through the peat, and to examine in more detail the expansion and decline of both yew and elm in the pollen record
- (3) A maximum of two additional radiocarbon dates from borehole <QBH3> to provide a chronological framework for the environmental changes and the colonisation of *Taxus* on the peat surface
- (4) Analysis of the waterlogged wood from borehole <QBH3>.

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## APPENDIX 1: OASIS

### Project details

Project name	50 Lombard Wall: Environmental Archeological Assessment
Short description of the project	Four geoarchaeological boreholes were put down across the site at selected locations. Combined with previous geotechnical records, a model of the sub-surface stratigraphy indicates a sequence of Shepperton Gravel overlain by sands and organic sands, alluvium (including peat) and made ground. The Shepperton Gravel undulates across the site from >-2m OD in the north, to approximately 0m OD at its centre. Assessment of three boreholes indicates that peat accumulation began during the Late Neolithic/Early Bronze Age to Middle Bronze Age. Possible evidence for human activity on the gravel islands is indicated in boreholes QBH1 and 2, while the presence of yew in borehole QBH3 provides new evidence for its expansion and decline in this part of the Lower Thames Valley. Analysis of all three boreholes is recommended.
Project dates	Start: 14-10-2011 End: 13-02-2012
Previous/future work	Yes / Yes
Any associated project reference codes	LBW11 - Sitecode
Type of project	Environmental assessment
Site status	None
Current Land use	Industry and Commerce 1 - Industrial
Significant Finds	PEAT Early Bronze Age
Survey techniques	Archaeology

### Project location

Country	England
Site location	GREATER LONDON GREENWICH GREENWICH 50 Lombard Wall
Postcode	SE7 7SQ
Site coordinates	TQ 3062 7608 51.4680904594 -0.119268800282 51 28 05 N 000 07 09 W Point
Height OD / Depth	Min: -1.94m Max: 1.61m

### Project creators

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

### Project archives

Physical Archive recipient	LAARC
Physical Contents	'Environmental'
Digital Archive recipient	LAARC
Digital Contents	'Environmental'
Digital Media available	'Images raster / digital photography','Images vector','Text'
Paper Archive Exists?	No
Paper Archive recipient	LAARC

### Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	50 LOMBARD WALL, CHARLTON, LONDON BOROUGH OF GREENWICH SE7 7SQ (SITE CODE: LBW11): GEOARCHAEOLOGICAL FIELDWORK REPORT
Author(s)/Editor(s)	C.R. Batchelor
Author(s)/Editor(s)	D.S. Young
Other bibliographic details	Unpublished Report November 2011; Project Number 157/11
Date	2011
Issuer or publisher	Quaternary Scientific (QUEST)
Place of issue or publication	University of Reading

### Project bibliography 2

Publication type	Grey literature (unpublished document/manuscript)
Title	50 LOMBARD WALL, CHARLTON, LONDON BOROUGH OF GREENWICH SE7 7SQ (SITE CODE: LBW11): ENVIRONMENTAL ARCHAEOLOGICAL ASSESSMENT REPORT
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