PLANNING DELIVERY ZONE 12
Trench PDZ12.01
London E15

London Borough of Newham

A post-excavation assessment

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MUSEUM OF LONDON Archaeology Service

PRE-CONSTRUCT ARCHAEOLOGY

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Trench PDZ12.01
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Executive summary

This report presents the results of excavation work undertaken within Trench PDZ12.01 within the Olympic park. The work was undertaken by the Museum of London Archaeology Service and Pre-Construct Archaeology (MoLAS-PCA) within the area of the Olympic, Paralympic and Legacy Transformations Planning Applications: Planning Delivery Zone 12, London Borough of Newham, London E15. The report was commissioned from MoLAS-PCA by the Olympic Delivery Authority (ODA).

As a result of evaluation it was determined that the archaeological sequence within Trench PDZ12.01 was of sufficient significance to require further investigation. The result of the mitigation work has helped to refine the initial findings and so assist in our better understanding the archaeological potential of the area.

The earliest deposits recorded were in Period 1. These terrace gravels were deposited in a former channel in the River Thames floodplain or the River Lea, probably 140,000–30,000 years ago. These were overlain by a sand bank, dated to the end of the last Ice Age. Evidence of cultural activity in Period 1 was limited to a few redeposited worked flints.

Post-dating this was a Neolithic stream channel and the earliest evidence for in situ human activity in Period 2. The eastern edge of a north-west/south-east aligned Neolithic river/stream channel was recorded. Environmental evidence from the channel fills was indicative of the varied habitats both within and at the margins of a river or a channel. A fragment of worked red deer antler was also found in this fill, along with a Neolithic pre-formed axe found in perfect condition.

In Period 3 a second, later, north-south river channel post-dated the infilled Period 2 channel. Its eastern edge lay within the excavation area and was aligned. The channel fills were dated to between the Late Neolithic and Late Bronze Age. Environmental samples indicated a freshwater river with stony bed and shores within a fairly open marshland with a scattering of trees across the floodplain. Three close-to-vertical stakes had been inserted into the gravel layer in the base of the channel. Curved axe stop marks on the stakes were typical of the small, socketed axes of the Late Bronze Age. Although these stakes could not be given a function, they probably did not represent the fragmentary remains of a jetty or revetment and may have been part of a fish trap. Also found horizontally in the upper channel fills were stakes that may have been a corduroy surface

In the next period, Period 4, another north-west to south-east channel cut across the Period 3 floodplain/marsh which had formed after the infilling of the Period 3 channel. Pottery dated to 100 BC–AD 100 was recovered from the channel. The fill was cut by stakes on a roughly north–south alignment. Their purpose was unclear. A floodplain deposit sealed this channel and its fill.

Post-dating this was Period 5, which included a further channel and its fills, a gully that drained into the channel, a timber structure driven into the fills of the channel, a plough soil beyond the limits of the channel and marsh deposit that had accumulated west of the plough soil, across the course of the channel and gully. A radiocarbon date from the channel fill was AD 980–AD 1160.

Post-dating these features were early post-medieval land reclamation and 18–19th-century development.

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1 Introduction

1.1 Site location

The excavation took place to the south-east of Stratford High Street, south-west of Rick Roberts Way, in the northern area of Planning Delivery Zone 12 (PDZ12) of the Olympic, Paralympic and Legacy Transformations Planning Applications, in the London Borough of Newham, designated as work package 1 within PDZ12 (Fig 1).

The zone as a whole occupies a corridor of land bounded to the north-east by Rick Roberts Way, to the north-west by Stratford High Street, to the south-west by the south side of the Northern Outfall Sewer, and to the south-east by the Abbey Lane Gas Depot and the open land west of the Channelsea River. A narrow spur congruent with the extent of the Northern Outfall Sewer continues the zone to the south-east, bounded by Canning Road to the south-east.

Trench PDZ12.01 is hereafter called 'the site' (Fig 2). The OS National Grid Reference for the centre of the excavation area is 538425 183635.

1.2 The scope of the project

This report was commissioned by the Olympic Delivery Authority (ODA) and produced by the Museum of London Archaeology Service and Pre-Construct Archaeology (MoLAS-PCA). The report has been prepared within the terms of the relevant Standard specified by the Institute of Field Archaeologists (IFA 2001). The project covers the excavations carried out at Trench PDZ12.01 in the Olympic Park.

This post-excavation assessment describes the results of archaeological excavation, undertaken by MoLAS-PCA. This report assesses the data recovered from the excavation and thus measures the archaeological potential of the site.

The aim of the project is to assess the archaeological significance of any findings made during the above works and understand them in their wider context, whether local, regional, national or international. The proposed analysis and publication project will address those issues raised in the project research aims whilst integrating local archaeological knowledge from other excavations in the immediate and surrounding area. This post-excavation assessment report incorporates specialist reports on animal bone, building material, clay tobacco pipe, leather, lithics, pottery, and worked wood (see 5.4–5.11). Conservation recommendations are also made (see 5.12. The environmental and geoarchaeological aspects of these inputs are incorporated into a specific section of this report (see 5.13).

Reference should be made to the preceding desk-based assessment undertaken for the whole of PDZ12 (MoLAS-PCA 2007a) and *Evaluation Report* (MoLAS-PCA 2008).

The excavation was carried out in accordance with a *Written Scheme of Investigation for Archaeological Excavation* (MoLAS-PCA 2007b).

1.3 Circumstances and dates of fieldwork

The legislative and planning framework in which the archaeological exercise took place was summarised in the *Written Scheme of Investigation for Archaeological Excavation* which formed the project design for the excavation (MoLAS-PCA 2007b).

In accordance with local and national policies an archaeological evaluation was required in advance of the redevelopment as part of the planning process. An evaluation trench (PDZ12, Work Package 1), oriented north-east to south-west, had been excavated at a point where east margin of the former valley of the River Lea met the northern margin of the former River Thames floodplain. The evaluation took place between 10 January to 6 February 2008.

As a result of the evaluation, it was considered that further archaeological and geoarchaeological fieldwork was necessary to examine and record the nature and extent of the prehistoric and later activity identified in PDZ12.01 evaluation trench and its inter-relationship with the changing environment and river characteristics. This work involved an extension of the trench eastwards, to examine whether occupation activity existed on the dryland identified in this area, and whether earlier phases of the river regime survived. The base of the trench was also extended south-west, where tufa deposits, associated with a spring and likely to be of significance for local prehistoric activity were identified during the evaluation. Evidence for the later evolution of the river was also suggested for this area. The excavation took place between 3 March to 2 May 2008.

The archive comprises: one electronically surveyed overall trench plan, one drawn detailed trench plan at a scale of 1:20 and 144 plans also at a scale of 1:20. 328 context records were allocated and 95 sections were drawn. In addition, 41 bulk samples, 2 radiocarbon samples were taken, and three monolith sequences were taken. The site finds and records have been allocated the site code OL-08707.

1.4 Organisation of the report

The *Post-excavation assessment* is intended to sum up what is already known and what further work will be required to reach the goal of a well-argued presentation of the results of recording and analysis.

The principles underlying the concept of post-excavation assessment and updated project design were established by English Heritage in the *Management of Archaeological Projects 2* (MAP2), (1991).

This document details the work undertaken on the analysis of the site sequence (section 4), for the assessment of the archive (section 5). It compares observations with the original research aims (section 6.1) and discusses the site's wider significance (section 7)

As part of the *Post-excavation assessment*, the analysis has resulted, in terms of the report, in elements of the excavation being referred by subgroup(i.e. SG01 etc), or where a particular description is required, the term context (e.g. [100]) is used. Each is a unique numerical reference, within its type, which relates to a specific element of the excavation, where a subgroup is an amalgamation of contexts, representing a related group of contexts.

2 Historical and archaeological background

The following summary of the historical and archaeological background to the site is based Section 2 in the desk-based assessment for PDZ12 (MoLAS-PCA 2007a) and draws upon the results of the preceding evaluation (MoLAS-PCA 2008).

2.1 Modern topography and drainage

The site is located in the River Lea valley, between the Waterworks/Three Mills Wall River and Channelsea River, *c* 3km north of the modern confluence with the River Thames. The site lies just south-east of the grid–like network of river channels known as the Bow Back Rivers. Modern ground level at the north-west corner of the site, at the junction of Livingstone Road and the High Street is 6.90m OD, and there is a steady decline to the south-east, with the ground level at the junction of Livingstone Road and Union Street, towards the south of the site being 3.40m OD.

The modern topography and drainage of the area has been much modified by man and bears little resemblance to the landscape of the site in historic and prehistoric times. Several metres of modern ground raising mask the natural land surface: these deposits were shown to be up to 3m thick in the evaluation (MoLAS-PCA 2008).

Similarly, very little of the natural course of the Lea remains in the modern landscape, which today flows through a series of mostly man-made canalised and culverted channels, such as those bounding and crossing the site itself.

2.2 Natural topography and past landscape setting

The site lies on alluvium, which represents a range of different wetland and dry land environments existing on the valley floor (floodplain) of the Lea from the Mesolithic period onwards. The alluvium is underlain by the Lea Valley Gravels, deposited following the scouring–out of the valley floor during the Palaeolithic period (the Pleistocene). The gravels are the most recent in a series of Pleistocene river terrace deposits, which today form an irregular flight of steps in the valley side. The Kempton Park Gravels and older Taplow Gravels form the lowest of these river terraces, at the edge of the valley. Tertiary bedrock, variably London Clay and Woolwich and Reading Beds, underlies the gravels. The bedrock pre–dates the period of human evolution and its surface acts as the bottom line for deposits of archaeological interest.

A summary of the buried landscape characteristics of the site and its archaeological implications is given here:

- The site is located in the central part of the valley floor, with the valley side immediately to the east. It is likely to have been a low-lying wetland area.
- A relatively deep channel existed in the central part of the site and it is possible that the channel relates to an earlier natural course of the Channelsea

River. A meander of the Lea formerly also crossed the site and was likely to have migrated across the site in the past.

- Most of the site would have been a low-lying wetland area for most of the prehistoric period and later, while the low gravel surface slopes upwards towards the Low Terrace (which has been recorded down the eastern part of the valley floor).
- The Low Terrace to the east remained as dry ground throughout the prehistoric period and into historic times and much evidence for occupation of prehistoric, Roman and medieval date has been found on it in the Stratford area.
- The site has the potential for Late Glacial beds and pockets of clay, silt and organic sediment within the gravels, and may contain important environmental remains. Such remains would be deeply buried, at -3m OD (*c* 7m below modern ground level).

The evaluation showed that Pleistocene river terrace gravels survived to a maximum height of -0.20m OD. The overlying alluvium had a surface level of *c* 2.10m OD (MoLAS-PCA 2008).

2.3 Prehistoric

The surface of the Lea Valley Gravel, together with any exposed bedrock and earlier gravel surfaces approximates the land surface at the start of the Holocene, about 10,000 years ago, at the start of the Mesolithic. In this period the site was likely to have been within an area of dry land, crossed by a network of watercourses. Residual finds from the Mesolithic found at the site of Stratford Langthorne Abbey, on the opposite side of the Channelsea to the site, attest to land use in the area at this time.

As river levels rose during the Holocene the dry land surfaces would have become waterlogged at progressively higher elevations through time. As a result, wetland areas are likely to have developed across much of the lower-lying land around the site during the prehistoric period. Evidence for late prehistoric cultural activity has been found close to the site and there is potential for this settlement having influenced the nature of the site's use during the late prehistoric period. At the site of Stratford Langthorne Abbey, archaeological excavations revealed a horse burial close to a crouched human inhumation, suggesting ritual/religious activity dating from the middle Iron Age to Roman periods. Also in this area was a dense concentration of pits, postholes and hut circles cut into the clay subsoil, covering an area of at least 1.5 acres. This has been interpreted as a multi-phase settlement, which was occupied from the Late Bronze Age through to the 4th century AD. Residual finds from the Mesolithic attest to earlier land use in this area.

The location of the site in the wetland and close to/within both a deep watercourse and the higher land of the river terrace suggests that characteristic prehistoric timber structures, particularly track ways and platforms may exist, particularly as prehistoric occupation is known from the Low Terrace to the north and east of the site.

Prehistoric finds made during the evaluation confirmed this potential. Neolithic pottery and animal bone were found within the upper gravels, but it was unclear whether these finds were discarded on a channel bar or were transported there by the river. These finds may have been associated with four nearby wooden stakes. Also, dry sieving produced flint knapping debitage and more (unabraded) Neolithic pottery. The unabraded nature of the material suggests that the position from where they were found was not far from their original location of deposition. Associated with these finds was an assemblage of animal remains, including horse (MoLAS-PCA 2008).

2.4 Roman

The Lea was likely to have been an important route in the Roman period. It may have been used to supply the London area both with agricultural produce and, in the late period, with pottery from Much Hadham, via the River Stort. Excavations have established that a Roman settlement existed in an area north–west of the study site close to Old Ford, which fronted onto the Roman road that stretched from *Londinium* to the Roman Colonia of *Camulodunum* (Colchester). The road was used for the transportation of food from Essex and East Anglia to Londinium. A network of yards and fields were laid out behind the road. The projected line of this road passes roughly east–west, *c* 500m north of the site. Roman activity has been recorded close to the site at Abbey Road during excavations of Stratford Langthorne Abbey on the opposite bank of the Channelsea River; the evidence included burials (both human and animal). If seasonally a dry land area, the site may have been exploited in a similar fashion.

With evidence for Roman activity both to the west and east of the site, it is possible that the site was subject to some level of Roman-period cultural impact/exploitation. However, no Roman features or finds were observed during the evaluation (MoLAS-PCA 2008).

2.5 Saxon

Several place names in the Lea Valley have Saxon origins. Hackney derives from a Saxon reference to the well–watered meadows by the marshes of the River Lea. Clapton means the farm on the hill, while Leyton derives from settlement on the Lea.

Saxon pottery and burials recorded during archaeological excavations at Stratford Market Depot indicate that this period saw use of both the river and the land to its east in the site vicinity. Further, it is likely that the Roman crossing at Old Ford and the course of the Roman road/causeway across the marshes and east side of the valley remained in use during much of the Saxon period.

The Saxon–period Lea, flowing south through Stratford, appears to have branched into several channels, collectively called the Stratford Back Rivers. Although the pattern of channels has been associated with King Alfred, who in 895 AD apparently obstructed the river to strand the Danish fleet, the evidence is inconclusive and they are more likely to be man-made channels modifying earlier streams in order to create mill leats to work the mills associated with the Bow Back Rivers on historic maps. Saxon remains within PDZ12, if present, are most likely to comprise disassociated finds and riverside structures, similar to that found in the Stratford Box site to the north, which may also have been associated with a former channel of the Channelsea River or a meander of the Lea. However, the evaluation uncovered nothing from this period (MoLAS-PCA 2008).

2.6 Medieval

The site lies adjacent to Stratford Langthorne Abbey and its precinct. There is the possibility for field structures and buildings associated with the Abbey, as well as waterfront features associated with the Cistercians alteration and control of the river system of the Channelsea. PDZ12 also crosses the Channelsea in the vicinity of the medieval Abbey Mill. Any medieval remains are likely to be of local to regional significance. The medieval road running along the north edge of the site (Stratford High Street) also raises the possibility of buildings having stood along the line of the road.

A turf line/landsurface recorded in the evaluation, although not dateable through finds evidence, may have dated to this period (the overlying deposits included redeposited medieval building material and pottery) (MoLAS-PCA 2008).

2.7 Post-medieval

The use of the local waterways for industry, transport and a source of power for the operation of mills was a major theme in the later development of the Lea Valley.

The 18th century brings the first evidence for the nature of activity at the study site. The John Rocque map of 1746 is the earliest representation of the site showing the majority of the area was used as fields, with the High Road (Stratford High Street) and a couple of roadside houses with gardens. By the beginning of the 19th century the frontage was occupied with terraced housing fronting onto the Bow Causeway road, while towards the south there was an osier bed in the Channelsea River adjacent to the crossing of Abbey Lane by the Abbey Mill precinct. By the time of Stanford's map in 1862 the area is still parcelled into fields. Stanford's map also shows the Northern Outfall Sewer to the south–west. Between 1882 and 1896 the area around the site became increasingly built up, with buildings occupying the northern half of the site and two new roads having been founded: Livingstone Road and Stanley Road. A church (Christ Church with attendant charity school) was on the northern corner of the High Street and Union Street, in the northern most corner of the site, although much of the church probably lies under the present dual-carriageway, known as Rick Roberts Way. The layout for the site remained relatively unchanged until the latter half of the 20th century; between 1955 and 1965 Stanley Road was removed and a large office building erected along the north side of Livingstone Road with Union Street running down to join Livingstone Road.

Post-medieval consolidation dumps and structural remains (a well, pits, culverts/drains and walls/foundations/footings) were recorded in the evaluation (MoLAS-PCA 2008).

3 Original research aims

The following research aims and objectives for the excavation were established in the *Written Scheme of Investigation for an Archaeological Excavation at Trench PDZ12.01* (MoLAS-PCA 2007b) and are intended to address the research priorities established in the Museum of London's *A research framework for London Archaeology* (2002) and those of the evaluation (MoLAS-PCA 2008):

- To identify evidence for settlement of prehistoric and historic date, particularly within zones of higher ground not already truncated by quarrying.
- To identify wetland and channel margin activity of prehistoric date and riverside structures of historic date.
- To identify evidence for the nature and/or date of past land management and exploitation.

Further consideration was given to the potential for ritual activities associated with water resources (stream and spring); to the wooden four-post structure and associated features (if any); the interaction between fluvial and dry land activities, particularly in the early prehistoric period; to later prehistoric anthropogenic and natural land uses and interactions; for evidence of medieval land consolidation and occupation.

4 Site sequence: statement on fieldwork

4.1 Introduction

The excavation refined the understanding of the depositional sequence uncovered in the evaluation, and subsequent analysis allowed meaningful interpretations to be made.

The sequence was divided in eight periods (Periods 1–8), discussed below.

Periods 1–5 were dominated by riverine activity and alluvial deposition, with evidence for a cultural presence and landscape activity in Periods 2–5. Periods 6–8 were post-medieval to modern.

4.2 Period 1: Terraces gravels and the late glacial development of dry-land deposits

Period 1 represents the development of the landscape from the earliest deposits to the late glacial period (*c* 12 thousand years ago). It consisted of two subgroups.

SG01 consisted of the sorted gravels at base of the sequence. These terrace gravels, were deposited in a former channel in the River Thames floodplain or the River Lea, probably 140,000–30,000 years ago assuming they are comparable to the topographically similar Tilbury Marsh Gravels (Howell *et al* in prep). The gravels (shaped by later cuts) were observed from -0.03m OD in north-east down to -1.46m OD in the south-west. This variation in levels reflects the site's position on the east side of the Lea Valley, where the topography slopes down towards the central, deeper, area of the valley.

SG02 overlay SG01. This was a sand bank, with lenses of grey sandy clays and laminates of sands and gravel. Optically Stimulated Luminescence (OSL: a method of dating minerals where the last exposure to sunlight is recorded), provided a range of dates suggesting these deposits formed at the end of the last Ice Age. Three contexts ([193], [185] and [187]) were dated by OSL from 12,600 years ago to 13,900 years ago. Context [193], to the north-east of the trench was higher than the other SG02 deposit at 1.60m OD. This was interpreted as a buried land surface because of its high clay content (a result of low-energy deposition) and orange colour, suggesting oxygenated deposition. Root action observed in this deposit will have penetrated from above, a conclusion supported by a radiocarbon date from [223] (a layer within SG02) of 3980 BC–3800 BC: i.e. roots in the sampled deposit had grown-down from the Period 2 Neolithic bank above into the Period 1 late glacial deposits.

Evidence of cultural activity in Period 1 was limited to a few worked flints found in uppermost SG02 deposits. These were presumably brought downstream from where they were originally deposited. The slim evidence for cultural activity might be due to the area of the trench being within a marine or estuarine environment during part of the Mesolithic (12,000 to 4,500 years ago).

4.3 Period 2: Neolithic stream channel and the earliest *in situ* human activity

Period 2 represents the earliest identified stream channel and human activity in the trench (Fig 3). It consisted of two subgroups:

- SG03, the channel itself and material that had built up within the limits of the channel (for sections see Figs 8 and 9)
- SG04, deposits alongside the channel which had been lain during episodes of flooding (for section see Fig 10)

SG03 consists of the evidence for the eastern edge of a north-west/south-east aligned Neolithic river/stream channel recorded at the south-west of the trench, which had not been seen in the evaluation. Only the eastern side of the channel was seen: its western extent was beyond the limit of excavation. Furthermore, its eastern edge also extended north-west and south-east beyond the limit of excavation. The deepest level of the channel in this area was *c* -1.40m OD.

The main fill deposit within the channel was [580], a firm, mid olive-grey peaty sandy clay between *c* -1.40m OD and *c* -0.70m OD. This context was characterised by sample {126}, which was rich in wetland plants and insects. This aquatic assemblage is indicative of the varied habitats both within and at the margins of a river or a channel with little velocity, suggesting [580] was a flood deposit (Section 5.13.3.4). A fragment of worked red deer antler was also found in this fill, along with a Neolithic pre-formed axe <6>, (see 5.5).

The large flint axe was found in perfect condition, and its manufacture had not been fully completed. The axe would have lain in a deposit visible to any passer-by. Other accounts of flint axes from this period in the Lea valley suggest these objects may have been placed in these locations as some kind of offering (Smith 1894, 309-11), possibly to a deity or as a signifier of the religious significance of the margin of the river bank, between the dry land and the flowing river.

A 50mm-thick layer of peat [596] with soft dark brown decayed wood sealed the peaty sandy clay. The material was characterised by sample {121} which consisted mainly of roots but also seeds, especially *Alnus glutinosa* (Alder), and *Theodoxus fluviatilis* (a snail mostly found in calcium-rich, clean, fast-moving fresh water). This would typically represents an alder fen: a marshy environment next to the river (see 5.13.3.4). However, in this case – as the deposit was within the channel – it represents a period in which the channel had become silted up and bog/marshlike.

SG04 consists of two successive layers of alluvial clay interpreted as over-bank and floodplain deposits seen in the north-east of the trench. These were lain concurrent with the active period of the SG03 stream/river channel. OSL dating shows that these deposits accumulated *c* 6,000 years ago (see Table 13).

4.4 Period 3: Bronze Age river migration

Period 3 represents the eastward migration of a second, later, river channel (Fig 4). It consisted of two subgroups.

- SG06, the channel itself and material that had built up within the limits of the channel, sealing the peat within SG03, the underlying channel (for sections see Figs 8, 9 and 10)
- SG05, deposits alongside the channel which had been lain during episodes of flooding (for section see Fig 10)

The arrival of the Period 3 channel was defined by [574], a layer of sandy fine gravels with a surface level of *c* -0.50m OD (0.35m thickness). These sealed the SG03 peat and were lain down in a high-energy fluvial environment. The marsh-like conditions represented by the peat deposited at the end of Period 2 had ceased, and a new channel had commenced flowing across this area: succeeding the now-infilled Period 2 channel (which no longer left any surface evidence).

The western edge of [165], the Period 3 channel, was beyond the limit of excavation. Its eastern edge however lay within the excavation area and was aligned north-south (see Fig 4). The deepest level at which the base of the channel was seen was -0.70m OD.

The SG06 channel fills were found between *c* -0.70m OD and c 0.40m OD. Three radiocarbon dates were derived for the fills: 1360 BC–1050 BC from [183/191], 1430 BC–1260 BC from [210] and 2870 BC–2570 BC from [177] (see Table 13). These indicate that sediments in this channel accumulated between the Late Neolithic and Late Bronze Age. Environmental sample 11 from [183], a mixed deposit of peaty material, silt and tufa, confirmed a freshwater river with stony bed and shores with a fairly open marshland with a scattering of trees across the floodplain. The high diversity of sediments and organic materials combined with a rich macrofossil and microfossil data indicate this context represents a severe flood event (see 5.13.3.4). Sample 14 from [210] (a dark brown organic clayey silt) also indicated a mixed environment indicative of a flood deposit (see 5.13.3.4). Samples 5 and 27 from [177], an organic silty clay, included alder (which dominated the floodplain) and indicated the presence of disturbed (including cultivated) ground alongside the channel (see 5.13.3.4).

Three close-to-vertical stakes ([577], [578], [581]) cut into [574], the fine gravel layer in the base of the channel (see 5.11 and Fig 4). Curved axe stop marks just under 45mm wide were typical of the small, socketed axes of the late Bronze Age (Section 5.11.4.5). Although these stakes could not be given a function, they were however located within the main body of this channel, and had been driven with a purpose in mind. Being within the channel, it is unlikely they represent the fragmentary remains of a jetty or revetment. They might be part of a fish trap.

Also found horizontally in the upper fills were four pointed stakes or small piles that although reused were orientated with the tips in line (on north-west/south-east alignment) that had been laid in roughly the position they were found in, perhaps as a rough corduroy surface over part of a particularly soft area of channel fill.

Close to the top of the fill sequence was a rolled tufa deposit [191/570]. This type of calcium carbonate forms in water saturated with mineral deposits derived from the underlying geology. It is typically associated with springs. However, in this case the tufa took the form of discrete lenses and had not formed *in situ* (it was within the fills of the channel). Therefore it had washed into this position from further upstream.

The uppermost channel fill was a layer of decayed wood and wood fragments [533], with a surface level of *c* 0.40m OD. As with Period 2, Period 3 had now seen the cessation of fast-flowing water and the encroachment of a low-energy marsh type environment. This context was characterised by sample {102}. Aquatic, riverside and terrestrial insects were also present, including possible indicators of domesticated animals. This context represents a wooded, marshy floodplain subject to flooding (see 5.13.3.4).

SG05 was represented by [219], a layer of alluvial clay with a surface level of between 1.00m OD and 1.50m OD. This was contemporary with and alongside the Period 3 channel. Environmental data from monolith tin M4 showed that [219] contained some iron mineral, perhaps indicative of weathering, and fragments of what appears to be charcoal (indicative of either natural or man-made fire). Although not conclusive, the weathered appearance suggested this layer was formed by overbank flooding, where the deposits would be exposed to dry-land conditions (see 5.13.3.3). Two OSL dates for SG05 indicate deposition 3,300 years ago and 3,400 years ago: i.e. congruent with the radiocarbon dating of the later channel fills within SG06 (Table 13).

4.5 Period 4: Iron Age and Roman channel

Period 4 represents the formation of another channel, which cut across the Period 3 floodplain/marsh which had formed after the infilling of the SG06 channel (Fig 5). It consisted of two subgroups:

- SG07, the channel itself and material that had built up within the limits of the channel (for sections see Fig 8 and 9)
- SG08, deposits over the channel which had been accumulated in a watermeadow/fenland type environment (for sections see Figs 8 and 9)

Unlike the channels in the previous periods, the west edge of the Period 4 channel (SG07) was seen in the excavation area. Aligned roughly north-west to south-east, it extended both north and south beyond the limits of excavation. Its east edge, however, was truncated by features from the next period (or beyond the limit of excavation). The base of the channel had variable levels, but at its deepest was -0.40m OD.

The SG07 stream gradually silted up, to a level of 0.30m OD. Of the three fills recorded, [572], the lowermost, was a dark sandy deposit. This contained noticeably more pottery than the other fills. Pottery dated to 100 BC–AD 100 was recovered from it (see Section 5.6). The majority of the sherds, however, dated to the Late Bronze Age and Early Iron Age. Together, this suggests accumulation over a long period, a suggestion supported by abraded state of the sherds.

A further sandy layer with clay lenses, [569], was the next successive channel fill. This layer was cut by a group of three stakes [565], [567] and [568] (see section 5.11.4.4). The three stakes formed a roughly north–south alignment (Fig 5) with their truncated tops surviving up to 0.09m OD. They varied in diameter between 60mm and 40mm and survived 0.5 to 0.2m long, Two had pencil-type points and [568] (probably alder) had a point formed from the natural curved of the stem and two smooth facets up to 45mm wide. The smooth character of the facets showed that metal tools had been used: of what form it is difficult to be certain. An Iron Age or Roman date seems likely from the stratigraphic situation, the stake points and depth of survival, but a slightly later date might be possible. The sandy layer with clay lenses [569] also included un-worked tree stump [566], drift logs [573] and also a small stake [571], 35mm diameter (section 5.11.4.4).

At the top of the SG07 fills was [564], a layer of clay with sand lenses with pottery dated to AD 120–AD 250 (see Section 5.7.2).

SG08 was a floodplain deposit that sealed the SG07 channel. This grey silt was found between *c* 0.30m OD and *c* 0.45m OD and was typical of a deposit formed in waterlogged, but not marsh conditions. Although there was no direct dating evidence, its stratigraphic position over the SG07 channel places SG08 as after *c* AD 250.

4.6 Period 5: Medieval channel and developed land use

Period 5 represents a channel that cut through the extensive floodplain deposits represented by SG08 in Period 4 (Fig 6). It consisted of five subgroups.

- SG09 was a further channel and its fills (for section see Fig 8)
- SG10 was roughly north-east/south-west gully that drained into the SG09 channel
- SG11 was timber structure driven into the fills of the SG09 channel
- SG12 was a plough soil beyond the limits of the channel (for section see Fig 10)
- SG13 a marsh deposit that had accumulated west of the plough soil, across the course of the SG09 channel and SG10 gully (for sections see Figs 8 and 9)

SG09 consisted of the complete width of a 5m-wide channel aligned north-west/south-east. It was 1.70m deep with a base level of -0.49m OD. It survived to 1.22m OD (the eastern bank was higher than the western). The fills were a clean clay capped with peaty clay.

Three bulk samples were taken from the fills of this channel. Sample 8 from [173], the lower fill, was a clay silt, contained very little environmental information being virtually all rootlets, considered through pollen analysis to be a grass-sedge fen (grassy marsh) (section 5.13.3.4). Sample 7 from [172] and Sample 17 from [169], the upper fills, were a dark brown organic silt which contained fragments of wood, roots and mainly wetland (aquatic) seeds. The plant and pollen data indicate a marsh environment, probably becoming seasonally dry over time with cereal production taking place locally. This deposit was interpreted as the fill of boggy hollow, possibly partially wooded, which slowly silted up through flooding (section 5.13.3.4). A radiocarbon date from fill [172] was AD 980–AD 1160 (Table 13).

Twenty one items of worked wood were recovered form SG09 (see section 5.11.4.3). Most were lying horizontally (not *in situ*) but some of the stakes may have formed a possible east–west revetment, e.g. [544]-[546] with [554] (see Fig 6). The horizontal material included possible branch loppings and possibly displaced horizontal wattle fragments. The timber specialist has suggested that these truncated stakes may be remnants of channel revetments, or possibly fish traps or hunting blinds.

SG10 consisted of a north-east/south-west gully that fed into the SG09 channel (Fig 6). The gully was cut from *c* 0.35m OD, and 1.10m wide and 0.15m deep. It was probably a drainage gully; draining areas to the west into the SG09 channel. The gully was filled with the same type of organic-rich peaty clay that formed the upper fill of the SG09 channel (see Sample 7 from [172] and Sample 17 from [169]): i.e. the SG09 channel and the gulley both became infilled as a result of the same inundation event

SG11 consisted of three stakes and a stake hole, arranged in an apparent square within the fills of the SG09 channel. The highest observed level was *c* -0.45m OD. Stratigraphically, this structure could be earlier than Period 5 and it has been suggested that on typological/comparative grounds the structure was either Iron Age, Roman or early medieval, based on a comparative fifth-century structure from Enfield (see section 5.11.4.2). However, the stakes were driven in the base of the SG09 channel through its fills, therefore an 11th-century date is suggested.

SG12 consisted of [218], a single layer of firm mid brown clay silt capping the over bank sequence at the north-east of the trench, recorded between 1.50m OD and 2.10m OD. Monolith tins M1 and M2 from sequence {109} suggested that [218] had a stronger terrestrial component than the lower deposits in the over bank sequence (see section 5.13.2.3.2), suggesting it could have been a plough soil. Beyond its geographic situation and its levels, this deposit was placed in this period as there was a lack of evidence for truncation between SG12 and the overlying deposits.

SG13 was found across most of trench at the top of alluvial sequence, west of the SG12 plough soil. It was recorded between 0.35m OD and 1.15m OD. Plant remains still visible. Indeed, sample 16 from [207] was a silty clay dominated by wetland (aquatic) plants, specifically *Cyperaceae* (sedge), indicative of a marshy environment (section 5.13.3.4). A radiocarbon date of AD 1310–AD 1440 (see Table 12), also from context [207], indicates this area of the trench was marsh in the late medieval period.

4.7 Period 6: Early post-medieval land reclamation

Period 6 was spot-dated to after AD 1480 by pottery and consisted of two subgroups that sealed the SG012 plough soil and SG013 marsh (see Fig 8–Fig 10).

SG14 and SG15 consisted of layers of sands and gravels, deposited as consolidation over the earlier marshland at levels of up to 2.80m OD.

4.8 Period 7: 18th-century houses

Period 7 was represented by SG16, which consisted of the remains of buildings and associated structures/layers, dating from the late 18th to 19th century (Fig 7). A brick-lined drain, two brick-lined pits (probably soakaways) and a series of pier bases were observed, along with two rubbish pits.

Bricks from the structure of the drain were dated to 1750–1900, more probably to the 19th century. Pantile from the drain fill was of a mid 17th–19th century type (see 5.4).

Otherwise, finds from Period 7 were dated to 1820–1900 (pottery: see 5.7.4) and 1780–1820 (clay tobacco pipe: see 5.8)

Although these remains may have represented more than one phase of development, in broad terms they can be related to the later terraced housing recorded on the site by Milne's map of 1800.

4.9 Period 8: 19th- and 20th-century development

Period 8 (not illustrated) was represented by SG17, which consisted of a 19th-century stock brick retaining wall (contexts [100] and [101]) on the north-east of the site. This appeared to be the south-west property boundary of Christ Church, Stratford Marsh, and school, built in 1852. The church was a stone building designed by John Johnson in 14th-century style with a north tower and spire. It was demolished in 1975.

Besides the stock brick wall, other remains structural remains included an inspection chamber, drains and a concrete surface that had covered most of the trench. Sandy layers formed the consolidation for the concrete surface.

Map evidence suggests many of the structural remains can be associated with the terraced housing shown on the OS 2nd ed map of 1869, an arrangement distinct from the SG16 terraced properties in Period 7. The concrete surface was constructed between 1982 and 1995 after the demolition of most of the terraced properties on the site.

5 Quantification and assessment

5.1 Post-excavation review

In order to produce this report, a statement of the potential of the stratigraphic archive was produced (section 6). An assessment has been made (section 6.1) of the degree of realisation of the original research aims and of the research potential generated by this.

5.2 The site archive and assessment: stratigraphic

Tasks completed to date:

- Subgrouping completed
- Subgroup matrix completed and checked
- Subgroups allocated
- Provisional periods allocated
- Site matrices completed and checked
- All plans digitised in AutoCad
- All environmental material processed and assessed
- All finds processed and assessed

Type	Description	Quantity	Notes
Contexts	Combined evaluation and excavation	328	Evaluation: 244 Excavation: 84 Not included 26 void contexts
Plans	'A4' 1:20	144	Evaluation: 7 Excavation: 137
Sections	'A4' 1:10, 1:20 and 1:50	95	Evaluation: 60 @ 1:20 Excavation: 35 @ 1:10
Drawing	'A 4'	3	miscellaneous
Matrices	Plan, context and subgroup	15	Digital and paper copies
Photographs	Black and white, colour and digital	136	94 slides (includes duplicate images) 42 digital images

Table 1: Stratigraphic archive

5.3 Site archive and assessment: finds and environmental

Building material	Two small crates of ceramic building material (all bulk items discarded). Total 5.56kg
Worked flint	42 pieces (half standard box)
Prehistoric pottery	16 sherds. Total 365g
Roman pottery	1 sherd; 1 ENV; 1g
Medieval pottery	6 sherds; 6 ENV; weight 97g
Post-medieval pottery	57 sherds; 33 ENV; weight 2415g
Leather	1 item
Coins	1
Clay pipes	0.25 box (bulk/accessioned) = 12 fragments
Bulk Soil Samples	41 bulk samples
Monolith tin	3
C14 samples	2
Animal bone	estimated 220 fragments. Total 18.311 kg.
Mollusc shell	estimated >1000 shells. Total <0.50 kg

Table 2 Finds and environmental archive: general summary

5.4 The building material

Ian Betts

5.4.1 Introduction

All the building material has been recorded using the standard recording forms used by the Museum of London. This has involved fabric analysis undertaken with a x10 binocular microscope. The information on the recording forms has been added to an Oracle database.

Material	**Count**	**Count as % of total**	**Weight (kg)**	**Weight as % of total**
Stone	1	5	0.040	0.7
Medieval ceramic	1	5	0.020	0.4
Post-med ceramic	19	85	5.500	98.9
Mortar	1	5	0.001	<0.1
Total	22		5.566	

Table 3 Building material

5.4.2 Medieval building material

The only medieval building material present on the site was a small fragment of peg tile (Fabric: 2271) of broad 1180–1480 date from SG014.

5.4.3 Post-medieval stone building material

A small piece of chalk and a thin slither of mortar were found with post-medieval roofing tile in SG014.

5.4.4 Post-medieval ceramic building material

A small quantity of post-medieval peg roofing tile (Fabric: 2276) was found in subgroups 14, and 16. SG014 also contained a piece of ridge tile which would have been used on the same roof, or roofs. The peg tiles are of two round nail hole type and most have nail holes between *c* 11mm and 14mm diameter. Another peg tile, from the fill (SG016) of a probable 18th century brick-lined drain, has a nail hole only 8mm in diameter. This is probably mid 18th–19th century in date.

A fragment of pantile (Fabric: 3259/3202) was also recovered from the fill of the brick-lined drain (SG016). This is mid 17th–19th century date.

A number of brick samples (Fabric: 3032) were collected from the brick-lined drain (SG016). These are all sharp edged with a very shallow frog and can be dated to 1750–1900, although they are more likely to be 19th rather than 18th century. They were almost certainly made at a brickyard close to London.

5.4.5 Potential

The assemblage has no research potential beyond its relevance to the site and no further work on it is recommended.

5.5 Lithics

Tony Grey

5.5.1 Introduction

The worked flint was collected on site by hand, dry-sieving and wet-sieving according to the likelihood of maximising recovery. The recovered items were recorded and assessed according to current Museum of London archaeological practice. The assemblage included a Neolithic flint axe <6>, a scraper, a retouched flake fragment, two cores and thirty waste flakes. In addition, 13 pieces of burnt flint weighing 297g were recovered from SGs 6, 7, 8 and 9 (see Table 4).

Ctxt	Subgroup	Flakes	Blades, blade-like flakes	Cores, core fragments	Retouched forms	Total	Comments
55	2	11					Small or tiny flakes Sq 1, field flint Sq 2
162	2	3					Small flakes SF 1,2,3
192	7						3 burnt flint 50g, 2 field flint
219	4	2					Secondary flakes
532	8						Burnt flint
533	6						Burnt flint
569	7	3		1	1		Worked out blade core, retouched flake fragment, plunging flake, 2 flake frags, burnt flint
570	7						Field flint
572	7	4					Plus field flint
574	6	5					Shattered fragments and field flint
576	8						Burnt flint
580	5	2		1	2		Abraded flake core, crude scraper on primary flake, primary flake, secondary flake, field flint, Neolithic axe (complete) <6>
Total		**30**		**2**	**3**	**35**	

Table 4: Breakdown of struck/worked flint assemblage

5.5.2 Catalogue by subgroup

SG02 produced fourteen small flakes.

SG03 produced a complete Neolithic axe <6> (see front cover). The piece is fully flaked bi-facially but not ground or polished and is 220mm in length by 80mm breadth at the widest point and is of the thin-butted variety. The flint is mid- to dark grey with flaws. The axe is undamaged and presumably not utilised. Such axes were produced by preparing a preform from a roughout and creating a sharp cutting edge by shallow retouch with a soft hammer. Both sides were shaped by multi-directional shallow retouch.

Also from this SG03 were a crudely worked scraper on a primary flake of black flint with a crystalline mass and buff cortex, an abraded flake core in dark flint with black cortex, a primary flake in opaque pale grey flint and a secondary flake in ochre flint.

SG04 produced two small flakes.

SG06 produced five shattered flake fragments and burnt flint.

SG07 produced a fragment of a plunging flake with buff cortex, two flake fragments, a retouched flake fragment in black flint and a worked out blade core, four secondary flakes (one a large flake in opaque pale grey flint) and burnt flint.

SG08 produced burnt flint only.

5.5.3 Discussion

The raw material is flint of frequently poor quality in colours ranging from buff and ochre to various shades of grey to black. Several bear cortex ranging in colour from buff to peat/silt blackened. None show any patina. The buff cortex on the scraper and several flakes flake indicates derivation from a chalk based environment. Other flakes and shattered fragments were probably derived from gravel pebbles. Most of the pieces of field flint are peat/silt blackened. Hard hammer technology has been used and some flakes show a prominent bulb of percussion below the platform. Several pieces are shattered fragments and the blade core is abraded suggesting secondary deposition and river action.

5.5.4 Overview

The flint assemblage indicates prehistoric activity at and in the vicinity of the site over a long time period. Differing environmental conditions have affected the material with some riverine peat/silt blackened and some not. There appear to be three sub-assemblages with Mesolithic residual material present (including the worked out blade/bladelet core in grey flint), Neolithic material exemplified by the complete flaked axe <6> from SG03 and Late Bronze Age material. Residual Mesolithic flint from earlier land use was also found at the site of Stratford Langhorne Abbey on the opposite side of the Channelsea to the south-east.

5.5.5 Potential

The flint assemblage is of importance as it demonstrates activity in the area from the Neolithic to the Late Bronze Age and contributes to the understanding of prehistoric activity and material culture in the Lea Valley.

The axe is a rarity of intrinsic interest and warrants further research in the form of comparative study for parallels, both from the vicinity and further afield to establish whether any shared technological aspects are apparent.

5.6 The prehistoric pottery

Lyn Blackmore

5.6.1 Introduction

A small collection of Bronze Age and Iron Age pottery was recovered from the site (total 16 sherds, 365g). The sherds range in size from small to large fragment of 157g (average sherd size *c* 40–50mm; average weight *c* 23g). The material is in relatively good condition and includes four rims and one decorated sherd.

5.6.2 Methodology

The pottery was examined macroscopically and using a binocular microscope (x 20), and recorded on proforma sheets and on the Oracle database using a series of Museum of London fabric codes.

5.6.3 Fabrics

Three main fabric groups are represented, as described below. Most are probably locally made, although the large shell-tempered storage jar could be from Kent.

5.6.3.1 Flint-tempered (FLIN)

These wares are present in all contexts. Most sherds fall into this category, and in most flint is the only inclusion, with a range of combinations of fine to very coarse and sparse to abundant inclusions. One sherd recorded from SG02, although probably from SG06 or 7, contained rounded quartz sand as well as flint.

5.6.3.2 Sand-tempered (SAND)

Two sand-tempered sherds were found in SG07. Of these a bead-rimmed jar is in a very fine brickearth with no obvious inclusions, while a body sherd is coarser with abundant fine rounded quartz sand, mainly up to 0.3mm, but some up to 1mm across.

5.6.3.3 Shell-tempered (SHEL, NKSH) and calcareous (CALCS)

Two sherds contain shell, of which a thumbed rim from SG07 has in inclusion-free matrix with sparse quartz sand and is probably an Early Iron Age Essex ware (SHEL), while a storage jar rim from SG07 is in a Kentish fabric (NKSH) dating from the 1st century BC to 1st century AD. A burnished sherd is from the same context and probably of the same date contains sparse fine calcareous inclusions in a very fine sandy matrix.

5.6.4 Forms

The earliest diagnostic sherd is from a bucket urn or cordoned jar in SG07. The dominant form type within the Deverel-Rimbury tradition, bucket urns are straight-sided or flaring, with a rim diameter that is greater than base, usually in coarse flint-tempered fabrics (Barrett 1980, 298–300; Gibson 2002, 105). The present sherd has an applied horizontal cordon with thumbed decoration, and would thus belong to urn type 5 as defined by Ellison at Kimpton (1981, 174): straight-sided, medium size with flaring rim, often with horizontal cordon around the girth, sometimes interrupted by lugs.

Possibly of slightly later date and also from SG07 is a battered and abraded rim in a flint-tempered ware that appears to be from a biconical or shouldered jar with short everted rim. Late Bronze Age examples are illustrated by Gibson (2002, fig 54, no.4) and Greenwood (1982, 188, top left corner), while an Early Iron Age example from Shoebury is illustrated by Brown (1995, fig 67, no. 121). An Early Iron Age date would also apply to another rim from SG07 which is externally thumbed, for which a close parallel, also in a shell-tempered ware, was found at Shoebury (ibid, 83, fig 65, no.95).

Another problematic find, also from SG07 is what appears to be the rim of a bowl; the rim itself is expanded with rounded outer edge; it could be flat-topped, in which case the wall is more or less vertical, or everted, in which case it will flare out. The outer surface is abraded but the inner wall is slightly burnished. No parallel has been found for this form and although it could be Iron Age date the large size of the flint inclusions suggest that it may be earlier.

The latest diagnostic finds, both from SG07 and probably of late Iron Age/early Roman date, are a bead-rimmed bowl in a brickearth fabric and a large storage jar with rolled rim in a shell-tempered ware. The latter is similar to finds from Southwark (Marsh and Tyers 1978, form II.A.3; Hammerson 1988, 199, fig 77).

5.6.5 Discussion

Dating flint-tempered body sherds is extremely difficult, but the rims and featured sherds suggests that the assemblage spans up to 1000 years, from the later Bronze Age to the late Iron Age/early Roman period. Shell-tempered wares do not seem to occur in Essex until the Early Iron Age; at Shoebury a trend from flint-tempered to shell-tempered wares was noted in the 6th century BC (Brown 1995, 83). The largest group (nine sherds) is mixed, with both Bronze Age pottery and sherds dating from *c* 50BC to 50AD. The date of the expanded flint-tempered rim from SG07 is uncertain.

From the above it can be suggested the prehistoric pottery represent two groups; of Late Bronze Age/Early Iron Age date (probably 900–600BC) and, the later dating from 100BC–AD100.

5.6.6 Significance and potential

The pottery is of importance as it demonstrates activity in the area from the Mid- to Late Bronze Age to the Late Iron Age/early Roman period. As such it agrees well with finds from the adjacent site of Stratford Langthorne Abbey, where widespread evidence for a multi-phase settlement occupied from the Late Bronze Age through to the 4th century AD was found (Barber et al 2004).

Both the fabric and forms will contribute to the understanding of prehistoric activity and material culture in the Lea Valley and six finds merit illustration.

The pottery is primarily of local significance but will be of interest to those working on the prehistoric period in Greater London and Essex as a whole.

5.7 The Roman, medieval and later pottery

Nigel Jeffries

5.7.1 Introduction

The pottery was examined macroscopically, using a binocular microscope (x 20) where appropriate, and recorded on paper and computer, using standard Museum of London codes for fabrics, forms and decoration. The numerical data comprises sherd count, estimated number of vessels and weight and entered onto the ORACLE database. This assessment aims to evaluate the character and the date range of the assemblage, determine the research questions the material has the potential to address and identify any areas of further work.

5.7.2 Roman pottery

One small sherd of central Gaulish samian ware (SAMCG) was recorded in SG07, and dated as AD 120–250. The form cannot be identified and no other Roman pottery was recorded on the site.

5.7.3 Medieval pottery fabrics and forms

Six sherds of medieval pottery were collected, all small fragments, with little in the way of identifiable characteristics present beyond fabric and form. Four sherds of London type-ware (LOND) were found (in Subgroups 14), made by one of the major suppliers of pottery into London during the medieval period (kilns have been found in Woolwich), and identified in jar and jug forms. There is also one small sherd of Mill Green ware (MG) in SG014. This fine red earthenware was made near Ingatestone, Essex and is dated to AD 1270–1350. The handle of a jug in Colchester-type slipware (COLS) was recorded in SG09 and from its form probably dates to the 15th century. Traces of white slip used for decoration remain on the surface of the handle.

5.7.4 Post-medieval pottery fabrics and forms

The evaluation comprised groups from subgroups 14 and 15, weighing 510g (average weight per sherd of 72.8g). This material comprised 12 sherds from a minimum of seven vessels (estimated number of vessels: ENV). This was recovered in a variable condition, with 87% of the total weight of the assemblage provided by a single vessel from SG015. The rest of the pottery is relatively poorly preserved, reflecting the nature of the levels from which they were retrieved. The pottery consisted mostly of Surrey-Hampshire border wares (BORDB, BORDG) or London-area red earthenwares (PMR), made in production centres located on the south bank of the Thames, notably at Woolwich, Deptford and Lambeth. Both were found in utilitarian bowl and dish forms.

The excavation yielded a further 45 sherds of post-medieval pottery from a minimum of 26 vessels (total weight 1905g). The earliest find was part of a jug in Raeren stoneware (RAER), dated to *c* 1480–1610, found in SG014. While the evaluation was based on finds of border wares and London-area redwares, which could be dated broadly to the 17th to 18th centuries, the excavation phase found a somewhat later emphasis in the material collected, although close dating can be hindered by small sample size. Surrey-Hampshire border redwares continued in use throughout the 17th to 19th centuries, although some of the forms identified are later than c 1700, including chamber pots and handled bowls of similar form. London-area redwares also continued throughout this period, with sherds from a sugar-loaf mould, used in sugar refining, found in SG017. Factory-made finewares from the Midlands and north of England provide good dating evidence for mid to late 18th-century contexts and for the 19th century. Sherds of white salt-glazed stoneware (SWSG) date from c 1720–80 and include sherds from teawares in context [515], amongst which is a toy teabowl. Further good dating evidence comes from the presence of creamware (CREA) in its fully developed form, current from the 1760s onwards (found in SG018). Pearlware (PEAR) was introduced in the last quarter of the 18th century and part of a teabowl or cup with early underglaze blue transfer-printing dates SG018 to *c* 1770–1810. The latest find was part of a plate with black transfer-printing in a design described on the base as 'PANDAH'. This piece probably dates to the mid 19th century.

5.7.5 Discussion

Despite being poorly preserved, the pottery assemblage from OL-08707 can provide enough information to answer some of the research aims for this site in addition to supplying a consistent chronology for the recorded land use (see Table 5). The main period of activity attested in the collected material extends from the mid 18th to mid 19th century, with a small number of sherds from the medieval and 16th to 17th centuries. The pottery is almost entirely domestic in character, although there is limited evidence for sugar refining in the vicinity.

Subgroup	Type	TPQ	TAQ	SC	ENV	Wt
9	MPOT	1400	1500	1	1	52
14	MPOT	1270	1350	3	3	26
14	PPOT	1580	1700	3	3	124
14	MPOT	1080	1350	2	2	19
14	PPOT	1600	1700	5	3	32
15	PPOT	1580	1800	5	3	453
16	PPOT	1820	1900	28	19	616
17	PPOT	1700	1800	16	6	890
Total				**57**	**33**	**2415**

Table 5 The chronological distribution of the medieval and later pottery, giving sherd count (SC), estimated number of vessels (ENV) and weight in grams per context

5.7.6 Significance and potential

Representing common finds from London, the pottery assemblage furthers understanding of the recorded land use and characterises the deposits from which it was recovered. The finds are certainly of significance in relation to the site and its environs, although, on their own, they do not have any wider importance for regional studies.

5.8 The clay tobacco pipes

Tony Grey

5.8.1 Introduction

Total no. of fragments	12
No. of bowl fragments	4
No. of stem fragments	8
No. of mouthpieces	0
Accessioned pipes	3
Marked pipes	3
Decorated pipes	0
Imported pipes	0
Complete pipes	0
Wasters	0
Kiln material fragments	0
Boxes (bulk\accessioned)	0.25

Table 6 Clay tobacco pipe quantification

The clay tobacco pipe assemblage from OL-08707 was recorded in accordance with current Museum of London practice and entered onto the Oracle database. The pipe bowls have been classified and dated according to the Chronology of London Bowl Types (Atkinson and Oswald 1969), with the dating of some of the 18th-century pipes refined where appropriate by reference to the Simplified General Typology (Oswald

1975, 37–41). The prefixes AO and OS are used to indicate which typology has been applied. Quantification and recording follow guidelines set out by Higgins and Davey (1994; Davey 1997).

5.8.2 The character of the clay pipe assemblage

Four pipe bowls were recorded, the earliest of which comes from the back fill of a drain in SG016 and dates to *c* 1610–40 (type AO5). It is stamped under the heel with the maker's initials EB in relief. These cannot be matched with the name of any known pipemaker working in London at this period, although the pipe was a London product. The other three pipes date to the later 18th to early 19th century and come from Subgroups 16 and 17, which have a latest date (on clay pipe evidence) of *c* 1780–1820 based on two pipes of type AO27. There is also a pipe bowl of type OS12 in SG017. The two later pipes both have maker's initials moulded in relief on the sides of the heel, although in each case they are unclear, masking the identity of the pipemaker. No decorated pipes were found.

5.8.3 Marked pipes

5.8.3.1 Moulded marks

<2> [507] sgp16 AO27 (1780–1820): base of bowl with maker's initials "IR" moulded in relief on the sides of the heel.

<4> [518] sgp16 AO27 (1780–1820): bowl with maker's initials "EH" moulded in relief on the sides of the heel.

5.8.3.2 Stamped marks

<3> [515] sgp16 AO5 (1610–40): bowl with maker's initials "EB" stamped in relief underneath the heel.

5.8.4 Significance and potential

The clay pipe assemblage from OL-08707 is very small, with few datable bowls and two of the three marked examples are unclear. The third and earliest, however, can be matched with other examples bearing the same mark and found in the City of London. The main potential of the material is for refining the dates obtained from pottery and other finds.

Although the assemblage has no research potential beyond its relevance to the site and no further work on it is recommended, the 17th-century stamped pipe from SG016 adds usefully to the MOL database of clay pipe makers' marks, extending the known area of distribution for this mark.

5.9 The leather, glass, iron nail and coin

Beth Richardson

5.9.1 The leather

There is one item of leather from the site: a shoe sole from SG017.

The sole is from a small child's shoe (length 119mm, measured before conservation). It is a natural-shaped straight sole (i.e. not made for a left or right foot) with a line of widely-spaced grain/flesh stitch holes around the perimeter, and, within that, a scored line for tunnel-stitching.

Shoe parts from children's shoes are often difficult to date as they did not always reflect adult fashions; the construction method used for this one is almost certainly 18th or 19th century.

The shoe sole is being conserved, but no further research or publication text is required.

5.9.2 The glass

There are four pieces of post-medieval glass from two contexts: [40] and [145]. The three joining pieces from [145] are from a late 18th- or 19th- century green glass cylindrical wine bottle. The glass is light green and thin walled, suggesting French manufacture, possibly from a cylindrical 19th century Burgundy or cognac bottle. The single piece from [40], in a darker green glass, is from a domed base of an English wine bottle which could date from the late 16th to the 19th century.

No further work is necessary.

5.9.3 Iron nail

There is a large square-sectioned corroded iron nail and a smaller piece of iron (also from a nail) from [154]. It may be Roman (the one sherd of pottery from this context is Roman, although possibly residual).

5.9.4 Coin

The one registered find from the site, a slightly convex copper alloy button (<1> [8]) is corroded and indistinct. It is decorated with a man's head (facing left) and possibly an inscription around the edge.

It may be a 19th century military button (pers. comm. Geoff Egan).

5.9.5 Significance and potential

These finds have no research potential beyond their relevance to the site and no further work on it is recommended (beyond the conservation noted above).

5.10 The animal bone

Alan Pipe

5.10.1 Introduction

This report identifies, quantifies and interprets the animal bone from OL-08707. Each context and sample group was described in terms of weight (kg), estimated fragment count, species, carcase-part, fragmentation, preservation, modification, and the recovery of epiphyses, mandibular tooth rows, measurable bones, complete long bones, and sub-adult age groups. The assemblage was not recorded as individual fragments or identified to skeletal element. All identifications referred to the

Osteology Section reference collection. Fragments not identifiable to species or genus level were generally allocated to an approximate category; 'ox-sized' or 'sheep-sized', as appropriate. Each context and sample assemblage was then grouped with any available feature description.

5.10.2 Summary

This assemblage provided 6.850 kg, estimated 675 fragments, of well-preserved hand-collected and wet-sieved animal bone with a minimum fragment size generally between 25 and >75mm. The hand-collected bone produced 6.350 kg, estimated 675 fragments; the wet-sieved assemblage produced 0.500 kg, estimated 350 fragments.

The bulk of the hand-collected bone derived from adult and juvenile ox, ox-sized animals, sheep/goat, sheep-sized animals, horse and dog, with smaller amounts of adult pig and red deer. There was also a single bone from the upper limb of an adult swan.

Wet-sieved samples produced small fragment counts all derived from the major domesticates; ox, ox-sized animals, sheep/goat, sheep-sized animals and dog. There was no recovery of fish, amphibians, perching birds or small mammals.

Wild game species were represented only by swan upper limb from SG07; and a red deer antler from Subgroups 3 and 15. There was no recovery of other wild species. There were no foetal, neonate or infant animals.

The major domesticates were represented by elements of the vertebra, rib, upper limb and lower limb, areas of moderate and good meat-bearing quality, with only occasional recovery of the head and feet. Clear evidence of butchery was seen mainly on ox and ox-sized fragments with single examples of butchery on pig (SG16); horse (SG09) and dog (SG09). There was no recovery of human bone.

SG03 included a fragment of worked red deer antler, the only evidence for bone working from the assemblage. A single unidentifiable fragment of sheep-sized bone from SG02 had been calcined, although this appears to have been brought down from upper deposits, possibly the result of machine action. There was no evidence of pathological change or any other modification.

The assemblage produced some evidence for age at death of the major domesticates with seven mandibular tooth rows and 83 epiphyses; metrical evidence was more limited, with 22 measurable bones including ten complete longbones.

5.10.3 Significance and potential

The hand-collected and wet-sieved post-medieval assemblage has some definite potential for further study of the local meat diet and patterns of waste disposal, particularly with reference to carcass-part selection and age at death of poultry and the major domesticates; cattle, sheep/goats and pigs, and butchery of cattle and sheep/goats. The recorded wet-sieved assemblages from this period provide evidence for the consumption of marine/estuarine and freshwater fish and of a limited range of bird and mammal wild game.

In view of the absence of amphibians and small mammals from the samples, there is no potential for interpretation of local habitats.

The hand-collected and wet-sieved animal bone is of definite local significance, particularly in terms of meat diet, with emphasis on fish and the skeletal representation and age-selection of chicken, cattle, sheep/goat, pig and, to a lesser extent, game.

There is no wider significance or significance in terms of local habitats.

5.11 The worked wood

Damien Goodburn

5.11.1 Background

The survival of waterlogged structural woodwork from the Roman and medieval periods is well known from the London and wider region, with a large corpus of published material. However a substantial amount of prehistoric woodwork has also been found and systematically recorded since the mid 1980s. Some of this material is published in outline (e.g. Meddens 1996) and a small number of assemblages have been published in some detail (e.g. Goodburn 1996 and Goodburn 2003).

Key areas of investigations have included toolmark studies in dated assemblages and broad patterns of change in tool mark types are becoming apparent (e.g.. Sands 1997, and Goodburn in Masefield et al 2003). Recently experimental archaeological work has also sharpened abilities to recognise diagnostic features of tool marks and in some contexts to provide broad initial dating of excavated material. However, for clear diagnostic tool marks to survive the material worked has to be well preserved timber or large round wood.

The site lies in a low-lying position in the River Lea valley. Despite the canalisation of the water channels in the river valley, the naturally lain deposits are waterlogged and, therefore, preserve the wood remains.

By linking tightly dated timber structures to adjacent contemporaneous dry land surfaces such as quay surfaces, building floors, and river side roads, it has been possible to link the levels of survival of early woodwork to their broad dating when close to the tidal Thames. Trench PDZ 12.01 is close to where the Lea channels joined the Thames and known to have been tidal in medieval times. Roman shore side timbers not far from Leamouth are documented to have survived between *c* 2.0 - 1.5m in the 1st century AD to around 0.0m OD at c. 300 AD followed by a rise back up to *c* +1.70m OD by *c* 700 AD as seen at the Ebbsfleet tide mill dam. Late prehistoric woodwork has been found in the Thames flood plain near by surviving between *c* 1.0m to –1.0m OD (occasionally lower). The current safe ground surface near Leamouth would be around +5m OD except for surge tide conditions when it is protected by the Thames Barrier.

5.11.2 Methodology

The general approach to the excavation and the recording of worked wood, followed the practice set out in the Museum of London Archaeological Site Manual Excavation (Spence 1990) and in accordance with the practice established on other London prehistoric wetland sites and is compatible with the parameters of best practice set out in the Waterlogged Wood: English Heritage's national guidelines document (Brunning 1996).

The lifted material was rapidly scanned and some initial notes prepared. Each worked, or possibly worked, item was given an individual timber number and a timber sheet filled out for it. However, nearly all the material is not technically timber but worked round wood (i.e. cut poles), smaller rods and also cut branch wood. None of the material had enough annual rings (*c* 45) for tree-ring dating, so no dendrochronological samples were taken.

5.11.3 Character and condition of the wood

The general character of the woodwork found is widely used material from early prehistory to rustic woodwork of the present day: exclusively worked round wood, mostly less than 75mm in diameter. The relatively small stem sizes meant that tool marks were only partially preserved, so attributing broad dating has to be treated with caution in most cases.

The ancient natural effects of water flowing across the site both moved woody material, eroded it and truncated it to varying degrees at different times. This removed some of the evidence which may have survived in less dynamic wetland sites. Any piece of worked wood with a pointed end has been termed a stake, even when found lying horizontal. Some of these items were clearly displaced, whilst others were probably cut branch ends left over from de-branching stems.

5.11.4 The worked round wood

5.11.4.1 Worked round wood associated with channel (Period 3: SG06)

A group of three stakes [577], [578] and [581] and a small amount of other material in woody peat [533] were revealed below the dark sandy deposit [572] which contained Iron Age pottery and residual Bronze Age pottery.

Together with their soft root-punctured condition, the level at which they survived of –0.57m OD is in keeping with a late prehistoric, probably Bronze Age, date. Stake [581] was found at an inclined angle, possibly as a result of scouring, whilst the other two were more vertical. Stake [581] was also the largest at *c* 120mm diameter and survived 0.88mm long in fragmentary condition. The smallest of the three stakes was [578] at 0.69m long by 75mm diameter.

The point forms were of the pencil type, but the compacted sand and gravel they were driven into resulted in generally poor tool mark survival. However, on the sides of stake [578] where the axe shaping of the point had began curved axe stop marks just under 45mm wide could be seen which would fit the typical, small socketed axes of the Late Bronze Age (Goodburn 2003). The function of the stakes is uncertain.

Four pointed stakes or small piles were exposed in section: [66], [68], [69] and [70]. They were not last used as stakes or piles but had been extracted and reused. It was immediately clear that they had traces of working and further excavation revealed their pencil-type pointed ends. They were orientated horizontally with the tips all in line at the north-west end with machine cut ends to the south-east indicating that they could not have been simply washed-in by water movement from up stream. They must have been laid in roughly the position they were found in, perhaps to function as rough corduroy surface over part of a particularly soft area of channel fill. The uppermost parts of the reused stakes lay at *c* –0.50m to –0.60m OD. The best preserved was the largest [69] the size of a small pile, slightly squashed to an oval section of 140 by 100mm and surviving 0.78m long with the bark intact. It appeared to be of alder. The tool marks were also well preserved with very straight incomplete axe stop marks up to 70mm wide left by a blade at least 75mm wide with a rather straight edge. This size and form of blade is known from the Iron Age, Roman and early medieval periods in the south-west but not the Late Bronze Age. In the case of this large stake even some signature striations left by nicks in the axe blade survived. The other stakes were similarly made from whole stems but smaller except for stake [68] which had been hewn out of a cleft half log giving a 'D' shaped cross section 95mm by 60mm and survived 0.47m long. All the material had small almost square root holes, which is a typical feature of late prehistoric waterlogged wood on the Thames flood plain.

Just a short distance to the north-west the roughly made stake [180] was found in a vertical position. It was only 55mm diameter and survived 0.62m long. The stake had many branch stubs protruding showing that it was either cut from a branch or parts of a tree-crown and had been used the reverse way up to the growing direction. It could only have been driven in very, very soft ground.

5.11.4.2 Worked round wood associated with channel (Period 4: SG07)

This group of three stakes [565], [567] and [568] was in a roughly north–south alignment with their truncated tops surviving up to +0.09m OD. They varied in diameter between 60mm and 40mm and survived 0.50m to 0.20m long. Two had pencil-type points and [568] (probably alder) had a point formed from the natural curve of the stem and two smooth facets up to 45mm wide. The smooth character of the facets showed that metal tools had been used: but of what form is difficult to be certain. These stakes were driven into a sandy layer with clay lenses which included un-worked tree stump [566], drift logs [573] and also a small stake [571], 35mm diameter.

An Iron Age or Roman date seems likely from the stratigraphic situation, from of the stake points and depth of survival, but a slightly later date might be possible.

5.11.4.3 Worked round wood associated with channel (Period 5: SG09)

Twenty-one worked items (18 pieces of worked round wood and three small off-cuts) were recovered from SG09.

The tops of the worked material survived up to between *c* +0.40 and +0.70 m OD. In some cases the material was vertically set stakes, which had truncated tops, and in other cases the cut material lay horizontally.

The horizon stakes were varied in character but generally of small diameter e.g. stake [555] made from a straight, 25mm diameter rod cut with one blow of a small metal axe to form a chisel-type point, this survived a crumpled 0.23m long. By contrast stake [544] was cut from a crooked end of a 50mm diameter rod to form a chisel point. Stake [546] was one of only two in the assemblage as it was made from a large stem 62mm in diameter split in half.

The horizontal material seems to have included branch loppings and possibly displaced horizontal wattle fragments. An example of a probable fragment of lopped branch wood, which appears to be alder, is [552]. It was 60mm diameter and over 0.3m long with a chisel type cut end with an incomplete rounded axe stop mark 50mm wide on it.

Some of the stakes were found in possible alignments: e.g. an east–west line of [544]-[546] with [554]. It is likely that the stakes once had wattle work or horizontal timbers or poles associated with them which have not survived.

The evidence is not totally distinctive but we may suggest that such truncated stakes could be remnants of channel revetments, possibly fish traps or hunting blinds.

The strangest worked wood item from this location was [554], a stem *c* 50mm diameter with what seems to have been a slightly charred surface ending in a multi-stemmed bulbous end *c* 110mm across. This end was found set in the ground in what must have been a small post hole with the smooth straight stem sticking up as a very small post. The bulbous multi-stemmed end would have been uppermost originally and resembled the ends of a small pollarded or shredded stem or branch. Evidence of what were probably annually cut small regrowth stems remained with smooth metal blade, cut ends. This the sort of item that may be an indicator of hedgerow basketry in which young pliable stems, often only one year old are repeatedly harvested from established trees. It will be particularly important to carry out a botanical species ID of this very unusual item.

5.11.4.4 Four post structure (Period 5: SG011)

The most coherent roundwood stake structure was the rectangular arrangement of four stakes (see Fig 6).

Three of the stakes survived intact [503], [504], [505] and a fourth was largely implied by a stake hole [77]. The arrangement measured 0.80m long by 0.60m wide and was first seen at c. –0.43m OD, but the stakes were clearly truncated and would have extended at least to 0m OD. All the stakes had pencil-type metal axe cut points and were made of whole stems. Stake [503] was 90mm diameter with a truncated length of 0.71m. Stake [504] was 80m diameter by 0.56m truncated length. Stake [505] was similar with a truncated length of 0.55m and a diameter 70mm. Stake [579] survived only as a tip fragment.

Small four post structures are well known features of Iron Age dry land sites and two partially waterlogged examples were recently found further up the River Lea at Enfield. They were built on sand banks near the edge of the main river next to a small crannog-type platform excavated at Glover Drive Enfield (Goodburn, in prep). The smaller of the two examples in this case was also 0.60m wide but longer at 1.20m. The reused oak timber of the main crannog platform has been dated to bark edge at AD471. However, in the case of this excavation, the stakes were driven into the base of the SG09 channel through its fills, therefore an 11th-century date is suggested.

On dry land sites such structures have been interpreted as granaries or fowl houses. However, in the wet environment that must have existed around this site other functions have to be considered such as a fishing platform, hunting blind or possibly even a toilet platform.

5.11.4.5 Worked round wood (Period 5: SG013)

A very truncated stake tip was found in SG013 marsh deposit in and was probably of early post-medieval date. This was the tip of a stake made from a whole stem of soft deciduous wood of *c* 65mm diameter. It had three facets up to 35mm wide and only survived 0.15m long.

5.11.5 Significance and potential

This assemblage of worked round wood is of modest size but has been carefully excavated and systematically recorded and sampled.

It must be viewed as both regionally and locally significant and to date the most substantial late prehistoric and early historic assemblage of woodwork excavated during the Olympic Park project.

Following tightening of the dating framework, with carefully selected radiocarbon samples taken from small young worked round wood, it will be possible to compare the assemblage with others from the region and distinctive features may emerge. At this stage relying on visual identifications of small roundwood we can suggest the species used were mainly local wetland trees, but this will be clarified by botanical analysis.

The woodwork is very much part of the story of peoples interaction with the delta of the river Lea over millennia, how its resources were used and how it was gradually tamed.

5.12 Conservation

Liz Barham

5.12.1 Introduction

The following assessment of conservation needs for the accessioned and bulk finds from the excavation encompasses the requirements for finds analysis, illustration, analytical conservation and long term curation.

Treatment of objects at the fieldwork stage includes the stabilisation of vulnerable materials and composites, cleaning of coins for dating purposes and investigative cleaning and conservation according to archaeological priorities.

Conservation work on the coin began with visual examination under a binocular microscope, followed by mechanical cleaning using scalpel and other hand tools.

The bulk leather was treated using glycerol as a stabilising agent and cryogenic protector, followed by freeze drying.

All conserved objects are packed in archive quality materials and stored in suitable environmental conditions. Records of all conservation work are prepared on paper and on the Museum of London collections management system (MimsyXG) and stored at the Museum of London.

5.12.2 Investigation and analysis

The accessioned finds were assessed by visual examination of the objects, and reviewed with reference to the written finds assessments by Ian Betts, Beth Richardson, Tony Grey and Nigel Jeffries, and to discussions with Jacqui Pearce in advance of the completion of her finds assessment.

None of the objects have been identified as requiring conservation work for investigation and analysis.

5.12.3 Work required for illustration and photography

None of the objects have been identified as requiring conservation work to prepare them for illustration or photography.

5.12.4 Preparation for deposition in the archive

The small finds from this site are appropriately packed for the archive, in accordance with MAP2 (English Heritage 1992) and the Museum of London's Standards for archive preparation (Museum of London 1999). No further work is necessary for transfer into the archive.

5.13 Environmental samples and geoarchaeological records

Graham Spurr

Several visits were made by MoLAS-PCA geoarchaeologists to examine, record and sample the natural sequences exposed within the trench. Three sequences of monolith tins were taken from sections exposed in the trench and a series of bulk samples was also taken adjacent to the monolith tins to provide sediment for off-site examination. See Figs 8–10 for location of monolith tins.

The results of the monolith associated assessments are included in section 5.13.2. Archaeological features, where excavated, were also sampled with bulks and/or monoliths, as appropriate. The results of the bulk sample associated assessments are included under the assessment of the environmental evidence in section 5.13.1.

5.13.1 Assessment of environmental evidence

5.13.1.1 Introduction

Environmental bulk soil samples were collected for the potential recovery of macro-biological remains, and information on the character of the local environment and possible evidence of human activities in the area. These samples were taken adjacent to, and in association with, monoliths sampled through the sedimentary and soil sequences within the trench. Information from the macro-biological remains could compliment the potential ecological data from micro-environmental material contained within these monoliths and establish possible spatial and temporal changes in the character of the environment on both a local and regional scale.

The aim of the assessment was to establish the level of preservation, the frequency and species-diversity of any environmental remains, and the potential for further work. An initial assessment was carried out on six samples collected during the evaluation phase to establish preservation conditions within the trench (Giorgi 2008). The following assessment is concerned primarily with the botanical remains although reference shall be made to other biological material within the samples, for which separate assessments, in some instances, are being carried out.

Forty-one bulk samples were assessed from sands, clays, alluvium and peats, associated with channel, marsh and floodplain deposits.

5.13.1.2 Plant Macrofossils

John Giorgi

The size of the bulk samples ranged from ten to 40 litres with most of the samples being ten litres. Between five and nine litres from each sample was processed by flotation using sieves of 0.25mm and 0.5mm for the recovery of the flot and residue respectively. An additional litre from each of these samples was also wet-sieved to 0.25mm for the potential recovery of molluscs. Furthermore, two litres was wet-sieved through a 300mm sieve in preparation for insect assessment. Between five and 15 litres of soil from all the samples was retained for the potential recovery of further botanical or other biological remains on the basis of the assessment results.

All 41 bulk samples produced organic flots ranging in size from 5ml to 1000ml, although just over half of the flots were 100ml or less. The wet flots were divided into fractions using a stack of sieves and scanned using a binocular microscope with the item frequency and species diversity of all biological remains being recorded using the following rating system of 1 to 3.

Frequency: 1 = 1-10 items; 2 = 11–50 items; 3 = 50+ items

Diversity: 1 = 1-4 species; 2 = 5–7 species: 3 = 7+ species

The results from the assessment showing biological and other materials in both the flots and residues are listed in Table 7.

Context	Sample	Grain	Wood	Seed	Roots	Wood	Moss	Comments
		CHD	CHD	WLG	WLG	WLG	WLG	
162	38		2 1	3 3	1 1	3 1	1 1	>wood(lg & sm frags);>seeds esp Alngl & car/cype;mod good molluscs(fw/tr); 50% assessed
198	10				3 1	3 1		Virt all fragmented wood & roots; 50%<2mm scanned; occ/mod beetles; occ molluscs
223	2			1 1	3 1	3 1		Virt all frag wood;some roots;occ seeds
55	39			2 1	3 1	3 1		Mainly v frag wood & roots;occ wetland spp;mod beetles & occ molluscs
506	100			3 1	3 1			ALL frag degraded wood & rootlets; no id'ble plant remains; mod insect frags (c 50)
596	121			3 2		3 1	2 1	Mainly roots but also good nos seeds (esp alngl) & moderate beetles
580	126			3 2	2 1	3 1		50% assessed;>frags wood,>seeds,mod spp div (wetland esp car), moderate beetles
585	127			2 2	3 1	3 1	1 1	Mod nos seeds,mod spp div (wetland),v frag wood & roots; moderate insects (c 50)
533	102			3 2	2 1	3 1		>frags wood,mod nos seeds/mod spp div(mainly wet);mod insects
574	125			3 2		3 1	1 1	Mod nos seeds/spp div(wet/aquatic & some wood/dist gds pp),mod nos beetles
564	110			3 3	2 1	3 1		>>wood;>seeds esp wet & dist/waste gd;mod beetles
569	111			3 3	3 1	3 1		Rich seeds;good spp div(>wet(aquatic) spp);mod beetles,occ molluscs:>frags wood;50% assessed;2 flots
570	112			2 2	2 1	3 1		Mainly v frag wood & roots;>molluscs;small nos seeds (30-40) & mod beetles (c50); 2 flots; 25% flot assessed
572	113		1 1	3 3	2 1	3 1	1 1	>>seeds/>spp div(wetland inc aquatic);also woodland & dist/waste gd;mod beetles & molluscs; 2 flots
532	101			3 2	3 1	2 1		Mod nos seeds/mod spp div(wet/aquatic spp) good rep cype/car;mod nos beetles & molluscs
183	11		2 1	3 3	2 1	3 1	1 1	>wood frags; >seeds (>spp diversity); wet, dist gd & shrub/wood enviro; good beetle assemblage; small nos molluscs (c 30)
183	24 s 5			2 2	3 1	3 1		Mod nos seeds (c50);>frags wood; mod molluscs; occ insects
183	24 s7			2 1	2 1	3 1		Virt all frag wood,roots;occ seeds & beetles;mod freq molluscs
185	4			1 1	2 1	3 1		Virt all v frag wood; occ seeds
185	12	1 1		3 3	3 1	3 1		>seeds>wetland spp,some dist gd spp,occ grain;mod beetles & molluscs
185	22			1 1	3 1	3 1		Virt all frag wood & roots; occ seeds
187	3			1 1	2 1	3 1		Virt all frag wood & roots
191	20		1 1	3 3	3 1	3 1	1 1	>wood & roots;>seeds esp woodland/shrub & wetland enviro; mod molluscs; occ/mod insects; 4 jars (25% ass)
182	21	1 1	2 1	3 3	3 1	3 1		>degraded wood/roots;>seeds –wetland (aquatic); some dist/waste gd & occ grassland plants; g ood insects;mod molluscs(fw) & ostracods; 50% flot < 2mm scanned

Context	Sample	Grain	Wood	Seed	Roots	Wood	Moss	Comments
182	13			3 3	3 1	3 1		>v frag wood, roots; >seeds & good spp div; >wetland(aquatic) esp cype; mod nos dist/waste gd spp; mod rich beetles
182	24		1 1	3 3	3 1	3 1		>degraded wood & roots; good seed assemblage –mainly wetland (aquatic) plants; small nos dist gd/waste gd; mod rich beetles; good molluscs (100+); 2 flots ss 4 & 5
182	26			3 3	2 1	3 1		25% assessed;>>wood;mod nos seeds;woodland spp
172	7			3 2		3 1		Wetland/dist gd enviro; good nos seeds & mod spp div Small nos insect frags (30-50)
174	6			1 1	3 1	3 1	1 1	Mainly roots, degraded wood; few id'ble remains Mod nos beetle fragments (c 50)
177	5		2 1	2 2		3 1	1 1	>frags wood,some charcoal; small nos seeds – dist ground & shrub/woodland
177	27			3 2	3 1	3 1		>frags wood/roots;mod seeds/spp div (mainly wetland),mod beetles
169	17			3 3	3 1	3 1		2 jars (25% ass); >frag wood & roots;>seeds -mainly wetland (aquatic); occ/mod beetles
173	8			1 1	3 1	3 1		Very little; occ seeds; virtually all rootlets
207	16		1 1	3 3	3 1	3 1		>roots;>seeds – wetland (aquatic) plants; occ/mod beetles; 50%<2mm scanned
208	15		1 1	3 2	3 1	3 1		>roots & wood;>seeds (mod spp div) –wetland(aquatic) plants; occ/mod beetles; 2 jars (25% ass)
210	14			3 2	3 1	3 1		>v degraded wood & roots;mod rich seed assemblage – wetland & disturbed ground; mod rich beetles
543	109			3 2	3 1	3 1		Mod nos seeds –mainly wetland; good insects
?	114		1 1	1 1	2 1	2 1		Mainly gravel; clinker, roots, degraded wood & charcoal Virtually no id'ble remains
?	115			3 3	3 1	3 1	1 1	>wood fgs; >seeds & spp diversity; mainly wetland spp (>PTM); some dist & waste gd; good beetle assemblage; some molluscs (50); occ ostracods
?	116			3 3	3 1	3 1	1 1	50% assessed;>frag wood;>seeds,>spp div;mainly wet/aquatic;some woodland/dist gds pp; mod beetles & molluscs

Table 7: Plant macrofossil remains

5.13.1.2.1 RESULTS

Charred plant remains

Ten bulk samples contained small amounts of very fragmented charcoal, none of which, however, are probably of a sufficient size for identification. Single charred grains of hulled barley (*Hordeum vulgare*) and wheat (*Triticum* sp.) were noted in two samples, from deposit [185] (sample {4}) and sandy clay [182] (sample {21}), respectively.

Waterlogged plant remains

All the bulk samples produced varying amounts of botanical remains preserved by waterlogging or in an anoxic environment, with these assemblages including fruits and seeds, wood, buds, catkins and moss fragments.

Variable amounts of fragmented wood were present in all the samples, which included twigs, branch wood and bark fragments, with small and large fragments (up to 60mm in length) in a number of samples, for example from sand [198] (sample {10}), tufa [191] (sample {20}), and marsh deposit [208] (sample {15}). Occasional to large amounts of 'waterlogged' roots were also noted in 35 of the 41 samples.

Identifiable seeds and fruits were present in 38 of the 41 flots, with high frequency and high species diversity in 15 samples, from channel deposit [162] (sample {38}), tufa [191] (sample {20}), organic deposit [183] (sample {11}), deposit [185] (sample {12}), sand/clay [182] (samples {13},{ 21},{ 24} and { 26}), marsh deposits [169] (sample {17}) and [207] (sample {16}), clay [564] (sample {110}), sands [569] (sample {111}) and [572] (samples {113}, {115} and {116}). There were large numbers of seeds with moderate species diversity in another ten samples, moderate seed frequency and smaller species diversity in six flots, and occasional seeds in a further seven samples.

The waterlogged seeds and fruits were from mainly plants of wetland (aquatic and bankside/marshland) environments, with some evidence for disturbed/waste ground and woodland/hedgerow habitats and only occasional evidence for grassland environments.

Wetland plants were present in all the seed assemblages with often a very wide range of species being represented, but with seeds of sedges (*Carex* spp.) being particularly prolific. There were true aquatics including pondweeds (*Potamogeton* spp.) and stoneworts (*Chara* spp.), and plants that may be found in a wide range of wetland habitats, in rivers, ponds, lakes, ditches, marshes and fens, including water plantain (*Alisma* spp.), branched bur-reed (*Sparganium erectum*), fine-leaved water dropwort (*Oenanthe aquatica*), tubular water dropwort (*O. fistulosa*), crowfoots (*Ranunculus Batrachium* gp), bogbean (*Menyanthes trifoliata*), common/slender spike-rush (*Eleocharis palustris/uniglimis*). celery-leaved crowfoot (*Ranunculus sceleratus*), gypsy wort (*Lycopus europaeus*), and rushes (*Juncus* spp.).

There was a smaller range of plants of disturbed (including cultivated) ground and waste places, including goosefoots (*Chenopodium* spp.), oraches (*Atriplex* spp.), docks (*Rumex* spp.), chickweeds (*Stellaria media* gp.), and stinging nettle (*Urtica dioca*), with several other species being more characteristic of arable ground, for example, fool's parsley (*Aethusa cynapium*) and corn marigold (*Chrysanthemum* *segetum*). Some of these weeds are indicative of nitrogen rich soils, which may point to human activity.

A number of the assemblages contained evidence for a woodland/hedgerow environment, including alder (*Alnus glutinosa*) (represented by both catkins and fruits), hawthorn (*Crateagus monogyna*), hazel nut (*Corylus avellana*), plum/bullace (*Prunus domestica*), sloe/blackthorn (*P. spinosa*), cherry (*P. avium*), elder (*Sambucus nigra*) and brambles (*Rubus* spp.). Most of these plants are potential sources of food. There were also a few grassland plants in the samples, for example, self-heal (*Prunella vulgaris*), hawkbit (*Leontodon* spp.), and possibly the buttercups (*Ranunculus acris/repens/bulbosus*), sedges, rushes and indeterminate grasses (Poaceae).

Other waterlogged plant remains in the samples included occasional moss fragments in ten samples and a few bud fragments in two flots.

5.13.1.2.2 DISCUSSION

The plant macrofossils in the bulk samples consisted mainly of variable but large amounts of waterlogged remains, but very little charred plant material.

There were rich waterlogged assemblages, with high seed frequencies and moderate to high species diversity of identifiable remains, in 25 of the 41 assessed samples. The waterlogged plant remains consisted mainly of fragmented wood and identifiable fruits/seeds, all from wild plants, but particularly from wetland (aquatic and bankside/marshland) species, and to a lesser degree, plants of disturbed (including cultivated) ground/waste places, and woodland/hedgerow habitats. The charred plant material consisted of only small amounts of fragmented charcoal in just ten samples and single cereal grains in two flots.

A chronological assessment of the results indicates a good representation of plant macrofossils in most periods throughout the sequence, which will allow for an investigation into the changing character of the environment over time.

5.13.1.2.3 RECOMMENDATIONS

Soil was retained from 37 bulk samples. On the basis of the assessment results, remaining soil from 27 of these samples that produced rich or moderately rich plant assemblages could be processed to potentially increase species diversity and potential information on environmental conditions at the site.

These assemblages are from contexts [169] sample {17}; [172] sample {7}; [177] sample {27}; [182] samples {12}, {13}, {24} (subsamples 4 and 5) and {26}; [183] samples {11} and {24} (subsample 5); [185] sample {12}; [191] sample {20}; [207] sample {16}; [208] sample {15}; [210] sample {14}; [532] sample {101}; [533] sample {102}; [543] sample {109}; [564] sample {110}; [569] sample {111}; [572] sample {113}; [574] sample {125}; [580] samples {121} and {126}; and samples {115} and {116}. Sample {4} from [185] did not produce large amounts of plant remains but contained a charred cereal grain so processing of the remaining soil from this sample may recover more charred material for which at present there is limited evidence.

5.13.1.3 Insects

Enid Alison

5.13.1.3.1 METHODOLOGY

Twenty-two sub-samples with individual volumes of two litres were washed to 0.30mm by MoLAS and submitted for assessment of insect remains. Sub-samples were processed by paraffin flotation to extract insect remains following the methods described by Kenward *et al.* (1980, 1986) with flots recovered on 0.3mm mesh. Flots were scanned for the presence of insects and other invertebrates using a low-power binocular microscope (x10 – x50). Abundances of various groups were estimated, and the state of preservation assessed. Nomenclature follows Kloet and Hincks (1966-77).

The flots are currently stored in industrial methylated spirits in plastic jars.

5.13.1.3.2 RESULTS

The results of the assessment are presented by subgroup, beginning with the earliest material.

SG02

Context 185, sample {12}: A flot with a volume of 20ml was produced. It contained a low concentration of well preserved insect remains and mites. Water snails were common and included several *Theodoxus fluviatilis* found on stony bottoms of swiftly flowing water and on wave-washed freshwater shores. Such conditions were also indicated by the beetle assemblage. *Macronychus quadripustulatus* (another riffle beetle) is found in active water channels in gravel and on submerged wood including exposed tree roots and woody debris (Holland 1972; Godfrey 2003). Water beetles accounted for about half of the taxa noted during scanning. Processing of a further quantity of sediment is recommended as the assemblage recovered from this sub-sample is not particularly large, although it is well preserved. Detailed analysis will provide data on local aquatic and terrestrial conditions.

Context 223, sample {2}: The flot had a volume of ~15ml. It contained single individuals of three beetle taxa: *Helophorus* (a water beetle), a ground beetle (*Carabidae*) and an *aleocharine* rove beetle (*Aleochariinae*). No other invertebrate taxa were present. No further work is recommended for this sample.

Context 506, sample {100}: the flot had a volume of ~15ml. It consisted chiefly of fine plant material with a very low concentration of insect remains and small numbers of ostracods. Four beetle taxa were noted: two *Helophorus* species, an aleocharine rove beetle, and an elytral fragment of a leaf beetle (*Chrysomelidae*). No further work is recommended.

SG03

Context 580, sample {126}: the flot had a volume of ~15ml. A quite large beetle and bug assemblage (estimated 100+ individuals) and mites were recovered. Fragmentation of the insect remains was quite high but preservation was good with individual fragments showing few signs of chemical erosion. Water beetles were well represented indicating aquatic deposition, and *Hydraena* and *Ochthebius* were common. The aquatic assemblage is indicative of the varied habitats that would exist at the margins of a river. *Esolus parallelepipedus* (a riffle beetle: Elmidae) indicates that the active channel contained clear running water on a stony bed, but other taxa suggest slowly moving or still water. *Ochthebius minimus,* for example, is typically found in mud by shallow, usually still or slowly flowing water. *Chaetarthria seminulum* is usually found in mud and moss by still water but is occasionally found on the muddy banks of the slower reaches of streams (Friday 1988, 148-151; Hansen 1987, 211). On land there would have been areas of marshy vegetation: *Limnobaris* is chiefly found on *Carex* (Bullock 1992). Other plant feeders (Chrysomelidae, Curculionidae) and ground beetles (Carabidae) have the potential to provide detailed information on terrestrial conditions. Fragments of *Aphodius* dung beetles may suggest grazing by herbivores in the vicinity.

Further analysis of this sample will provide detailed environmental information on both aquatic and terrestrial conditions and further work is strongly recommended. the flot had a volume of ~15ml. A quite large beetle and bug assemblage (estimated 100+ individuals) and mites were recovered. Fragmentation of the insect remains was quite high but preservation was good with individual fragments showing few signs of chemical erosion. Water beetles were well represented indicating aquatic deposition, and *Hydraena* and *Ochthebius* were common. The aquatic assemblage is indicative of the varied habitats that would exist at the margins of a river. *Esolus parallelepipedus* (a riffle beetle: *Elmidae*) indicates that the active channel contained clear running water on a stony bed, but other taxa suggest slowly moving or still water. *Ochthebius minimus,* for example, is typically found in mud by shallow, usually still or slowly flowing water. *Chaetarthria seminulum* is usually found in mud and moss by still water but is occasionally found on the muddy banks of the slower reaches of streams (Friday 1988, 148-151; Hansen 1987, 211). On land there would have been areas of marshy vegetation: *Limnobaris* is chiefly found on *Carex* (Bullock 1992). Other plant feeders (*Chrysomelidae, Curculionidae*) and ground beetles (*Carabidae*) have the potential to provide detailed information on terrestrial conditions. Fragments of Aphodius dung beetles may suggest grazing by herbivores in the vicinity. Further analysis of this sample will provide detailed environmental information on both aquatic and terrestrial conditions and further work is strongly recommended.

Context 585, sample {127}: the flot produced was quite large (~60ml) and was difficult to scan because of the relatively large amount of fine plant remains. It was quite rich in insect remains (estimated 50-100 beetles and bugs) and mites. Aquatic and damp ground taxa accounted for a high proportion of the beetles and bugs seen during scanning. Processing of more sediment and further analysis is recommended.

SG06

*Context 55, sample {39}:*The flot had a volume of ~15ml and contained a small assemblage of beetles and bugs (estimated 25 individuals), mites (*Acari*), water snails and a few ostracods. The beetle and bug remains were in a very fragmented condition with very few complete sclerites, although erosion was low. About 20 taxa from both aquatic and terrestrial habitats were present. Water beetles included *Bagous* (a weevil) and a donacine leaf beetle, both found on aquatic vegetation. Among terrestrial beetles decomposer taxa included *Aphodius*, a genus that is usually associated with herbivore dung although some species also exploit other foul organic material. Processing of more sediment would provide a larger assemblage, but the very fragmented state of the assemblage will prevent close identification of many taxa, and therefore the potential for environmental reconstruction is limited.

Context 174, sample {6}: the flot had a volume of 10ml and contained a small beetle assemblage (estimated 20 individuals), caddis larval case fragments, mites, ostracods and water snails. Fragmentation of the insect remains was high but there were few signs of chemical erosion on individual fragments. Water beetles accounted for about half of the fragments seen during scanning. They included two species of riffle beetle (*Oulimnius* and *Esolus parallelepipedus*) indicating clean running water in a stony channel. Processing of further material is necessary to provide sufficient material for analysis, particularly of terrestrial taxa.

Context 183, sample {11}: The flot had a volume of ~15ml. Insect remains were well preserved but highly fragmented. A fair-sized assemblage of beetles and bugs was recovered (estimated 50-100 individuals), together with parasitic *hymnenoptera*, a spider, ostracods and water snails. The beetle and bug assemblage contained a variety of aquatic and terrestrial taxa. Four species of riffle beetles were present (Elmidae: *Oulimnius*, *Esolus parallelepipedus*, *Macronychus quadrituberculatus* and *Stenelmis canaliculata*) indicating an input from a running water channel with a stony bed into this deposit. *S. canaliculata* is found on stony shores and *M. quadrituberculatus* on submerged wood. Both species are currently rare with restricted distributions (Holland 1972), although they appear to have occurred more widely in the past. Several *Dryops* indicate waterside mud. Terrestrial taxa included ground beetles *Calathus fuscipes*, typical of rather open conditions (Luff 2007, 121), *Dyschirius*, and *Bembidion*. *Phyllopertha horticola* indicates poor quality grassland, and there were several taxa associated with herbivore dung (*Onthophagus*, *Aphodius* spp.). Further processing and a detailed analysis are recommended.

Context 210, sample {14}: The flot had a volume of 30ml. It contained a fair sized assemblage of beetles and bugs (estimated 50-100 individuals), mites and ostracods. Fragmentation of insect sclerites was high but there were few signs of erosion on individual fragments. Aquatic and damp ground taxa were numerous. The presence of *Macronychus quadrituberculatus* indicates an input from clear running water with submerged woody debris or tree roots. Other water beetles suggest still water: *Hygrotus inaequalis* is found in permanent bodies of usually well vegetated stagnant water (Cuppen 1983). *Donacia* and *Plateumaris,* leaf beetles found on aquatic vegetation, were common. *Paederus* found in marshy and waterside habitats was well represented, and *Dryops* is indicative of mud. Several species of *Aphodius* dung beetles suggest that nearby land was used for grazing. Processing of a further quantity of sediment and a detailed analysis is recommended.

Context 533, sample {102}: layer of decayed wood and wood fragments. The flot had a volume of 15ml. It contained a fairly well preserved insect assemblage (estimated 50 beetle and bugs). About 50% of sclerites were fragmented and erosion was low. Mites were common. Aquatic and waterside beetles were well represented, and terrestrial forms included the dung-associated taxa *Geotrupes* and *Aphodius*. The assemblage, although well preserved, is not particularly large and processing of further material is required to provide detailed environmental information.

Context 570, sample {112}: the flot from this sub-sample was negligible consisting of a very small amount of amorphous plant material, an elytral fragment of a ground beetle (Carabidae), and sand grains.

Context 574, sample {125}: The flot had a volume of ~10ml. It was quite rich in reasonably well preserved insect remains – fragmentation was high but the fragments showed few signs of erosion. Ostracods and mites were present. The riffle beetle *Oulimnius* indicates clear running water in the channel. The presence of *Prasocuris phellandrii* implies that umbellifers (*Sium, Oenanthe*) grew around the water margins, at least in places. Grassland used for grazing may have been close to the point of deposition. *Sphaeridium, Geotrupes* and several species of *Aphodius* are all strongly associated with dung. One of the *Aphodius* was *A. granarius* which is most often found in cow dung and decomposing vegetable matter, and sometimes in muddy places under stones (Jessop 1986, 24). *Phyllopertha horticola* (a chafer: the June bug) and a click beetle *Agrypnus murinus* indicate local grassland. Processing of a further quantity of sediment and a full insect analysis is recommended.

SG07

Context 182, sample {24}: A flot with a volume of 15ml was produced. It was quite rich in relatively well preserved insect remains (estimated 50-100 beetles and bugs). Ostracods were common and a few water snails were recovered. Aquatic beetles were common – at least eleven taxa were noted during scanning. They included *Oulimnius* indicative of running water. Other aquatics were either euryoecious species or not identified closely enough provide indications of water type and quality. *Bagous*, a weevil found on aquatic plants, was quite common and *Dryops* suggests that there was waterside mud. Several species of *Aphodius*, including *A. contaminatus*, point to the presence of herbivores in the vicinity. A range of other terrestrial taxa have the potential to provide detailed environmental data. Processing of an additional quantity of sediment and further analysis is therefore recommended.

Context 182, sample {26}: The flot had a volume of 10ml. A small assemblage of beetles and bugs (estimated 30 individuals) and mites was recovered. Water snails were common. The beetle and bug remains were highly fragmented but generally uneroded. A variety of aquatic and terrestrial taxa were recovered which have the potential to produce data on local environmental conditions. The assemblage is quite small and processing of a further quantity of sediment is required to produce a larger assemblage for analysis, however.

Context 564, sample {110}: the flot had a volume of 15ml and relatively well preserved beetles (estimated 50 individuals), mites, water flea ephippia (*Cladocera*: resting eggs), ostracods, and both terrestrial and water snails indicated aquatic deposition. Water beetles included two *Ochthebius* species and *Normandia nitens*, a riffle beetle found in clean running water. *Bagous*, found on aquatic plants, was common. Terrestrial insects suggest grassland grazed by herbivores in the vicinity. *Chaetocnema concinna* is found on *Polygonum* (Bullock 1992) indicating that some weedy vegetation was present. Processing of a further quantity of sediment is required to produce a larger assemblage for detailed analysis.

Context 569, sample {111}: a flot with a volume of 10ml was produced. It was rich in fragmentary but otherwise well preserved insect remains (estimated 50-100 beetles and bugs) and mites. Ostracods and water snails were also present. Aquatics were common in the beetle and bug assemblage. Terrestrial taxa point to a variety of habitat types on land and there was a distinctive group of beetles associated with herbivore dung: (several *Aphodius* species, *Onthophagus* and *Sphaeridium*). Plant feeders included *Chaetocnema concinna* found on *Polygonum*. Processing of a further quantity of sediment and detailed analysis is recommended.

Context 572, sample {113}: the flot had a volume of ~10ml. Invertebrates present indicate that this deposit was waterlain. A moderately sized assemblage of beetles (estimated 50 individuals), fragments of caddis larval cases and insect larvae, earthworm egg capsules, ostracods, mites, and snails were noted. The latter were predominantly water snails. The beetle remains were highly fragmented but generally uneroded and individual fragments were relatively well preserved. The presence of the riffle beetle *Oulimnius* suggests that this deposit received an input from clear, well-oxygenated running water. Other aquatic taxa included *Donacia* found on aquatic plants. *Pterostichus nigrita* is a strongly hygrophilous species commonly found in lowland habitats, usually near water (Luff 2007, 114), and *Dryops* is found on waterside mud. Other taxa indicate a variety of local habitat types. They included several ground beetles (Carabidae), *Megasternum concinnum* a generalized decomposer, *Aphodius* associated with foul organic material (usually dung), a chafer (*Cetoniinae*), *Chaetocnema arida* group found on grasses and sedges, various other plant feeders (*Apionidae, Curculionidae*), and a bark beetle *(Scolytinae*). Processing of a further quantity of sediment and detailed analysis is recommended.

SG08

Context 532, sample {101}: a flot with a volume of 15ml was produced. It was quite rich in insect remains (estimated 50 beetles and bugs) and mites. Ostracods were abundant and there were a few water snails and water flea ephippia. The insect remains were relatively well preserved, and fragmentation was rather lower than in many other sub-samples. Aquatics were common and included the riffle beetle *Oulimnius*, and *Donacia* and *Bagous* found on aquatic plants. Waterside mud was indicated and other terrestrial taxa from a variety of habitats were recovered. Plant feeding taxa included ?*Gastrophysa viridis* found on docks (*Rumex*). Processing of a further quantity of sediment and detailed analysis is recommended.

SG09

*Context 172, sample {7}:*The flot had a volume of ~10ml. A small beetle assemblage (estimated 20 individuals), insect larval fragments, caddis larval case fragments, mites, earthworm egg capsules and a few water flea ephippia (Cladocera: resting eggs) were recovered. Beetles from both aquatic and terrestrial habitats were present. The beetle remains were very fragmented and some fragments were pale and chemically eroded. Processing of a larger amount of sediment would be desirable to produce a larger assemblage. The poor preservation will limit the close identification of taxa and therefore any interpretation based on the assemblage, however.

Context 177, sample {5}: The flot had a volume of ~10ml. It contained an assemblage of beetles and bugs (estimated 30 individuals) with rather variable preservation: fragmentation was high and approximately half of the fragments were pale and filmy making identification problematic in some cases. Mites were common and there were fragments of caddis larval cases. Aquatics were quite common and *Ochthebius* spp. and *Hydraena* were each represented by several individuals. The aquatic group included *Macronychus quadrituberculatus* found in clear flowing water channels with stony bottoms. There may have been woodland or trees close to the point of deposition – *M. quadrituberculatus* is found on submerged wood such as exposed tree roots, and *Drymus brunneus*, a ground bug found in woodland, was tentatively identified. Marshy and muddy ground was indicated by *Cyphon* and *Dryops* respectively and poor quality grassland by *Phyllopertha horticola*. Processing of a further quantity of sediment and detailed analysis is recommended.

*Context 177, sample {27}:*The flot had a volume of 20ml. It contained a well preserved beetle assemblage from a variety of aquatic and terrestrial habitats (estimated 50 individuals) and mites. Ostracods were common and deposition in aquatic conditions was indicated. A greater proportion of the insect sclerites were in a reasonably complete condition than in assemblages from other sub-samples examined. Processing of a further quantity of sediment and detailed analysis is recommended.

Context 526, sample {109}: the flot had a volume of 20ml. A well preserved assemblage of beetles and bugs (estimated 50 individuals), mites and ostracods was produced. The abundance of water beetles and ostracods indicates that deposition was aquatic. The beetle assemblage included *Coelostoma orbiculare* found mainly at the edges of eutrophic, open well vegetated ponds (Hansen 1987, 127-8) and *Cymbiodyta marginellus* found at the edges of shallow, stagnant, well vegetated water and sometimes along the slower reaches of running water (Hansen 1987, 209). Terrestrial insects included the nettle ground bug *Heterogaster urticae*, found as the name suggests on nettles (*Urtica*). Processing of a further quantity of sediment and detailed analysis is recommended.

5.13.1.3.3 CONCLUSIONS

Significant numbers of insect remains were recovered from 19 of the sub-samples examined. Fragmentation of sclerites was high in most of the assemblages and in some erosion had also taken place. Generally however, although fragmentary, the insect remains recovered were in a good state of preservation in most of the sub-samples.

Aquatic and terrestrial beetles and bugs were well represented and have the potential to provide detailed information on the local environment. Riffle beetles (*Elmidae*) were present in most assemblages. Five species were represented, all of which are all found in clear, clean, well-oxygenated flowing water in channels with a stony bed, especially in shallow riffles or rapids. They cannot live in silty water or where silt is present on the channel bed. Elmids appear to have been much more widely distributed in the earlier part of the Holocene than they are at the present day and they are now no longer found in the Thames drainage system. A recent study in the catchment of the River Rede in northern England has found the presence or absence of silt to be the most important single variable in their distribution (Eyre *et al.* 1993). Osbourne (1988) has suggested that their disappearance from many lowland rivers may have been linked to an increase in the silt content of the water in many areas during and after phases of alluviation associated with major fluvial changes from the Late Bronze Age onwards. Recording the occurrence of this group of beetles together with other aquatics will provide data relating to fluvial conditions in the area over the time represented by the sequence of deposits sampled. Taxa representing other aquatic habitats were noted in the sub-samples, indicating the varied conditions found at the margins of a river channel, and in some of the later deposits (particularly SG13) possibly relating to development of marshland.

Rich and diverse assemblages of terrestrial insects, especially ground beetles (Carabidae) and various plant-associated taxa, have the potential to provide detailed information on the local environment and land use. Many of the sub-samples contained taxa strongly associated with herbivore dung and poor quality grassland.

5.13.1.3.4 RECOMMENDATIONS

It is recommended that a further quantity of sediment is processed from 19 samples to increase the sizes of the insect assemblages recovered. Detailed analysis of all 19 samples should then be carried out.

A further 3 litres of sediment from 16 samples from the following contexts should be processed by paraffin flotation to enhance the assemblages of insect remains: [177], sample {5}; [177], sample {27}; [182], sample {24}; [182], sample {26}; [183], sample {11}; [185], sample {12}; [210], sample {14}; [532], sample {101}; [533], sample {102}; [543], sample {109}; [564], sample {110}; [569], sample {111}; [572], sample {113};[574], sample {125}; [580], sample {126}; [585], sample {127}.

Three sub-samples contained low concentrations of insects (estimated <50 individuals). It is recommended that a further 8 litres from each of these are processed by paraffin flotation to improve recovery of remains: [55], sample {39}; [172], sample {7}; [174], sample {6}.

5.13.1.4 Mollusc remains

Alan Pipe

5.13.1.4.1 INTRODUCTION

This report identifies, quantifies and interprets the invertebrate remains from 250-micron wet-sieved contexts [55], [162], [172], [173], [177], [182], [183], [185], [187], [191], [198], [223], [506], [532], [543], [564], [569], [570], [572], [574], [580], [585] and samples {114}, {115} and {116} (see Table 8).

Each sample was inspected for the presence of foraminiferids, crustaceans and molluscs.

5.13.1.4.2 RESULTS

Wet-sieved invertebrate remains were recorded onto Table 8 in terms of species-diversity, shell count and preservation. With the exception of the economically important marine/estuarine molluscs and particularly distinctive freshwater and terrestrial genera and species, no attempt was made to accurately identify any of the molluscs or crustaceans beyond family level. The presence of foraminiferids, crustaceans and molluscs was quantified in terms of three estimated degrees of abundance; few (<10); medium (11-100); many (>100). Inspection for foraminiferids followed Murray 1979; preliminary identification of freshwater ostracods followed Henderson 1990; preliminary identification of freshwater and terrestrial molluscs followed Cameron & Redfern 1976; and Macan 1977. Preliminary identification of marine/estuarine molluscs followed Hayward, Nelson-Smith & Shields, 1996.

CONTEXT	SAMPLE	F/W MOLLUSCA	MARINE MOLL	TERR. MOLLUSCA	PRES.
55	39	*Bithynia sp.;* bivalve; Planorbidae 1; *Theodoxus fluviatilis; Valvata sp.*	nil	nil	good
162	38	*Bithynia sp.;* bivalve; Planorbidae 2; *Theodoxus fluviatilis; Valvata sp.*	nil	nil	good
172	7	nil	nil	nil	good
173	8	nil	nil	nil	
177	27	*Bithynia sp.;* bivalve	nil	nil	good
182	13	*Bithynia sp.;* bivalve; Lymnaeidae; Planorbidae 2; *Theodoxus fluviatilis; Valvata sp.*	nil	nil	good
182	21	*Bithynia sp.;* bivalve; Planorbidae 1; *Valvata sp.*	nil	nil	good
182	21	nil	nil	snail species 1&2	poor
182	24	*Bithynia sp.;* bivalve; Lymnaeidae; Planorbidae 2; *Theodoxus fluviatilis; Valvata sp.*	nil	nil	good
182	26	*Bithynia sp.;* Lymnaeidae; Planorbidae 1,2,3; *Theodoxus fluviatilis; Valvata sp.*	nil	nil	good
183	11	*Bithynia sp.;* bivalve; Planorbidae 1.; *Theodoxus fluviatilis*	nil	nil	good
183	24	*Bithynia sp.;* bivalve; Lymnaeidae; Planorbidae 1,2,3,4; *Theodoxus fluviatilis; Valvata sp.*	nil	nil	good
185	4	*Bithynia sp.;* bivalve; Lymnaeidae; Planorbidae 1; *Theodoxus fluviatilis; Valvata sp.*	nil	nil	good
185	12	nil	nil	*Carychium sp.*	good
185	22	nil	nil	nil	
187	3	nil	nil	nil	
191	20	*Bithynia sp.;* bivalve; Planorbidae 1,2,3,4; *Theodoxus fluviatilis; Valvata sp.*	nil	nil	good
223	2	nil	nil	nil	
506	100	nil	nil	nil	
532	101	Lymnaeidae; Planorbidae 1,2,3	nil	nil	good
533	102	nil	nil	nil	
543	109	*Bithynia sp.*	nil	nil	good
564	110	*Bithynia sp.;* bivalve; Lymnaeidae; Planorbidae 1,3; *Theodoxus fluviatilis; Valvata sp.*	nil	nil	good
564	110	nil	nil	*Carychium sp.*	good
569	111	*Bithynia sp.;* bivalve; Lymnaeidae; Planorbidae 1; *Theodoxus fluviatilis; Valvata sp.*	nil	nil	good
570	112	*Bithynia sp.;* bivalve; Lymnaeidae; Planorbidae 1,2,5; *Theodoxus fluviatilis; Valvata sp.; Succinea sp.*	nil	nil	good
570	112	nil	nil	snail species 1	good
572	113	*Bithynia sp.;* bivalve; Lymnaeidae; Planorbidae 1,2,4; *Theodoxus fluviatilis; Valvata sp.; Succinea sp.*	nil	nil	good

572	113	nil	nil	snail species 1	good
574	125	*Bithynia sp.;* bivalve; *Theodoxus fluviatilis; Valvata sp.*	nil	nil	good
596	121	*Theodoxus fluviatilis*	nil	nil	good
580	126	*Bithynia sp.*	nil	nil	good
585	127	nil	snail species 1	nil	medium
	114	nil	nil	nil	
	115	*Bithynia sp.;* bivalve; Lymnaeidae; *Valvata sp.*	nil	nil	good
	116	Bivalve; Planorbidae 1; *Valvata sp.*	nil	nil	good

Table 8: Wet sieved invertebrate remains from PDZ 12.01

A worn, probably sub-fossil, fragment of marine snail, possibly needle whelk *Bittium reticulatum*, from alluvial deposit [585] {127} was the only evidence for marine or estuarine species from the whole assemblage. This snail occurs mainly as dead shells, on muddy sand often with eelgrass *Zostera marina*, or among mud on sheltered rock (Hayward, Nelson-Smith & Shields 1996).

Only a very small assemblage of terrestrial molluscs was recovered. These derived from occasional herald snail or slender herald snail *Carychium sp.*, probably herald/sedge snail *Carychium minimum* from [185] and [564]. These snails are widely distributed throughout southern England in moist, sheltered, well-vegetated places. *C. minimum* is common in wet places generally; it is virtually amphibious and can survive prolonged winter flooding (Kerney 1999, 44). In addition, small numbers of two unidentified snail species (species 1 and species 2), were respectively recovered from [182], [570] and [572]; and [182].

Well-preserved shells of freshwater molluscs provided the bulk of the invertebrate assemblage, varying in abundance between one and more than 100 per sample. The recovered taxa included bivalves and the snails; bithynia *Bithynia sp.*, river nerite *Theodoxus fluviatilis*, valve snails *Valvata sp.*, pond snails Lymnaeidae, ram's-horn snails Planorbidae (at least five species) and amber snail *Succinea sp.;* all abundant in suitable habitats throughout SE England.

No foraminiferids were recovered.

5.13.1.4.3 CONCLUSION AND RECOMMENDATIONS

Although there is an abundant and diverse molluscan fauna, the sparse terrestrial component is of very limited potential for further study with respect to either abundance or diversity. Recovery of grass snail *Vallonia sp.* and whorl snail *Vertigo sp.* suggests the presence of grassland; moss snail *Cochlicopa sp.* occurs in a wide range of sheltered and moderately damp places. All three taxa are common and widely-distributed in suitable habitats throughout SE England.

In contrast, the much larger and more diverse freshwater group offers definite potential for further study. Although the identified species, genera and families so far identified are well-represented in suitable habitats throughout the London area and SE England, they exhibit marked inter-specific variation in their ecological requirements in terms of the physical, chemical and biological characteristics of local freshwater and marginal habitats. In particular, the ram's-horn snails Planorbidae and, to a lesser extent, the pond snails Lymnaeidae, from this assemblage show a range of identifiable species and therefore have obvious potential for habitat interpretation. Identification and relative quantification of these species will allow considerable comment on the substrate, water flow, chemistry and seasonality of local freshwater habitats, together with their vegetation and that of the adjacent terrestrial margins.

The invertebrate assemblage offers no potential for study of foraminiferids or marine/estuarine molluscs.

5.13.2 Assessment of the geoarchaeological evidence

5.13.2.1 Introduction

Three sequences of monolith tins (samples {1}, {9} and {109}) were taken from the sections revealed in the trench and a series of bulk samples were also taken adjacent to the monolith tins to provide sediment of off-site examination of deposit characteristics, macrofossils, microfossils and radiocarbon dating, as described below (Table 9,Table 10 and Table 11). See Figs 10–12 for location of monolith tins.

Each monolith tin sequence was plotted on the section drawing and related to Ordnance Datum (OD) by the supervising archaeologist. The monolith tins were then sealed and together with the bulk samples were transported to the MoLAS Environmental laboratories.

5.13.2.2 Sediments

Sediments sampled in the monolith tins were recorded in the laboratory and subsamples were taken for further analysis. All the monolith tin samples were described using standard sedimentary criteria (relating to colour, compaction, texture, structure, bedding, inclusions, and clast-size) and the nature of the contacts between adjacent distinct units was noted. The descriptions of the monolith tin samples are tabulated as follows:

Elevation and thickness of unit	**Trench:OL-08707 PDZ12.01 Monolith Sample: [1] Sedimentary description**	*Context*	*Microfossil subsamples*
+1.34mOD to+1.29mOD	Orangey-brown slight gritty SILT. Strong iron staining. Contact with the unit below is clear and horizontal.	171	-
+1.29mOD to +1.09mOD	Brown firm slightly CLAYEY SILT with iron staining. Contact with the unit below is gradual.	173	Pollen Diatom Ostracod +1.265mOD
+1.09mOD to +0.57mOD	Very dark brown hard ORGANIC SILT with occasional sandy lenses and black organic patches. Contact with the unit below is gradual.	172	Pollen Diatom Ostracod AMS +1.065mOD and +0.665mOD
+0.57mOD to +0.29mOD	Dark brown, firm, slightly SILTY CLAY with root material and iron staining. Contact with the unit below is clear and horizontal.	174	Pollen Diatom Ostracod +0.565mOD
+0.29mOD to +0.15mOD	Very dark brown/black firm ORGANIC SILTY CLAY/reworked peat? With occasional large flint clasts. Contact with the unit below is clear and horizontal.	177	Pollen Diatom Ostracod AMS +0.185mOD
+0.15mOD to -0.18mOD	Mid-brownish grey SILTY CLAY/CLAYEY SILT. Exhibits patches of black organic matter/Mn and FE stained root channels, wood fragments and occasional sandy lenses. Contact with the unit below is clear and horizontal.	185	Pollen Diatom Ostracod +0.105mOD
-0.18mOD to-0.49mOD	Light brown/yellow medium SAND with occasional silty sand bands, organic root and iron staining. Contact with the unit below is clear and horizontal.	187	Pollen Diatom Ostracod -0.415mOD and OSL -0.36mOD and -0.33mOD
-0.49mOD to-0.82mOD	Mid brown/grey CLAYEY SILT. Exhibits iron staining and plant root macro fossils. Contact with the unit below is gradual.	223	Pollen Diatom Ostracod AMS -0.815mOD
-0.82mOD to depth unknown	Greyish brown SILTY SAND with occasional gravel and vertical roots. Grades into SANDY GRAVEL at the base of the unit.	63	-

Table 9: Sedimentary description of monolith sample sequence {1}

Elevation and thickness of unit	**Trench:OL-08707 PDZ12.01 Monolith Sample: {9} Sedimentary description**	*Context*	*Microfossil subsamples*
+1.07mOD to+0.85mOD	Greyish brown firm SILTY CLAY becoming increasingly silty towards the top of the unit. Contact with unit below is gradual	207	Pollen Diatom +1.045mOD +0.885mOD and Ostracod and AMS +1.045mOD
+0.85mOD to +0.50mOD	Very dark brown SILT. With occasional shell fragments, wood/plant material. Contact with unit below is gradual	208	Pollen Diatom +0.785mOD +0.635mOD and Ostracod +0.785mOD and AMS +0.635mOD
+0.50mOD to +0.18mOD	Very dark brown SILT. With occasional shell fragments, wood/plant material. The base of the unit contains occasional lenses of fine sand and becomes slightly clayey. Contact with unit below is gradual.	210	Pollen Diatom Ostracod +0.485mOD +0.335mOD +0.195mOD and AMS +0.195mOD
+0.18mOD to -0.24mOD	Interbedded greyish yellow SANDS and brown/black SILTY CLAY. Sands contain flint pebbles, shell fragments. Silty clays contain moderate shell fragments/whole gastropods with some woody organic matter. Contact with unit below is gradual.	182	Pollen Diatom -0.035mOD -0.235mOD and Ostracod -0.035mOD
-0.24mOD to -0.42mOD	Discontinuous yellow/grey SAND and blackish brown SILTY CLAY with some organic matter/wood. Contact with unit below is clear and horizontal.	183/191	Pollen Diatom Ostracod -0.40mOD (M11) AMS -0.40mOD (M11) and -0.44mOD (M6)
-0.42mOD to -0.53mOD	Greenish grey slightly fine SANDY SILT with some iron staining and occasional wood/plant fragments. Contact with unit below is clear and horizontal.	162/185	Pollen Diatom -0.535mOD (M6)
-0.53mOD to -0.575mOD	Greenish grey gravel with reedy organics and rooting. Contact with unit below is clear and horizontal.	195	-
-0.575mOD to -0.63mOD	Greenish grey clay sand interbedded with granular gravels. Contact with unit below is clear and horizontal.	197	-
-0.63mOD to -0.75mOD	Light brownish grey slightly yellow loose friable coarse sand with moderate medium coarse flint clasts	198	Pollen Diatom -0.715mOD
-0.75mOD to depth unknown	Light brown slightly yellow loose friable coarse sand with moderate medium coarse flint clasts and twigs.	63	-

Table 10: Sedimentary description of monolith sample sequence {9}

Elevation and thickness of unit	**Trench:OL-08707 PDZ12.01** **Monolith Sample: [109]** **Sedimentary description**	*Context*	*Microfossil subsamples*
+2.18mOD to +2.10mOD	Mid brown, friable soil/made ground with occasional C.B.M, charcoal, chalk and moderate flint clasts. The contact with unit below is sharp and clear.	202; 215	-
+2.10mOD to +1.56mOD	Mid brown with orange weathering, firm CLAY SILT The contact with unit below is gradual.	218	Ostracod +1.195mOD
+1.56mOD to +1.06mOD	Mid brown with orange weathering, SANDY SILT with occasional fine flint clasts and Mn specks. The contact with unit below is gradual.	219	Pollen Diatom Ostracod and OSL +1.585mOD +1.085mOD
+1.06mOD to +0.66mOD	Dark greenish brown slightly SILTY/CLAY. Exhibits some Mn speckling and occasional flint clasts. The contact with unit below is gradual.	247	OSL +0.82mOD
+0.66mOD to +0.27mOD	Mid brown with orange weathering CLAYEY/SILT with occasional flint clasts and possible tufa flecks at base. The contact with unit below is gradual.	194	Pollen Diatom Ostracod +0.565mOD
+0.27mOD to -0.16mOD	Mid brown SILTY/CLAY with occasional pebbles and roots. The contact with unit below is clear and horizontal	193; 195	Pollen Diatom Ostracod and OSL +0.15mOD
-0.16mOD to depth unknown	Yellow/grey SANDY GRAVEL with some root material.	63	-

Table 11: Sedimentary description of monolith sample sequence {109}

5.13.2.3 Microfossils

Sub-samples for microfossil assessment including diatoms, ostracods and pollen were taken at selected locations within key sedimentary units (see Table 9, Table 10 and Table 11). The aim of assessment was to determine the preservation, presence, abundance and diversity of the microfossils within the profile and provide valuable information about the evolving past environment (for example, vegetation, water characteristics, and indirect evidence for human activity, in particular landscape clearance, cultivation and other disturbance), which is likely to be complimentary to the macro-remains from bulk samples.

5.13.2.3.1 DIATOMS

Nigel Cameron

Twenty four sediment samples have been assessed for diatoms. These were sub sampled from monolith sample sequences {1}, {9} and {109}.

Methodology

Diatom preparation followed standard techniques. Coverslips were made from each sample and fixed in Naphrax for diatom microscopy. A large area of the coverslips on each slide was scanned for diatoms at magnifications of x400 and x1000 under phase contrast illumination.

Diatom floras and taxonomic publications were consulted to assist with diatom identification; these include Hartley *et al.* (1996) and Krammer & Lange-Bertalot (1986-1991). Diatom species' salinity preferences are discussed using the classification data in Denys (1992), Vos & de Wolf (1988, 1993) and the halobian groups of Hustedt (1953, 1957: 199),

Results and Discussion

The results of the diatom evaluation are summarised in Table 12.

Mono seq. (Mono no.)	Context	Sample Height (m.OD)	Diatom Sample No.	Diatom numbers	Quality of preservation	Diversity	Assemblage type	Potential for % count
9 (M9)	207	1.045	D1	ex.low	very poor	ex.low	aero	none
9 (M9)	207	0.885	D2	v. low	very poor	very low	aero fw non-pk	none
9 (M9)	208 (up)	0.785	D3	mod to low	mod to poor	mod low	fw *Fragilaria* dominated	mod
9 (M9)	208 (low)	0.635	D4	ex.low	very poor	very low	fw aero	none
9 (M8)	210 (up)	0.485	D6	low	poor to mod	mod	fw aero non-pk pk	some/ mod
9 (M8)	210 (mid)	0.335	D7	high	good to mod	high	fw non-pk pk	good
9 (M8/M7)	210 (low)	0.195	D5	high	good to poor	mod high	fw non-pk epiphy	very good
9 (M7)	182 (up)	-0.035	D8	low to mod	mod to poor	mod	fw non-pk	mod
9 (M6)	182 (low)	-0.235	D9	v.low	poor	low	fw non-pk	low
9 (M6)	183/191	-0.435	D10	ex.low	ex.poor	-	one fw	none
9 (M6)	162/185	-0.535	D11	-	-	-	-	none
9 (M11)	198	-0.715	D12	-	-	-	-	none
1 (M5)	173	1.265	D13	-	-	-	chyrsophyte cyst	none
1 (M5)	172 (up)	1.065	D14	low	very poor	low-mod	fw non-pk epiphy chrysophyte cysts	some/ low
1 (M4)	172 (low)	0.665	D15	ex.low	ex.poor	-	one fw	none
1 (M4)	174	0.565	D16	low	very poor	very low	fw aero benthic	v.low
1 (M3)	177	0.185	D17	-	-	-	-	none
1 (M3)	185	0.105	D18	-	-	-	-	none
1 (M2)	187	-0.415	D19	-	-	-	-	none
1 (M1)	223	-0.815	D20	ex.low	ex.poor	very low	fw aero	none
109 (M2)	219 (up)	1.585	D21	-	-	-	-	none
109 (M3)	219 (low)	1.085	D22	-	-	-	-	none
109 (M4)	194	0.565	D23	-	-	-	-	none
109 (M6)	193	0.015	D24	-	-	-	-	none

(fw – freshwater, bk – brackish, mar – marine, halophil – halophilous, aero – aerophilous)

Table 12: Summary of diatom evaluation results

Monolith 1 (Diatom sub-samples 13-20)

Eight sub-samples were assessed for diatoms from Monolith 1. Diatoms are completely absent from four samples (D13 [173], D17 [177], D18 [185], D19 [187]); a single chrysophyte cyst was present in the slide prepared from D13 [173]. Diatoms are present in four samples, however, in the case of D15 [172], a single dissolved fragment of the freshwater, non-planktonic diatom *Synedra ulna* was identified. In diatom sample D20 [223] there is an extremely low number of very poorly preserved freshwater (*Synedra ulna*) and aerophilous (*Ellerbeckia arenaria*) diatoms. The former is also associated with epipsammic (sand) habitats. These six samples (D13, D15, D17-D20) have no further potential for diatom analysis.

Two samples (D14 [172 upper], D16 [174]) have a low number of very poorly preserved diatoms, the former with slightly greater potential for further analysis. Sample D14 [172] has a freshwater non-planktonic diatom flora (*Amphora libyca, Fragilaria brevistriata, Fragilaria construens* var. *venter, Fragilaria pinnata, Gomphonema angustatum, Synedra ulna*). As well as these attached taxa the benthic diatom *Gyrosigma attenuatum* is present. Two halophilous diatoms *Fragilaria virescens* and *Anomoeoneis sphaerophora* were recorded. However, these are not estuarine diatoms and are found in freshwater with slightly increased salt content. Similarly the mesohalobous diatom *Synedra tabulata*, found in sample D16 [174], although favouring waters with higher salt levels is not necessarily an indicator of tidal waters. In sample D16 [174] the notable diatom features are the relative abundance of *Ellerbeckia arenaria* (see above), when this is common the species is sometimes, but not exclusively, associated with sediments of early age. In addition the large epipelic (mud surface) diatom *Gyrosigma attenuatum* is abundant in D16 [174].

Monolith 9 (Diatom sub-samples 1-12)

Twelve samples were assessed for diatoms from Monolith 9. The sub-samples for diatom evaluation were taken from a sequence of four monoliths (M6-M9). Overall Monolith 9 has the better diatom preservation of the three sequences assessed for diatoms. Diatoms are absent from the two samples at the base D12 [198] and D11[162/185]. A single dissolved fragment of the freshwater diatom *Synedra ulna* is present in D10 [183/191]. In D9 [182] (sand) there is a freshwater, non-planktonic diatom flora with species such as *Cocconeis disculus* and *Cymbella sinuata* present. The epipsammic aerophile *Ellerbeckia arenaria* is also present. However, the poor preservation means that there is low potential for percentage counting here. In the overlying samples (D8 [182], D7 [210], D6 [210], D5 [210]) from silty clay/clayey silt the number of diatoms, their quality of preservation and species diversity increase. In these samples there is moderate to very good potential for percentage diatom counting. The main components in each case are shallow freshwater non-planktonic diatoms with epiphytes such as *Cocconeis placentula* and other attached diatoms dominating the assemblages (e.g. *Amphora inariensis, Fragilaria* spp., *Achnanthes lanceolata, Achnanthes clevei*) as well as some benthic types (*Gyrosigma* spp. *Navicula radiosa, Navicula tripunctata*). Sample D4 [208] has an extremely low number of mainly aerophilous diatoms (*Pinnularia major, Ellerbeckia arenaria*). Sample D3 [208] has a *Fragilaria* spp. dominated flora, species that usually to indicate an unstable habitat, but there are a number of other non planktonic taxa (e.g. *Amphora libyca, Aulacoseira italica, Meridion circulare*) and moderate potential for percentage counting. The two uppermost samples D2 [207] and D1 [207] have freshwater aerophilous diatom assemblages with *Pinnularia major* and *Pinnularia subcapitata*, but in D2 [207] also with attached taxa such as *Epithemia* sp. and *Amphora libyca*. The very poor preservation and low numbers of diatoms in D1 [207] and D2 [207], means that there is no potential for further analysis. With the exception of a low number of valves of *Cyclotella kuetzingiana* and the halophile *Cyclotella meneghiniana* in D7 [210] and D6 [210] planktonic diatoms are rare in the sequence.

Monolith 109 (Diatom sub-samples 21-24)

Four sub-samples - D21 [219], D22 [219], D23 [194] and D24 [193] - were assessed from monolith sequence {109}. These diatom samples were taken from a series of six monoliths (M1-M6), Diatoms are absent from the four samples There is therefore no potential for percentage diatom counting of these samples. The monolith sequence {109} is probably a mixture of very old, possibly Pleistocene, sediments at the base, later covered with deposits from a small channel, a feature which was identified elsewhere on the site (Birchenough *et al.* 2008).

Conclusions and recommendations

Diatoms are present in fourteen samples and absent from ten samples assessed from trench PDZ12.01. Seventy-five diatom taxa were identified in the assessment counts. Diatoms are completely absent from Monolith sequence {109} and absent or poorly preserved in most samples from Monolith sequence {1}. Two samples from Monolith sequence {1} have low potential for percentage diatom counting. The diatom assemblages with most potential and recommended for further analysis are in Monolith sequence {9}.

The diatom assessment showed no assemblages with clear evidence, from polyhalobous or estuarine mesohalobous taxa, for contact with the tidal Thames. However, some halophilous taxa were identified. The dominant diatom types are attached and benthic oligohalobous indifferent taxa. Some assemblages were dominated by aerophiles such as *Ellerbeckia arenaria* with particular habitat preferences. Planktonic diatoms are generally uncommon whilst in some samples a *Fragilaria*-dominated flora suggests an unstable habitat for diatoms. Eutrophic diatom assemblages associated with high nutrient levels are not evident.

5.13.2.3.2 OSTRACODS

John Whittaker

Twelve sediment samples have been assessed for ostracods. These were sub sampled from monolith sample sequences {1}, {9} and {109} taken from Trench PDZ 12.01.

Methodology

Each sample was weighed and then thoroughly dried in the oven. Boiling water was then poured on the sample and a little sodium carbonate added to help remove the clay fraction on washing. It was then left to soak overnight. Breakdown was readily achieved when washed with hot water through a 75 micron sieve. The resulting residue was finally decanted back into the bowl for drying in the oven. When dry the sample was stored in a labelled plastic bag. Examination of the residue was undertaken under a binocular microscope. First the residue was put through a nest of dry sieves (>500, >250 and >150 microns) and then sprinkled out a fraction and a little at a time onto a tray.

Results

Monolith sequence {1}

Earthworm granules, scraps of molluscs (including possible *Pupilla*) and a few immature *Bithynia* opercula, found in context [185], indicate nearby soil formation and wet grassland. The sediments of monolith sequence {1} appear to represent a river channel but unfortunately of too high an energy for the preservation of ostracods.

Monolith sequence {9}

Contexts [182] and [183] contain virtually the same microfossils as the above. The organic remains comprise many plant remains (and seeds), molluscs, *Bithynia* opercula, earthworm granules, charophyte oogonia, fish/amphibian remains (including eel) and freshwater ostracods, this being from a silty sand, with worn fragments of tufa. It is my opinion that the whole deposit appears to be redeposited after an overbank flood and the tufa reinforced this, as it is not fresh and seems to have been eroded from elsewhere. The ostracod fauna lacks some of the interstitial, spring-dwelling forms and most would have lived mainly in a weed-rich slow flowing water, probably a backwater (rather than in the main channel) that was been inundated in a flood; others, it is true, could also have come from the original tufa spring, if it was not too far distant. Context [182], as already indicated, contains practically an identical fauna to [183] and may just represent more sediments of the same or another flood event. It certainly is not intertidal (brackish), but remains wholly freshwater.

The sediments of the overlying contexts [208] and [207] are very organic (and not conducive to the preservation of ostracods (or any other calcareous shells for that matter), but are still clearly freshwater, as evidenced by the organic-walled egg-cases (ephippia) of cladocera (*Daphne*-like Crustacea), and lack of foraminifera (a diligent search for which was made). They are probably the result of the river migrating away from the site, as indeed previously suggested, which then became a wetland area of marshland (but not saltmarsh) peripheral to the river and less influenced by it.

Monolith sequence {109}

Ostracods (and only a few scraps at that) were found in [193] but they give no indication as to the age of this deposit. Quite rich plant debris augurs well for a pollen analysis which may offer some further clues, as well as to the vegetation. [193] also contains rhizoliths (tubes formed around rootlets) which may indicate some drying out of the river flats, either because of climatic conditions or a migrating channel. The samples from [194] and [219] contain some iron mineral, perhaps indicative of weathering (or again climate) and fragments of what appears to be charcoal (indicative of either natural or man-made fire). The uppermost sample [218] has a stronger terrestrial component in the form of earthworm granules and bone (possibly of an amphibian). The whole sequence is freshwater riverine, of variable energy, geography and perhaps, climate.

Recommendations

No further work is considered necessary.

5.13.2.3.3 POLLEN

Rob Scaife

Twenty-four sediment samples have been assessed for pollen. These were sub sampled from monolith sample sequences {1}, {9} and {109}. See Fig 6 for location of monolith tins.

Methodology

Standard pollen extraction techniques were used on samples of 2ml volume (Moore and Webb 1978; Moore et al. 1992). Pollen was identified and counted using an Olympus biological research microscope fitted with Leitz optics. Total pollen (assessment) sums of between 100 and 200 grains per level were identified and counted. Percentages have been calculated as follows:

Sum =	% total dry land pollen (tdlp) (incl. Alnus)
Marsh/aquatic =	% tdlp + sum of marsh/aquatics
Spores =	% tdlp + sum of spores
Misc. =	% tdlp + sum of misc. taxa.

Absolute pollen numbers were calculated using the addition of a known number of exotic spikes (*Lycopodium*) to the known volume of sample (Stockmarr 1971). Taxonomy in general follows that of Moore and Webb (1978) modified according to Bennett et al. (1994) for pollen types and Stace (1992) for plant descriptions.

These procedures were carried out in the Palaeoecology Laboratory of the School of Geography, University of Southampton.

Results

The results are presented in terms of the monolith sequences in order from {1}, {9} and {109}.

Monolith Sequence {1}

Although only five levels out of eight - contexts [223][177][174][172][173] - produced adequate pollen that appear to be changes within the profile. Two local pollen assemblage zones have been tentatively recognised. These are characterised as follows.

Zone 1: -0.815mOD to 0.565mOD Contexts [223][177][174]. *Alnus glutinosa* (alder) and *Corylus avellana* type (hazel) are dominant and characterised this zone with high values at 109cm (to 80% of pollen sum) and 20% respectively. Other trees include Pinus (pine; 7% at the base of the profile), *Tilia* (lime; to 9%) and occasional *Ulmus* (elm). Herbs are also important with Poaceae most important (to 38%) although depressed at 0.185mOD [177] due to high the high values of *Alnus* pollen. Other herbs comprise *Lactucoideae* (dandelion types; 14%) in the basal mineral samples where preservation is poor and sporadic occurrences of *Apiaceae* (umbellifers), *Rumex conglomeratus* type (dock), *Plantago lanceolata* (ribwort plantain; to 2% in the basal sample) and *Asteraceae* types.

Marsh taxa are fewer than in the subsequent zone with only small numbers of *Cyperaceae* (sedges) but relatively important numbers of *Typha angustifolia* type (bur reed and reed mace). Spores of ferns include Monolete forms (*Dryopteris* type), *Pteridium aquilinum* (bracken) and some *Polypodium vulgare* (polypody fern).

Zone 2: 0.565m OD to 1.265m OD. Contexts [172][173]. There is a marked reduction in the pollen numbers of trees and shrubs and strong expansion of herbs dominated by *Poaceae* (to ca. 60%) and *Cyperaceae* (to 30%). Small numbers of *Quercus* (to ca 12% max), *Tilia* (4%) and *Corylus* avellana type (declining to 5%) remain with sporadic *Betula, Pinus and Salix.* In addition to *Poaceae* and *Cyperaceae* noted *Plantago lanceolata* becomes more important at the base of this zone (6%). *Asteraceae* types also expand with *Lactucoideae* especially in the upper levels (17%). The latter is due to over representation of this thick walled and robust pollen grain in poor preserving conditions. Cereal type pollen in this zone is of note. Marsh pollen taxa are dominated by *Cyperaceae* with aquatics *Potamogeton* type (pondweed) and marginal aquatics which include *Typha angustifolia* type, *Typha latifolia* type (greater reed mace). Spores are as in the preceding zone but with increased numbers of derived pre-Quaternary palynomorphs.

Monolith Sequence {9}

Twelve samples have been assessed from 1.045m.OD to -0.535m.OD. Of these, eleven contained sub-fossil pollen and spores allowing preliminary counts to be made. Monolith 11 (at –0.715m.OD) lies lower in this sequence but because it is spatially disparate it has been discussed separately. As with all other profiles pollen was very variably preserved. There is a diverse range of pollen taxa present. These are throughout by herb taxa with greater importance of trees and shrubs in the lowest and upper levels. Three preliminary local assemblage zones have been recognised and are characterised as follows.

Zone 1: -0.535mOD to -0.235mOD.Contexts [162/185][183/191][182]. Tree and shrub pollen are of greater importance in this basal zone. Taxa include *Pinus* (to 18%), *Quercus* (14%), *Alnus* (single peak to 26%), *Corylus avellana* type (peak to 28%) and occasional *Ulmus*. There are occasional *Ericales* (Calluna and Erica). Herbs are present with *Poaceae* attaining high values at the base (to ca. 80%) with *Plantago lanceolata* (6%). Marsh and aquatic taxa show high basal values of *Cyperaceae* (30% sum+marsh). Also present are *Typha angustifolia* type (3-4%), *Alisma* type (water plantain), *Littorella* (shoreweed), *Sagittaria* (arrowhead) and *Potamogeton* type. Spores comprise *Pteridium aquilinum*, *Dryopteris* type and *Polypodium*. The basal minerogenic sample contains substantial numbers of Pre-Quaternary palynomorphs.

Zone 2: -0.235mOD to +0.195mOD. Contexts [182][210]. Trees and shrubs are much reduced and herbs become dominant with *Poaceae* most important (75%). *Plantago lanceolata* (9%), *Ranunculus type* (buttercups) and *Lactucoideae* (11%) are also of note. Cereal type is present. There is some reduction in marsh/aquatic taxa from the preceding zone. Taxa noted for zone 1 remain.

Zone 3: +0.195mOD to +1.045mOD. Contexts [210] [208] [207]. This upper zone is characterised by a marked expansion of *Cyperaceae*. Trees and shrubs are present with a peak of *Quercus* (to 18%) with consistent *Corylus avellana* type remaining constant (5-10%). *Alnus* dies out mid-zone. Herb diversity increases in this zone with *Poaceae, Plantago lanceolata* and *Lactucoideae* being the principal taxa. Also present/note are *Rumex* (docks) and cereal type. Marsh and aquatic taxa become important with *Cyperaceae* dominant (to 40%) with *Typha angustifolia* type (6%), *Typha latifolia, Potamogeton* type, Iris, cf. *Hottonia* (water crowfoot) and *Caltha* type (marsh marigold). There is an expansion of *Pteridium aquilinum* spores.

Monolith 11: -0.715mOD, context [198]. Pollen was relatively well preserved. Herbs are dominant with relatively small numbers and low diversity of tree and shrubs pollen taxa. The latter are solely dominated *Pinus* (25%) with a single record of *Corylus avellana* type. Herbs are dominated by *Poaceae* (56%) and *Cyperaceae* (26% pollen sum+marsh). There are small numbers/sporadic occurrences of other herbs. Miscellaneous microfossil taxa include substantial numbers of Pre-Quaternary palynomorphs (Tertiary including *Carya*) and *Dinoflaggellates* (Holocene or more probably derived from reworked Tertiary sediments).

Monolith Sequence {109}

Four pollen samples were examined from this column at 0.015m.OD [193], 0.565m.OD [194], 1.085m.OD [219] and 1.585m.OD [219]. Pollen was only present in the lowest sample in the sequence at 0.015m.OD, context [193]. Even here, a basic pollen count was only obtained with difficulty because of the very small pollen numbers present and poor preservation. This attributed to the section being in the upper part of the trench sequence and subject to wetting and drying and oxidation which is severely detrimental to preservation.

The pollen spectrum has negligible trees and shrubs with only single occurrences of *Alnus* (alder) and *Corylus avellana* type (hazel). Herbs are most important but with a low diversity. *Poaceae* (grasses) are dominant (83% of total pollen). The only other significant occurrence is *Cyperaceae* (sedges) at 13% of total pollen. Spores of ferns are represented by small numbers of *Dryopteris* type (monolete forms).

There are proportionally substantially more pre-Quaternary palynomorphs which are derived from the local, Tertiary, bedrock (including Carya). Dinoflaggellates are relatively numerous (dinoflagellates are marine plankton, but they are common in salt water habitats as well). These may also be from secondary/geological services although it should also be considered that they are from Holocene marine conditions. Small numbers of cysts of algal Pediastrum (easily transported freshwater algae which are often found in abundance in marine sediments) are present.

Interpretation

The interpretation is presented in terms of the monolith sequences in order from {1}, {9} and {109}.

Monolith Sequence {1}

This pollen profile appears to show a major, on-site environmental change from alder dominated flood plain woodland with partially wooded interfluves (zone 1: [223][177][174]) in proximity to the site to one of grass-sedge fen or very wet floodplain fen grassland (zone 2: [172][173]).

Zone 1 shows some importance of lime (*Tilia*) woodland with oak and hazel growing on the drier interfluve soils whilst alder carr with willow (poorly represented in pollen spectra) grew on the floodplain. Probably due to rising relative sea level within the region rising local base levels resulted in waterlogging and destruction of the on-site alder community. This was replaced by a grass-sedge fen community prior to further flooding and deposition of alluvial sediments. This is commonly seen in the upper floodplain sediment sequences of the Thames and occurred during the late prehistoric and early historic period. It is likely that these dates also apply here. Minor increases in *Chenopodiaceae* pollen in zone 2 may be attributed to development of salt marsh and mud flat conditions lower in the fluvial catchment.

There is no evidence of human activity in zone 1 other than the fact that woodland clearance and probable grassland occurred during this early period (as evidenced by ribwort plantain and grass pollen). However, in zone 2 there is an expansion of cereal pollen in the upper levels. It should be noted that this pollen may also include pollen from certain grasses which also have typically large pollen grains as do cereals. However, it is thought that the grains recorded here do reflect cereal crops. It should also be noted that expansion here does not necessarily suggest local increase in agriculture since other taphonomic processes such as fluvial rather than airborne transport may be a factor.

Although pollen is very variably preserved, some useful data has been obtained which characterises the environment and changes at this site. These can be related to the sedimentology and other environmental evidence. Clearly, dating is required to place these deposits within a temporal framework for these environmental changes. Where preservation permits some additional pollen analysis at a closer sampling interval should be considered. This would lend detail to the pollen stratigraphy and add greater taxonomic detail. The pollen zones described are only tentative and require such additional analysis for confirmation.

Monolith Sequence {9}

This is a complex sequence which shows change from a partially wooded environment of oak, hazel probably with some ash and lime. This is probably of late-prehistoric age (Bronze Age) (zone 1: [162/185][183/191][182]). On site vegetation during this early phase (zone 1) was grass-sedge fen. This habitat remained until rising ground water table caused further waterlogging of the floodplain causing the development of a wetter fen probably with areas of standing water (in zone 3: [210][208][207]). This change probably occurred through regionally rising (relative) sea level that caused ponding back of river systems. It is also possible that woodland clearance also played a part in rising ground water through reduction of evapotranspiration rates and increased surface run-off from the interfluves. This event is also seen in sequence {1} and was probably of very late-prehistoric (LBA) or early historic date (IA/RB). There is some evidence of cereal cultivation/agriculture in adjacent drier areas associated with the woodland clearance (zone 2) [182][210].

In monolith 11 at -0.715mOD, context [198], herbs are dominant suggesting an open environment. Grasses and sedges also indicate that the depositional environment was fen. Substantial numbers of derived geological spores demonstrate that this was a sedimentary environment with low energy or overbank deposition of sediment onto a floodplain. Pine is the dominant tree. This is enigmatic. It is well known that fluvial environments can cause over representation of pine pollen in sediments and this may be the case here. However, it is the only tree and, coupled with the fact that this sample is the lowest in the sequence at this site, it is possible that the sediments are of late-Devensian or more probably early Holocene date. That is, from the Boreal (Flandrian 1a/b) at ca. 9,300-9,000 BP when it is known that pine forest was dominant in this region.

Monolith Sequence {109}

Even though pollen preservation is exceedingly poor, being only found in [193], it can be suggested from the pollen data that the environment both on the floodplain and nearby interfluves was open and treeless. The on-site habitat was probably a grass sedge dominated fen or damp floodplain. High levels of derived geological pollen and spores suggest the latter with sediments and incorporated palynomorphs deposited through over-bank deposition onto the floodplain. Given the poor preservation in this section, no further work is anticipated.

Conclusions

Overall, pollen is sparse in the sediments examined. Of the sequences examined, sequence {1} with associated monolith 11 appears to have the most useful information which embraces/is comparable with that of sequence {9}. The earliest pollen record may date back to the early Holocene period of pine dominance (monolith 11, context [198]). If this is the case, there would be a major hiatus in the sediments.

Sequence {9} appears to show woodland in the lower levels. This was cleared and there is some evidence of ensuing arable agriculture within an open landscape. The depositional environment was predominantly grass-sedge fen or damp floodplain grassland. This became wetter caused by late-Holocene rising relative sea-level and possibly increasing groundwater caused by the woodland clearance noted. This caused a change to wet sedge fen which is evidence in sequence {1} and {9} and elsewhere in London along the River Thames floodplain. Radiocarbon dating is essential for sequence {9}. Sequence {1} has high pollen values of alder (*Alnus*) in the lower levels (zone 1: [223] [177][174]). Values are such that on-site growth is probable. This is not represented to the same degree in sequence {9} although a lesser peak is also noted. It is possible that this was an immediate local growth.

Recommendations

Monolith sequence <9> is the most representative and satisfactory of the three profiles examined. Additional work should comprise a closer sampling interval of this sequence. This would provide better biostratigraphical resolution and where preservation allows, large pollen counts to give greater taxonomic detail.

5.13.2.4 Dating

Although some idea of the date of the deposits excavated has been inferred from their characteristics and level and very occasional dateable finds, environmental evidence unlike artefacts, is not intrinsically dateable and the information about the past landscape preserved in the deposit sequence means little unless it is tied in to an archaeological timeframe.

As a consequence, sub-samples were taken from the top and bottom of organic deposits in monolith tin samples for radiocarbon dating by Accelerator Mass Spectrometry (AMS) and subsamples of non-organic sediments for optically stimulated luminescence dating (OSL) were taken from sections (see Table 13 and Appendix 3: Report on optical dating of sediments).

The radiocarbon dating was carried out by Beta Analytic, Florida, and OSL dating by Dr Phil Toms at the University of Gloucester. See Figs 8–10 for location of dated samples.

{Mono seq} Context	Sample Height (m.OD)	MoLAS ref.	Sediment type	Lab no. (Beta ref = AMS dating; GLO ref = OSL dating)	$^{13}C/^{12}C$ ratio	Uncalibrated date	Calibrated date 2 σ (95% probability)
{9} 207	1.045	OLY1201009/5	peat	Beta - 250602	-24.4	550±40	AD 1310 to 1360 (640 - 590 BP) and AD 1380 to 1440 (570 - 510 BP)
{9} 208	0.635	OLY1201009/4	organic sediment	Beta - 250601	-27.9	1790±40	AD 130 to 340 (1820 - 1610 BP)
{9} 210	0.195	OLY1201009/3	organic sediment	Beta - 250600	-28.5	3140±40	1430 to 1260 BC (3380 - 3210 BP)
{9} 183/191 (M11)	-0.4	OLY1201009/1	wood	Beta - 250598	-27.2	4250±40	2910 to 2860 BC (4860 - 4810 BP) and 2800 to 2760 BC (4750 - 4710 BP)
{9} 183/191 (M6)	-0.435	OLY1201009/2	wood	Beta - 250599	-24.3	2960±40	1360 to 1350 BC (3310 - 3300 BP) and 1310 to 1050 BC (3260 - 3000 BP)
{109} 219 (upper)	1.585	107	Quartz grain	GLO8011	-	-	3.4 +/- 0.3 ka (c.1,700 to 1,100BC)
{109} 219 (lower)	1.085	106	Quartz grain	GLO8010	-	-	3.3 +/- 0.2 ka (c.1,500 to 1,100BC)
{109} 247	0.82	108	Quartz grain	GLO8012	-	-	6.0 +/- 0.6 ka (c.4,600 to 3,400BC)
{109} 193	0.015	105	Quartz grain	GLO8009	-	-	12.6 +/- 1.0 ka BP (c.11,600 to 9,600BC)
{1} 172 (upper)	1.065	OLY1201/1/04	peat	Beta - 250597	-26.9	990±40	AD 980 to 1160 (960 - 800 BP)
{1} 172 (lower)	0.665	OLY1201/1/03	organic sediment	Beta - 250596	-28.2	2630±40	840 to 780 BC (2790 - 2730 BP)
{1} 177	0.185	OLY1201/1/02	peat	Beta - 250595	-28.3	4120±40	2870 to 2570 BC (4820 - 4520 BP)
{1} 185	-0.33	104	Quartz grain	GLO8008	-	-	13.9 +/- 1.1 ka BP (c.13,000 to 10,800BC)
{1} 187	-0.415	103	Quartz grain	GLO8007	-	-	13.7 +/- 1.0 ka (c.12,700 to 10,700BC)
{1} 223	-0.815	OLY1201/1/01	peat	Beta - 250594	-28.3	5110±40	3980 to 3800 BC (5930 - 5740 BP)

Table 13: AMS and OSL dates

5.13.3 Synthesis of environmental and geoarchaeological results

The results of the different types of sedimentary, macrofossil, microfossil and radiocarbon analyses outlined above have been drawn together in this geoarchaeological summary with regards, in particular, to the Monolith sample sequences. See Figs 8–10 for location of monolith tins.

5.13.3.1 Monolith sample sequence {1}

Monolith sequence {1} sampled (from the base upward) contexts [223][187][185][177][174][172][171] and [173]. It was located in the northern corner of the trench (sections 26, 22 and 18). The sampled section ranged from -0.96mOD to +1.35mOD, some 2.3 metres in total. This sedimentary profile was selected to investigate the sediments accumulating at the NW side of a stream/minor channel that was considered to be a floodplain edge running watercourse which, in turn, represented the farthest extent of the deposits associated with the main channel.

The lowest contexts sampled were [223], [187] and [185] (-0.96mOD to +0.15mOD). These deposits are considered to belong to SG02, the earliest identified channel deposits consisting of a riverside sand bank and laminated sands and silts overlying the River Lea terrace gravels. Context [223] was described as a firm, silty sand with root fragments. It was dated by AMS to the Early Neolithic and reflected a flora dominated by trees, particularly deciduous species such as Lime (*Tilia*) and water edge species such as Alder, typical of the climatic optimum of the mid Holocene which correlates with the dating. The river itself was considered through insect analysis to be clear freshwater with a sandy substrate (as substantiated by the sediments). Over [223] was [187] which was described as yellow friable sand with roots. The sediments were dated to around 13.7 +/- 1.0 ka by OSL, which equates to the very late Palaeolithic period. [187] was however devoid of any environmental indicators other than a few fragments of wood and snail *(Bithynia)* opercula. Over this lay [185], a clayey silt with iron staining along the penetrating woody root channels thought to relate to a period of channel stability when the main flow of the river was to the west and the stream channel continued to flow in this area. [185] however, dated also by OSL dating, returned a date of 13.9 +/- 1.1 ka BP, similar to [187] albeit from across the channel (see section). Although devoid of pollen and diatoms, [185] had insect remains indicating a swift flowing river with stony substrate.

Clearly there is an anomaly with the dating at these levels as [223] is AMS dated to the Early Neolithic (3980 to 3800 BC) and underlies [187], OSL dated to 13,000 years ago, the very late Palaeolithic. This OSL date is substantiated by the dating of [185] which, at a similar level and sediment type returned a similar date. Likewise, but with less scientific rigour, the Neolithic date for [223] is substantiated by the pollen data, which seems to indicate mid Holocene vegetation. However, dating by radiocarbon (AMS) is influenced by organic matter intrusion such as roots penetrating the sediments (and we have roots throughout [185]). Indeed, roots can also bring pollen down from a later, higher stratum, which was incidentally probably how the single charred grain of hulled barley (*Hordeum vulgare*) was found in this deposit in the plant macrofossil assessment. However, equally intriguing is that around 13,000BP the Late glacial Windermere interstadial occurred, a period of rapid warming at the end of the Devensian glacial where summer temperatures rose to a maximum of 17°C but winters remained cold (1°C) and dry. If the *Bithynia* opercula, noted in the wider ostracod analysis of [187], are not in themselves intrusive, it must have been already fully temperate during the deposition of context [187] which could influence the reading of the pollen assessment. It is also possible that the bank of sediments to the north east of the trench were undercut by the force of the main channel (or indeed the smaller channel adjacent to sediment sequence {1}) and slumped down across the Neolithic deposits. This conundrum, although very interesting, can only be the subject of further, closer sampling and analysis at a later stage of work however, if an answer is to be found.

The next group of contexts [177] and [174] (+0.15mOD to +0.57mOD) are sampled from SG09 and SG06 respectively, deposits representing the eastward migration of the main river channel. Context [177], an organic silty clay, is considered to be the fill of pool in lower lying area of the former stream, but not fed by tidal inwashing over the mudflats as originally thought. [177] was dated to the mid to later Neolithic (2870 to 2570 BC). At these levels there is no indicator of brackish conditions although certainly marsh. Alder dominates the pollen spectra and importantly indicators of disturbed (including cultivated) ground begin to appear in the pollen and plant macrofossil data. Again the insect remains indicate (the main channel to be) free flowing water over stone but also with marshy and muddy ground with woodland nearby. Fluvial energy has dropped as the main river, as suggested, has probably migrated away from the site, but apparently not that far. It is quite likely however that in times of high water discharge during winter for example former subsidiary channels as in this area of the site would become reenergised with free flowing water through an otherwise marshy area. By the formation of [174] the area seems to have dried out somewhat because, although predominantly still marshy with less of a presence of trees and more grasses and reeds, the sediments at this level show signs of weathering/water table fluctuation.

Context [172] (+0.57mOD to +1.09mOD) which overlies [174] is aligned with SG09 - deposits in a north to south aligned 5m wide channel which flows across the site. [172], thought to be a fill of boggy hollow formed after pool [177] had silted up, has a wide date range associated with it. At the base of [172] a late Bronze Age date (840 to 780 BC) was returned whereas the top of the context dated to the early medieval period (AD 980 to 1160). This almost two thousand year gap is either due to the slow sedimentation process involved as the channel became increasingly redundant or through multiple sedimentation and erosion events through time through periodic channel reinvigoration; the former is probably the case. The plant and pollen spectra continue the theme of a marsh environment, probably becoming seasonally dry over time with cereal production to take place locally. Interestingly, in the upper sample from [172], possible saline indicators were found in the diatom assessment along with freshwater diatoms. Very few indicators of brackish conditions have been found at the Olympic Site which has long been an incongruity in the Lea valley as the Lea is clearly tidal today. It must be noted of course that tidal influence in the Thames which itself would have been affected by rising sea levels, can have the affect of ponding back largely freshwater tributaries like the Lea raising and lowering the water level daily without the water being saline at all.

Finally, from +1.09mOD to +1.34mOD in monolith sequence {1}, context [173], a brown, slightly clayey silt with iron staining - part of SG013 (marsh deposits across most of trench at top of alluvial sequence) – was deposited. Similar level and deposits as [173] seen elsewhere across the trench were dated to the late medieval period and finally sealed by ground consolidation [171] which was spot-dated to the post medieval period. Probably subject to weathering and ground water fluctuations this medieval landscape continued to be largely grass dominated marsh similar to [172] with some sparse trees and shrubs and cereal production on the higher ground.

5.13.3.2 Monolith sample sequence {9}

Monolith sequence {9} sampled contexts [63] [198] [197] [195] [162/185] [183/191] [182] [210] [208] and [207], sampled from basal sediments upward. The sampled sections were NE facing 25, 21 and 17 along the central axis of the trench. The monolith sequence ranged from -0.50mOD to +1.07mOD, some 1.6 metres in total. These sediments were sampled as representative of the main channel floodplain deposits.

The lowest contexts above the terrace gravels of [63] (to -0.42mOD, SG01) were [198][197][195] and [162/185] all belonging to SG02 and ranging in height from -0.75mOD to -0.42mOD. This sedimentary stack was a series of interbedded sandy clays and gravels and represents, in this area of the trench, the margins of channel deposits from the main channel to the south-west. Probably they represent flood deposits of varying energy interspersed with erosional events. Notably, these deposits were recorded as cut by a four stake structure but these could have been driven from much higher in the sequence. The lowest context to be assessed was [198] which, although not dated, seemed through pollen analysis to either belong to the late Devensian period or being eroded from Pleistocene sediments as it was rich in pre-Quaternary polymorphs and reflecting a largely treeless environment dominated by grasses. [162/185] was the next context assessed and, as described above in monolith sequence {1}, the insect analysis reflected a fast flowing freshwater environment over a stony substrate for [185]. The molluscs infer a sheltered, well vegetated riparian environment. The plant macrofossil analysis largely points to a wetland environment but also disturbed ground. On the face of it there seems to be a long period of time between the deposition of [198] and [162/185] although it is likely the bulk of these sediments accumulated in the mid Holocene when the river channel to the south west migrated toward the site.

Contexts [183/191] [182] [210] and [208], lying in sequence over [162/185], all belong to SG06 and range from -0.42mOD to +0.85mOD. [183/191] was a particularly interesting context environmentally as it was sands and silty clays full of decayed wood fragments and a rolled tufa deposit [191]. This context represents a severe flood event which uprooted trees along the river bank whose roots still held the tufa they penetrated originally. Diatoms, snails and insect remains all confirm a freshwater river with stony bed and shores but also fairly open terrestrial conditions, a wetland with a scattering of trees. Disturbed ground flora is also noted and interestingly, herbivore dung, possibly also associated with agricultural practices locally. Two radiocarbon dates were submitted from this context at similar levels (-0.4mOD M6 and -0.435mOD M11) but due to the nature of the trench excavation, some distance apart (monolith 11 is approximately 4m NW of monolith 6). The dates returned indicate that sediments taken from M11 are consistent with the mid to later Neolithic period (2910 to 2760BC) and those subsampled from M6 equate to the mid to later Bronze Age (1360 to 1050 BC), some two thousand years later. Although at the same OD level, the differences in dates could be accounted for by M6 being closer to the main channel and therefore in an area subject to more erosive events during this period creating hiatuses in the depositional sequence. Overlying the severe flood deposit [183/191], lies [182] a context of interbedded sands and clays. Originally thought possibly to be mudflats in an intertidal deposit this has been discounted through microfossil analysis and simply a series of less severe flood deposits seems to be the case. The insect remains suggest running freshwater with aquatic plants and waterside muds indicating a less energised environment than [183/191], and perhaps a river more laden with silts and clays. Again, wetland and disturbed ground flora are present (including a charred wheat grain) as well as insects associated with herbivore dung, suggesting the continuation of agricultural practices locally. Overlying [182] is context [210], a dark brown organic clayey silt with wood and snails and occasional lenses of fine sand. [210] returned a radiocarbon date at its base corresponding with mid Bronze Age (1430 to 1060BC). This date is very close to the date returned from [183/191] although some 0.6m higher up the profile of monolith sequence {9}. This is probably indicative of an increased rate of sedimentation during this period possibly due to eustatic change (sea levels rise) and the subsequent ponding back of the Lea and possibly anthropogenic disturbance (for example vegetation clearance). Certainly the sediments indicate pulses of higher fluvial energy laying down sands amid clays indicative of flood events. The environmental indicators also point to possible flood events as, although consistently wetland or marshy, insect remains indicate flowing water as well as stagnant pools of water accumulating – typical of flood and receding flood deposits ponding across a floodplain. Diatoms also indicate shallow freshwater and also, notably planktonic (marine/estuarine) remains which could substantiate the idea of the ponding back of the Lea at this time by estuarine waters of the Thames as mentioned above. As before however, local agricultural practice indicators continue to show up in both the insect remains and plant macrofossils. The penultimate context in SG06 is [208], a dark brown organic silt. This deposit is dated at the base of the unit to the mid Roman period. By this time the stratigraphic and environmental indicators portray an increasingly quiet river environment, with a grass dominated fen environment probably exposed to seasonal flood events. The final deposit sampled in the sequence, context [207], was a dark brown firm clay radiocarbon dated at the top to the late medieval period (AD1310 to 1440). Macro and microfossil analysis continue to depict an environment much like [208] – an open, grass-dominated freshwater marsh which probably continued through to ground consolidation in the post medieval period.

5.13.3.3 Monolith sample sequence {109}

Monolith sequence {109} sampled, from bottom to top, contexts [63][195][193][194][247][219][218][215] and [202]. The sampled sections were south-west facing 23, 19 and 15, with the monoliths ranging from -0.27mOD to +2.18m OD, some 2.5 metres in total. The samples were taken to examine sediments adjacent to the channel, into which the channel (and stream) cut at the edge of the floodplain.

The lowest contexts above the terrace gravels of [63] (to -0.16mOD, SG01) were [195] and [193] belonging to SG02, ranging in height from -0.16mOD to +0.27mOD. [195] and [193] are essentially the same sedimentary deposit – a mid-brown silty clay with occasional pebbles and roots, although [195] is a little sandier reflecting the mixing of deposits at the interface of the sandy gravels of [63] and the silt [195/193]. [193] was dated mid unit by OSL dating to between 12.6 +/- 1 ka years BP, which equates to the very late Palaeolithic period. Again, this date aligns with the Late glacial Windermere interstadial, the warm period at the end of the Devensian. This is reflected in the microfossil data as grasses and sedges, with some Alder and Hazel as well as many pre-Quaternary polymorphs.

Above [193] lies contexts [194] and [247], both part of SG04, consisting of over-bank and floodplain deposits in the north-east of the trench and possibly concurrent with the active period of the stream or river channel (SG03) seen in the south-west of the trench (monolith sequence 9). Little environmental detail was obtainable from [194], a mid brown clayey silt, which was the only context of these two to be assessed, except for some fragments of charcoal and signs of weathering (the latter of which probably accounts for the lack of microfossil data). The greenish brown silty clay of [247] however was dated mid unit and returned a date of 6.0 +/- 0.6 ka years BP, approximately the late Mesolithic/early Neolithic period. Interestingly, as this equates with the AMS date returned on [223], a deposit at the base of the channel in monolith sequence {1}, which could indicate this is the approximate time this area of the site was eroded by the migrating main channel of the Lea approaching from the SW.

Over [247], contexts [219] and [218] were deposited, bank deposits on the eastern margin. Context [219], a weathered, mid brown sandy silt, was dated to approximately between 3.4 +/- 0.3 ka and 3.3 +/- 0.2 ka (early to mid Bronze Age). This date aligns well with two other radiocarbon dates (1360 BC–1050 BC from context [183/191] and 1430 BC–1260 BC from context [210] linking it with the eastward migration of the channel, i.e. SG06. Unfortunately, little environmental data was recovered from [219] except for some fragments of charcoal and signs of weathering.

5.13.3.4 Non-monolith macrofossil data

Nearly all plant macrofossil assessments indicate a wetland and aquatic flora existing across the site indicative of a changing, freshwater river environment as was seen in the microfossil assessment. There were rich botanical assemblages consisting mainly of identifiable fruits and seeds, all from wild plants, but particularly from wetland species, and to a lesser degree, plants of disturbed or cultivated ground and waste places as well as woodland and hedgerow habitats.

The insects and snails, where present, also concur with the microfossil assessment with species identified preferring freshwater and river marginal environments. Interestingly, as was found in the monolith sequences generally, wider insect assessment found there was a preponderance of beetles representing clear, clean, well-oxygenated flowing water in the earlier part of the Holocene which reduce in number over time as the silt content of the water increases particularly from the Late Bronze Age onwards, possibly indicative of the influence of people on the river catchment particularly in relation to vegetation clearance rather than changes in river regime through relative sea level rise.

The following samples have value due to their potential to identify significant contexts (see section 4):

- Sample 126 from [580] was a peaty sand found to be rich in wetland plants and insects. Overall the macrofossils suggested an aquatic assemblage indicative of the varied habitats that would exist both within and at the margins of a river, indicating perhaps [580] was a flood deposit.
- Sample 121 from [596] was a peaty layer consisting mainly of roots but also seeds, especially *Alnus glutinosa* (Alder), and *Theodoxus fluviatilis,* a snail mostly found in calcium-rich, clean, fast-moving fresh water. This probably represents an alder fen, a marshy environment next to the river.
- Sample 11 from [183] is a mixed deposit of peaty material, silt and tufa. Diatoms, snails and insect remains all confirm a freshwater river with stony bed and shores with a fairly open marshland with a scattering of trees across the floodplain. The high diversity of sediments and organic materials combined with a rich macrofossil and microfossil data indicate this context represents a severe flood event.
- Sample 14 from [210] was a dark brown organic clayey silt with wood and snails and occasional lenses of fine sand. Mixed environments ranging from within the river to the marshy floodplain are represented in microfossil and macrofossil assessment making this context indicative of a flood deposit.
- Sample 5 from [177] was an organic silty clay. This context included Alder (which dominated the floodplain) and indicators of disturbed (including cultivated) ground alongside a clean, free flowing main channel. This context probably represents a marshy, lower lying area of a former stream subject to flood events from a migrating main channel.
- Sample 27 from [177] as sample 5 from [177]
- Sample 102 from [533] is an organic deposit with fragments of wood and moderate amount of seeds from wetland species. Aquatic, riverside and terrestrial insects also present including possible indicators domesticated animals. Described by excavators as an 'alder carr-type' deposit (although Alder is not confirmed by macrofossil assessment) this context does represent a wooded, marshy floodplain, subject to flooding.
- Sample 7 from [172] was a dark brown organic silt. The plant and pollen data indicate a marsh environment, probably becoming seasonally dry over time with cereal production to take place locally. This deposit is thought to be a fill of boggy hollow which slowly silted up through flooding.
- Sample 17 from [169] was a clay which contained fragments of wood, roots and mainly wetland (aquatic) seeds. This context was considered a marsh deposit, possibly partially wooded.
- Sample 8 from [173] was clay silt which contained very little environmental information being virtually all rootlets, considered through pollen analysis to be a grass-sedge fen (grassy marsh).
- Sample 16 from [207] was a silty clay dominated by wetland (aquatic) plants, specifically Cyperaceae (sedge) indicative of a marshy environment.

5.13.4 Summary

Overall the contexts assessed through sedimentary, macrofossil, microfossil and radiocarbon/OSL analyses have returned clear indications of the nature of the local environment and changes across the site through time.

The three different monolith sample sequences investigated initially three separate microenvironments in this eastern area of the Lea floodplain. Monolith sequence {1} sediments associated with the stream or minor channel that skirted the floodplain from NW to SE showed how complex reconstructing the environment at the floodplain edge can be. Initially, for example, the interaction between the bank and main channel deposits led to a complicated dating sequence. Overall however this area of the site appears to have been a subsidiary channel running parallel to the main channel active from the Neolithic onward and although constant to some degree was probably seasonally invigorated largely as an overflow channel to the main river. Once tree lined and flowing with clear water it became redundant, filling up with silts and clays until finally subsumed into the wider marsh like conditions that took over the site later in prehistory.

Monolith sequence {9} was taken through flood deposits from the main channel. These sediments again seem to have been deposited from the Neolithic, originally scouring the ancient pre-Holocene bank sediments before laying down clays and gravels indicating pulses of fluvial energy probably related to migration of the river channel toward and away from the site. One very large flood event seems to have torn trees from the river banks and strewn bedload deposits across the flood plain later in the Neolithic or Bronze Age. For most of prehistory this channel would have been fast flowing clear water with a stony bed and shores. By the Roman period however, as across the site as a whole, the area seems to have become largely a marsh, an environment which stays more or less the same until the post medieval period when ground consolidation takes place, blanketing the original landscape until the modern day.

Monolith sequence {109} looked at the sediments associated with the bank of the wider floodplain to the northern end of the site. Acting as something of a 'control' sedimentary sequence to the whole site it was found unfortunately to be largely devoid of any environmental indicators probably through weathering and exposure to the elements over a very long period of time. At the base of the profile pre-Holocene dates indicated the original sediments on the site dated to about 13,000 years ago at the time of the Windermere interstadial, a brief warm period just before the end of the last glaciation. These sediments were undercut, slumped and entrained into the river channel deposits initially although like the rest of the site were subsumed by marsh deposits later on.

Interestingly, there seems to have been indications of indirect estuarine/saltwater conditions affecting the site. This is thought to be due to sea level rise during the prehistoric period causing the Thames to pond back the Lea which led to the ubiquitous marsh conditions later on. However, it should be pointed out that throughout all profiles the influence of people locally was noted both physically in the archaeology and in the environmental evidence (largely though agricultural indicators). The change in river regime therefore cannot be entirely due to changes in relative sea level as vegetation clearance practices so often accompanying agriculture and settlement in river catchments inevitably would have led to the release of silts and clays choking the once clear water rivers and silting up the entire area.

Insect and plant material recovered clearly portray an open, aquatic/marshland environment under the influence of a local freshwater river. In particular assemblages of beetles representing clear, clean, well-oxygenated flowing water in the earlier part of the Holocene reduce in number over time as the silt content of the water increases particularly from the Late Bronze Age onwards.

Elmids appear to have been much more widely distributed than they are at the present day and they are now no longer found in the Thames drainage system. A recent study in the catchment of the River Rede in northern England has found the presence or absence of silt to be the most important single variable in their distribution (Eyre *et al.* 1993). Osbourne (1988) has suggested that their disappearance from many lowland rivers may have been linked to an increase in the silt content of the water in many areas during and after phases of alluviation associated with major fluvial changes. Recording the occurrence of this group of beetles together with other aquatics will provide data relating to fluvial conditions in the area over the time represented by the sequence of deposits sampled. Taxa representing other aquatic habitats were noted in the sub-samples, indicating the varied conditions found at the margins of a river channel, and in some of the later deposits (particularly Sub-group 11) possibly relating to development of marshland.

In general, a fining-upward sequence was identified in the stratigraphies of both monolith sequences with intermittent pulses of higher energy deposition, all of which seems to concur with the phasing.

Sediment deposition has been essentially due to flood events and a southerly river migration which subsumed earlier prehistoric features. Pollen data in particular pointed toward erosion from interfluves, transportation and re-deposition occurring onto the river floodplain.

Interestingly, the radiocarbon dates (along with the archaeological evidence) indicate these contexts were not deposited until late in the Holocene/prehistoric period, meaning the early Holocene/Pleistocene landscape would have remained unchanged for a considerable period of time.

Furthermore, the presence (and possible influence) of people seem to be concurrent with the accumulation of the deposits with arable agriculture taking place locally. The dates returned also indicate that the area began to stabilise or become a much lower energy environment really throughout the Saxon period when a more mature fen habitat develops across the site and water levels fluctuate.

6 Potential of the data

6.1 Realisation of the original research aims

The research aims and objectives for the excavation were established in the *Written scheme of investigation for an archaeological excavation at trench 12.01* (MoLAS-PCA 2007b).

To identify evidence for settlement of prehistoric and historic date, particularly within zones of higher ground not already truncated by quarrying.

Whilst there were no zones of higher ground truncated by quarrying, the only evidence of settlement within the trench was the remains of the 18th- and 19th-building in Periods 7 and 8.

However, although prehistoric settlement within the trench was not conclusively proved, there was evidence for Neolithic, Bronze Age, Iron Age/Roman and medieval cultural activity in Periods 2–5.

To identify wetland and channel margin activity of prehistoric date and riverside structures of historic date.

The Neolithic, Bronze Age, Iron Age/Roman and medieval cultural activity in Periods 2–5 provided evidence for the above.

To identify evidence for the nature and/or date of past waterways management and exploitation.

Again, the Neolithic, Bronze Age, Iron Age/Roman and medieval cultural activity in Periods 2–5 provided evidence for the above.

6.2 General discussion of potential

There is scope for further work to be carried out that will enable a fuller picture of the lower Lea Valley to be realised by contextualising the site in relation to the other Olympic archaeological interventions, defining and dating the activities in its landscape.

The pre-formed flint axe <6> was the most significant find. The other finds recovered in the excavation date the archaeological features, but otherwise do not own contribute to the research potential of the site. They should be considered in relation to the Olympic site as a whole.

There is very good potential for further analysis of the environmental datasets (e.g. the plant marcofossils, insects and pollen). Closer microfossil sampling and dating of key levels and deposits will allow closer resolution and linking to be achieved and should form the first stage of any further work. Further bulk sample analysis is recommended on certain key, productive deposits also.

Specific aspects of the site archive have potential to address key research questions based on themes that include:

- The chronological development of the site
- Land use
- Local economy
- The changing environment

6.2.1 Terrace gravels and the late glacial development of dry-land deposits (Period 1)

The excavation adds to understanding this aspect of the landscape. Therefore, it has the potential to contribute to the understanding/reconstruction of the Terrace Gravels and late glacial deposits of the lower Lea Valley (Museum of London 2002, 78–9). Significance might be attached to the plant macrofossils and some aspects of the microfossil assemblage in SG02 in determining evidence for an interstadial in the late glacial period.

As a baseline, the excavation has the potential to form part of a model used to develop an understanding of landscape formation (Museum of London 2002, 79).

6.2.2 Neolithic stream channel and the earliest human activity (Period 2)

This period contained the earliest deposits with evidence for cultural activity, a peaty sand that would have formed in the medium-fast flowing water of the eastern edge of a Neolithic river channel (6.5 thousand to 4.5 thousand years ago). The evidence consisted of a single, large flint axe in perfect condition, whose manufacture had not been fully completed. The axe would have lain in a deposit visible to any passer-by. Other similar accounts of finding flint axes from this period in the River Lea valley suggest these objects may have been placed in these locations, indicating some kind of offering, possibly to a deity or signifying the religious significance of the margin between the river bank and the fast flowing river. Therefore this find, in its own right and in its setting, has the potential to contribute to our understanding of 'placed deposits' and the influence of landscape (Museum of London 2002, 22–3).

Plant macrofossil, insects and some aspects of the microfossil assemblages have the potential to contribute to the understanding/reconstruction of the Neolithic environment of the lower Lea Valley (Museum of London 2002, 78–9).

6.2.3 Bronze Age river migration (Period 3)

The river migration in this period has the potential to address the nature, extent and impact of differing hydrological regimes over different period of the lower Lea Valley, and how this may have determined or helped shape settlement patterns and communications (Museum of London 2002, 78–9).

As a baseline, the pottery, insects and pollen have the potential to contribute to the understanding of the Bronze Age settlement and environment of the lower Lea Valley (Museum of London 2002, 23–6 and 78–9).

6.2.4 Iron Age and Roman side channel (Period 4)

The side channel in this period has the potential to address the nature, extent and impact of differing hydrological regimes over different periods of the lower Lea Valley, and how this may have determined or helped shape settlement patterns and communications (Museum of London 2002, 78–9).

As a baseline, the pottery, worked wood, insects and pollen have the potential to contribute to the understanding of the Iron Age and Roman settlement, waterway management and environment of the lower Lea Valley (Museum of London 2002, 26–7 and 78–9).

6.2.5 Medieval channel and developed land use (Period 5)

The channel in this period and its associated structures has the potential to contribute to our understanding of waterside industry, agricultural practice, and marginal land activity in the lower Lea Valley in the medieval period (Museum of London 2002, 46–7, and 58–9).

As a baseline, the pottery, worked wood, insects and pollen have the potential to contribute to the understanding of the medieval waterside industry, agricultural practice, and marginal land activity in the lower Lea Valley in the medieval period (Museum of London 2002, 26–7 and 78–9).

6.2.6 Early post-medieval land reclamation (Period 6)

Early post-medieval land reclamation offers the potential to understand the development of the site and its immediate landscape.

6.2.7 18th-century houses (Period 7)

Period 7 offers the potential to understand the development of the site and its immediate landscape.

6.2.8 19th- and 20th-century development (Period 8)

Period 8 offers the potential to understand the development of the site and its immediate landscape.

7 Significance of the data

This excavation has uncovered what to date is the only known unbroken, continuous sequence of prehistoric to modern activity on the Olympic site. It has contributed to the understanding of the Lower Lea valley and the processes which shaped this area. Sediment deposition and landscape formation has been due to changes in river regimes and the overbank accumulation of flood deposits; all of which concurs with the radiocarbon and finds dating, and phasing.

The sequence of alluvial sediments had within it dry land, river channels, backwaters, and marshy environments. There was evidence for Neolithic, Bronze Age, Iron Age/Roman, medieval and post-medieval cultural activity, despite much of the site being too waterlogged in these periods for occupation, or to be effectively exploited in an archaeologically visible manner.

Furthermore, the presence of people seems to be concurrent with marginal land activity, whether ritual or industrial, until the post-medieval period.

The environmental and geoarcheaological analyses have returned clear indications of the nature of the local environment. Insect, plant, pollen and diatom material recovered clearly portray an open, aquatic/marshland environment under the influence of a local freshwater river.

The archaeological remains are significant in two ways:

- they impose a time frame onto the sequence of environmental information
- the archaeological evidence indicates how marginal areas were used in specific periods

The evidence of Neolithic ritual activity is of at least regional significance, if not national. Indirect evidence of Late Bronze Age/Early Iron Age and Late Iron Age/early Roman settlement aids in the understanding of the past land use of the site and of the area in general. Medieval marginal land use and structures may be of regional significance depending on the evidence of surrounding sites.

This information will contribute to our understanding of the past environment of the site and its environs and will assist in landscape reconstruction models being developed. When considered alongside the information currently being obtained from the other parts of the Olympic site, however, the site undoubtedly has regional significance.

8 Recommendations

Although on its own the site merits publication, it is recommended instead the results of this excavation are assimilated into a site-wide assessment of all archaeological interventions of the Olympic site to assign contextual significance and further refine the importance of the archaeological survival, and thereafter assimilated into any publication discussing/disseminating the results.

The decision on the appropriate archaeological response to the deposits existing on the site rests with the Local Planning Authority and their designated archaeological advisor.

9 Acknowledgements

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11 NMR OASIS archaeological report form

A previous NMR OASIS archaeological report form already exists for the evaluation (ref: OASIS ID: molas1-40627).

OASIS ID: molas1-55513

Project details

Project name	Olympics Delivery Zone 12, Trench PDZ12.01
Short description of the project	An archaeological excavation of the proposed construction impacts of the London 2012 Olympics Site
Project dates	Start: 03-03-2008 End: 02-05-2008
Previous/future work	Yes/No
Any associated project reference codes	OL-08707 - Sitecode
Type of project	Recording project
Site status	None
Current Land use	Industry and Commerce 2 - Offices
Monument type	BURIED LAND SURFACE Upper Palaeolithic
Monument type	CHANNEL Neolithic
Monument type	RIVERBANK Neolithic
Monument type	CHANNEL Bronze Age
Monument type	RIVERBANK Bronze Age
Monument type	CHANNEL Iron Age
Monument type	MARSH Roman
Monument type	CHANNEL Early Medieval
Monument type	GULLY Early Medieval
Monument type	WOODEN STRUCTURE Early Medieval
Monument type	PLOUGH SOIL Uncertain

Monument type	MARSH Medieval
Monument type	LAND RECLAMATION Post Medieval
Monument type	MADE GROUND Post Medieval
Monument type	BUILDING REMAINS Post Medieval
Monument type	BUILDING REMAINS Modern
Significant Finds	FLINT AXE Neolithic
Significant Finds	POTTERY Late Bronze Age
Significant Finds	POTTERY Late Iron Age
Significant Finds	WOODEN STAKES Iron Age
Significant Finds	WOODEN STAKES Early Medieval
Investigation type	'Open-area excavation'
Prompt	Direction from Local Planning Authority - PPG16

Project location

Country	England
Site location	GREATER LONDON NEWHAM STRATFORD Olympics Planning Delivery Zone 12
Postcode	E15
Study area	3000.00 Square metres
Site coordinates	TQ 38425 83635 51.5341279407 -0.00399460956357 51 32 02 N 000 00 14 W Point
Height OD/Depth	Min: -2.00m Max: 8.00m

Project creators

Name of Organisation	MoLAS/PCA
Project brief originator	ODA
Project design originator	MoLAS/PCA
Project director/manager	Gary Brown
Project supervisor	Isca Howell
Type of sponsor/funding body	ODA

Name of sponsor/funding body	Olympic Delivery Authority

Project archives

Physical Archive recipient	LAARC
Physical Archive ID	OL-08707
Physical Contents	'Animal Bones','Ceramics','Environmental','Glass','Leather','Metal','Wood','Worked bone','Worked stone/lithics'
Digital Archive recipient	LAARC
Digital Archive ID	OL-08707
Digital Contents	'Animal Bones','Ceramics','Environmental','Glass','Leather','Metal','Stratigraphic','Survey','Wood','Worked bone','Worked stone/lithics'
Digital Media available	'Database','GIS','Images raster/digital photography','Survey','Text'
Paper Archive recipient	LAARC
Paper Archive ID	OL-08707
Paper Contents	'Animal Bones','Ceramics','Environmental','Glass','Leather','Metal','Stratigraphic','Survey','Wood','Worked bone','Worked stone/lithics'
Paper Media available	'Context sheet','Correspondence','Diary','Drawing','Matrices','Notebook - Excavation',' Research',' General Notes','Photograph','Plan','Report','Section','Survey ','Unpublished Text','Unspecified Archive'

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Description	Post-excavation assessment

12 Appendix 1: Context index

Context No.	Sub-group	Period	Type	Description	Section
1	17	8	Layer	Made ground	S6
2	15	6	Layer	Made ground	S10
3	15	6	Layer	Made ground	S10
4	15	6	Layer	Made ground	S10
5	15	6	Layer	Made ground	S10
6	15	6	Layer	Made ground	S10
7	15	6	Layer	Made ground	S10
8	16	7	Fill	Fill of [9]	S6, S10
9	16	7	Timber	Timber-lined pit	S6, S10
10	16	7	Fill	Fill of [11]	S10
11	16	7	Cut	Irregular small pit	S10
12	15	6	Layer	Made ground	S6
13	17	8	Structure	Concrete drain	S10
14	16	7	Structure	Well	S10
15	16	7	Fill	Backfill of well [17]	S10
16	16	7	Structure	brick-lined well	S10
17	16	7	Structure	Well	S10
18	15	6	Layer	Made ground	S10
19	15	6	Layer	Made ground	S10
20	15	6	Layer	Made ground	S10
21	15	6	Layer	Made ground	S10
22	15	6	Layer	Made ground	S10
23	15	6	Layer	Made ground	S10
24	15	6	Layer	Made ground	S10
25	15	6	Layer	Made ground	S10
26	16	7	Fill	Fill of [29]	S10
27	16	7	Masonry	Brick wall	6, S10
28	16	7	Timber	Base for wall [27]	S10
29	16	7	Cut	Construction cut for [27]	S10
30	16	7	Layer	Made ground	S10
31	15	6	Layer	Made ground	S10
32	15	6	Layer	Made ground	S10
33	15	6	Layer	Made ground	S10
34	17	8	Layer	Made ground	S10
35	17	8	Layer	Made ground	S10
36	17	8	Layer	Made ground	S10
37	15	6	Layer	Made ground	S10
38	15	6	Layer	Made ground	S10
39	15	6	Layer	Made ground	S10, S14
40	15	6	Layer	Alluvial clay	S10, S14
41	15	6	Layer	Made ground	S10

Context No.	Sub-group	Period	Type	Description	Section
42	16	7	Structure	Culvert pipe	S10
43	16	7	Cut	Construction trench for [42]	S10
44	17	8	Masonry	Foundation	S10
45	17	8	Cut	Construction cut for [44]	S10
46	15	6	Layer	Made ground	S10
47	15	6	Layer	Made ground	S10
48	15	6	Layer	Made ground	S10
49	15	6	Layer	Made ground	S10
50	15	6	Layer	Made ground	S10
51	15	6	Cut	Undefined cut	S10
52	15	6	Fill	Fill of [51]	S10
53	14	6	Layer	Made ground	S10
54	17	8	Layer	Made ground	S10
55	6	3	Layer	Gravel	S22
56	2	1	Layer	Alluvial clay	
57	2	1	Layer	Alluvial clay	
58	6	3	Layer	Alluvial clay	
59	2	1	Layer	Channel fill	
60	2	1	Layer	Sand bank	S22
61	2	1	Layer	Alluvial clay	S22
62	2	1	Layer	Channel cut/bank	
63	1	1	Layer	Terrace gravels	S23
64	2	1	Layer	Sandy channel deposit	
65	2	1	Layer	Channel deposit	
66	6	3	Timber	Worked wood	
68	6	3	Timber	Worked wood	
69	6	3	Timber	Worked wood	
70	6	3	Timber	Worked wood	
71	6	3	Timber	Worked wood	
72	6	3	Timber	Worked wood	
73	11	5	Timber	In-situ stake	
74	11	5	Timber	In-Situ stake	
75	11	5	Timber	In-situ stake	
76	11	5	Fill	Packing for [77]	
77	11	5	Timber	In-situ stake	
79	17	8	Fill	Fill of [80]	S6
80	17	8	Cut	Undefined cut	S6
81	15	6	Layer	Construction debris	S6
82	17	8	Masonry	Wall foundation	S6
83	17	8	Cut	Construction trench for [82]	S6
84	17	8	Fill	Fill of [85]	S6
85	16	7	Cut	Undefined cut	S6
86	15	6	Layer	Made ground	S6
87	17	8	Layer	Made ground	

Context No.	Sub-group	Period	Type	Description	Section
88	17	8	Layer	Made ground	S6
89	17	8	Masonry	Wall foundation	S6
90	17	8	Cut	Construction cut for [89]	S6
91	16	7	Fill	Fill of [92]	S6
92	16	7	Cut	Sewage pipe cut	S6
93	15	6	Layer	Sandy lens	S6
94	16	7	Masonry	Brick foundation	S6
95	16	7	Cut	Construction cut for [94]	S6
96	16	7	Fill	Fill of [97]	S6
97	16	7	Cut	Undefined cut	S6
98	16	7	Fill	Fill of [99]	S6
99	16	7	Cut	Sewage pipe cut	
100	17	8	Masonry	Wall foundation	S7
101	17	8	Masonry	Wall foundation	S7, S11
102	17	8	Layer	Made ground	S6
103	16	7	Masonry	Wall foundation	S6
104	16	7	Cut	Construction cut for [103]	S6
105	17	8	Cut	Construction cut for [100]	
106	17	8	Cut	Construction cut for [101]	S11
107	16	7	Layer	Made ground	S6
108	16	7	Masonry	Foundation	S6
109	16	7	Cut	Construction cut for [108]	S6
110	15	6	Layer	Demolition debris	S6
111	15	6	Layer	Made ground	S6
112	15	6	Layer	Made ground	S6
113	15	6	Fill	Fill of [115]	S14
114	15	6	Fill	Fill of [115]	S14
115	15	6	Cut	Pit	S10, S14
116	15	6	Layer	Made ground	S14
117	15	6	Fill	Fill of[119]	S14
118	15	6	Fill	Fill of [119]	S14
119	15	6	Cut	Pit	S14
120	14	6	Layer	Made ground	S14
121	15	6	Layer	Made ground	S14
122	15	6	Layer	Made ground	S14
123	15	6	Layer	Made ground	S14
124	14	6	Layer	Made ground	S14
125	14	6	Layer	Made ground	S14
126	14	6	Layer	Made ground	S14
127	14	6	Layer	Made ground	S14
128	14	6	Layer	Made ground	S14
129	14	6	Layer	Made ground	S14
130	14	6	Layer	Made ground	S14

Context No.	Sub-group	Period	Type	Description	Section
131	14	6	Layer	Made ground	S14, S18
132	15	6	Layer	Made ground	S14
133	15	6	Layer	Made ground	S14
134	15	6	Layer	Made ground	S14
135	15	6	Layer	Made ground	S14
136	14	6	Layer	Made ground	S14
137	15	6	Layer	Made ground	S14
138	15	6	Layer	Made ground	S14, S18
139	15	6	Layer	Made ground	S14
140	15	6	Layer	Made ground	S14
141	14	6	Layer	Made ground	S14
142	14	6	Layer	Made ground	S14
143	15	6	Layer	Made ground	S14
144	15	6	Layer	Made ground	S14
145	15	6	Layer	Demolition debris	S14
146	15	6	Layer	Made ground	S14
147	14	6	Cut	Pit	S14, S18
148	14	6	Fill	Fill of [153]	S14
149	14	6	Fill	Fill of [153]	S14
150	14	6	Fill	Fill of [153]	S14
151	14	6	Fill	Fill of [153]	S14
152	14	6	Fill	Fill of [153]	S14, S18
153	14	6	Cut	Pit	S14, S18
154	14	6	Fill	Fill of [157]	S14
155	14	6	Fill	Fill of [157]	S14
156	14	6	Fill	Fill of [157]	S14
157	14	6	Cut	Pit	S14
158	14	6	Layer	Made ground	S14
159	13	5	Layer	Alluvial clay	S14
160	9	5	Layer	Alluvial clay	S14
161	14	6	Layer	Made ground	S14
162	2	1	Layer	Gravel	S25
163	16	7	Masonry	Well	
164	6	3	Cut	Channel	S19, S23
165	14	6	Cut	Cut for [217]	S15, S19
167	14	6	Layer	Made ground	S17, S18
168	14	6	Layer	Made ground	S17 S18
169	13	5	Layer	Alluvial clay	S17 S18
170	6	3	Layer	Alluvial clay	S17 S18
171	14	6	Layer	Alluvial clay	S18
172	9	5	Layer	Alluvial clay	S18, S22
173	13	5	Layer	Alluvial clay	S18
174	6	3	Layer	Alluvial clay	S18
175	6	3	Layer	Alluvial clay	S18
176	6	3	Layer	Alluvial clay	S18
177	6	3	Layer	Alluvial clay	S22
178	6	3	Layer	Channel fill	S22, S23

Context No.	Sub-group	Period	Type	Description	Section
179	9	5	Cut	Channel	S22
181	6	3	Timber	Worked wood	
182	7	4	Layer	Channel deposit	S21, S22
183	6	3	Layer	Peat, silt and tufa	S21 S22
184	6	3	Layer	Alluvial clay	S22
185	2	1	Layer	Alluvial clay	S22
186	6	3	Layer	Gravel	S22
187	2	1	Layer	Sand	S22
188	14	6	Timber	Worked wood	S18
189	2	1	Layer	Silt deposit	S22
191	6	3	Layer	Tufa deposit	S21
192	6	3	Layer	Organic deposit	S19, S23
193	2	1	Layer	Buried land surface	S23
194	4	2	Layer	Weathered alluvium	S19, S23
195	2	1	Layer	Sand with roots	
196	2	1	Layer	Silt and clay deposit	S25
197	2	1	Layer	Channel deposit	S25, S26
198	2	1	Layer	Channel deposit	S25, S26
199	17	8	Layer	Made ground	S11
200	14	6	Layer	Made ground	S11
201	14	6	Layer	Made ground	S11
202	14	6	Layer	Made ground	S11, S15
203	14	6	Layer	Made ground	S11
204	14	6	Layer	Made ground	S11
205	16	7	Structure	Drain	S11
206	16	7	Cut	Construction cut for [205]	S11
207	13	5	Layer	Alluvial clay	S17
208	6	3	Layer	Organic alluvium	S17
209	6	3	Layer	Organic alluviu	S17
210	6	3	Layer	Channel deposit	S17
211	6	3	Fill	Fill of [212]	
212	6	3	Cut	Stake hole	
214	14	6	Layer	Made ground	S15
215	14	6	Layer	Made ground	S15
216	14	6	Layer	Made ground	S15
217	14	6	Fill	Fill of [165]	S15 S19
218	12	5	Layer	Alluvial clay	S15
219	5	3	Layer	Alluvial clay	S15 S19
220	6	3	Cut	Tree bowl	S19
221	2	1	Layer	Peaty silt	S26
222	2	1	Layer	Alluvial silt	S26
223	2	1	Layer	Alluvial silt	S26, S27
224	1	1	Layer	Terrace gravels	S26, S27
225	14	6	cut	Tree bowl	S15
226	14	6	Layer	Made ground	S15
227	14	6	Layer	Made ground	S15

Context No.	Sub-group	Period	Type	Description	Section
228	16	7	Fill	Fill of [229]	S6
229	16	7	Cut	Pit	S6
230	16	7	Fill	Fill of [229]	S6
231	17	8	Fill	Fill of [232]	S6
232	17	8	Cut	Pit	S6
233	17	8	Structure	Wall foundation	S6
234	17	8	Cut	Construction cut for [233]	S6
235	17	8	Structure	Wall foundation	S6
236	17	8	Cut	Construction trench for [235]	S6
237	17	8	Layer	Made ground	S6
238	15	6	Layer	Made ground	S6
239	15	6	Layer	Made ground	S6
240	15	6	Layer	Made ground	S6
241	15	6	Layer	Made ground	S6
242	15	6	Layer	Made ground	S6
243	17	8	Fill	Fill of [232]	S6
244	15	6	Layer	Made ground	S6
245	17	8	Layer	Made ground	S10
246	15	6	Layer	Made ground	S10
247	4	2		Alluvial clay	S6, S19
248	16	7		Wall foundation	S6
249	16	7		Construction trench for [248]	S6
250	16	7		Construction trench for [205]	S11
500	14	6	Layer	Made ground	S200
501	13	5	Layer	Humic layer	S200
502	13	5	Layer	Alluvial clay	S200, S201
503	11	5	Timber	In-situ stake	
504	11	5	Timber	In-situ stake	
505	11	5	Timber	In-situ stake	
506	2	1	Layer	Channel deposit	S205, S207
507	16	7	Fill	Fill of [516]	
510	16	7	Fill	Fill of [512]	
511	16	7	Structure	Brick-lined pit	
512	16	7	Cut	Cut for [511]	
513	16	7	Structure	Brick-lined drain	
514	16	7	Cut	Cut for [513]	
515	16	7	Fill	Fill of [513]	
516	16	7	Cut	Pit	
517	16	7	Timber	Plank	
518	16	7	Fill	Fill of [519]	
519	16	7	Cut	Pit	
520	16	7	Fill	Fill of [521]	
521	16	7	Structure	Brick-lined pit	
522	16	7		Cut for [521]	

Context No.	Sub-group	Period	Type	Description	Section
523	14	6	Layer	Made ground	S201
524	5	3	Layer	Alluvial clay	S205
526	9	5	Layer	Alluvial clay	S201, S204, S205
527	16	7	Structure	Brick pier base	
528	16	7	Structure	Brick pier base	
529	16	7	Structure	Brick pier base	
530	14	6	Layer	Made ground	S201
532	8	4	Layer	Alluvial clay	S203, S204
533	6	3	Layer	Organic deposit	S200
534	13	5	Fill	Fill of [535]	
535	13	5	Cut	Tree bowl	
536	10	5	Cut	Gully	
537	9	5	Layer	Organic deposit	S201, S204
538	10	5	Fill	Fill of [536]	
539	13	5	Timber	Stake	
540	9	5	Timber	Worked wood	
541	9	5	Timber	Worked wood	
544	9	5	Timber	Worked wood	
545	9	5	Timber	Worked wood	
546	9	5	Timber	Worked wood	
548	9	5	Timber	Worked wood	
549	9	5	Timber	Worked wood	
550	9	5	Timber	Worked wood	
551	9	5	Timber	Worked wood	
552	9	5	Timber	Worked wood	
553	9	5	Timber	Worked wood	
554	9	5	Timber	Worked wood	
555	9	5	Timber	Worked wood	
556	9	5	Timber	Worked wood	
557	9	5	Timber	Worked wood	
558	9	5	Timber	Worked wood	
559	9	5	Timber	Worked wood	
560	9	5	Timber	Worked wood	
561	9	5	Timber	Worked wood	
562	6	3	Layer	Alluvial clay	S202, S203, S204
563	9	5	Cut	Erosional cut	S201, S204, S205
564	7	4	Layer	Clay with sand	S202, S204
565	7	4	Timber	Worked wood	
566	7	4	Timber	Worked wood	
567	7	4	Timber	Worked wood	
568	7	4	Timber	Worked wood	
569	7	4	Layer	Sand with clay	S202, S204
570	6	3	Layer	Tufa	
571	7	4	Timber	Worked wood	
572	7	4	Layer	Channel deposit	S203, S204

Context No.	Sub-group	Period	Type	Description	Section
573	7	4	Timber	Worked wood	
574	6	3	Layer	Channel deposit	S202, S205, S206
577	6	3	Timber	Worked wood	
578	6	3	Timber	Worked wood	
579	6	3	Timber	Worked wood	
580	3	2	Layer	Channel deposit	S205, S207
581	6	3	Timber	Worked wood	
583	4	2	Layer	Alluvial clay	S205
585	3	2	Layer	Channel deposit	S206
591	2	1	Layer	Channel deposit	S205
592	2	1	Layer	Sand	S205
593	2	1	Layer	Laminates of sand and clay	S205
595	2	1	Layer	Alluvial clay	S205
596	3	2	Layer	Peat	S205, S206, S207
600	7	4	Cut	Erosional cut	S202
601	2	1	Layer	Channel deposit	S207
602	3	2	Cut	Erosional cut	S205
603	1	1	Layer	Terrace gravels	S207

13 Appendix 2: Context index by period

Period	Sub-group	Context No.	Section	Type	Description
1	1	63	S23	Layer	Terrace gravels
1	1	224	S26, S27	Layer	Terrace gravels
1	1	603	S207	Layer	Terrace gravels
1	2	56		Layer	Alluvial clay
1	2	57		Layer	Alluvial clay
1	2	59		Layer	Channel fill
1	2	60	S22	Layer	Sand bank
1	2	61	S22	Layer	Alluvial clay
1	2	62		Layer	Channel cut/bank
1	2	64		Layer	Sandy channel deposit
1	2	65		Layer	Channel deposit
1	2	162	S25	Layer	Gravel
1	2	185	S22	Layer	Alluvial clay
1	2	187	S22	Layer	Sand
1	2	189	S22	Layer	Silt deposit
1	2	193	S23	Layer	Buried land surface
1	2	195		Layer	Sand with roots
1	2	196	S25	Layer	Silt and clay deposit
1	2	197	S25, S26	Layer	Channel deposit
1	2	198	S25, S26	Layer	Channel deposit
1	2	221	S26	Layer	Peaty silt
1	2	222	S26	Layer	Alluvial silt
1	2	223	S26, S27	Layer	Alluvial silt
1	2	506	S205, S207	Layer	Channel deposit
1	2	591	S205	Layer	Channel deposit
1	2	592	S205	Layer	Sand
1	2	593	S205	Layer	Laminates of sand and clay
1	2	595	S205	Layer	Alluvial clay
1	2	601	S207	Layer	Channel deposit
2	3	580	S205, S207	Layer	Channel deposit
2	3	585	S206	Layer	Channel deposit
2	3	596	S205, S206, S207	Layer	Peat
2	3	602	S205	Cut	Erosional cut
2	4	194	S19, S23	Layer	Weathered alluvium
2	4	247	S6, S19		Alluvial clay
2	4	583	S205	Layer	Alluvial clay
3	5	219	S15 S19	Layer	Alluvial clay

Period	Sub-group	Context No.	Section	Type	Description
3	5	524	S205	Layer	Alluvial clay
3	6	55	S22	Layer	Gravel
3	6	58		Layer	Alluvial clay
3	6	66		Timber	Worked wood
3	6	68		Timber	Worked wood
3	6	69		Timber	Worked wood
3	6	70		Timber	Worked wood
3	6	71		Timber	Worked wood
3	6	72		Timber	Worked wood
3	6	164	S19, S23	Cut	Channel
3	6	170	S17 S18	Layer	Alluvial clay
3	6	174	S18	Layer	Alluvial clay
3	6	175	S18	Layer	Alluvial clay
3	6	176	S18	Layer	Alluvial clay
3	6	177	S22	Layer	Alluvial clay
3	6	178	S22, S23	Layer	Channel fill
3	6	181		Timber	Worked wood
3	6	183	S21 S22	Layer	Peat, silt and tufa
3	6	184	S22	Layer	Alluvial clay
3	6	186	S22	Layer	Gravel
3	6	191	S21	Layer	Tufa deposit
3	6	192	S19, S23	Layer	Organic deposit
3	6	208	S17	Layer	Organic alluvium
3	6	209	S17	Layer	Organic alluviu
3	6	210	S17	Layer	Channel deposit
3	6	211		Fill	Fill of [212]
3	6	212		Cut	Stake hole
3	6	220	S19	Cut	Tree bowl
3	6	533	S200	Layer	Organic deposit
3	6	562	S202, S203, S204	Layer	Alluvial clay
3	6	570		Layer	Tufa
3	6	574	S202, S205, S206	Layer	Channel deposit
3	6	577		Timber	Worked wood
3	6	578		Timber	Worked wood
3	6	579		Timber	Worked wood
3	6	581		Timber	Worked wood
4	7	182	S21, S22	Layer	Channel deposit
4	7	564	S202, S204	Layer	Clay with sand
4	7	565		Timber	Worked wood
4	7	566		Timber	Worked wood
4	7	567		Timber	Worked wood
4	7	568		Timber	Worked wood

Period	Sub-group	Context No.	Section	Type	Description
4	7	569	S202, S204	Layer	Sand with clay
4	7	571		Timber	Worked wood
4	7	572	S203, S204	Layer	Channel deposit
4	7	573		Timber	Worked wood
4	7	600	S202	Cut	Erosional cut
4	8	532	S203, S204	Layer	Alluvial clay
5	9	160	S14	Layer	Alluvial clay
5	9	172	S18, S22	Layer	Alluvial clay
5	9	179	S22	Cut	Channel
5	9	526	S201, S204, S205	Layer	Alluvial clay
5	9	537	S201, S204	Layer	Organic deposit
5	9	540		Timber	Worked wood
5	9	541		Timber	Worked wood
5	9	544		Timber	Worked wood
5	9	545		Timber	Worked wood
5	9	546		Timber	Worked wood
5	9	548		Timber	Worked wood
5	9	549		Timber	Worked wood
5	9	550		Timber	Worked wood
5	9	551		Timber	Worked wood
5	9	552		Timber	Worked wood
5	9	553		Timber	Worked wood
5	9	554		Timber	Worked wood
5	9	555		Timber	Worked wood
5	9	556		Timber	Worked wood
5	9	557		Timber	Worked wood
5	9	558		Timber	Worked wood
5	9	559		Timber	Worked wood
5	9	560		Timber	Worked wood
5	9	561		Timber	Worked wood
5	9	563	S201, S204, S205	Cut	Erosional cut
5	10	536		Cut	Gully
5	10	538		Fill	Fill of [536]
5	11	73		Timber	In-situ stake
5	11	74		Timber	In-Situ stake
5	11	75		Timber	In-situ stake
5	11	76		Fill	Packing for [77]
5	11	77		Timber	In-situ stake
5	11	503		Timber	In-situ stake
5	11	504		Timber	In-situ stake
5	11	505		Timber	In-situ stake

Period	Sub-group	Context No.	Section	Type	Description
5	12	218	S15	Layer	Alluvial clay
5	13	159	S14	Layer	Alluvial clay
5	13	169	S17 S18	Layer	Alluvial clay
5	13	173	S18	Layer	Alluvial clay
5	13	207	S17	Layer	Alluvial clay
5	13	501	S200	Layer	Humic layer
5	13	502	S200, S201	Layer	Alluvial clay
5	13	534		Fill	Fill of [535]
5	13	535		Cut	Tree bowl
5	13	539		Timber	Stake
6	14	53	S10	Layer	Made ground
6	14	120	S14	Layer	Made ground
6	14	124	S14	Layer	Made ground
6	14	125	S14	Layer	Made ground
6	14	126	S14	Layer	Made ground
6	14	127	S14	Layer	Made ground
6	14	128	S14	Layer	Made ground
6	14	129	S14	Layer	Made ground
6	14	130	S14	Layer	Made ground
6	14	131	S14, S18	Layer	Made ground
6	14	136	S14	Layer	Made ground
6	14	141	S14	Layer	Made ground
6	14	142	S14	Layer	Made ground
6	14	147	S14, S18	Cut	Pit
6	14	148	S14	Fill	Fill of [153]
6	14	149	S14	Fill	Fill of [153]
6	14	150	S14	Fill	Fill of [153]
6	14	151	S14	Fill	Fill of [153]
6	14	152	S14, S18	Fill	Fill of [153]
6	14	153	S14, S18	Cut	Pit
6	14	154	S14	Fill	Fill of [157]
6	14	155	S14	Fill	Fill of [157]
6	14	156	S14	Fill	Fill of [157]
6	14	157	S14	Cut	Pit
6	14	158	S14	Layer	Made ground
6	14	161	S14	Layer	Made ground
6	14	165	S15, S19	Cut	Cut for [217]
6	14	167	S17, S18	Layer	Made ground
6	14	168	S17 S18	Layer	Made ground
6	14	171	S18	Layer	Alluvial clay
6	14	188	S18	Timber	Worked wood
6	14	200	S11	Layer	Made ground
6	14	201	S11	Layer	Made ground
6	14	202	S11, S15	Layer	Made ground
6	14	203	S11	Layer	Made ground
6	14	204	S11	Layer	Made ground

Period	Sub-group	Context No.	Section	Type	Description
6	14	214	S15	Layer	Made ground
6	14	215	S15	Layer	Made ground
6	14	216	S15	Layer	Made ground
6	14	217	S15 S19	Fill	Fill of [165]
6	14	225	S15	cut	Tree bowl
6	14	226	S15	Layer	Made ground
6	14	227	S15	Layer	Made ground
6	14	500	S200	Layer	Made ground
6	14	523	S201	Layer	Made ground
6	14	530	S201	Layer	Made ground
6	15	2	S10	Layer	Made ground
6	15	3	S10	Layer	Made ground
6	15	4	S10	Layer	Made ground
6	15	5	S10	Layer	Made ground
6	15	6	S10	Layer	Made ground
6	15	7	S10	Layer	Made ground
6	15	12	S6	Layer	Made ground
6	15	18	S10	Layer	Made ground
6	15	19	S10	Layer	Made ground
6	15	20	S10	Layer	Made ground
6	15	21	S10	Layer	Made ground
6	15	22	S10	Layer	Made ground
6	15	23	S10	Layer	Made ground
6	15	24	S10	Layer	Made ground
6	15	25	S10	Layer	Made ground
6	15	31	S10	Layer	Made ground
6	15	32	S10	Layer	Made ground
6	15	33	S10	Layer	Made ground
6	15	37	S10	Layer	Made ground
6	15	38	S10	Layer	Made ground
6	15	39	S10, S14	Layer	Made ground
6	15	40	S10, S14	Layer	Alluvial clay
6	15	41	S10	Layer	Made ground
6	15	46	S10	Layer	Made ground
6	15	47	S10	Layer	Made ground
6	15	48	S10	Layer	Made ground
6	15	49	S10	Layer	Made ground
6	15	50	S10	Layer	Made ground
6	15	51	S10	Cut	Undefined cut
6	15	52	S10	Fill	Fill of [51]
6	15	81	S6	Layer	Construction debris
6	15	86	S6	Layer	Made ground
6	15	93	S6	Layer	Sandy lens
6	15	110	S6	Layer	Demolition debris
6	15	111	S6	Layer	Made ground
6	15	112	S6	Layer	Made ground
6	15	113	S14	Fill	Fill of [115]

Period	Sub-group	Context No.	Section	Type	Description
6	15	114	S14	Fill	Fill of [115]
6	15	115	S10, S14	Cut	Pit
6	15	116	S14	Layer	Made ground
6	15	117	S14	Fill	Fill of[119]
6	15	118	S14	Fill	Fill of [119]
6	15	119	S14	Cut	Pit
6	15	121	S14	Layer	Made ground
6	15	122	S14	Layer	Made ground
6	15	123	S14	Layer	Made ground
6	15	132	S14	Layer	Made ground
6	15	133	S14	Layer	Made ground
6	15	134	S14	Layer	Made ground
6	15	135	S14	Layer	Made ground
6	15	137	S14	Layer	Made ground
6	15	138	S14, S18	Layer	Made ground
6	15	139	S14	Layer	Made ground
6	15	140	S14	Layer	Made ground
6	15	143	S14	Layer	Made ground
6	15	144	S14	Layer	Made ground
6	15	145	S14	Layer	Demolition debris
6	15	146	S14	Layer	Made ground
6	15	238	S6	Layer	Made ground
6	15	239	S6	Layer	Made ground
6	15	240	S6	Layer	Made ground
6	15	241	S6	Layer	Made ground
6	15	242	S6	Layer	Made ground
6	15	244	S6	Layer	Made ground
6	15	246	S10	Layer	Made ground
7	16	8	S6, S10	Fill	Fill of [9]
7	16	9	S6, S10	Timber	Timber-lined pit
7	16	10	S10	Fill	Fill of [11]
7	16	11	S10	Cut	Irregular small pit
7	16	14	S10	Structure	Well
7	16	15	S10	Fill	Backfill of well [17]
7	16	16	S10	Structure	brick-lined well
7	16	17	S10	Structure	Well
7	16	26	S10	Fill	Fill of [29]
7	16	27	6, S10	Masonry	Brick wall
7	16	28	S10	Timber	Base for wall [27]
7	16	29	S10	Cut	Construction cut for [27]
7	16	30	S10	Layer	Made ground
7	16	42	S10	Structure	Culvert pipe
7	16	43	S10	Cut	Construction trench for [42]
7	16	85	S6	Cut	Undefined cut
7	16	91	S6	Fill	Fill of [92]
7	16	92	S6	Cut	Sewage pipe cut

Period	Sub-group	Context No.	Section	Type	Description
7	16	94	S6	Masonry	Brick foundation
7	16	95	S6	Cut	Construction cut for [94]
7	16	96	S6	Fill	Fill of [97]
7	16	97	S6	Cut	Undefined cut
7	16	98	S6	Fill	Fill of [99]
7	16	99		Cut	Sewage pipe cut
7	16	103	S6	Masonry	Wall foundation
7	16	104	S6	Cut	Construction cut for [103]
7	16	107	S6	Layer	Made ground
7	16	108	S6	Masonry	Foundation
7	16	109	S6	Cut	Construction cut for [108]
7	16	163		Masonry	Well
7	16	205	S11	Structure	Drain
7	16	206	S11	Cut	Construction cut for [205]
7	16	228	S6	Fill	Fill of [229]
7	16	229	S6	Cut	Pit
7	16	230	S6	Fill	Fill of [229]
7	16	248	S6		Wall foundation
7	16	249	S6		Construction trench for [248]
7	16	250	S11		Construction trench for [205]
7	16	507		Fill	Fill of [516]
7	16	510		Fill	Fill of [512]
7	16	511		Structure	Brick-lined pit
7	16	512		Cut	Cut for [511]
7	16	513		Structure	Brick-lined drain
7	16	514		Cut	Cut for [513]
7	16	515		Fill	Fill of [513]
7	16	516		Cut	Pit
7	16	517		Timber	Plank
7	16	518		Fill	Fill of [519]
7	16	519		Cut	Pit
7	16	520		Fill	Fill of [521]
7	16	521		Structure	Brick-lined pit
7	16	522			Cut for [521]
7	16	527		Structure	Brick pier base
7	16	528		Structure	Brick pier base
7	16	529		Structure	Brick pier base
8	17	1	S6	Layer	Made ground
8	17	13	S10	Structure	Concrete drain
8	17	34	S10	Layer	Made ground
8	17	35	S10	Layer	Made ground
8	17	36	S10	Layer	Made ground

Period	Sub-group	Context No.	Section	Type	Description
8	17	44	S10	Masonry	Foundation
8	17	45	S10	Cut	Construction cut for [44]
8	17	54	S10	Layer	Made ground
8	17	79	S6	Fill	Fill of [80]
8	17	80	S6	Cut	Undefined cut
8	17	82	S6	Masonry	Wall foundation
8	17	83	S6	Cut	Construction trench for [82]
8	17	84	S6	Fill	Fill of [85]
8	17	87		Layer	Made ground
8	17	88	S6	Layer	Made ground
8	17	89	S6	Masonry	Wall foundation
8	17	90	S6	Cut	Construction cut for [89]
8	17	100	S7	Masonry	Wall foundation
8	17	101	S7, S11	Masonry	Wall foundation
8	17	102	S6	Layer	Made ground
8	17	105		Cut	Construction cut for [100]
8	17	106	S11	Cut	Construction cut for [101]
8	17	199	S11	Layer	Made ground
8	17	231	S6	Fill	Fill of [232]
8	17	232	S6	Cut	Pit
8	17	233	S6	Structure	Wall foundation
8	17	234	S6	Cut	Construction cut for [233]
8	17	235	S6	Structure	Wall foundation
8	17	236	S6	Cut	Construction trench for [235]
8	17	237	S6	Layer	Made ground
8	17	243	S6	Fill	Fill of [232]
8	17	245	S10	Layer	Made ground

14 Appendix 3: Report on optical dating of sediments

University of Gloucestershire

Geochronology Laboratories

Optical dating of sediments within the Livingstone Road excavations

to

G. Spurr, Museum of London Archaeological Service

Prepared by Dr P.S. Toms, 14th November 2008

Contents

Field Code	Lab Code	Location	Overburden (m)	Grain size (µm)	Moisture content	NaI γ-spectrometry (in situ)			γ D_r (Gy.ka^{-1})	Ge γ-spectrometry (lab based)			α D_r (Gy.ka^{-1})	β D_r (Gy.ka^{-1})	Cosmic D_r (Gy.ka^{-1})	Total D_r (Gy.ka^{-1})	Preheat (°C for 10s)	D_e (Gy)	Age (ka)
						K (%)	Th (ppm)	U (ppm)		K (%)	Th (ppm)	U (ppm)							
PDZ12.01/103	GL08007	52°N, 0°W, 6m	2.9	18-250	0.17 ± 0.04	0.26 ± 0.01	1.49 ± 0.11	0.80 ± 0.07	0.23 ± 0.01	0.31 ± 0.02	1.68 ± 0.30	0.50 ± 0.06	-	0.25 ± 0.03	0.13 ± 0.01	0.61 ± 0.03	240	8.3 ± 0.4	13.7 ± 1.0 (0.8)
PDZ12.01/104	GL08008	52°N, 0°W, 6m	2.8	125-180	0.23 ± 0.06	0.79 ± 0.02	3.40 ± 0.15	1.92 ± 0.11	0.57 ± 0.02	1.24 ± 0.06	5.37 ± 0.42	1.25 ± 0.08	-	0.87 ± 0.10	0.13 ± 0.01	1.57 ± 0.11	240	21.8 ± 0.8	13.9 ± 1.1 (0.8)
PDZ12.01/105	GL08009	52°N, 0°W, 6m	2.6	125-180	0.21 ± 0.05	0.57 ± 0.02	2.99 ± 0.14	1.72 ± 0.10	0.48 ± 0.02	1.25 ± 0.06	6.10 ± 0.46	1.61 ± 0.09	-	0.95 ± 0.10	0.14 ± 0.01	1.56 ± 0.11	240	19.7 ± 0.9	12.6 ± 1.0 (0.8)
PDZ12.01/106	GL08010	52°N, 0°W, 6m	1.4	125-180	0.22 ± 0.16	0.64 ± 0.02	4.78 ± 0.18	2.31 ± 0.18	0.64 ± 0.03	1.01 ± 0.05	6.95 ± 0.53	1.50 ± 0.09	-	0.81 ± 0.09	0.16 ± 0.02	1.62 ± 0.10	240	5.4 ± 0.2	3.3 ± 0.2 (0.2)
PDZ12.01/107	GL08011	52°N, 0°W, 6m	0.9	125-180	0.16 ± 0.04	0.62 ± 0.02	4.33 ± 0.19	2.10 ± 0.13	0.59 ± 0.02	0.91 ± 0.05	5.34 ± 0.41	1.15 ± 0.08	-	0.76 ± 0.07	0.18 ± 0.02	1.54 ± 0.08	220	5.2 ± 0.4	3.4 ± 0.3 (0.3)
PDZ12.01/108	GL08012	52°N, 0°W, 6m	1.7	125-180	0.35 ± 0.09	0.86 ± 0.02	5.44 ± 0.20	2.20 ± 0.13	0.72 ± 0.03	1.43 ± 0.07	10.77 ± 0.61	1.57 ± 0.09	-	0.90 ± 0.14	0.16 ± 0.01	1.77 ± 0.14	260	10.6 ± 0.5	6.0 ± 0.6 (0.5)

Table 1 D_r, D_e and Age data of submitted samples. Uncertainties in age are quoted at 1σ confidence, are based on analytical errors and reflect combined systematic and experimental variability and (in parenthesis) experimental variability alone (see 6.0). Blue indicates samples with accepted age estimates, red, age estimates with caveats (see Table 2).

Generic considerations	Field Code	Lab Code	Sample specific considerations
None Pedoturbation effects? (see 3.2.2)	PDZ12.01/103	GL08007	Accept
	PDZ12.01/104	GL08008	Accept
	PDZ12.01/105	GL08009	Overdispersion of regenerative-dose data; accept tentatively (see 3.1.4)
	PDZ12.01/106	GL08010	Overdispersion of regenerative-dose data; accept tentatively (see 3.1.4)
	PDZ12.01/107	GL08011	Overdispersion of regenerative-dose data; accept tentatively (see 3.1.4)
	PDZ12.01/108	GL08012	Insufficient sample mass for all diagnostics; accept tentatively (see p.17)

Table 2 Validity of sample suite age estimates and caveats for consideration

1.0 Mechanisms and principles

Upon exposure to ionising radiation, electrons within the crystal lattice of insulating minerals are displaced from their atomic orbits. Whilst this dislocation is momentary for most electrons, a portion of charge is redistributed to meta-stable sites (traps) within the crystal lattice. In the absence of significant optical and thermal stimuli, this charge can be stored for extensive periods. The quantity of charge relocation and storage relates to the magnitude and period of irradiation. When the lattice is optically or thermally stimulated, charge is evicted from traps and may return to a vacant orbit position (hole). Upon recombination with a hole, an electron's energy can be dissipated in the form of light generating crystal luminescence providing a measure of dose absorption.

Herein, quartz is segregated for dating. The utility of this minerogenic dosimeter lies in the stability of its datable signal over the mid to late Quaternary period, predicted through isothermal decay studies (e.g. Smith *et al.*, 1990; retention lifetime 630 Ma at 20°C) and evidenced by optical age estimates concordant with independent chronological controls (e.g. Murray and Olley, 2002). This stability is in contrast to the anomalous fading of comparable signals commonly observed for other ubiquitous sedimentary minerals such as feldspar and zircon (Wintle, 1973; Templer, 1985; Spooner, 1993)

Optical age estimates of sedimentation (Huntley *et al.*, 1985) are premised upon reduction of the minerogenic time dependent signal (Optically Stimulated Luminescence, OSL) to zero through exposure to sunlight and, once buried, signal reformulation by absorption of litho- and cosmogenic radiation. The signal accumulated post burial acts as a dosimeter recording total dose absorption, converting to a chronometer by estimating the rate of dose absorption quantified through the assay of radioactivity in the surrounding lithology and streaming from the cosmos.

$$\text{Age} = \frac{\text{Mean Equivalent Dose } (D_e, \text{ Gy})}{\text{Mean Dose Rate } (D_r, \text{ Gy.ka}^{-1})}$$

Aitken (1998) and Bøtter-Jensen et al. (2003) offer a detailed review of optical dating.

2.0 Sample Collection and Preparation

Six conventional sediment samples – those located within matrix-supported units composed predominantly of sand and silt – were collected in daylight from sections by means of opaque plastic tubing (150x45 mm) forced into each face. Each sample was wrapped in cellophane and parcel tape in order to preserve moisture content and integrity until ready for laboratory preparation. For each sample, an additional c 100 g of sediment was collected for laboratory-based assessment of radioactive disequilibrium.

To preclude optical erosion of the datable signal prior to measurement, all samples are prepared under controlled laboratory illumination provided by Encapsulite RB-10 (red) filters. To isolate that material potentially exposed to daylight during sampling, sediment located within 20 mm of each tube-end is removed.

The remaining sample is dried and then sieved. Depending upon each samples modal grain size, quartz within the fine sand (63-90 μm, 90-125 μm, 125-180 μm) or fine silt (5-15 μm) fraction is then segregated (Table 1). Samples are subjected to acid and alkaline digestion (10% HCl, 15% H_2O_2) to attain removal of carbonate and organic components respectively.

For fine sand fractions, a further acid digestion in HF (40%, 60 mins) is used to etch the outer 10-15 μm layer affected by α radiation and degrade each samples' feldspar content. During HF treatment, continuous magnetic stirring is used to effect isotropic etching of grains. 10% HCl is then added to remove acid soluble fluorides. Each sample is dried, resieved and quartz isolated from the remaining heavy mineral fraction using a sodium polytungstate density separation at 2.68g.cm^{-3}. 12 multi-grain aliquots (*c.* 3-6 mg) of quartz from each sample are then mounted on aluminium discs for determination of D_e values.

Fine silt sized quartz, along with other mineral grains of varying density and size, is extracted by sample sedimentation in acetone (<15 μm in 2 min 20 s, >5 μm in 21 mins at 20°C). Feldspars and amorphous silica are then removed from this fraction through acid digestion (35% H_2SiF_6 for 2 weeks, Jackson *et al.*, 1976; Berger *et al.*, 1980). Following addition of 10% HCl to remove acid soluble fluorides, grains degraded to <5 μm as a result of acid treatment are removed by acetone sedimentation. 6 aliquots (ca. 1.5 mg) are then mounted on aluminium discs for D_e evaluation.

All drying is conducted at 40°C to prevent thermal erosion of the signal. All acids and alkalis are Analar grade. All dilutions (removing toxic-corrosive and non-minerogenic luminescence-bearing substances) are conducted with distilled water to prevent signal contamination by extraneous particles.

3.0 Acquisition and accuracy of D_e value

All minerals naturally exhibit marked inter-sample variability in luminescence per unit dose (sensitivity). Therefore, the estimation of D_e acquired since burial requires calibration of the natural signal using known amounts of laboratory dose. D_e values are quantified using a single-aliquot regenerative-dose (SAR) protocol (Murray and Wintle 2000; 2003) facilitated by a Risø TL-DA-15 irradiation-stimulation-detection system (Markey *et al.*, 1997; Bøtter-Jensen *et al.*, 1999). Within this apparatus, optical signal stimulation is provided by an assembly of blue diodes (5 packs of 6 Nichia NSPB500S), filtered to 470±80 nm conveying 15 mW.cm^{-2} using a 3 mm Schott GG420 positioned in front of each diode pack. Infrared (IR) stimulation, provided by 6 IR diodes (Telefunken TSHA 6203) stimulating at 875±80nm delivering ~5 mW.cm^{-2}, is used to indicate the presence of contaminant feldspars (Hütt *et al.*, 1988). Stimulated photon emissions from quartz aliquots are in the ultraviolet (UV) range and are filtered from stimulating photons by 7.5 mm HOYA U-340 glass and detected by an EMI 9235QA photomultiplier fitted with a blue-green sensitive bialkali photocathode. Aliquot irradiation is conducted using a 1.48 GBq $^{90}Sr/^{90}Y$ β source calibrated for multi-grain aliquots of each isolated quartz fraction against the 'Hotspot 800' ^{60}Co γ source located at the National Physical Laboratory (NPL), UK.

SAR by definition evaluates D_e through measuring the natural signal (Fig. 1) of a single aliquot and then regenerating that aliquot's signal by using known laboratory doses to enable calibration. For each aliquot, 5 different regenerative-doses are administered so as to image dose response. D_e values for each aliquot are then interpolated, and associated counting and fitting errors calculated, by way of linear or exponential regression (Fig. 1). Weighted (geometric) mean D_e values are calculated, given sufficient mass, from 12 aliquots using the central age model outlined by Galbraith *et al.* (1999) and are quoted at 1σ confidence. The accuracy with which D_e equates to total absorbed dose and that dose absorbed since burial is assessed. The former can be considered a function of laboratory factors, the latter, one of environmental issues. Diagnostics are deployed to estimate the influence of these factors and criteria instituted to optimise the accuracy of D_e values.

3.1 Laboratory Factors

3.1.1 Feldspar contamination

The propensity of feldspar signals to fade and underestimate age, coupled with their higher sensitivity relative to quartz makes it imperative to quantify feldspar contamination. At room temperature, feldspars generate a signal (IRSL) upon exposure to IR whereas quartz does not. The signal from feldspars contributing to OSL can be depleted by prior exposure to IR. For all aliquots the contribution of any remaining feldspars was estimated from the OSL IR depletion ratio

(Duller, 2003). If the addition to OSL by feldspars is insignificant, then the repeat dose ratio of OSL to post-IR OSL should be statistically consistent with unity (Fig. 2). Any aliquots that did not fulfil this criterion were rejected. The source of feldspar contamination is rarely routed in sample preparation; it predominantly results from the occurrence of feldspars as inclusions within quartz.

3.1.2 Preheating

Preheating aliquots between irradiation and optical stimulation is necessary to ensure comparability between natural and laboratory-induced signals. However, the multiple irradiation and preheating steps that are required to define single-aliquot regenerative-dose response leads to signal sensitisation, rendering calibration of the natural signal inaccurate. The SAR protocol (Murray and Wintle, 2000; 2003) enables this sensitisation to be monitored and corrected using a test dose, here set at 5 Gy preheated to 220°C for 10s, to track signal sensitivity between irradiation-preheat steps. However, the accuracy of sensitisation correction for both natural and laboratory signals can be preheat dependent. Three diagnostics are used to assess the optimal preheat temperature for accurate correction and calibration.

Irradiation-preheat cycling (Fig. 2) quantifies the preheat dependence of sensitisation correction for laboratory-induced signals. If sensitisation is accurately corrected, then the same regenerative-dose should yield an equivalent sensitivity corrected value irrespective of the number of times it is applied and its associated signal measured. The ratio of subsequent to initial corrected regenerative-dose signals should be statistically concordant with unity. Alternatively, this ratio may differ from unity yet attain consistency after one or more cycles evidencing accurate sensitivity correction exists if the sample is primed by irradiation-preheat cycles. For this diagnostic, 18 aliquots are divided into sets of 3 and assigned a 10 s preheat between 180°C and 280°C.

D_e preheat dependence (Fig. 3) quantifies the combined effects of thermal transfer and sensitisation on the natural signal. Insignificant adjustment in D_e values in response to differing preheats may reflect limited influence of these effects. Samples generating D_e values <10Gy and exhibiting a systematic, statistically significant adjustment in D_e value with increasing preheat temperature may indicate the presence of significant thermal transfer; in such instances low temperature (<220°C) preheats provide the apposite measure of D_e. For this diagnostic, the D_e value of each of the same 18 aliquots and their assigned preheat is assessed.

Dose Recovery (Fig. 4) attempts to replicate the above diagnostic, yet provide improved resolution of thermal effects through removal of variability induced by heterogeneous dose absorption in the environment, using a precise lab dose to simulate natural dose. The ratio between the applied dose and recovered D_e value should be statistically concordant with unity. For this diagnostic, a further 6 aliquots are each assigned a 10 s preheat between 180°C and 280°C.

That preheat treatment fulfilling the criterion of accuracy for all three diagnostics is selected to refine the final D_e value from a further 9 aliquots. Further thermal treatments, prescribed by Murray and Wintle (2000; 2003), are applied to optimise accuracy and precision. Optical stimulation occurs at 125ºC in order to minimise effects associated with photo-transferred thermoluminescence and maximise signal to noise ratios. Inter-cycle optical stimulation is conducted at 280°C to minimise recuperation.

3.1.3 Irradiation

For all samples having D_e values in excess of 100 Gy, matters of signal saturation and laboratory irradiation effects are of concern. With regards the former, the rate of signal accumulation generally adheres to a saturating exponential form and it is this that limits the precision and accuracy of D_e values for samples having absorbed large doses. For such samples, the functional range of D_e interpolation is defined from log-linear plots of dose response (Fig. 1). Within these plots, the maximum D_e value is delimited by the cessation of statistically significant increases in signal response.

Laboratory irradiation effects may evolve from the contrasting rates of natural dose exposure and the calibrating laboratory dose, the latter delivered to each aliquot at 9 orders of magnitude faster than the former. Bailey (2004) has suggested that for doses in excess of ~40 Gy an overestimation of age may arise due to competing mechanisms of signal accumulation within the crystal lattice of quartz. Bailey (2004) suggests this effect can be countered by using pulsed irradiation-preheats (10 Gy, 240°C cycles) rather than single large doses. Dose response to this revised irradiation procedure is quantified for all samples having D_e >40 Gy (Fig. 1). Where pulsed irradiation D_e values are significantly less than those generated from continuous irradiation, the mean D_e generated from the former is used to define age.

3.1.4 Internal consistency

Quasi-radial plots (Fig. 5; *cf* Galbraith, 1990) are used to illustrate inter-aliquot D_e variability for natural and regenerated signals. D_e values are standardised relative to the central D_e value for natural signals and applied dose for regenerated signals. D_e values are described as overdispersed when >5% lie beyond $\pm 2\sigma$ of the standardising value; resulting from a heterogeneous absorption of burial dose and/or response to the SAR protocol. For multi-grain aliquots, overdispersion for natural signals does not necessarily imply inaccuracy. However where overdispersion is observed for regenerated signals, the age estimate from that sample should be accepted tentatively.

3.2 Environmental factors

3.2.1 Incomplete zeroing

Post-burial OSL signals residual of pre-burial dose absorption can result where pre-burial sunlight exposure is limited in spectrum, intensity and/or period, leading to age overestimation. This effect is particularly acute for material eroded and redeposited sub-aqueously (Olley *et al.*, 1998, 1999; Wallinga, 2002) and exposed to a burial dose of <20 Gy (e.g. Olley *et al.*, 2004), has some influence in sub-aerial contexts but is rarely of consequence where aerial transport has occurred.

Within single-aliquot regenerative-dose optical dating there are two diagnostics of partial resetting (or bleaching); signal analysis (Agersnap-Larsen *et al.*, 2000; Bailey *et al.*, 2003) and inter-aliquot D_e distribution studies (Murray *et al.*, 1995).

Within this study, signal analysis is used to quantify the change in D_e value with respect to optical stimulation time for multi-grain aliquots. This exploits the existence of traps within minerogenic dosimeters that bleach with different efficiency for a given wavelength of light to verify partial bleaching. D_e (t) plots (Fig. 6; Bailey *et al.*, 2003) are constructed from separate integrals of signal decay as laboratory optical stimulation progresses. A statistically significant increase in natural D_e (t) is indicative of partial bleaching assuming three conditions are fulfilled. Firstly, that a statistically significant increase in D_e (t) is observed when partial bleaching is simulated within the laboratory. Secondly, that there is no significant rise in D_e (t) when full bleaching is simulated. Finally, there should be no significant augmentation in D_e (t) when zero dose is simulated. Where partial bleaching is detected, the age derived from the sample should be considered a maximum estimate only. However, the utility of signal analysis is strongly dependent upon a samples pre-burial experience of sunlight's spectrum and its residual to post-burial signal ratio. Given in the majority of cases, the spectral exposure history of a deposit is uncertain, the absence of an increase in natural D_e (t) does not necessarily testify to the absence of partial bleaching.

Where requested and feasible, the insensitivities of multi-grain single-aliquot signal analysis may be circumvented by inter-aliquot D_e distribution studies. This analysis uses aliquots of single sand grains to quantify inter-grain D_e distribution. At present, it is contended that asymmetric inter-grain D_e distributions are symptomatic of partial bleaching and/or pedoturbation (Murray *et al.*, 1995; Olley *et al.*, 1999; Olley *et al.*, 2004; Bateman *et al.*, 2003). For partial bleaching at least, it is further contended that the D_e acquired during burial is located in the minimum region of such ranges. The mean and breadth of this minimum region is the subject of current debate, as it is additionally influenced by heterogeneity in microdosimetry, variable inter-grain response to SAR and residual to post-burial signal ratios. Presently, the apposite measure of age is that defined by the D_e interval delimited by the minimum and central age models of Galbraith *et al.* (1999).

3.2.2 Pedoturbation

The accuracy of sedimentation ages can further be controlled by post-burial trans-strata grain movements forced by pedo- or cryoturbation. Berger (2003) contends pedogenesis prompts a reduction in the apparent sedimentation age of parent material through bioturbation and illuviation of younger material from above and/or by biological recycling and resetting of the datable signal of surface material. Berger (2003) proposes that the chronological products of this remobilisation are A-horizon age estimates reflecting the cessation of pedogenic activity, Bc/C-horizon ages delimiting the maximum age for the initiation of pedogenesis with estimates obtained from Bt-horizons providing an intermediate age 'close to the age of cessation of soil development'. Singhvi et al. (2001), in contrast, suggest that B and C-horizons closely approximate the age of the parent material, the A-horizon, that of the 'soil forming episode'. At present there is no post-sampling mechanism for the direct detection of and correction for post-burial sediment remobilisation. However, intervals of palaeosol evolution can be delimited by a maximum age derived from parent material and a minimum age obtained from a unit overlying the palaeosol. Inaccuracy forced by cryoturbation may be bidirectional, heaving older material upwards or drawing younger material downwards into the level to be dated. Cryogenic deformation of matrix-supported material is, typically, visible; sampling of such cryogenically-disturbed sediments can be avoided.

4.0 Acquisition and accuracy of D_r value

Lithogenic D_r values are defined through measurement of U, Th and K radionuclide concentration and conversion of these quantities into β and γ D_r values (Table 1). β contributions are estimated from sub-samples by laboratory-based γ spectrometry using an Ortec GEM-S high purity Ge coaxial detector system, calibrated using certified reference materials supplied by CANMET. γ dose rates are estimated from *in situ* NaI gamma spectrometry or, where direct measurements are unavailable, from laboratory-based Ge γ spectrometry. *In situ* measurements are conducted using an EG&G μNomad portable NaI gamma spectrometer (calibrated using the block standards at RLAHA, University of Oxford); these reduce uncertainty relating to potential heterogeneity in the γ dose field surrounding each sample. The level of U disequilibrium is estimated by laboratory-based Ge γ spectrometry. Estimates of radionuclide concentration are converted into D_r values (Adamiec and Aitken, 1998), accounting for D_r modulation forced by grain size (Mejdahl, 1979), present moisture content (Zimmerman, 1971) and, where D_e values are generated from 5-15 μm quartz, reduced signal sensitivity to α radiation (a-value 0.050 $\pm$ 0.002; Toms, unpub. data). Cosmogenic D_r values are calculated on the basis of sample depth, geographical position and matrix density (Prescott and Hutton, 1994).

The spatiotemporal validity of D_r values can be considered as five variables. Firstly, age estimates devoid of *in situ* γ spectrometry data should be accepted tentatively if the sampled unit is heterogeneous in texture or if the sample is located within 300 mm of strata consisting of differing texture and/or mineralogy. However, where samples are obtained throughout a vertical profile, consistent values of γ D_r based solely on laboratory measurements may evidence the homogeneity of the γ field and hence accuracy of γ D_r values. Secondly, disequilibrium can force temporal instability in U and Th emissions. The impact of this infrequent phenomenon (Olley et al., 1996) upon age estimates is usually insignificant given their associated margins of error. However, for samples where this effect is pronounced (>50% disequilibrium between ^{238}U and ^{226}Ra; Fig. 7), the resulting age estimates should be accepted tentatively. Thirdly, pedogenically-induced variations in matrix composition of B and C-horizons, such as radionuclide and/or mineral remobilisation, may alter the rate of energy emission and/or absorption. If D_r is invariant through a dated profile and samples encompass primary parent material, then element mobility is likely limited in effect. Fourthly, spatiotemporal detractions from present moisture content are difficult to assess directly, requiring knowledge of the magnitude and timing of differing contents. However, the maximum influence of moisture content variations can be delimited by recalculating D_r for minimum (zero) and maximum (saturation) content. Finally, temporal alteration in the thickness of overburden alters cosmic D_r values. Cosmic D_r often forms a negligible portion of total D_r. It is possible to quantify the maximum influence of overburden flux by recalculating D_r for minimum (zero) and maximum (surface sample) cosmic D_r.

5.0 Estimation of Age

Age estimates reported in Table 1 provide an estimate of sediment burial period based on mean D_e and D_r values and their associated analytical uncertainties. Uncertainty in age estimates is reported as a product of systematic and experimental errors, with the magnitude of experimental errors alone shown in parenthesis (Table 1). Probability distributions indicate the inter-aliquot variability in age (Fig. 8). The maximum influence of temporal variations in D_r forced by minima-maxima variation in moisture content and overburden thickness is illustrated in Fig. 8. Where uncertainty in these parameters exists this age range may prove instructive, however the combined extremes represented should not be construed as preferred age estimates.

6.0 Analytical uncertainty

All errors are based upon analytical uncertainty and quoted at 1σ confidence. Error calculations account for the propagation of systematic and/or experimental (random) errors associated with D_e and D_r values.

For D_e values, systematic errors are confined to laboratory β source calibration. Uncertainty in this respect is that combined from the delivery of the calibrating γ dose (1.2%; NPL, pers. comm.), the conversion of this dose for SiO_2 using the respective mass energy-absorption coefficient (2%; Hubbell, 1982) and experimental error, totalling 3.5%. Mass attenuation and bremsstrahlung losses during γ dose delivery are considered negligible. Experimental errors relate to D_e interpolation using sensitisation corrected dose responses. Natural and regenerated sensitisation corrected dose points (S_i) are quantified by,

$$S_i = (D_i - x.L_i) / (d_i - x.L_i) \qquad \textbf{Eq.1}$$

where D_i = Natural or regenerated OSL, initial 0.2 s
L_i = Background natural or regenerated OSL, final 5 s
d_i = Test dose OSL, initial 0.2 s
x = Scaling factor, 0.08

The error on each signal parameter is based on counting statistics, reflected by the square-root of measured values. The propagation of these errors within Eq. 1 generating σS_i follows the general formula given in Eq. 2. σS_i are then used to define fitting and interpolation errors within linear or exponential regressions (Green and Margerison, 1978; Ixaru et al., 2004).

For D_r values, systematic errors accommodate uncertainty in radionuclide conversion factors (5%), β attenuation coefficients (5%), a-value (4%; derived from a systematic α source uncertainty of 3.5% and experimental error), matrix density (0.20 $g.cm^{-3}$), vertical thickness of sampled section (specific to sample collection device), saturation moisture content (3%), moisture content attenuation (2%), burial moisture content (25% relative, unless direct evidence exists of the magnitude and period of differing content), NaI gamma spectrometer calibration (3%) and/or NAA/ICP-MS (2%). Experimental errors are associated with radionuclide quantification for each sample by gamma spectrometry and/or NAA/ ICP-MS.

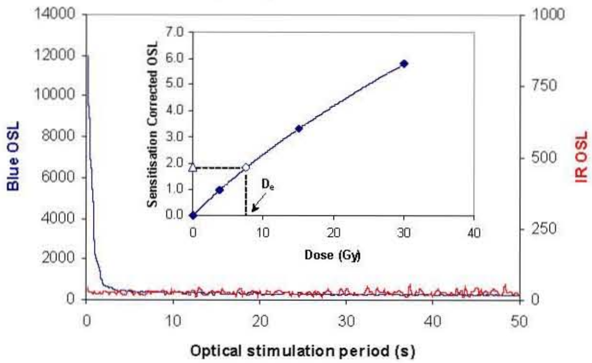
The propagation of these errors through to age calculation is quantified using the expression,

$$\sigma y\ (\delta y/\delta x) = (\Sigma\ ((\delta y/\delta x_n).\sigma x_n)^2)^{1/2} \qquad \textbf{Eq. 2}$$

where y is a value equivalent to that function comprising terms x_n and where σy and σx_n are associated uncertainties.

Errors on age estimates are presented as combined systematic and experimental errors and experimental errors alone. The former (combined) error should be considered when comparing luminescence ages herein with independent chronometric controls. The latter assumes systematic errors are common to luminescence age estimates generated by means equal to those detailed herein and enable direct comparison with those estimates.

Fig. 1 Signal Calibration



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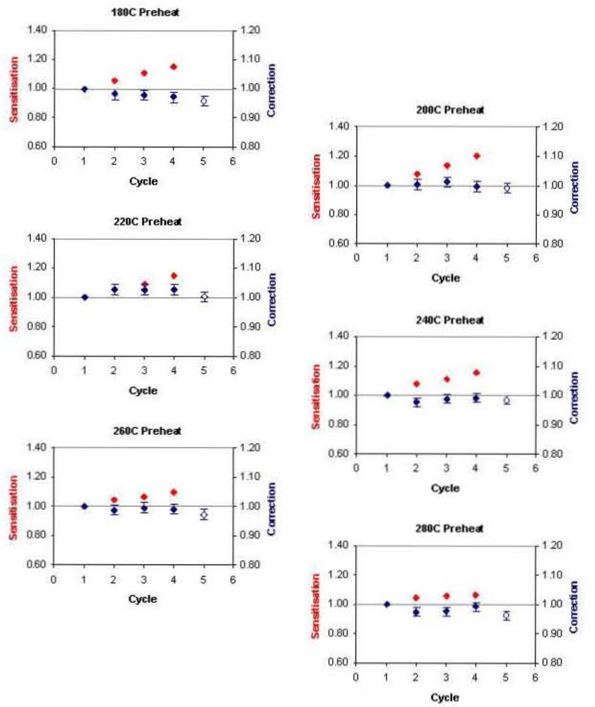


Fig. 3 D_e Preheat Dependence

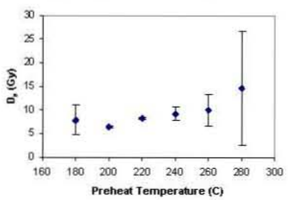
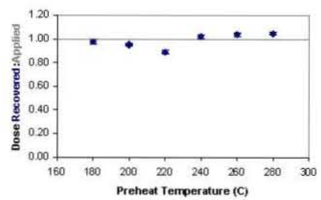


Fig. 4 Dose Recovery



Sample: GL08007

Fig. 5 Inter-aliquot D_e distribution

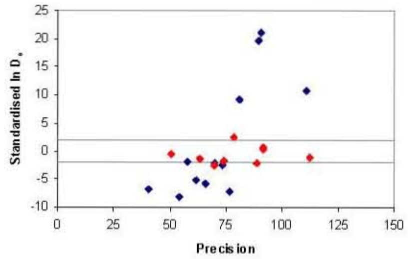


Fig. 6 Signal Analysis

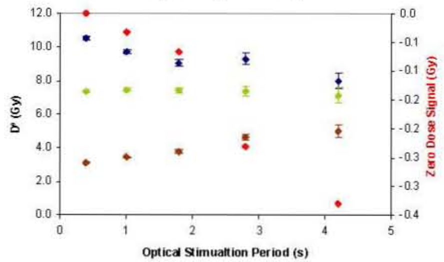


Fig. 7 U Decay Activity

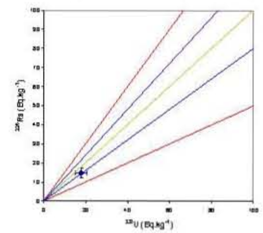
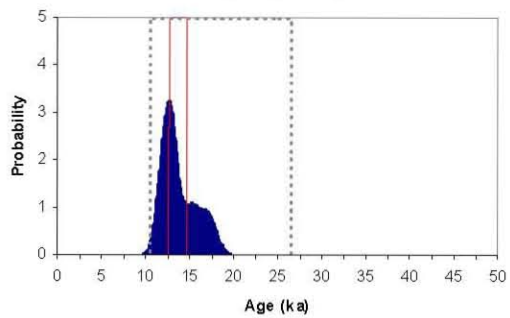


Fig. 8 Age Range



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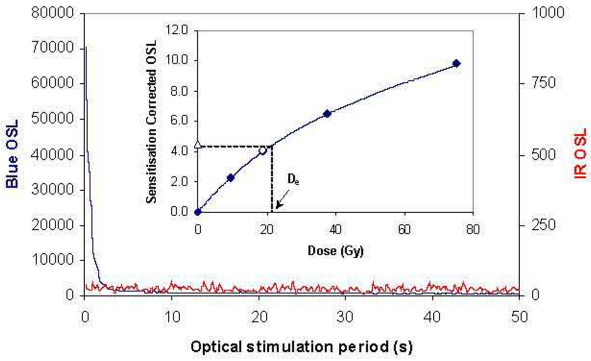


Fig. 2 Irradiation-Preheat Cycling

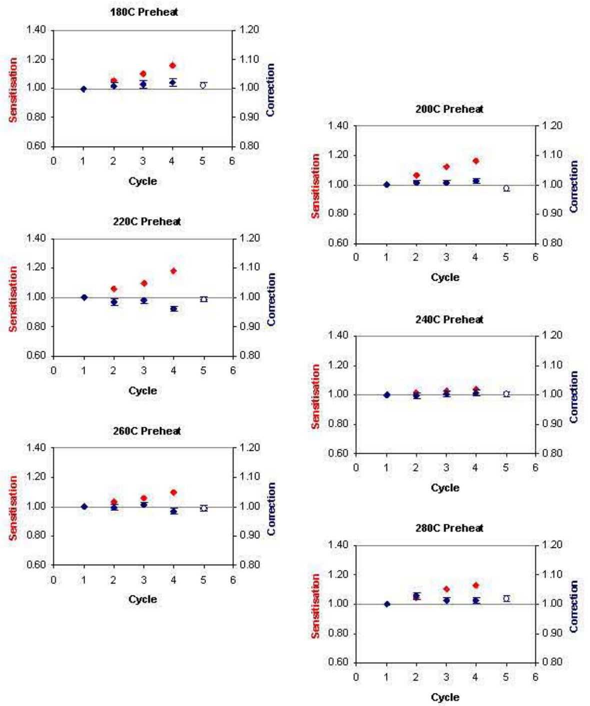


Fig. 3 D_e Preheat Dependence

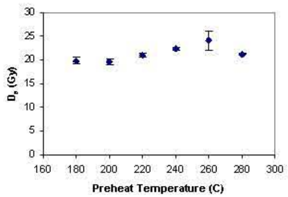
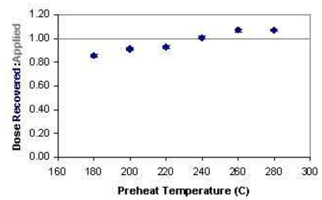


Fig. 4 Dose Recovery



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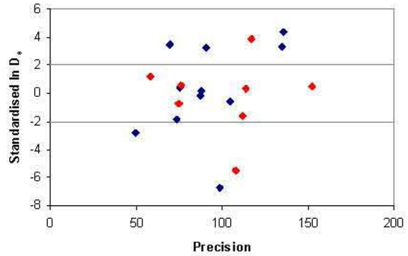

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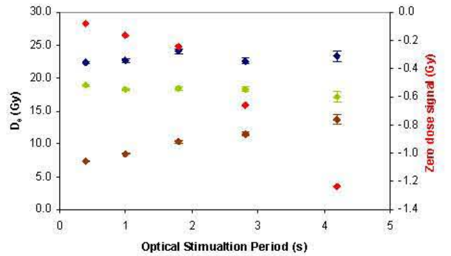

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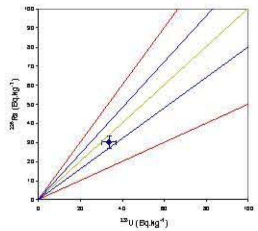
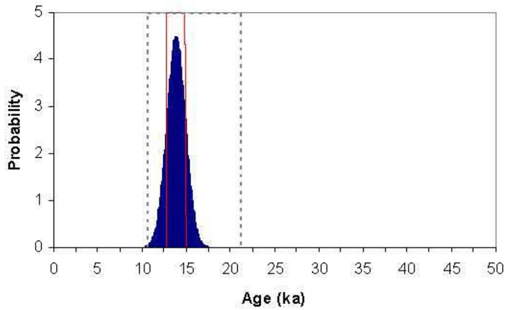


Fig. 8 Age Range



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Sample: GL08008

Fig. 1 Signal Calibration

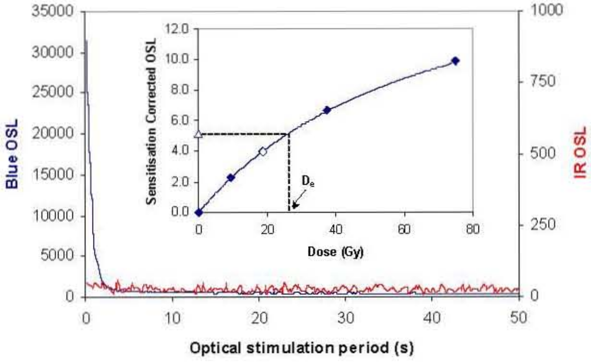


Fig. 2 Irradiation-Preheat Cycling

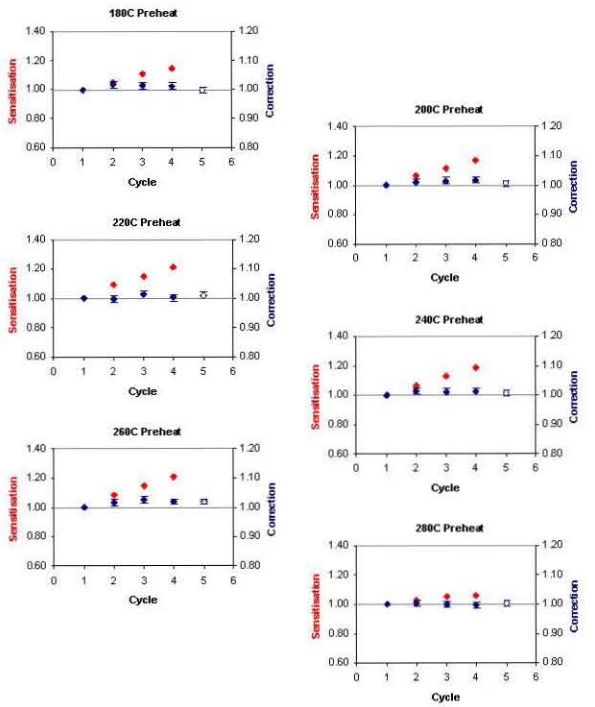


Fig. 3 D_e Preheat Dependence

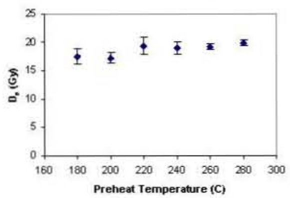
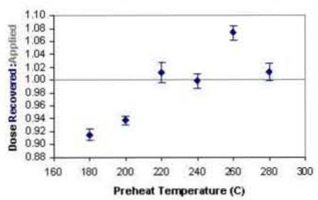


Fig. 4 Dose Recovery



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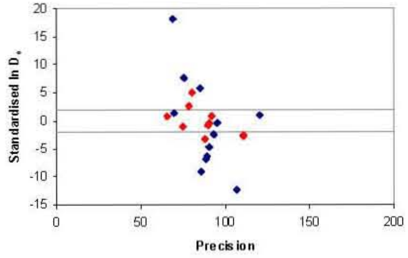
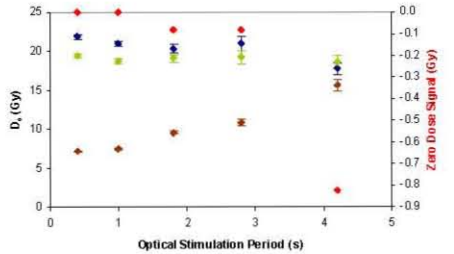


Fig. 6 Signal Analysis



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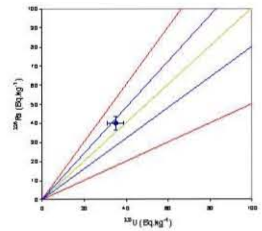
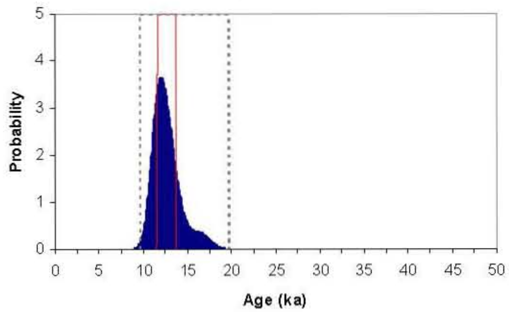


Fig. 8 Age Range



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Sample: GL08009

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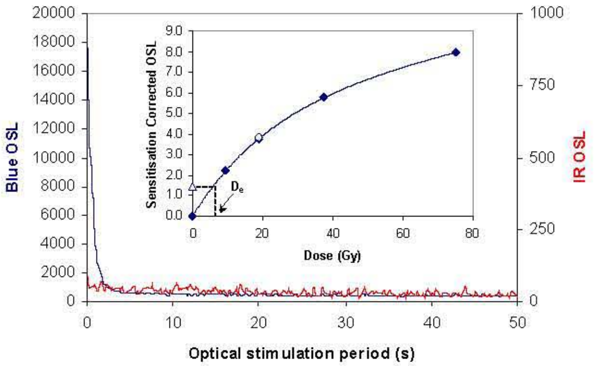

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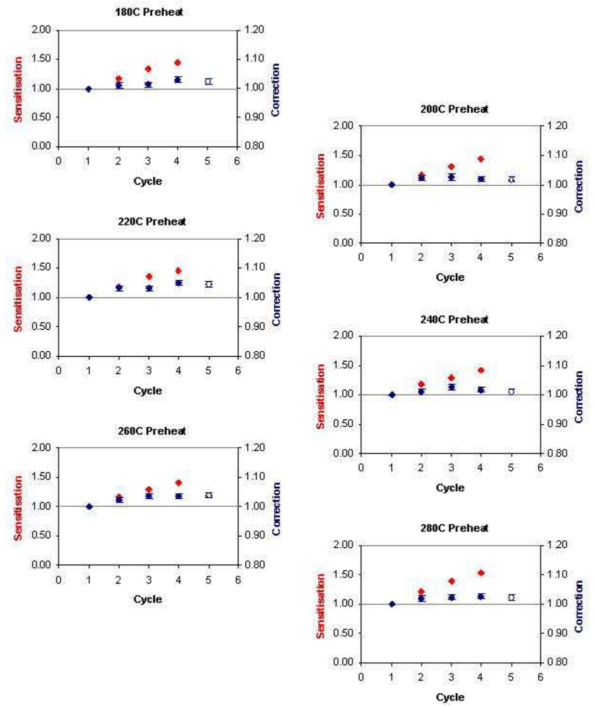


Fig. 5 Inter-aliquot D_e distribution

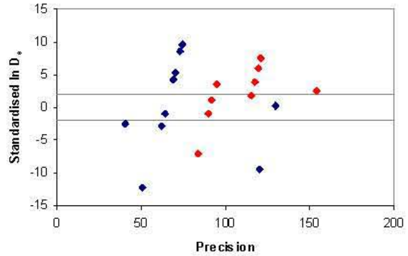


Fig. 6 Signal Analysis

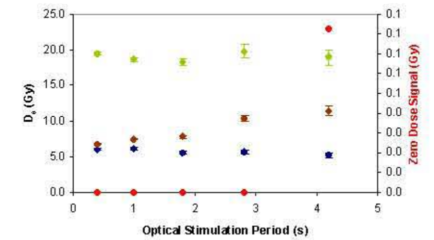


Fig. 7 U Decay Activity

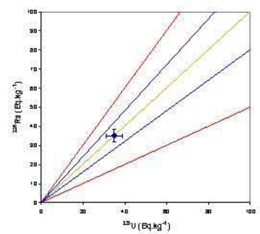


Fig. 3 D_e Preheat Dependence

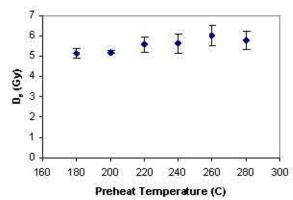


Fig. 4 Dose Recovery

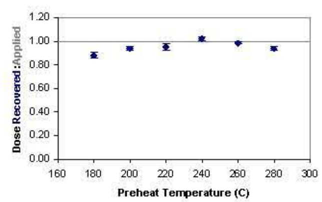
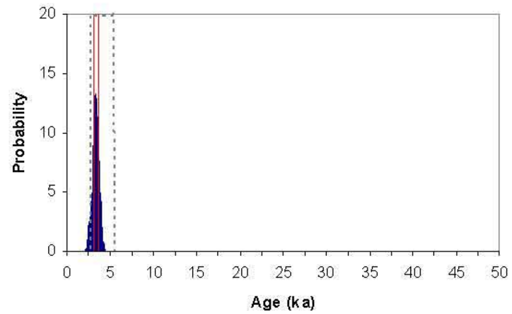


Fig. 8 Age Range



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Sample: GL08010

Fig. 1 Signal Calibration

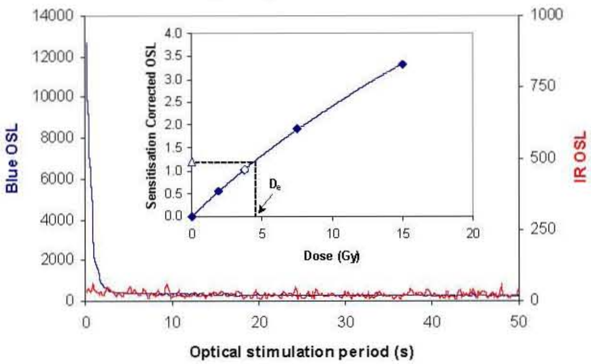
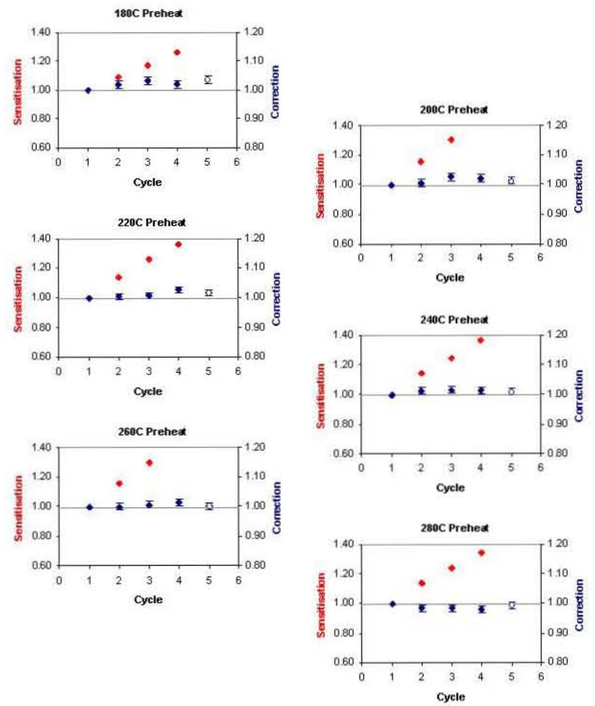


Fig. 2 Irradiation-Preheat Cycling



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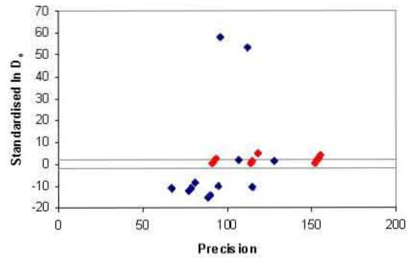


Fig. 6 Signal Analysis

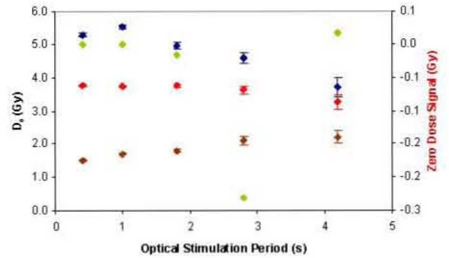


Fig. 7 U Decay Activity

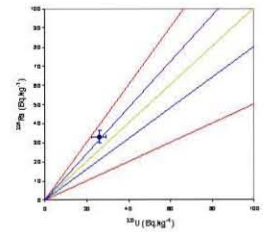
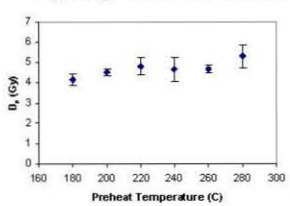


Fig. 3 D_e Preheat Dependence



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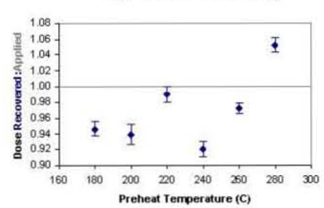

Fig. 8 Age Range

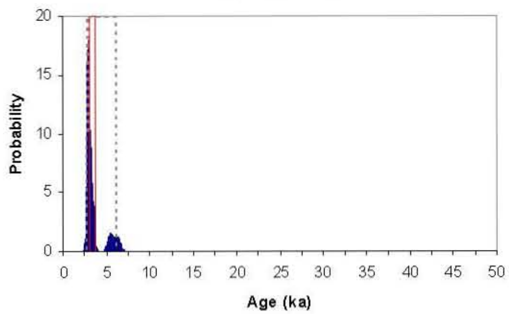

Fig. 1 Signal Calibration Natural blue and laboratory-induced infrared (IR) OSL signals. Detectable IR signal decays are diagnostic of feldspar contamination. Inset, the natural blue OSL signal (open triangle) of each aliquot is calibrated against known laboratory doses to yield equivalent dose (D_e) values. Where D_e values are >40 Gy, a pulsed irradiation response is shown; pulsed irradiation D_e values are used in age calculations if significantly different from continuous irradiation-based D_e. Where D_e values are >100Gy, a log-linear plot of dose response is shown; D_e can be confidently interpolated if signal response increases with dose.

Fig. 2 Irradiation-Preheat Cycling The acquisition of D_e values is necessarily predicated upon thermal treatment of aliquots succeeding environmental and laboratory irradiation. Repeated irradiation and thermal treatment results in aliquot sensitisation, rendering calibration of the natural signal inaccurate. This sensitisation can be monitored and corrected for. The accuracy of correction can be preheat dependent; irradiation-preheat cycling quantifies this dependence for laboratory-induced signals, examining the reproducibility of corrected OSL resultant of repeat laboratory doses. The significance of feldspar contamination can be quantified by measuring the post-IR blue repeat ratio (open symbol).

Fig. 3 D_e Preheat Dependence Quantifies the combined effects of thermal transfer and sensitisation on the natural signal. Insignificant adjustment in D_e may reflect limited influence of these effects

Fig. 4 Dose Recovery Attempts to replicate the above diagnostic, yet provide improved resolution of thermal effects through removal of variability induced by heterogeneous dose absorption in the environment and using a precise lab dose to simulate natural dose. Based on this and preceding data an appropriate thermal treatment is selected to refine the final D_e value.

Fig. 5 Inter-aliquot D_e distribution Provides a measure of inter-aliquot statistical concordance in D_e values derived from **natural** and **laboratory** irradiation. Discordant data (those points lying beyond ±2 standardised ln D_e) reflects heterogeneous dose absorption and/or inaccuracies in calibration.

Fig. 6 Signal Analysis Statistically significant increase in **natural** D_e value with signal stimulation period is indicative of a partially-bleached signal, provided a significant increase in D_e results from **simulated partial bleaching** along with insignificant adjustment in D_e for simulated **zero** and **full bleach** conditions. Ages from such samples are considered maximum estimates.

Fig. 7 U Activity Statistical concordance (equilibrium) in the activities of the daughter radioisotope ^{226}Ra with its parent ^{238}U may signify the temporal stability of D_r emissions from these chains. Significant differences (disequilibrium; >50%) in activity indicate addition or removal of isotopes creating a time-dependent shift in D_r values and increased uncertainty in the accuracy of age estimates. 20% disequilibrium marker is also shown.

Fig. 8 Age Range The **mean age range** provides an estimate of sediment burial period based on mean D_e and D_r values with associated analytical uncertainties. The probability distribution indicates the inter-aliquot variability in age. The maximum influence of temporal variations in D_r forced by minima-maxima variation in moisture content and overburden thickness may prove instructive where there is uncertainty in these parameters, however the combined extremes represented should not be construed as preferred age estimates.

Sample: GL08011

Fig. 1 Signal Calibration

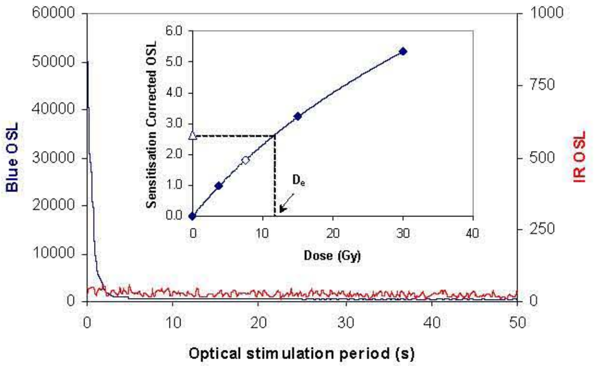

Fig. 1 Signal Calibration Natural blue and laboratory-induced infrared (IR) OSL signals. Detectable IR signal decays are diagnostic of feldspar contamination. Inset, the natural blue OSL signal (open triangle) of each aliquot is calibrated against known laboratory doses to yield equivalent dose (D_e) values. Where D_e values are >40 Gy, a pulsed irradiation response is shown; pulsed irradiation D_e values are used in age calculations if significantly different from continuous irradiation-based D_e. Where D_e values are >100Gy, a log-linear plot of dose response is shown; D_e can be confidently interpolated if signal response increases with dose.

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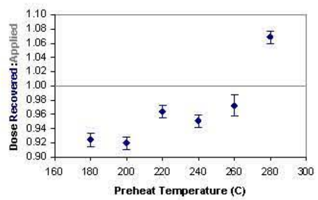
Fig. 2 Irradiation-Preheat Cycling

Insufficient Sample Mass

Fig. 3 D_e Preheat Dependence

Insufficient Sample Mass

Fig. 4 Dose Recovery



Sample: GL08012

Fig. 5 Inter-aliquot D_e distribution

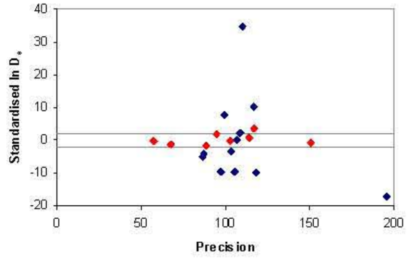


Fig. 6 Signal Analysis

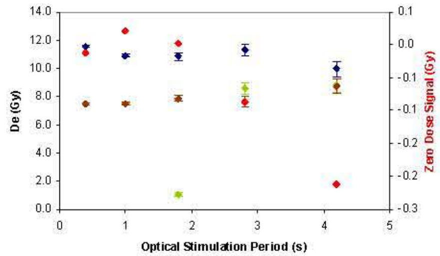


Fig. 7 U Decay Activity

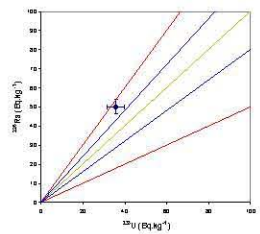
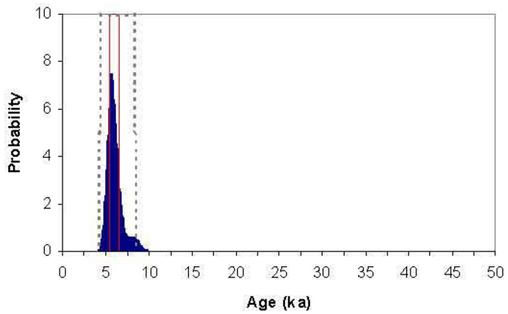


Fig. 8 Age Range



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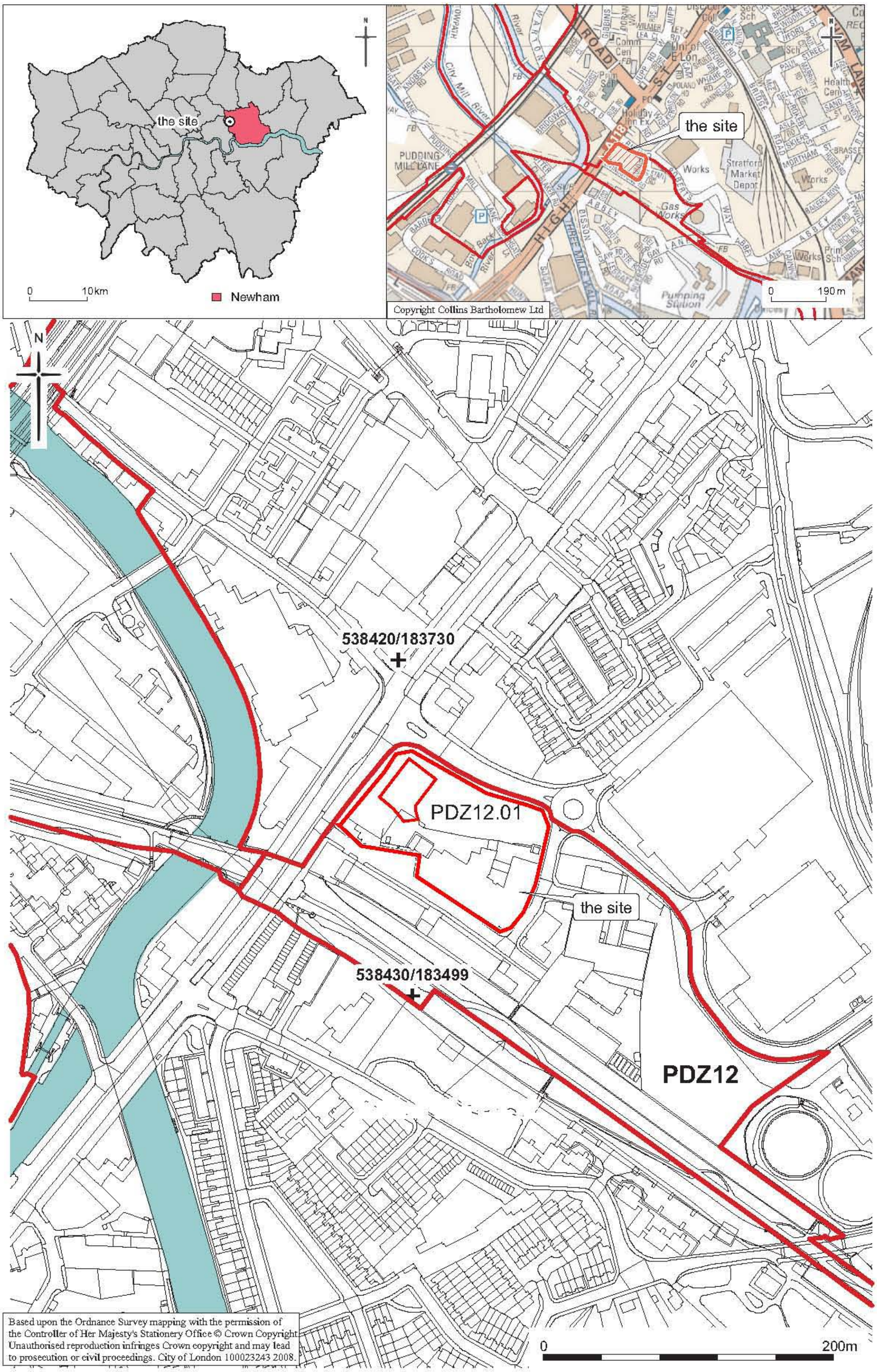


Fig 1 Site location

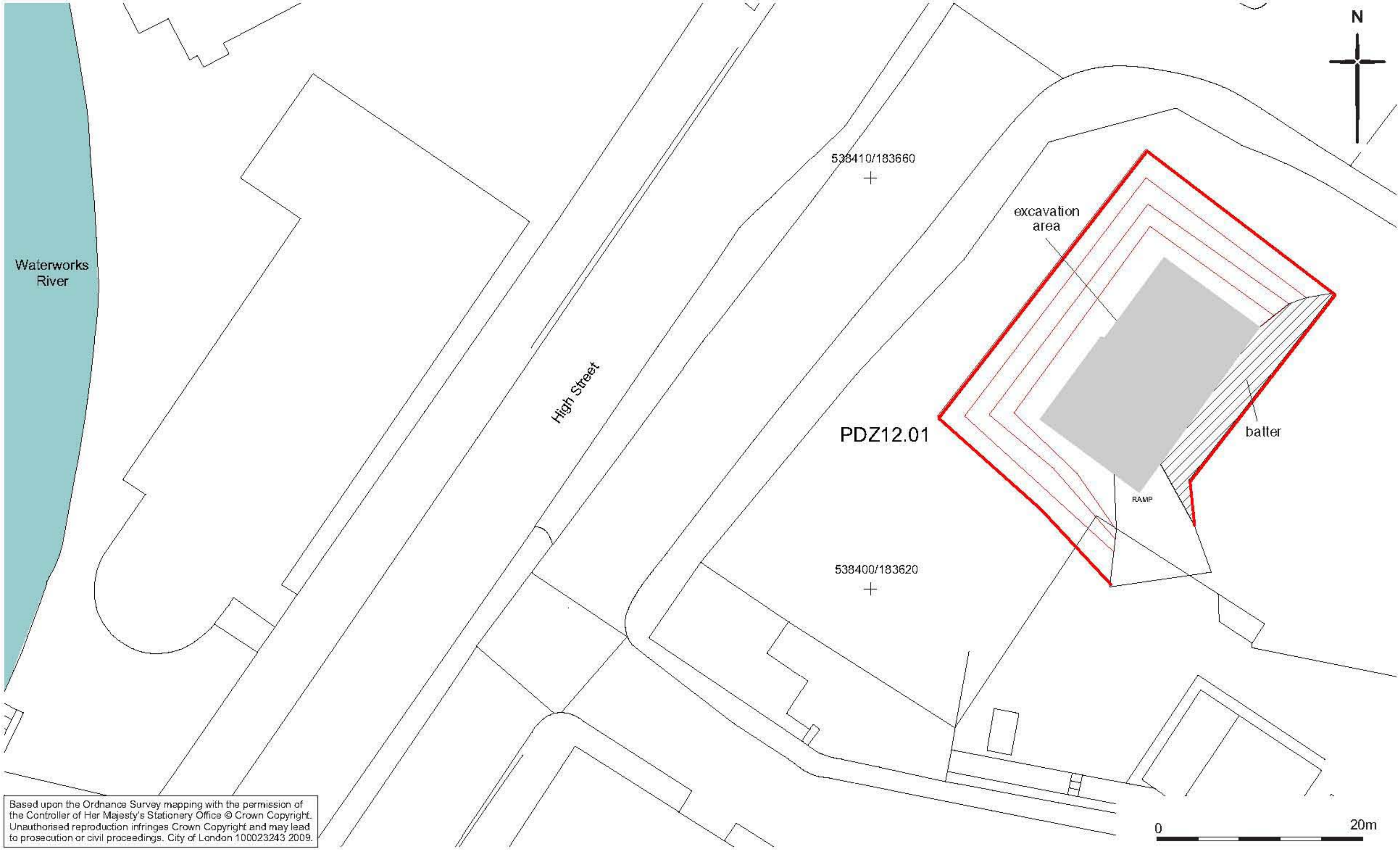


Fig 2 Trench location

Fig 3 Period 2

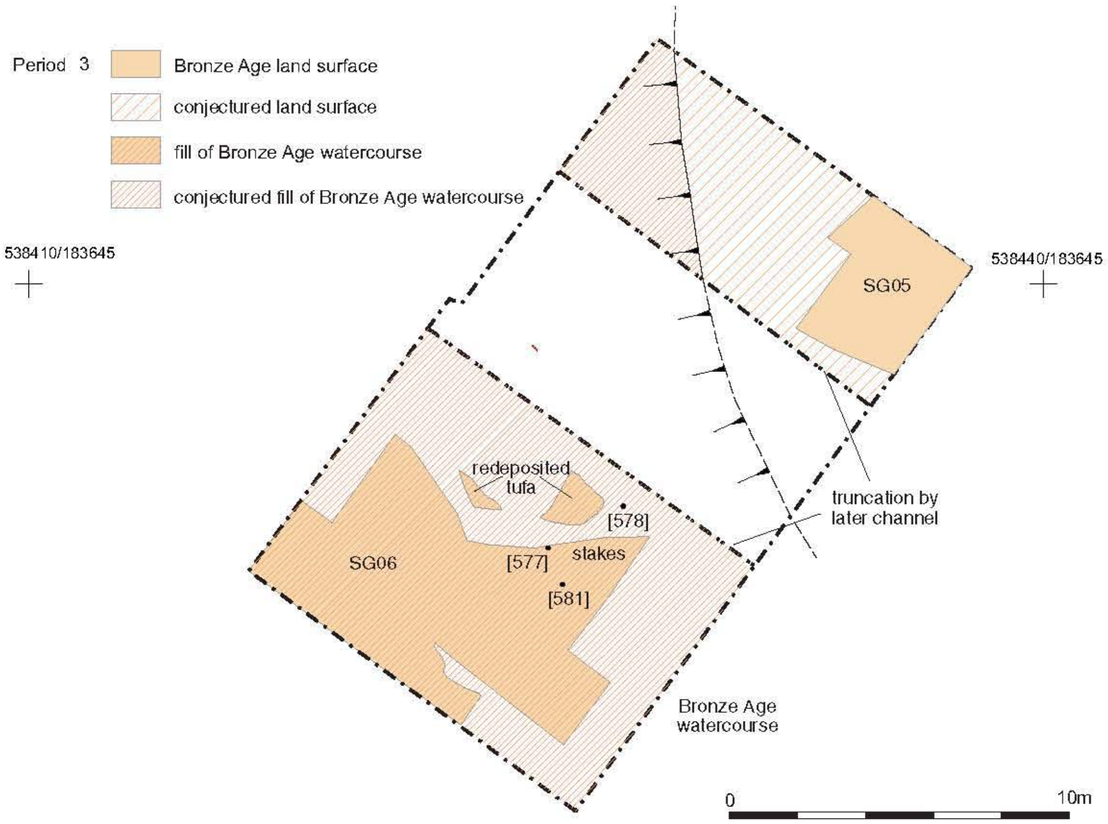


Fig 4 Period 3

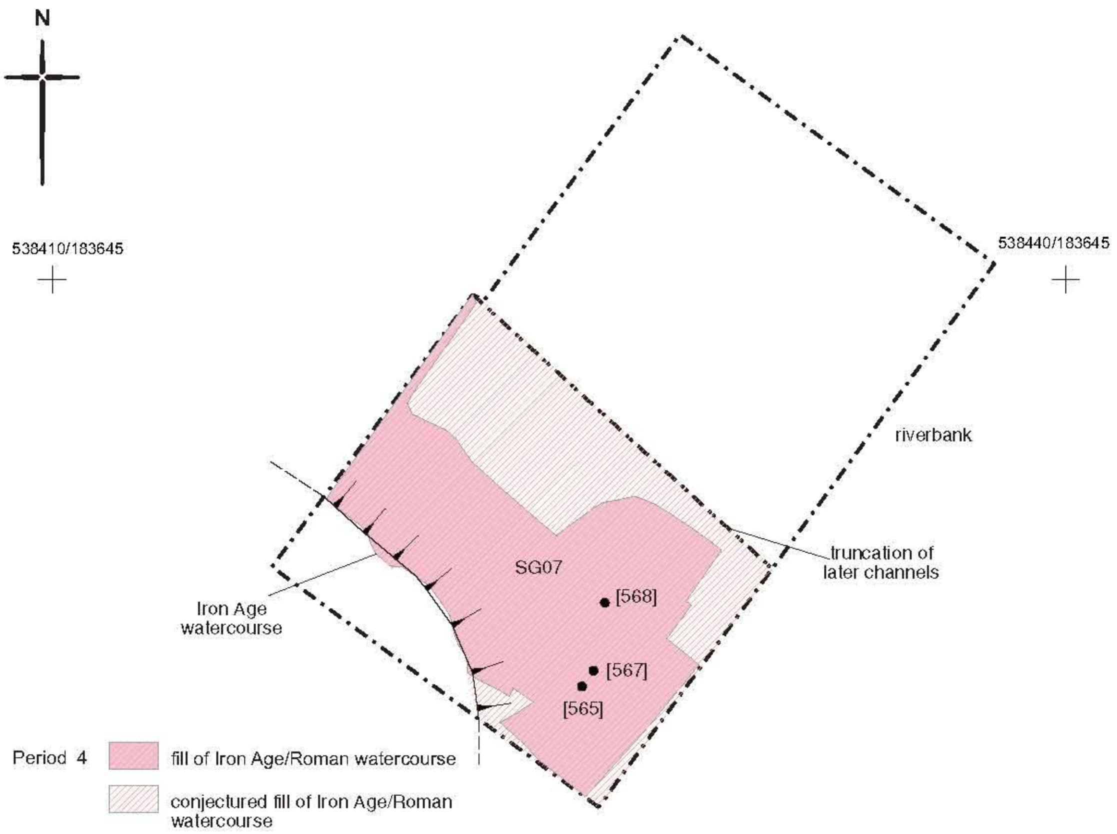


Fig 5 Period 4

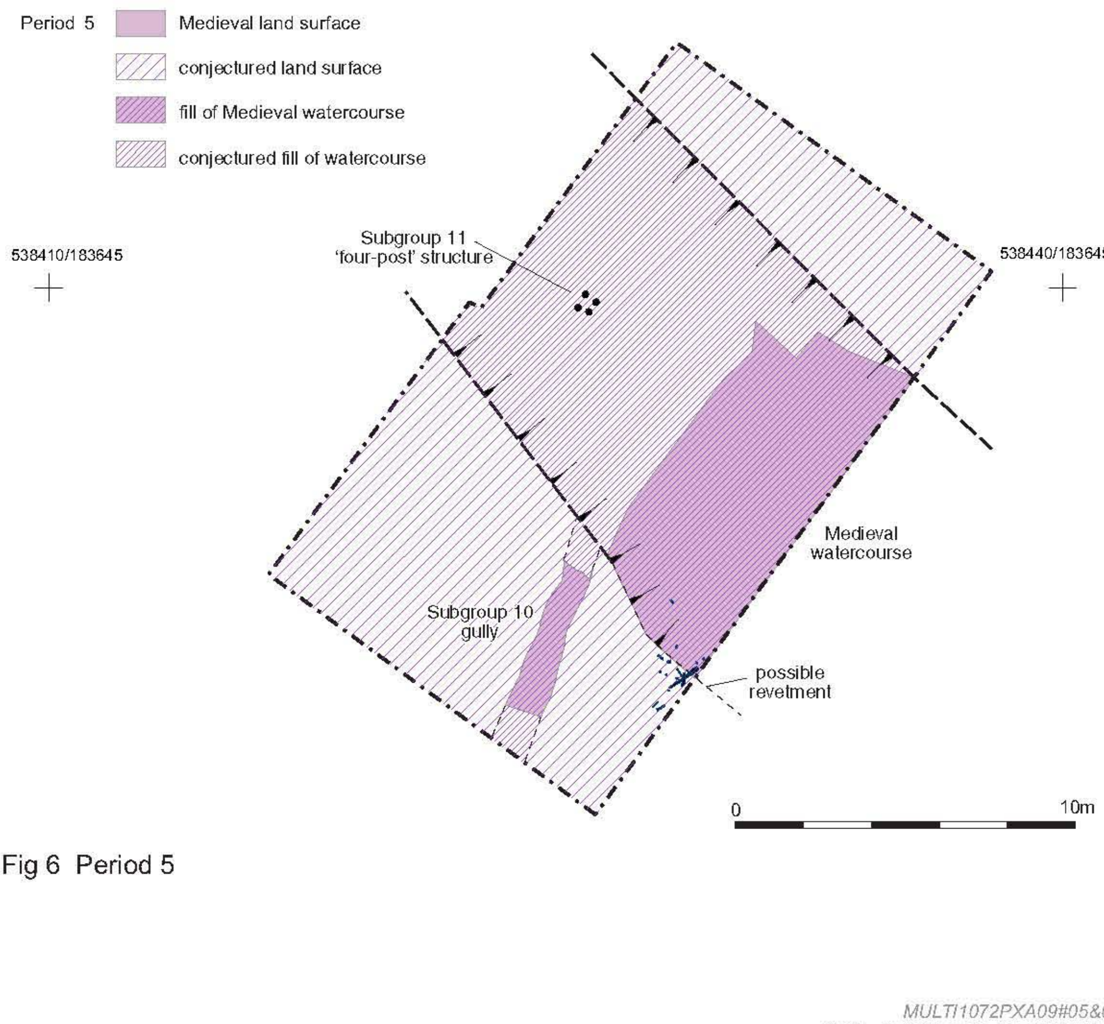


Fig 6 Period 5

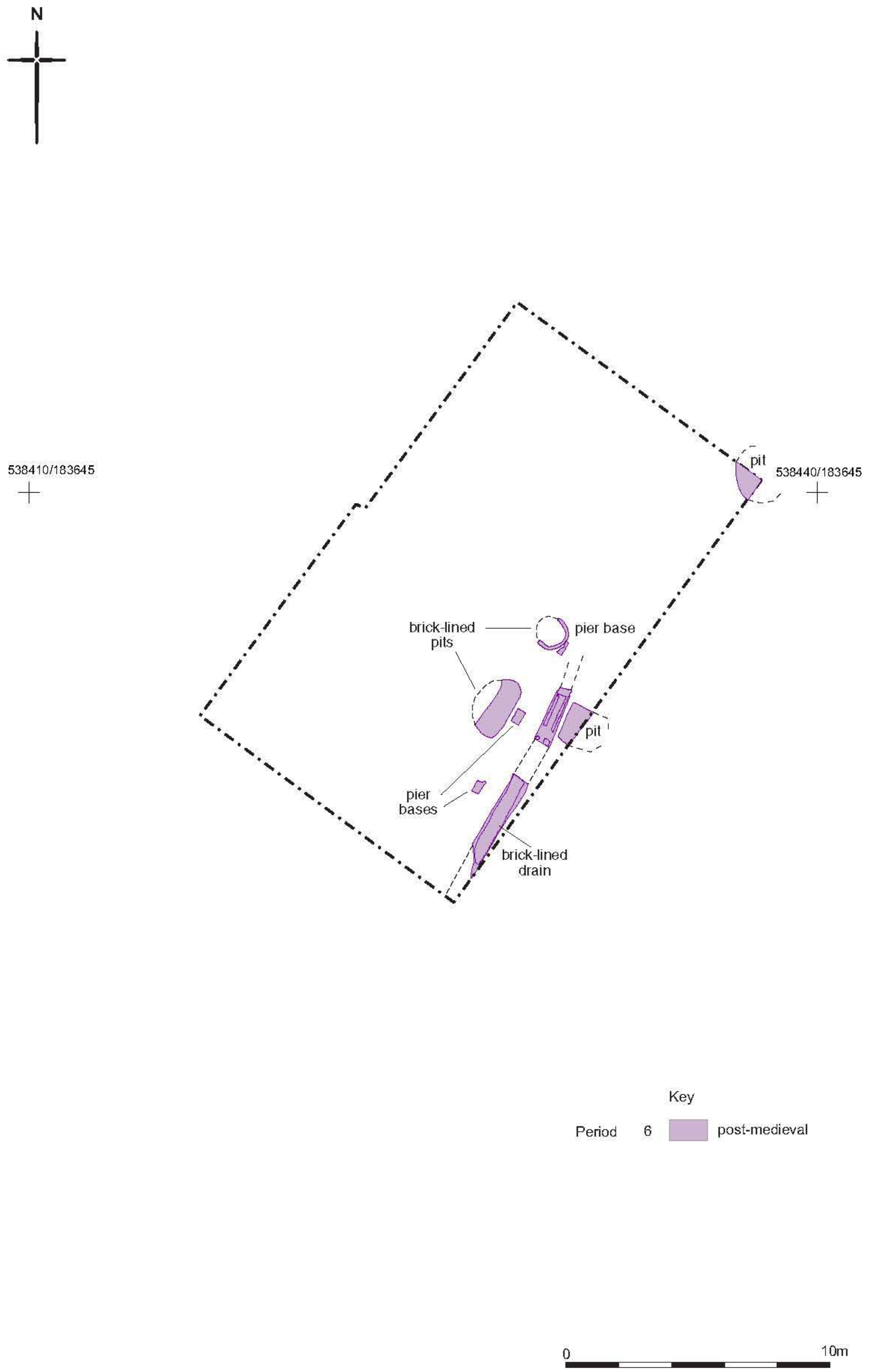


Fig 7 Period 7 structures

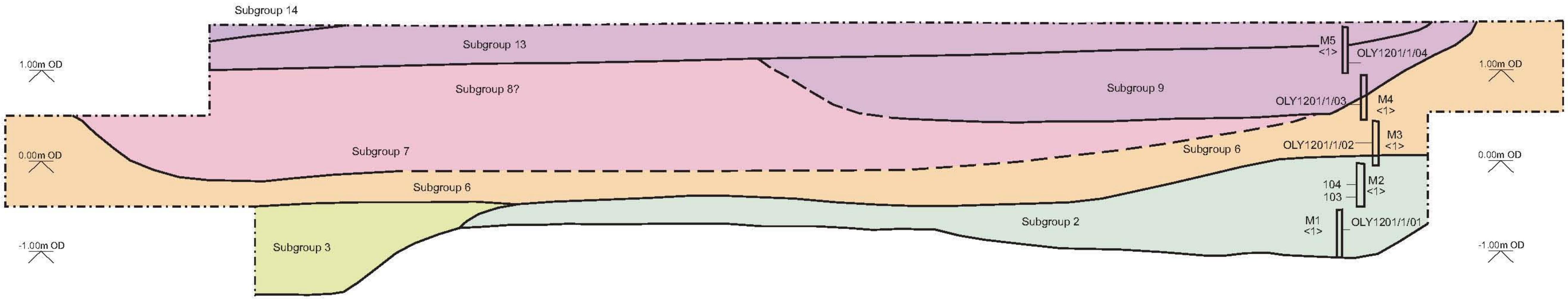
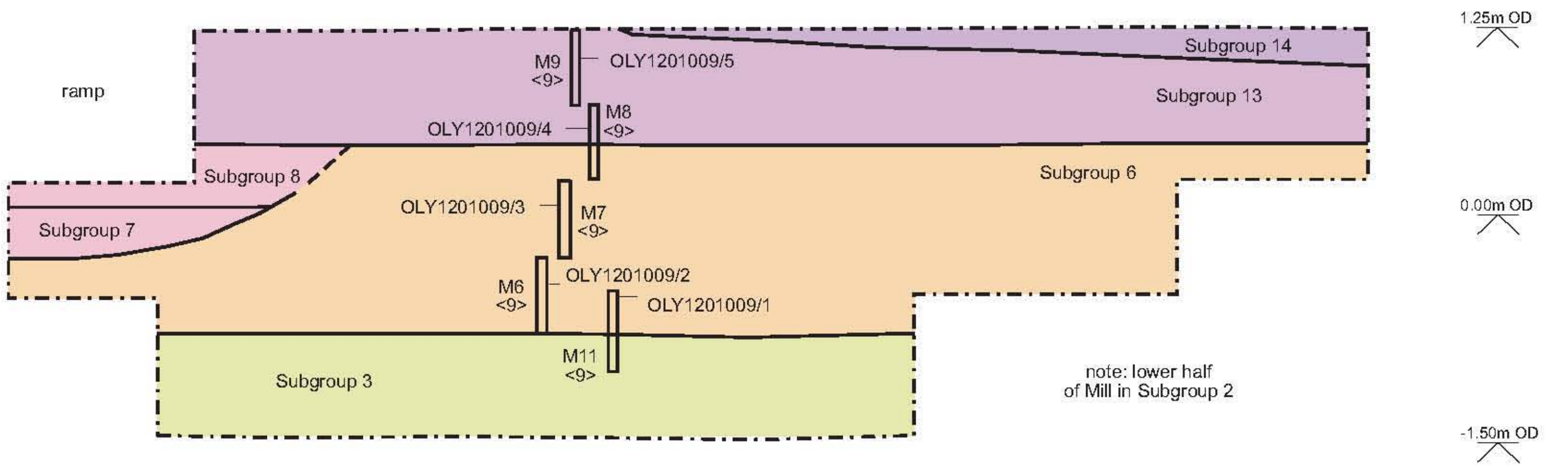


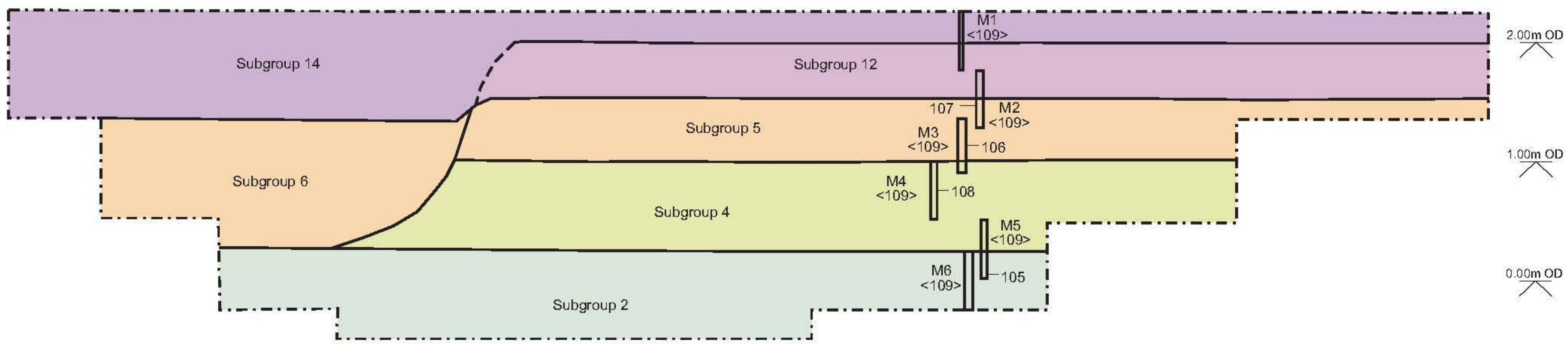
Fig 8 Composite sectional drawing of south-east facing side of Trench PDZ12.01 showing Subgroups, Periods and location of monolith sequence <1> (scale 1:50)



Key

Period		
1		earliest
2		Neolithic
3		Bronze Age
4		Iron Age/Roman
5		medieval
6		post-medieval

Fig 9 Composite sectional drawing of north-east facing side of Trench PDZ12.01 showing Subgroups, Periods and location of monolith sequence <9> (scale 1:50)



0 2.5m

Fig 10 Composite sectional drawing of south-west facing side of Trench PDZ12.01 showing Subgroups, Periods and location of monolith sequence <109> (scale 1:50)