



Lion Business Park Denton Marshes, Gravesend Kent

Geoarchaeological Interim Assessment Report



29th August 2006

**Client: Ardent Consulting Engineers
Limited**

Issue N^o: 1
OA Job N^o: 3313
Planning Ref N^o: GR/20020544
NGR: TQ 666 738

Client Name: Ardent Consulting Engineers Limited

Client Ref No:

Document Title: Interim Geoarchaeological Assessment Report

Document Type: Evaluation

Issue Number: 1

National Grid Reference: TQ 666 738

Planning Reference:

OA Job Number: 3313

Site code: GRLION06

Invoice code: GRLIONEV


Receiving Museum:

Museum Accession No:

Prepared by: C Champness
Position: Geoarchaeologist
Date: 29th August 2006

Checked by: E Stafford
Position: Head of Geoarchaeological Services
Date: 29th August 2006

Approved by: S. Foreman
Position: Senior Project Manager
Date: 29th August 2006

Signed. 

Document File Location Server1:\Projects\Lion Business Park, Gravesend\Stage
1_Borehole Survey\ Interim Report

Graphics File Location As above
Illustrated by C Champness/ M Saunders

Disclaimer:

This document has been prepared for the titled project or named part thereof and should not be relied upon or used for any other project without an independent check being carried out as to its suitability and prior written authority of Oxford Archaeology being obtained. Oxford Archaeology accepts no responsibility or liability for the consequences of this document being used for a purpose other than the purposes for which it was commissioned. Any person/party using or relying on the document for such other purposes agrees, and will by such use or reliance be taken to confirm their agreement to indemnify Oxford Archaeology for all loss or damage resulting therefrom. Oxford Archaeology accepts no responsibility or liability for this document to any party other than the person/party by whom it was commissioned.

Oxford Archaeology

© Oxford Archaeological Unit Ltd 2006

Janus House

Osney Mead

Oxford OX2 0ES

t: (0044) 01865 263800

e: info@oxfordarch.co.uk

f: (0044) 01865 793496

w: www.oxfordarch.co.uk

Oxford Archaeological Unit Limited is a Registered Charity No: 285627

Lion Business Park, Denton Marshes, Gravesend, Kent

INTERIM GEOARCHAEOLOGICAL ASSESSMENT REPORT

CONTENTS

1	Introduction	3
1.1	Location and scope of work	3
1.2	Geology and topography	3
1.3	Archaeological and historical background	3
1.4	Geoarchaeological and environmental background	4
2	Aims	6
3	Methodology	7
4	Results	7
4.1	Summary	7
4.2	Pre-Holocene deposits and basement topography	8
4.3	The Holocene sediment sequence	9
5	Discussion	10
6	Conclusions and recommendations	12
6.1	Conclusions	12
6.2	Recommendations	13
7	References	16

LIST OF FIGURES

- Figure 1: Site location
- Figure 2: Borehole locations
- Figure 3: Early Holocene land surface (m OD)
- Figure 4: Thickness of peat deposits (m)
- Figure 5: Section A-A'
- Figure 6: Section B-B'
- Figure 7: Proposed trench location

Summary

In July 2006 Oxford Archaeology (OA) carried out a purposive geoarchaeological borehole survey at Denton Marshes, Gravesend, Kent. The investigation was commissioned by Ardent Consulting Engineers Limited in advance of the development of the site as a business park. The borehole survey forms the first stage in a two stage archaeological evaluation strategy, with the intention of providing baseline stratigraphic data prior to a programme of trial trenching.

Following a brief review of existing geotechnical records and previous archaeological work within the area, five boreholes were drilled at selected locations. Correlation of key stratigraphic units has allowed the creation of a preliminary subsurface deposit model for the site.

Extensive Pleistocene deposits, probably deposited in a cold environment during the Devensian glaciation by either fluvial or solifluction processes, exist as units of coarse sand, gravel and stiff clay, directly overlying chalk bedrock. Similarities, however, of some these deposits with Thanet Sands and London Clay may suggest that a more complex sequence of bedrock exists in this area than that indicated by the British Geological Survey maps. Examination of the elevations of the surface of the Pleistocene deposits revealed a significant area of high ground just to the southeast of the site that probably represents the edge of the terrace. A possible area of higher ground was also identified near to the centre of the site, which could have persisted as an island of drier ground within a predominantly wetland environment from the late Mesolithic period onwards. As such this area, as well as the terrace edge, may have provided a focus for prehistoric activity. Based on current regional models of sea-level change and estuarine inundation on the Lower Thames floodplain, the elevations suggest that this area may not have been submerged until after the middle to late Bronze Age.

Overlying the Pleistocene deposits are significant thicknesses of undisturbed Holocene alluvial and peat deposits that exist throughout the site, sealed beneath variable thicknesses of made-ground. Superficially the Holocene sequence is similar to numerous other alluvial sites investigated on the Lower Thames floodplain. Closer examination, however, reveals significant variation representative of a range of different sedimentary environments that could have existed at any one time. This is probably a reflection of the location of the site at the edge of the gravel terrace as opposed to a mid floodplain situation, where local factors of topography and hydrology will have effected sedimentation patterns.

A major, though discontinuous, peat body exists sealed either within minerogenic silt-clays or, at higher elevations, resting directly on Pleistocene deposits between approximately -2.0m and -5.0m OD. The surface of the peat varies between 2.4m and 7.0m below current ground level. The most deeply buried deposits exist in the northern and eastern parts of the site. A broad Neolithic or Bronze Age date may be assigned to these deposits on the basis of elevation, and it is possible they are equivalent to Devoy's Tilbury III and IV peats. This would, however, require confirmation by radiocarbon dating. Further localised peat deposits were noted at higher elevations in the geotechnical logs. These

may be considered equivalent to Devoy's Tilbury V peat of Roman date. All records however derive from cone penetration tests carried out during geotechnical investigations and were not recorded in either geotechnical or purposive archaeological boreholes.

The presence of extensive organic deposits preserved at depth across the site area, has clear potential for the preservation of waterlogged timbers and material for paleoenvironmental reconstruction (pollen, diatoms, plant remains, insects). These deposits have the potential to address aspects of floodplain development, sea-level change and vegetation patterns during the prehistoric and later periods. Suitable samples have been retrieved during the borehole survey for future analysis if deemed appropriate. This potential, however, would be greatly enhanced if found in association with archaeological remains. Although neither the peats or minerogenic deposits examined from the purposive archaeological boreholes contained visible anthropogenic inclusions, a number of areas across the site have been identified that may have acted as a focus for activity in the past.

Examination of the thicknesses of made/ground across the site suggests that open trenching evaluation of the upper minerogenic clay/silts is achievable to the levels at which Roman archaeology was discovered in 1998 at the Water Treatment Works to the north of the site. Given the depth of the underlying peat deposits, it is recommended that a programme of rapid test pitting during the trial trenching be carried out on targeted areas.

1 INTRODUCTION

1.1 Location and scope of work

- 1.1.1 In July 2006 Oxford Archaeology (OA) were commissioned by Ardent consulting Limited on behalf of Gravesham Borough Council, to undertake an archaeological evaluation at the site of the proposed Lion Business Park Development at Denton Marshes, Gravesend.
- 1.1.2 The evaluation strategy, as outlined in the specification produced by the Kent County Heritage Conservation Group, comprises a purposive geoarchaeological borehole survey and a programme of trial trenching.
- 1.1.3 This report presents the results of the initial borehole survey and preliminary sub-surface deposit model. It is intended that the results of the survey will provide additional baseline stratigraphic in order to further inform the strategy for evaluation trenching.
- 1.1.4 Subsurface deposit modelling has the ability to reconstruct past geographies (palaeogeographies) for areas where the surface expression bears little or no relationship to those buried at depth. This type of approach is particularly valuable in floodplain environments where the archaeological potential is difficult to assess by traditional evaluation methods. In many of the floodplains of the larger rivers and estuaries in England and Wales, this is often due to thick deposits of made-ground and alluvium effectively masking earlier deposits that frequently lies at great depth.

1.2 Geology and topography

- 1.2.1 The site is situated to the east of Gravesend town centre. It is located on the northern side of the Denton Relief Road, directly south of the Gravesend Waste Water Treatment Centre. The site is currently used for informal recreation and grazing, although unauthorised tipping is known to have occurred within the development area (Fig. 1).
- 1.2.2 The site lies in an area of low lying marsh, approximate ground levels of +1.8m and +2.9m OD, within the River Thames floodplain. The underlying geology is alluvium and floodplain gravel overlying Upper Chalk (BGS, 271). The area includes undifferentiated Head and River Terrace Deposits to the southwest.

1.3 Archaeological and historical background

- 1.3.1 The primary background information regarding the archaeological resource within the vicinity of the site is derived from the County Sites and Monuments Record. A wide range of archaeological remains are known in the area. These include Mesolithic flintwork (SMR No: TQ 67 SE 41) at the north end of the Denton Relief Road, probable prehistoric ring ditches or enclosures (SMR No: TQ 67 SE 89) about 200 m to the east of the roundabout, Roman pottery (SMR No: TQ 67 SE 36) at the waste

treatment works immediately to the north of the site, the post-medieval manor of West Court about 100 m east of the southern part of the scheme, and the post-medieval canal basin (SMR No: TQ 67 SE 46) about 200 m to the north of the scheme.

- 1.3.2 Extensive quantities of dumped Roman pottery were found within alluvial deposits during construction work in 1978 at the Waste Water Treatment Works immediately to the north of the site (Harker 1978). An archaeological evaluation at the Works in 1998, comprising testpits and an auger/borehole survey, identified dumped deposits, at a similar location to that previously noted, containing Roman pottery sherds, bone, shell and building material. The artefacts were recovered from minerogenic and organic alluvial deposits at +1.4m OD in testpit 2. The pottery included Samian, terra nigra and coarsewares, probably dating to about AD 100 (Firth 2000, WA 1998).
- 1.3.3 Archaeological evaluation was carried out along the route of the new relief road which runs along the southern perimeter of the site in 1999 (ASE 1999). Six 20m trenches were excavated to the top of the 'natural' or the top of any significant archaeological layer, whichever was higher. A probable 1st century Roman pit or posthole was identified in trench 3 cut into alluvium at approximately +2.70m OD, sealed by modern topsoil. This trench was located approximately 50m beyond the western limit of the current proposed development area. Two drainage ditches of unknown date were also identified in trenches 1 and 3.
- 1.3.4 Between August 2002 and February 2003, a further phase of archaeological work associated with the construction of the relief road was carried out (OA 2003). Four boreholes were drilled between approximately 50m and 200m from the north-western limit of the current proposed development in order to investigate the underlying stratigraphy. Archaeological monitoring and recording was further maintained during the period of construction and, with the exception of a single recently infilled drainage ditch, no archaeological features/deposits or finds were recorded.

1.4 Geoarchaeological and environmental background

Regional setting

- 1.4.1 The site lies in the lower Thames valley at the point in the estuarine part of the river where the inner estuary starts to open into the outer estuary. Today the estuary is characterised as a tide dominated estuary (*sensu* Dalrymple *et al.*, 1992) in which major sand bars occur within the outer estuary area (marine dominated zone) and tidal meanders in an inner mixed energy zone. Holocene sediments within the site area are part of a continuum forming a wedge thickening downstream from less than 2m at Tower Bridge to reach a maximum thickness of 35m east of the study area at Canvey Island (Marsland, 1986).
- 1.4.2 Our current understanding of the sedimentary sequences of the area are derived from work undertaken by Gibbard (1994) and Devoy (1977, 1979) who have previously considered the main sediment sequences present within our study area. However, in

contrast to the relatively well known sequences of Pleistocene age that typically flank the modern floodplain (Gibbard, 1994) the nature of the Holocene sediments resting on bedrock or pre-Holocene sand and gravel deposits are poorly understood and have only, with few exceptions, been described superficially (Devoy, 1977, 1979).

- 1.4.3 The basis for subdivision of these deposits was established by Devoy during the early 1970's (1979, 1982) using borehole stratigraphies integrated with biostratigraphic studies to infer successive phases of marine transgressions (typified by clay-silt deposition) and regressions (typified by peat formation). Devoy's work has resulted in a view of sediment accumulation being controlled within the area by a combination of factors dominated by sea-level change and tectonic depression of southern England. Most recently regional models for sequence development have been described by Long *et al.* (2000) and Bates and Whittaker (2004) which begin to address the range of factors responsible for sequence accumulation.
- 1.4.4 In order to fully understand the distribution of potential archaeological sites in the lower estuary area and the reasons behind major changes in settlement patterns in the past it is necessary to understand the changing nature of the estuary. These changes have been summarised recently by Bates and Whittaker (2004) for the inner estuary but presently little is known of the nature and significance of the deeper areas close to the inland edge of the outer estuary. This is particularly problematic for the site under investigation as the site lies within the transitional zone from the inner to outer parts of the estuary. This transition is likely to be accompanied by changes in both the nature of depositional environments, and consequently sediment types produced and preserved, as well as changes in ecology influencing human activities within the floodplain area.

Site setting

- 1.4.5 Previous ground investigations in the area have been undertaken as part of archaeological investigations by Archaeology South East (1999), Wessex Archaeology (WA 1998, Firth 2000) and Oxford Archaeology (2003). However, no known detailed palaeoenvironmental investigations of these sequences have been undertaken. Consequently, the prime source of information remains the work of Devoy (1977, 1979) who examined sequences both up-estuary in the vicinity of Tilbury and downstream at the Isle of Grain. His work indicated that a series of five major peat units could be identified in places within the estuary. These peats were noted to rise in altitude in an upstream direction.
- 1.4.6 Geological mapping of the site area indicates that the site is underlain by Chalk with gravels correlated with the Shepperton Member of late Devensian age overlying the Chalk (British Geological Survey, 1997). Sediments adjacent to the site area include undifferentiated Head and River Terrace Deposits to the west of the site area.
- 1.4.7 To summarise the previous work has suggested that:

1. The site lies close to the margins of the modern floodplain within an area of the Thames underlain by Chalk bedrock (British Geological Survey 1997; ASE 1999).
2. A complex topography of both Chalk bedrock profiles and overlying gravel surface elevations exist within the area to the south of the present site investigation area (ASE 1999).
3. The ASE investigation suggested that two altitudinally discrete gravel bodies exist to the south of the present site area.
4. A thick sequence of fine grained sediments including peats, organic silts and clay-silts occur both to the south (ASE 1999), to the north (Firth, 2000) and west (OA 2003). Extensive peat bodies were identified to the north between -3.0m and -5.5m OD (Firth, 2000). The majority of these sediment bodies appear to have formed in developing wetland environments (either organic or minerogenic dominated sediments) during the Holocene.
5. The organic sequences present in the area are superficially similar to those proposed previously by Devoy (1977, 1979) and consequently it is likely that the main peat body should be of broadly Neolithic date (a conclusion also reached by Firth, 2000).

2 AIMS

- 2.1.1 The primary objective of the investigation is the development of a deposit model specific to the site. This model will provide base-line data regarding the character and archaeological potential of the sub-surface stratigraphy. Specifically the investigation will aim to:
- Characterise the sequence of sediments and patterns of accumulation across site, including the depth and lateral extent of major stratigraphic units, and the character of any potential land surfaces/buried soils within or pre-dating these sediments.
 - Identify significant variations in the deposit sequence indicative of localised features such as topographic highs or palaeochannels.
 - Identify the location and extent of any waterlogged organic deposits and where appropriate and practicable retrieve suitable samples in order to assess the potential for the preservation of palaeoenvironmental remains and material for scientific dating.
 - Clarify the relationships between sediment sequences and other deposit types, including periods of 'soil', peat growth, archaeological remains, and the effects of relatively recent human disturbance, including the location and extent of made-ground.

3 METHODOLOGY

- 3.1.1 An initial assessment was carried out of selected stratigraphic data from previous archaeological investigations in the vicinity of the site, and geotechnical records located within the site area (OA 2006). The geotechnical records derive from a ground investigation carried out by Southern Testing Limited in 2003. The locations are illustrated in Fig 2. The lithological data was entered into geological modelling software (©Rockworks2004) and was used to correlate and model the main stratigraphic units across the area. At this stage no core or sample data was available to verify any of the observations made from the geotechnical records. All information comprised paper copies of logs from boreholes, test pits and CPT data. Consequently a range of problems have been previously identified with this type of data set (Bates *et al* 2000). In order to ground truth and refine the preliminary deposit model, and obtain suitable samples for future palaeoenvironmental analysis, a series of five targeted boreholes were proposed at locations agreed with Kent County Council (Fig. 2).
- 3.1.2 The boreholes were drilled using a cable percussion technique, allowing for the retrieval of continuous U4/100 cores, from the base of the made-ground to the top of the Pleistocene gravels. Cutting shoe samples were also retained, in addition to bulk samples where core samples could not be retrieved due to the unconsolidated nature of the sediments. Each borehole location was surveyed in using a GPS, ensuring co-ordinates and levels relative to National Grid and Ordnance Datum were retrieved.
- 3.1.3 All cores were extruded and logged by a qualified geoarchaeologist using standard sediment terminology (Jones *et al* 1999) including information about depth, texture, composition, colour, clast orientation, structure (bedding, ped characteristics etc), contacts between deposits. Note was also be made of any visible ecofactual, or artefactual inclusions e.g. pottery, daub or charcoal fragments. This information was then entered into the computer modelling software to check and refine the correlations made in the original deposit model. 2-D plots and cross sections have been generated in order to illustrate the main points for discussion (Figs 3-6).

4 RESULTS

4.1 Summary

- 4.1.1 The alluvial sequences in the vicinity of the site are associated with the Lower Thames sequence. The stratigraphy was relatively consistent and comprised of:
- **Made Ground:** Sandy gravels, brick, concrete, ash and rubbish deposits
 - **Alluvium II:** Light to mid Grey homogeneous silty clay
 - **Peat:** Fibrous peat with silt bands
 - **Alluvium I:** Light grey silty clay

- **Sand and sandy gravel:** Coarse sand with rare poorly sorted sub-angular to angular gravels.
- **Stiff clays:** Stiff to firm greyish olive clay
- **Sandy gravel/sands:** Well-sorted sandy flint gravels, yellow to grey fine to coarse sub-angular to sub-rounded clasts.
- **Bedrock:** Chalk

4.2 Pre-Holocene deposits and basement topography

- 4.2.1 **Bedrock:** The underlying bedrock across the site is recorded as Upper Cretaceous Chalk (BGS Map Sheet 271). It was generally recovered as weathered chalk blocks. Where the boreholes penetrated these deposits it produced elevations of between -1.2m and -17.86m OD, reflecting a shape drop in the bedrock surface across the site from the southwest to the northeast.
- 4.2.2 **Sands and sandy gravels:** Coarse to medium sands and sandy gravels appear to extend across the site overlying bedrock and being sealed by stiff clay deposits and Holocene alluvial deposits. The elevations of this surface is recorded between -16.44m OD (CPT9) to -19.06 m OD (BH1). The coarse grained nature of these deposits suggests high-energy fluvial deposition. These deposits were only covered by CPT data and geotechnical boreholes and therefore some ambiguity exist about whether these deposits might represent Thanet sands.
- 4.2.3 **Stiff clays:** The unit consists of stiff greyish olive clay. They are thickest towards the Northeast of site where they vary from 0.2m (CPT2) to 11.8m (CPT2) in thickness, and are found at elevations between -0.4m and -6.93m OD. Similarities of these deposits to the London clay have been previously noted (OA, 2004). It therefore possible that these deposits represent previously unmapped deposit of the London clay within the site area.
- 4.2.4 **Sands:** This unit consists of fine to coarse-grained grey sands with rare inclusions of angular to sub-angular gravel and chalk pebble sized clasts. These deposits are localised near the edge of the gravel terrace at elevations between -3.53m OD (OA5) and -6.12m OD (CPT9). They were identified within only certain boreholes (BH3, CPT3, CPT4, CPT5, CPT6, CPT7, CPT8, CPT9, CPT10, CPT11, CPT12, CPT14, CPT15, OA1 and OA5).
- 4.2.5 These coarse grained character of the deposits suggests high-energy deposition within a cold environment either through fluvial or solifluction processes. Any archaeological remains identified within these deposits are unlikely to be in-situ and would have undergone a high degree of lateral movement.
- 4.2.6 The surface of the gravely sand and stiff clay deposits essentially defines the topography of the early Holocene landscape (Fig, 3). Bates (1998) refers to this as the 'topographic template' and suggests that variations in the template largely dictated

the patterns of subsequent landscape evolution, as flooding and sedimentation ensued during the prehistoric period.

- 4.2.7 On initial examination the elevations of the surface of the gravely sands exhibit some localised variation. The highest elevations were recorded within the northeast sector of the site possibly showing the higher ground of the terrace gravels at levels of up to +2.0m OD (BH02). The lowest levels occur in the southern sector, particularly in the southeast near CPT1, CPT2 and CPT8 down to -6.5m OD (BH32). These lower elevations are likely result of a deepening of the floodplain towards the north. There is also one possible topographic high, or 'island', located towards the centre of site near CPT6 suggested by the high elevations around -1m OD.

4.3 The Holocene sediment sequence

- 4.3.1 Alluvium I: These deposits are localised only being identified within 19 locations across the area, directly overlying Pleistocene deposits. They vary from bluish grey silty clays to clay silts. They range in thickness from 0.04m (OA1) to 1.2m (BH1), averaging about 0.40m over the site. The elevation of this deposit ranges between -3.05m (OA1) and -6.12m OD (CPT8). Varying amounts of organic content appear to be present within the deposit, including localised pockets of peat. These variations indicate that a range of different depositional environments could have existed within the floodplain at the any one time. The more organic parts of the sequence suggest lower energy conditions within shallow water conditions at the edge of the floodplain, compared to the more minerogenic deposits, which may represent higher energy environments. Any archaeological material associated with these deposits is likely to have been subject to some degree of lateral movement depending on position within the floodplain.
- 4.3.2 Peat-organic complex: These deposits occur broadly between -2m to -5m OD ranging from friable peats to silty peats containing varying amounts of plant and woody material. Silt clay lenses indicate brief periods of flooding. The peat thickness varies from 0.1m (CPT10) to 1.94m (OA5), averaging 1.34m across the area. The thickest deposits exist towards the deep areas to the north and within a shallow inlet towards the centre of the site (Fig.4).
- 4.3.3 The peat deposits are likely to be representative of wetland environments such as reed swamp and alder and willow carr. Any archaeological material associated with these deposits is should be considered representative of in-situ activity with relatively little modification.
- 4.3.4 Alluvium II: These deposits consist of silty clays and clay silts with evidence of root action and weathering of its upper surface. The deposit extends across the entire site and ranges in thickness from 0.2m (CPT10) to 5.3m (CPT1). These deposits represent the most recent episode of sedimentation within the Thames Floodplain. The fine grained nature of these deposits indicate low energy deposition. Any archaeological material present within clay and silt deposits will have undergone low levels of lateral movement.

- 4.3.5 Made-Ground. Variably thick deposits of made-ground across the site. These deposits were recorded as sandy gravels/sandy clays with brick, concrete, ash and associated dumped rubbish material overlain by tarmac and concrete. During the borehole monitoring it was noted that substantial fly dipping had occurred on site.
- 4.3.6 These deposits are thickest to the north of site where made-ground deposits have been previously used to raise up the ground level above that of the flooding. These deposits varies between 0.3m (CPT10) and 3.0m (OA5) in thickness. There is evidence for the made-ground and rubbish deposits being directly deposited upon the alluvium.

5 DISCUSSION

- 5.1.1 Some difficulties exist with the interpretation of the lower part of the sequence that has been identified within the site area. Previous work (OA, 2003) suggested discrepancies in the BGS mapping (1997) of the solid and drift geology of the area. The underlying geology of the site is mapped as Chalk bedrock overlain by sandy gravels. However overlying these deposits are gravely sands and stiff bluish and olive grey clay that share characteristics with the Thanet sands and London clay respectively. In addition an overlying undulating sand deposit located just off the edge of the gravel terrace would appear to represent higher energy deposition associated with a cold environment. The presence of sub-angular gravel and chalk clasts within the deposit might indicate that these deposits represent solifluction deposits derived from terrace stabilisation and cold climate colluviation rather than fluvial action..
- 5.1.2 The onset of the early Holocene saw rapid warming and the silting up of former Pleistocene channels. The climate amelioration allowed the diverse temperate vegetation to become established and this created suitable conditions for the soil formation. Eventually oak, elm, ash and lime forest would have formed a dense forest cover over much of the country, with the wetter valley bottoms being dominated by species like alder and willow. As sea levels rose, estuarine conditions would have begun to migrate further up the river valleys and the processes of Holocene sedimentation would have started to occur.
- 5.1.3 The patterns of Holocene sedimentation were previously believed to have been controlled by sea-level change and tectonic depressions (Devoy, 1982) taking no account of local palaeogeography, sediment basin size and local to regional sediment size. Bates has recently questioned these assumptions (Bates, 1998, Bates et al 2000, 2004) highlighting the importance of local factors such as the proximity of the gravel terrace, undulations in the Holocene template and local drainage patterns. Following his work it is increasingly being realised the important role the topographic template plays in the sedimentation patterns of an area. It is clear that such features are present within the site and may account for the different environments of deposition that have been detected. The mapping and identification of this template within the site area is therefore key to understanding the patterns of sedimentation and the potential for detecting human activity within these deposits.

- 5.1.4 The elevation data from the surface of the gravel has been used to create topography of the early Holocene. Comparisons with previous regional models proposed for the Lower Thames floodplain by Bates and Whittaker (2004), based on radiocarbon dates/altitude data, allow age estimates to be applied to the sequence based on correlation of deposit types and elevations.
- 5.1.5 At lower elevations (-6.5m to -5m OD) towards the northeast of site, heading towards the Thames, major flooding and sedimentation may not have occurred until somewhere in the region of 6ka BP. For the majority of the site that lies between -3m to -1.5m OD, flooding would have occurred slightly later, possibly around 5ka BP. This suggests that for much of the early Holocene the area would have been relatively dry and that evidence of activity dating from the Mesolithic period to the early Neolithic period, could be found associated with this surface. The higher elevations of the gravel terrace (2m to 0m OD) located at the south-western edge of the site, and the area located near CPT6 (-1 to 0m OD), inundation would have occurred later. As flooding ensued during the Holocene these areas would have been reduced to dry ground within a predominantly wetland environment and as such may have acted as a focus of archaeological activity exploiting the abundant resources available within the floodplain environment. This suggests archaeological remains of any period could be potentially located within these areas up until the middle to late Bronze Age, and in the case of the gravel terrace, possible into historical periods. Previous work in the Lower Thames has shown that archaeology is often associated with gravel islands and floodplain margins. Very little however is identified in the wetter areas, away from such features.
- 5.1.6 The character of the sediment sequence overlying the Holocene template at Denton, are consistent in terms of lithology and elevations previously identified in the area (OA, 2003). On a broader level they are comparable to many sequences investigated in the Lower Thames by numerous workers. With reference to the recent model proposed by Bates and Whittaker (2004), it is likely that Alluvium I and peat units relate to the development of wetland systems between 3-8ka BP. This period saw the development of marsh land systems and large expanses of alder carr and reedswamp, dissected by areas occupied by eroding channels. The height data for the peat unit, commonly occurring at elevations between -2m and -5 m OD, is comparable to other radio-carbon dated sequences in the Lower Thames and probably equates with Devoy's Tilbury III or IV peat.
- 5.1.7 The deposition of Alluvium II represents the final phase of alluviation within the sequence as a result of the expansion of brackish water conditions caused by rising relative sea-level around the end of the Late Bronze and continuing up until modern times (0-3 ka BP). Traditionally the focus of archaeological and palaeoenvironment research has been on the earlier prehistoric deposits of the Thames system. Little attention has been paid to the upper alluvium largely because of the difficulty of dating the deposits. The environment of the floodplain during this period would have consisted of salt marsh and mud flats interspersed with tidal creeks and perhaps fresh water streams issuing from the terrace. Activity within the area would have likely

been low-level, exploiting various seasonal resources. Evidence of such activity is increasingly being identified in the form of ephemeral structures such as fishtraps, wattlework and seasonal activity areas. Evidence of land reclamation dated to the 12th and 13th centuries AD, in the form of drainage ditches and sea-banks, have been identified within the upper alluvium on Rainham and Wennington Marshes on the North bank of the Thames (OA 2001).

- 5.1.8 The thickness of made ground deposits vary considerably across the site. The site surface elevations provide a good indication of areas where material has been dumped to the north of site in order to raise the ground above the level of flooding.
- 5.1.9 The presence of waterlogged organic deposits preserved at depth across the site area, has clear potential for the preservation of timbers and material for palaeoenvironmental reconstruction (e.g. pollen, diatoms, plant remains, insects). These deposits have the potential to address aspects of floodplain development, sea-level change and vegetation patterns during the prehistoric and later periods. Stratified sequences of peat and clay silts are common within the Thames Estuary area. However, the majority of sites that have been investigated for palaeoenvironmental material (ie that may provide important information on the nature of the human environments during later Prehistoric and Historic periods) lie within the parts of the estuary upstream of Gravesend. Important changes in the nature of the estuary occur in the vicinity of Gravesend and those sequences may exhibit properties that vary considerably from those of the study area.. Thus the sediments preserved in the boreholes may contain unique evidence for this stretch of the estuary for which little comparative investigation has occurred. Suitable samples have been retrieved during the borehole survey for future analysis if deemed appropriate.
- 5.1.10 It is noted that the palaeoenvironmental potential of the borehole sequences, would be greatly enhanced if found in association with archaeological remains. Although neither the peats or minerogenic deposits examined from the purposive archaeological boreholes contained visible anthropogenic inclusions, a number of areas across the site have been identified that may have acted as a focus for activity in the past.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

- 6.1.1 The assessment has served well to characterise the nature of the sub-surface stratigraphy underlying the present ground surface within the site area. The following conclusions can be drawn:
- The major Holocene stratigraphic units identified within the sequence conform to the regional deposit model of the Lower Thames outlined by previous works (Bates and Whittaker, 2004).

- Sufficient ambiguity exists within the lower part of the sequence that might indicate a greater degree of complexity exists within the solid and drift geology of the area to that indicated by the British Geological Survey.
- The assessment has confirmed the presence and significance of localised detail within the site area, associated with different environments of deposition and local topographic features, such as the edge of the gravel terrace and a gravel island within the floodplain. The model has confirmed the presence of an area of high ground within the centre of the site that may have existed as a gravel island within a predominantly wetland environment for much of the Neolithic and Bronze Age. As such these areas of higher ground overlying a prehistoric floodplain environment would have provided attractive locations in which to exploit the rich wetland environment.
- A significant peat deposit extends across the site at elevations of -2m to -5m OD, broadly dating to the Neolithic and Bronze Age. Previous archaeological investigations within the Lower Thames, at terrace edge situations, have identified Bronze Age trackways, wooden platforms and other forms of activity associated with these deposits.
- The waterlogged conditions identified on the site increase the likelihood of the preservation of organic remains. This could include the remains of wooden structures, trackways and artefacts, associated with the peat, as well as palaeoenvironmental material dating from the Mesolithic onwards.
- The study was appropriate to the task of identifying the main sedimentary units across the site area.

6.2 Recommendations

- 6.2.1 Due to the nature and depth of the sub-surface sequence identified within the assessment, the following recommendations for a further stage of archaeological work can be made:

Aims and methods for evaluation trenching

- 6.2.2 The main aim of any further evaluation will be two-fold: To identify any activity that is cut into or within the upper alluvial deposits, and to identify any earlier activity that may predate this phase of flooding. Most of the activity represented in the upper alluvium is likely to represent low-level Roman to medieval activity. Any earlier prehistoric deposits (Mesolithic to late Bronze Age) will only be identified if trenches are excavated to a sufficient depth to penetrate into the peat units. Towards the northeast of the site these peat deposits are buried at sufficient depth (5m to 6m) to make them unreachable by conventional trial trenching methods. Within the southeast part of the site, at the edge of the gravel terrace, the deposits are likely to be found at 2m to 3m below the ground surface.

- 6.2.3 It is recommended that, due to the depth of overlying alluvium and underlying peat deposits, a standard 4% coverage of the site area will only be attempted to the level at which Roman and/or medieval features may be expected (as indicated on the cross-sections (Figures 5 and 6). Ten 20m x 2m trenches will be excavated for this purpose at the locations shown on figure 7. Coverage extends over all areas of the site, but are targeted in particular at the edge of the floodplain, where deposits are shallower. The assessment has outlined the reasons why such areas may prove to have higher archaeological potential compared with areas flooded earlier in the Holocene. Trench locations have been selected to take account of current ground conditions, as indicated on figure 7, avoiding areas with substantial depths of made ground, large spoil heaps, drainage ditches and a concrete access track.
- 6.2.4 The standard trenches may, in some cases, need to be stepped in order to achieve a safe working depth for recording. The trench locations avoid areas of made ground, so this is unlikely if the medieval/ Roman levels are comparable with those identified in neighbouring investigations (Firth 2000). If necessary it is proposed that trenches be taken first to a depth of c.1m. The trench sides will then be battered to a safe angle and excavation will proceed to a maximum of c. 2.0 m.
- 6.2.5 Holocene alluvial deposits at greater depth will be subject to limited evaluation by excavating machine-dug test pits (2m x 2m) to the maximum reach of the mechanical excavator at selected locations (normally at one end of an existing trench, up to a maximum of five locations). These will be used to validate the results of the borehole and CPT logs. Examination of excavated spoil from the test pits may also detect very dense and extensive prehistoric artefact scatters or traces of timber structures, while causing a minimum of disturbance. No manual access will be permitted to these pits, which will be back-filled as soon as the sequence has been logged. Locations will be selected in the field, subject to local ground conditions.
- 6.2.6 Kent County Council (KCC) will be kept informed of progress and invited to view trenches as far as reasonably practicable. However, it has been agreed with the KCC Archaeological Officer, that unless significant archaeological material is encountered, deeper trenches will be recorded and backfilled the same day, for safety reasons and to prevent flooding.

Further work on borehole cores

- 6.2.7 Regarding further work on the borehole samples, the presence of extensive organic deposits preserved at depth across the site area, has clear potential for the preservation of waterlogged timbers and material for paleoenvironmental reconstruction (pollen, diatoms, plant remains, insects). As discussed above (5.1.9), these deposits have the potential to address aspects of floodplain development, sea-level change and vegetation patterns during the prehistoric and later periods. Suitable samples have been retrieved during the borehole survey for future analysis if deemed appropriate as a contribution to objectives set out in 'an archaeological research framework for the Greater Thames Estuary' (Williams and Brown, eds, 1999).

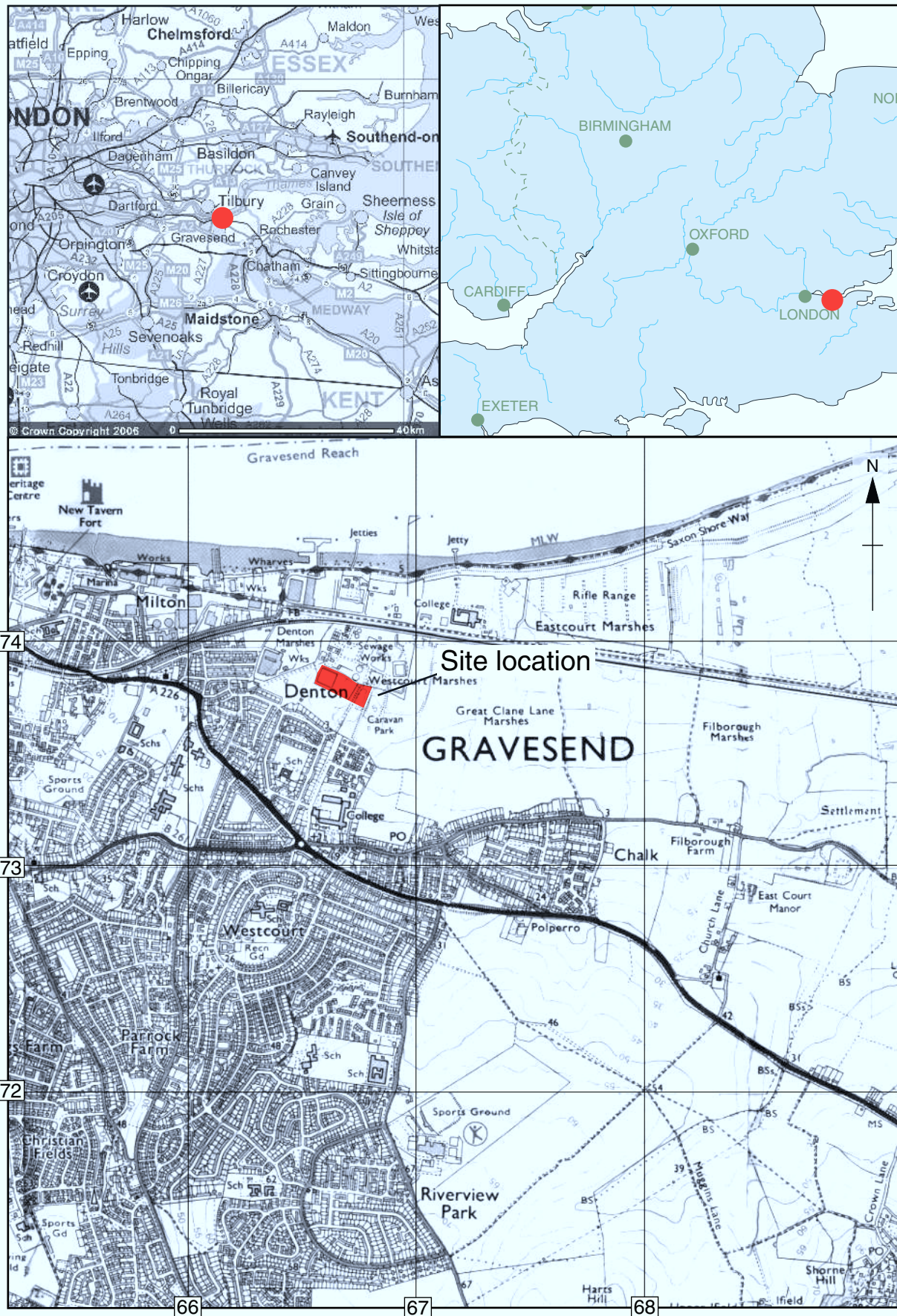
However, the potential will be much greater if archaeological remains are found in association with sampled deposits.

- 6.2.8 As a minimum, in the absence of associated archaeology, radiocarbon dating of the deposit sequence, accompanied by further stratigraphic analysis in light of the trenching results, is recommended to provide a local index point for sea-level change. This would allow the sequence to be incorporated in wider regional geoarchaeological studies.

7 REFERENCES

- | | | |
|--|------|--|
| Archaeological South East | 1999 | An Archaeological Evaluation of the line of the Denton Relief Road, Gravesend, Kent. Archaeological South-east, Project n.1043, client report for Gravesend Borough Council. |
| Bates, M.R. | 1998 | Locating and evaluating archaeology below the alluvium: the role of sub-surface stratigraphic modelling. <i>Lithics</i> 19: 4 – 18. |
| Bates, M.R., Barnham, A.J. | 1995 | Holocene alluvial stratigraphic architecture and archaeology in the Lower Thames area. 85 – 98. In: Bridgland, D.R., Allen, P. and Haggart, B.A. (eds.) <i>The Quaternary of the Lower Reaches of the Thames. Field Guide</i> . Quaternary Research Association: Cambridge |
| Bates, M.R. and Bates, C.R. | 2000 | Multidisciplinary approaches to the geoarchaeological evaluation of deeply stratified sedimentary sequences: Examples from Pleistocene and Holocene deposits in southern England, United Kingdom. <i>Journal of Archaeological Science</i> 27: 845-858 |
| Bates, M.R. and Whittaker, K | 2004 | Landscape Evolution in the Lower Thames Valley: Implications for the archaeology of the earlier Holocene period, in J Cotton, D Field (eds.) <i>Towards a New Stone Age: Aspects of the Neolithic in Southeast England</i> . CBA Research Report 137 |
| British Geological Survey | 1997 | Inner Thames Estuary. Pre-Quaternary and Quaternary Geology. 1:50 000 Coastal Geology Series. British Geological Survey: Keyworth |
| Dalrymple, R.W., Zaitlin, B.A. and Bord, R | 1992 | Estuarine facies models: conceptual, basis and stratigraphical implications. <i>Journal of Sedimentary Petrology</i> 62, 1130-1146 |
| Devoy, R.J.N | 1982 | Analysis of the geological evidence for Holocene sea-level movements in Southeast England. <i>Proceedings of the geologists' Association</i> 93:65-90 |
| Devoy, R.J.N | 1979 | Flandrian sea-level changes and vegetational history of the lower Thames Estuary. <i>Philosophical Transactions of the Royal Society of London</i> B285:355-407. |
| Devoy, R.J.N | 1977 | Flandrian sea-level changes in the Thames Estuary and the implications for land subsidence in England and Wales. <i>Nature</i> 220: 712-715 |
| Gibbard, P.L. | 1994 | Pleistocene history of the Lower Thames Valley. Cambridge University Press: Cambridge |
| Harker, S. | 1978 | Another Roman site in the North Kent marshes. <i>Kent Archaeological Review</i> 51, 7 |

-
- | | | |
|---|------|--|
| Long, A. J., Scaife, R.G. and Edwards, R.J. | 2000 | Stratigraphic architecture, relative sea-level, and models of estuary development in southern England: new data from Southampton Water, in Pye,K and Allen, R.J.L. (eds) Coastal and Estuarine Environments: sedimentation, geomorphology and geoarchaeology. Geological Society, London Special Publication 175:253-279. The Geological Society, London |
| Marsland, A | 1986 | The floodplain deposits of the Lower Thames. Quaternary Journal of Engineering Geology 19, 223-247. |
| Oxford Archaeology | 2006 | Lion Business Park, Denton Marshes, Gravesend, Kent: Geoarchaeological borehole investigation method statement |
| Oxford Archaeology | 2003 | Denton Relief Road, Near Gravesend, Kent. Archaeological Investigation Report |
| Williams, J and Brown, N | 1999 | An Archaeological Research Framework for the Greater Thames Estuary', Kent County Council, Essex County Council, English Heritage, Thames Estuary Partnership |



Reproduced from the Landranger 1:50,000 scale by permission of the Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office
© Crown Copyright 1984. All rights reserved. Licence No. AL 100005569

Figure 1: Site location

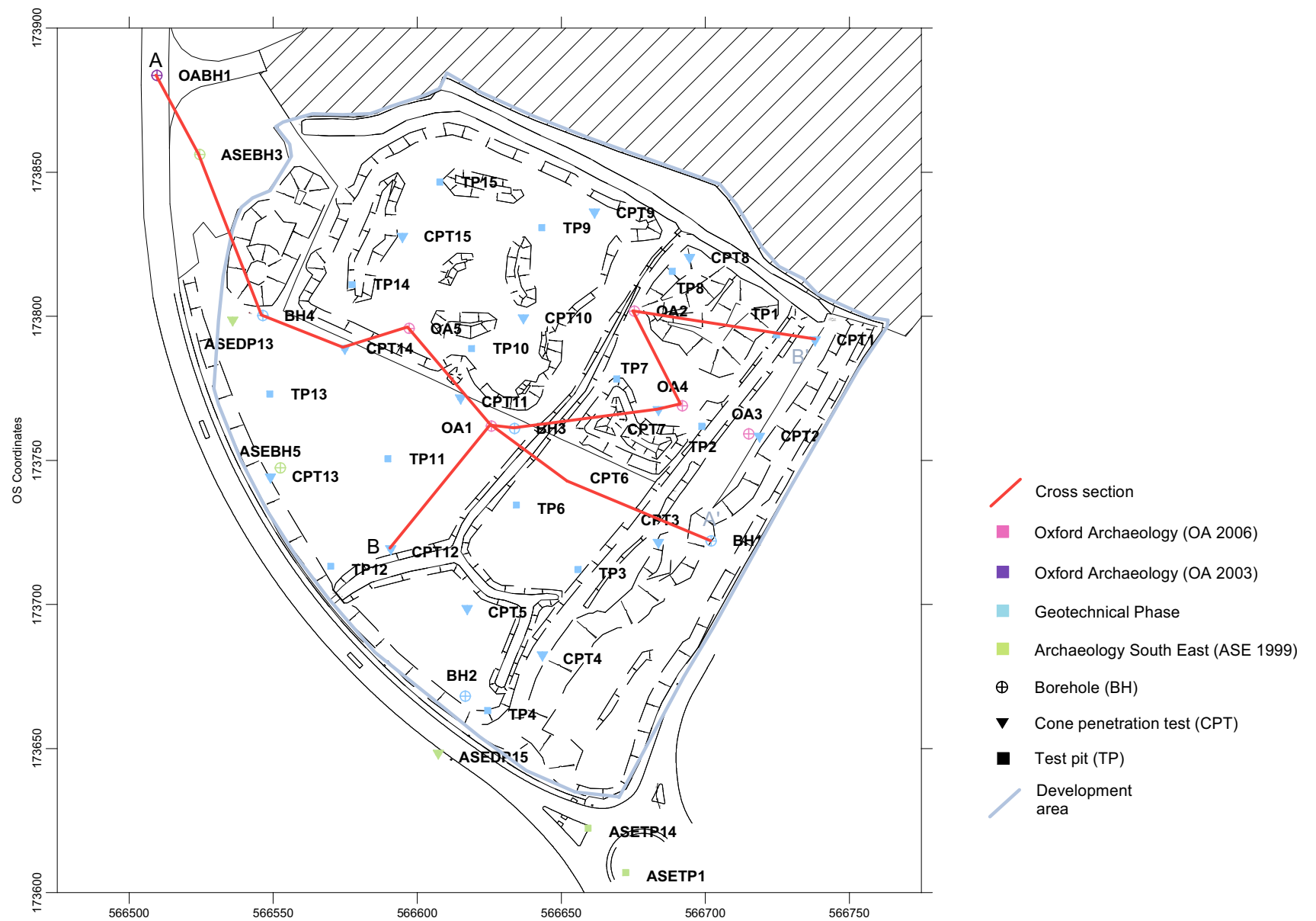


Figure 2 - Borehole locations

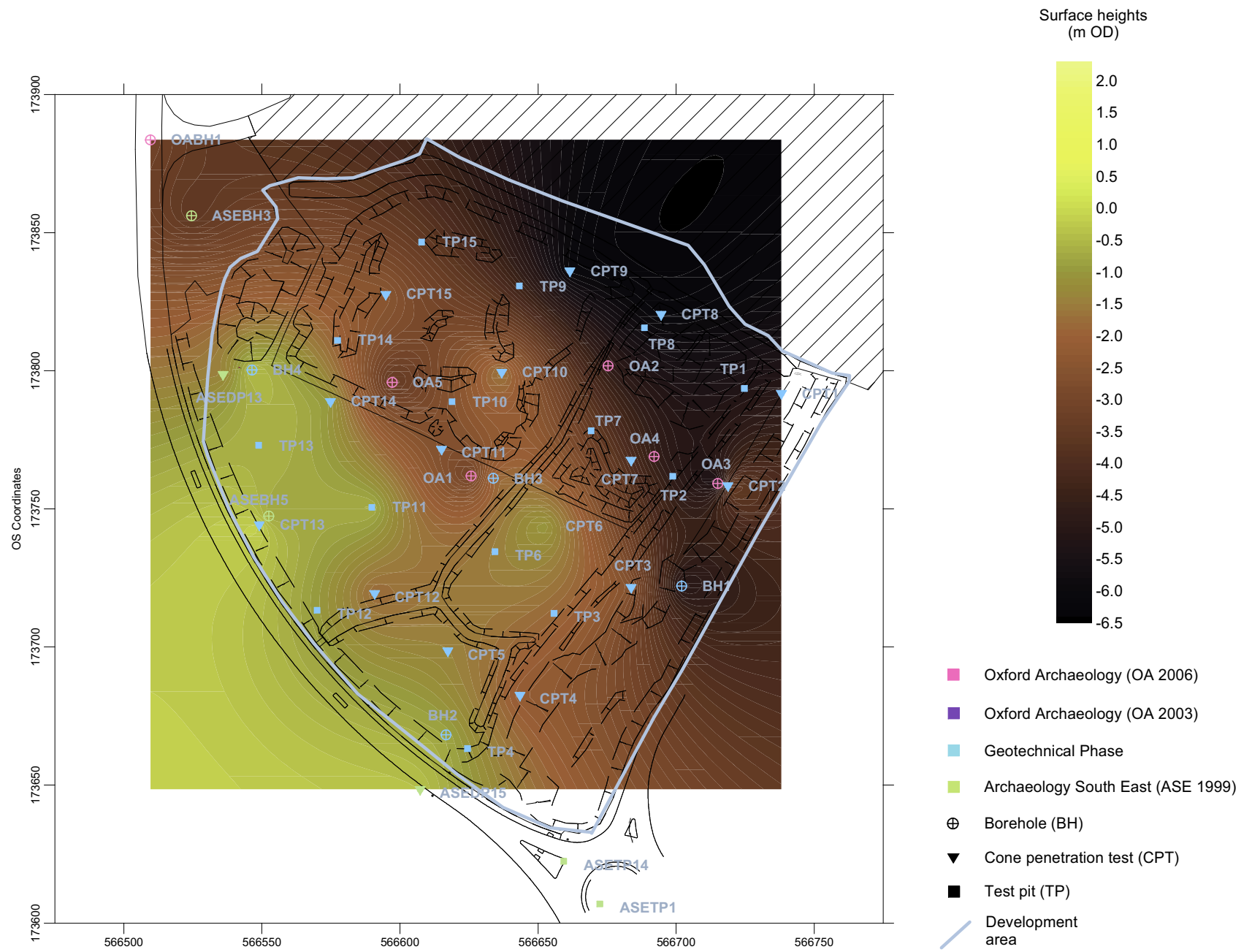


Figure 3 - Early Holocene land surface (m OD)

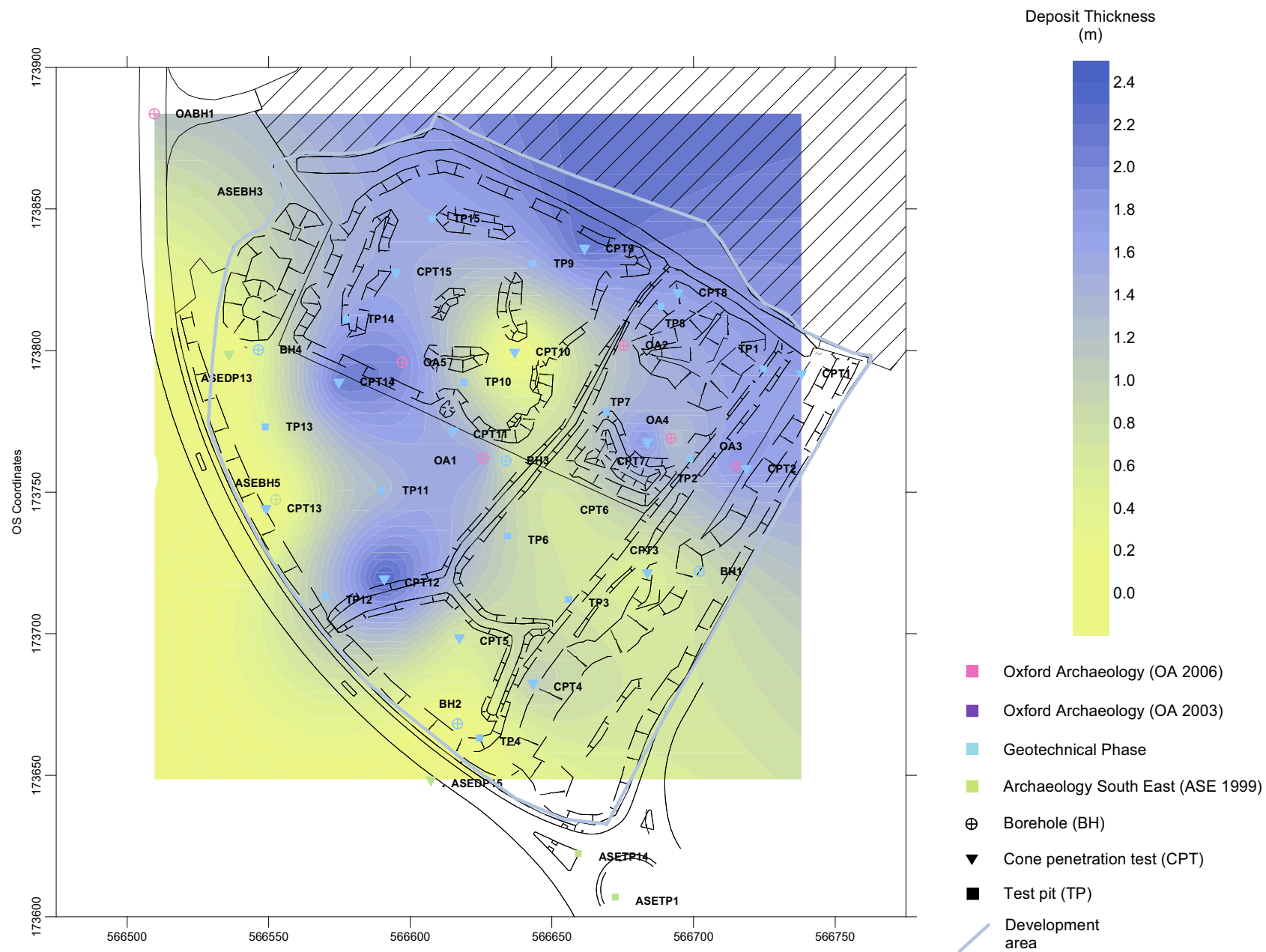


Figure 4 - Thickness of peat deposits (m)

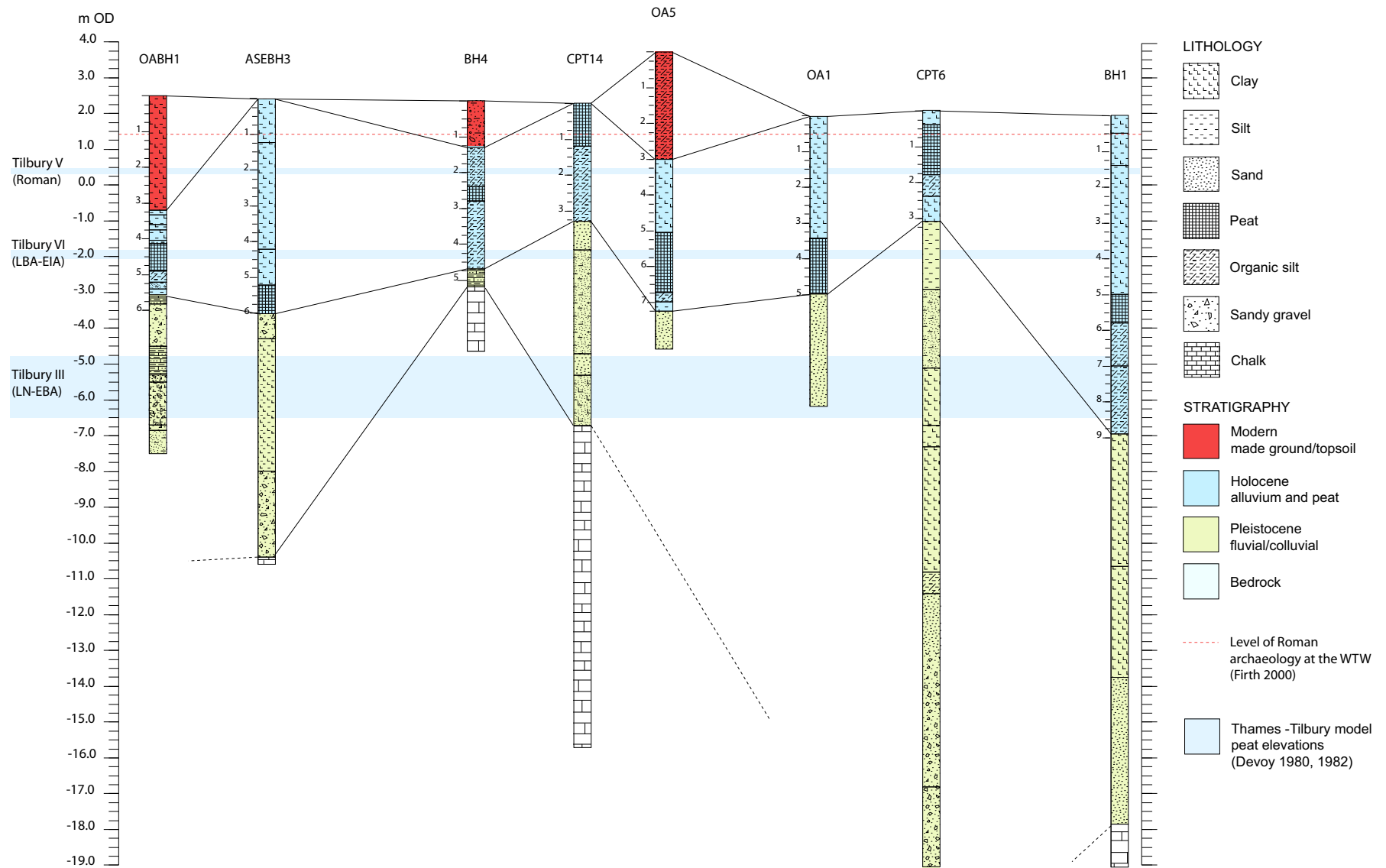


Figure 5 - Section A-A'

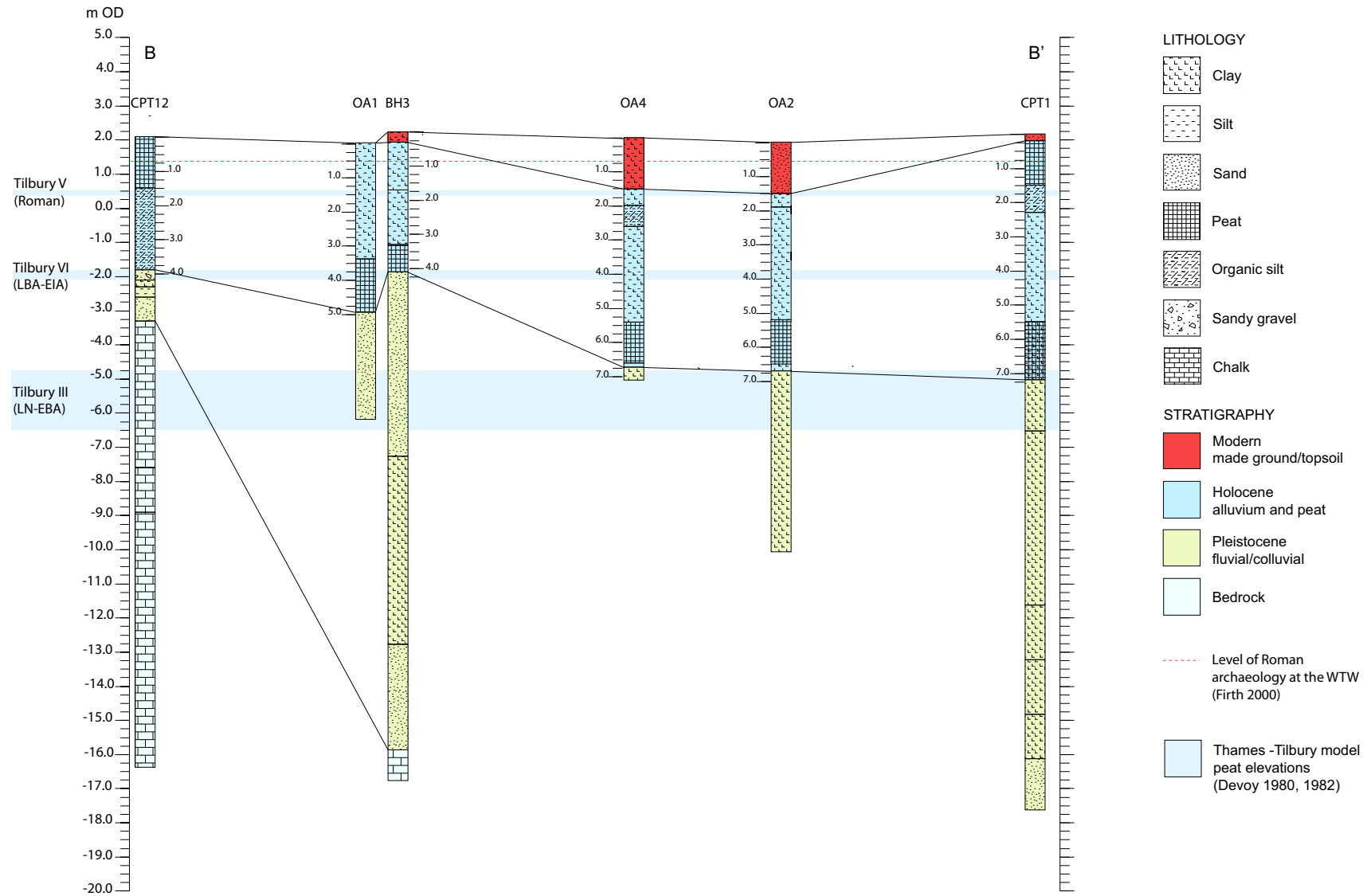


Figure 6 - Section B-B'

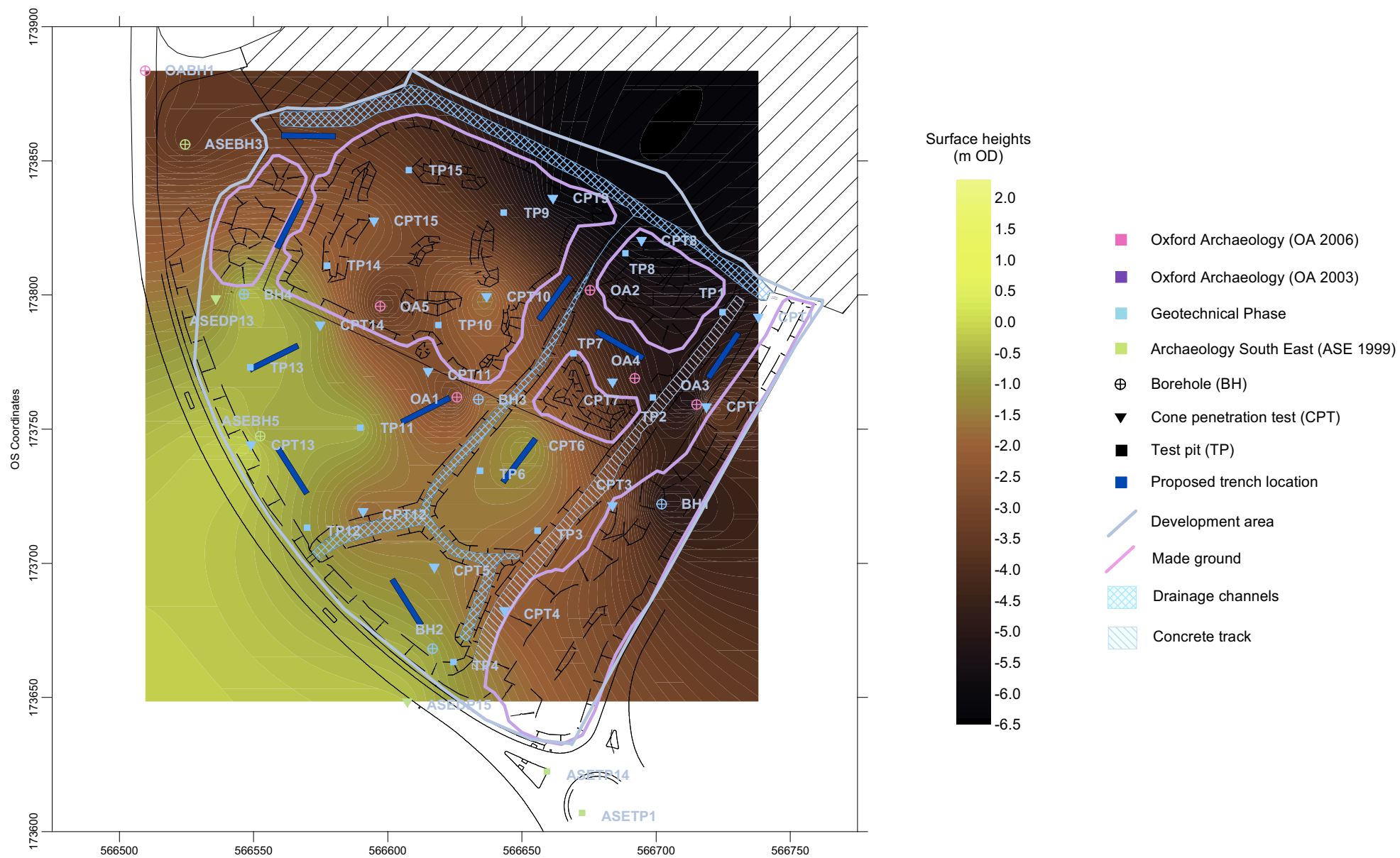


Figure 7 - Proposed trench locations



Oxford Archaeology

Janus House
Osney Mead
Oxford OX2 0ES

t: (0044) 01865 263800
f: (0044) 01865 793496
e: info@oxfordarch.co.uk
w: www.oxfordarch.co.uk



Oxford Archaeology North

Storey Institute
Meeting House Lane
Lancaster LA1 1TF

t: (0044) 01524 848666
f: (0044) 01524 848606
e: lancinfo@oxfordarch.co.uk
w: www.oxfordarch.co.uk



Director: David Jennings, BA MIFA FSA

Oxford Archaeological Unit is a
Private Limited Company, N^o: 1618597
and a Registered Charity, N^o: 285627

Registered Office:

Oxford Archaeological Unit
Janus House, Osney Mead, Oxford OX2 0ES