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OPUS II, BELVEDERE, GREATER LONDON: GEOARCHAEOLOGICAL ASSESSMENT OF BOREHOLES

Prepared for Wardell Armstrong Archaeology

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SUMMARY

In October 2016, ARCA logged five borehole cores totalling 25m from the Opus II site at Belvedere, Greater London. In conjunction with eight borehole logs from ground investigation work by TRC Companies Ltd, the Shepperton Gravel Member was determined to sub crop at between -5.04 OD and -7.68m OD. The site lies over the western margin of a possible west-north-west to east-south-east trending Late Glacial channel of the Thames identified by Young et al *(2012). Overlying the Shepperton Gravel Member was a Lower Alluvium, a sandy silt/clay channel fill. This unit, in turn, was overlain by peat possibly filling later channels cut into the top of the alluvium. The peat was characteristic of a wooded, wetland environment subject to flooding. It was between 3.30m and 2.60m thick and sub cropped between -1.84m OD and -3.51m OD. Eventual inundation of this semi terrestrial environment is evidenced by* c.*2m of fine sandy silt/clays forming an Upper Alluvium. Hiatuses within this deposit are marked by rare, thin, peaty mud horizons. Topsoil and made ground complete the sequence. The site stratigraphy is discussed in the context of the neighbouring Pirelli Works site and more local BGS borehole data.*

1. INTRODUCTION

1.1 In October 2016 at the request of Mr Nick Daffern of Wardell Armstrong Archaeology, five geoarchaeological borehole cores were logged in the ARCA Laboratory at the University of Winchester. One core was sampled for chronometric and palaeoenvironmental data. The cores were recovered from Opus II, Belvedere, Greater London (henceforth known as the 'site') as part of a programme of archaeological field evaluation to support the future planning application for redevelopment

1.2 This document assesses the stratigraphic sequence recovered from the site. It is arranged as follows: first a brief account is provided of the geographic, geological and methodological background to the geoarchaeological project; secondly the borehole stratigraphy is described in detail; and finally the potential of the sample resource in the boreholes to address the questions outlined in Section 1.7 is assessed. A bibliography and appendices containing sample type and elevation, the locations of the boreholes and the lithological descriptions of the stratigraphy complete the document.

1.3 The site is located in the Lower River Thames Valley, *c.*1km west from Erith Reach on the south bank. It is bounded on the west by The Bronze Age Way (the A2016 trunk road), on the north by St Thomas Road, on the east by Crabtree Manorway North and on the north by a major drain. It occupies an area of 0.87ha of undeveloped land at an elevation of *c.*0.5m OD, and is centred on National Grid Reference 550060, 179640.

1.4 The British Geological Survey (BGS) map the site as lying on superficial deposits of unlithified clays, silts, peats, and sand that date to the Holocene Epoch 10000 BP to present. Underlying these deposits is the Shepperton Gravel Member, a gravel with sand and clay fractions that lies unconformably on an erosional surface cut into the Thanet Formation bedrock. This bedrock Formation consists of predominantly yellowish brown glauconitic sands that can be slightly clayey. The bedrock is part of the Palaeogene Period and dates from the Thanetian Age 59.2 Ma (million years ago) (BGS 2016a).

1.5 The site (0.87ha) is adjacent to the extensive (*c.*27ha) Pirelli Works site and is located on its north west boundary. Young *et al* have analysed 40 borehole records pertinent to the Pirelli site and have identified five main sedimentary units: '(1) Shepperton

Gravel (incorporating Basal Sands); (2) Lower Alluvium (incorporating the Lower Organic Horizon); (3) Peat; (4) Upper Alluvium, and (5) Made Ground' (Young *et al* 2012, 7). These informal geological units will be followed in this report.

1.6 Young *et al* (2012) have identified two possible channels both trending west-north-west to east-south-east that are cut into the Shepperton Gravel Member. These channels are filled with fine grained mieralogenic alluvium with peat growth in the intervening areas. This interpretation supersedes Halsey's possible Early to Mid Holocene channel trending west-south-west to east-north-east (Halsey 2007 cited in Young *et al* 2012) (for a detailed discussion see Young *et al* 2012, 1-2). The Belvedere site is situated over the eastern margin of the probable course of the western channel.

1.7 The objectives of the geoarchaeological work at the site were to:

1.7.1 Determine the Holocene sedimentary sequence on the site.
1.7.2 Assess the archaeological and palaeoenvironmental potential of the Holocene sedimentary units encountered.

2. METHODOLOGY

2.1 The five geoarchaeological boreholes WAA WS1 to WAA WS5 were drilled for Wardell Armstrong Archaeology using a Competitor Window Sampler rig (Figure 1). The borehole cores were transported to the ARCA Laboratory at the University of Winchester where they were described by ARCA geoarchaeologists using standard geological criteria (Tucker 1982; Jones *et al* 1999; Munsell Color 2000). Borehole core WWA WS5 was selected for sub sampling. Thirteen geotechnical boreholes were also recorded: five from the BGS (BGS 2016b) located outside the site in the immediate environs and eight drilled by TRC Companies Ltd within the site for ground investigation works (TRC 2015, 2016). The sub sample type and elevation, the borehole locations and full stratigraphic descriptions of the borehole cores, including drillers' records for the geotechnical cores, are presented in Appendices 1, 2 and 3 respectively.

2.2 Lithological descriptions and positional data from all the boreholes were combined within a RockWorks database (RockWare 2013). The RockWorks software package was then

used to plot four lithological cross sections. Both formal and informal lithostratigraphic nomenclature has been adopted here (Figures 2, 3, 4 and 6).

2.3 The cores are held in storage at the ARCA Laboratory at the University of Winchester. Digital data (photographs and Rockworks files) are held on the University of Winchester server. No artefacts were recovered.

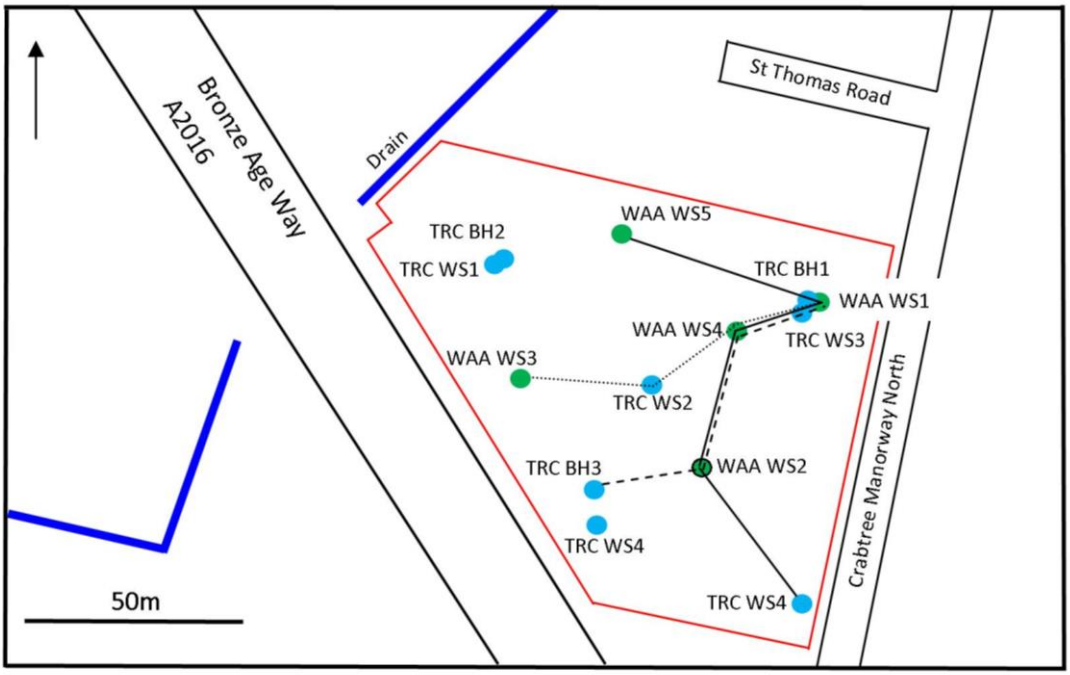

Figure 1. Plan of the site. Site boundary in red. West to east section 1: WAA WS3 – WAA WS1. West to east section 2: TRC BH3 – WAA WS1. South to north section TRC WS4 – WAA WS5.

3. BOREHOLE STRATIGRAPHY

The stratigraphy described in this section includes not only the geoarchaeological boreholes but also the ground investigation boreholes drilled on the site: a total of 13 boreholes. The BGS boreholes drilled off the site will be discussed in section 6.1. Four major stratigraphic units (formal and informal members) were recorded in the borehole stratigraphy (Figure 2). These are reviewed below in chronological order.

3.1 Thanet Formation

3.1.1 The Thanet Formation is believed to represent inner shelf to coastal deposits. It occurs in the middle and eastern parts of the London basin and is thickest in north Kent where it reaches 20–30m.

3.1.2 Rockhead of the Thanet Formation was not encountered in the geoarchaeological and ground investigation boreholes on the site. The maximum depth recorded was -18.27m OD in TRC BH3 and gravels of the Shepperton Gravel Member were recovered. Approximately 250m to the southwest of the site sands of the Thanet Formation were recorded at -13.38m OD in BGS TQ47NE211.

3.1.3 The Thanet Formation is unconformably overlain by Quaternary sediments in BGS TQ47NE211.

3.2 Shepperton Gravel Member

3.2.1 Deposits of fluvial gravel were encountered in TRC BH1, TRC BH2 and TRC BH3 and sub cropped between -5.04m OD and -7.68m OD in TRC BH2 and TRC BH1 respectively (Figure 3). Sand was recorded as a distinct lithological unit only in TRC BH2 and even then it contained a gravel fraction; it was described in the drillers' log as 'Medium dense brown grey slightly gravelly silty SAND with occasional shell fragments. Gravel is fine to coarse subangular to rounded flint'. The gravel was described in a similar fashion but with emphasis on the gravel component: 'Dense grey brown sandy silty GRAVEL with occasional shell fragments. Gravel is fine to coarse subangular to rounded flint' (TRC 2016).

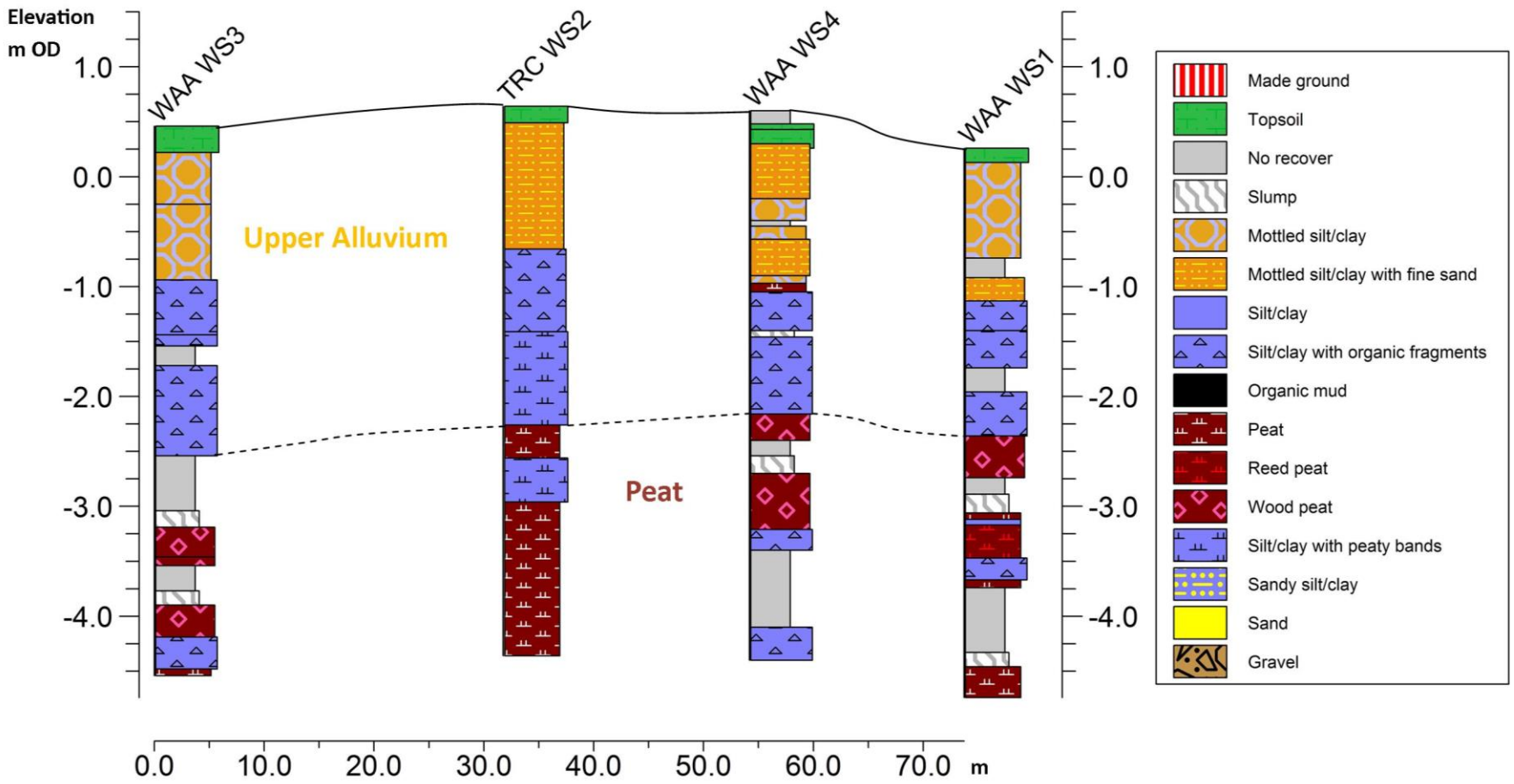

Figure 2. West to east section 1: WAA WS3 – WAA WS1. Vertical exaggeration x10.

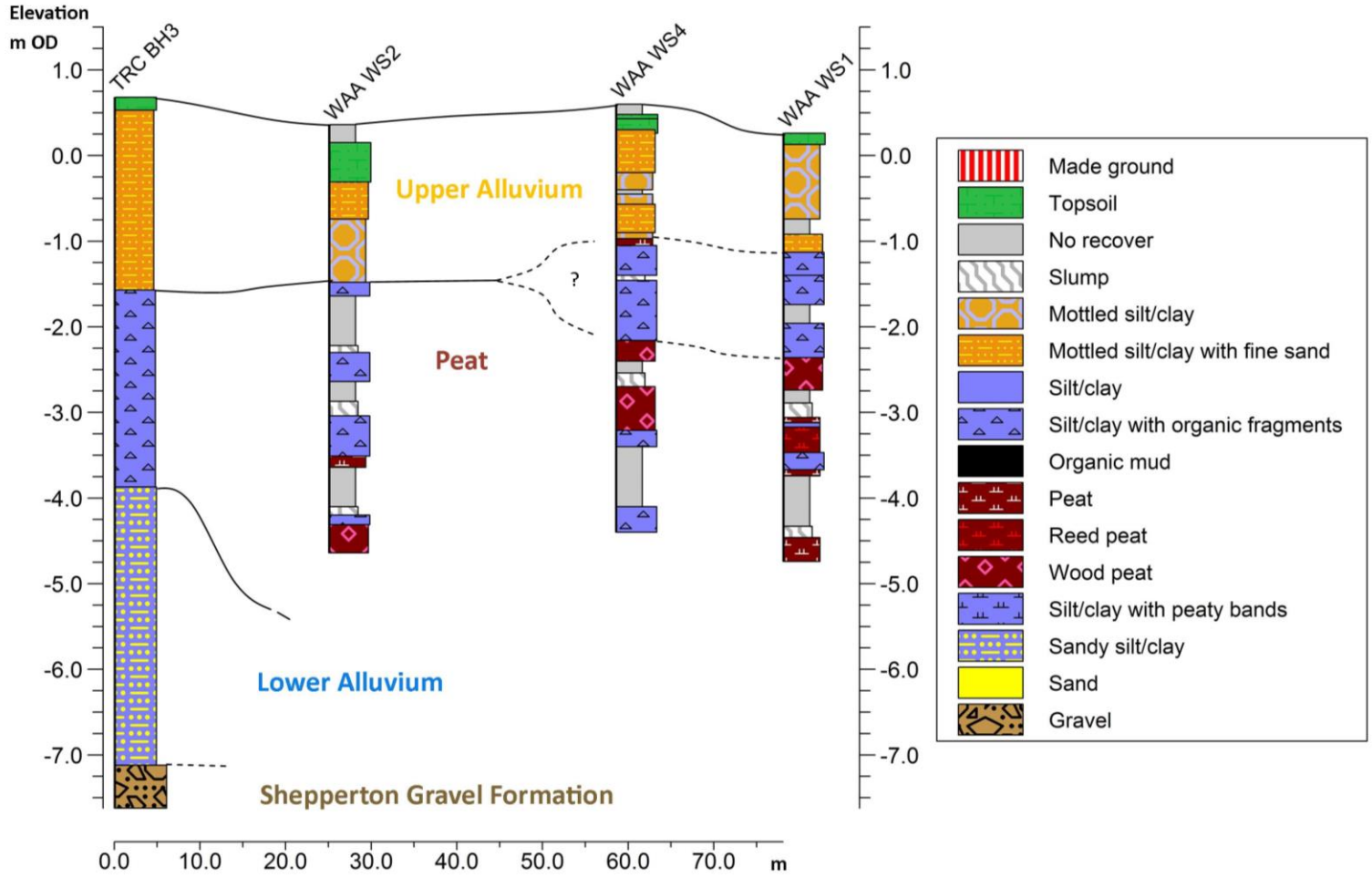

Figure 3. West to east section 2: TRC BH3- WAA WS1. Vertical exaggeration x32.

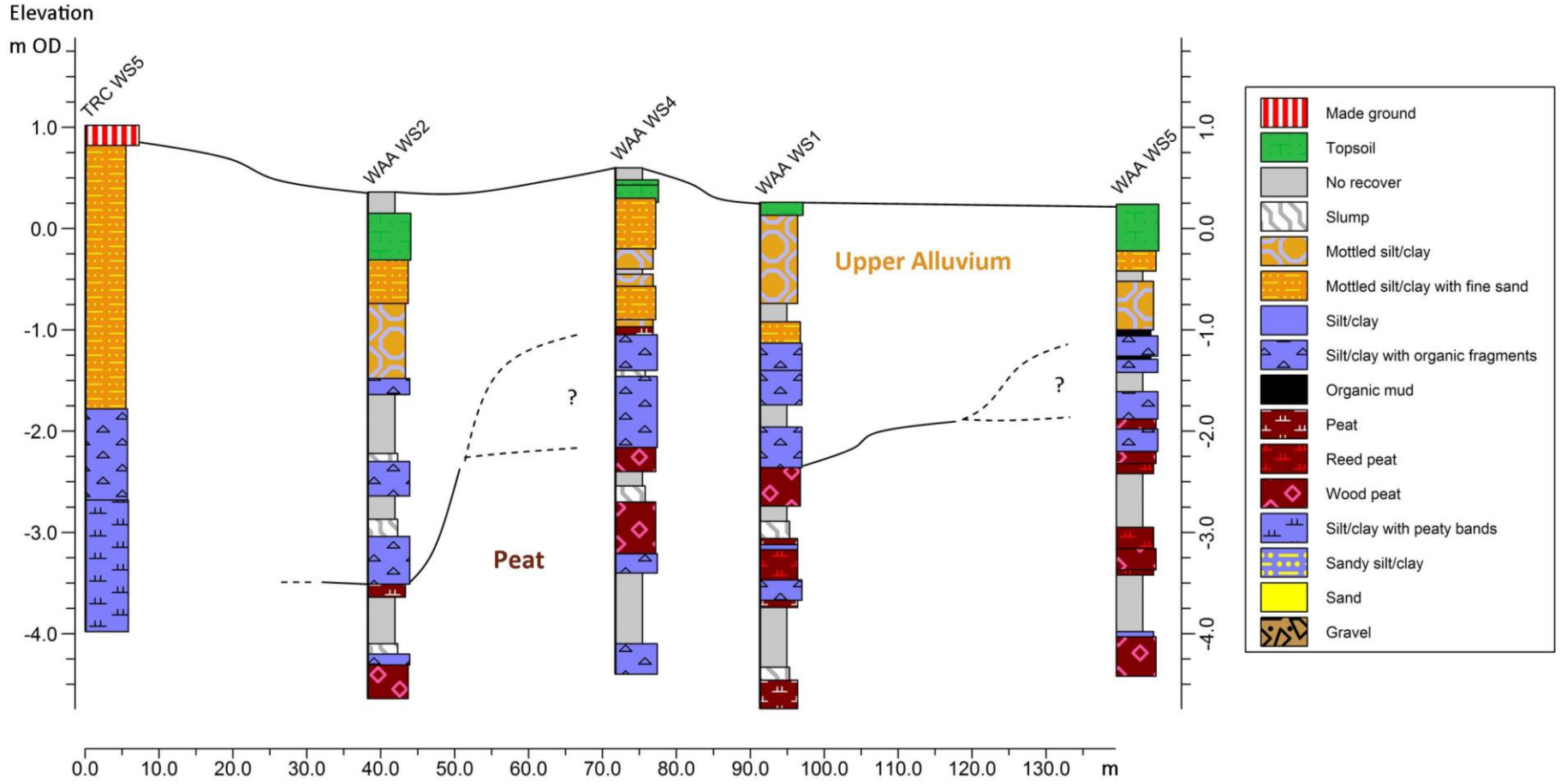

Figure 4. South to north section vertical exaggeration x13.7. Radiometric and palaeoenvironmental sub samples taken from borehole WAA WS5.

3.2.2 The gravel high recorded in TRC BH2 in the north east of the site possibly corresponds to gravel bars on the west bank of the west-north-west to east-south-east channel identified at the Pirelli Works site.

3.2.3 The Shepperton Gravel Member is conformably overlain by predominantly fine grained alluvial deposits.

3.3 Lower Alluvium

3.3.1 Young *et al* (2012, 11) describe a Lower Organic Horizon at the Pirelli Works that has an irregular, patchy occurrence overlying the Shepperton Gravel member in the channels and on the gravel highs with an average thickness of 0.2–1m. This deposit was not recorded on the site. Approximately 250m south west of the site peat was recorded over the gravels at 6.38m OD in BGS TQ47NE211 and the lowermost section of this deposit may represent the Lower Organic Horizon (Figures 5 and 6; see section 6.1.3 for a discussion of this borehole).

3.3.2 At the site fine grained alluvial strata sub crop in three of the 13 boreholes between -3.87m OD (TRC BH3) and -5.58m OD (TRC BH1). The thickness of the deposit varies between 0.6m (TRC BH2) on the gravel high, and 3.25m (TRC BH3) (Figure 3). The Lower Alluvium was not reached in the WAA window sample boreholes.

3.3.3 The drillers' logs record the Lower Alluvium as 'Very soft grey slightly sandy silty CLAY'.

3.3.4 The Lower Alluvium was conformably overlain by Peat.

3.4 Peat

3.4.1 Peat was recorded in 10 of the 13 boreholes on the site: TRC BH1 and TRC BH2; TRC WS1, TRC WS2 and TRC WS3; and WAA WS1, WAA WS2, WAA WS3, WAA WS4 and WAA WS5. It sub cropped between -1.84m OD in TRC BH2 and -3.51m OD in WAA WS2 (Figures 2, 3 and 4). It must be noted that elevations recorded are approximate due to the compression of the cores during the drilling operation. Compression was registered as 'no recover' in the Wardell Armstrong Archaeology (WAA WS) window sample cores, however, it is not known whether similar distortion occurred in the window sample cores drilled by TRC Companies Ltd (TRC WS).

3.4.2 Peat thickness is also difficult to state accurately because of the compression. The base of the peat and its contact with the Lower Alluvium was not recorded by the window sample boreholes all of which terminated drilling at 5m below ground level before reaching the contact. In the deeper boreholes, TRC BH1 and TRC BH2, the contact was recorded and peat thickness ranged between 3.30m in TRC BH1 and 2.6m in TRC BH2.

3.4.3 The lithology of the peat recorded in the Wardell Armstrong Archaeology cores was very similar and was described as wood peat: 7.5 YR 3/3 Dark brown with a slightly spongy, finely fibrous, well humified texture with no internal structure. On exposure it oxidised to a black colour. It contained frequent clasts of wood – both eroded fragments and twigs – ranging in size from coarse sand to cobble (0.5–>62mm) although granular to medium pebble-size (2–16mm) was the norm.

3.4.4 Included within the Peat lithostratigraphic unit were beds of humic silt/clay of varying thickness (*c.*0.25m) that contained organic fragments both peaty and woody but more frequently the latter. The clastic content of the silt/clay was highest just above the contact with an underlying peat and fell as the bed aggraded until a sharp contact was made with an overlying peat. These alluvial interbeds were dark grey in colour (5 Y 4/1) often with darker humic mottles. They were usually structureless, except on a rare occasion (WAA WS2 2.30–2.64m OD) where a set of very fine beds were preserved that displayed alternating dark and light grey silt/clay where fine grained humic particles composed the dark beds.

3.4.5 Reed peat was less commonly recorded and sub cropped at -3.17m OD in WAA WS1 and at -1.32m OD in WAA WS5 (Figures 2, 3 and 4). Its thickness was estimated at 0.30m. In the latter borehole the reed peat was interbedded with wood peat. Reed fragments were rare and the peat tended to be more highly humified than the wood peat.

3.4.6 In two boreholes, WAA WS4 and WAA WS5, thin peaty muds were recorded at higher stratigraphic level than the peat *sensu stricto* described above. Their preservation was probably due to their position just below the modern water table and as a consequence they had not been oxidised. They sub cropped at *c.*-1.00m OD. It was unclear whether these units should be included within the Peat or Upper Alluvium.

3.4.7 The Peat where it occurred, was overlain by the Upper Alluvium in all the boreholes on the site.

3.5 Upper Alluvium

3.5.1 The Upper Alluvium was recorded in all the boreholes on the site (Figures 2, 3, and 4). The modern topsoil had developed in the top of the Upper Alluvium and as a consequence the unit outcropped at ground level in all but TRC WS5 where it was truncated by Made Ground (see Section 3.6).

3.5.2 The thickness of the unit varied between 3.87m in WWA WS2 and 2.30m in TRC WS1 if the minor peaty muds are included (see Section 3.4.6).

3.5.3 The lithology of the Upper Alluvium was a compact silt/clay with frequent fine sand grains that, on occasion, formed fine lenses and disrupted, horizontal laminae. Below the water table (*c.*-1.0m OD) the unit exhibited a grey colour (10 YR 3/1) and above it was mottled brown (10 YR 4/3) by iron oxide as a result of post depositional redox reactions.

3.5.4 In borehole TRC WS5 Made Ground truncated the Upper Alluvium.

3.6 Made Ground

3.6.1 'Made Ground' is a term used by the BGS to describe superficial deposits of variable composition that are man-made (BGS 2016a).

3.6.2 Made ground is recorded in TRC WS5 to a depth below ground of 0.20m. It was composed of clayey, sandy gravel with clasts of brick, concrete and flint according to the drillers' record. No archaeological material was recovered

4. ASSESSMENT

4.1 The Late Glacial and Holocene stratigraphy

4.1.1 The Late Glacial and Holocene stratigraphy on the Belvedere site will be discussed with reference to Figure 5 that illustrates the location of a southwest to northeast section of borehole logs derived from the BGS (2016b), and Figure 6 that illustrates the lithostratigraphic cross section.

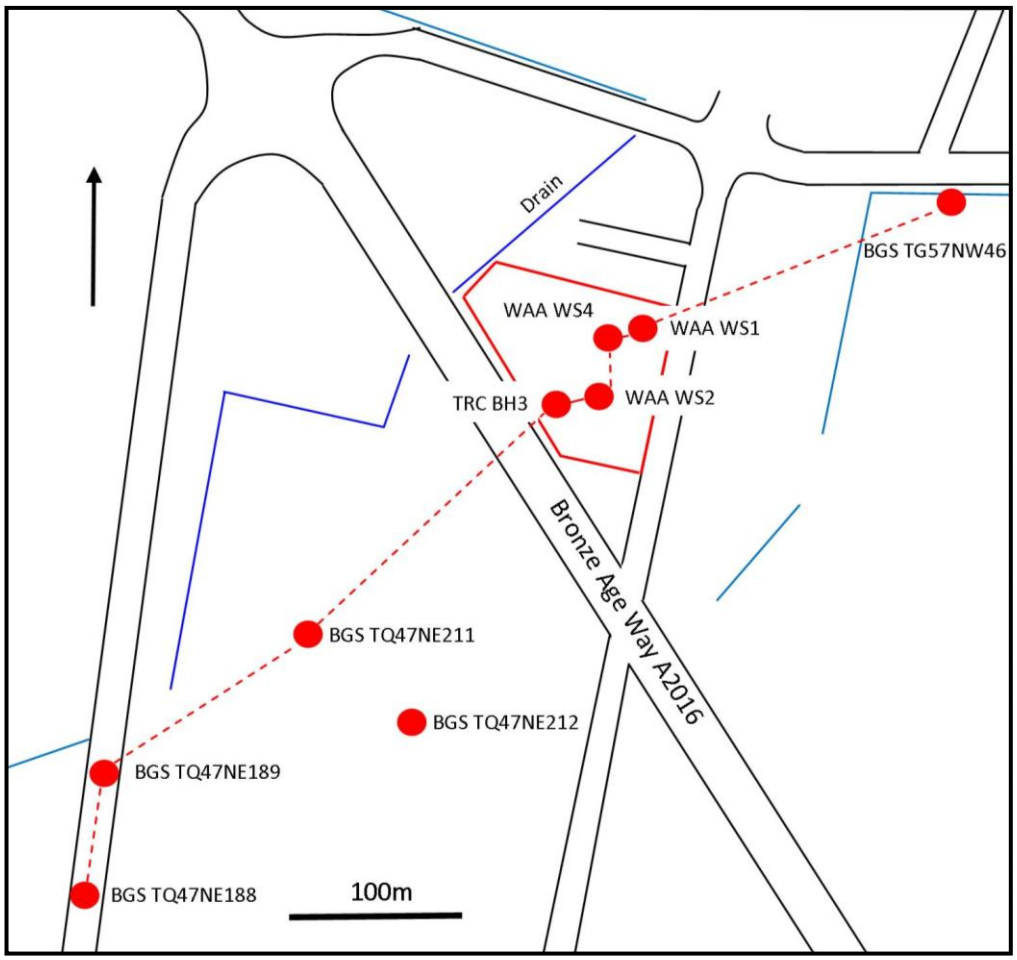

Figure 5. Plan of the location of the southwest to northeast section. The site is outlined in red.

4.1.2 On the site, the Shepperton Gravel Member was laid down by the ancient braided River Thames under a periglacial climate and high energy regime, in the Late Devensian from 15000ka to 10000ka (Gibbard 1994, 193). A deep section of the western channel identified by Young *et al* (2012) at the Pirelli Works site is possibly recorded in BGS TQ47NE188 and sub crops at -9.76m OD. This depth is consistent with the maximum depth of the western channel (-9.73m OD) recorded by Young *et al* (2012, 11). Moving northeast towards the site, the gravel surface varies in elevation and reaches a minimum (a gravel high) of -5.04m OD in TRC BH2 located on the site in the northwest.

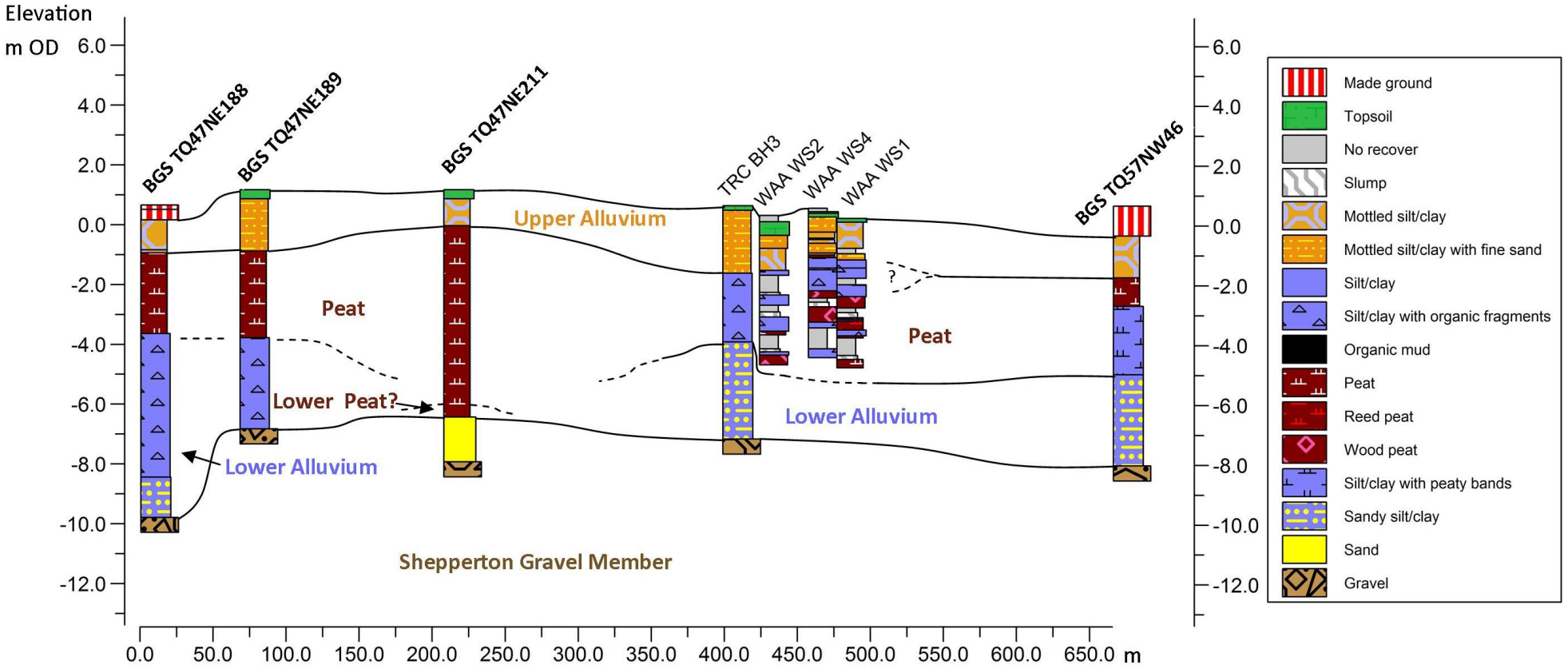

Figure 6. Southwest to northeast lithostratigraphic section that includes BGS TQ57NW46 on the Pirelli Works site.

4.1.3 With a slackening of the river flow rate towards the end of the Late Devensian, sands were deposited over the gravels as recorded in BGS TQ47NE188 where the lithology is composed of a sandy fraction (see Section 3.2.1). Climatic amelioration resulted in the river stabilising within its channel(s) as flow rate and sediment supply fell. Vegetation colonised the ground surface and peat formed in damp depressions across the old braided valley floor.

4.1.4 The earliest peats, denominated the Lower Organic Horizon, occupy depths of -9.0 and -8.0m OD and on the gravel highs between *c.*-7.0 and -6.0m OD on the Pirelli Works site (Young *et al* 2012, 11). On the Belvedere site, however, there were none; although in BGS TQ47NE211 to the southwest, a possible contender sub crops at -6.38m OD (Figure 6). A note of caution is necessary though when reviewing the BGS borehole records because identification of the lithology depends upon the drillers' descriptions which can be terse. In this example, 21 feet of 'peat' were recorded with no further qualification and in comparison to neighbouring boreholes on the cross section it appears anomalous, however, in the BGS TQ47NE212 immediately south, and drilled at the same time in the 1940s, there is a similar record.

4.1.5 The early to mid Holocene sees the river adopting a meandering morphology with the deposition of sandy mineralogenic alluvium probably as channel fill and designated the Lower Alluvium. On the Pirelli Works site its surface elevation is generally between -4.0 and -2.0m OD (Young *et al* 2012, 12) but deeper in the west towards the Belvedere site where it sub crops between -3.87m OD (TRC BH3) and -5.58m OD (TRC BH1).

4.1.6 The Lower Alluvium is overlain by peat in all but three of the 20 boreholes investigated (see Section 3.4). In general, it is woody (with some monocotyledonous reed peat too) and well humified. It is subject to inundation as is evidenced in BGS TQ57NW46 and in the WAA window sample boreholes. Muddy waters (both fluvial and marine) charged with eroded peaty fragments entrained from submerging wetlands flood the peat surface and are indicative of a general rise in the watertable. The clastic content of the inundating silt/clays falls off as the peats are progressively buried. The eustatic marine transgressions alternate with regressions as is shown by renewed peat growth following a regression phase in the complex Holocene history of the lower reaches of the Thames. The semi terrestrial

environment, perhaps not fit for occupation, would have been suitable for human exploitation.

4.1.7 The thickness of the peat is very variable from 6.4m in BGS TQ47NE211, discussed in Section 4.1.4, to 0.95m in BGS TQ57NW46. This is similar to the thicknesses reported from the Pirelli Works site. On the Belvedere site the peat appears to occupy a depression (a later secondary channel?) in the Upper Alluvium, the base of which was not proven. The upper surface of the peat lies between +0.02m OD in TQ47NE211 and -3.51m OD in WAA WS2 which compares to the Pirelli Works site where there is less variation: -0.5m OD to -2m OD. Were one to discount the voids due to compression recorded in the WAA WS2 borehole then this variation would be considerably reduced.

4.1.8 The peat is overlain by the Upper Alluvium, a fine grained mineralogenic flood plain deposit. It signifies a continuation of the rising sea levels that may be related to the Thames III regression (Devoy 1979). Minor peaty muds were recorded in the Upper Alluvium on the site that would probably have been more widespread but not recorded in the BGS geotechnical boreholes. They are indicative of slightly dryer periods and apposite for past human profit. The modern top soil has developed in the Upper Alluvium and on occasion the alluvium has been truncated by modern made ground.

4.2 Archaeological and palaeoenvironmental significance

4.2.1 The Shepperton Gravel Member was not encountered by the WAA window sample boreholes, however, it was recorded on the site in geotechnical boreholes. The braided river environment was not conducive to human occupation even though people were present at the time the Gravel Member was laid down. The Gravel Member may contain lenses and beds of fine grained material that could contain biological remains and it may contain reworked flint artefacts. It is concluded therefore that the Gravels have a *low palaeoenvironmental and archaeological potential.*

4.2.2 Neither the Lower Alluvium nor the Lower Organic Horizon were encountered by the WAA window sampler boreholes, however, the former was recorded on the site in geotechnical boreholes. The alluvium is believed to be channel fill and has a *low palaeoenvironmental and archaeological potential.*

4.2.3 The peat, indicative of wet woodland and fens, are semi terrestrial and were probably environments of only intermittent exploitation by people. The peat deposits, therefore, have *low archaeological potential*. On the other hand, deposits have *high palaeoenvironmental potential.*

4.2.4 The later deposits of fine grained alluvium – the Upper Alluvium – have *low archaeological potential* because they most probably represent an accreting flood plain under fluvial and marine influence not conducive to human occupation. The Upper Alluvium may have a *moderate to high palaeoenvironmental potential* with the preservation of pollen and diatoms in units devoid of fine sand and in muddy peat interbeds.

5. ACKNOWLEDGEMENTS

ARCA would like to thank Mr Nick Daffern of Wardell Armstrong Archaeology and Dr Eleanor Standley of the University of Oxford for their help during the course of this project.

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APPENDIX 1: ^{14}C AMS, POLLEN AND DIATOM SAMPLES FROM WAA WS5

Pollen		Diatoms		^{14}C		Material
m BGL	-m OD	m BGL	-m OD	m BGL	-m OD	
1.62	1.04	1.6	1.02	1.61	1.03	Peaty mud
1.86	1.28	1.65	1.07	1.86	1.28	Peaty mud
2.5	1.92	1.81	1.23	2.48	1.9	Wood fragments
2.8	2.22	1.9	1.32	2.88	2.3	Wood cobble
2.95	2.37	2.35	1.77	4.93	4.35	Wood fragments
3.77	3.19	2.58	2			
3.95	3.37	2.76	2.18			
4.95	4.37	4.59	4.01			

BGL: below ground level

APPENDIX 2: BOREHOLE LOCATIONS

Borehole	Easting	Northing	Elevation m OD
WAA WS1	550102.07	179656.99	0.26
WAA WS2	550076.03	179618.39	0.36
WAA WS3	550032.740	179638.730	0.46
WAA WS4	550083.450	179651.050	0.60
WAA WS5	550057.040	179674.010	0.58
TRC WS1	550027.41	179666.45	0.66
TRC WS2	550064.5	179639.08	0.64
TRC WS3	550099.94	179654.68	0.29

TRC WS4	550051.39	179605.16	0.65
TRC WS5	550098.73	179587.66	1.02
TRC BH1	550100.14	179657.43	0.42
TRC BH2	550030.59	179667.51	0.56
TRC BH3	550051.45	179613.56	0.68
BGS TQ47NE188	549785	179339	0.71
BGS TQ47NE189	549796	179406	1.22
BGS TQ47NE211	549913	179482	1.22
BGS TQ47NE212	549968	179448	1.22
BGS TQ57NW46	550277	179729	0.67

APPENDIX 3: LITHOSTRATIGRAPHY OF THE BOREHOLES

Borehole	**Top**	**Base**	**Lithology**	**Comments (ARCA Logs)**
WAA WS1	0.00	0.13	Topsoil	10 YR 3/1 Very dark grey silt/clay, hard and dry, granular becoming prismatic structure. Bioturbated by fine roots and earthworms. Gradual boundary to:
WAA WS1	0.13	1.00	Mottled silt/clay	10 YR 4/3 Brown silt/clay overall colour with fine orange iron oxide mottles and blueish grey silt/clay intimately interdigitated . Reduced blueish grey colour becomes more prominent towards base. Occasional fine root bioturbation. Rare fine sand towards base.
WAA WS1	1.00	1.18	No recover	Void

WAA WS1	1.18	1.39	Mottled silt/clay with fine sand	10 YR 4/3 Brown silt/clay overall colour with fine orange iron oxide mottles and blueish grey silt/clay intimately interdigitated. Frequent fine to medium sand, poorly and finely bedded at 1.36m. Sharp boundary to:
WAA WS1	1.39	1.66	Silt/clay with organic fragments	10 YR 3/1 Very dark grey silt/clay, humic, intermixed with well humified black organic matter with rare horizontal structure. Occasional granular-sized wood fragments. Diffuse boundary to:
WAA WS1	1.66	2.00	Silt/clay with organic fragments	2.5 Y 4/1 Dark grey silt/clay with occasional humic staining and grains and granules of wood/organic matter distributed throughout.
WAA WS1	2.00	2.22	No recover	Void
WAA WS1	2.22	2.62	Silt/clay with organic fragments	2.5 Y 4/1 Dark grey and 5 Y 3/1 Very dark grey silt/clay with occasional humic staining and grains and granules of wood/organic matter distributed throughout. Rare medium pebble-sized wood fragment. Sharp boundary to:
WAA WS1	2.62	3.00	Wood peat	7.5 YR 2.5/2 Very dark brown oxidizing to black wood peat. Well humified peaty texture. Rare coarse pebble -sized wood fragment and rare granular-sized reed fragments towards the base. Frequent granules and grains of wood throughout.
WAA WS1	3.00	3.15	No recover	Void

WAA WS1	3.15	3.32	Slump	Slump
WAA WS1	3.32	3.38	Peat	7.5 YR 2.5/2 Very dark brown oxidizing black, fibrous peat. Moderately humified. Sharp boundary to:
WAA WS1	3.38	3.43	Silt/clay	5 Y 4/1 Dark grey silt/clay. Sharp boundary to:
WAA WS1	3.43	3.73	Reed peat	7.5 YR 2.5/2 Very dark brown oxidizing black, fibrous peat. Moderately humified. Occasional granular-sized reed fragments. Sharp boundary to:
WAA WS1	3.73	3.93	Silt/clay with organic fragments	5 Y 4/1 Dark grey and 10 YR 3/1 Very dark grey silt/clay with occasional coarse pebble-sized wood fragments and occasional grains and granules of wood. Sharp boundary to:
WAA WS1	3.93	4.00	Peat	7.5 YR 2.5/2 Very dark brown oxidizing black peat. Well humified. Occasional wood granule. Peaty texture.
WAA WS1	4.00	4.59	No recover	Void
WAA WS1	4.59	4.72	Slump	Slump
WAA WS1	4.72	5.00	Peat	7.5 YR 2.5/2 Very dark brown oxidizing black, fibrous peat. Very wet. Occasional grains and granules of wood. Grey silt/clay lens at the base.
WAA WS2	0.00	0.21	No recover	Void
WAA WS2	0.21	0.67	Topsoil	10 YR 3/1 Very dark grey silt/clay, hard and dry, granular becoming prismatic structure. Bioturbated by fine roots and earthworms. .

				Gradual boundary to:
WAA WS2	0.67	1.10	Mottled silt/clay with fine sand	10 YR 4/2 Dark greyish brown silt/clay with frequent white fine sand grains in disrupted granular-sized lenses. Bioturbated. Occasional to frequent orange iron oxide mottles. (oxidised alluvium on levee?)
WAA WS2	1.10	1.84	Mottled silt/clay	10 YR 4/2 Dark greyish brown grading into 4/1 dark grey silt/clay, compact and plastic. Grey/black humic mottles at top with frequent orange iron oxide mottles and grains increasing towards the base. (Oxidised alluvium).
WAA WS2	1.84	2.00	Silt/clay with organic fragments	5 Y 5/1 to 4/1 Grey to dark grey (with a blueish tinge) silt/clay with frequent coarse sand-sized to granular-sized organic fragments predominantly wood often appear as hard brown clasts with no wood-like internal structure.
WAA WS2	2.00	2.58	No recover	Void
WAA WS2	2.58	2.66	Slump	Slump
WAA WS2	2.66	3.00	Silt/clay with organic fragments	5 Y 5/1 to 4/1 Grey to dark grey (with a blueish tinge) silt/clay with occasional coarse sand-sized to granular-sized organic fragments predominantly wood and rare twig increase towards the base.. Fine bedded structure: 12mm clay bed alternating with 3mm darker humic bed with very fine to fine grains of

				organic matter.
WAA WS2	3.00	3.23	No recover	Void
WAA WS2	3.23	3.40	Slump	Slump
WAA WS2	3.40	3.87	Silt/clay with organic fragments	5 Y 5/1 to 4/1 Grey to dark grey (with a blueish tinge) silt/clay with occasional coarse sand-sized to granular-sized wood fragments. Sharp boundary to:
WAA WS2	3.87	4.00	Peat	7.5 2.5/1 Black peat. Well humified with occasional coarse sand-sized fibres and rare wood granule. Dry, fine peaty texture.
WAA WS2	4.00	4.46	No recover	Void
WAA WS2	4.46	4.56	Slump	Slump
WAA WS2	4.56	4.67	Silt/clay with organic fragments	2.5 Y 4/1 and 4/2 Dark grey and dark greyish brown mixed silt/clay with occasional granules of wood. Sharp boundary to:
WAA WS2	4.67	5.00	Wood peat	7.5 YR 2.5/1 Black wood peat. Wet, well humified, peaty texture with rare, medium pebble-sized wood fragments. End of bh.
WAA WS3	0.00	0.24	Topsoil	10 YR 3/1 Very dark grey silt/clay, hard and dry, granular becoming prismatic structure. Bioturbated by fine roots and earthworms. Rare granule of coal and shell fragment. Gradual boundary to:
WAA WS3	0.24	0.71	Mottled silt/clay	!0 YR 4/2 Dark greyish brown silt/clay, hard and dry, with occasional orange iron oxide mottles and grains. Prismatic structure. Occasional fine roots and root holes. Sharp

				boundary to:
WAA WS3	0.71	1.40	Mottled silt/clay	10 YR 4/3 Brown silt/clay, compact with more frequent mottles and grains towards the base. (Oxidised alluvium). Sharp boundary to:
WAA WS3	1.40	1.90	Silt/clay with organic fragments	10 YR 4/1 Dark grey silt/clay compact and plastic. Distinct dark grey/black mottling dominates towards the base with occasional black wood grains and granules. (Water table).
WAA WS3	1.90	2.00	Silt/clay with organic fragments	10 YR 3/1 Very dark grey silt/clay with coarse sand-sized to fine pebble-sized wood. Rare granular structure and rare to occasional plant matter ?reed. (Peaty clay/ humic alluvium).
WAA WS3	2.00	2.18	No recover	Void
WAA WS3	2.18	3.00	Silt/clay with organic fragments	10 YR 3/1 Very dark grey mottled with 10 YR 4/3 Brown silt/clay with coarse sand-sized to fine pebble-sized wood. Granular-sized wood dominates. Rare granular structure and rare to occasional plant matter ?reed. Shiny, oily lustre to unit. (Waterlogged wood in humic alluvium)
WAA WS3	3.00	3.50	No recover	Void
WAA WS3	3.50	3.65	Slump	Slump
WAA WS3	3.65	3.92	Wood peat	7.5 YR 2.5/2 Very dark brown oxidizing to black wood peat. Dry, well humified, firm, fine peaty texture with frequent granular-sized twigs, and wood granules. No coarser

				fragments. Sharp boundary to:
WAA WS3	3.92	4.00	Wood peat	7.5 YR 2.5/1 Black wood peat. Dry, well humified, firm, fine peaty texture with frequent granular-sized twigs, and wood granules. Rare coarse pebble-sized wood fragment.
WAA WS3	4.00	4.23	No recover	Void
WAA WS3	4.23	4.36	Slump	Slump
WAA WS3	4.36	4.65	Wood peat	7.5 YR 2.5/1 Black wood peat. Wet, well humified, fine peaty texture with frequent granular-sized twigs, and wood granules. Rare indistinct granular-sized lens of 10 YR 4/1 dark grey silt/clay.
WAA WS3	4.65	4.94	Silt/clay with organic fragments	10 YR 3/1 Very dark grey mottled with 10 YR 4/3 Brown silt/clay with coarse sand-sized to fine pebble-sized wood. Granular-sized wood dominates. (Waterlogged wood in humic alluvium). Sharp boundary to:
WAA WS3	4.94	5.00	Peat	7.5 YR 2.5/1 Black, homogenous, dry, fine well humified peat. Rare coarse sand-sized fibres. No wood. End of bh.
WAA WS4	0.00	0.12	No recover	Void
WAA WS4	0.12	0.30	Topsoil	10 YR 3/1 Very dark grey silt/clay, hard and dry, granular structure. Bioturbated by fine roots and earthworms. Gradual boundary to:
WAA WS4	0.30	0.80	Mottled silt/clay with fine sand	10 YR 4/2 Dark greyish brown silt/clay with frequent fine sand, hard and dry, granular

				becoming prismatic structure. Orange iron oxide mottling. Bioturbated by fine roots and earthworms. Gradual boundary to:
WAA WS4	0.80	1.00	Mottled silt/clay	10 YR 4/3 Brown silt/clay overall colour with fine orange iron oxide mottles and blueish grey silt/clay intimately interdigitated. Compact and damp.
WAA WS4	1.00	1.05	No recover	Void
WAA WS4	1.05	1.17	Mottled silt/clay	10 YR 4/3 Brown silt/clay overall colour with fine orange iron oxide mottles and blueish grey silt/clay intimately interdigitated. Compact and damp. Gradual boundary to:
WAA WS4	1.17	1.50	Mottled silt/clay with fine sand	10 YR 4/3 Brown fine clayey sand. Coarse orange iron oxide mottling. Sharp boundary to:
WAA WS4	1.50	1.57	Mottled silt/clay	10 YR 4/2 Dark greyish brown, compact silt/clay. Occasional orange iron oxide mottling. Sharp boundary to:
WAA WS4	1.57	1.65	Peat	5 Y 2.5/1 Black silt/clay intimately mixed with well humified peat, possibly grains of wood and occasional fibre. Sharp boundary to:
WAA WS4	1.65	2.00	Silt/clay with organic fragments	10 YR 4/2 Dark greyish brown grading into 5 Y 4/1 Dark grey silt/clay with occasional humic speckles. Grains and granules of organic matter increase towards the base becoming peat-like with frequent wood granules.

WAA WS4	2.00	2.06	Slump	Slump of sand.
WAA WS4	2.06	2.76	Silt/clay with organic fragments	5 Y 4/1 Dark grey silt/clay with coarse mottles of 10 YR 4/2 Dark greyish brown and 4/1 Dark grey. Frequent grains and granules of peat and wood increase towards the base with occasional coarse pebble-sized wood fragments, some decayed to lens-like brown clay. Gradual boundary to:
WAA WS4	2.76	3.00	Wood peat	7.5 YR 2.5/2 Very dark brown oxidizing to black wood peat. Frequent granular to pebble-sized wood fragments. Occasional 50mm long reed fragments, vertical rather than horizontal.
WAA WS4	3.00	3.14	No recover	Void
WAA WS4	3.14	3.30	Slump	Slump of sand.
WAA WS4	3.30	3.81	Wood peat	7.5 YR 3/3 Dark brown wood peat oxidizing to black. Woody fibrous texture. Frequent coarse sand to medium pebble-sized wood fragments. Sharp boundary to:
WAA WS4	3.81	4.00	Silt/clay with organic fragments	5 Y 4/1 Grey grading into 3/1 Very dark grey silt/clay. Corresponding increase in organic matter: grains and granules of wood and ?peat towards the base. Occasional fine pebble-sized wood fragments at base (alluvial inundation of wood peat beds?)
WAA WS4	4.00	4.70	No recover	Void
WAA WS4	4.70	5.00	Silt/clay with organic	5 Y 4/1 Grey grading into 3/1 Very dark grey

			fragments	silt/clay. Corresponding increase in organic matter: grains and granules of wood and ?peat towards the base. Coarse pebble-sized wood fragment at base (alluvial inundation of wood peat beds?)
WAA WS4	0.00	0.17	No recover	Void
WAA WS4	0.17	0.34	Topsoil	10 YR 3/1 Very dark grey silt/clay, hard and dry, granular structure. Biotubated by fine roots and earthworms. Gradual boundary to:
WAA WS5	0.34	0.80	Topsoil	10 YR 3/1 Very dark grey silt/clay, hard and dry, granular to prismatic structure. Occasional fine sand grains. Biotubated by fine roots and earthworms. Gradual boundary to:
WAA WS5	0.80	1.00	Mottled silt/clay with fine sand	10 YR 4/3 Brown silt/clay with occasional orange iron oxide mottling and fine sand grains.
WAA WS5	1.00	1.10	No recover	Void
WAA WS5	1.10	1.58	Mottled silt/clay	10 YR 4/3 Brown silt/clay with occasional orange iron oxide mottles and grains. Compact and damp. Gradual boundary to:
WAA WS5	1.58	1.64	Organic mud	10 YR 2/1 Black very humic silt/clay with rare well humified ?peat/ organic matter. Rare ?reed fragments. (Peaty mud). *Diatom sub sample at 1.60m, C14 sub sample at 1.61m, Pollen sub sample at 1.62m.*
WAA WS5	1.64	1.84	Silt/clay with organic	5 Y 5/2 Olive grey silt/clay. Mottled with 5 Y

			fragments	4/1 Dark grey becoming dramatically darker and greyer at the base with frequent organic grains and humic mottles. *Diatom sub samples at 1.65m and 1.81m.* Diffuse boundary to:
WAA WS5	1.84	1.87	Organic mud	2.5 Y 2.5/1 Black humic silt/clay. Occasional grain and granule of organic matter in a humic silt/clay matrix (Peaty mud). *Pollen sub sample at 1.86m, C14 sub sample at 1.86m.* Diffuse boundary to:
WAA WS5	1.87	2.00	Silt/clay with organic fragments	2.5 Y 4/1 Dark grey silt/clay with frequent grains and granules of organic matter and wood. *Diatom sub sample at 1.90m.*
WAA WS5	2.00	2.19	No recover	Void
WAA WS5	2.19	2.46	Silt/clay with organic fragments	2.5 Y 4/1 Dark grey silt/clay with frequent grains and granules of organic matter and wood increase towards the base. Cobble-sized wood fragment at base. *Diatom sub sample at 2.35m.* Diffuse boundary to:
WAA WS5	2.46	2.56	Wood peat	7.5 YR 2.5/1 Black wood peat. Well humified, fine peaty texture wiith rare coarse sand-sized fibres. No oxidation on exposure (?). *C14 sub sample at 2.48m, Pollen sub sample at 2.50m.* Sharp boundary to:
WAA WS5	2.56	2.78	Silt/clay with organic fragments	2.5 Y 4/1 Dark grey silt/clay with grains and granules of organic matter and wood that increase dramaticaly at the base. *Diatom sub samples at 2.58m and 2.76m.* Diffuse

				boundary to:
WAA WS5	2.78	2.90	Wood peat	7.5 YR 3/3 Dark brown wood peat oxidizing to black. Woody fibrous texture. Frequent coarse sand to fine pebble-sized wood fragments. Cobble of wood. *Pollen sub sample at 2.80m, C14 sub sample of wood cobble at 2.88m.* Sharp boundary to:
WAA WS5	2.90	3.00	Reed peat	7.5 2.5/1 Black peat. Very well humified, no wood, rare granular-sized reed fragments. *Pollen sub sample at 2.95m*
WAA WS5	3.00	3.53	No recover	Void
WAA WS5	3.53	3.74	Reed peat	7.5 2.5/1 Black peat. Very well humified, no wood, rare granular-sized reed fragments.
WAA WS5	3.74	3.95	Wood peat	7.5 YR 2.5/3 Very dark brown wood peat. Well hunified peaty matrix with frequent granules of wood. *Pollen subsamples at 3.77m.* Sharp boundary to:
WAA WS5	3.95	4.00	Reed peat	7.5 2.5/1 Black peat. Very well humified, no wood, rare granular-sized reed fragments. *Pollen sub sample at 3.95m.*
WAA WS5	4.00	4.56	No recover	Void
WAA WS5	4.56	4.61	Silt/clay	2.5 YR 4/1 Dark grey silt/clay. Very wet. *Diatom sub sample at 4.59m.* Sharp boundary to:
WAA WS5	4.61	5.00	Wood peat	7.5 YR 2.5/1 Black wood peat. Vey wet, well humified matix with a peaty texture and occasional granule of wood. Occasional fine

				fibres. Rare, disrupted, light grey sillt/clay lens towards base. *C14 sub sample at 4.93m, Pollen sub sample at 4.95m.* End of bh.
				Driller's logs
TRC WS1	0.00	0.20	Topsoil	Low rise vegetation overlying firm dark brown slightly sandy silty CLAY with rootlets throughout.
TRC WS1	0.20	1.10	Mottled silt/clay with fine sand	Firm orange brown mottled red slightly sandy silty CLAY with lenses of sand throughout and rootlets to 0.80m
TRC WS1	1.10	1.80	Mottled silt/clay with fine sand	Soft brown mottled orange silty CLAY with black organic staining in parts.
TRC WS1	1.80	2.30	Silt/clay with peaty bands	Soft dark brown grey slightly sandy silty CLAY with frequent lenses of peat and fragments of wood, plant and organic material.
TRC WS1	2.30	5.00	Peat	Spongy dark brown locally light reddish brown pseudo fibrous PEAT with frequent plant and wood fragments.
TRC WS2	0.00	0.15	Topsoil	Low rise vegetation overlying firm dark brown slightly sandy silty CLAY with rootlets throughout.
TRC WS2	0.15	1.30	Mottled silt/clay with fine sand	Firm locally stiff orange brown mottled red slightly sandy silty CLAY with lenses of sand throughout and rootlets to 0.70m.
TRC WS2	1.30	2.05	Silt/clay with organic fragments	Soft orange brown and grey locally slightly sandy silty CLAY with occasional plant fragments.

TRC WS2	2.05	2.90	Silt/clay with peaty bands	Soft dark brown grey slightly sandy silty CLAY with frequent lenses of peat and fragments of wood, plant and organic material.
TRC WS2	2.90	3.20	Peat	Spongy dark brown pseudo fibrous PEAT with frequent plant and wood fragments.
TRC WS2	3.20	3.60	Silt/clay with peaty bands	Soft dark brown grey slightly sandy silty CLAY with frequent lenses of peat and fragments of wood, plant and organic material.
TRC WS2	3.60	5.00	Peat	Spongy dark brown locally light reddish brown pseudo fibrous PEAT with frequent plant and wood fragments.
TRC WS3	0.00	0.10	Topsoil	Low rise vegetation overlying firm dark brown slightly sandy silty CLAY with rootlets throughout.
TRC WS3	0.10	1.00	Mottled silt/clay with fine sand	Firm locally stiff orange brown mottled red slightly sandy silty CLAY with lenses of sand throughout.
TRC WS3	1.00	1.70	Silt/clay with organic fragments	Soft light brown and grey locally slightly sandy silty CLAY with plant and wood fragments and black organic staining throughout.
TRC WS3	1.70	2.50	Silt/clay with peaty bands	Soft dark brown grey slightly sandy silty CLAY with frequent lenses of peat and fragments of wood, plant and organic material.
TRC WS3	2.50	4.10	Peat	Spongy dark brown locally light reddish brown pseudo fibrous PEAT with frequent plant and wood fragments.
TRC WS3	4.10	5.00	Silt/clay with peaty	Very soft dark brown and grey slightly sandy

			bands	silty CLAY with frequent lenses of peat and fragments of wood, plant and organic material.
TRC WS4	0.00	0.10	Topsoil	Low rise vegetation overlying firm dark brown slightly sandy silty CLAY with rootlets throughout.
TRC WS4	0.10	1.05	Mottled silt/clay with fine sand	Firm locally stiff orange brown mottled red slightly sandy silty CLAY with lenses of sand throughout.
TRC WS4	1.05	2.20	Mottled silt/clay	Soft brown mottled orange silty CLAY with black organic staining in parts.
TRC WS4	2.20	5.00	Silt/clay with organic fragments	Soft grey slightly sandy silty CLAY with occasional fragments of wood, plant and organic material.
TRC WS5	0.00	0.20	Made ground	MADE GROUND: Dark brown/black silty locally clayey sandy GRAVEL. Sand is fine to coarse. Gravel is fine to coarse subrounded to angular flint, concrete, brick and fragments of bound layer.
TRC WS5	2.00	2.80	Mottled silt/clay with fine sand	Firm orange brown mottled red slightly sandy silty CLAY with lenses of sand throughout.
TRC WS5	2.80	3.70	Silt/clay with organic fragments	Soft grey slightly sandy silty CLAY with occasional fragments of wood, plant and organic material.
TRC WS5	3.70	5.00	Silt/clay with peaty bands	Soft dark brown grey slightly sandy silty CLAY with frequent lenses of peat and fragments of wood, plant and organic material.
TRC BH1	0.00	0.20	Topsoil	Low rise vegetation overlying firm dark brown

				locally slightly sandy silty CLAY with rootlets throughout.
TRC BH1	0.20	1.05	Mottled silt/clay with fine sand	Firm to stiff orange brown mottle red slightly sandy silty CLAY with lenses of sand throughout.
TRC BH1	1.05	2.70	Silt/clay with organic fragments	Soft light brown and grey locally sandy silty CLAY with organic staining plant and wood fragments throughout.
TRC BH1	2.70	6.00	Peat	Plastic dark brown locally light reddish brown amorphous peat with bands of pseudo fibrous peat and frequent plant remains, wood and organic content.
TRC BH1	6.00	6.60	Silt/clay with peaty bands	Very soft to soft grey sandy silty CLAY with lenses of peat throughout.
TRC BH1	6.60	8.10	Sandy silt/clay	Very soft grey slightly sandy silty CLAY.
TRC BH1	8.10	8.60	Gravel	Dense grey brown sandy silty GRAVEL with occasional shell fragments. Gravel is fine to coarse subangular to rounded flint.
TRC BH2	0.00	0.20	Topsoil	Low rise vegetation overlying firm dark brown locally slightly sandy silty CLAY with rootlets throughout.
TRC BH2	0.20	1.50	Mottled silt/clay	Firm to stiff orange brown mottle red slightly sandy silty CLAY with lenses of sand throughout.
TRC BH2	1.50	2.40	Silt/clay with organic fragments	Soft to firm brown locally mottled orange silty CLAY with organic lenses and black staining in parts.

TRC BH2	2.40	5.00	Peat	Spongy dark brown locally light reddish brown pseudo fibrous locally amorphous peat with frequent plant remains, wood and organic content.
TRC BH2	5.00	5.60	Sandy silt/clay	Very soft to soft grey sandy silty CLAY
TRC BH2	5.60	8.80	Sand	Medium dense brown grey slightly gravelly silty SAND with occasional shell fragments. Gravel is fine to coarse subangular to rounded flint.
TRC BH2	8.80	11.10	Sand	Dense brown grey gravelly silty SAND with occasional shell fragments. Gravel is fine to coarse subangular to rounded flint.
TRC BH2	11.10	11.60	Gravel	Dense grey brown sandy silty GRAVEL with occasional shell fragments. Gravel is fine to coarse subangular to rounded flint.
TRC BH3	0.00	0.15	Topsoil	Low rise vegetation overlying firm dark brown locally slightly sandy silty CLAY with rootlets throughout.
TRC BH3	0.15	2.25	Mottled silt/clay with fine sand	Firm to stiff orange brown mottle red slightly sandy silty CLAY with lenses of sand throughout.
TRC BH3	2.25	4.55	Silt/clay with organic fragments	Very soft to soft light grey and brown slightly sandy silty CLAY with organic staining plant and wood fragments throughout.
TRC BH3	4.55	7.80	Sandy silt/clay	Very soft to soft light grey slightly sandy silty CLAY.
TRC BH3	7.80	8.30	Gravel	Very dense grey brown sandy silty GRAVEL

				with occasional shell fragments. Gravel is fine to coarse subangular to rounded flint.
BGS 881675	0.00	0.15	Made ground	Topsoil (Made ground).
BGS 881675	0.15	0.50	Made ground	Stones and topsoil (Made ground).
BGS 881675	0.50	1.50	Mottled silt/clay	Firm brown clay.
BGS 881675	1.50	1.60	Mottled silt/clay	Very brown and grey silty clay.
BGS 881675	1.60	4.30	Peat	Peat
BGS 881675	4.30	9.10	Silt/clay with organic fragments	Very soft grey silty clay with traces of peat.
BGS 881675	9.10	10.45	Sandy silt/clay	Firm dark grey silty sandy clay with some gravel.
BGS 881675	10.45	10.95	Gravel	Loose to medium dense grey sandy gravel.
BGS 881676	0.00	0.30	Topsoil	Topsoil .
BGS 881676	0.30	2.05	Mottled silt/clay with fine sand	Firm to stiff brown mottled sandy clay.
BGS 881676	2.05	4.95	Peat	Peat.
BGS 881676	4.95	8.00	Silt/clay with organic fragments	Very soft grey silty clay with traces of peat.
BGS 881676	8.00	8.50	Gravel	Loose to medium dense gravel with some grey sand.
BGS 881701	0.00	0.30	Topsoil	Topsoil.
BGS 881701	0.30	1.20	Mottled silt/clay	Clay.
BGS 881701	1.20	7.60	Peat	Peat.
BGS 881701	7.60	9.10	Sand	Grey Sand.
BGS 881701	9.10	14.60	Gravel	Thames ballast (Gravel).
BGS 881702	0.00	0.30	Topsoil	Topsoil.

BGS 881702	0.30	1.20	Mottled silt/clay	Clay.
BGS 881702	1.20	7.60	Peat	Peat.
BGS 881702	7.60	9.10	Sand	Grey Sand.
BGS 881702	9.10	14.60	Gravel	Thames ballast (Gravel).
BGS 845172	0.00	1.00	Made ground	FILL (topsoil, roots, stones, concrete, and brick fragments)
BGS 845172	1.00	2.40	Mottled silt/clay	Mottled grey and brown silty CLAY with peat fragments.
BGS 845172	2.40	3.35	Peat	Fibrous dark brown PEAT
BGS 845172	3.35	5.64	Silt/clay with peaty bands	Grey, peaty silty Clay, with shell fragments in places.
BGS 845172	5.64	8.69	Sandy silt/clay	Grey slightly clayey sandy SILT, with occasional peat fragments.
BGS 845172	8.69	9.19	Gravel	Grey sandy fine to medium gravel.