

## **WEST HAM BUS GARAGE (THE FORMER PARCEL FORCE DEPOT), WEST OF STEPHENSON STREET, LONDON BOROUGH OF NEWHAM (SITE CODE: WHQ09): ENVIRONMENTAL ARCHAEOLOGICAL ASSESSMENT**

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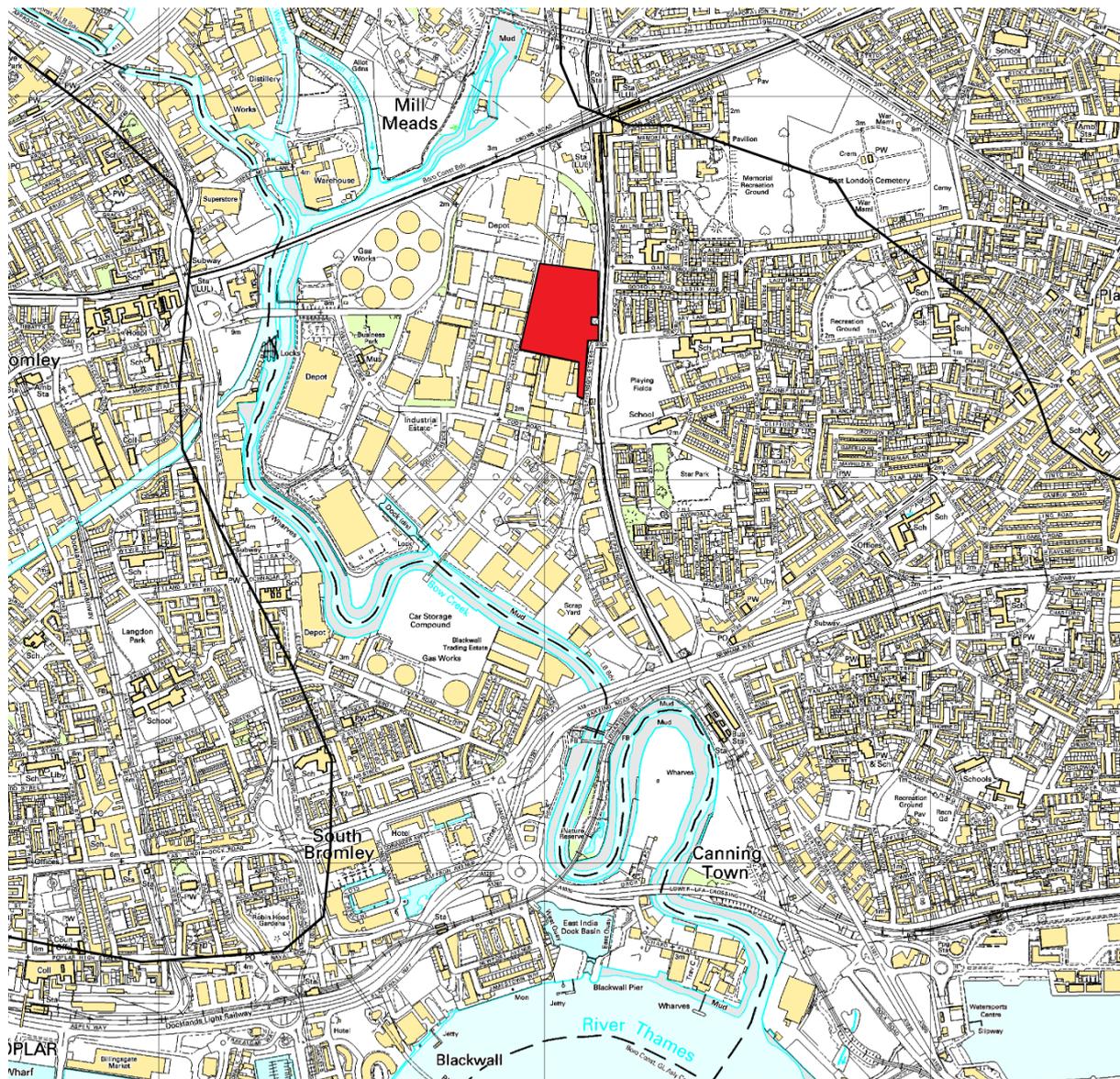
### **INTRODUCTION**

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 West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09; National Grid Reference: TQ 539050 182500; Figures 1 and 2). The results of an archaeological desk-based assessment conducted by Bull and Corcoran (2007), and the Lea Valley Mapping Project by Burton *et al.* (2004), suggested the site has considerable potential for addressing a range of important research questions with respect to the environmental and cultural histories of the Lea Valley. Situated centrally within the modern floodplain of the Lea Valley, and only a short distance upstream from the confluence with the River Thames, Bull and Corcoran (2007) recorded a stratigraphic sequence comprising Holocene alluvium (floodplain deposits) overlying Pleistocene gravels. The thickness of the alluvium and height of the gravel surface deepened towards the eastern boundary of the site. This suggested that the former course of the River Lea may have occupied the eastern limits, with the remaining area comprising relatively dry ground (alluvium <1.5m in thickness), which was only subject to intermittent flooding. This alluvial sequence in the western part of the site probably represents a series of landsurfaces (“accretionary soils” see Bull and Corcoran, 2007, 15), located proximal to the river channel, and its tributary streams, which have progressively accumulated during prehistory and into the historic period. The margins of the former river channel have also been identified by the presence of peat, and it is these deposits and possible former channel fills that provide the potential for reconstructing the environmental history of the site and its environs, enabling records to be compiled of human impact on the wetland and adjacent dryland environment e.g. woodland clearance and farming (these comments are also supported by Bull and Corcoran, 2007). Bull and Corcoran also conclude that if the peat deposit is an extensive unit, it may be of a similar age to the Middle Holocene peat recorded extensively within the Lower Thames Valley. At several sites in the Lower Thames Valley, this peat unit has been linked to a period of marine regression, where the

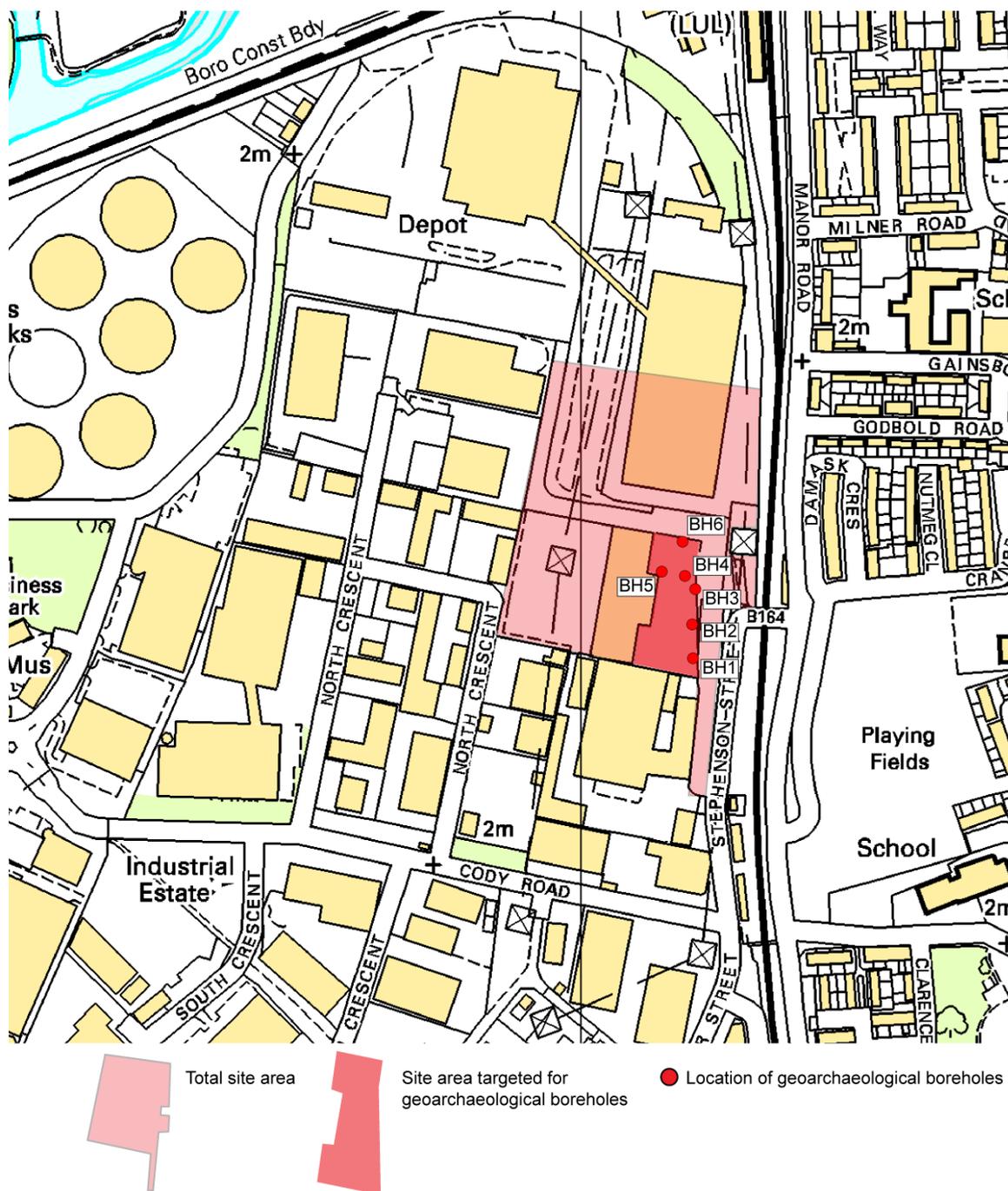
rate of Holocene sea level rise since the end of the last glaciation has slowed, resulting in the transition from estuarine sediment deposition (alluvium) to peat formation within a semi-terrestrial environment.

The results of a recent geoarchaeological borehole survey and preliminary deposit model of the site (Batchelor *et al.*, 2009) supports the work of Bull and Corcoran (2007), and Burton *et al.* (2004). The overarching aim of the environmental archaeological assessment was therefore to evaluate the potential of the new sedimentary sequences for reconstructing the environmental history of the site and its environs. In order to achieve this aim, the environmental archaeological assessment consisted of:

1. Determining variations in organic matter content to supplement the preliminary reconstruction of the sedimentary history undertaken during the recent geoarchaeological survey (Batchelor *et al.*, 2009)
2. Assessment of 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
3. Assessment of the preservation and concentration of waterlogged macroscopic plant (seeds, wood) to provide a preliminary reconstruction of the vegetation history and general environmental context of the site.



**Figure 1: Location of West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09) (reproduced from Ordnance Survey digital map data ©Crown copyright 2009. All rights reserved. License number 0100031673)**



**Figure 2: Location of Boreholes BH1 to BH6, Location of West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09) (reproduced from Ordnance Survey digital map data ©Crown copyright 2009. All rights reserved. License number 0100031673)**

## METHODS

### *Field Investigations*

Six boreholes (<BH1> to <BH6>) were put down in the south-eastern area of the site (Phase 3 of the construction work; Figure 2). The ground surface (located at approximately 1.5m OD across the site) was initially cleared of all reinforced concrete and contaminated Made Ground by Mansell Construction Services Limited. As soon as natural uncontaminated sediments were recorded in the field by Quaternary Scientific, boreholes were then put down using an Eijkelkamp window sampler and gouge set driven by an Atlas Copco TT 2-stroke percussion engine. Each borehole was put down until coarse grained unconsolidated sediments had been recorded. The spatial attributes of each borehole was recorded from the ground surface by Mansell Construction Services Limited (Table 1 and Figure 2).

**Table 1: Location of Boreholes BH1 to BH6, Location of West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09)**

Borehole number	Easting	Northing	Depth at surface (m OD)
BH1	539088.853	182320.893	1.38
BH2	539088.278	182347.701	1.55
BH3	539090.695	182375.626	1.39
BH4	539082.465	182386.137	1.33
BH5	539063.815	182389.620	1.38
BH6	539080.647	182413.135	1.47

### *Lithostratigraphic descriptions*

All borehole core samples were retained and described in the laboratory using standard procedures for recording unconsolidated sediment and peat, noting the physical properties (colour), composition (gravel, sand, clay, silt and organic matter) and inclusions (e.g. artefacts). The procedure involved: (1) cleaning the samples with a spatula or scalpel blade and distilled water to remove surface contaminants; (2) recording the physical properties, most notably colour; (3) recording the composition e.g. gravel, fine sand, silt and clay; (4) recording the degree of peat humification, and (5) recording the unit boundaries e.g. sharp or diffuse (Tables 2 to 7).

### *Organic matter determinations*

Sixty-four sub-samples were taken from boreholes <BH1>, <BH3> and <BH4> for determination of the organic matter content (Tables 8 to 10; Figure 4). These records were important for two reasons: (1) they identified lithostratigraphic units with a higher organic matter content that may be suitable for radiocarbon dating, and (2) they identified 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 (2) re-weighing the sub-sample obtain the 'loss-on-ignition' value (see Bengtsson and Enell, 1986).

### ***Pollen assessment***

Fifteen sub-samples borehole <BH1> and six sub-samples from borehole <BH3> were extracted for an assessment of pollen content. The pollen was extracted as follows: (1) sampling a standard volume of sediment (1ml); (2) deflocculation of the sample in 1% Sodium pyrophosphate; (3) sieving of the sample to remove coarse mineral and organic fractions (>125µ); (4) acetolysis; (5) removal of finer minerogenic fraction using Sodium polytungstate (specific gravity of 2.0g/cm<sup>3</sup>); (6) 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). Plant nomenclature follows the Flora Europaea as summarised in Stace (1997). The assessment procedure consisted of scanning the prepared slides, and recording the concentration and preservation of pollen grains and spores, and the principle taxa on four transects (10% of the slide) (Tables 11 and 12).

### ***Waterlogged plant macrofossil (seeds and wood) assessment***

Ten bulk samples subsampled from boreholes <BH1> and <BH3> were processed and assessed for waterlogged plant macrofossils. Four 10cm sub-samples extracted from borehole <BH1>, and six 10cm sub-samples extracted from borehole <BH3> were processed by wet-sieving using 300 micron and 1mm mesh sizes. Both fractions from each sample were scanned under a stereozoom microscope at x7-45 magnifications and the plant remains were recorded. Preliminary identifications of botanical remains have been made using modern comparative material and reference atlases (Cappers *et al.* 2006, Hather 2000, Schweingruber 1990, Schoch *et al.* 2004). Nomenclature used follows Stace (2005). The quantities of waterlogged seeds and wood were recorded for each sample, with identifications of the main seed and wood taxa (Tables 5 and 6).

## RESULTS AND INTERPRETATION OF THE LITHOSTRATIGRAPHIC ASSESSMENT

The deepest sedimentary units recorded comprised dominantly coarse-grained mineral-rich sediments in boreholes <BH1>, <BH3>, <BH4> and <BH6> (Figure 3). These deposits were not recorded elsewhere; borehole <BH2> had to be abandoned due the presence of contaminated Made Ground, and the base of the sequence was not reached in borehole BH5. There was some variation in the nature of the basal sediments, but they mainly consisted of gravels and sands, with some silt, clay and detrital wood. The upper surface of these deposits varies, between -2.86m in borehole <BH1> and -0.14m OD in borehole <BH6>, indicating a steep topographic rise in the gravel surface from south to north, in this area of the site. These records approximately reflect the findings of previous investigations (Bull and Corcoran, 2007), and represent the upper and/or reworked surface of the Pleistocene Gravel.

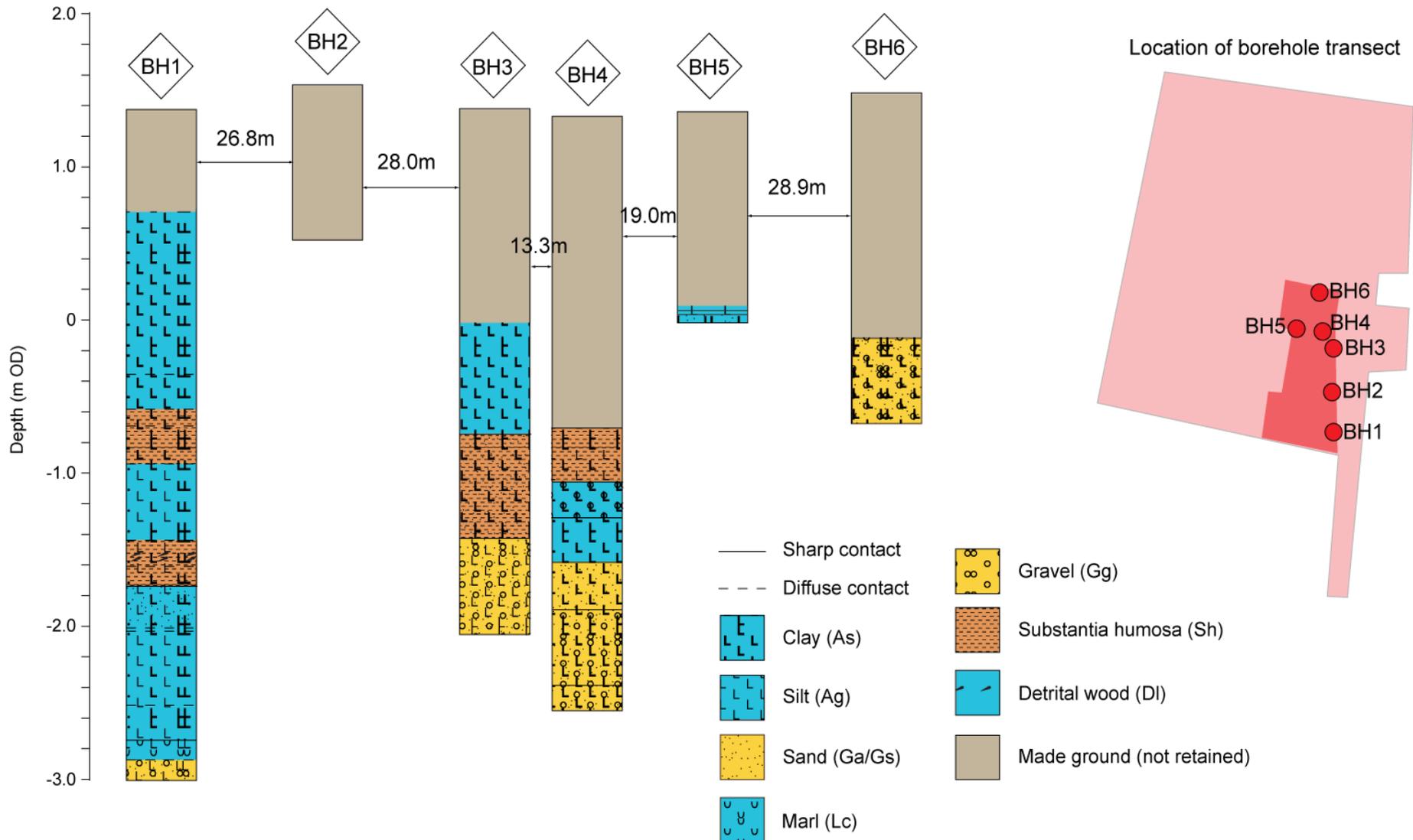
Overlying these coarse-grained sediments in boreholes <BH1>, <BH3>, <BH4>, <BH5>, and almost certainly <BH2>, was a varying thickness of fine-grained alluvial deposits, generally comprising silt and clay. A very thin layer of these deposits was also visually recorded in borehole <BH6> following clearance of the reinforced concrete and Made Ground. However, its absence within the borehole record would suggest that backfilling of the trench, (prior to drilling), removed what little material was originally present.

There is some variability in the nature of the alluvial deposits with three boreholes (<BH1>, <BH3> and <BH4>) containing organic-rich layers (*Substantia humosa*; up to 60% organic; Figures 3 and 4), which represent a transition towards semi-terrestrial conditions. In borehole <BH1> (Table 2), two of these horizons are recorded between -1.74m OD and -1.43m OD (Units 7 and 8), and -0.94 to -0.58m OD. These units approximately span a single, thicker unit of organic-rich sediments in borehole <BH3> (-1.42 to -0.76m OD; Unit 2; Table 4) which formed directly over the underlying gravel surface. A thinner unit of organic-rich sedimentation is also recorded in borehole <BH4> at approximately the same elevation as the second unit recorded in borehole <BH1>. These results therefore indicate at least one temporary shift towards semi-terrestrial conditions occurred contemporaneously across the site, between boreholes <BH1> and most likely <BH5>. The absence of these deposits towards the north of the site at borehole <BH6> is most likely the result of the rising topography of the underlying Gravel towards higher drier ground. Alternatively these deposits may have been subsequently truncated.

In addition, recorded at the transition between the Shepperton Gravel and alluvial deposits in borehole <BH1> only, were three Units spanning ca. 50cm containing significant quantities of

calcareous material that represents tufa sands. Similar deposits have been recorded in the Lea Valley approximately 2km north-west at the Olympic Park. Here, a sequence of calcareous sandy deposits developing into peaty silts and peats, suggested the infilling of initially active fluvial channels during the Middle Holocene (Green *et al.*, 2009). It is therefore suggested that the sequence (and therefore environmental history) recorded in the transect at West Ham Bus Garage, may have similar characteristics to those recorded at the Olympic Park.

In all boreholes, the fine grained alluvium was overlain by Made Ground that ranged in thickness, up to 2m. This variable thickness was similar to that recorded during previous investigations (Bull and Corcoran, 2007).



**Figure 3: Transect of lithostratigraphic sequences from Boreholes BH1 to BH6, West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09). The borehole logs are accurately spaced representing their geographical location**

**Table 2: Lithostratigraphic descriptions of Borehole <BH1>, West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09)**

Depth (m OD)	Unit number	Description
1.38 to 0.65	14	Made ground
0.65 to -0.35	13	5Y 3/2 with 10YR 2/1 and 2.5Y 7/2; As4 Gs+; Dark olive gray clay with small patches of black and occasional light gray sand. Diffuse contact into:
-0.35 to -0.58	12	5Y 3/2; As4 Sh+; Dark olive gray clay with organic matter. Diffuse contact into:
-0.58 to -0.69	11	10YR2/1; Sh2 As1 Ag1; Black organic rich silty clay. Diffuse contact into:
-0.69 to -0.94	10	10YR 2/1 to 5Y 3/2; As3 Sh1 DI+; Black to dark olive gray organic-rich clay with detrital wood. Diffuse contact into:
-0.94 to -1.43	9	5Y 3/2; As3 Ag1 Sh+ DI+; Dark olive gray silty clay with organic matter and detrital wood. Diffuse contact into:
-1.43 to -1.61	8	10YR2/1 to 5Y 3/2; As2 Sh1 DI1; Black to dark olive gray organic-rich clay with detrital wood. Diffuse contact into:
-1.61 to -1.74	7	10YR 2/1 to 5Y 3/2 with 2.5Y 6/2; As2 Ag1 Sh1 Gs+ DI+; Black to dark olive gray organic-rich silty clay with traces of light brownish gray sand and detrital wood. Sharp contact into:
-1.74 to -2.01	6	2.5Y 5/2 to 2.5Y 4/3; Ag2 As1 Ga1 Sh+ DI+ Humo 2; Grayish brown to olive brown clayey sandy silt with organic matter and detrital wood. Diffuse contact into:
-2.01 to -2.03	5	10YR 3/2; As3 Ag1; Very dark grayish brown silty clay.
-2.03 to -2.52	4	10YR 3/2; As2 Ag2 Ga+ DI+; Very dark grayish brown silty clay with traces of sand and detrital wood. Diffuse contact into:
-2.52 to -2.75	3	2.5Y 4/3; Ag3 As1 Lc+ Ga+ Sh+ DI+; Olive brown clayey silt with traces of sand, organic matter, tufa and detrital wood. Sharp contact into:
-2.75 to -2.86	2	2.5Y 4/2 to 2.5Y 7/2; Lc2 As1 Ag1 Ga+; Layers of dark grayish brown to light gray silty clayey tufa with sand. Diffuse contact into:
-2.86 to -3.03	1	10YR 2/1 to 10YR 4/1; Gs2 Gg1 Ag1 As+ Sh+ Lc+; Black to dark gray silty gravelly sand with clay, organic material and tufa.

**Table 3: Lithostratigraphic descriptions of Borehole <BH2>, West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09)**

Depth (m OD)	Unit number	Description
1.55 to 0.55	1	Made Ground – borehole abandoned

**Table 4: Lithostratigraphic descriptions of Borehole <BH3>, West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09)**

Depth (m OD)	Unit number	Description
1.39 to 0	4	Made Ground
0 to -0.76	3	2.5Y 4/3 mottled with 10YR 2/1 and 10YR 5/6; As4; Olive brown mottled with black and yellowish brown clay. Diffuse contact into:
-0.76 to -1.42	2	10YR 3/1; Sh2 Ag1 Ga1, DI+; Very dark grey organic-rich silt with occasional sandy horizons, detrital wood and Mollusca inclusions. Sharp contact into:
-1.42 to -2.04	1	10YR 4/1; Gs2 As1 Gg1 DI+; Dark gray clayey sand with gravel and detrital wood inclusions.

**Table 5: Lithostratigraphic descriptions of Borehole <BH4>, West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09)**

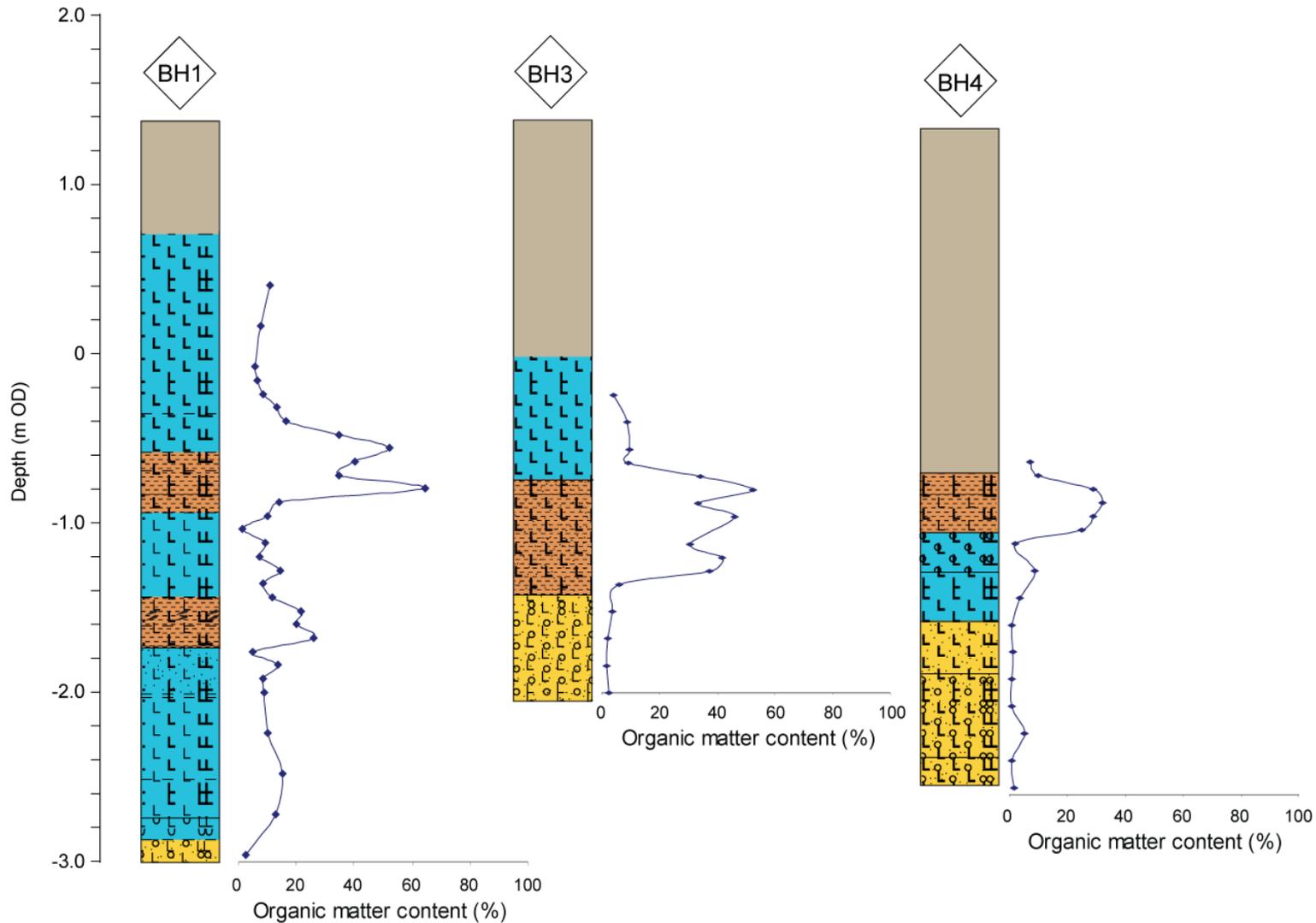
Depth (m OD)	Unit number	Description
1.34 to -0.70	7	Made Ground
-0.70 to -1.06	6	2.5Y 4/3 to 2.5Y 2.5/1; Ag2 As1 Sh1; Olive brown to black organic-rich clayey silt. Sharp contact into:
-1.06 to -1.29	5	10YR 4/1; Gs2 Gg1 As1; Dark gray clayey gravelly sand. Sharp contact into:
-1.29 to -1.57	4	10YR 4/1 to 10YR 2/1; Gs2 As2 Sh+; Dark gray to black clayey sand with organic-rich inclusions. Diffuse contact into:
-1.57 to -1.90	3	10YR 4/1; Gs2 As2 Gg+; Dark gray clayey sand with gravel. Sharp contact into:
-1.90 to -2.39	2	10YR 3/1; Gs2 Gg1 As1; Very dark gray, clayey gravelly sand. Sharp contact into:
-2.39 to -2.87	1	10YR 3/1; Gg2 Gs1 As1; Very dark gray clayey sandy gravel.

**Table 6: Lithostratigraphic descriptions of Borehole <BH5>, West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09)**

Depth (cm)	Unit number	Description
1.38 to 0.18	6	Made Ground
0.18 to 0.08	5	2.5Y 3/1; As3 Ag1 Gs+ Sh+ Dh+ DI+; Very dark gray silty clay with sand, organic-rich and detrital wood and plant remains. Unknown contact into:
0.08 to 0.13	4	2.5Y 3/1; As3 Ag1 Gs+ Sh+ Dh+; Very dark gray silty clay with sand, organic-rich and detrital plant remains. Unknown contact into:
0.13 to 0.08	3	2.5Y 3/1; As3 Ag1 Sh+ Dh+; Very dark gray silty clay with organic-rich and detrital plant remains. Unknown contact into:
0.08 to 0.03	2	2.5Y 3/1; As3 Ag1 Gs+ Sh+ Dh+ DI+; Very dark gray silty clay with sand, organic-rich, detrital wood and plant remains. Unknown contact into:
0.03 to -0.02	1	2.5Y 3/1; As2 Ag1 Gs1 Gg+ Sh+ Dh+ DI+; Very dark gray silty sandy clay with gravel, organic-rich, detrital wood and plant remains

**Table 7: Lithostratigraphic descriptions of Borehole <BH6>, West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09)**

Depth (m OD)	Unit number	Description
1.47 to -0.14	2	Made Ground
-0.14 to -0.69	1	10YR 3/1; Gs2 Gg1 As1 DI+; Very dark gray clayey gravelly sand with detrital wood and Mollusca inclusions



**Figure 4: Organic matter content values for Boreholes <BH1>, <BH3> and <BH4>, West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09). The borehole logs are accurately spaced representing their geographical location**

**Table 8: Organic matter content determinations of Borehole <BH1>, West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09)**

Depth (m OD)	Unit number	Organic matter (%)
0.39 to 0.40	13	10.88
0.15 to 0.16	13	7.38
-0.09 to -0.08	13	5.58
-0.17 to -0.16	13	6.37
-0.25 to -0.24	13	8.44
-0.33 to -0.32	13	13.05
-0.41 to -0.40	12	16.53
-0.49 to -0.48	12	34.71
-0.57 to -0.56	12	52.23
-0.65 to -0.64	11	40.20
-0.73 to -0.72	10	34.70
-0.81 to -0.80	10	64.35
-0.89 to -0.88	10	14.03
-0.97 to -0.96	9	9.82
-1.05 to -1.04	9	1.31
-1.13 to -1.12	9	8.98
-1.21 to -1.20	9	7.15
-1.29 to -1.28	9	14.30
-1.37 to -1.36	9	8.56
-1.45 to -1.44	8	11.43
-1.53 to -1.52	8	21.33
-1.61 to -1.60	8	19.98
-1.69 to -1.68	7	25.83
-1.77 to -1.76	5	4.81
-1.85 to -1.84	6	13.50
-1.93 to -1.92	6	8.53
-2.01 to -2.00	6	8.69
-2.25 to -2.24	4	10.02
-2.49 to -2.48	4	15.32
-2.73 to -2.72	2	12.80
-2.97 to -2.96	1	2.19

**Table 9: Organic matter content determinations of Borehole <BH3>, West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09)**

Depth (m OD)	Unit number	Organic matter (%)
-0.09 to -0.08	3	0.00
-0.25 to -0.24	3	4.03
-0.41 to -0.40	3	8.61
-0.57 to -0.56	3	9.40
-0.65 to -0.64	3	9.02
-0.73 to -0.72	3	34.15
-0.81 to -0.80	2	52.53
-0.89 to -0.88	2	33.20
-0.97 to -0.96	2	45.84
-1.13 to -1.12	2	30.65
-1.21 to -1.20	2	41.52
-1.29 to -1.28	2	37.38
-1.37 to -1.36	2	6.01
-1.53 to -1.52	1	3.56
-1.69 to -1.68	1	2.00
-1.85 to -1.84	1	1.66
-2.01 to -2.00	1	2.32

**Table 10: Organic matter content determinations of Borehole <BH3>, West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09)**

Depth (m OD)	Unit number	Organic matter (%)
-0.72 to -0.71	6	9.85
-0.80 to -0.79	6	29.08
-0.88 to -0.87	6	32.18
-0.96 to -0.95	6	28.92
-1.04 to -1.03	6	25.10
-1.12 to -1.11	5	1.81
-1.28 to -1.27	5	8.76
-1.44 to -1.43	4	3.60
-1.60 to -1.59	3	0.76
-1.76 to -1.75	3	1.14
-1.92 to -1.91	2	0.71
-2.08 to -2.07	2	0.92
-2.24 to -2.23	2	5.31
-2.40 to -2.39	1	0.87
-2.56 to -2.55	1	1.52

## RESULTS OF THE POLLEN-STRATIGRAPHIC ASSESSMENT

### **Borehole <BH1>**

Fifteen sub-samples were extracted from borehole <BH1> for assessment of the pollen content (Table 11). No pollen or microscopic charred particles were preserved in the single sample from the sand and gravel deposits at the base of the sequence (-2.96 to -2.97m OD; unit 1). In the five sub-samples collected from the tufa sand, clay and silt units overlying the gravels (between -2.73m and -1.76m OD; units 3-6), the concentration of pollen was absent or poor, and preservation poor to moderate. Pollen is best preserved in anaerobic and acidic environments, and therefore its limited concentration and variable preservation in these calcareous-rich sediments is unsurprising. Nevertheless, the occurrence of Cyperaceae (sedge family), Poaceae (grass family), *Typha latifolia* (bulrush) and *Sparganium* type (bur-reed) indicate the growth of herbaceous and aquatic plants, most likely in a semi-aquatic environment. Microscopic charred particles were either absent or recorded in very low concentrations in these samples.

Pollen preservation and concentration was also poor or absent in the five samples taken between -1.53m and -0.56m OD, which comprised the two organic-rich, and single mineral-rich horizons (units 8-11). *Alnus* (alder) was the most commonly preserved with *Corylus* type (e.g. hazel) and *Pinus* (pine). Microscopic charred particles were either absent or recorded in very low concentrations in these samples. In the four samples taken from the fine grained mineral-rich sediments at the top of the sequence (units 12-13), pollen concentration and preservation was generally very low to absent, with the exception of the sample taken from -0.32 to -0.33m OD had a very high concentration and moderate preservation. The main taxa included *Alnus* (alder), Poaceae (grass family), Cyperaceae (sedge family) and *Typha latifolia* (bulrush). The assemblage is indicative of wet woodland dominated by alder, with an understorey of grasses, sedges and aquatics. *Corylus* type (e.g. hazel) may have grown on the wetland, but is equally likely to have formed mixed deciduous woodland on the dryland with *Tilia* (lime). Microscopic charred particles were recorded in low to moderate concentrations in these samples.

**Table 11: Pollen-stratigraphic assessment of Borehole <BH1>, West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09)**

Depth (m OD)	Unit number	Concentration	Preservation	Microscopic charcoal	Main taxa	
					Latin name	Common name
0.40 to 0.39	13	1	1	3	cf Poaceae	grass family
0.16 to 0.15	13	0	-	2	-	-
-0.08 to -0.09	13	1	2	2	<i>Corylus</i> type	e.g. hazel
-0.32 to -0.33	13	5	3	2	<i>Alnus</i> <i>Tilia</i> <i>Pinus</i> <i>Corylus</i> type Poaceae Cyperaceae <i>Typha latifolia</i>	alder lime pine e.g. hazel grass family sedge family bulrush
-0.56 to -0.57	11	1-2	3	1	<i>Alnus</i> <i>Pinus</i>	alder pine
-0.80 to -0.81	10	1	2	1	<i>Alnus</i> <i>Corylus</i> type	alder e.g. hazel
-1.04 to -1.05	9	0	-	1	-	-
-1.28 to -1.29	9	1	2	1	<i>Alnus</i>	alder
-1.52 to -1.53	8	1	2	2	<i>Alnus</i> <i>Corylus</i> type	alder e.g. hazel
-1.76 to -1.77	6	0	-	-	-	-
-2.00 to -2.01	5	0	-	-	-	-
-2.24 to -2.25	4	1	2-3	1	Cyperaceae	sedge family
-2.48 to -2.49	4	1	3	-	cf <i>Trifolium</i> type Poaceae	e.g. red clover grass family
-2.72 to -2.73	3	1	4	-	Poaceae <i>Typha latifolia</i> <i>Sparganium</i> type	grass family bulrush bur-reed
-2.96 to -2.97	1	0	-	-	-	-

Key: 0 = 0 estimated grains per slide; 1 = 1 to 75; 2 = 76 to 150; 3 = 151 to 225; 4 = 226-300; 5 = 300+. Estimated number based on assessment of 10% of total number of slide transects (4 of 40 transects)

### **Borehole <BH3>**

Six sub-samples were extracted from the organic-rich horizon (unit 2) within borehole <BH3> for assessment of the pollen content (Table 12). Pollen concentration and preservation was moderate to very high throughout, whilst the quantity of microscopic charred particles increased towards the top of the sequence.

The main taxa included *Alnus* (alder), *Quercus* (oak), *Corylus* type (e.g. hazel/bog myrtle), *Pinus* (pine), *Salix* (willow), *Fraxinus* (ash) and *Tilia* (lime). This assemblage is indicative of wet woodland dominated by alder, with willow, ash, and an understorey of grasses (Poaceae), sedges (Cyperaceae), aquatics (e.g. *Typha latifolia* – bulrush), and ferns (e.g. *Dryopteris* type – buckler fern). Oak and hazel may have grown on the wetland, but are

equally likely to have formed mixed deciduous/coniferous woodland on the dryland with *Tilia* (lime) and *Pinus* (pine).

**Table 12: Pollen-stratigraphic assessment of Borehole <BH3>, West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09)**

Depth (m OD)	Unit number	Concentration	Preservation	Microscopic charcoal	Main taxa	
					Latin name	Common name
-0.76 to -0.77	2	4-5	3	2	<i>Alnus</i> Poaceae Cyperaceae cf <i>Sparganium</i> type	alder grass family sedge family bur-reed
-0.98 to -0.99	2	3	3	1	<i>Alnus</i> <i>Betula/Corylus</i> type <i>Tilia</i> cf <i>Fraxinus</i> <i>Dryopteris</i> type	alder birch/e.g. hazel  lime ash buckler fern
-1.00 to -1.01	2	3-4	3-4	1	<i>Alnus</i> cf <i>Tilia</i> cf <i>Salix</i> <i>Typha latifolia</i> <i>Sparganium</i> type <i>Dryopteris</i> type	alder lime willow bulrush bur-reed buckler fern
-1.08 to -1.09	2	4	3	0	<i>Alnus</i> <i>Quercus</i> <i>Pinus</i> Poaceae <i>Dryopteris</i> type	alder oak pine grass family buckler fern
-1.18 to -1.19	2	5	4	0	<i>Alnus</i> <i>Quercus</i> <i>Pinus</i> <i>Dryopteris</i> type	alder oak pine buckler fern
-1.23 to -1.24	2	3	3	0	<i>Alnus</i> <i>Quercus</i> <i>Corylus</i> type cf Cyperaceae <i>Sparganium</i> type <i>Dryopteris</i> type	alder oak e.g. hazel sedge family bur-reed buckler fern

Key: 0 = 0 estimated grains per slide; 1 = 1 to 75; 2 = 76 to 150; 3 = 151 to 225; 4 = 226-300; 5 = 300+. Estimated number based on assessment of 10% of total number of slide transects (4 of 40 transects)

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

Ten bulk samples subsampled from boreholes <BH1> and <BH3> were processed and assessed for waterlogged plant macrofossils. Four 10cm sub-samples extracted from borehole BH1, and six 10cm sub-samples extracted from borehole <BH3>.

### ***Borehole <BH1>***

The results of the waterlogged plant macrofossil assessment indicate that a low quantity of wood and seeds were preserved in the the organic horizons of borehole <BH1>. The waterlogged wood assemblage comprised two pieces of possible alder (cf *Alnus glutinosa*), and a number of unidentifiable fragments. The waterlogged seed assemblage consisted of *Ranunculus* sp (buttercup family) and indeterminate fruit skins.

### ***Borehole <BH3>***

The results of the waterlogged plant macrofossil assessment indicate that a low quantity of wood and seeds were preserved in the the organic horizons of borehole <BH3>. The waterlogged wood assemblage comprised two pieces of possible alder (cf *Alnus glutinosa*), two pieces of hazel/alder (*Corylus/Alnus*) and a number of unidentifiable fragments. The waterlogged seed assemblage consisted of *Alnus glutinosa* (seeds and catkins), *Sambucus nigra* (elder) and indeterminate fruit and seed skins.

**Table 5: Results of the waterlogged plant macrofossil (seeds and wood) assessment of Borehole <BH1>, West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09)**

Depth (m OD)	Unit number	Volume (litres)	Fraction (e.g. flot, residue, >300µm)	Waterlogged		Main taxa	
				Wood	Seeds	Latin name	Common name
-0.80 to -0.90	10	<0.1	>1mm	1	1	<u>Waterlogged wood</u>	<u>Waterlogged wood</u>
			>300µm	0	0	- <u>Waterlogged seeds</u> <i>Sambucas nigra</i>	Indeterminate <u>Waterlogged seeds</u> elder
-0.90 to -1.00	9/10	<0.1	>1mm	1	0	<u>Waterlogged wood</u>	<u>Waterlogged wood</u>
			>300µm	0	1	cf <i>Alnus glutinosa</i> <u>Waterlogged seeds</u>	alder <u>Waterlogged seeds</u> Indeterminate fruit skins
-1.00 to -1.10	9	<0.1	>1mm	1	0	<u>Waterlogged wood</u>	<u>Waterlogged wood</u>
			>300µm	1	1	cf <i>Alnus glutinosa</i> <u>Waterlogged seeds</u>	alder <u>Waterlogged seeds</u> Indeterminate fruit skins
-1.10 to -1.20	9	<0.1	>1mm	1	1	<u>Waterlogged wood</u>	<u>Waterlogged wood</u>
			>300µm	0	0	- <u>Waterlogged seeds</u> cf <i>Ranunculus</i> sp	Indeterminate <u>Waterlogged seeds</u> buttercup family Monocotyledon stem fragments

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 6: Results of the waterlogged plant macrofossil (seeds and wood) assessment of Borehole <BH3>, West Ham Bus Garage (the former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09)**

Depth (m OD)	Unit number	Volume (litres)	Fraction (e.g. flot, residue, >300µm)	Waterlogged		Main taxa	
				Wood	Seeds	Latin name	Common name
-0.75 to -0.85	2	<0.1	>1mm	2	1	<u>Waterlogged wood</u>	<u>Waterlogged wood</u>
			>300µm	1	1	<i>Corylus/Alnus</i> sp (2) <i>Alnus glutinosa</i> <u>Waterlogged seeds</u> <i>Sambucas nigra</i>	hazel/alder alder <u>Waterlogged seeds</u> elder Indeterminate fruit skins
-0.85 to -0.95	2	<0.1	>1mm	1	2	<u>Waterlogged wood</u>	<u>Waterlogged wood</u>
			>300µm	0	0	- <u>Waterlogged seeds</u> <i>Alnus glutinosa</i> (fruits and catkins)	Indeterminate <u>Waterlogged seeds</u> alder  Monocotyledon stem fragments
-0.95 to -1.05	2	<0.1	>1mm	1	0	<u>Waterlogged wood</u>	<u>Waterlogged wood</u>
			>300µm	1	1	- <u>Waterlogged seeds</u> <i>Alnus glutinosa</i>	Indeterminate <u>Waterlogged seeds</u> alder
-1.05 to -1.15	2	<0.1	>1mm	1	1	<u>Waterlogged wood</u>	<u>Waterlogged wood</u>
			>300µm	1	1	- <u>Waterlogged seeds</u> <i>Alnus glutinosa</i>	Indeterminate <u>Waterlogged seeds</u> alder Monocotyledon stem fragments Indeterminate fruit skins
-1.15 to -1.25	2	<0.1	>1mm	1	1	<u>Waterlogged wood</u>	<u>Waterlogged wood</u>
			>300µm	0	1	<i>Alnus glutinosa</i> <u>Waterlogged seeds</u> <i>Alnus glutinosa</i>	alder <u>Waterlogged seeds</u> alder Monocotyledon stem fragments
-1.25 to -1.35	2	<0.1	>1mm	1	0	<u>Waterlogged wood</u>	<u>Waterlogged wood</u>
			>300µm	0	1	- <u>Waterlogged seeds</u>	Indeterminate <u>Waterlogged seeds</u> Leaf fragments Monocotyledon stem fragments Indeterminate fruit and seed fragments

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+

## **DISCUSSION AND CONCLUSIONS**

The preliminary deposit model for the West Ham Bus Garage proposed by Batchelor *et al* (2009) has been confirmed by the results of the environmental archaeological assessment. The sequence of deposition can be divided into five main stratigraphic units, in order of deposition as follows:

1. Coarse grained mineral-rich sediments dominated by gravels and sands probably representative of the Pleistocene Shepperton Gravel were recorded at the base of the sequence. The surface elevation of these deposits indicates a steep rise towards the north of the site.
2. Calcareous-rich sediments were recorded above the Pleistocene Gravel to the south of the site, in the deepest borehole sequence (<BH1>), representing tufa deposits at the base of a previously active channel
3. Alluvial fine grained mineral-rich deposits overlay the Pleistocene Gravel/calcareous deposits across the site. These deposits reflected the underlying topography, being thickest in the south of the site, and thinning towards the north, where the elevation of the Pleistocene Gravel indicates the presence of higher, drier ground.
4. Organic-rich deposits representative of shifts towards semi-terrestrial conditions were recorded within the alluvium. These deposits were thickest in borehole <BH3>, where they formed directly over the gravels and sands.
5. Made Ground of variable thickness truncated the natural deposits in all boreholes.

The biostratigraphic record (pollen and waterlogged plant macrofossils) indicates that during the deposition of the alluvium, and in particular the organic-rich horizons, the wetland was dominated by alder, with an understorey of shrubs (including willow, elder and hazel) grasses, sedges and semi-aquatic taxa. On the dryland, the pollen-stratigraphic assessment indicates the presence of mixed deciduous woodland dominated by oak with lime. No definitive indicators of anthropogenic activity (e.g. cereals) were recorded within the assessment.

## **RECOMMENDATIONS**

The preservation and concentration of pollen and waterlogged plant macrofossils was very limited within the sedimentary sequence from borehole <BH1>. It is therefore recommended that no further work is carried out on this sequence.

The preservation and concentration of pollen is moderate to high in the sedimentary sequence from borehole <BH3>. Pollen analysis definitely has the potential to provide a reconstruction of the vegetation history, and detect evidence for human activities (e.g.

woodland clearance and cultivation) in this part of the Lea Valley and is therefore recommended. The results of the waterlogged plant assessment indicate that the preservation and concentration of wood and seeds is too limited to permit further work. Nevertheless the results of the assessment can be integrated into the analysis. Radiocarbon dating of the organic-rich (top and base) from borehole <BH3> will also form an essential part of the analysis.

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## APPENDIX B: OASIS FORM

**OASIS ID: quaterna1-62755**

### Project details

Project name	Environmental archaeological assessment, West Ham Bus Depot (site code: WHQ09)
Short description of the project	Environmental archaeological assessment was carried out on boreholes collected during a previous borehole survey at the site. The investigations consisted of organic matter determinations, and pollen and waterlogged plant macrofossil (seeds and wood) assessments. The results revealed that preservation and concentration of pollen was poor in borehole but moderate-high in . Waterlogged plant macrofossils were limited in both boreholes assessed. The biostratigraphic assessment results broadly indicate that during the deposition of alluvium, and in particular the organic-rich horizons, the wetland was dominated by alder, with an understorey of shrubs (including willow, elder and hazel) grasses, sedges and semi-aquatic taxa. On the dryland, the pollen-stratigraphic assessment indicates the presence of mixed deciduous woodland dominated by oak with lime. No definitive indicators of anthropogenic activity (e.g. cereals) were recorded within the assessment.
Project dates	Start: 15-05-2009 End: 31-07-2009
Previous/future work	Yes / Not known
Any associated project reference codes	WHQ09 - Sitecode
Type of project	Environmental assessment
Site status	None
Current Land use	Community Service 1 - Community Buildings
Monument type	BUS STATION Uncertain
Significant Finds	PEAT Uncertain
Significant Finds	ALLUVIUM Uncertain
Survey techniques	Ecology

### Project location

Country	England
Site location	GREATER LONDON NEWHAM WEST HAM West Ham Bus Garage
Postcode	E16
Study area	5.20 Hectares
Site coordinates	TQ 39050 82500 51.5237738094 0.00456342060556 51 31 25 N 000 00 16 E Point
Height OD / Depth	Min: -2.90m Max: 0.70m

### Project creators

Name of Organisation	Quaternary Scientific (QUEST)
Project brief originator	Quaternary Scientific (QUEST)
Project design originator	Dr N.P. Branch
Project director/manager	C.R. Batchelor
Project supervisor	C.R. Batchelor
Type of sponsor/funding body	Developer
Name of sponsor/funding body	Mansell Construction Services Limited

### Project archives

Physical Archive recipient	LAARC
Physical Archive ID	WHQ09
Physical Contents	'Environmental'

Digital Archive recipient	LAARC
Digital Archive ID	WHQ09
Digital Contents	'Environmental','Stratigraphic','Survey'
Digital Media available	'Images raster / digital photography','Images vector','Spreadsheets','Survey','Text'
Paper Archive recipient	LAARC
Paper Archive ID	WHQ09
Paper Contents	'Environmental','Stratigraphic','Survey'
Paper Media available	'Correspondence','Report'

### Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	WEST HAM BUS GARAGE (THE FORMER PARCEL FORCE DEPOT), WEST OF STEPHENSON STREET, LONDON BOROUGH OF NEWHAM (SITE CODE: WHQ09): ENVIRONMENTAL ARCHAEOLOGICAL ASSESSMENT
Author(s)/Editor(s)	Batchelor, C.R.
Author(s)/Editor(s)	Branch, N.P.
Author(s)/Editor(s)	Allott, L.
Author(s)/Editor(s)	Morgan, P.
Author(s)/Editor(s)	Young, D.
Other bibliographic details	Unpublished Report July 2009; Project Number 007/08

Date 2009

Issuer or publisher Quaternary Scientific (QUEST)

Place of issue or publication Unpublished report

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**Project bibliography 2**

Publication type Grey literature (unpublished document/manuscript)

Title A report on the geoarchaeological borehole investigations: West Ham Bus Garage (The former Parcel Force Depot), West of Stephenson Street, London Borough of Newham (site code: WHQ09)

Author(s)/Editor(s) Batchelor, C.R.

Author(s)/Editor(s) Branch, N.P.

Author(s)/Editor(s) Morgan, P.

Author(s)/Editor(s) Young, D.

Other bibliographic details Quaternary Scientific (QUEST) Unpublished Report April 2009; Project Number 007/08

Date 2009

Issuer or publisher Quaternary Scientific (QUEST)

Place of issue or publication Unpublished report

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**Project bibliography 3**

Publication type Grey literature (unpublished document/manuscript)

Title Parcel Force Depot, West of Stephenson Street, London, E16: Desk-based assessment

Author(s)/Editor(s) Bull, R.

Author(s)/Editor(s) Corcoran, J.  
Date 2007  
Issuer or publisher MoLAS-PCA Archaeology Limited  
Place of issue or publication Unpublished report

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**Project bibliography 4**

Publication type Grey literature (unpublished document/manuscript)  
Title Written Scheme of Investigation for the geoarchaeological investigation of The Parcel Force Depot, West of Stephenson Street, London, E16  
Author(s)/Editor(s) Branch, N.P.  
Date 2008  
Issuer or publisher ArchaeoScape  
Place of issue or publication Unpublished report

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