C257 ARCHAEOLOGY CENTRAL

Fieldwork Report

Archaeological Excavation and Watching Briefs

Broadgate Ticket Hall Utilities Combined Report 2013 (XSM10)

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Non-technical summary

This report covers a summary of the results from archaeological fieldwork carried out by Museum of London Archaeology (MOLA) on the site of the future Crossrail Broadgate Ticket Hall, Liverpool Street, London EC2M, within the City of London. The site consists of the new utilities corridor and other utilities diversions within the Broadgate Ticket Hall construction worksite. The report was commissioned from MOLA by Crossrail Ltd.

The phases of fieldwork covered in this report include the utilities corridor, sewer shafts MHS1 and MHS2-100 and the open cut sewer diversion. A sewer heading leading from MHS2-100 was undertaken as a general watching brief. This fieldwork follows the initial phase of archaeological evaluation in 2010–2011 (MOLA for Crossrail 2012, C257-MLA-X-RGN-CRG02-50064 [v2]) and 2011–2012 (MOLA for Crossrail 2012, C257-MLA-X-XCS-CRG02-50012 [v2]); the current report amalgamates these results in order to further inform the forthcoming excavation of the future ticket hall.

Natural terrace gravels were reached in every trench, overlain by waterlain deposits of alluvial clay interspersed with occasional bands of gravel. These are thought to represent episodes of flooding from the Walbrook stream. The eastern edge of the stream itself was present at the western side of the site, running north–south.

While a small group of redeposited struck flints was recovered during the fieldwork, there was no tangible evidence for prehistoric activity on the site itself. Evidence was found for several phases of Roman activity, dating to the early 2nd century AD, demonstrating water management in this area of the Walbrook valley. Two timber gates from this period had been laid at the water's edge, presumably to create a platform. Other forms of waterside activity appear to have continued into the later 2nd and possibly 3rd centuries: further remains of a minor east–west Roman road, seen previously during excavations south of Eldon Street and thought to have been seen in fieldwork on the site in 2011 (Crossrail 2011d), probably led to a route across the channel.

To the south of the road and the east of the waterway, Roman ditches, pits and dump layers represent activity in what would have been a boggy area, prone to flooding from the channel, which itself contained a number of human skulls, probably washed in from established burial grounds upstream.

A number of residual medieval finds were recovered from post-Roman features, but few in situ medieval deposits have been identified, and none associated with St Mary Bethlehem Hospital. The post-Roman to early post-medieval sequence is characterised largely by a series of marsh deposits. These were sealed across the whole site by 16th-century reclamation deposits, laid deliberately to consolidate ground for the establishment of the Bethlehem Burial Ground. In addition to these dumps, a group of elm timber piles were recorded running NNE to SSW. These are thought to have provided essential stability through the marshy ground directly below the original 16th-century cemetery western boundary wall. A segment of brick wall represented part of that early construction. To the east, further timber piles and sections of a brick and stone wall were recorded as part of a 17th-century rebuild.

A total of 72 in situ post-medieval burials from the Bethlehem Burial Ground were recorded during this phase, increasing the number of archaeologically excavated in situ burials on this site to 373.

Previous fieldwork has revealed a large and rare assemblage of post-medieval worked animal bone and ivory waste, as well as other industrial waste such as glass slag. Worked bone offcuts recovered during this latest phase of fieldwork, primarily derived from the backfill of a trench dug to remove building material from the 17th-century cemetery perimeter wall, has added to this important assemblage. One aim of future fieldwork will be to establish whether this material was deposited both during the use of the burial ground and after it was no longer used for burials.

The site represents a rare chance to explore and define Roman extra-mural activity within this area, with a high potential for further Roman remains, as well as more 16th to 18th-century burials which will help to further our knowledge and understanding of society, life, death and burial during this time.

The archaeological results from this phase of work at Liverpool Street will be used by the Crossrail Project Archaeologist to revise and finalise the mitigation strategy for the site.

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1 Introduction

Crossrail is a new London rail link project that will provide transport routes in the south-east and across London. The proposed development will include the construction of seven stations within central London which will interchange with other public transport modes, including the London Underground, National Rail and the London Bus service; the development will also include the renewal and/or upgrade of existing stations outside central London. The route itself will link Maidenhead and Heathrow in the west with Shenfield in the north-east and Abbey Wood in the south-east.

As part of these works a new station is required running from Moorgate to Liverpool Street. The Broadgate Ticket Hall worksite (the site of a new ticket hall and utilities corridor to the south) consists of an area in the road and pavement of Liverpool Street, to the east of Blomfield Street and to the south and west of the disused ticket hall/sub-station.

The Crossrail mitigation response to archaeology is described in the Crossrail Generic WSI (Crossrail 2009a) and the detailed desk based assessment (DDBA; Crossrail 2008), and can be summarised as follows:

- In the event that intact and important archaeological remains are identified at Crossrail worksites through this process, it may be preferable, where practicable, to preserve these where they are found (ie preservation in situ).
- However, because of the nature of major works projects such as Crossrail, experience of other similar projects suggests that preservation by record is usually the most appropriate method of dealing with archaeological finds.
- Following an extensive Environmental Impact Assessment (EIA) supporting the Crossrail Bill, and the production of site-specific DDBAs, appropriate mitigation measures were scoped and specified in detail in individual project designs (site-specific WSIs – Written Schemes of Investigation) which were prepared in accordance with the principles set out in the Generic WSI, and developed in consultation with the relevant statutory authorities.
- Archaeological information that is gained from fieldwork will be followed by analysis and publication of the results and will be transferred to an approved public receiving body.

This report covers five archaeological investigation tasks carried out at the location of the Broadgate Ticket Hall, Liverpool Street, NGR 533050 181610, by C257 Museum of London Archaeology (MOLA), between 13/10/11 and 19/03/12 (see Figure 1). They were supervised by MOLA Senior Archaeologist Robert Hartle and Project Officer Alison Telfer, and included the following:

Task	Principal Contractor	Date
• Excavation [and associated watching briefs], the Utilities Corridor [*c* 51 x 2.5m]	C503 VCUK [Vinci Construction UK Limited]	GL1 to GL8: 19/03/13 to 25/04/13 GL8 to QVT: 14/08/13 to 16/09/13
• General and Targeted Watching Brief, Area around Sewer Shaft MHS1 [*c* 11.2 x 8.6m]	C503 VCUK	15/07/13 to 18/10/13
• General and Targeted Watching Brief, Sewer Shaft MHS2-100 (at the western end of the Open Cut Sewer Trench) [*c* 3.5 x 3.5m]	C503 VCUK	05/08/13 to 30/08/13
• General and Targeted Watching Brief, Open Cut Sewer [*c* 1.7 x 20.7m]	C503 VCUK	12/04/13 to 09/05/13
• General Watching Brief, Heading from MHS2-100 to Blomfield Street sewer [*c* 16.75 x 1.7m]	C503 VCUK	10/09/13 to 03/10/13
• General Watching Brief, demolition of Manhole X [4m x 4m]	C503 VCUK	09/12/13 to 13/12/13
• Targeted Watching Brief, Manhole MHS2 [4m x 4m]	C503 VCUK	20/01/14 to 03/02/14

Table 1: Fieldwork conducted between 19/03/12 and 03/02/14

All grid coordinates in this report are cited as both the National Ordinance Survey and London Survey Grid, and all levels cited as both Ordnance Datum (m OD) and Above Tunnel Datum (m ATD)(ATD = OD +100m).

The event code (sitecode) is **XSM10**.

2 Planning background

The overall framework within which archaeological work will be undertaken is set out in the Environmental Minimum Requirements (EMR) for Crossrail (Crossrail 2008). The requirements being progressed follow the principles of Planning Policy Guidance Note 16 (PPG16) (DoE, 1990), and its replacements Planning Policy Statement 5 (PPS5)(DCLG, 2010) and the National Policy Planning Framework (NPPF)(DCLG, 2012), on archaeology and planning. Accordingly the nominated undertaker or any contractors will be required to implement certain control measures in relation to archaeology before construction work begins.

Schedules 9, 10 and 15 of the Crossrail Bill (2005) concern matters relating to archaeology and the built heritage and allows the dis-application by Crossrail of various planning and legislative provisions including those related to listed building status, conservation areas and scheduled ancient monuments (Schedule 9). Schedule 10 allows certain rights of entry to English Heritage given that Schedule 9 effectively dis-applied their existing rights to the Crossrail project, and Schedule 15 allows Crossrail to bypass any ecclesiastical or other existing legislation relating to burial grounds.

Notwithstanding these dis-applications, it is intended that agreements setting out the detail of the works and requiring relevant consultations, and approvals of detail and of mitigation arrangements, will be entered into by the nominated undertaker with the relevant local planning authorities and English Heritage in relation to listed buildings, and with the Department of Culture, Media and Sport (DCMS) and English Heritage in relation to Scheduled Ancient Monuments (SAMs).

3 Origin and scope of the report

This report has been commissioned from Museum of London Archaeology (MOLA), by Crossrail Ltd. It has been prepared within the terms of the relevant standard specified by the Institute for Archaeologists (IFA, 2001). It considers the significance of the fieldwork results (in local, regional or national terms) and makes appropriate recommendations for any further action, commensurate with the results.

This report will be made available from the London Archaeological Archive and Research Centre (LAARC) in due course.

4 Previous work relevant to archaeology of site

The principal previous Crossrail studies are as follows:

- Crossrail, Assessment of Archaeological Impacts, Technical Report, Part 2 of 6, Central Section, Report Number 1E0318-C1E00-00001, 2005
- Crossrail, Archaeological Programming Assessment, Report Number 1E0318-G0E00-00006 (Rev B), 2006
- Crossrail, Archaeology Generic Written Scheme of Investigation, Document Number CRPN-LWS-EN-SY-00001, 2009
- Crossrail, Archaeological Detailed Desk Based Assessment Liverpool Street Station, Report No CR-SD-LIV-EN-SR-00001, 2008

- Crossrail, MDC3 Archaeology Updated Baseline Assessment, Document Number 20032008-87MB-YYK5, 2008
- Crossrail, Archaeological Monitoring of Ground Investigations, Borehole Package 13, September 2009
- Crossrail, Central Section Project Fieldwork Report Archaeological Evaluation and Watching Brief Broadgate Ticket Hall (XSM10), Document Number C257-XRL-X-XCS-CRG02-50010, v2, 07.03.12
- Crossrail, Central Section Project Archaeology Framework C257 Central Package, Summary of LSS85 Archive – Broadgate Excavations, Doc No: C257-MLA-T1-XTC-C101_WS102-00001, Revision 2.0, Feb 2012
- Crossrail, C257 Archaeology Central Fieldwork Report, Archaeological Excavated Evaluations and Watching Briefs, Pit 4, Pit 11, Trench 14 and 15, Pile Line Pits and SSET/UKPN Utility Diversions, Broadgate Ticket Hall (XSM10), Doc No: C257-MLA-X-XCS-CRG02-50015, v2, 20.06.12

The fieldwork was carried out in accordance with:

- A Crossrail Site-specific Written Scheme of Investigation (SS-WSI): Liverpool Street Station, Site-specific Written Scheme of Investigation, Doc. No. C138-MMD-T1-RST-C101-00001 Version 2, 29.04.10, the addendum to the SS-WSI, Doc. No. C138-MMD-T1-RST-C101-00004, Revision 1.0, August 2010.
- The addendum to the SS-WSI, Doc. No. C138-MMD-T1-RST-C101-00004, Revision 3.0, July 2011
- An Archaeological Method Statement: MOLA, C257 Archaeology Central Method Statement Archaeological Excavation and Watching Briefs, Broadgate Ticket Hall, Utilities Corridor (XSM10), Doc No: C257-MLA-X-GMS-C101-50001, Revision 3.0, 30/05/12. The MOLA method statement was prepared in line with the Principal Contractor's method statement.
- The Written Scheme of Investigation (WSI) and Method Statements will be available from the LAARC.

5 Geology and topography of site

The geological and topographical setting was covered in detail in the Liverpool Street SS-WSI (Crossrail 2010b) and DDBA (Crossrail 2008), and is summarised below.

The drift geology on this site consists of Taplow terrace sands and gravels of the Thames valley, laid down approximately 128,000 to 280,000 BP (Before Present), within the valley of the River Walbrook, just south of its spring line. The archaeological potential of the terrace gravel deposits is considered to be very low. The natural geology was only reached within Pits 11 and 10 during this phase of investigation. No other trench was excavated to the base of the archaeological sequence during this phase.

In Pit 11, at the western end of the site, the levels and character of the natural deposits were consistent with those found previously in Trench 1 (Crossrail 2011d). At the base of the trench, London Clay [996] was found at 107.00m ATD, overlain by natural clayey terrace gravels [994] at between 107.30 and 107.40m ATD. In Pit 10, at the eastern end of the site, terrace gravels [924] were found at between 107.91m to 107.71m ATD (5.00 to 5.20m bGL). To date, this is the easternmost area to be fully excavated to natural, and the highest area of terrace gravel yet found. Previous evaluation results suggested little change in the level of natural terrace gravel west to east across the south of the site (Crossrail 2011d). However, levels of terrace gravel in Pit 10 would suggest a gradual downward slope east to west over the wider area. Such a slope would support the hypothesised location of the Blomfield Street Stream at, or possibly within, the western edge of the site.

The River Walbrook is a tributary of the Thames and formed a broad, shallow valley at its headwaters, with stream channels criss-crossing the area to the north. These channels converged to the west of the site to form a deeper, steeper channel now known as the Blomfield Street stream, running approximately north to south in a position now mirrored by the present-day Blomfield Street. The Walbrook is now entirely built over, much of it by the time John Stow published his survey of London in 1598, and has been diverted into underground culverts.

Streams of the Walbrook have been identified to the north and west of the Broadgate Ticket Hall site (FIN81, LSS85 and BDC03). A channel examined at the Broad Street Station site (LSS85) ran north-east to south-west across the site and reached a recorded depth of 106.3m ATD. It is clear that the course of the stream shifted within its valley over time (Dyson et al 1987). The western edge of the Blomfield Street stream was also tentatively identified in excavations during developments on the western side of Blomfield Street (FIN81).

During the 2011 evaluation (Crossrail 2012), terrace gravels were overlain by possible alluvial weathered natural deposits of clay, interspersed with occasional bands of gravel. These deposits appeared to be archaeologically sterile and devoid of any anthropogenic disturbance. While these deposits may have been deposited by the Walbrook, perhaps through seasonal flooding, no clear stream channels belonging to the historic River Walbrook were found.

Sporadic deposits of brickearth have been known to occur in the local area, as recorded at MoLAS site LNA99, overlying the river terrace gravels and sealed by the alluvium. The absence of undisturbed brickearth is consistent with previous results (Crossrail 2009c, 2009d, 2010a, 2011d and 2012) and with other local sites. Any capping brickearth may have been eroded within the flood plain of the Walbrook due to the activity of the river or truncated by later Roman activity.

6 Archaeological and Historical Background

The historic background and archaeological potential of the Liverpool Street Broadgate Ticket Hall site is summarised below and covered in detail in the Liverpool Street SS-WSI (Crossrail 2010b) and DDBA (Crossrail 2008), which are updated by the results of the initial phase of evaluations (Crossrail 2011d) and subsequent fieldwork (Crossrail 2012); these have been incorporated below.

There has been little evidence for Palaeolithic activity in the local area. Prehistoric activity recorded in archaeological interventions in the area of the Crossrail worksites for Liverpool Street consists of residual material found in later deposits; for example, Neolithic and Bronze Age flints at Moor House (MRL98) and late Iron Age pottery at River Plate House (RIB87).

The site of the Broadgate Ticket Hall lies *c* 120m north of the Roman and medieval city walls, within the upper Walbrook valley, immediately east of the Blomfield Street tributary of the River Walbrook. Excavations in the nearby area, off Old Broad Street, New Broad Street, Eldon Street and Blomfield Street, have shown evidence for significant Roman extra-mural activity, including the control and management of the Walbrook channel with revetment and banking, land-reclamation activity including drainage ditches, burials, and domestic and industrial occupation (site codes AD M81, BDC03, BRO90, CAP86, BLM87, NEB87, COLS3, GM122, LSS85, and FIN81). In addition, a Roman road was recently discovered to the west of the site during excavations south of Eldon Street (RIV87, FIB88, ENS03, ELD88 and BDC03). This road was found running west to east toward Bishopsgate, a route that, if it continued, would take it through the northern part of the Broadgate Ticket Hall site.

During the last phase of fieldwork, in Trench 14, augering was halted when a hard surface was encountered which could not be penetrated. This is likely to be a continuation of metalled and compacted gravel ground surface, which was found in Trench 13 to the south-east at 108.50m ATD. If so, this metalled surface would extend over an area approximately 5m or more south to north. This has prompted closer analysis and comparison with previous excavations in the local area, in particular, the character and route of the hypothesised Roman road, and has led to significant re-interpretations of previous evaluation results (Crossrail 2011d).

Both Trenches 13 and 14 are located within the path of the hypothesized Roman road (see Figure 5), based on the most recent conjectured route of the road based on the Eldon Street excavations to the north-west (Harwood et al, in prep 2012). Previously, in evaluation Trench 13, Roman features had been interpreted as attempts at land drainage and consolidation, since the thickness of the gravels and the character of the underlying deposits had not been considered consistent with Roman road construction techniques. However, sections of the Roman road found in the excavations south of Eldon Street (RIV87, FIB88, ENS03, ELD88 and BDC03) were of a similar character. Indeed, the latest interpretations of this road see it not as an intrinsic part of the road network, but more likely a local track leading across extra-mural open ground (Harwood et al, in prep). In addition, the road found south of Eldon Street was found to be of several phases, and dated broadly to the same period as features within Trench 13 (*c* mid- 2nd to mid- 3rd century AD).

The construction of the City Wall between *c* AD 180 and 225 was one of many factors that influenced the development of the upper Walbrook valley. Although the stream was conducted through the wall in a conduit, the wall is thought to have

significantly impeded the natural drainage of the upper Walbrook, and an area of distinctly marshy land formed in the valley outside the City Wall.

During previous phases of evaluation at this site (Crossrail 2011d and 2012), Roman archaeology was found at a fairly consistent level (at 108.85m ATD, *c* 5m below ground level (bGL) and was approximately 1m thick. Roman features included dump layers, four east–west aligned ditches, one north–south aligned ditch, a possible beam slot, floor/ground surfaces and pits. Despite the site's location being within the general area of the northern cemetery of the Roman City, no *in situ* Roman burials were discovered. However, a disarticulated human bone was found in Roman pit fill (Crossrail 2012). It is possible the bone is residual material from a disturbed burial in the area, for example, washed into the pit by flooding. Provisional dating places Roman activity within this area from the 1st century to the 3rd century AD.

Later medieval urbanisation north of the City Wall was initially only characterised by ribbon development along Bishopsgate, to the east. As a result, the area within the site remained a marginal area and open land. Earlier work associated with the Crossrail development at Finsbury Circus (XRZ10) has located Moorfields Marsh deposits overlying earlier Roman pits (Crossrail 2011b). Fieldwork (Crossrail 2011d) has suggested that there was little obvious activity in the post-Roman to early post-medieval period on this site. No Saxon or medieval features or structures were identified. In particular, no medieval remains associated with St Mary Bethlehem Hospital have been found.

In 1568/9, the City established the 'New Churchyard', the first of the early modern non-parochial churchyards. The burial ground would later become more commonly known as the 'Bethlehem Burial Ground' because of its association with the medieval Bethlehem Hospital (see Figure 13). The priory and hospital of St Mary (of) Bethlehem had been founded on the western side of Bishopsgate in 1247, on a site now beneath the present Great Eastern Hotel, and the burial ground was established on one acre of land belonging to the hospital. The site had not initially been intended for the exclusive use of the hospital, however, but as an 'overflow' area, relieving pressure on the increasingly crowded burial grounds within the City. In 1563, there was an outbreak of plague and, consequently, the City had sought to increase burial capacity in case of further epidemics. The extent of the 'New Churchyard' is shown on several historic maps (see Figure 15 to Figure 17). During the mid-19th century, Liverpool Street was widened to incorporate the southern part of the burial ground. The Broadgate Ticket Hall site is consequently located within the south-western part of the cemetery, in what is now the western half of Liverpool Street's carriageway and pavements.

In 1985, excavations at Broad Street Station (LSS85), immediately north of the site, investigated burials which had survived the construction of the station within the development footprint of Broadgate. The excavation trench was located under what had been the taxi cab ramp, immediately in front of the station building itself. Within the main excavation trench, over 400 partial or complete burials were encountered at a density of up to 8 per m^3 of ground and 200 more came from further test-pits (Malt & White 1987). More recent utility related excavations have continued to confirm the presence of human remains within the Broadgate Ticket Hall site (LVB06 and XRF09).

The previous phase of Crossrail evaluation (2012), found a total of 301 in situ post-medieval burials within the burial ground at a density of approximately 3.9 bodies per m^3 of ground (Crossrail 2012). The most recent phase of fieldwork added 72, giving a total of 373 articulated Bedlam burials so far.

7 Research objectives and aims

7.1 Objectives of the fieldwork

7.1.1 Fieldwork Objectives

The overall objectives of the excavation and watching briefs are to mitigate the impact of the relevant parts of the Crossrail works within their footprint, contributing to the wider mitigation for the Broadgate Ticket Hall.

The task-specific aims and objectives from the Addendum to the WSI (Doc. No. C138-MMD-T1-RST-C101-00004 Revision 3.0, section 2.1.1 and 2.2.1) are:

- The aim is to investigate and report on surviving archaeological deposits within the footprint of the Crossrail works in Liverpool Street, including those relating to a post-medieval burial ground (BG208), which survives within the worksite footprint, and also deposits relating to the medieval and Roman periods that have been positively identified.
- Mitigation in the form of archaeological excavation and general and targeted watching brief to excavate and record archaeological deposits for analysis and dissemination in accordance with the Crossrail Generic WSI (document number CRPN- LWS-EN-SY-00001) and the standards listed therein.

7.1.1.1 Topography and Geology

- What is the character of natural geology across the site, and is there any variation westward toward the Walbrook channel (truncation or topography)?
- Does any brickearth survive, and if so, what does this indicate about truncation by Roman or later activity?
- Is there evidence of any palaeochannels (eg precursors to the Walbrook channel of the Roman and post-Roman periods) or other topographic or geological features?

7.1.1.2 Roman:

- What are the nature, layout, and date of the different phases of Roman extra-mural activity and land use? For example, land reclamation (including drainage ditches of/into the Walbrook), potential occupation (including buildings), or other land uses (such as pitting, quarrying, or farming).
- Does the hypothesised Roman road lie within the site and, if so, how does it relate to other Roman activity within the area?
- Are there any Roman burials, disarticulated human remains or potential grave goods within the Roman deposits?
- What are the extent, orientation, dating, and character of the Walbrook channel(s) from the Roman period?
- Do any waterlain deposits have potential for organic preservation and palaeoenvironmental remains, and what do they indicate about the environment and conditions in and around the Walbrook?

- Is there evidence that the Walbrook channel was revetted, canalised or bridged from the Roman period onward? Did the timber posts seen in Blomfield Street during the 1925 (GM122) and 1981 (FIN81) watching briefs belong to a revetment(s) which extended into the Liverpool Street site?
- Is the ditch found in Pit 11/Trench 1 the canalised eastern edge of the Blomfield Street Walbrook channel, and was this feature open into the post-Roman period?

7.1.1.3 Medieval:

- What are the character, extent and date of the Moorfields Marsh in this area? Do the thin marsh deposits represent a continuum of medieval to post-medieval deposition, or post-medieval with residual medieval artefacts?
- Is there any further evidence for activities in the area of the marsh, for example ice skating, or in the surrounding area, perhaps from any refuse dumped in/on it?
- Is there any evidence of attempts to reclaim the marsh, eg by drainage (ditches etc) and dumping (land raising and consolidation) before the post-medieval?

7.1.1.4 Bethlehem cemetery:

- What is the character and date of the sequence of post-medieval dumping and reclamation associated with the establishment of the cemetery?
- What is the character, sequence, and dating of burials, in particular the date at which the cemetery went out of use?
- What is the character of the burial practice, and how does it change spatially and chronologically?
- What is the evidence for organisation/management and zoning of the burial ground?
- Are multiple or pit burials confined to the northern part of the site around Trenches 13 and 14, and the 1985 excavations?
- Can gravestones or marker/ledger slabs provide evidence which will identify individuals, and can these be correlated with documentary sources?

7.1.1.5 Other post-medieval:

- What is the date and taphonomy of deposition of the important worked bone assemblage? For example, are these finds residual in the post-cemetery deposits, or does it represent continued deposition during and after the use of the cemetery? Also, what is the spatial and chronological division of the different types of bone artefact across the site?
- What activities and industries in the surrounding area are represented by waste materials within dumps and the cemetery sequence?
- What is the character and date of any activity and occupation outside the burial ground?
- What is the character and date of structural remains relating to 18th and 19th-century urbanisation and development?

7.2 Research Aims

The original aims and objectives were listed in the SS- WSI Liverpool Street Station (Crossrail 2010b, section 4) and stated that 'Archaeological investigation and mitigation within the Crossrail worksites for Liverpool Street Station have the potential to contribute to the research themes set out below':

Evidence relating to the Walbrook, its tributaries and Moorfields Marsh deposits may provide data relevant to the following themes:

- Understanding London's hydrology, river systems and tributaries and the relationship between rivers and floodplains
- Understanding how water supply and drainage provision were installed and managed
- Refining our understanding of the chronology and function of the landward and riverside defences and extramural evidence of defensive or military structures in the Roman period
- Understanding the relationships between urban settlements and royal villas or religious estates
- Examining the proposal that there was an ideological polarity between town and anti-town systems: Roman towns did not so much fail as change
- The end of the Roman occupation: developing explanatory models to explain socio-political change and considering the influence of surviving Roman structures on Saxon development; and
- Examining the use in any one period of materials from an earlier period (e.g. Saxon use of surviving Roman fabric) and the influence on craftsmanship, manufacture and building techniques.

Evidence relating to the Medieval Bethlehem Hospital precinct and cemetery, bisected by Liverpool Street may provide data relevant to the following themes:

- Understanding the differences, if any, between burial practices in the city and outlying cemeteries
- Understanding life expectancy, origins and belief, seen through studying health, diet and disease, and preparing models for future research
- Considering the relationship between cemeteries and major or minor roads, in terms of symbolism, status, privacy and convenience; and
- Synthesising data on known religious sites and buildings, their chronology, use and influence locally, regionally and nationally.

Revised and new objectives for future fieldwork are presented in 13.1.

8 Methodology of site-based and off-site work

8.1 General

All archaeological excavation and recording during the fieldwork was carried out in accordance with the Crossrail Generic and Site Specific WSIs (Crossrail 2009a, 2010b, 2012b), Addendum (Crossrail 2011a), the MOLA Method Statement (MOLA 2013) and the Archaeological Site Manual (MoL 1994).

The purpose of the most recent phase of fieldwork was to mitigate the impact of the relevant parts of the Crossrail works within their footprint, contributing to the wider mitigation for the Broadgate Ticket Hall. Information has been collated on the presence or absence, character, extent, date, preservation, and importance of the archaeological remains predicted to exist in that area, in order to inform future mitigation of potential impacts of the Crossrail works.

The site finds and records can be found under the site code XSM10 in the MOLA archive. They will be stored there pending a future decision over the longer-term archive deposition and public access process for the wider Crossrail scheme. For the location of archaeological investigations see Figure 2.

8.1.1 Excavation and Recording of Human Remains

It was anticipated that human remains would be present on this site and an application was made to the Ministry of Justice for an exhumation licence. This was forwarded to the Design Archaeologist and Project Archaeologist for distribution to the Principal Contractor and any others who required them. A copy was kept on site with the TCS supervisor:

- Exhumation contractor TCS (T Cribb and Sons) Exhumation Limited received a burial licence for the removal of human remains (Licence number 11-0110, 20 July 2011).
- In a letter of the 21 September 2011, amending the conditions of the above licence, the Ministry of Justice permitted the extension of the burial license to 24 December 2014, that ‘any remains exhumed by TCS Exhumations Limited shall be reinterred, no later than 31 January 2015, at Willows Cemetery, Canvey Island’, and that ‘any remains exhumed by Museum of London Archaeology (MOLA) which are considered, in conjunction with Crossrail Project Archaeologist, to merit long term retention shall be kept safely, privately and decently by MOLA under the control of a competent member of staff; otherwise they shall be reburied, no later than 31 January 2015, by TCS Exhumations Limited’.

The methodology employed for the excavation of human remains is set out in the sections below, and in more detail in the SS-WSI (Crossrail 2010b) and the MOLA Method Statement (MOLA 2013, sections 5 and 7.2).

Human remains were removed by the C503 exhumation contractor, TCS, from the Open Cut, but recorded fully and removed for later assessment by MOLA from shafts MHS1 and MHS2-100.

Where in situ human remains would be visible to the public while excavated by the exhumation contractor, the Principal Contractor provided suitable screening. Additionally, the archaeologists avoided leaving remains exposed overnight wherever possible. In all cases, any disarticulated human remains were rapidly bagged and

removed to secure storage within the Liverpool Street site compound, and then removed from site by TCS.

Human remains excavated by exhumation contractor TCS were not recorded or otherwise dealt with by MOLA, who recorded the levels and extent of these remains, removed any coffin plates, gravestones, or other significant features, if present. A written and drawn record was made in accordance with the principles set out in the Museum of London site recording manual (MoL 1994). Trench location co-ordinates were supplied to the MOLA Geomatics team by the Principal Contractor.

8.1.2 Detailed Excavation Methodology for Human Remains

Human remains were encountered during the targeted watching briefs in both MHS1 and MHS2-100. In the case of post-medieval cemeteries the burials tend to be highly standardised and it was unnecessary to plan both skeleton and coffin. Where they existed, coffins were planned to scale. Skeletons were only planned to scale if there was no coffin. In addition, skeletons were recorded with a sketch on the reverse of the context sheet.

Where skeletons and/or coffins conformed to a standard, it was noted as such on the relevant recording sheet, and only aspects which differed from the norm were described. Coffin fittings were located on the sketch (or scale plan), as appropriate.

At all stages of archaeological work, human remains encountered were treated with care and respect. An osteologist was available throughout the project to offer advice to staff.

Where in situ human remains would be visible to the public, the Principal Contractor provided suitable screening. Additionally, the archaeologists avoided leaving remains exposed overnight wherever possible.

Digital record photographs were taken of all burials and significant deposits of disarticulated bone or other features. Human burials were recovered and bagged individually on site in large opaque plastic bags to ensure that the integrity of each burial was retained. Each skeleton was placed in archive quality perforated plastic bags with site code, context number and details.

8.1.3 Methodology for Disarticulated Human Remains

All disarticulated human remains recovered during the excavation of the Open cut, MHS1 and MHS2-100 were retained and passed to the Principal Contractor for storage until they could be transferred to the appointed C503 exhumation contractor (TCS Exhumation), who will rebury the remains in accordance with the terms of the burial licence.

8.2 Excavation methodology for the Utilities Corridor [GL1 to GL8; GL8 to the QVT]

The Utilities Corridor is located along the southern edge of the site, leading into sewer shaft MHS1 at the western end. Excavation of the trench was undertaken in two sections: the first from grid lines 1 to 8, the second from grid line 8 to the Queen Victoria Tunnel (QVT). Modern overburden was removed by the Principal Contractor (groundworks subcontractor McNicholas for C503 VCUK) using hand excavation, down to first significant archaeological deposit under supervision of MOLA staff. Where possible, McNicholas continued to excavate using a grab loading machine (extensive homogenous dumps as land reclamation). The remainder of the

archaeological deposits and features were hand excavated by MOLA. All archaeological deposits were recorded by MOLA.

A written, drawn and photographic record of all archaeological deposits encountered was made in accordance with the principles set out in the Museum of London site recording manual (MoL, 1994).

The locations of the trenches were recorded by MOLA Geomatics by optical survey. The survey utilised Crossrail London Survey Grid control stations, which were then tied into the Ordnance Survey.

8.3 Targeted Watching Briefs, MHS1, MHS2-100 and MHS2

The archaeological recording and excavation in sewer shafts MHS1 and MHS2-100, located at the western edge of the site where it meets Blomfield Street, and manhole MHS2, located at the eastern edge of the site where it meets Broad Street, were conducted as Targeted Watching Briefs.

The C503 Principal Contractor broke out the ground surface and removed the modern overburden down to the first archaeological horizon by machine, under supervision by the C257 MOLA Supervisor.

Low significance archaeological remains (marsh and dump layers) were also removed by C503 with MOLA supervision and recording, while burials and moderate/high significance archaeological remains (cut features) were investigated, recorded, and excavated by MOLA (including environmental sampling, see below).

A written, drawn and photographic record of all archaeological deposits encountered was made in accordance with the principles set out in the Museum of London site recording manual (MoL 1994).

The watching briefs ceased when natural deposits, such as terrace gravels or London Clay, were encountered and identified; river gravels were recorded as part of the archaeological investigation.

8.3.1 Environmental archaeology investigation methodology

The sampling strategy for the Liverpool Street sub-site is covered in more detail within the MOLA Method Statement (Crossrail 2012a).

Monolith tins were used to obtain a sequence through the river or flood deposits in each shaft; these will be analysed for environmental attributes on a local basis, giving a much broader picture of the area prior to occupation by the Romans, as well as complementing the Roman artefacts recovered from the edge of the channel. Clear evidence of Roman waterside activity and management will help to address the overall site objectives and identify any additional research aims.

Sampling, in general, was undertaken by the archaeologists in the form of 40 litre bulk samples, where possible. Samples were then processed and analysed off-site by archaeo-botanical and archaeo-zoological specialists. The initial environmental results from these samples can be found in 19.12.

The environmental procedures outlined in the Archaeological Site Manual (MoL 1994) and Environmental archaeology: a guide to the theory and practice of methods, from sampling and recovery to post-excavation (English Heritage 2002) were followed.

8.4 General Watching Brief Methodology (MHS1, MHS2-100, Open Cut Sewer, Utilities Corridor, Heading from MHS2-100, Manhole X)

The General Watching Briefs consisted of a basic monitoring presence to observe the works carried out either by the Principal Contractor or their sub-contractor without constraint on their working methods. A C257 MOLA Senior Archaeologist monitored all initial ground reduction by means of periodic visits, and longer attendance when required or called to site by the C503 Groundworks Contractor, McNicholas, when potential archaeological deposits were encountered. In the Open Cut sewer, work was then conducted under MOLA supervision. Excavation was by hand by McNicholas (SSET/UKPN diversion) and, where human remains were present, by TCS Exhumation.

For safety reasons, the C503 site managers determined that only trained miners could enter the MHS2-100 to Blomfield Street Sewer Heading Tunnel. The MOLA site supervisor therefore devised a new task-specific methodology, whereby MOLA could work with the McNicholas miners to produce an adequate record of archaeological remains, despite not being able to enter the heading.

McNicholas ably assisted MOLA by photographing the face (section) of the tunnel at a distance of every metre along the tunnel, enabling a composite section drawing to be produced, with the aid of key measurements taken by the miners after discussion with the MOLA archaeologist of the image(s) on the screen of the digital camera, as well as retrieving artefacts during excavation. The post-medieval timber piles were also plotted by McNicholas, enabling interpretation of the stratigraphy by MOLA.

This strategy was successful thanks to the co-operation of the McNicholas staff, not only producing an archaeological record, but recovering human skulls, an intact urn with its undisturbed cremation in-situ, with the critical evidence of their context.

9 Results and observations including stratigraphic report and quantitative report

Task	Date	Figures	Photos
Excavation [and associated watching briefs], the Utilities Corridor (see 9.1.1).	GL1-8 19/03/13 to 25/04/11 GL8–QVT 14/08/13 to 16/09/13	Figure 2, Figure 6, Figure 10, Figure 11	Photo 1, Photo 2 Photo 3
General and Targeted Watching Brief on area around Sewer Shaft MHS1 (see 9.2.1).	15/07/13 to 18/10/13	Figure 2, Figure 3, Figure 4, Figure 7, Figure 8, Figure 9, Figure 12	Photo 4, Photo 5, Photo 6
General and Targeted Watching Brief, Open Cut Sewer (see 9.2.2)	12/04/13 to 09/05/13	Figure 2, Figure 3, Figure 5, Figure 6	Photo 7, Photo 8 Photo 9
General and Targeted Watching Brief, Sewer Shaft MHS2-100 (see 9.2.3)	05/08/13 to 30/08/13	Figure 2, Figure 3, Figure 5, Figure 7, Figure 8	Photo 10 to Photo 14
General Watching Brief, sewer Heading from MHS2-100 (see 9.3.1)	10/09/13 to 03/10/13	Figure 2, Figure 4, Figure 5	Photo 15, Photo 16 Photo 17

Table 2: Archaeological investigations

See Figure 2 for trench locations

9.1 Excavation Trenches

9.1.1 Utilities Corridor

Photo 1: Excavation in Utilities Corridor GL8–QVT, looking west

Utilities Corridor (Figure 2, Figure 6, Figure 10, Figure 11)	
Location	Southern side of Liverpool Street, western end. Section GL1 to GL8 lies to the west and was investigated first. Subsequent section GL8 to the Queen Victoria Tunnel (QVT) lay towards the centre and east.
Dimensions	2.5m (north to south) x 51.3m (east to west) x depth to base archaeology 6m

London Survey grid coordinates	83384 36283
OS National grid coordinates	533033 181599
Modern Ground Level	Road surface at 112.32m
Modern subsurface deposits	Road surface 100mm thick, over concrete 500mm thick, above modern material 1500mm thick.
Level of base of archaeological deposits observed and/or base of trench	106.40m ATD
Natural geology observed	Terrace gravels at 107.83m ATD at the eastern end of the corridor and at 106.42m ATD at the western end. London Clay was present at 106.60m ATD.
Extent of modern truncation/overburden	Approximately 3m in depth
Archaeological remains	Dating Evidence, Finds, and Samples
Walbrook river gravels [1028], [1029], [1056], [1061], [1062], [1063], [1064], [1377], [1378], [1379] and [1380] were seen at a maximum height of 107.26m ATD, overlying alluvial clay at 106.60m ATD	Presumed prehistoric Samples taken, including monoliths samples {54}, {55}, and bulk samples {56} and {57}
Roman pit [1370] (108.50m ATD); six fills: [1371], [1372], [1373], [1374], [1375] and [1376], a mix of grey and brown clays and sandy silts	Roman pottery – AD 50 to 140, probably 2nd century if Northgate House product Fragments from Roman leather shoes (19.6) Samples taken, including bulk sample {81}
Roman gully/ditch [1055], E–W, 107.29m ATD, cut by Roman gully/ditch [1048] with possible row of stakes along its edge, NW–SE, 107.40m ATD	Roman pottery – AD 100 to 150 Samples taken, including bulk samples {52} and {53}
Roman ditch [1351], orientated east–west, 108.94m ATD	Presumed Roman
Roman ditch [1382], orientated north–south, 108.62m ATD	Roman pottery – AD 120 to 250
Roman dumps [1023], [1024], [1027], [1042], [1045], [1352] 108.78m ATD	Roman pottery – AD 200 to 300 Roman silver coin dated AD 200 to 202 Samples taken, including bulk sample {34} Copper alloy hairpins from [1023] and [1027]; bone gaming counter from [1027] (19.7) Wooden writing tablet and copper alloy needle from [1045] (19.7)

Marsh deposit [1018], [1020], [1021], [1025], [1037], [1040], [1041], - Grey brown clay silt, 109.40m ATD.	Roman pottery – AD 200 to 300 Samples taken, including bulk samples {32}, {42} and {46}
Ditch cut [1049 (fill [1036]), orientated north–south, 109.10m ATD	Roman pottery and leather shoe fragment – former AD 140 to 200, but probably residual as cuts marsh deposit Copper alloy wire of probable medieval date or later in [1036] (19.7)
Rubbish dump [1034], possibly 16th-century	Contained imported post-medieval pottery (19.3); Venetian gold coin (19.18); lead cloth seals, copper alloy candle holder and spoon, small brush, iron buckles, knife and horseshoe (19.7)
Consolidation dump [1017]	Tudor floor tile and residual medieval Penn tile (19.1)
Ditch cut [1348], orientated north–south, 109.62m ATD	Presumed post-medieval; fill [1343] contained a small copper bell (19.7)
Ditch cut [1356], orientated north–south, 109.62m ATD	Presumed post-medieval
Interpretation and summary	
Although excavated in two stages, GL1–GL8 and GL8–QVT, the results of the Utilities Corridor are presented together. River gravels overlying the natural terrace gravels appear to represent episodes of flooding, or early (pre-Roman) river coursing associated with the Walbrook. The Roman features include four possible ditches [(1048), (1055), (1351) and (1382)], probably dug to aid drainage in this area. A likely pit was also recorded [1370]. These had been overlain by marsh deposits, thought to date from the medieval to the early post-medieval periods. This boggy build-up had been cut into by a large feature, [1049]. It is unclear whether this was a pit or either part of, or a recut of, a feature identified previously in Trench 1 and Pit 11 (contexts [710] and [988] respectively). If it is the latter, the whole feature (cut [1049] measured 10m east–west and appeared to be orientated north–south) may be early post-medieval and relate to the north–south canalised course of the Walbrook illustrated on the Copperplate map from the 1553 (Figure 14).	

Photo 2: South-facing section of GL8–QVT showing Roman dumping over probable river flooding; looking north-west

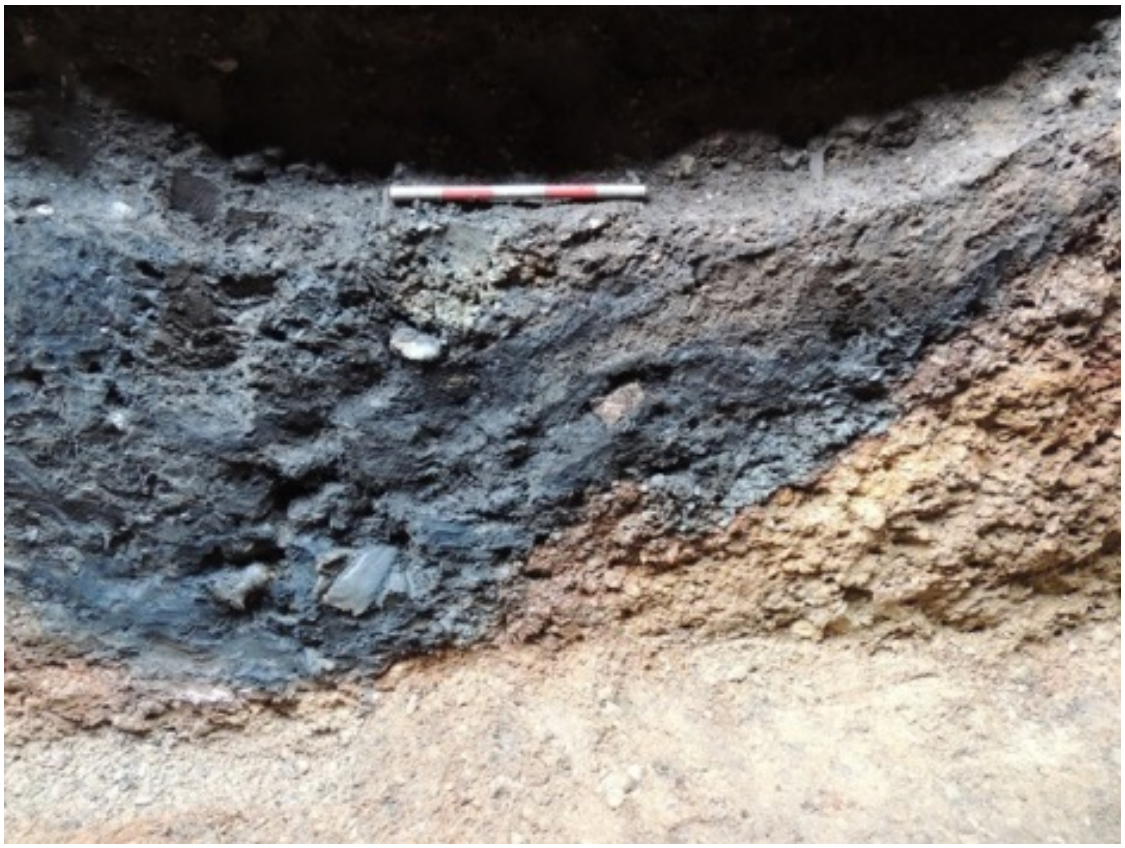

Photo 3: North-facing section of GL8–QVT, showing the backfill of a probable Roman pit; looking south

9.2 Targeted Watching Briefs

9.2.1 Sewer shaft MHS1

Photo 4: MHS1 excavation, looking west

MHS1 (Figure 2, Figure 3, Figure 4, Figure 7, Figure 8, Figure 9, Figure 12)	
Location	South-western corner of the site; western end of the Utilities Corridor.
Dimensions	11.2m (north to south) x 8.6m (east to west) x depth 7m
London Survey grid coordinates	83363 36294
OS National grid coordinates	533013 181609
Modern Ground Level	112.32m ATD
Modern subsurface deposits	Variable Generally 1m or thicker, up to 5m (subterranean lavatory)
Level of base of archaeological deposits observed and/or base of trench	106.25 to 106.42m ATD
Natural geology observed	Natural terrace gravels were seen at 106.42m ATD; London Clay was seen at 106.25m ATD.
Extent of modern truncation/overburden	Up to 5m deep
Archaeological remains	Dating Evidence, Finds, and Samples
Walbrook river gravels [1403], [1426], [1427], [1429], [1431], [1432], [1441], [1442], [1446], [1448] and [1453] - were recorded during a GWB to reach London Clay, 107.68m ATD	Presumed prehistoric Samples taken, including monoliths {102},and {103}, and bulk samples {89}, {93}, {94}, {95}, {97}, {98}, {99}, {100} and {101}
Roman dumping/ waterlain debris [1401], [1402], [1430] and [1443], dark grey organic clay silt, light brown silty clay, light grey blue clay, 107.66m ATD and 107.42m ATD	Roman pottery – AD 70 to 160 Human skull Roman leather shoe sole (19.6) Samples taken, including monoliths {86}, {87}, {88}, {91} and {92}, and bulk samples {84}, {85} and {90}
Roman timber structure: re-used gates [1423] and [1428], 107.45m ATD	Presumed early Roman
Roman timber structure: posts [1424] and [1425]	Presumed early Roman
Roman dumping/ waterlain debris [1353], [1399] [1422], [1445], [1447] mottled grey brown silty clay 107.72m ATD	Roman pottery – AD 120 to 200
Roman water channel [1405] (fills [1391], [1400]), 107.90m ATD	Human skulls, plus some other human bone; presumed early Roman
Roman dumps [1301], [1397], dark brown sandy silt, 108.81m ATD	Roman pottery – AD 120 to 160 1st- 2nd-century AD child's bracelet from [1397] (19.7) Samples taken, including bulk sample

	{83}
Marsh deposits [1193], [1384], mid grey organic silty clay 109.11m ATD.	Post-medieval pottery – 1480 to 1600 Also seven coins dated to late 3rd century AD Samples taken, including bulk sample {75}
Post-marsh consolidation dumps [1148], [1149], [1150], [1169], light grey sandy silt with CBM fragments, 110.89m ATD	Post-medieval pottery – 1630 to 1650 Also residual medieval pottery and decorated medieval floor tile Clay tobacco pipes Samples taken, including bulk samples {69} and {70}
Timber piles [1266], [1354], [1358], [1359], [1360], [1361], [1363], [1406], [1435], [1436], [1451] and [1452], surviving at max 109.61m ATD	Presumed early post-medieval
17th-century cemetery wall [1145], [1146], with timber piles [1358] and [1362], 110.50m ATD	Known part of the Bedlam burial ground
Earlier phase of post-medieval burials [1287], [1288], [1289], [1290], base of burials 108.87m ATD, top 109.03m ATD.	Known part of the Bedlam burial ground
Dumping/ soil build up in between phases of post-medieval burial, [1136], [1142], [1147], [1151], [1152], [1153], mixed rubble and dark grey sandy clay, 110.05m ATD	Post-medieval pottery – 1580 to 1700 Possible vitrified furnace lining from [1136] (19.7)
Later phase of post-medieval burials [1118], [1119], [1120], [1121], [1123], [1124], [1126], [1130], [1137], [1138], [1139], [1140], [1141], base of burials 110.00m ATD, top 110.67m ATD	Known part of the Bedlam burial ground; grave fill [1125] contained part of a glass tube dating to the 17th century (19.5)
Brick wall [1112] and [1113] with two fragmentary gravestones recovered from the core ([1115] and [1135]) – see 19.17.	Post-1666 brick One gravestone inscribed 1672, other second half of the 17th or very early-mid 18th century
Robber cut [1134] (fill [1133]) for cemetery wall [1145] *c* 109.90m OD	Post-medieval ceramic clay tobacco pipe fragments *c* 1660–1710 (19.4); offcuts of elephant ivory found in [1133] (19.7)
19th-century sewers [1342], [1449], 108.83m ATD	Observed evidence
Victorian toilet block [1450], *c*110.60m ATD	Observed evidence

Interpretation and summary
At least two phases of Walbrook watercourse were seen; the earlier, thought to be pre-Roman, comprised bands of clay and gravel, which appeared to slope from east down to west; at some point the water flow deposited light grey blue clay ([1401] and [1430]), which appeared to form a bank to the east. On top of this was a fairly thick layer, built up from a combination of waterlain debris, but with the addition of Roman dumping. On top of this layer was what appeared to be a timber platform made from two re-used Roman gates, [1423] and [1428], most likely a pair in their former life (Photo 5; see 19.16). Dating to the 2nd-century AD , it is likely that they were associated with activity at or near the edge of the Walbrook channel, presumably to add some stability to the ground. Figure 3 shows the location of the gates; the direction and position of the channel has been postulated from the presence of the blue clay in two areas, one in the south-facing section in MHS1, the second 11m into the MHS2-100 Heading. Two posts ([1424] and [1425]) had been driven through the wood of the gates. The fact that only the base points of the posts remained suggested that these were associated with a later timber structure (19.16). The location of the posts towards the edges of the gates and a lack of contemporary posts elsewhere in the area suggests the possibility that the posts were part of a superstructure, perhaps providing a roof for the structure itself, or as mooring posts. Water from the channel had flooded the area of the gates, leaving behind yellow gravel [1391], thought to be the result of fast-flowing water. The gravel (also recorded further north in the MHS2-100 Heading as [1437]) contained a number of human skulls (19.9), as well as horse remains (19.11), and had been sealed by a number of later episodes of flooding, leaving behind clay. This clay suggesting slower-moving currents. The marsh of the post-Roman to early post-medieval period had formed over these. Pre-Bethlehem burial ground cemetery consolidation dumps overlay the marsh deposits; these had been truncated by the construction cut for a rebuild of the western wall of the cemetery (the original wall was further east and seen during the 2011 fieldwork (Crossrail 2011d). Timber piles were driven through the marshy deposits, in order to support the brickwork above. Only two piles were seen as part of the 17th-century wall; numerous timbers were recorded as part of the 16th-century boundary (recorded in the MHS2-100 Heading and in MHS1). A total of 17 burials were recorded in MHS1 as part of the Bedlam burial ground; four were seen at a height of *c* 109m ATD, with the remainder about 1.50m higher up, suggesting the possibility of two separate phases of burial. Brick wall [1112/3] (Figure 9), incorporating fragments of grave slabs (19.17) assumed to be from the Bedlam burial ground, represents a mid to late 18th-century building encroaching onto the area of the burial ground. This was probably one of those seen in the south-western corner of the burial ground on Rocque's map of 1746 (Figure 17) or Horwood's of 1799 (Figure 18). Two Victorian culvert brick sewers, one disused, its replacement still active, were present running east–west across MHS1. Both had been built by the 'cut and cover' technique, as opposed to tunnelling. The earlier sewer [1342], built from a mix of red and yellow bricks, was seen previously in Pit 1 [535]. A section of this sewer had been backfilled with concrete to create a foundation for the floor of a subterranean toilet block, the top of which can be seen on Ordnance Survey maps from 1913 to 1951.

Photo 5: The Roman timber gates in MHS1

Photo 6: The Roman water channel in MHS1: the yellow gravel represents the course of the water, the dark grey clay the eastern bank; looking north-west

9.2.2 Open Cut Sewer

Photo 7: Open Cut Sewer, looking east

Open Cut Sewer (Figure 2, Figure 3, Figure 5, Figure 6)	
Location	Sewer trench located along the northern edge of the western end of Liverpool Street, to the north of the pavement and to the immediate east of MHS2-100.
Dimensions	1.7m (north to south) x 20.7m (east to west) x depth 5.5m
London Survey grid coordinates	83389 36306

OS National grid coordinates	533038 181622
Modern Ground Level	112.91m ATD
Level of base of archaeological deposits observed and/or base of trench	Base of trench at 106.54m ATD
Natural geology observed	Terrace gavels were seen at 107.39m ATD.
Archaeological remains	Dating Evidence, Finds, and Samples
A possible water channel was cut into terrace gravels, [1097], 107.39m ATD	Presumed prehistoric
Waterlain bands of clay and gravel [1093], [1094], [1095], [1096] and [1098] at 107.53m ATD	Presumed prehistoric Samples taken, including bulk sample {66}
Timber stake [1092], 107.73m ATD	Presumed early Roman, or possibly pre-Roman (19.16)
Roman road foundation layer of twigs/ brushwood [1087], 107.55m ATD	Presumed early Roman
Roman road gravel make-up, road surface and wheel ruts [1030], [1079], [1081], [1084], [1085], [1086] and [1091], compacted mid grey brown sand, gravel and flint, 108.27m ATD	Roman pottery – AD 50 to 100 Samples taken, including bulk sample {65} Dropped bar terret ring from harness in [1091] (19.7)
Second phase of Roman road make-up and gravel surface [1075], [1076] and [1077], compacted mid brown grey gravel and sandy silt, 108.62m ATD	Roman pottery – AD 120 to 250
Marsh deposits [1072], [1073], [1074], mid grey and brown peaty clay organic mix, 109.88m ATD	Roman pottery – AD 100 to 120, but probably residual Samples taken, including bulk samples {62}, {63} and {64}
Ditch cut, possibly as part of early post-medieval canalised channel [1069], 109.23m ATD	Roman pottery – AD 170 to 300 Samples taken, including bulk samples {59}, {60} and {61}
Consolidation dump [1066], mid brown grey organic clay and silt, 109.44m ATD	Post-medieval pottery – 1580 to 1600 Samples taken, including bulk sample {58}
Post-medieval burials excavated by the C502 exhumation contractor	Known part of the Bedlam burial ground
Interpretation and summary	
The archaeological investigation in the Open Cut sewer was undertaken in two stages. The main area of the trench was conducted as a general watching brief on removal of bone and concrete deposited in 1985, as reburial of disarticulated human remains; the western end a targeted watching brief, following removal of the post-medieval remains by an exhumation contractor. During the targeted watching brief in MHS2-100, the backfill in the western end of the Open Cut was re-excavated.	

The proximity of the two areas has enabled an amalgamation of results (see MHS2-100; section 9.2.3).

Walbrook river gravels had been pierced by a single timber stake, surviving at the western end of the Open Cut trench. The stake, possibly part of a structure pre-dating the Roman period altogether (19.16), had been covered over by the foundation brushwood of the first phase of a Roman road, whose make-up layers had been covered by a metalled surface, complete with wheel ruts and horseshoes (19.8). A later phase of make-up and gravel combined to form a second road surface [1075].

Marsh deposits, believed to date from the post-Roman to early post-medieval period, had settled over the Roman road. A large feature [1069], thought to be the western edge of a north–south ditch (or even the early post-medieval canalised channel of the Walbrook, as illustrated on the Copperplate map 1553: Figure 14), was recorded cutting the marshy deposits. A single consolidation dump sealed its backfill; this is the same pre-cemetery consolidation dump seen in MHS1 and MHS2-100 (see 9.2.1 and 9.2.3). The post-medieval burials, part of the Bethlehem burial ground, were removed by an exhumation contractor for Crossrail.

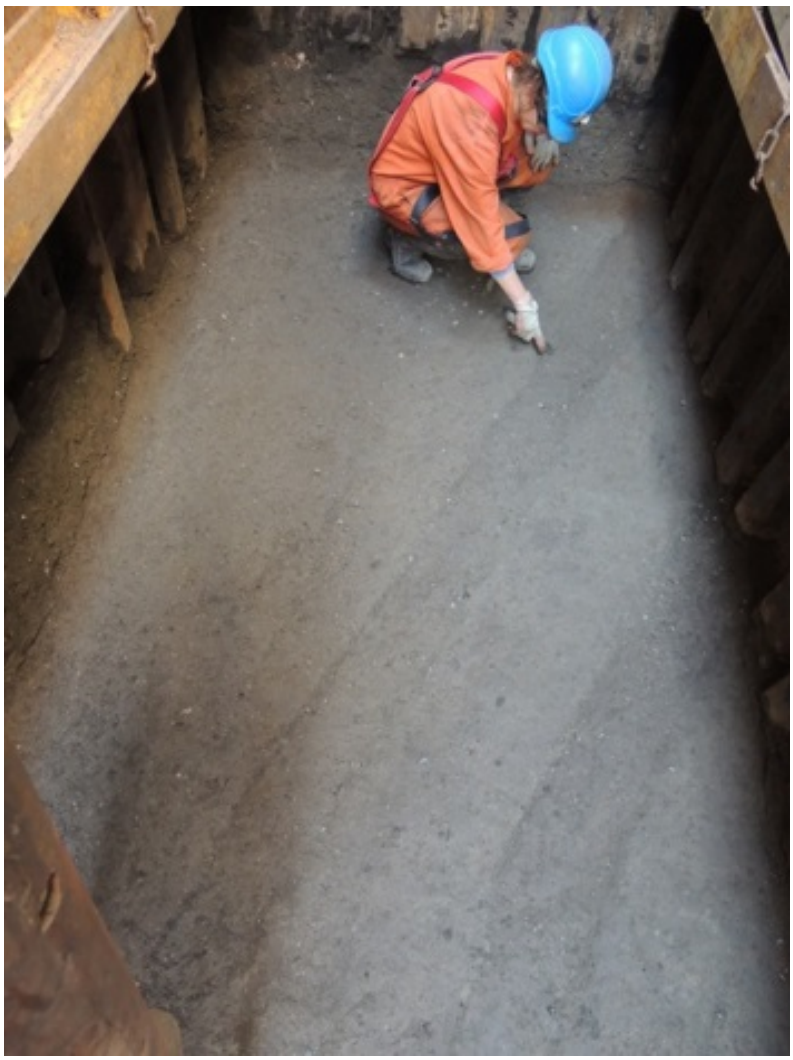

Photo 8: Wheel ruts across the earlier Roman road in Open Cut TWB; looking west

Photo 9: Brushwood foundation for earlier Roman road; looking west

9.2.3 Sewer shaft MHS2-100

Photo 10: Lifting up the skip in MHS2-100; looking east

Photo 11: Three stakes from a possible structure pre-dating the Roman road. Twigs from the road foundation can just be seen to the right; looking east

MHS2-100 (Figure 2, Figure 3, Figure 5, Figure 7, Figure 8)	
Location	North-western corner of the site, junction of Liverpool Street and Blomfield Street. The western end of the Open Cut sewer trench (TWB) intruded into the shaft (9.2.2).
Dimensions	3.5m (north–south) x 3.5m (east–west) x 6m depth
London Survey grid coordinates	83379 36309
OS National grid coordinates	533028 181624
Modern Ground Level	113.00m ATD
Modern subsurface deposits	Modern backfill to ground surface and concrete *c* 1.40m bGL
Level of base of archaeological deposits observed and/or base of trench	Base of shaft at 107.35m ATD
Natural geology observed	Natural deposits were not reached.
Extent of modern truncation/overburden	Approximately 1.40m in depth
Archaeological remains	Dating Evidence, Finds, and Samples
Three stakes [1338], [1339] and [1340], orientated east–west, *c* 107.40m ATD, cut into river clay [1341]	Presumed early Roman, or possibly pre-Roman (19.16)
Roman road foundation layer of brushwood [1337], 107.35m ATD	Presumed early Roman Samples taken, including bulk sample

	{77}
Roman road gravel make-up, road surface and wheel ruts [1305], [1307], [1327], [1328], [1329] and [1335], compacted yellow and grey sand with flint and gravel, 108.34m ATD	Context [1335] contained part of a Roman leather shoe 19.6) The road has been generally assigned to the mid- 2nd to early 4th centuries.
Second phase of Roman road make-up and gravel surface [1315], [1318], [1319], [1320], [1321], [1322], [1323], [1324], [1325] and [1326], compacted mid brown gravel and sand, 108.66m ATD	Hipposandals from [1323] (19.8) and a worn Trajan coin from [1322] (19.18).
Deposits [1311] and [1314] over road, mid grey slightly organic silty clay, possibly associated with localised flooding, 109.15m ATD	Dump [1314] contained a battered silver coin (denarius), hipposandals and a stone hone (19.7; 19.8, 19.18)
Marsh deposit [1291], mid grey and black organic silty clay, 110.10m ATD	Date unknown, probably medieval Samples taken, including column sample {73}
Latest marsh deposit [1284]	Presumed medieval
Consolidation dumps prior to instigation of burial ground [1280], [1242], mid greenish grey clay silt with mortar, chalk and CBM fragments, 110.73m ATD	Post-medieval pottery – 1580 to 1600
Earlier phase of post-medieval burials, [1217], [1252], [1256], [1272], [1276], base of burials 110.57m ATD, top 110.69m ATD	Known part of the Bedlam burial ground
Oak land tie, possibly associated with construction of 17th-century cemetery wall (rebuild) [1293], [1294], [1295] 110.50m ATD	Known part of the Bedlam burial ground (See 19.16)
Brick and stone wall [1215], orientated north-east–south-west, 111.27m ATD	17th-century bricks, stone (worked), re-used
Later phase of post-medieval burials [1159], [1161], [1162], [1163], [1165], [1167], [1172], [1174], [1175], [1196], [1198], [1200], [1202], [1204], [1211], [1213], [1219], [1221], [1223], [1226], [1228], [1230], [1232], [1234], [1236], [1238], [1240], [1243], [1245], [1247], [1249], [1254], [1262], [1267], [1269], [1270], [1272], [1276], [1277], [1285], with charnel pit [1283], base of burials 110.20m ATD, top 110.97m ATD	Known part of the Bedlam burial ground
Last phase of post-medieval burials [1157], [1170], [1178], [1180], [1182],	Known part of the Bedlam burial ground

[1194], 111.15m ATD	
General context number for cemetery soil [1156], dark greyish-brown clay silt, 111.58m OD	Contained ceramic clay pipe fragments *c* 1680–1710 (19.4); copper alloy buckle and strap end (19.7)

Interpretation and summary
Three small stakes in a row [1337]–[1339] were recorded, orientated NE–SW. Possibly associated with [1092] in neighbouring Open Cut TWB (9.2.2), as part of a fence line or pen. The stakes had been sealed by the foundation for an initial phase of Roman road. The road itself was recorded in the Open Cut, MHS2-100 and the Heading leading off MHS2-100 (9.3.1), giving it the projected line that is shown in Figure 5. It consisted of several layers of make-up and phases of compacted gravel surfaces, one with probable wheel ruts. The two phases of road identified were also recorded in neighbouring Open Cut sewer (9.2.2; ie later surface [1315] in MHS2-100 provisionally equated to [1075] in Open Cut; earlier surface with wheel ruts [1328] in MHS2-100 equated to [1083], complete with hipposandals, in Open Cut (19.8). Possible flood deposits covered the later road phase, with Moorfields marsh deposits over that. Consolidating dumps were present on top of the marsh, laid prior to the first burials recorded in this part of the site, as part of the Bethlehem burial ground. A number of graves had been disturbed in order to construct a new cemetery wall at the western edge of the burial ground in the 17th century (see Photo 13; Figs 7 and 8). A charnel pit was also seen, its formation probably also as a direct result of the disturbance. The remains of an oak land tie are thought to be associated with the construction of the wall, suggesting ongoing flooding from the Walbrook tributary in this area. Individuals buried after the construction of the wall were laid out in two phases, the earlier east–west, the later more stacked and orientated north–south, suggesting further disturbance. Survival of burials was greater in this shaft, due to a much lesser degree of later post-medieval and modern activity.

Photo 12: The post-medieval land tie in MHS2-100, thought to be associated with the construction of the later cemetery wall in the 17th century (also seen); looking west

Photo 13: Burial disturbance from construction cut for later 17th-century cemetery wall, looking south-west

Photo 14: The second phase of post-medieval burials appearing in MHS2-100; looking west

9.3 General Watching Briefs

9.3.1 MHS2-100 Heading

Photo 15: The MHS2-100 sewer heading; looking south-west

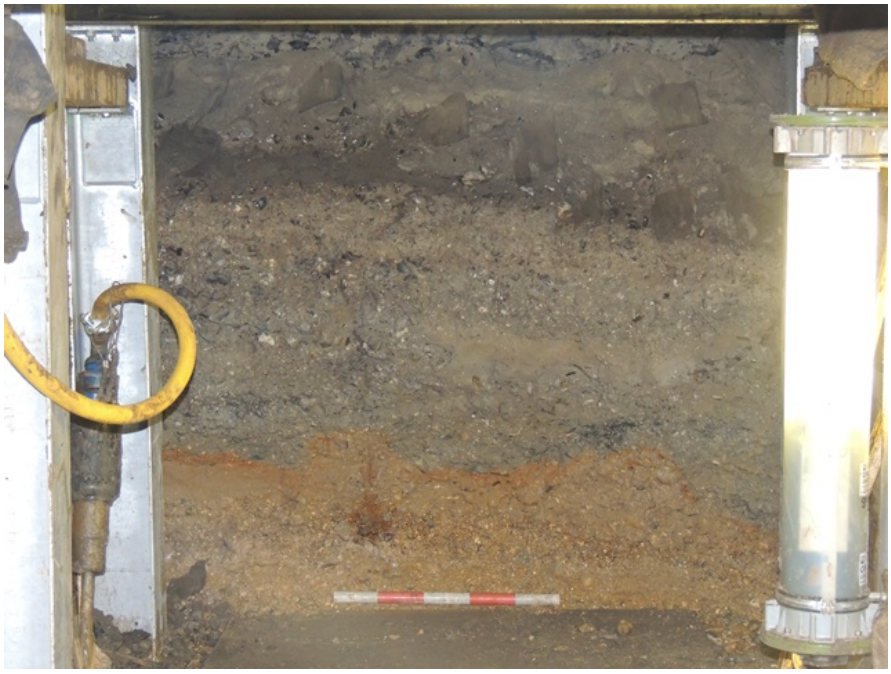

Photo 16: The section at 4m into the heading from MHS2-100. It shows twigs from the foundation of the Roman road at the top, overlying a large band of river clay; this overlay river gravels, with natural terrace gravels at the base; looking south-west

MHS2-100 Heading (Figs 2, 4, 5)	
Location	5m below ground surface, between sewer shaft MHS2-100 and the Blomfield Street sewer. Orientated NE–SW. Base of Heading at 106.80m ATD.
Dimensions	16.75m (NE–SW) x 1.7m (NW–SE) x depth 1.75m
London Survey grid coordinates	83372 36306
OS National grid coordinates	533021 181622
Modern Ground Level	N/A: continued from base of MHS2-100 at 107.35m ATD
Modern subsurface deposits	N/A
Level of base of archaeological deposits observed and/or base of trench	106.80m ATD (SW) to 107.20m ATD (NE)
Natural observed	Natural terrace gravels were present at the NE end at 107.20m ATD and 106.90m ATD at the SW.
Extent of modern truncation/overburden	N/A
Archaeological remains	Dating Evidence, Finds, and Samples
Bands of river clay (108.25m ATD) [1455] and gravel [1456] were present (107.80m ATD)	Presumed prehistoric
Walbrook river gravel [1437]	Roman
Twig/ brushwood foundation [1335] for Roman road (108.35m ATD)	Presumed early Roman
Cremation burial [1439] (base of pot at 108.25m ATD)	Roman pottery – AD 120 to 160 (see Appendix 19.2)
Feature containing human skull, fill [1438]; Photo 17; mid grey brown sandy silt, (base at 108m ATD)	Presumed Roman
Timber piles (elm), lowest point reached by a tip: 107.80m ATD	Thought to date to the 16th century

Interpretation and summary
See section 8.4 for the unusual circumstances and methodology of this watching brief. Bands of river clay and gravel overlay the natural terrace gravels; these are thought to have been deposited in a Walbrook channel in a Palaeolithic environment. Remains of the twigs/brushwood layer [1335], seen previously in the neighbouring MHS2-100 sewer shaft, continued into the Heading to a distance of approximately 5m from its north-eastern entrance (where it meets MHS2-100). The twigs helped to provide a stable foundation for the road gravels across a boggy landscape.

Both the potential burial activity (human skull in deposit [1438], present at 11m into Heading) and (cremation [1439], present at 16m into Heading) and the remains of the Roman road foundation [1335] appear to be later than the yellow gravel [1437] of the infilled water channel. Although this is not conclusive proof of their contemporaneity, it does suggest that both forms of activity occurred after this specific water channel had silted up and dried out.

A series of timber piles were recorded penetrating the Roman river gravels, between 8m and 11m into the Heading from MHS2-100, to a depth of 107.80m ATD. The timbers, identified as being elm, were plotted onto the LSG (project) grid; slightly clustered, they appear in linear form and are believed to have been a foundation for the original 16th-century western brick wall of the Bethlehem Hospital burial ground.

Photo 17: The section at 11m into the heading from MHS2-100. It shows a human skull that appears to be contained within a cut feature [1438], above the yellow river gravels; looking south-west

9.3.2 Manhole X

Photo 18: River clay and gravel bands overlying natural terrace gravels, truncated by Manhole X and heading

Manhole X (Figure 2)	
Location	Northern edge of site, in central position
Dimensions	4m (E–W) x 4m (N–S) x 6.50m
London Survey grid coordinates	83401 36302
OS National grid coordinates	533094 181586
Modern Ground Level	Pavement at 112m ATD
Modern subsurface deposits	Modern backfill to ground surface and concrete *c* 3.50m bGL
Level of base of archaeological deposits observed and/or base of trench	The manhole was present to a depth of *c* 106.5m ATD; the shaft itself reached a total depth of *c* 105.5m ATD, in order to remove part of the heading (see Photo 18).
Natural observed	Natural terrace gravels were present at *c* 105.8m ATD
Extent of modern truncation/overburden	Approx 3.50m in depth

Archaeological remains	Dating Evidence, Finds, and Samples
• Layers of waterlain clay and gravel were present at 108.50m ATD, thought to have been the result of flooding from the Walbrook to the west.	Date unknown

Interpretation and summary
• The demolition of Manhole X involved the excavation of a shaft by McNicholas. This was undertaken as general watching brief by MOLA. Manhole X was present to a depth of *c* 106.5m ATD; the shaft itself was extended to a depth of *c* 105.5m ATD, in order to remove part of the heading. • A narrow band of archaeological stratigraphy (approximately 0.50m north–south) survived on the southern side of the manhole only. No other archaeological deposits were exposed.

9.3.3 TWB manhole MHS2

Photo 19: View into MHS2, looking down to south

MHS2 (Figure 2)	
Location	
Dimensions	4m (E–W) x 4m (N–S) x depth 5.50m
London Survey grid coordinates	83442 36269
OS National grid coordinates	533052 181618
Modern Ground Level	Road surface at 112.32m
Modern subsurface deposits	Modern backfill to ground surface and concrete till *c* 4m bGL
Level of base of archaeological deposits observed and/or base of trench	Base of archaeology at c 107.30m ATD
Natural observed	Natural terrace gravels were present at 107.30m ATD
Extent of modern truncation/overburden	3m–4m in depth
Archaeological remains	Dating Evidence, Finds, and Samples
Dump [1456]; mid grey brown clay silt	Either Roman or early post-medieval, mix of Roman and 16th-century pottery
Ditch [1455] with very dark brown organic fill [1454]; survived to height of	Early post-medieval: 16th-century pottery, animal horn and bone

c 108.30m ATD	
Victorian pipes (N–S) [1457] and Victorian sewer [1458]	Observed evidence

Interpretation and summary
Below the modern backfill and concrete were the remains of an E–W ditch [1455] dating to the early post-medieval period. The earliest ditch fill [1454] (very dark brown clay) at the base of the ditch can be seen at the southern edge of the trench (Photo 19; below the wooden props). This ditch had cut a large grey-brown silty dump [1456], remains of which can be seen to the north and survived to a height of 108.90m ATD. Dating for the dump is inconclusive; it contained both Roman and early post-medieval pottery sherds and it is unclear whether one or other was residual or intrusive. Natural terrace gravel was present below [1456] at a height of 107.30m ATD and is also visible as a patch of brown to the right (west) of the centre of the photo. The small circular feature in the centre of the photo turned into a linear cut [1458] full of 18th-century demolition material. Yellow gravel backfill from north–south Victorian service pipes [1457] can be seen to the left (east) of the photo. To the immediate south of the circular skip, an east–west line can be seen between grey silt and the brown natural gravel. This grey backfill concealed an east–west concrete and brick structure; its western end is visible in Photo 20. It is thought that this was part of a manhole, possibly associated with the large east–west sewer [1458] which was underneath. Although no burials or human remains were found, the extent of modern truncation in this shaft means that it is not possible to determine whether the burial ground originally extended this far east or not.

Photo 20: Photo showing the western end of the concrete and brick manhole, looking north

10 Assessment of Results against Research Aims

The following research questions, laid out previously in section 7.1, have been met and information recovered on:

10.1 Topography and Geology

- *What is the character of natural geology across the site, and is there any variation westward toward the Walbrook channel (truncation or topography)?*

As in the previous phase (Crossrail 2012), a gradual drop was noted in the natural terrace gravels from east down to west; this ties in with the presence of the water channel, as part of the Walbrook, at the western end of the site. A drop of over a metre was recorded between GL8–QVT to the east (107.83m ATD), and MHS1 to the west (106.42m ATD).

There is also a lesser gradient from north down to south, one only really seen at the western edge (as might be expected with fluvial activity leading south towards the Thames). Terrace gravels were recorded at 107.20m ATD at the north-eastern end of the MHS2-100 Heading; these fell to 106.90m ATD at its south-western end, dropping to 106.42m ATD, already stated for MHS1.

Bands of clay, gravel and peat, seen across the entire site, are thought to relate to episodes of flooding from the Walbrook; these can be investigated in a more informative site-wide context during the main excavation of the ticket hall area. London Clay was reached only in the Utilities Corridor (GL1–GL8) and in MHS1 (at 106.60m ATD and 106.25m ATD respectively).

Of potential interest was the inconsistency of both the terrace gravels and London Clay in MHS1; river gravels were overlying the terrace gravels in the northern section, but London Clay in the southern. The gravels were much deeper to the north of the trench, with London Clay appearing here at 105.29m ATD, compared with 106.25m ATD in the south. This dive down to the north suggests eddying water during the deposition of the terrace gravels in the environment of the Pleistocene period, but show a degree of early Holocene reworking that suggests they lay at the eroding edge of the channel. Once this period of likely early prehistoric landscape instability ceased, however, fen vegetation appeared to have formed in a mudflat environment. Subsequent flood events gave way to more consistent, higher energy flow, with deposition forming a stabilised river bank, on which the later Roman activity appears to have taken place.

- *Does any brickearth survive, and if so, what does this indicate about truncation by Roman or later activity?*

No brickearth was seen during the most recent phase of fieldwork.

- *Is there evidence of any palaeochannels (eg precursors to the Walbrook channel of the Roman and post-Roman periods) or other topographic or geological features?*

Remains of a palaeochannel were recorded in MHS1 (9.2.1); its approximate north–south path has been reproduced on Figure 3. Alternating layers of clay and gravel, associated with both the flow of water and the filling up of the channel, were seen largely during machine excavation and sampled for environmental evidence (19.13).

Remains of another possible channel were recorded at the western edge of the Open Cut sewer (9.2.2), but too little was seen to allow positive identification. A probable

pond was recorded in the utilities corridor, however, associated with flooding from the channel (19.13).

- *What are the nature, layout, and date of the different phases of Roman extra-mural activity and land use? For example, land reclamation (including drainage ditches of/into the Walbrook), potential occupation (including buildings), or other land uses (such as pitting, quarrying, or farming).*

New evidence has emerged for waterside activity in the form of timber structures, funerary ritual and road construction (see Table 3). A group of stakes was recorded to the immediate east of the postulated route of a pre-Roman Walbrook channel; the group may have been part of a fence or small structure. Further south, again to the immediate east of the channel, were two Roman gates laid flat as a probable platform. The wood from the gates dates to the early 2nd century AD. Waterlain gravel overlying the gates contained nearly 40 Roman skulls, thought to have been washed downstream from an established Roman cemetery. These also date largely to the 2nd century AD.

A cremation pot had been buried above the same river gravel; a single skull may have also originated from a dug feature in this area, suggesting ritual burial. All of these features add to the Roman landscape already recorded during previous fieldwork phases, which included remains of a fairly substantial Roman road, as well as pits, rubbish dumps and ditches further east, away from the Walbrook. The recovery of wall plaster from two features along the northern edge of the site also suggests building in the general vicinity.

- *Does the hypothesised Roman road lie within the site and, if so, how does it relate to other Roman activity within the area?*

Further remains of the Roman road, thought to have run roughly north-west to south-east, have been recorded in MHS2-100 (9.2.3) and the Open Cut sewer (9.2.2), where a brushwood foundation and several layers of gravel make-up were recorded below two phases of metalled surface that included wheel ruts and associated horseshoes (19.8). The southern extent of the road foundation was seen up to 5m into the MHS2-100 Heading (9.3.1).

- *Are there any Roman burials, disarticulated human remains or potential grave goods within the Roman deposits?*

As stated above, nearly 40 human skulls were recovered from river gravel. Also present were a number of Roman ceramic pots (19.2) that possibly originated from the same graves. The recovery of the cremation pot and skull from features dug into the river gravel additionally indicates Roman burial on the site itself.

- *What are the extent, orientation, dating, and character of the Walbrook channel(s) from the Roman period?*

The fieldwork revealed the eastern edge of a water channel thought to belong to the Walbrook in the Roman period. Substantial yellow gravel infill enabled a projected line and orientation for the channel to be plotted (Figure 4). The deposition of the gravel, suggesting fast water flow, may be linked to the construction of the City Wall at the end of the 2nd century. If the river was stemmed further north in order to allow the building work to go ahead, there may have been occasional torrents as water was either released or else escaped at certain points.

- *Do any waterlain deposits have potential for organic preservation and palaeoenvironmental remains, and what do they indicate about the environment and conditions in and around the Walbrook?*

A number of column samples taken across the pre-Roman and Roman sequence of the Walbrook stream have yet to be analysed; their results will be included in a revised version of this report when external assessments are received.

- *Is there evidence that the Walbrook channel was revetted, canalised or bridged from the Roman period onward? Did the timber posts seen in Blomfield Street during the 1925 (GM122) and 1981 (FIN81) watching briefs belong to a revetment(s) which extended into the Liverpool Street site?*

So far, there is no evidence for the revetting or canalising of the Walbrook channel within the footprint of the site. It is likely, however, given its orientation, that the Roman road would have crossed the watercourse and it is possible that there was a bridge in the immediate vicinity. Although the relationship between the road and the yellow river gravel could not be established, it is highly likely that the road, like the cremation and the feature with the human skull, was built over this phase of silting up. The gravel, being fairly dense, would have provided some stability; the continuing waterlogged nature of the area, however, is borne out by the brushwood foundation of the road, which would have been effective at soaking up some of the water. The fact that there were two phases of road surface would not be unusual and does not necessarily suggest any specific ongoing problems with water.

- *Is the ditch found in Pit 11/Trench 1 the canalised eastern edge of the Blomfield Street Walbrook channel, and was this feature open into the post-Roman period?*

It is possible that the ditch found previously appeared again in the Open Cut sewer and at the western end of the Utilities Corridor (see Fig 6). The excavation of the future ticket hall should confirm or refute the suggestion that these features are part of the same canalised channel.

10.2 Medieval

- *What are the character, extent and date of the Moorfields Marsh in this area? Do the thin marsh deposits represent a continuum of medieval to post-medieval deposition, or post-medieval with residual medieval artefacts?*

The marsh deposits were seen in every shaft or trench excavated during the fieldwork. No precise eastern limit for the Moorfields Marsh has yet been established; this may change in the event of further fieldwork. No medieval remains associated with St Mary Bethlehem Hospital have been found either. The only medieval find was a metapodial ice skate (19.7), but, as in the previous phase of fieldwork, no medieval occupation deposits or features have been identified.

- *Is there any further evidence for activities in the area of the marsh, for example ice skating, or in the surrounding area, perhaps from any refuse dumped in/on it?*

As mentioned above, a bone skate was recovered during this latest phase of fieldwork, bringing the total to three skates altogether. This suggests ice skating somewhere in the surrounding area. There was no evidence for other medieval activities in the area of the marsh, however; only three features yielded medieval pottery, but this is likely to have been redeposited. The final phase of fieldwork is expected to add to our knowledge of this period.

- *Is there any evidence of attempts to reclaim the marsh, eg by drainage (ditches etc) and dumping (land raising and consolidation) before the post-medieval?*

As above, the lack of evidence for medieval activities also extends to marsh reclamation.

10.3 Bethlehem cemetery

- *What is the character and date of the sequence of post-medieval dumping and reclamation associated with the establishment of the cemetery?*

Post-Roman Moorfields Marsh deposits were sealed across the whole site by early post-medieval reclamation deposits, laid to consolidate the ground for the establishment of the Bethlehem burial ground. Elements from two phases of the western cemetery wall were identified; about 40 timber piles from the former and five from the latter, presumably sunk to provide stability in the marshy ground, were still in situ, penetrating Roman deposits below. A later wall, also built above timber piles about a metre to the east of the original one, was associated with a timber land-tie (19.16), suggesting ongoing issues from the water of the Walbrook.

- *What is the character, sequence, and dating of burials, in particular the date at which the cemetery went out of use?*

A minimum number of 72 in situ articulated burials from the 16th–17th-century burial ground were recorded from trenches MHS1 and MHS2-100. Three distinct phases of burial have so far been identified – there is evidence for dumping/ ground consolidation in between the first two, with a late episode of burial disturbance resulting in a 'restacking' of the coffins in a north–south orientation. The earliest phase may relate to those individuals interred in the 16th century, the second possibly to the period after the rebuilding of the boundary wall at the western edge of the burial ground in the 17th century. Three burial phases, including multiple burials in pits, were also recorded in 2011 (Crossrail 2011d and 2012). Further research into the dating of these phases, including that of the disuse of the cemetery, will be undertaken once all of the skeletons from the area of the future ticket hall have also been recovered.

- *What is the character of the burial practice, and how does it change spatially and chronologically?*

As stated above, three phases of burial have been identified so far. A charnel pit was also recorded in MHS2-100, fitting stratigraphically between the first and second phases. It is thought that the pit probably dated to the construction of the later cemetery wall, which created disturbance to the early graves in the 17th century. The additional results from the excavation of the future ticket hall should be able to sort these different elements of burial practice into a comprehensive pattern.

- *What is the evidence for organisation/management and zoning of the burial ground?*

The evidence for management of the burial ground has come largely, to date, from areas around the perimeter of the burial ground. Information from the excavation and analysis of the entire assemblage will provide fuller answers to these questions.

- *Are multiple or pit burials confined to the northern part of the site around Trenches 13 and 14, and the 1985 excavations?*

This is another question which should be able to be answered more fully after the final area of the site has been excavated and analysed.

- *Can gravestones or marker/ledger slabs provide evidence which will identify individuals, and can these be correlated with documentary sources?*

The fragments of monuments to Sarah Long and possibly the undated one to Samuell Pack (19.17) provide additional potential for documentary research to recover biographical information about individuals interred in this burial ground.

10.4 Other post-medieval

- *What is the date and taphonomy of deposition of the important worked bone assemblage? For example, are these finds residual in the post-cemetery deposits, or does it represent continued deposition during and after the use of the cemetery? Also, what is the spatial and chronological division of the different types of bone artefact across the site?*

Fifteen fragments of bone waste and four of ivory waste were recovered during the latest phase of fieldwork. This waste was concentrated in the backfill of a robber cut to remove bricks from the 17th-century cemetery wall, and produced blocks and offcuts of elephant ivory and cattle long bone wall, as well as ring offcuts from working cattle metapodia on the lathe. As with the previous phase of fieldwork, a range of tool marks are present, helping to demonstrate the range of tools, which should tighten dating during the final analysis. Once the remainder of the site has been excavated, information on the spatial and chronological division should be forthcoming.

- *What activities and industries in the surrounding area are represented by waste materials within dumps and the cemetery sequence?*

A number of fragments of wire in a range of gauges were also found, mostly from context [1036] (19.7). These probably related to some kind of local craft activity. The recovered of a pinner's bone (for the manufacture of wire pins), a fragment of possible vitrified mould or furnace lining (with a coppery residue) and a fragment from a mid- 17th-century striped glass tube (used in the production of glass beads) all suggest industrial activity in the surrounding area.

- *What is the character and date of any activity and occupation outside the burial ground?*

The bone-working debris most likely came from industrial activity outside of the site itself, but was probably from a workshop in the vicinity of the burial ground.

- *What is the character and date of structural remains relating to 18th and 19th-century urbanisation and development?*

As known from previous trenches, the burial ground was sealed by a horizon of disturbed cemetery soil with refuse and possible further consolidation dumping, possibly associated with the urbanisation of the area in the mid- to late 18th century, which included evidence for local industry. Brick and stone structures (walls and sewers) found during this phase of evaluation were mainly sewers or drains dating to the 18th and 19th centuries, but included a wall from a mid to late 18th-century building encroaching onto the area of the burial ground. The subterranean Victorian toilet block that dominated an area of MHS1 can be seen on early 20th-century photographs (not illustrated).

For revised and new objectives for further fieldwork based on evaluation results, see section 13.1.

11 Statement of potential archaeology

11.1 Known remains, demonstrated to be present on the site

- Roman features including timber structures, burial evidence, pits, a possible ditch (possibly the canalised eastern edge of the Roman Walbrook stream, although this dating is to be refined), at least two phases of road and consolidation/ reclamation dumps are known to be present on the site. These features essentially define the landscape on the eastern side of the Walbrook. The future phase of fieldwork will concentrate on an area away from the stream edge, but within its flood plain, where features such as drainage ditches, pits and consolidation dumps are expected. Evidence from the both the Utilities Corridor and the Open Cut further suggests this, as both covered a reasonable east–west transect to the north and south of the future fieldwork area.
- The projected line of the road is expected to extend across the central area of the site.
- The post-Roman to early post-medieval Moorfields Marsh deposits incorporating refuse dumping and canalisation of the Walbrook channel
- Early post-medieval reclamation deposits overlaying the Moorfields Marsh, to consolidate ground for the establishment of Bethlehem burial ground
- Post-medieval remains in the form of both disarticulated human remains and in situ burials from the Bethlehem burial ground
- Two phases of construction of the western cemetery wall, including possible evidence for up to two land ties used during the construction of the later wall, their presence suggesting the continuing need to mitigate the water channel.
- An important assemblage of post-medieval worked animal bone and other craft/ industry waste
- Post-medieval buildings/ structures encroaching on the burial ground after its closure to burial

11.2 Potential for further remains

- Low potential for prehistoric activity, which is likely to be limited to stray finds and isolated truncated features
- High potential for further Roman remains; as the fieldwork area bears east, however, evidence for water management, land reclamation and burial may diminish. Remains of the metalled road, giving further information on its nature and exact path, are extremely likely, as is the presence of further pits, ditches and dumps, and possibly evidence for stabling. On current evidence, there is also a low potential for Roman funerary activity which might extend along the route of the Roman road.
- Low potential for archaeological remains of Saxon date, owing to the presence of the Moorfields Marsh
- Low potential for medieval activity, such as drainage ditches or rubbish, cess or quarry pits

- High potential for further burials, as part of the post-medieval burial ground

11.3 Importance of Resources

The importance of the excavated remains has been assessed using professional judgement, informed, where applicable, by the criteria for assessing the national importance of monuments (DCMS 2010, Annex 1).

While archaeological excavations within the Walbrook valley to the north of the Roman city are not uncommon, the site offers an opportunity to investigate this relatively unexplored area situated north of the Roman City Wall, between known Roman burial grounds and roads. The Roman remains uncovered during this latest phase of fieldwork represent land reclamation activities at the eastern edge of the Walbrook stream, evidence for burial practices, water management and refuse disposal incorporated within land reclamation dumps; some of these activities took place before the construction of the City Wall at the end of the 2nd century AD .

In addition to the Walbrook channel, containing disarticulated human remains, at least two phases of Roman waterside activity were identified, including important evidence for cremation and possible burial. It has also been possible to retrieve a sequence of samples through the river deposits from the pre-Roman period into the Roman. Along with clear evidence for the presence of the hypothesised Roman road, part of which was revealed complete with wheel ruts and horseshoes, the Roman remains are now considered to be of regional importance.

The post-Roman to early post-medieval marsh and later reclamation dumps appear, as in previous fieldwork, to demonstrate consistency across the area under investigation. The environment and human interaction in this period are of local interest, however, and these remains are considered to be of low importance.

The ground within the Crossrail Broadgate Ticket Hall worksite is likely to contain the last surviving remains from within the original footprint of the Bethlehem (Bedlam) burial ground. Fieldwork has shown that large areas of the burial ground still survive intact; although bone preservation is good, coffin survival is poor. Identification of potential phases of burial within the cemetery, however, will provide the potential to highlight any important differences in society and burial between the first occupants of the cemetery and those buried nearer its end date.

In addition, the recovery of a small number of gravestones may lead to a greater understanding of those named individuals and their lives. All of the information gathered so far, including an accurate plot of the western extent of the burial ground, can be amalgamated with the results of excavation from the same burial ground in the 1980s (Malt & White 1987), and will be of use in the larger context of historical burial practices from this period across London.

The latest phase of fieldwork did not significantly contribute to the post-cemetery archaeological record, due in part to the removal of burials from the Open Cut by the exhumation contractor TCS, which reduced the potential for the recovery of further off-cuts from ivory and bone production. Further worked animal bone fragments were recovered primarily from the backfill of a trench dug (recorded in MHS2-100) to remove bricks from the 17th-century cemetery perimeter wall, indicating industrial waste dumping after the burial ground went out of use. Of interest was evidence for dumping during the use of the burial ground, however; one of the graves in MHS1 contained a fragment from a mid- 17th-century striped glass tube, used in the production of glass beads (see 19.5).

Segments of 19th-century sewers and drains were recorded. These will be added to the existing data and expanded in the final site report.

Overall, the remains are of **moderate** importance, in particular the evidence for Roman burial and the Roman road, as well as the presence of the post-medieval burials and evidence for local post-medieval industry in the form of the worked bone assemblage.

12 Conclusions

12.1 Geology

Natural geology was reached in all of the trenches in this phase of fieldwork, except for the Open Cut Sewer (9.2.2) and MHS2-100 sewer shaft (9.2.3).

As in the previous phase (Crossrail 2012), a gradual drop was noted in the natural terrace gravels from east down to west; this ties in with the presence of the water channel, as part of the Walbrook, at the western end of the site. A drop of over a metre was recorded between GL8–QVT to the east (107.83m ATD), and MHS1 to the west (106.42m ATD).

There is also a gradient from north down to south, albeit less pronounced, one only really seen at the western edge (as might be expected with fluvial activity leading south towards the Thames). Terrace gravels were recorded at 107.20m ATD at the northern end of the MHS2-100 Heading; these fell to 106.90m ATD at its southern end, dropping to 106.42m ATD already stated for MHS1.

Bands of clay, gravel and peat, seen across the entire site, are thought to be derived from episodes of flooding from the Walbrook; these can be investigated in a more informative site-wide context during the main excavation of the ticket hall area. London Clay was reached only in the Utilities Corridor (GL1–GL8) and in MHS1 (at 106.60m ATD and 106.25m ATD respectively). Of potential interest was the inconsistency of both the terrace gravels and London Clay in MHS1; river gravels were overlying the terrace gravels in the northern section, but London Clay in the southern. The gravels were much deeper to the north of the trench, with London Clay appearing here at 105.29m ATD, compared with 106.25m ATD in the south. This dive down to the north suggests eddying water during the deposition of the terrace gravels in the environment of the Quaternary period.

Pollen analysis has shown that, overall, the landscape surrounding the Walbrook, in the period before the Romans, was open, with no trees in the local vicinity and a mixed agricultural arable and pastoral. The on-site habitat was probably a herb dominated (grass-sedge) fen floodplain.

12.2 Prehistoric remains

No in situ prehistoric remains were found during these investigations. If originally present, any prehistoric features or deposits must have been entirely truncated by Roman activity. A small number of worked flints were recovered from the river gravels at the western edge of the site, samples from which may yield valuable information about the prehistoric environment. There remains a low potential for prehistoric features or deposits in the remaining unexcavated areas of the site.

12.3 Roman remains

(Figure 3, Figure 4, Figure 5)

The trenches excavated in this phase of works (MHS1, MHS2-100, the Open Cut, the Utilities Corridor and GL8–QVT) have provided a remarkable record of the stratigraphy at the eastern edge of a water channel associated with the network of streams and channels that formed the tributaries of the Walbrook stream. In this area

of London, the location of the Walbrook has provided much speculation, and the presence of the river deposits at the western end of Liverpool Street will greatly bolster known information about this ancient waterway. At least two phases of watercourse were seen; the earlier, thought to be pre-Roman, comprised bands of clay and gravel, forming a bank to the east. To the east of this, in the utilities corridor, was evidence for a small pond, thought to have formed as a direct result of flooding from the channel (19.13).

On the bank were two wooden gates, [1423] and [1428], laid flat, presumably to provide a platform at the edge of the water. The gates had been covered by a later flood of water [1391], which brought with it nearly 40 human skulls (see 19.9), as well as animal remains dominated by horse bone (19.11), and general rubbish dumped onto its eastern bank. The 'flood' left a linear deposit of yellow sandy gravel, suggesting fairly fast-flowing water.

It is likely that the gates, probably a pair in their original use, dated to the early 2nd century AD. They had been laid together length-ways; a small triangular kink between them may have mirrored a slight bend in the channel. At least one piece of wood from the southern gate [1428] had been re-used three times, suggesting some years between the felling of the tree and the inclusion of this piece in the gate (19.16). It is difficult to say how long the structures were in use as gates, but this period also adds significance to the time span. Further, the horizontal gates appeared to have been speared by two later posts, [1424] and [1425], apparently associated with a later structure, as only the tips of the posts had survived.

Further north, in MHS2-100, three small stakes ([1337], [1338] and [1339]) were recorded in a row, orientated north-east–south-west. It is unknown whether these were contemporary with the gates, but they are also believed to be from an earlier Roman period (19.16). The additional presence of a similar stake in the neighbouring Open Cut [1092] to the east suggests the presence of a structure near the edge of the channel, possibly a fence-line or pen. The stakes had been sealed by the foundation for the Roman road, which is thought to date from the 2nd century AD; the very different alignment of the road to the stakes suggests elapsed time between them.

It is thought likely that the human skulls in the river gravels had originally been interred, along with the rest of their bodies, in the large Roman cemetery known to have existed further west; the water, fast-flowing and sweeping enough to totally flood the structure made from the gates, may also have been capable of sweeping along the edge of the cemetery. Skulls, being rounded and therefore more mobile, may have been more inclined to move with the water, ending up deposited together when the current slowed.

Evidence from the MHS2-100 Heading (9.3.1), immediately to the south-west of MHS2-100, suggests the possibility of at least part of the area being used as a burial ground in the Roman period. Above the yellow river gravel containing the skulls were two features, one containing a cremation urn, the other another human skull. The cremation pot [1439] (19.9) was recovered from the ceiling of the Heading; its impressive drop (and catch by the McNicholas miners) into the void created by the Heading must have separated the pot from its lid. That there was no trace of soil inside the pot suggests strongly that the contents had been covered and further implies not only deliberate burial in the ground, but a subsequent lack of disturbance from further flooding, or any other activity. In addition, a photograph from 11m into the MHS2-100 Heading shows a human skull above the river gravels, surrounded by soil, into which the skull had either been placed or somehow ended up (ie a in feature such as a ditch) (Photo 17). Even if this was not an actual grave, it has the appearance of a dug feature. Like the cremation pot, the skull appears to have been

placed in the ground after this phase of water channel had deposited the yellow gravels and additionally dried out sufficiently to enable burial.

The road itself was recorded in the Open Cut (9.2.2), MHS2-100 (9.2.3) and the Heading leading off MHS2-100 (9.3.1), giving it the projected line that is shown in Fig 5. It consisted of several layers of make-up and phases of compacted gravel surfaces, two with probable wheel ruts and one with evidence for use by horses (19.8). The road found west of Broadgate, south of Eldon Street (Malt & White 1987) was found to be of several phases, and dated broadly to *c* mid- 2nd to mid- 3rd century AD . This dates tallies with that of a coin (AD 228–230) recovered from the surface of the road in Pit 13 (Crossrail 2012). It is possible there are more than two phases of road at Liverpool Street, but these were the ones identified during the recent fieldwork, the remains in Open Cut corresponding to those surviving in MHS2-100.

At the base of the gravel layers was a substantial foundation, largely made up of brushwood. It may not be possible to pinpoint a precise date for the construction of the road, but, the few finds that have been recovered from the most recent fieldwork corroborate a date from the mid-2nd to the early 3rd century AD. As with the cremation burial, it seems likely that the road was laid during a drier period, again probably after the yellow gravels [1391] had settled in the channel. A visual record in section of the brushwood foundation of the road was seen in the Heading up to a distance of 5m from the southern edge of MHS2-100, giving the road a potential width of at least 7m (Figure 5). That the road surface included the remains recorded previously in Trenches 13 and 14 may need to be re-examined during the final analysis, along with the hypothesis that the consistent levels no these gravel surfaces suggests a level embankment leading to a bridge across the Walbrook, rather than a ford. The stratigraphy in Trench 13 did not include the twig foundation and the gravel surface encountered in Trench 14 could not be penetrated by the auger. Further excavation may be able to determine a more accurate alignment and nature of the road.

The wheel ruts left in the road obviously propose the exact direction of travel taken in a way that a metalled surface alone cannot and their presence has enabled fine-tuning to the orientation of the route from the last interim report (Crossrail 2011d). The recovery of hipposandals (horseshoes) from the road surface itself, a significant number of which have been found previously in the vicinity of the site (see 19.8), along with a predominance of horse bone recovered from the yellow gravels [1391] of the channel, point to the area housing Roman stables.

The extra-mural activity recorded in the previous phase of fieldwork (Crossrail 2011d, section 10.2) included pits, dumps and a possible ditch. Similar features have also been recorded in the last phase. A couple of pits and a number of ditches, possibly for drainage, were recorded along the length of the Utilities Corridor.

12.3.1 Updated Provisional Phasing and associations, incorporating previous evaluation results with re-interpretation

Previous fieldwork on the site has been largely piecemeal in nature; the most recent phase of fieldwork, however, has added a significant amount of information, which has emerged, in particular, from the western edge of the site, due to the investigation of the two large sewer headings, MHS1 and MHS2-100. Although provisional dating is still tentative, a comprehensive sequence of events inspired by the presence of the water channel at this western edge has been proposed (Table 3). Interpretations have advanced to suggest elements of the Roman landscape over three centuries.

A basic comparison of trench sections from the previous and current phases of investigation tentatively suggest some potential associations, based on current interpretations, corresponding sequences, dating and levels. In general terms, it will not be possible to link stratigraphic relationships in the wider landscape until further excavation is conducted across the main area of the site.

Provisional Phase	MHS1	MHS2-100	Utilities Corridor	Open Cut	MHS2-100 Heading
?1st century AD (Figure 3)		Waterside activity Wooden stakes /structure [1337], [1338] and [1339]		Waterside activity Wooden stake [1092] (as possible part of structure with stakes from MHS2-100)	
Early 2nd century AD (Figure 3)	Water management and waterside activity Re-used timber gates [1423] and [1428];				
2nd century AD (Figure 4, Figure 10, Figure 15)	Flooding and rubbish dumps		Ditches, pits and dumps Roman pit [1370] Roman gully/ditch [1055], E–W, cut by Roman gully/ditch [1048] with possible row of stakes along its edge, NW–SE Roman ditch [1351], orientated east–west Roman ditch [1382], orientated north–south		
Late 2nd- mid 3rd century AD ? (Figure 16, Figure 5, Photo 8 and Photo 9)	Dump on eastern bank [1397] River gravels [1391] containing human and horse skulls (from early 3rd century AD)	Metalled road surface with wheel ruts and brushwood foundation [1305], [1327], [1335] Second road surface [1315]		Metalled road surface with wheel ruts and brushwood foundation [1083] and [1087]	Cremation and possible burial [1439] and [1438] Brushwood foundation for road [1335]

Table 3 Provisional Roman phasing of selected features (only significant spot dates shown)

12.4 Medieval remains

As with the previous phases of fieldwork (Crossrail 2012), there is little trace of activity between the Roman and early post-medieval periods. No Saxon or medieval features or structures were found. In particular, there was no evidence for medieval remains associated with St Mary Bethlehem Hospital.

Further evidence for the extent of the Moorfields Marsh was recorded, however. The following contexts may be identified as likely post-Roman probable marsh deposits: [1193] and [1384] in MHS1; [1291] in MHS2-100; [1072] in the Open Cut; [1018] in the Utilities Corridor. Evidence for marshland from these areas adds to that from the pits and trenches already identified during the previous phase of fieldwork (Pit 4, Pit 11, Trench 14, Pit 3, Pit 6, Pit 7, Pit 8, Pit 9A, and Pit 10). The levels of this marsh horizon – across the whole site - remain consistent throughout the fieldwork, ranging from *c* 109m to 110m ATD, and becoming thicker, as expected due to the locality of the water channel, to the west.

The highly organic nature of these deposits suggests seasonal flooding and ponds or pooling; no cut features, such as drainage ditches or pits, have been dated with certainty to the post-Roman and pre-cemetery period. Remains of a ditch, seen in Trench 1 and Pit 11 and thought possibly to be Roman (Crossrail 2011d), however, may continue in to the south in the Utilities Corridor (Fig 6). The feature spanned a width of 10m in this area. A projected line links these tentatively with [1069] in the Open Cut to the north, although it is recognised that further fieldwork is essential to validate these separate interventions as a single feature. The north–south orientation of the 'ditch' possibly mirrors that of the canalised channel of the Walbrook shown on the Copperplate map from the mid-16th century (Figure 14). Although possibly too far to the east to be the same feature, it is recognised that this map had a 'bird's eye' view quality to it and its features may be taken as indicative, rather than precise. By that token, the 'ditch' could be the canal channel from the 16th century that existed when the Bethlehem Hospital was founded, but was filled in in order to create the burial grounds. It may therefore date from the late medieval period, but, as before, further investigation is needed.

12.5 Post-medieval remains

(Figure 14 to)

12.5.1.1 Pre-cemetery

The previous phases of evaluation results (Crossrail 2012) have revealed that medieval and earlier deposits were sealed across the whole site, by a rapidly-deposited post-medieval dump(s). From the most recent phase of fieldwork, deposits [1057], [1058], [1059] and [1060] from the Utilities Corridor, [1148], [1149], [1150] and [1169] from MHS1 and [1242] and [1280] from MHS2-100 can be added.

These layers were deliberately laid down to raise and consolidate the ground, presumably to prevent flooding and to establish the cemetery. Spot dating of pottery and building material waste within all of these contexts confirms an early post-medieval date consistent with the opening of the cemetery in 1568/9. The frequent inclusion of charcoal, mortar and building material, including brick, tile and a structural timber fragment, may suggest that a significant part of this consolidation was formed of construction debris or demolition material brought to be dumped at the site from sources within the City or its suburbs.

12.6 Bethlehem Burial Ground

As mentioned previously (12.4), the Copperplate map from the mid-16th century shows the eastern edge of the moor fields to be aligned north–south with a canalised channel of the Walbrook running alongside; by the time of Faithorne and Newcourt's map (1658), the canal has been filled in and a wall built to separate the moor from the 'Bedlame' grounds (Figure 15), dating from its establishment at the end of the 1560s (section 6). It is likely to be remains of this wall, which formed the western edge of the burial ground that survived on site in the SSET/UKPN trench [context (915)]; its bricks dating to between 1550 and 1666 (Figure 7; Crossrail 2012). The angle of this wall (NNE to SSW), suggests that it was built to span the width of the north–south canal.

Elm piles recorded in MHS1 and the MHS2-100 Heading are also thought to date to the 16th century (19.16). The corresponding alignment of the timbers and the Tudor brickwork described above suggests that these were part of the same structure, the piles being sunk into the ground to provide stability for the wall.

The Ogilby and Morgan map of 1676 (Figure 16) shows the addition of a road between the Moorfields and the burial ground. This change in the urban landscape, which included the infilling of the canalised Walbrook channel, most likely created the need for a new cemetery wall further east to accommodate the road. Several segments of a later brick wall were recorded in MHS1 and MHS2-100 during the fieldwork [(11450 and (1146)]. The bricks had a timber beam at their base, which also sat on top of upright timber piles; a number of worked stones, probably from an earlier structure, had been incorporated into the base.

Evidence for continuing flooding from the Walbrook was recorded in the form of a land tie (see Photo 12). Land ties would have been built as part of revetting, probably to deal with water issues while the wall was being built. The timbers of this structure are thought to date to the 16th century (see 19.16). Although estimated to be only about 1.0 to 1.50m to the east of the first cemetery wall, a date of between 1658 and 1676 is proposed for the construction of the later wall and the land tie, with regard to layout in the maps of Faithorne and Newcourt and Ogilby and Morgan (see Figure 15 and Figure 16).

A total of 373 in situ post-medieval burials have now been archaeologically excavated across the site as a whole (19.9). In addition, excavation in the Open Cut by the exhumation contractor TCS, during the MOLA general watching brief, cleared that area of all in situ burials. A charnel pit was seen in MHS2-100 at a similar height to the base of the later cemetery wall, and is therefore thought to be the direct result of disturbance from its construction in the 17th century.

12.6.1.1 Coffins

As in previous phases, coffins appeared to be the standard 'kite' shape (widest around the shoulder area and tapering to both head and feet). Unfortunately, coffin survival was generally poor. The majority of coffins appear to have been of plain wood, which in most cases survived as little more than fibrous traces. Although textiles survived from coffin coverings or linings, coffin grips (handles) were recovered from seven contexts (see 19.14). In addition, rows of copper alloy studs were recorded as decoration on a number of coffin fragments.

12.6.1.2 Burial practice

The previous phase (Crossrail 2012) found evidence for three types of burial: early in shroud (and no coffin), inhumation in coffin, and multiple burials in larger pits (eg in Trenches 13 and 14; Crossrail 2012). During the latest fieldwork, the targeted watching brief in MHS1 revealed four burials recorded at 109m ATD; there was no trace of coffin with any of them. Nearby, potentially later burials (in coffins) were present at 110.50m ATD. Similarly, in MHS2-100, the construction cut for the 17th-century cemetery wall had truncated a number of earlier burials and the backfill of the cut was filled with disarticulated bone (see Photo 13). It is evident that the earlier individuals, being at the original western edge of the burial ground, had decomposed sufficiently for their remains to be moved and redeposited in this way when the cemetery boundary was moved eastwards. A later phase of activity still was identified in MHS2-100; individuals buried towards the later stages of interment in the cemetery had been presumably disturbed. Coffins were stacked on top of each other, orientated north–south. Similarly, pit burial in Trench 14 was overlain by a later and final phase of coffined inhumations, buried individually or in small stacks (Crossrail 2012). Both trenches therefore suggest different episodes of burial, albeit for different reasons.

Further information will be available once the assemblage from the future ticket hall excavation is also analysed.

12.6.1.3 Cemetery management

A great number of the graves uncovered during the fieldwork have been intercutting, leaving many skeletons badly truncated, with displaced bone and coffin fragments reburied in the backfill of later graves. As a consequence, identifying individual grave cuts and fills was often challenging, although fieldwork in 2011, 2012 and 2013 was able to identify truncation by the grave cuts of the more distinctive pre-cemetery layers. The primary phase of burial in Trench 14, for example, was located between two layers of pre-cemetery dumping, suggesting that early burials occurred while the site was still being established (Crossrail 2012).

Until full post-excavation analysis of the skeletons is undertaken after the main excavation, little can be stated regarding plots or patterns of burial, based on, for example, age, gender, or social status. Research into recovered grave slabs will be an intrinsic part of the analysis.

Analysis of spatial patterning within the cemetery is limited at this time by the size and isolated nature of the trenches. Genuine patterns, if present, may only be discernible after full excavation. Therefore, no firm conclusions can be based on the two phases of evaluation results, and future fieldwork should attempt to address this question (see 13.1).

12.6.2 17th to 18th-century structural remains

(Figure 9)

It is known that burial within the cemetery continued until at least 1714, the date of the latest datable burial (Jenkes family vault (LSS85), Malt & White 1987). Unfortunately, the precise date of the burial ground's closure remains unknown. The nature and circumstances of the cemetery's closure also remains unclear.

Post-medieval structures found during the last phase of evaluation are almost certainly the remains of buildings seen on 17th to 19th-century maps (Figure 9; Crossrail 2012, Fig 18). Faithorne and Newcourt's map of 1658 (Figure 15), followed

by Ogilby and Morgan's map of 1676 Figure 16), are the first to show buildings within the grounds of the cemetery. These may be directly associated with the cemetery, perhaps entrances or administrative buildings.

As in the previous phases of fieldwork, the post-cemetery horizon contained worked animal bone and ivory waste. Much of this material was again also worked into the cemetery horizon within grave fills.

12.7 19th-century remains

(Figure 9)

There is little evidence of 19th-century archaeology on this site. The continuation of the disused east–west 19th-century brick culvert sewer found in Trench 5 (Crossrail 2011d), was recorded across MHS1. It had been constructed using the 'cut and cover' technique and reached a maximum depth of 107.47m ATD; part of this structure had later been broken through, filled with concrete and reused as a foundation for the below-ground toilet block constructed during the Victorian period, at the western end of Liverpool Street. The sewer itself (seen previously in Pit 1, Crossrail 2012) had been replaced by another, also 19th-century and constructed using 'cut and cover'; this was still in use during the targeted watching brief. Its base was at 106m ATD.

13 Recommendations for appropriate mitigation strategy

The good survival of Roman remains that informed the previous fieldwork report can now be reviewed with the current results. The western edge of the site, covered largely by the targeted watching briefs of MHS1, MHS2-100, and, to a lesser extent by the general watching brief of the MHS2-100 Heading, revealed evidence for considerable Roman remains in the vicinity. Structural remains were present at the eastern edge of the Walbrook; a sequence of natural deposition within the channel itself also survived, providing the potential for a remarkable and extremely informative sequence through Roman activity in this vicinity. **The Walbrook channel is not expected to extend into the area of the future ticket hall**.

Further remains of the Roman road, of which at least two phases of gravel surface appear to mark a route from north-west to south-east, are expected to traverse the large central area of the future Broadgate Ticket Hall, still to be investigated. **It is possible that evidence for further burials will be present along the route of the road**.

Previous fieldwork on the site in the utilities corridor, which provided a window across the site east-west, as well as the open cut and trenches investigated in 2011 and 2012, have uncovered remains of Roman activity associated more with land at the periphery of a water course, ie boggy land or wasteland, such as pits, dumps and ditches. With the exception of the Roman road, therefore, it seems likely that further remains of this nature, along with marsh and pre-cemetery consolidation dumping, would be expected in the area still to be excavated.

As before, continued excavation on the site will also expand our knowledge and understanding of burial and society from the 16th to the 18th century. Although the preservation of coffins and coffin fittings has been consistently poor across the site, there is a potential for further headstones and, consequently, access to individuals' histories. Evidence has so far been collated for several types of burial practice, so further excavation should be able to fine-tune statistics concerning positioning of burials, zoning and burial management gathered to date. Current evidence indicates a more complicated cemetery sequence with a broader range of burial practices in the northern half of the site, an area also known to contain burial vaults (Malt & White 1987). As the Bethlehem burial ground accommodated the dead from other areas of London as well, a larger assemblage will also provide a more accurate picture of burial customs on a regional scale.

Further excavation is also likely to reveal more *c* 17th to 18th-century structural remains, in particular, within the south and south-west parts of the site, where buildings can be seen on maps from the mid- 17th-century onwards (Figure 15 to Figure 17). While analysis of historical maps may help clarify locations and alignments, the exact nature, date or relationships of these structures may only be confirmed with further excavation. The structures themselves have potential for grave slab re-use in their foundations, as noted above. Further dumps containing remnants from post-medieval bone working are also expected.

The 19th-century sewers, running east–west near the southern edge of the site, are expected to have truncated earlier remains down to a maximum depth of 106m ATD. No 16th to 18th-century burials are expected to survive in this area, although there is potential for Roman stratigraphy below the 19th-century brickwork.

The Project Archaeologist will produce recommendations for further work and refine the mitigation strategy for Crossrail works at Liverpool Street.

13.1 Revised and new objectives for further fieldwork

13.1.1 Topography and geology

- Bands of waterlain clay and gravel have been seen across the whole site, can the dating of these be refined?

13.1.2 Roman and medieval

- Is there any further evidence for horse remains that may confirm the possibility of Roman stables in the area? Could there be a link between the human and animal remains that may suggest military activity?
- Can Roman activity across the site help to refine a sequence of flooding and water management relating to the Walbrook tributary in this period (building on the evidence from the sequence of structures and deposits recorded in MHS1 and MHS2-100)?
- Is the in situ evidence for Roman burials confined to the western end of the site over the dried-out Walbrook channel or does it extend across the whole site?
- Determine if the ditch found in Pit 11/Trench 1 is the canalised eastern edge of the Blomfield Street Walbrook channel, and whether cuts [1050] in the Utilities Corridor and [1069] in the Open Cut relate to this.
- Characterise and understand the nature, layout, and dates of the different phases of Roman extra-mural activity and land use, including potential occupation in the form and date of any buildings, as well as the function and date of drainage features and how they relate to the Walbrook and Moorfields Marsh.
- Confirm the orientation of the Roman road(s) and investigate the relationship of the earlier phase with the wheel ruts/ horseshoes with remains found in 2011 and 2012 in Trenches 13 and 14 and in MHS2-100 and the Open Cut on site, as well as from previous excavations at Eldon Street. Is there an earlier phase of road with a slightly different alignment? If so, do the remains mirror the activity of the water channel? How does the road relate to other Roman activity within the area?
- Do the road foundations of clay and brushwood represent an embanked bridge approach or do they extend along the length of the road?
- What evidence is there for animal butchery in the vicinity?
- Determine the eastern extent of the Moorfields Marsh in this area
- Identify evidence for activities in the area of the marsh, or in the surrounding area, represented by dumping of refuse in/on it.

13.1.3 Relating to the Bethlehem cemetery

- Characterise and date the sequence of post-medieval dumping and reclamation associated with the establishment of the cemetery
- Characterise and refine the sequence and dating of burials, further defining the variety of burial practices already identified, in particular the date at which the cemetery went out of use

- Characterise burial practice and how it changed spatially and chronologically, and identify any indications of organisation/management and zoning
- In particular, are multiple or pit burials confined to the northern part of the site?
- Can gravestones or marker/ledger slabs provide evidence which will identify individuals and can these be correlated with documentary sources?

13.1.4 Other post-medieval

- What is the date and taphonomy of deposition of the important worked bone assemblage? For example, are these finds residual in the post-cemetery deposits, or does it represent continued deposition during and after the use of the cemetery? Also, what is the spatial and chronological division (see 19.7) of the different types of bone artefact across the site?
- Identify evidence for activities and industries in the surrounding area, represented by waste materials within dumps and the cemetery sequence
- Characterise and date structural remains relating to 18th and 19th-century urbanisation and development

14 Publication and dissemination proposals

Excavation and watching brief results will initially be disseminated via this report; the supporting site archive of records, including digital data and by incorporation into the wider predictive deposit modelling for the Crossrail scheme.

The results are expected to be included, along with the other past and future results from the Broadgate Ticket Hall site, in the relevant volumes of proposed Crossrail publication CRL11 Roman and Medieval Broadgate and Blomfield Street.

15 Archive deposition

The site archive containing original records will be stored temporarily with MOLA pending a future decision over the longer-term archive deposition and public access process for the wider Crossrail project

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18 NMR OASIS archaeological report form

18.1 OASIS ID: molas1-166476

Project details	
Project name	Crossrail Broadgate Ticket Hall
Short description of the project	Following previous fieldwork in 2011 and 2012, a further phase of excavation and watching briefs was undertaken at the site, located at the western end of Liverpool Street. Four trenches and a sewer heading were investigated; two of the trenches were at the western end of the site, in an area believed to overlie a former tributary of the Walbrook. Waterlain bands of clays and gravels were seen overlying natural terrace gravels; these are thought to relate to the pre-Roman channel. Structural waterside remains from the Roman period were also recorded, including re-used timber gates and a road, as well as two phases of cemetery wall as the western limit of the Bethlehem Hospital burial ground. The earlier wall is thought to date to the Tudor period, the later build to the 17th century.
Project dates	Start: 19-03-2013 End: 21-10-2013
Previous/future work	Yes / Yes
Any associated project reference codes	XSM10 - Sitecode
Any associated project reference codes	molas1-111282 - OASIS form ID

Any associated project reference codes	molas1-124320 - OASIS form ID
Type of project	Field evaluation
Site status	Area of Archaeological Importance (AAI)
Current Land use	Transport and Utilities 1 - Highways and road transport
Monument type	RO AD Roman
Monument type	WATERSIDE STRUCTURE Roman
Monument type	WALLS Post Medieval
Significant Finds	COINS Roman
Significant Finds	COW BELL Medieval
Methods & techniques	"""Metal Detectors""","""Targeted Trenches""","""Environmental Sampling""","""Augering"""
Development type	Rail links/railway-related infrastructure (including Channel Tunnel)
Prompt	Crossrail Act 2008
Position in the planning process	After full determination (eg. As a condition)

Project location	
Country	England
Site location	GREATER LONDON CITY OF LONDON CITY OF LONDON Liverpool Street (Broadgate)
Postcode	EC2M 7NH
Study area	2741.00 Square metres
Site coordinates	TQ 81610 33028 51 0 51 04 02 N 000 35 32 E Point
Site coordinates	TQ 81603 33054 51 0 51 04 02 N 000 35 32 E Point
Height OD / Depth	Min: 6.42m Max: 8.50m

Project creators	
Name of Organisation	MoL Archaeology
Project brief originator	Crossrail
Project design originator	Crossrail
Project director/manager	Nicholas Elsden

Project supervisor	Alison Telfer
Project supervisor	Robert Hartle
Type of sponsor/funding body	Developer
Name of sponsor/funding body	Crossrail

Project archives

Physical Archive recipient	LAARC
Physical Contents	"Animal Bones","Ceramics","Environmental","Glass","Human Bones","Industrial","Leather","Metal","Wood","Worked bone","Worked stone/lithics"
Digital Archive recipient	LAARC
Digital Media available	"Images raster / digital photography","Survey","Text"
Paper Archive recipient	LAARC
Paper Contents	"Stratigraphic"

Paper Media available	"Context sheet","Diary","Matrices","Plan","Report","Section","Survey","Unpublished Text"
Project bibliography 1	
Publication type	Grey literature (unpublished document/manuscript)
Title	C257 ARCHAEOLOGY CENTRAL, Fieldwork Report, Archaeological Excavation and Watching Briefs, MHS1, MHS2-100, Utilities Corridor and Open Cut, Broadgate Ticket Hall (XSM10)
Author(s)/Editor(s)	Telfer, A./ Elsden, N.
Date	2013
Issuer or publisher	Museum of London Archaeology
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Entered by	Alison Telfer (atelfer@mola.org.uk)
Entered on	11 December 2013

19 Appendices:

19.1 Building materials

Ian M Betts

Building material was recovered from 49 contexts from this phase of fieldwork. This comprises mainly Roman roofing tile and brick and post-medieval brick samples. Roman box-flue tile is also present along with post-medieval roofing tile and glazed floor tile.

Roman

Most of the Roman building material comprises brick and roofing tile (tegula and imbrex) of 1st to mid- 2nd-century date. A number of bricks are unusually thick (59–68mm), these may be sesquipedalis or bipedalis bricks (Brodribb 1987, 3) which were principally used to cap stacks of pila bricks in the floor of buildings with a hypocaust heating system. More evidence for a hypocausted building, or buildings, is provided by a number of box-flue tiles that would have been set into the room walls. These have scored, combed and relief-patterned keying. The latter is keyed with die 46. Tiles keyed with this roller stamp are relatively rare, outside London they are only known from three sites in Essex and a single site in Berkshire (Betts et al 1997, 114–115).

Other Roman building material includes plain red wall plaster from context [1027] and plain white plaster from context [1023]).

Medieval

The building material of medieval date comprise three decorated floor tiles from the tilery at Penn, Buckinghamshire (residual in post-medieval contexts in the Utilities Corridor), a cream Low Countries brick (context [1347]) and a small number of peg roofing tiles. The Penn tilery was in production from about 1350 to 1390; tiles are decorated with Eames (1980) designs: 2037, 2536 and a further design type first identified at Merton Priory (Betts 2007, 205, fig 202 <T93>). These tiles probably paved the floor of a parish church or monastic building. The Low Countries brick is unusual in having a deep circular hole in the top surface. This brick may have been used as a door-post.

Post-Medieval

Tudor plain glazed Low Countries (‘Flemish’) floor tiles were recovered from contexts [1017] and [1191]. Bricks of similar date were found in contexts [1145], [1146] and [1215]. A Tudor brick from context [1066] is unusual in having diagonal cut marks in the top surface. This may have been used as a type of non-slip paving. Also of possible Tudor date is a rectangular drain with a central semi-circular depression running along the tile length (context [1154]).

Dating to the early-mid 17th century is a fragment of tin-glazed floor tile with a flower and leaf design painted in blue, brown, green and yellow on a white background. This was probably made in London, although a Dutch origin cannot be discounted. A complete tile with a similar design is shown in Betts and Weinstein (2010, 109, no. 102).

Other bricks from the site range in date from the 17th to the 19th century. Also present is peg and pantile roofing, although little can be closely dated. There is also the corner of a decorated delft wall tile. This shows the edge of a landscape scene in blue set in an octagonal purple border. The design has blue carnation heads corners. This is a London design dating to around 1740–1760. Horne (1989, 22–23, nos 33–45, 47–49, 51) illustrated a number of delft tiles with similar decoration.

Discussion

The building material retained is mainly of Roman date and post-medieval date. The Roman tile is predominantly 1st to mid- 2nd-century, but a few later fabric types are present, including a calcareous roofing tile dating to AD 140–300. The box-flue tiles would have come from a masonry building with a hypocaust heating system.

The post-Roman building material is mainly brick samples, but there are a few decorated and plain floor tiles which probably derive from a church or monastic building. The decorated tin-glazed floor tile would have been installed in a building of considerable social status, whilst the delftware wall tile probably came from a decorated fire surround.

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19.2 Roman Pottery

Fiona Seeley

Introduction

The pottery from this phase of fieldwork was spot-dated and recorded in accordance with current MOL archaeology procedure, using standard fabric, form and decoration codes. The data was entered onto the Oracle database, including quantification by sherd count, estimated number of vessels and weight in grams. This phase of excavation has produced an assemblage of 684 sherds (weight 43812 g) of Roman pottery from 53 contexts (all hand collected). The majority of the assemblages are small in size (less than 30 sherds) and some are comprised of only one or two sherds. There are three medium-sized groups (30–100 sherds), two large (100 sherds and over) and one very large (four standard boxes).

Roman Pottery

It is notable that most of the pottery dates to the 2nd century AD, in particular the period dating from *c* AD 120/40. There are relatively few sherds of 1st-century pottery and these tend to be residual in later contexts. A few assemblages date to the 3rd century AD, but there is a notable absence of forms and fabrics that are typical of the late 3rd and 4th centuries. The sherd size is notably larger than is typical of City assemblages and this may be due to the pottery once deposited, being little disturbed. Mud staining is a feature of the assemblage and is especially evident on the amphorae and oxidised wares and is in keeping with the material being deposited in a marshy or waterlogged environment. Much of the pottery exhibits signs of use such as sooting on the cooking vessels, limescale from the boiling of liquids and wear marks on the mortaria and, to some extent, on the samian vessels. There is one jar that was used to contain a cremation [1439] (9.3.1). Additionally, there are several vessels from one context [1437] (also 9.3.1) that are semi-complete and may have been accessory vessels to burial and cremations.

The assemblage as a whole is dominated by the reduced wares, in particular Highgate Wood ware C and the various black-burnished ware fabrics that occur in London from *c* AD 120 (BB1, BB2, BBS). There is slightly more BB2 than BB1 and this combined with the high levels of Highgate Wood ware C, may suggest the overall assemblage dates from the middle of the 2nd century AD rather than the second quarter. Both the main oxidised fabrics produced by the Verulamium region, Verulamium region white ware (VRW) and coarse white-slipped ware (VCWS), are present in significant numbers.

The majority of the samian is central Gaulish (Lezoux and les Martres-de-Veyre) as would be expected of this period. Other imported fine wares include Cologne colour-coated ware beakers which are decorated with roughcasting or hunt scenes. A range of amphorae is present on the site, mainly Dressel form 20 in context [1301] (9.2.1), which was used to transport olive oil. Context Of particular interest amongst the imports is a late Rhineland mortarium rim which is similar to those produced by the potter Verecundus from context [1284] (9.2.3).

Groups of particular interest

Walbrook sequence:

1) Context [1439] (9.3.1): cremation vessel from MHS2-100 Heading. This is a Brockley Hill white-slipped ware necked jar with thick squared off rim (BHWS 2G3). The form is typical of the jars produced by the Verulamium region industry in the 2nd century AD. However, it is not commonly found in this fabric which was made at the kilns at Brockley Hill. Also associated with this jar is a fragment of a Highgate Wood ware C lid which may originally have sealed the cremation. Dated AD 100–160.
2) Context [1391] (9.2.1): yellow river sand and gravel. This medium-sized assemblage is mostly composed of domestic pottery and is dated AD 140–200.
3) Context [1437] (9.3.1): there are several semi-complete vessels from this context which, given the proximity of the site to the western section of the northern cemetery, could conceivably have been originally related to burials. These include a Verulamium region white ware neckless jar (VRW 2J), a Highgate Wood ware C round-bodied necked jar (HWC 2E), a black-burnished ware 1 jar with everted rim (BB1 2F AL) and a London oxidised ware lid (LOXI 9A). There is also a fragment from a face pot, which is of interest given that another face pot was found in the same fabric from an earlier excavation on the site (context [714]). These vessels are not common and the presence of two examples from the same area is noteworthy. Overall this is dated AD 180–200.
4) Contexts [1422] and [1447] (9.2.1): overall, these small groups of pottery are dated AD 120–200.
5) Context [1448] (9.2.1): this small group of pottery is dated AD 120–200.

19.3 Medieval and later pottery

Nigel Jeffries

Introduction

The medieval and later pottery assemblage from this particular phase of archaeological work amounts to 324 sherds (221 ENV, 13.9kg) from 32 contexts ([1017] to [1396]). Where appropriate the sherds were examined macroscopically and using a binocular microscope (x 20), 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. The data can be accessed on the Oracle database.

The medieval wares

Seven contexts containing residual sherds of medieval pottery nevertheless dated to the 13th to 15th century. This isolates three contexts [1027], [1044] and [1186] as potentially medieval in date, although Roman material was also present here; consequently it cannot be yet determined if medieval landuse has survived until phasing is undertaken across the whole site.

The post-medieval wares

Post-medieval wares are present in 29 of the 32 contexts which contained pottery, and therefore provided the overwhelming majority of the pottery assemblage from this excavation phase (307 of the 324 sherds). Whilst this material is characterised by London-made redwares with some typical imports from continental Europe, the assemblage from these latest excavated deposits are notable for the consistent mid- to late 16th-century terminus post-quem they provide to the excavated landuse.

Each pottery vessel survived as large-sized joining sherds although reconstructable profiles were few and no complete vessels were retrieved. Coarse redwares from London area in various fabrics, either plain (notably PMRE and PMBR) or with slip coated decoration (PMSR), are the most common category (190 of the 307 sherds), with cauldrons and pipkins, bowls and dishes dominating, but including a few rounded jugs and jars. Of note is the large portion of a carinated bowl in [1066].

Imports from Continental Europe amount to 46 sherds, with a mix of German stonewares from Raeren and Frechen, a few redwares from the Netherlands and south Netherlands, Italy and Spain maiolica found. The former are mostly Raeran mugs and jugs. Of note is the upper portion of an unglazed Saintonge pegua in [1034]. Decorative tablewares are provided by the tin-glazed or maiolica retrieved, for example the two south Netherlands maiolica alberellos, tazza fragments from Montelupo in central Italy and the Valencian sourced dish from Catalonia, Spain.

Surrey-Hampshire border wares - largely the whiteware variants - supplied 42 sherds in a range of utilitarian cooking (tripod pipkins) and serving wares (mostly dishes). Minor fabric types include post-medieval fine redware from Essex (11 sherds) in a range of drinking vessels; similarly Cistercian-type wares describing finely potted mugs made at various pothouses across England during the later 15th into the 16th centuries were also present in small numbers.

Discussion

The post-medieval pottery could be derived from a number of sources in the area, or simply rubbish brought out of the city. Despite not being related to any structural sequences the sources of supply represented are remarkably consistent, with an overwhelming emphasis on locally made coarse redwares in cooking vessels such as cauldrons and tripod pipkins, dumped relatively quickly, potentially in order to level the land just prior to its use as the Bedlam burial ground from the late 16th century.

19.4 Clay tobacco pipes

Nigel Jeffries

Introduction

The clay tobacco pipes from XSM10 were recorded in accordance with current MOLA 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), using the prefix AO, with the dating of 18th-century pipes refined by reference to Oswald's Simplified General Typology, distinguished by the prefix OS (Oswald 1975). Quantification and recording follow guidelines set out by Higgins and Davey (1994; Davey 1997).

The clay pipes

A total of 17 clay pipe bowls and five stem fragments were recovered from three contexts [1133] (9.2.1), [1156] (9.2.3) and [1169] (9.2.1). There were no decorated or marked pipes and hence no accessioned items. All identifiable pipe bowls are typical of London manufacture and all show signs of having been smoked.

The pipe bowls range in date from *c* 1610–40 for the earliest examples, to *c* 1680–1710 for the latest. The only type recorded within the earlier range is the AO4, with the remainder of the pipe bowls in the *c* 1660–1710 date range. Context [1156] yielded the largest quantity of pipe bowls (16) and has been dated to *c* 1680–1710. One each of type AO4 (1610–40), AO13 (1660–80), and AO18 (1660–80), two types AO15 (1660–80) pipe bowls, together with 11 type AO22 (1680–1710), were found in this deposit with the last giving this landuse its later date. In the absence of makers' marks there is no possibility of refining the clay pipe chronology further. Context [1169] contained pipe stems only and consequently can only be broadly dated 1580–1910.

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19.5 A note on a piece of glass bead-making waste

Beth Richardson

A length of early to mid-17th-century cobalt blue- and white striped glass tube for bead making (<409>, [1125]; 9.2.1) is a significant find. Similar early post-medieval bead-making waste is known from only two other London sites, Hammersmith Embankment (HWR99) and a single piece from Southbridge House, Southwark (SBH88). Cylindrical striped 'trade' beads of this type were made for export, specifically for trading for goods from the East and West Indies and Africa. They are known to have been made in quantity in Amsterdam and Venice and, from recent evidence from Hammersmith (Egan 2004, HWR99 registered finds assessment) it now seems likely that immigrant glassworkers specialising in bead manufacture were also employed in London to make beads for this lucrative trade. Significant 17th-century glass vessel waste has also been found from this site (notes by Lyn Blackmore).

19.6 Leather

Beth Richardson

A note on the Roman leather

The site produced several single soles from Roman 1st- and 2nd-century shoes and sandals. Individual accessions include distinctive sandal soles with ends shaped like toes and with holes for toe-thongs (<490>, <492>, context [1373]; 9.1.1). They have small hobnails around the underside-perimeter and up the centre, a common feature of Roman footwear. There is also a natural-shaped nailed sandal sole with a thick cut thong-loop at the toe (<492>, [1373]) and a sole with a slightly pointed toe, which has cross-diagonal scoring on the underside (<489>, [1335]).

There are residual pieces from more Roman nailed soles in bulk leather contexts [1036], [1045] and [1057]. Most are individual fragments but one sole is still layered with four remaining layers ([1036]). There is also a piece of sole with loops of thick leather from a single-piece shoe or sandal ([1402]; 9.2.1).

This leather was examined while wet. It is well preserved with some interesting sole shapes and fastening features, which will help date the contexts within which they were found. When conserved it will require further examination with a short report and recording on the MOLA Oracle database.

A note on the post-medieval leather

There is a sizeable group of Tudor shoe parts and waste leather from the site. The shoes are early to mid-16th-century, with wide rounded toes and latchet (strap) fastenings over the instep. Three vamps/soles are ‘cow-mouth’ or ‘eared’ with small sole-protrusions widening and fashionably exaggerating the toe area (all residual in post-medieval contexts [1017], [1034] (both 9.1.1) and [1066] (9.2.2). All of the vamps (the front part of the shoe) are decorated with a raised horizontal seam and in one case with a V- slit at the instep. One has a surviving toe puff lining. Some quarters (backs) also survive, and two latchet-fastenings, one (from a child’s shoe) with a small buckle.

There are also some wide straps with large buckles, possibly from a bag or harness (<333>, <334>, <336>) and some waste leather from cobbling. One or two of the shoes have been cut, and may be cobbling waste.

Shoes of this date are comparatively rare and the group should be recorded and catalogued. When conserved it will require further examination with a short report and catalogue records on the MOLA Oracle database.

19.7 Accessioned finds

Michael Marshall

Introduction

This note covers finds from contexts within the range [1000] – [1448] with the exception of coins, accessioned ceramic vessels and building material, leather and post-medieval glass. All of the finds have been catalogued onto the registered finds form of the MOLA Oracle database. The finds fall conveniently into three groups, Roman, post Roman, and undatable, and they are discussed by material under these headings below.

Roman finds

Summary by material

Copper-alloy

There are nine Roman copper-alloy objects. Find <433>, [1397] is a bracelet made of twisted strands of different coloured copper-alloy wire. It may originally have had a third strand in iron but this is now missing. This style was in use from the mid-1st century onwards and is best known from 1st to 2nd-century AD deposits in London. While this example is broken, the relatively tight curvature, if original, could suggest it was worn by a child. Two copper-alloy hairpins were also recovered. <377>, [1027] is a highly decorative form with a ring head belonging to Cool (1990) type 9. It is a rare type, but there are other parallels in south-east England including an example from dumps in the Middle Walbrook valley which probably indicates that the type was already in use before *c* AD 125. <378>, [1023] is another decorative type with a reel and bead head. It does not equate precisely to any of the types published by Cool, and although examples with similar heads are known in bone during the Late Roman period it is not clear if the two materials share the same dating.

A copper-alloy needle <362>, [1045] is of a type that could have been used for stitching textiles and leather but may also have had a role in hairdressing. It has been bent which is of some interest as a large number of bent needles were recovered during recent excavations by MOLA at Bloomberg London (BZY10) in the Middle Walbrook valley and elsewhere in the upper Walbrook valley at Draper's Garden by Pre-Construct Archaeology. The only other object which may be associated with craft work is a small sheet strip <372>, [1045], perhaps an offcut.

A dropped bar terret ring <380>, [1091] is a relatively rare find for London and derives from cart or chariot harness. It is interesting that is occurs on the same site as the concentration of iron hipposandals (see below) and it will be interesting to determine if it is contemporary although it does not seem to be directly associated with them.

The other copper-alloy finds are commonplace domestic objects: an early Roman cochlear type spoon <432>, [1395]; a fragment of a decorative sheet mount <431>, [1395] and a lock plate pin <379>, [1023]

Iron

There are 12 iron objects that can be intrinsically dated to the Roman period. This assemblage is dominated by a group of 11 hipposandals, temporary horseshoes; this

important group is the largest assemblage from any single excavation in London and is discussed in more detail by Angela Wardle (19.8). The final diagnostically Roman iron object is a small type 2 slide lock key (Manning 1985).

Glass

Only three sherds of Roman glass were recovered. Naturally coloured vessel glass came from contexts [1373] and [1397]. The only diagnostic fragment was a handle fragment from a mid-1st to 2nd-century naturally coloured blue green bottle <441>, [1397].

Stone

Two stone objects of Roman date were recovered. The first is a lugged rim fragment from a stone vessel or mortar <450>, [1311] of unusual lithology. The colour and lamination is reminiscent of shale but this would be an unusual material for this style of object and also seems rather heavy. It will require further specialist examination. The second is a hone stone <451>, [1314].

Bone

There are only six bone Roman finds. There are two type 2 hairpins which date to the mid-1st to 2nd century AD (Crummy 1983), but only one of these <445> [1154] is stratified. A bone needle <445>, residual in [1154], came from a robust example but is too fragmentary to assign to a type. There are two gaming counters: an example of Greep (1995) type 2 <357>, [1027] with a counter sunk face, a style in use from the 2nd century onwards, and an example of type 3 <356>, [1045] with concentric circular groove decoration, which are not closely datable within the Roman period. The final bone object is a cylindrical hinge segment <447>, [1430] from a box or piece of furniture.

Wood

Two small fragments of wood probably derive from a single wooden stylus writing tablet <331>, [1045], identifiable by its raised border. Given their poor condition it is unlikely that any useful text would be recoverable.

Discussion

The Roman assemblage is relatively small but interesting and its value is increased by the excellent preservation of the finds. Where the finds can be closely dated they are mostly of mid-1st to 2nd-century AD date; there is nothing later than this. Full integration with the stratigraphic record will take place at analysis, but it is notable that none of the finds reported on here came from contexts identified as part of the Walbrook sequence by the site supervisors. Further south within the city, Walbrook channels and associated dumps and landfilling have produced extremely rich finds and it is possible that a different depositional process is taking place here outside / beyond the main focus of the early city.

Overall the character of the assemblage is largely domestic dominated by personal ornament, amongst which women and perhaps children are well represented, and including some furnishings/domestic equipment, such as the bone hinge and the stone mortar/vessel rim. Some of this material could ultimately prove to derive from

graves, especially given the good condition of fragile dress accessories such as pins, but all would be acceptable as household waste. Some objects came from the same contexts as disarticulated human remains, including: copper-alloy pin <430> from [1352], copper-alloy pin <488> and ?post Roman lace chape <487> from [1369] and copper-alloy spoon <432> and copper-alloy decorative mount frag <431> from [1395].

Craft and industrial activity is well known elsewhere in the upper Walbrook valley, but it is very poorly represented here. The most distinctive feature of the assemblage, however, is the large amount of equipment associated with transport / travel which was not present amongst the finds from the earlier phases of excavation. This category of material is normally absent or very scarce on intra mural sites / sites in the main urban core of the city, and the appearance of the terret and especially the hipposandals in this extra mural / peripheral context are of significant interest. Their relationship to the road leading out of the city and the overall distribution of similar evidence within London is discussed further by Angela Wardle (19.8).

Post-Roman finds

Summary by material

Ceramic

A single unusual ceramic object was recovered <477>, [1347]. This is an abraded slab with a truncated conical socket or impression. Its function is unclear, the smoothed interior of the socket could indicate use as a pivot but it is rather insubstantial for this and there is a ?metallic residue on the interior which could indicate that it functioned as a mould. Scientific analysis should help clarify this issue.

Copper-alloy

There are 27 copper-alloy post-Roman accessions. A small group of dress accessories includes an range of types common to the later medieval and post-medieval period: an ornate double oval buckle <464>, [1156]; a lace chape <487>, [1369]; a simple folded over and riveted sheet strap end <466>, [1156] and a number of pins. Eight of these are small wire dress pins with wire wound heads while one <430>, [1352] is a more elaborate version, with a larger head with pellet decoration that can be paralleled by a late 15th to 16th-century example from Southwark (Egan 2005, 51, no. 221). A small wire wound loop <427>, [1204] is probably from a clasp or a similar dress accessory.

A number of fragments of wire in a range of gauges were also found, mostly from context [1036]. These probably relate to some kind of craft activity on site and similar material has also been found during earlier phases of excavation at XSM10, as was a pinner's bone for the manufacture of wire pins. A fragment of possible vitrified mould or furnace lining with a coppery residue <412>, [1136] may also relate to industrial activity.

A small group of domestic material includes a 15th to 16th-century candleholder <373>; a 16th-century spoon with a fig shaped bowl <374>; a small ring fitting <375>, and a small fragment of a decorated stamped sheet object <376>, all from a single context [1034], thought to represent a dump deposit on the Walbrook floodplain. Similar material from elsewhere comprises a small bell <467>, [1343] and a small nail or tack <410>, [1133].

Iron

The twelve iron post-medieval objects are not particularly diagnostic and most come from a single context [1034]. Dress accessories are limited to small buckles <341> and <349> with circular or ovoid frames with central bars; probably from shoes. Also from this context are a whittle tang table knife with a makers stamp <339>; a horseshoe <342> and a few bits of structural fittings and furniture strapping. <345> is possibly a fragment of chain mail, but needs further conservation and x-raying before detailed recording.

Lead

Nine lead finds can be assigned to the post-medieval period. The most important of these is a group of three lead cloth seals all of which came from a single context [1034]. These will require specialist examination. The other lead finds were much less diagnostic and comprises small fragments of sheet and bar, some of which may be structural, and other waste.

Bone and Ivory

A single medieval bone find was recovered. This is a metapodial ice skate <446>, [1302] (which appears to be intrusive in a Roman context, most likely due to water-logged conditions of area) of a type most commonly encountered between the 8th and 13th centuries (Macgregor 1976). This is the third example of the type to come from XSM10.

As with earlier phases of work, waste from production continues to dominate, with 15 fragments of bone waste and four of ivory waste. This waste was concentrated in the backfill of a robber cut to remove bricks from the 17th-century cemetery wall; the fill produced 12 fragments, with a further six fragments unstratified. Individual pieces are described in detail on the MOLA database, but the general range includes blocks and offcuts of elephant ivory and cattle long bone wall as well as ring offcuts from working cattle metapodia on the lathe. The small bone rods which were common in most of the earlier phases of work, however, are absent, although at this stage it is unclear whether this is significant. Again, a range of tool marks are present, helping to demonstrate the range of tools (including knives, files, a lathe and saws) and the manner in which they were used in the manufacturing process.

The most diagnostic/ significant pieces provide information about the intended products. Accessioned find <397>, [1133] is a waster for making a bone screw-cap for a cylindrical box or needle case and <405>, [1133] is a cattle metapodial ring offcut with a part-finished product still in situ. This is a lathe turned D-sectioned ring, probably a curtain ring or similar fitting. These items came from the backfill of a post-medieval robber cut. The only other post-Roman find in this category is a fragment from the butt of an ivory post-medieval knife handle <390>, [from unstratified context 1104]. There is no definitive evidence that this is unfinished, but it came from the same context as some of the ivory waste, so it is possible that this too should be associated with the manufacturing activities.

Wood

A single wooden post-medieval object was recovered; a bundle of twigs <332>, [1034] is probably a small brush or broom head.

Discussion

With the exception of the bone skate <446> most of the post Roman assemblage can be preliminarily assigned to the post-medieval period, though the important transitional period of the 15th to 16th century is well represented amongst the more closely datable finds, and some of the finds such as wire dress pins are very long lived types.

There are clearly some key assemblages which will add significantly to our understanding of the site. Context [1034], a post-medieval levelling dump, produced a rich and diverse mixture of 15th-/ 16th-century material culture, which should be of use for a discussion of status and activity on site at that time. The material includes a range of domestic and dress/ personal finds, as well as some objects of commercial significance, such as the cloth seals. Other key contexts for finds include [1036], which produced a concentration of copper-alloy wire. The latter probably relates to craft activity on site and a similar concentration has also been found in the earlier phases of excavation in context [533]. That group was also associated with wire pins and a pinner's bone <286>, [507] was found in the same phase of excavation. The evidence for the processes which resulted in the wire waste found in [1036], however, is less clear.

The largest group of craft/industrial material is again bone working and ivory waste. This group is discussed above and adds to the very large assemblage of waste from working skeletal materials on site, which is of national importance. The associated dating for bone working waste from the site has previously focused on the 17th and 18th century, but close attention to the processes by which the waste entered the archaeological record will be necessary to further clarify this. The character of the present waste is sufficiently similar that it must be derived from the same workshop / craft processes as the material from the earlier phases of excavation, although there are some unique pieces which expand the previously understood picture and also some absences.

Undated finds and nails

Undated finds

The number of undated finds is relatively small and mostly comprises fragments of unidentifiable corroded metal objects. Only the most interesting and potentially identifiable finds are discussed here. It should be possible to assign these a date based upon their stratigraphic position and associations at analysis. The most important is undoubtedly <470> a complete pair of iron blacksmiths tongs. It is rare to find such excellently preserved examples archaeologically. It is unfortunate that they are not from a well stratified context, although the angular form of the jaws would be unusual in a Roman context and therefore a later date is perhaps more probable. Two iron knives are also currently undated: <346>, [1046] and <350>, [1019] but it should be possible to assign them to a date range at analysis.

Nails

The iron nails assemblage is unusually small in relation to the size of the accessioned finds assemblage comprising only 38 fragments (304g). These are generally moderately to very well preserved, most being relatively short handmade types with flat circular or sub circular heads (cf Manning 1985, type 1b). The size of the assemblage limits their potential for further study, but they may gain further importance when the nails from the site as a whole are considered.

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19.8 Roman Hipposandals

Angela Wardle

Introduction

A hipposandal is a form of temporary shoe, which was bound to the hoof of a horse or draught animal to provide additional traction in slippery conditions, or on a metalled surface, where it also protected the hoof. The Broadgate Ticket Hall fieldwork has produced eleven of these objects, seven of them substantially complete, and although the type is well known in London, this is the largest collection of well-stratified examples from a modern excavation in the city and possibly in Roman Britain. Significantly the Broadgate hipposandals are all from a road surface or from roadside ditches, an environment where loss might well occur. The distinction must be made here between hipposandals which were bound to the foot of the animal and the more familiar nailed horseshoe, of which there are no convincing Roman examples (Crummy 2011, 61).

Description

There are four types of hipposandal, the basic classification established by Aubert (1929) and refined by Manning (1985, 62–6). All consist of a flat plate of iron with side wings and hooks, projections or rings to provide a means of binding the shoe to the hoof. Many, as <S 2> <S 3> and <S 8> catalogued below, have ridges or grooves on the underside of the sole-plate which acted as treads to increase grip in slippery conditions. Three of the four basic types are represented at Broadgate. Type 1, <S 1> to <S 5> has a distinctive vertical neck, a long bar of iron which terminates in a hook, or as here a rolled loop, forward-facing side wings and a rear hook. It is probable that the horse's legs were bound to prevent any chafing from the long neck. All our examples are now badly bent and distorted, but the essential features can be distinguished. Two tread patterns can be seen, a distinctive lozenge-shaped series of stamped grooves, on <S 2> and the more usual triple grooves on <S 3>. Type 1 is the most common form of hipposandal from Britain, and especially in London. Many well preserved examples in the Museum of London's permanent collection are from deposits in the River Walbrook, which shows that they were in use by the late 1st/2nd century.

There are no examples in the Broadgate group of Type 2 hipposandals, where the wings run forward to meet in a loop above the fore-part, but they are represented in the London collection, with at least one example from the general area, in Bishopsgate (BM 1871. 7- 14.22).

Type 3 has no neck or frontal loop – the wings run forward without meeting and the heel is hooked, as on <S 6> and probably <S 7>. It is possible that there is a hole in the sole of <S 6>, appearing as a shadow on the radiograph (to be investigated). Oval or kite-shaped holes, which are sometimes seen on this type, reduced the amount of metal required for the shoe (Manning 1985, 65). The Broadgate group also contains two examples of Type 4 hipposandals, a variant of Type 3, identified by Manning (ibid), which has shorter wings terminating in hooks or loops which often contain rings <S 8>, <S 9>. The former, with one surviving ring may also have a perforated sole (to be investigated), but <S 9> has a lozenge-shaped tread on the underside. Again, this type appears to have been in use by the 2nd-century AD , but examples are also found in later contexts outside London.

Discussion

Hipposandals are commonly found in Gaul and Roman Germany, and there is little doubt that they were a Roman introduction to Britain (Manning 1985, 63). The general distribution in Britain is largely urban and military, and London has now produced over 70 examples. There are exceptions to the urban distribution. A recent study of finds from different types of site in Essex (Wardle 2013, 221) shows a concentration in small towns, but also a number (11) from a minor nucleated (religious) site at Witham, Ivy Chimneys. At Gorhambury Roman villa, near Verulamium, where numerous examples were found, a large group of hipposandals in a metalled area near the enclosure boundary and some distance from the main building contributed to the conclusion that it was the site of a stock pen, and perhaps an area where horses were traded (Neal, Wardle and Hunn 1990, 114). In Verulamium itself, Manning (1984, 87) commented that the large group from the town might reflect its importance as a market centre.

The distribution of hipposandals in London is of potential significance. Preservation is clearly a factor in the survival and recognition of these objects – frequently all that remains is the wing – and it can be no coincidence that many of the examples in both the Museum and archaeological collections are from waterlogged middle Walbrook sites or the Thames waterfront. However, over half the number of examples are from the general area of Finsbury Circus and Moorfields/Moorgate, on the northern edge of the city, which may well have been a good area for stabling horses, perhaps a place where they were shod before venturing upon the metalled roads of the city. The new finds are an important addition to the corpus of hipposandals from London, both in terms of their location and potential for dating.

Catalogue

<S 1> Iron hipposandal

<353>, [1089]

Complete; L 155mm; L of neck 90mm. Aubert/Manning Type 1. The neck is made from a stout bar, which tapers from the sole plate to the looped terminal; the triangular wings curve in at each side; hooked heel.

<S 2> Iron hipposandal

<354>, [1089]

Complete; 180mm. Aubert/Manning Type 1. The looped neck, made from a square-sectioned rod, is now bent back; one of the side wings (not cleaned) is bent down under the neck; rear hook complete. The sole is virtually complete and is of interest for the pattern of the tread on the underside, which consists of a central groove with two grooves branching from the centre in a triangular formation to meet two further lines running along the edges. Unusually, the grooves themselves consist of a series of running rectangles and appear to have been stamped, presumably when the object was flat and before the wings were turned up.

<S 3> Iron hipposandal

<352>, [1078]

Almost complete; L 170mm. Aubert/Manning Type 1, very encrusted and distorted. The looped neck is now bent back over the sole and the side wings have been

flattened; rear hook almost complete. The underside of the sole has a tread of three parallel grooves (at present visible only on x-ray); these appear to run the full length of the sole.

<S 4> Iron hipposandal

<351>, [1078]

Almost complete; very encrusted and measured from x-ray; L 195mm. Aubert/Manning Type 1 with a looped vertical neck at the front, now bent to one side. The two triangular side wings are visible on the radiograph (X10709) but the downturned rear hook appears to be incomplete. A line running along the sole may be the remains of tread, but requires cleaning.

A second object, a stylus is corroded to the hipposandal.

<S 5> Iron hipposandal

<472>, [1314]

Incomplete; L (135)mm. Hipposandal of Aubert/Manning Type 1, now bent and distorted. The looped vertical neck survives, made from a square-sectioned iron bar, and one side wing is now bent upwards; very encrusted.

<S 6> Iron hipposandal

<473>, [1314]

Complete; L 170mm. Aubert Type 3. The wings are now bent over, but it is clear that they did not meet when in use; the forepart is rounded, without a neck and the heel is hooked. The whole object is very encrusted, but it is possible that there is a hole in the sole, as on other examples.

<S 7> Iron hipposandal

<471>,[0]

Incomplete; L (145)mm. Fragment of sole plate with rear hook and wings which run forward, probably Type 3

<S 8> Iron hipposandal

<476>, [1323]

Complete; L 170mm. Manning (1985, 65) Type 4, heavily encrusted, but the details are visible on x-ray. One of the short hooked rings retains a ring but is bent over towards the sole; the other wing is bent outwards; rear hook intact. The x-ray shows a shadow in the sole, which may be a perforation, reducing the amount of metal needed for the shoe.

<S 9> Iron hipposandal

<438>, [1323]

Almost complete; L 160mm. Manning (1985, 65) Type 4, a variant of Aubert Type 3. The object is heavily encrusted, but the radiograph reveals that the wings

terminate in loops which may originally have held rings as on <S 8>; the hooked heel is damaged. The x-ray shows a lozenge-shaped tread on the underside of the sole with its apex at the rounded fore-part.

<S 10> Iron hipposandal

<474>, [1314]

Incomplete; L (120)mm. Fragment of sole plate with part of ?rear hook from a hipposandal of uncertain type.

<S 11> Iron hipposandal

<475>, [1323]

Incomplete; L (95)mm. Fragment of sole plate and rear hook from a hipposandal of uncertain type.

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19.9 Roman Human Bone

Don Walker

Introduction

This report has been brought forward from the future Broadgate Ticket Hall post excavation analysis on account of the interest in remains from the Walbrook. It records the results of the analysis of human remains recovered during excavations in 2013. In particular, it deals with bone from Roman contexts associated with a channel or tributary of the Walbrook River that ran north–south through the site, near the crossing of an east–west Roman road. The contexts were observed in two specific archaeological investigations, the area around Manhole MHS1 and the Heading from MHS2-100 to Blomfield Street sewer, both at the western end of the site where Liverpool Street meets Blomfield Street. The deposits were notable for the high numbers of skulls relative to postcranial (non-head) elements.

Due to the fact that MOLA archaeologists were not able to enter the MHS2-100 Heading, they relied upon the considerable assistance and co-operation of the McNicholas miners to retrieve and record the presence of archaeological features and human remains. Their help was invaluable in providing the archaeologists with the information they required. The majority of the bone was recovered from yellow sand and gravel (context [1437]).

Trench MHS1 contained river deposits of yellow sand and gravel (context [1391]), probably the same deposit as [1437]. Skulls made up the majority of the bone assemblage from contexts [1391] and [1437].

Archaeological contexts from different areas of the site could be linked allowing the association of human remains from similar layers, for example the yellow river sand and gravel [1391] and [1437]. A number of other contexts contained small amounts of human bone. All of the human remains reported here are believed to be associated with Roman river deposits.

Excavations in the upper Walbrook valley have revealed evidence of the engineering of channels in Roman times in order to control the flow of the river water. As well as areas of industrial activity and road construction, there was also funerary activity, particularly to the west of the present site of investigation, in the area of Finsbury Circus (Harward et al 2015).

This work is taking place in advance of a post-excavation assessment and it is clear that it has the potential to contribute to the study of a significant feature of Roman London, the deposition of disarticulated or partially articulated human remains in the Walbrook. It is hoped that this report, together with radiocarbon dating of teeth from four of the skulls, will help to clarify past work. It will also from part of the future post-excavation assessment work covering all of the fieldwork results from Broadgate.

Methods

All skeletal elements were recorded onto a spreadsheet, together with details of age, sex, preservation and staining where applicable. Measurements were taken for complete or semi-complete bones where appropriate. The relatively large number of skull elements from [1391] and [1437] were re-associated with separated or broken bones from the same individuals. In order to distinguish between these individuals, the skulls from both these contexts were given their own unique number (such as

[1391](1), [1392](2) etc). In cases where the skulls were relatively complete, higher level recording was carried out, involving details of ageing, sexing, metrics, non-metrics and pathological changes following the Museum of London osteology method statement for the recording of human remains (Connell and Rauxloh 2003, Powers 2008) (Table 4; Table 5).

Category	Age group	Description
Subadult	perinatal	inter-uterine/neonate
	1–6 months	early post-neonatal infant
	7–11 months	later post-neonatal infant
	1–5 years	early childhood
	6–11 years	later childhood
	12–17 years	adolescence
Adult	18–25 years	young adult
	26–35 years	early middle adult
	36–45 years	later middle adult
	≥46 years	mature adult
Unclassified	adult	>18 years
	subadult	<18 years

Table 4 Age categories

Sex
Male
Probable male
Intermediate
Probable female
Female
Undetermined

Table 5 Biological sex categories

Adult age at death estimates employed a combination of pubic symphysis, auricular surface and dental attrition schemes (Brothwell 1981; Lovejoy et al 1985; Brooks and Suchey 1990).

Individuals aged below 18 years of age were classed as ‘subadults’. Their age was estimated using a combination of long bone diaphyseal growth and stage of epiphyseal fusion (Scheuer and Black, 2000).

The assessment of the biological sex of individuals was only attempted on adults and was based on a suite of morphological characteristics in the os coxae and skull (Powers 2008, 15).

The diagnosis of pathological conditions followed the procedures set out by Roberts and Connell (2004, 34).

Disarticulated remains were catalogued in an Excel table with details of age, sex and pathological lesions included. A summary catalogue of disarticulated remains is provided at the end of this document.

Nature of the sample

A total of 13 contexts of human bone, all believed to be Roman in date, were found within deposits associated with the Walbrook River. The only evidence of articulation came from three skulls in [1391] where both the cranium and mandible were present; the remainder of the bone was disarticulated. The minimum number of individuals (MNI) within the total sample was 37, one subadult and 36 adults.

Skull bones from both [1391] and [1437] were dominated by elements from the calvarium (42/62: 67.7%), with frontal, parietal and occipital bones equally represented in [1437] (Diagram 1). Context [1391] contained a higher proportion of frontal bones (Diagram 2).

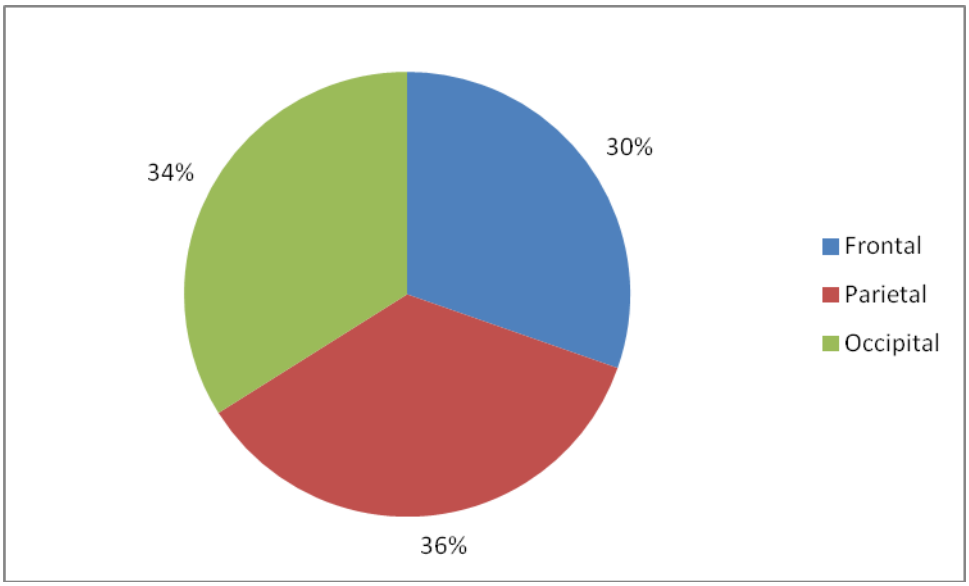

Diagram 1 Relative proportions of calvarium bones in [1437]

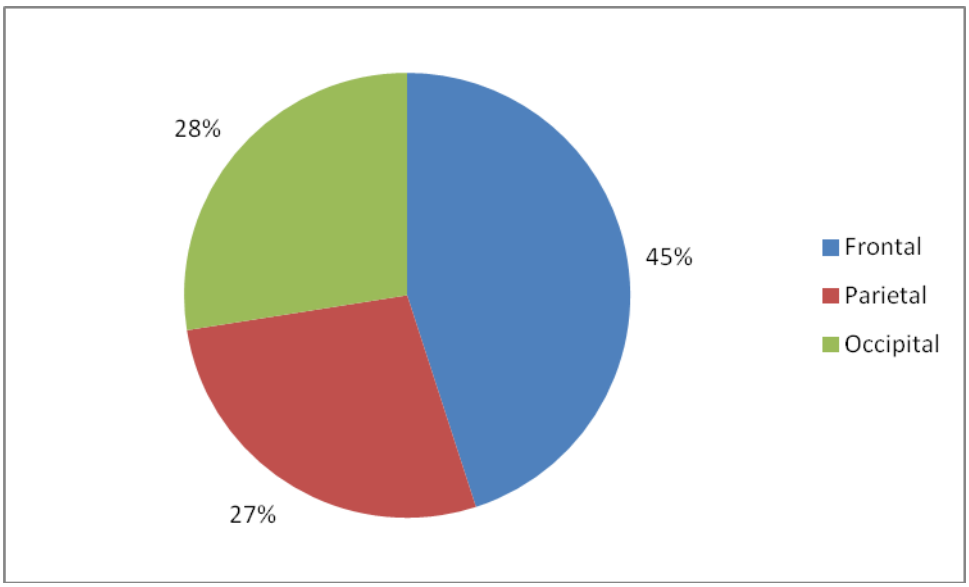

Diagram 2 Relative proportions of calvarium bones in [1391]

Postcranial elements were rare, representing a minimum number of six individuals. The majority were in context [1391] where elements from most areas of the body were found (Diagram 3).

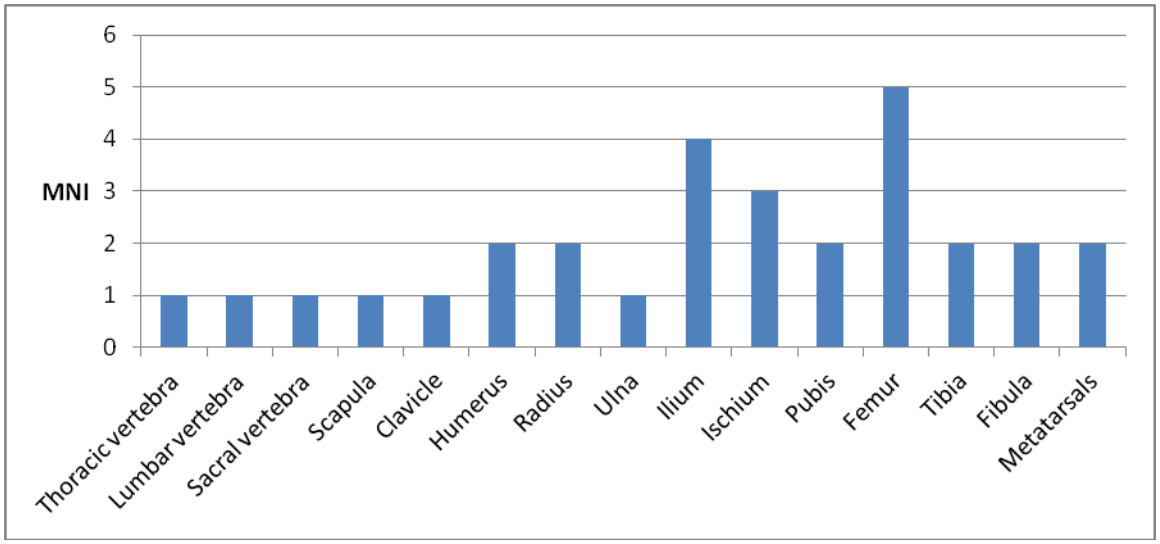

Diagram 3 MNI of each bone element from [1391]

Preservation and staining

The state of preservation was recorded for the more complete crania and mandibles (Diagram 4). Most were well preserved and none were in poor condition.

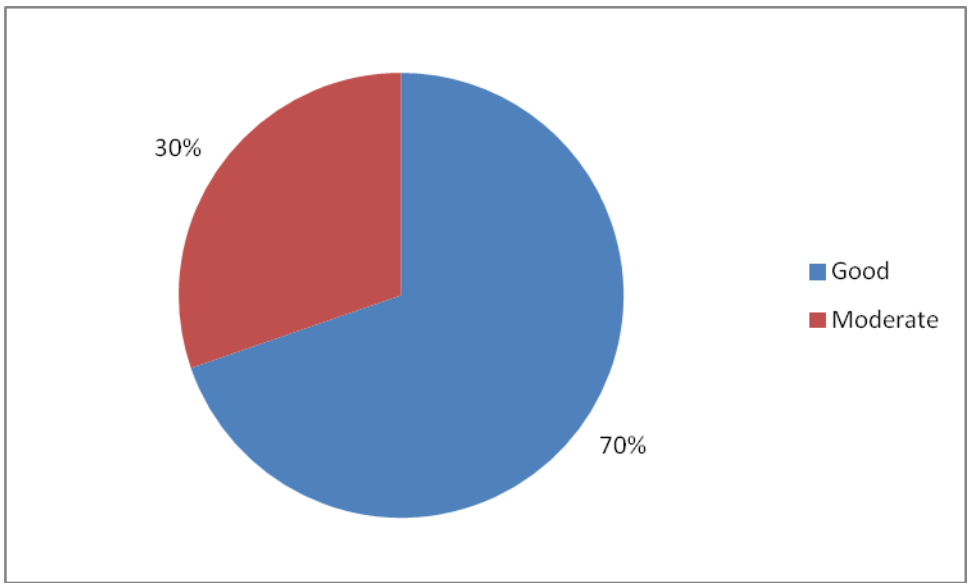

Diagram 4 Skeletal preservation

River sand and gravel context [1391] from MHS1 contained 18 skulls, of which four had evidence of post-mortem damage. Of these, one had diffuse surface damage that had removed part of the outer table of the skull and one had minor damage in the form of surface striations, possibly the effect of rolling along a gravel surface or lying in fast running water (Diagram 5). Another effect of lying in fast-running water may be polishing of external surfaces of bones, and this was observed in six skulls. One further skull was polished, but only on the internal surface (Photo 21). There were also apparent linear 'tide marks' on the surface of five crania, suggesting they had lain partially submerged in water or alternatively had been partially buried in the sides or base of a water-filled channel (Photo 22). Ten skulls had evidence of surface

staining and/or concretions, most commonly orange in colour, perhaps reflecting the gravel layer in which they were found and/or an iron oxide rich waterlogged environment (Photo 23). In two cases, the staining was very light brown, almost white in colour, contrasting with the mid brown colour of the majority of the skulls.

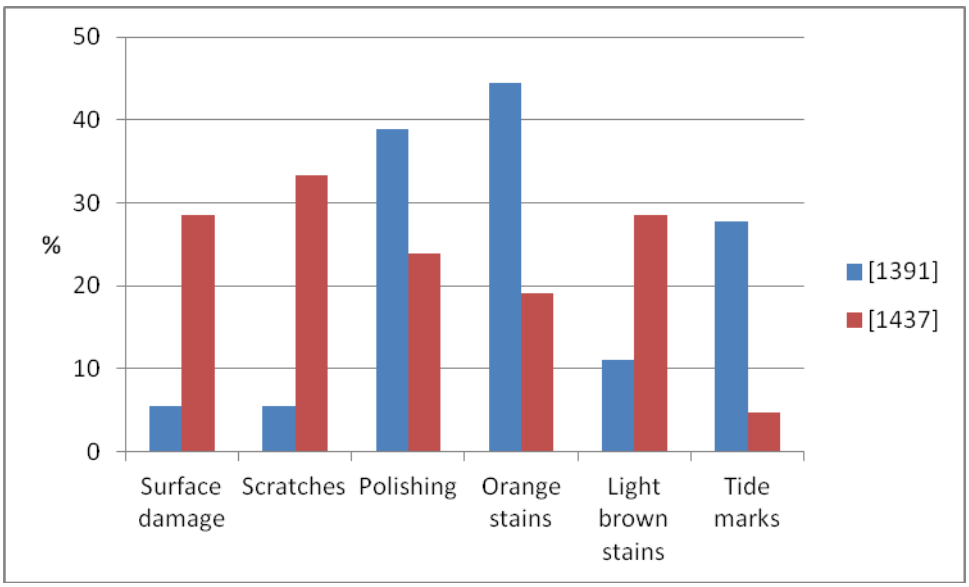

Diagram 5 Post-mortem changes observed in skulls from MHS1 [1391] and MHS2-100 Heading [1437]

Photo 21 XSM10 [1391](15) with endocranial polishing

Photo 22 XSM10 [1391](10) endocranial 'tide mark'

Photo 23 XSM10 [1391](7) orange concretions

Context [1437], within the MHS2–100 Heading, was thought to be part of the same layers as [1391]. It contained 21 skulls, of which seven had evidence of post-mortem damage. Of these, six were found with surface damage and seven with surface striations (Photo 24). Interestingly, no skulls were found with both surface damage and striations. Five skulls were polished and one had a 'tide mark'. Ten skulls were stained and/or covered in concretions. Six were stained light brown/white and four orange (Photo 25).

Photo 24 XSM10 [1437](14) with surface damage

Photo 25 XSM10 [1437](4) white staining on occipital

The majority of postcranial elements from [1391] were found to have post mortem damage. In the case of long bones, this involved the loss of both ends, leaving only the shaft remaining.

Dark brown staining, in stark contrast to the mid brown staining of the majority of bones, was evident on cranial elements from four contexts. The first of these was a right squamous temporal bone from [1314], a water lain deposit over the Roman road. The second was a mandible from [1395], a Roman dump at the edge of the channel. The third was a cranium within [1438], the fill of a possible feature cutting into the top of the yellow river gravels (such as [1391] and [1437]). Finally, a femur and tibia were recovered from [1440], a layer of river clay from the MHS2-100 Heading.

Sampling

Four human teeth were selected during recording and forwarded to Beta Analytic for C14 (AMS) dating on 23rd November 2013 (Table 6).

Trench	Context	Tooth (FDI)	Weight (g)
MHS1	1391(1)	47	2.2
MHS1	1391(3)	38	2.3
MHS1	1391(4)	48	1.8
MHS2-100 Heading	1437(1)	18	1.8

Table 6 Teeth for radiocarbon dating

Results of C14 dating

Lab code	Context	Notes	Material	Age BP	Cal date (2 Sigma)
366574	1437	skull 1	human tooth collagen	1850 +/- 30	Cal AD 80-380
366573	1391	skull 4	human tooth collagen	1760 +/- 30	Cal AD 220-380
366572	1391	skull 3	human tooth collagen	1800 +/- 30	Cal AD 130- 320
366571	1391	skull 1	human tooth collagen	1960 +/- 30	Cal BC 40- AD 80

Table 7 Radiocarbon determinations

Demographic data

Apart from a single subadult right radius, all elements belonged to adults.

Five os coxae from [1391] could be assessed for biological sex. Of these, four were classified as male and one as probable female. Three of the males were estimated to be 36–45 years of age at death. Once mandibles had been matched to crania, skulls from [1391] contained six males, two probable males and three probable females. Of the six skulls for which age could be estimated, all were between 18–35 years of age.

Age (years)	Male	Probable male	Intermediate	Probable female	Female	Undetermined	Total
18–25	1	0	1	0	0	0	2
26–35	3	0	0	1	0	0	4
36–45	0	0	0	0	0	0	0
>46	0	0	0	0	0	0	0
Adult	2	2	2	2	0	2	10
Total	6	2	3	3	0	2	16

Table 8 Demographic distribution of skulls in [1391]

Within context [1437], three skulls were classed as male, 14 as probable male and two as probable female (Table 9). One of the male skulls was 26–35 years of age at death.

Age (years)	Male	Probable male	Intermediate	Probable female	Female	Undetermined	Total
18–25	0	0	0	0	0	0	0
26–35	1	0	0	0	0	0	1
36–45	0	0	0	0	0	0	0
>46	0	0	0	0	0	0	0
Adult	2	14	1	2	0	1	20
Total	3	14	1	2	0	1	21

Table 9 Demographic distribution of skulls in [1437]

When river gravel contexts [1391] and [1437] were combined, the skulls produced a total of 25 males, or probable males, and 5 probable females, a ratio of 5:1. However, skulls are less reliable indicators of biological sex than os coxae. Age at death is difficult to assess in adult skulls. The presence of seven skulls that appear to be from individuals who died prior to the age of 36 years, hints that this may be a sample containing a large proportion of young adults.

The skull from [1438] was also classed as male.

Metric data

Metric data was recorded for all skulls and will be stored in the archive.

Non-metric traits

Non-metric data was recorded for all skulls and will be stored in the archive.

Palaeopathology

Brief details of pathological changes were recorded for each bone and are summarised in section 19.19, Table 31.

Summary and conclusions

The discovery of human skulls in the upper Walbrook valley has a long history and has been the source of much speculation (Harward et al (2015). The damage and polishing, together with differential staining of the bones from Broadgate Ticket Hall reflects the river gravels in which they were discovered, in that they were abraded due to exposure or partial exposure to rapidly flowing water. This would be consistent with the work of Harward et al (2015) on the excavations of the upper Walbrook Roman cemetery, where the skulls of burials were eroded out by the surrounding tributary streams. The presence of skulls within non-gravel deposits, such as [1438] within a possible cut feature, may reflect secondary or tertiary deposition during later activity. Alternatively they may reveal direct funerary activity. The discovery of a Roman cremation in MHS2-100 Heading shows that this area had an organised funerary function (19.2).

Limited articulation of elements was observed in three skulls where mandibles were successfully matched to crania. This is mirrored in other studies of Walbrook skulls (Edwards et al 2010) and suggests that at least some of the skulls entered the water intact, with the flesh or at least the attaching ligaments still intact. At the same time,

the absence of the cervical vertebrae of the neck implies that at least some of the skulls became separated from the vertebral column, before, during or after entering the water. The preferential post-mortem maintenance of articulation of the cranium and mandible over that of the cranium and neck can be investigated in forensic texts. A study of the disarticulation of human remains in aqueous environments reported that the mandible separated from the cranium prior to the cranium from the neck (Haglund and Sorg 2002, 208–12). However, this involved fully intact bodies. The skulls from Broadgate Ticket Hall may have originated from a buried environment, such as a cemetery, in which the pattern of body degeneration and disarticulation can vary and may differ significantly from that observed in forensic tests on fleshed bodies. In particular, bodies eroding out into water courses may be in varying states of decomposition and skeletisation, depending on the type of burial, the length of time the burial has been in the ground and the properties of the body and any accompanying adornments.

The results of the demographic analysis provide an unusually high ratio of adults to subadults, and males to females. In circumstances where an assemblage is formed by natural processes, it is conceivable that the larger, heavier skeletal elements of adults might become separated from those of subadults. Child cranial bones are not fully fused, making them more vulnerable to separation once skeletonised. However, natural processes would be unlikely to discriminate to such a degree on the basis of biological sex.

The only evidence of injury that may have been the result of interpersonal violence was a healed blunt force fracture on the right parietal of [1391](17). There were no peri-mortem injuries within the assemblage and consequently no evidence of violent death. As stated above, there were no cervical vertebrae from the neck which we might be expected find if decapitation of living individuals was involved, and no signs of post-mortem butchery. Of course the loss of the vast majority of the postcranial elements hampers the study and constrains its conclusions. An absence of evidence cannot be taken as evidence of absence.

Severe limitations apply to the osteological analysis and interpretation of human skeletal remains that have become disarticulated. Biological sex and age at death are more difficult to assign with confidence and the investigation of disease is restricted. Osteologists employ evidence from archaeological site records to interpret the circumstances of interment, where in normal circumstances information regarding the siting and position of primary burials can prove to be extremely helpful. Although a secondary burial may provide less complete osteological data, as some or all of the skeletal elements may have become disarticulated or lost, in many ways it can produce particularly interesting information on funerary behaviour and custom.

The interpretation of the processes that resulted in the presence of disarticulated bone within Roman layers at Broadgate Ticket Hall is dependent on two main factors. The first is the phase of deposition; in other words whether the human remains represent primary or secondary burials. This is linked in part to the second factor which could be termed the agency of deposition; whether the remains were deposited by deliberate human activity or natural processes, or a combination of the two. While the collection of a high concentration of skulls in preference to other skeletal elements can result from natural riverine processes (Harward et al 2015), the results of the osteological analysis, and in particular of the male to female ratio, show that human agency in the form of selection may have been active at some stage. Whether this stage was peri-mortem, post-mortem (funerary) and/or post-burial has yet to be determined.

However, this presupposes a population comprising equal numbers of males and females. If there was a high ratio of men to women living in London, the large

proportion of male skulls at Broadgate Ticket Hall, together with similarly high numbers of males in some Roman cemeteries, would simply be a reflection of the human population (Harward et al 2015, Table 8). The high ratio of males to females (3.5:1) in the nearby London upper Walbrook cemetery suggests we might expect to find a high proportion of males in any contemporary deposit of human remains in this area. This would be particularly relevant in the case of secondary deposition, where a body, in whatever state of decomposition, is moved from the location of its primary deposition, such as a grave, and re-deposited by natural and/or human agency.

The discovery of human skulls at Broadgate Ticket Office has provided an opportunity to observe and analyse human remains from London's past. This has implications for our understanding of Roman funerary activity, as well as land use and water management in the upper Walbrook valley.

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19.10 Post-medieval Human Bone

Michael Henderson

Introduction

An evaluation was conducted on the human skeletal remains uncovered during ongoing archaeological excavations by Museum of London Archaeology (MOLA) in advance of the proposed Crossrail Central Broadgate Ticket Hall.

This report contains an osteological evaluation of the in-situ articulated human skeletal remains (72 contexts) and disarticulated bone (2 contexts) associated with the post-medieval burial ground excavated in 2013 from trenches MHS1 and MHS2-100. This report also details the data gathered from the examination of disarticulated human bone from six as yet undated contexts.

Methods

The articulated and disarticulated remains were examined following Museum of London Archaeology standards (Powers unpublished). Each context representing an articulated skeleton was scanned and recorded directly into an Excel spreadsheet. This collated data for skeletal completeness, bone condition and created a summary catalogue of each body area present. Overall completeness was then estimated in 5% increments from 5-95% based upon the proportions of bone present (skull 20%, legs and feet 20%, arms and hands 20%, torso and pelvis 40%). Bone preservation was coded on a three-point scale from good to poor (1–3) following Connell and Rauxloh (2003).

Age and sex data was estimated for each individual when appropriate skeletal elements were present. Subadult age was estimated following observations of the eruption of the permanent teeth (Gustafson and Kock 1974) and stage of epiphyseal fusion (Scheuer and Black 2000). An adult age category was assigned in those individuals displaying erupted third molars and/ or with complete epiphyseal fusion. No attempt was made to further define adult age ranges at this stage. Adult biological sex was estimated through observations of cranial and pelvic morphology following (Buikstra and Ubelaker 1994), and recorded on a five point scale (Table 10).

Observations of pathological bone changes and dental disease were recorded by disease category following Connell and Rauxloh (2003) and supplemented by brief descriptions of location and type where appropriate.

A note was made of any staining of bone surfaces. Intrusive animal bone was separated and recorded. Intrusive human bone elements were noted and the minimum number of individuals (MNI) for each context calculated based on the age, sex and bone morphology of repeated elements.

The disarticulated bone was catalogued and recorded into an Excel spreadsheet when elements or bone segments were at least 50% present. Long bones were recorded by shaft (proximal, medial and distal). This allowed for the calculation of an MNI based on the presence of repeated elements. A note was made of any intrusive animal bone, staining or observations of any pathological conditions. Age and sex was recorded where possible.

Age code	0	Neonate/foetus
	1	1 month to 6 years (to M1 erupted)
	2	7-12 years (M2 unerupted)
	3	13-16 years (M3 unerupted)
	7	Adult
	12	Sub-adult (age unknown)
Sex code	1	Male
	2	? Male
	3	Intermediate
	4	? Female
	5	Female
	9	Undetermined
	0	Sub-adult

Table 10 Evaluation codes

Results

Seventy-two contexts of in-situ articulated human skeletons were excavated from Trenches MHS1 and MHS2-100. While the majority of contexts contained a single individual (47/72: 65.2%), 23 contexts contained an MNI of two (23/72: 31.9%) and two contexts contained the intrusive remains of at least three individuals (2/72: 2.8%). The majority of contexts showed moderate levels of bone preservation (45/72: 62.5%), with 34.7% (25/72) well preserved and only 2.8% (2/72) of contexts poorly preserved. Green staining from contact with copper objects within the grave was observed in 20.8% of contexts (15/71). Subadult [1211] had extensive green staining to the left and right tibial shafts. Intrusive animal bone was recorded mixed with adult [1138] (1/72: 1.4%).

The completeness of the articulated burials ranged from 5-90%. Half of the assemblage (36/72: 50.0%) had ≥ 50% of skeletal elements present, just under a quarter (17/72: 23.6%) were ≥ 75% complete. Approximately one third of burials (24/72: 33.3%) contained partial skeletons with ≤ 25% of elements present, reflecting the disturbed and truncated nature of many of the graves.

The demographic profile of the assemblage identified 58 adults (58/72: 80.6%) and 14 subadults (14/72: 19.4%) with a ratio of 4.1:1. The pooled definite and probable adult sexes showed a higher proportion of males (26/58: 44.8%) compared to females (17/58: 29.3%) with a ratio of 1.5:1. An absence of appropriate skeletal elements prevented the estimation of the sex of 15 adults (15/58: 25.9%). The majority of subadults were aged between 13-17 years at death (6/14: 42.9%) demonstrating a high proportion of adolescent individuals. Two individuals were aged between one month and six years (2/14: 14.3%) and one was aged between 7–12 years (1/14: 7.1%). The partial and incomplete nature of burials prevented the more refined aging of five subadults (5/14: 35.7%) (Table 11).

	n	%
Neonatal/feotal	0	0.0
1 month to 6 years	2	2.8
7-12 years	1	1.4
13-17 years	6	6.9
Subadult	5	6.9
Adult	58	80.6
Total	72	100.0

Table 11 Age distribution of the articulated burials

Twenty-seven individuals presented observable dentitions (27/72: 37.5%, 23/72: 31.9% adults and 4/72: 5.6% subadults). Of these, 25 individuals were affected by dental disease (25/72: 34.7%, 22/58: 37.9% adults, 3/14: 21.4% subadults). Nineteen individuals (19/72: 26.4%) suffered from dental caries (cavities) and calculus (calcified plaque) was adhered to the tooth surfaces of 21 individuals (21/72: 29.2%). Fourteen individuals had lost teeth during life (14/72: 19.4%), including female [1182] who had a fully edentulous mandible. Periodontal disease was present to the sockets of one individual (1/72: 1.4%) and female [1194] had a lesion at the external surface of a tooth socket representing a dental abscess. Subadult [1180] had linear grooves to the canine tooth surfaces indicating enamel hypoplasia (developmental crown defects). The maxillary left third molar of male [1118] was impacted and had failed to erupt. A well-worn, rounded notch to the biting surface of the teeth of male [1178] indicated the habitual smoking of a pipe.

Degenerative joint disease was recorded in 16 adults (16/72: 22.2%, 16/58: 27.6%). This affected the joints of the spinal column of 15 adults (15/72: 20.8%, 15/58: 25.9%) with evidence of Schmorl's nodes (disc herniation), osteoarthritis, osteophytes (new bone growth), intervertebral disc disease (pitting) and fusion of vertebral elements. Three adults (3/72: 4.1%, 3/58: 5.2%) had evidence of degenerative disease at extra-spinal joint locations. Male [1120] displayed expansive changes to the surfaces of the talonavicular joint of the right foot, male [1170] had osteoarthritis in the left hip with eburnation (polishing), pitting and marginal new bone formation. Osteoarthritic changes were also seen in the right acromioclavicular joint (shoulder) of adult [1202].

Four individuals displayed evidence of non-specific infectious bone lesions (4/72: 5.6%). Subadult [1139] had porous, woven periosteal bone formation to the medial surfaces of the tibiae and adult [1239] displayed lesions to the visceral (inside) surfaces of the ribs. The entire shaft of the right humerus of male [1249] was covered in a thick plaque of porous, woven bone and the distal third appeared swollen and expanded. The right ulna of male [1267] had a thick plaque of porous and spiculated new bone to the distal shaft. A large lytic lesion with irregular margins to the posterior aspect revealed a necrosed region of cortical bone and a post-mortem break presented a thickened cortical structure and a disorganised trabecular bone suggesting osteomyelitis (infection of the internal bone structures). There was corresponding new bone growth to the shaft of the right radius. The posterior midshaft of the right fibula also displayed expansive changes with porous new bone overlying more longstanding sclerotic bone. This surrounded two possible sinus lesions with smooth, defined margins also indicated osteomyelitis infection.

Traumatic injuries were recorded in three contexts (3/72: 4.2%, 2/58: 3.4% adults). Male [1123] had a fracture of the left third metacarpal (finger) and adult [1202] had a possible compression fracture to a thoracic vertebral body. The partial skull of a probable adult female [1256] displayed a large subcircular depression to the posterior left parietal suggesting a blunt force trauma injury to the back of the head. The injury was well healed although radiating fissures surrounded the lesion and a corresponding indentation was visible to the endocranial (internal surface).

Four adults (4/72: 5.6%, 4/58: 5.2% adults) had evidence of congenital or developmental bone disorders. Three individuals had bilateral spondylolysis, the separation of the posterior aspect of a vertebral body from the body (3/72: 4.2%). Male [1120] had hallux valgus deformity of the first metatarsals (great toes).

An intrusive cranium found mixed with subadult [1251] presented an unusual shape. The adult female cranium displayed large and square orbits and the forehead was narrow and sloped. The posterior occipital region of the skull was flattened and extended. This skull was not included in the above statistics and may require a new context number at analysis. Further examination of stratigraphic evidence may enable the reassociation of the skull with post-cranial elements.

Female [1172] presented evidence of probable neoplastic bone changes in the form of a subcircular rounded mass of sclerotic bone with no delimiting margins to the right posterior parietal. This may represent an osteoma, a benign tumour (Ortner 2003, 516). Probable female [1310] had evidence of cribra orbitalia, porous, pitted lesions to the roofs of the orbits.

Two contexts containing disarticulated human bone were recovered from features associated with the post-medieval burial ground. This produced an MNI of an additional two adult individuals. When combined with the articulated burial numbers this presented an overall MNI of 74 individuals.

The skull of a probable adult female from context [1167] had been sawn transversely indicating the individual had undergone a craniotomy.

A further six contexts overlying Roman features were found to contain elements of human bone. This presented an MNI of an additional seven individuals. These contexts were not included in the above statistics. These features remain as yet undated and further analysis of stratigraphic evidence may determine if these elements represent redeposited remains from disturbed post-medieval burials or Roman burials within the area. A full summary of the disarticulated bone examined can be found in Table 12 and Table 13 below.

Conclusion

A minimum number of 72 in situ articulated burials from the 16th- to early 18th-century burial ground were recorded during archaeological evaluation of Trenches MHS1 and MHS2-100. Two contexts of disarticulated bone recovered from features associated with the post-medieval burials produced an MNI of an additional two individuals. The information gathered from these burials can be combined to the dataset of burials previously recovered during archaeological evaluations at the Broadgate Ticket Hall, Liverpool Street works.

A further six undated contexts containing disarticulated bone produced an MNI of seven individuals.

Investigation and full analysis of these of these burials under modern archaeological conditions will further our knowledge of life, death and burial in post-medieval London. The possible early 16th- to early 18th-century date of the burials will help to

redress the underrepresentation of skeletons osteologically examined from this time period. This will help answer questions regarding the diversity of the population, the effects of urbanisation and population growth, and how increased pressures on resources and higher pollution levels contributed to the spread of disease, health and life expectancy of the inhabitants at a time of great change (Museum of London 2002, 71). Comparisons can be drawn with contemporary assemblages in London and nationwide.

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Tables of assessment data

Context	Body area	Elements present	Age	Sex	Pathology	MNI	Comments
1149	Upper limb	R. proximal ulna	7	9	None	1	None
1149	Torso	L. ilium, rib	7	9	None	1	None
1149	Lower limb	L. femur	7	9	None	1	None
1167	Skull	Cranium	7	4	Craniotomy, dental calculus	1	None
					Total	2	

Table 12 Summary of post-medieval bone

Context	Body area	Elements present	Age	Sex	Pathology	MNI	Comments
1019	Upper limb	R. radius	7	9	None	1	None
1019	Lower limb	R. fibula	7	9	None	1	None
1035	Skull	Frontals, parietals	7	7	None	1	Stained dark brown
1036	Lower limb	R. femur	7	9	None	1	Dark staining, blue stains to neck
1052	Torso	R. rib	7	9	None	1	None
1291	Lower limb	R. fibula	7	9	None	1	Animal bone
1369	Upper limb	L. humerus, L. ulna (x 2), L. clavicle, L. scapula, ribs	7	9	None	2	Dark stains
1369	Lower limb	Fibula (unsided)	7	9	None	1	None
					Total	7	

Table 13 Summary of undated disarticulated bone

19.11 Zoology

Alan Pipe

Introduction and methodology

Deposit [1391] produced 29 fragments of animal bone derived mainly from horse with single fragments of cattle scapula (shoulder blade) and sheep/goat rib; with small groups of chicken and dog. The horse group comprised 19 fragments all probably derived from the same adult animal; respectively, axis, thoracic and sacral vertebrae (neck, upper and lower back), rib fragments, mandibles (paired lower jaws) and innominates (pelves) from both sides of the body, and metapodials (foot elements). The mandibles showed severe wear on the incisor teeth suggesting an old animal aged between 20 and 25 years (Goody 1983, 40-41). One rib fragment showed evidence of pathological change, a poorly-healed break.

The cattle scapula had been split along the lateral side, probably in de-fleshing the shoulder blade. Chicken produced single fragments of juvenile tibia ('drumstick') and adult hen metatarsal (foot).

There were four fragments of adult dog; single examples of humerus (upper fore-leg) and metapodial (foot) with two fragments of tibia (lower hind-leg). Measurement of a complete tibia indicated an animal 0.425 metres tall at the withers (shoulder). Game species were represented by single fragments of adult red deer femur (thigh bone) and roe deer metatarsal (hind-foot).

Deposit [1396] produced seven fragments of animal bone derived mainly from horse with single fragments of cattle radius (lower fore-leg) and adult sheep metatarsal (hind-foot); respectively areas of moderate and poor meat-bearing quality. Measurement of the sheep metatarsal allowed calculation of an estimated withers (shoulder) height of 0.681 metres.

The horse group comprised fragments of rib, innominate (pelvis) and a single complete metacarpal (fore-foot) of an adult animal. Measurement of the metacarpal allowed calculation of an estimated withers (shoulder) height of 1.378 metres, equivalent to a Dales pony and in the centre of the calculated ranges for medieval and post-medieval horses in London (Rackham 1995, 170).

Deposit [1430] {90} produced only ten long bone fragments derived from juvenile frog or toad.

Deposit [1437] produced ten fragments of animal bone, all derived from adult horse. The group comprised fragments of skull, mandible (lower jaw), thoracic (upper back) vertebra, rib, metacarpal (fore-foot) and metatarsal (hind-foot); all possibly derived from the same adult animal.

Deposit [1438] produced single fragments of sheep/goat scapula (shoulder blade) and adult horse metacarpal and metatarsal (fore- and hind-foot). Measurement of the horse foot elements allowed calculation of estimated withers (shoulder) heights of 1.404 and 1.364 metres, again in the centre of the medieval and post-medieval ranges for London (Rackham 1995, 170).

Deposit [1448] produced 47 fragments of animal bone, the largest context group from the selected assemblage. This group derived mainly from horse and cattle with a

smaller group of sheep/goat and single fragments of pig, dog and game. Horse produced nine fragments derived from adult mandible (lower jaw), lumbar (lower back) vertebra, radius (lower fore-leg), innominate (pelvis), tibia (lower hind-leg) and three complete metatarsals (hind-foot) indicating disposal of elements of at last two adult horses. Measurements of a tibia (lower hind-leg) and three metatarsal (hind-foot) produced stature estimates in the range 1.247-1.306 metres indicating disposal of elements of at least three horses all equivalent to a modern riding pony – towards the centre of the Roman, medieval and early post-medieval ranges for London (Rackham 1995, 170).

The cattle group comprised a group of rib fragments with four fragments of scapula (shoulder blade) and single examples of adult metacarpal (fore-foot) and juvenile metatarsal (hind-foot); respectively areas of prime and poor meat-bearing quality suggesting disposal of butchery and primary preparation waste. Evidence of butchery comprised chop marks on rib and scapula fragments. Measurement of a cattle metacarpal (fore-foot) indicated an animal with an approximate shoulder height of 1.135 metres, well within the size ranges for British medieval and early post-medieval cattle (Davis 1987, 178).

The sheep/goat group comprised fragments of rib with a complete adult sheep metacarpal (fore-foot) and single fragments of radius (lower fore-leg), innominate (pelvis) and tibia (lower hind-leg); areas of prime, moderate and poor meat-bearing quality; the radius had been chopped at the mid-shaft, perhaps during preparation of a shoulder and middle-neck joint (Davis 1987,25). Measurement of a sheep metacarpal indicated an estimated stature of 0.619 metres at the shoulder.

Pig produced a knife-cut fragment of scapula (shoulder blade). Other domesticate bones comprised only a fragment of dog tibia (lower hind-leg).

Thematic section

Introduction and methodology

This report quantifies, identifies and interprets the hand-collected and wet-sieved animal bones recovered from contexts [1391], [1396], [1430] {90}, [1437], [1438] and [1448] selected from deposits in the Walbrook channel at Crossrail – Broadgate, London EC2, City of London (XSM10).

Animal bones from each context and sample group were described and recorded directly onto the MOLA animal bone post-assessment Oracle database in terms of species, skeletal element, body side, age, sex, fragmentation, and modification. Evidence for age at death was derived from surface texture, epiphysial fusion and tooth eruption and wear stages as appropriate. Interpretations of age at death were made using data cited by Amorosi 1989; Goody 1997; Grant 1982; and Schmid 1972. Species and skeletal element were determined using the MOLA animal bone reference collection together with Cohen & Serjeantson 1996; and Schmid 1972. Fragmentation was described using a numerical zone method devised at MOLA. Similarly, butchery, working, burning and gnawing were described using standard codes and conventions in use by MOLA Osteology. All fully fused, skeletally adult and well-preserved bones were measured using the techniques of von den Driesch 1976. In general, each bone fragment was assigned to species and skeletal element and recorded as an individual database entry; when this was impracticable due to extreme fragmentation and/or erosion, fragments were recorded at an approximate level of identification particularly ‘frog or toad’, ‘cattle-sized mammal’, ‘sheep-sized

mammal', 'sheep/goat' and 'long bone'. Fragments too damaged to be identified to at least these approximate levels were not recorded.

The chronological narrative gives a description of each context group in terms of species and skeletal recovery, age at death and modification. Where group and context sample size is sufficient to allow further comment, diet, industrial activity and habitat implications are discussed in the chronological narrative and thematic text sections.

Preservation and quantification
A total of 106 fragments of hand-collected and wet-sieved animal bone were recorded onto the MOLA post-assessment database. Preservation was good for all context and sample groups with surface damage generally insufficient to prevent identification of species, skeletal element, dental wear, epiphysial fusion and modification.

Faunal composition
The assemblage derived largely from horse Equus caballus (45 fragments) and cattle Bos taurus (26 fragments) with occasional recovery of sheep/goat (including sheep Ovis aries) (13 fragments) and smaller groups of poultry, pig Sus scrofa, dog Canis lupus familiaris and game.

Poultry included only two fragments of chicken or domestic fowl Gallus gallus [1391] with no recovery of domestic goose Anser anser domesticus, mallard or domestic duck Ansa platyrhynchos or domestic pigeon/rock dove Columba livia. Pig produced a single fragment [1448]; and dog produced five fragments, four from [1391] and one from 1448].

Game comprised a single fragment of adult red deer Cervus elaphus [1391] femur (thigh bone) and two fragments of roe deer Capreolus capreolus radius (lower fore-leg) and femur (upper hind-leg) [1448].

Recovery of amphibians was limited to ten fragments of limb long bone of juvenile frog or toad from [1430] {90}, suggesting that this context is the fill of a steep-sided feature effectively acting as a 'pit-fall' trap from the local ground surface. There was no recovery of fish or of very small mammals such as rat Rattus sp, or house mouse Mus musculus domesticus.

Meat diet
For all context and sample groups in this very small, but well-preserved, assemblage, the bulk of the meat weight would been provided by beef and mutton supplemented by only occasional consumption of chicken, pork and venison, with no recovery of fish, goose, domestic duck, game birds such as partridge, waders or wildfowl, or the smaller game mammals such as hare Lepus europaeus or rabbit Oryctolagus cuniculus. Throughout the assemblage there is consistent emphasis on adults with no recovery of foetal, neonate or infant animals and only two single recoveries of sub-adults; chicken tibia ('drumstick') [1391]; and cattle metatarsal (hind-foot) [1448].

Absence of these very young animals provides no evidence for on-site breeding or keeping of livestock. The major domesticates, cattle and sheep/goat are consistently represented by elements of good and moderate meat-bearing quality (skull, vertebra, rib upper and lower limb) quality as well as those of low (foot, toe) and negligible (horn core) value suggesting disposal of waste from butchery, consumption and primary carcase processing. Recovery of a red deer femur (thigh bone) [1391] and roe deer radius (lower fore-leg) and femur (thigh bone) [1448] indicates waste from

consumption of good quality venison, although recovery of roe deer metatarsal (hind-foot) from [1391] may suggest disposal of primary carcase-processing waste or processing of a roe deer hide.

Other domesticates
Recovery of horse (45 fragments) provided the bulk of the assemblage with small groups of adult horse bone present in contexts [1391], [1396], [1437], [1438] and [1448]. Carcase-part representation includes fragments from the skull, mandible (lower jaw), vertebra, rib, upper and lower fore-and hind-leg and fore- and hind-foot with no recovery of the toe joints. Mandibular dental evidence from [1391] indicates an old animal in at least the 20th year; a rib fragment from the same context showed a poorly-healed break. There was no evidence of butchery for either human or animal consumption. A total of seven estimated withers (shoulder) height estimates from [1396], [1438] and [1448] all lay in the range 1.247–1.404 metres, equivalent to a Dales pony and in the centre of the Roman, medieval and early post-medieval ranges for London (Rackham 1995, 170).

Dog produced only five fragments; humerus (upper fore-leg), metapodial (foot) and tibiae (lower hind-legs) from [1391]; and a tibia from [1448].

There was no recovery of cat Felis catus from the selected contexts.

Modification
Clear tool-mark evidence of butchery, particularly with use of cleavers, was noted on cattle scapula (shoulder blade) [1391] and [1448], and rib [1448]; and sheep/goat radius (lower fore-leg) [1448] with a single knife-cut pig scapula [1448] all suggesting de-fleshing and the production of manageable joints. There was no evidence of burning or gnawing; and no tool-mark indication of working of horn or bone.

Conclusion
This small assemblage seems to represent disposal of horse carcases, perhaps of old and/or infirm animals, with disposal of primary-processing, butchery and post-consumption waste associated mainly with consumption of beef and, to a lesser extent mutton, with minor components of chicken, pork and venison from red and roe deer. There is no evidence for local stock-rearing, dairying or working of horn or bone.

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19.12 Botany

Evaluation of the environmental samples

Anne Davis

Methodology

Forty-five environmental bulk samples were taken from this phase of the site. Information from sample sheets suggests that they came mostly from ditch and channel fills, waterlain or dumped deposits and fills of a quarry pit [1370]. Most were thought at the time of excavation to date from the Roman period but several are likely to be pre-Roman, natural deposits and a few date from the medieval and/or post-medieval periods. The samples were processed by flotation, and the wet flots evaluated to determine the presence and nature of any plant remains and other biological material present. As most of the sample flots were large, this evaluation was based on 50-100ml sub-samples in most cases. The results were recorded on the MoLAS Oracle database, and are summarised in section 19.19, Table 35.

Results

The majority of samples contained large and well-preserved assemblages of waterlogged plant remains. Almost all included plants of aquatic and/or marginal wetland habitats with taxa such as golden dock (Rumex maritimus), celery-leaved crowfoot (Ranunculus sceleratus), bur-marigold (Bidens sp.) and water pepper (Persicaria hydropiper), which grow on wet, marshy ground, particularly common. Fully aquatic species such as pondweed (Potamogeton sp.) and (Ceratophyllum submersum), which grow submerged or floating and indicate standing water, were less common but present in a number of samples and noted as relatively abundant in samples [1052]{51} and [1187]{72}. Further evidence for the wet and marshy conditions on the site, and also for standing water, was seen in the form of various invertebrate remains. Shells of freshwater molluscs were common and, in many cases, very abundant. Ostracods, waterflea eggs (Cladoceran ephippia) and caddis fly (Trichoptera) larval cases, which are all aquatic during at least one stage of their life cycle, were very numerous in some samples.

Twigs and smaller wood fragments were abundant in several samples, notably those from [1085]{65}, [1335]{76}, [1337]{77} and [1437]{95}, and often accompanied by willow (Salix sp.) buds and seed capsules. These were less common in samples from the ‘utility corridor’ area of the site, perhaps suggesting that tree/shrub cover was greater in the areas closer to the Walbrook tributary, although box (Buxus sempervirens) leaves seen in samples [1086]{47} and [1066]{58} suggest some sort of woody vegetation in the former area, perhaps in the form of hedging.

Plants of other habitats, notably waste, disturbed and grassy places, were all represented in many samples, but were rarely dominant in the assemblages, suggesting that these conditions could be found nearby, if not on the site itself. Many of these could equally have arrived in anthropogenic dumped material however, including stable waste and domestic kitchen refuse. Several sample flots, notably those from [1347]{78}, [1343]{80} and [1373]{81} consisted mainly of flattened plant stems, probably including cereal straw, and included several seeds of potential arable weeds and meadow plants, all of which suggest the dumping of stable sweepings.

Food remains were quite abundant in a number of samples with the widest diversity/highest numbers seen in samples [1034]{44}, [1086]{47}, [1066]{58}, [1150]{69}, [1169]{70}, [1177]{71}, [1343]{80} and [1369]{82}, thought to come from both the Roman and post-medieval periods. The majority of foods noted were commonly found fruit pips and stones, but more unusual finds in the form of olive (Olea europaea) stones were seen in four of these samples and a possible almond (Prunus amygdalus) stone in one. At this stage only a small proportion of most flots has been scanned, and these finds suggest that more detailed investigation may well reveal a wider range of plant foods.

Signs were seen in a few samples of textile industries in the neighbourhood: seeds of flax (Linus usitatissimum) and hemp (Cannabis sativa) in several samples and also flax seed capsules in [1312]{74}. Many seeds of teasel (Dipsacus sp.) seen in [1034]{44}. The spiny seed-heads of this plant were used for raising the nap on woollen cloth, and cultivated teasel grounds are known to have existed in the area.

Occasional finds of cultivated garden plants were also present in some of the samples, including seeds of ornamental plants such as marigold (Calendula sp.), opium poppy (Papaver somniferum) and leaves of box. Numerous hop (Humulus lupulus) seeds, seen in samples [1150]{69} and [1177]{71} may also result from garden crops grown for home brewing.

As far as can be seen during a brief assessment, samples seemed to be quite clearly divided between those containing various types of dumped material and those apparently containing only plant remains from the natural environment. The former often included signs of dumping from various sources, with food remains, garden plants and possible stable waste generally present in the same samples.

Charred plant remains were very rare in these samples, apart from fragmented charcoal in a few, and none contained charred assemblages large enough to merit further work.

Potential of the environmental samples

The excellent preservation of organic remains in these samples suggests that many of their plant assemblages are worthy of further analysis. This would provide potentially useful information on the natural environment of the site, including any spatial and chronological variations. Other information, on diet, and on activities taking place on or near the site will be gleaned from the related dumped materials present in many samples. Analysis of the insect remains from selected samples will maximise the information available both on aspects of the natural environment and local activities.

19.13 Geoarchaeological report

Virgil Yendell

Introduction

This report provides the results of the geoarchaeological assessment of samples taken during investigations into a channel related to the Walbrook at XSM10. Monolith sampling was undertaken at three trenches: the Utilities corridor (section drawings 16 and 21, south-facing, Figure 10 and Figure 11), the Open Cut Sewer trench (section 26, south-facing, not illustrated) and MHS1 (sections 37, south-facing, Figure 12 and section 38, north-facing, Figure 13).

Onsite methodology

On site, monolith tins were placed vertically into the side of sections exposed during the excavation, to retrieve continuous stratigraphic samples. The number of tins used was dependent upon the depth and/or significance of the stratigraphic sequence and the suitability of the stratigraphy for sampling. Each monolith tin was plotted on a section drawing and related to Above Tunnel Datum (ATD). Preliminary interpretation of the soil and sediment characteristics of the sequences was made and an overview of the stratigraphy produced that characterises the sequence. All the sediments examined were described according to standard sedimentary criteria, loosely following Jones et al (1999) and Tucker (1988) (relating to colour, compaction, texture, structure, bedding, inclusions, and clast size). The monolith samples were sealed and labelled and taken to MOLA geoarchaeology laboratories, to be kept in controlled storage during the assessment and analysis stages of the work.

Offsite methodology

The south-facing and north-facing sections of MHS1 (Figure 12 and Figure 13) were chosen for assessment as the best preserved sequences of natural Holocene deposits. Suitable key deposits within the sequences were sub-sampled; these sub-samples were submitted to external specialists for pollen and diatom assessment, in order to identify the preservation quality, range and abundance of environmental remains and their potential for past environment reconstruction.

A low resolution palaeoenvironmental assessment from the full natural Holocene sequence aims to examine the survival of different categories of environmental remains and their potential for reconstructing the natural environment and landscape, as well as providing direct or indirect evidence of human occupation and land use.

A table of the sub samples sent for assessment is presented in Table 14. The specialist reports are given below, with an integrated geoarchaeological summary toward the end of the section.

Sample Number	Section	Sample height (m ATD)	Sediment Summary
PD 1	38: North facing	107.63	1391
PD 2		107.59	1445
PD 3		107.11	1443
PD 4		107.25	1430

PD 5		107.20	1430
PD 6		107.12	1443
PD 7		107.02	1443
PD 8		106.98	1443
PD 9	37: South facing	107.75	1402
PD 10		107.64	1402
PD 11		107.49	1403
PD 12		107.44	1431
PD 13		107.40	1431
PD 14		107.34	1426
PD 15		107.09	1432
PD 16		107.18	1429

Table 14 Samples assessed for diatoms and pollen

The assessed sequence of deposits were logged in table format and entered into a digital database (Rockworks15), which was used to compare and correlate the stratigraphy across the site. Cross-sections were drawn through the data points and correlations made between key deposits, which were then interpreted into facies (a series of site-wide deposits which are representative of certain environments).

The Rockworks data was then transferred to Arc GIS v.10.1, through which the topographic plot of the early Holocene surface was created. These programmes give an approximation of the topography of the site as it existed at the beginning of the Holocene period (ie the early Mesolithic, *c* 10 000 years ago) and its development over time.

Assessed section logs

The logs for the assessed sections from MHS1 are as follows, containing more detailed descriptions of contexts from laboratory examination.

XSM10_MHS1_South_facing_section_37_centre				**Easting**	533039.14	
				Northing	181635.90	
Depth (m bgl)		**Elevation (m ATD)**		**Description**	**Samples**	**Facies**
Top	**Base**	**Top**	**Base**			
0	0.1	107.65	107.55	Context 1402; Dark grey brown coarse-granular sands with small to medium sub angular gravel, slightly orientated, possible flood deposits from channel in the west.	<87> Mono, <85> Bulk	Facies 4: flood deposit

0.1	0.2	107.55	107.45	Context 1403; Firm very dark brown to black silt with fine sand filled pockets <1 cm frequent Fe staining and moderate small to medium sub rounded to rounded gravels, possible weathered bank of channel. Over consolidated matrix supported gravel, medium sized to very coarse sub rounded/ sub angular gravels in filled with fine sandy silt, slightly dark and siltier at the top.	<87> Mono, <84> Bulk	Facies 4: high energy channel deposit subsequentlly forming channel bank
0.2	0.25	107.45	107.40	Context 1431; Firm light greyish yellow silt with Fe staining, possible pooling, weathered overbank flood deposits. Over mid reddish brown, slightly organic silts, carbonised seed/root at base.	<91> Mono	Facies 4: vegetated channel margins
0.25	0.4	107.40	107.25	Context 1426; Soft sticky blue clay	<91> <92> Monolith	Facies 4: mudflats
0.4	0.5	107.25	107.15	Context 1429; Mid to dark reddish brown slightly organic silt with pockets <1cm in size of light grey yellow slightly sandy silt. Over 2cm thick band of pale silty fine sand mottled brown. Over 2cm thick band of dark slightly organic sandy silt and pale medium sand. Possible flood events.	Monolith <91><92>	Facies 4: vegetated channel margins
0.5	1.4	107.15	106.25	Context 1432; Firm mid grey brown sandy silt getting less sandy with depth and moderately coarse medium to large rounded gravels.	<91> <92> Monolith, <97> Bulk	Facies 3: Silting up of channel / channel margins
1.4	1.65	106.25	106	Context 994; Sand and gravel. Natural terrace gravel.	Not sampled	Facies 1: Pleistocene floodplain gravels

Table 15: MHS1 Section 37 (south facing) centre

XSM10_MHS1_South_facing_section_37_east				Easting	533064.54	
				Northing	181594.26	
Depth (m bgl)		Elevation (m ATD)		Description	Samples	Facies
Top	Base	Top	Base			
0.05	0.1	107.60	107.55	Context 1402; Dark grey brown coarse-granular sands with small to medium sub angular gravel, slightly orientated, possible flood deposits from channel in the west.	<86> Mono	Facies 4: flood deposit

0.1	0.2	107.55	107.45	Context 1431; Firm light greyish yellow silt with Fe staining, possible pooling, weathered overbank flood deposits. Over mid reddish brown, slightly organic silts, carbonised seed/root at base.	<86> Mono	Facies 4: vegetated channel margins
0.2	0.5	107.45	107.15	Context 1426; Soft sticky blue clay	<86> Mono	Facies 4: mudflats
0.5	1.4	107.15	106.25	Context 1432; Firm mid grey brown sandy silt getting less sandy with depth and moderately coarse medium to large rounded gravels.	<86> Mono	Facies 3: Silting up of channel / channel margins

Table 16: MHS1 Section 37 (south facing) east

XSM10_MHS1_North_facing_section_38				Easting	533015.00	
				Northing	181603.00	
Depth (m bgl)		Elevation (m ATD)		Description	Samples	Facies
Top	Base	Top	Base			
0	0.15	107.78	107.63	Context 1391; Bedded yellow coarse sands and gravels, appears to be coarse in the east, with more sands and finer gravel towards the west.	None taken	Facies 4: Mudflats overlain by flood events then more consistent higher energy flow with later stabilisation on the banks (historic)
0.15	0.4	107.63	107.38	Context 1445; Light brown clay with mid brownish grey silty clay patches and lenses of pale yellow sand, shows evidence of banding.	<102> Monolith	
0.4	0.6	107.38	107.18	Context 1430; Firm very dark grey brown-black highly organic silt with a single large sub angular gravel, possible marginal channel/wetland	<102><103> Monolith, <90> Bulk	
0.6	0.8	107.18	106.98	Context 1443; Light greyish yellow fine sandy silt with rare Fe staining at top, single coarse 45mm sub rounded gravel @ 11cm, also gravelly patch (11-15cm) with occasional small sub angular to sub rounded gravel, rare fine sub rounded gravels throughout, sharp boundary	<102> <103> Monolith	Facies 2: Fluvially reworked marginal deposits (late prehistoric to historic)
0.8	0.85	106.98	106.93	Context 1444; Friable/loose, light blue grey mottled with organic brown fine to coarse sub angular to sub rounded gravelly clayey silt.	<103> Monolith	
0.85	0.95	106.93	106.83	Context 1453; Fairly well consolidated light yellow grey mottled with orange yellow, slightly clayey, medium to coarse sub rounded and sub angular gravel, some rooting from above.	<103> Monolith, <98> Bulk	

0.95	1.25	106.83	106.53	Context 1446; Stiff firm clay very compacted with frequent medium gravels	<99> Bulk	
1.25	1.3	106.53	106.48	Context 1441; Heavily compacted mid greenish brown coarse sand intermixed with stiff grey clay moderate medium and small gravels.	<100> Bulk	Facies 1: Pleistocene floodplain gravels
1.3	1.5	106.48	106.28	Context 1442; Mid greenish brown coarse sand intermixed with stiff grey clay moderate medium and small gravels heavily compacted	<101> Bulk	
1.5	1.85	106.28	105.93	Context 996; Stiff grey clay. London Clay	Not sampled	Facies 1: London clay

Table 17: Trench MHS1 Section 38 (north facing)

Unassessed section logs

The unassessed logs for all sections from the three trenches are as follows.

XSM10_Open_cut_sewer_section_26			Easting	533042.65	
			Northing	181621.89	
Depth (m bgl)		Elevation (m ATD)	Description	Samples	Facies
Top	Base	Top	Base			
0	0.15	107.55	107.4	Context 1093; Mixed brown peaty clay	Mono <67>	Facies 4: vegetated wetland
0.15	0.2	107.4	107.35	Context 1094; Mixed clay with dispersed sporadic gravels	Mono <67>	Facies 4: fluvial reworking of channel margins
0.2	0.25	107.35	107.3	Context 1095; Mixed Light grey clay	Mono <67>	Facies 4: channel margins/mudflats
0.25	0.4	107.3	107.15	Context 1096; Brownish peaty clay	Mono <67>	Facies 4: vegetated wetland
0.4	0.55	107.15	107	Context 1088; Light grey medium sands predominately coarse gravels intermixed with medium gravels	Mono <67>	Facies 3: Late Pleistocene to early Holocene channel fill
0.55	0.95	107	106.6	Context 1099; Light grey medium to coarse gravel in a matrix of medium sand.	Mono <68>	
0.95	1.00	106.6	106.55	Context 1100; sand and gravel	Mono <68>	Facies 1: Pleistocene floodplain gravels

Table 18: Open Cut Sewer Trench Section 26 (south facing)

XSM10_Utilities_corridor_section_16_west				Easting	533018.19	
				Northing	181604.91	
Depth (m bgl)		Elevation (m ATD)		Description	Samples	Facies
Top	Base	Top	Base			
0	2	109.3	107.30	Context 1035 Firm mid grey -black slightly organic silty clay with some small sand and mollusc fragments,	Mono <47>	Facies 5: Channel margins variable anthropogenic dumping
2	2.1	107.30	107.20	Context 1052: Dark grey silty clay.	Mono <47>	
2.1	3	107.20	106.30	Context 1061; mottled orange grey yellow gravels with flint pebbles.	Mono <47>	Facies 1: Pleistocene floodplain gravels
3	3.38	106.30	105.92	Context 1062; coarse sand with pebbles.	None	
3.38	3.63	105.92	105.67	Context 1063 Loose grey gritty sandy fine gravels	Mono <54> <55>, Bulk <56> <57>	
3.63	4	105.67	105.30	Context 1064 Compacted, light green grey gravel, grading into medium coarse sand.	Mono <54> <55>	
4	4.3	105.30	105.00	Context 1065; Very firm to stiff light orangey green brown grading into greenish brown clay (Weathered London Clay)	Mono <54> <55>	Facies 1: London Clay

Table 19: Utilities corridor Section 16 (south facing) west

XSM10_Utilities_corridor_section_16_centre				Easting	533048.69	
				Northing	181603.51	
Depth (m bgl)		Elevation (m ATD)		Description	Samples	Facies
Top	Base	Top	Base			
0	0.5	111.3	110.8	Context 1034 Firm dark grey clayey sand with gravel, occasional bone , CBM , mortar, shell and straw	Mono <39>	Facies 5: Channel margins variable anthropogenic dumping
0.5	2	110.8	109.3	Context 1035 Firm mid grey to black slightly organic silt with sandy element	Mono <41><39>	
2	2.5	109.3	108.8	Context 1036 Thin band of gravelly medium sand	Mono <41>	
2.5	3.5	108.8	107.8	Context 1045 Dark grey silty clay with peat lens.	Mono <48> <41>	
3.5	3.6	107.8	107.7	Context 1032 dark brown Peaty layer	Mono <48>	Facies 4: vegetated wetland
3.6	4.5	107.7	106.8	Context 1048 Dark grey sandy gravelly clay.	Mono <48>	Facies 3: Silting up of channel / channel margins

Table 20: Utilities corridor Section 16 (south facing) centre

XSM10_Utilities_corridor_section_21				Easting	533051.12	
				Northing	181596.70	
Depth (m bgl)		Elevation (m ATD)		Description	Samples	Facies
Top	Base	Top	Base			
0	0.46	108.96	108.5	Context 1018 Dark brown grey slightly humic silt with occasional twigs and molluscs.	Mono <37>	Facies 5: Channel margins variable anthropogenic dumping
0.46	0.66	108.5	108.3	Context 1019 Light brown grey clayey silt with Manganese staining root channels and occasional molluscs.	Mono <37><38>	
0.66	0.5	108.3	108.46	Context 1023 Mid brown grey sandy clay with small to medium gravels with rare granular CBM frags mortar and charcoal flecks with vivianite	Mono <36>	
0.5	0.9	108.46	108.06	Context 1041: Mid brown grey plastic silty clay with frequent Fe staining.	Mono <36>	
0.9	1.3	108.06	107.66	Context 1042: Mid yellowish brown sandy clay with moderate fine to medium gravel, some Fe staining.	Mono <36>	Facies 5: fill of cut [1043], a possible water management channel across the floodplain

Table 21: Utilities corridor Section 21 (south facing)

Diatoms

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Introduction

Sixteen sediment sub-samples from the site have been prepared and assessed for diatoms. These samples were taken from the exposed faces of two sections (Table 14).

The diatom assessment of these sequences evaluates the presence or absence of diatoms and the potential of the sediments for further diatom analysis. The assessment of each sample takes into account the numbers of diatoms, the state of preservation of the diatom assemblages, species diversity and diatom species environmental preferences.

Methods

Diatom preparation followed standard techniques (Battarbee et al 2001). Two 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 Hendey (1964), Werff & Huls (1957–1974), Hartley et al (1996), Krammer & Lange-Bertalot (1986–1991) and Witkowski et al (2000). Diatom species' salinity preferences are indicated using the halobian groups of Hustedt (1953, 1957: 199). These salinity groups are summarised as follows:

1. Polyhalobian: >30 g l-1

2. Mesohalobian: 0.2-30 g l-1

3. Oligohalobian - Halophilous: optimum in slightly brackish water

4. Oligohalobian - Indifferent: optimum in freshwater but tolerant of slightly brackish water

5. Halophobous: exclusively freshwater

6. Unknown: taxa of unknown salinity preference.

Results & Discussion

Diatom sample details are shown in Table 14. The results of the diatom evaluation are summarised in Table *22* and diatom species data are presented in Table 23.

Diatom Sample No.	Diatoms	Diatom Numbers	Quality of Preservation	Diversity	Assemblage type	Potential for % count
PD1	+	ex low	ex poor	ex low	aero fw	none
PD2	+	low	poor mod	low	fw non plankton	none
PD3	+	mod	mod	high	fw	good
PD4	+/- 0	ex low	ex poor	1 fragm	-	none
PD5	-	-	-	-	-	none
PD6	+	ex low	ex poor	1 sp.	fw aero	none
PD7	-	-	-	-	-	none
PD8	-	-	-	-	-	none
PD9	+	low	v poor	low	fw aero hal	none
PD10	+	ex low	ex poor	ex low	fw aero	none
PD11 to PD16	-	-	-	-	-	none

Table 22 Summary of diatom evaluation results for the Broadgate site (XSM10)(+ diatoms present; - diatoms absent; ex extremely; mod moderate; fw freshwater; hal halophilous; bk brackish; aero aerophilous)

Diatom/Sample	D1	D2	D3	D4	D6	D9	D10
Mesohalobous							
Nitzschia punctata							cf
Halophilous							
Anomoeoneis sphaerophora							1

Diploneis ovalis			1				
Melosira varians			3				
Oligohalobous Indifferent							
Achnanthes lanceolata		1	1				1
Amphora libyca		1	1				1
Cocconeis placentula		1	1				
Eunotia curvata			1				
Fragilaria brevistriata							1
Frustulia vulgaris			1				
Gomphonema angustatum			1				1
Hantzschia amphioxys	2				1	1	1
Meridion circulare			1				
Navicula capitata			1				
Navicula elginensis			1				
Navicula rhyncocephala			1				
Pinnularia brebissonii		1					
Pinnularia cf. major			1			1	
Synedra capitata			1				
Synedra ulna			1				3
Eunotia sp.			1				
Pinnularia sp.						1	
Unknown Salinity Group							
Cyclotella sp.			1				
Fragilaria sp.							1
Gyrosigma sp.			1				
Navicula sp.			1				
Nitzschia sp.							1
Indeterminate pennate diatom		1					1
Indeterminate Naviculaceae	1						1
Indeterminate diatom fragment	1	1		1	1		1

Table 23 Diatom species data from the assessment of diatom taxa (1 – present; 2 – common; 3 – relatively abundant)

MHS1 North-facing section (section 38; samples D1–D8; Figure 13)

Diatoms are present in five samples taken from the north-facing section (D1–D4, D6) and are absent from three samples (D5, D7, D8). However, the quality of diatom valve preservation in four of the diatomaceous samples is very poor and species diversity is low. There is further potential for diatom analysis of only one of the eight samples (D3) from the north facing section.

In the top sample (D1) from the north-facing section fragments of the aerophilous diatom Hantzschia amphioxys are relatively common. Aerophilous diatoms are tolerant of desiccation and are for example associated with ephemeral water bodies and soils. In sample D2 the diatom assemblage is comprised of non planktonic freshwater taxa. These diatoms include Achnanthes lanceolata, Amphora libyca, Cocconeis placentula and Pinnularia brebissonii. Pinnularia brebissonii is also an aerophilous diatom.

Sample D3 from this north-facing section contains a moderately well preserved diatom assemblage. The diatom assemblage is composed of freshwater and

halophilous taxa; however, there is no indication of estuarine influence. The halophilous taxa may indicate an elevated level of non-marine dissolved salts. The semi planktonic halophilous species Melosira varians is particularly abundant in sample D3. Melosira varians is associated with flowing water, as is the oligohalobous indifferent diatom Meridion circulare which is also present in sample D3. The halophilous benthic diatom Diploneis ovalis is present. The greatest number of taxa in D3 are non-planktonic, oligohalobous indifferent species which are associated with shallow water, in benthic or epiphytic habitats for example. These freshwater diatoms include Achnanthes lanceolata, Amphora libyca, Cocconeis placentula, Eunotia curvata, Frustulia vulgaris, Gomphonema angustatum, Navicula capitata, Navicula elginensis, Navicula rhyncocephala, Synedra capitata and Synedra ulna.

In sample D4, only a small fragment of an indeterminate diatom species was recorded. In sample D6, again the fragmentary remains of the aerophilous, freshwater diatom Hantzschia amphioxys are present.

MHS1 South-facing section (section 37; samples D9–D16; Figure 12)

Diatoms are present in two (D9, D10) of the eight samples assessed from the south-facing section and are absent from six samples (D11–D16). However, in the diatomaceous samples the quality of diatom preservation is very poor. There is therefore no potential for further analysis of any of the eight samples assessed for diatoms from the south facing section.

In sample D9 (107.75m ATD), the diatom assemblage is comprised of oligohalobous indifferent, freshwater taxa. These are aerophilous diatoms that are tolerant of desiccation. The diatoms include Hantzschia amphioxys and Pinnularia cf. major. Aerophilous diatoms are for example associated with ephemeral water bodies and soils. In sample D10 (107.64m ATD), the diatom assemblage is composed mainly of freshwater non planktonic diatoms. In particular Synedra ulna fragments are common. Other oligohalobous indifferent taxa in D10 include Achnanthes lanceolata, Amphora libyca, Fragilaria brevistriata, Gomphonema angustatum, and the aerophilous diatom Hantzschia amphioxys. The halophilous, benthic species Anomoeoneis sphaerophora is present. A possible fragment of the mesohalobous, benthic species Nitzschia punctata is also present in D10.

The relatively poor preservation, absence or low numbers of diatom remains in all but one of the sixteen samples assessed from both sections can be attributed to taphonomic processes (Flower 1993, Ryves et al 2001). This may be the result of diatom silica dissolution and breakage caused by factors such as extremes of sediment alkalinity or acidity, the under-saturation of sediment pore water with dissolved silica, cycles of prolonged drying and rehydration, or physical damage to diatom valves from abrasion or wave action.

Conclusions

Sixteen samples from two sections were prepared and assessed for diatoms. Diatoms are present in five samples of the eight samples taken from the North facing section. However, the quality of diatom valve preservation in four of the diatomaceous samples is very poor and species diversity is low. There is further potential for diatom analysis of only sample (D3) from Section 38.

Diatoms are present in two of the eight samples assessed from the South facing section and are absent from six samples. However, in the diatomaceous samples the quality of diatom preservation is very poor. There is therefore no potential for further analysis of any of the diatom samples from Section 37.

In the top sample (D1) from Section 38, fragments of an aerophilous diatom are relatively common. In sample D2, the diatom assemblage is comprised of non-planktonic freshwater taxa. In sample D3, the diatom assemblage is composed of a relatively diverse assemblage of freshwater and halophilous taxa. Although there is no indication of estuarine influence, the halophilous taxa may indicate an elevated level of non-marine dissolved salts. The semi planktonic halophilous species Melosira varians is particularly abundant in sample D3 and is associated with flowing water, as is the oligohalobous indifferent diatom Meridion circulare The greatest number of taxa in D3 are non-planktonic, oligohalobous indifferent species which are associated with shallow water, in benthic or epiphytic habitats, for example.

The two diatomaceous samples (D9, D10) from Section 37 have diatom assemblages composed of freshwater, non-planktonic diatoms. These diatoms are associated with shallow water benthic and epiphytic habitats and there are aerophilous diatoms present that are tolerant of desiccation. Aerophilous diatoms are found in soil and ephemeral aquatic environments for example. In sample D10 traces of a halophilous species are present and a fragment of a mesohalobous diatom may be present.

The relatively poor preservation, absence, or low numbers of diatom remains in all but one of the sixteen samples assessed from both sections can be attributed to taphonomic processes.

With the exception of sample D3 from Section 38, there is no potential for further, percentage diatom analysis of the sediment sequences from these two sections.

Pollen

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Introduction

A pollen assessment has been carried out on two profiles (MHS1, sections 37 and 38) from this site. The study was carried out to determine whether sub-fossil pollen and spores are present or not and if positive, to provide a preliminary view of the past vegetation and environment of the site. Pollen was extracted from both profiles but preservation is very variable. Sufficient pollen was, however, obtained to produce assessment style pollen diagrams and useful information to be gained.

Pollen method

Pollen sample details are shown in Table 14. Standard techniques for pollen concentration of the sub-fossil pollen and spores were used on these sub-samples of 1.5 ml. volume (Moore and Webb 1978; Moore et al 1992). Pollen counts of between 100 and 150 grains per level were made for each level. Numbers of pollen obtained depended on the preservation in the different sediments types, being poorest in the mineral sediment and absent in some places. Sufficient pollen was obtained to produce pollen diagrams (Figure 20 and Figure 21). These were constructed using Tilia and Tilia Graph in which percentages were calculated as follows:

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

Taxonomy follows that of Moore and Webb (1978) modified according to Bennett et al. (1994) for pollen types and Stace (1991) for plant descriptions. These procedures were carried out in the Palaeoecology Laboratory of the School of Geography, University of Southampton.

Section 38 profile: results

Pollen was sparse in most of the samples and absent at 107.20m.ATD (sandy silt) and in the basal (clay-sand-gravel) sample at 6.98m.OD. Overall, the poor pollen preservation is attributed to the predominantly minerogenic sediment. However, sufficient pollen was obtained from six of the samples to enable production of a pollen diagram (Figure 20). Two local pollen assemblage zones have been recognised. These are, however, largely taphonomically controlled by the sediment origin and type. These zones are characterised as follows.

l.p.a.z. 1: 61cm to 30cm (107.02m.ATD to 107.25m.ATD): This basal zone lies within the lower blue clay and sandy silt. It is characterised by high values of Lactucoideae (55%) which are an indication of the poor pollen preserving conditions, the differential preservation of this robust pollen taxon and possible fluvial/alluvial transport. It can be noted that there are also substantial numbers of derived/reworked pre-Quaternary palynomorphs which also attest to the latter (to 50% Sum + Misc.).

Overall, there is little tree and shrub pollen with only sporadic occurrences of Betula, Pinus, Alnus and Corylus avellana type. Quercus has slightly higher values to 6% in the lower level. This is still, however, a low value. Herbs are dominated by Poaceae (30%) and Cyperaceae (25% sum + marsh) with occurrences of Plantago lanceolata and occasional cereal pollen type. Fern spores are more abundant in this zone with Pteridium, Dryopteris and small numbers of Polypodium. There are occasional Pediastrum cysts.

l.p.a.z.2. 30cm to 0cm (107.25m.ATD to 107.63m.ATD): Poaceae become dominant with high values (to 78%) along with a greater diversity of herb pollen, which is, in part, due to slightly better preserving conditions. Tree and shrub pollen values remain small with occasional Pinus (probably long distance), Quercus, Tilia, Alnus and Corylus avellana type. Herbs, as noted, are dominated by Poaceae whereas the Lactucoideae of the preceding zone are largely absent. The herb diversity includes Ranunculaceae type, Chenopodiaceae, Fabaceae, Polygonum aviculare type, Rumex, Plantago lanceolata (2%) and a range of Asteraceae types. Cereal pollen

remains consistent at low levels. There is a small increase in fen taxa with Alisma plantago aquatica and Typha angustifolia type. In contrast, the values of Cyperaceae, and derived pre-Quaternary fern spores decline sharply from the preceding zone.

Interpretation: This profile, as with Section 37, shows an open treeless environment at least in proximity to the sample site.

The two local pollen assemblage zones which have been recognised relate to taphonomic changes caused by different sedimentary environments and resultant pollen preservation. The lower part of the profile (l.p.a.z. 1) has evidence of differential preservation in favour of robust pollen and spore forms. The former typically includes Lactucoideae (dandelion types) which attain high percentages. Coupled with the substantial numbers of pre-Quaternary palynomorphs in these lower levels, it is probable that there these are derived from reworked alluvium and/or from soil eroded and transported from the interfluves.

Initially, (l.p.a.z. 1 and lower half of l.p.a.z. 2), the on-site habitat appears to have been herb fen or alluvial floodplain (the sediments suggest the latter) with sedges and other marginal aquatic taxa including Royal Fern (Osmunda regalis). Subsequently (upper l.p.a.z. 2), these are reduced in number and it is not clear from the pollen what the on-site community changed to. Increase in grasses may indicate a grass rich floodplain with some sedges and other taxa.

In l.p.a.z. 2, there is a greater diversity of herbs. These include small numbers of cereal pollen and possible weeds of arable and disturbed ground indicating growth and/or use of crops. However, dominance of grasses with other herbs of grassland suggests dominant pasture.

Overall, the pollen spectra indicate and open landscape with no trees in the local vicinity and a mixed agricultural arable and pastoral.

Section 37 profile: results

Although there are some palynological variations within this sequence, no distinct local pollen assemblage zones have been recognised. Minor fluctuations are dealt with in text. The overall characteristics of the profile are as follows.

Trees and shrubs: Values are subordinated to herbs which dominate throughout. There are small numbers of Pinus (1%), Quercus (1–2%), Alnus and Corylus avellana type. There is a slight increase of both of the latter at 37cm.

Herbs: Poaceae are dominant throughout with high values (to 70%). Lactucoideae are important throughout but with a peak to 38% from c.44cm to 30cm in sands/silt overlying more humic silt. Other taxa include Cereal type, Plantago lanceolata, Ranunculaceae, Polygonaceae and Asteraceae types.

Fen/Marsh and aquatic: Numbers are small with sporadic occurrences of Nuphar, Potamogeton, Callitriche, Alisma plantago-aquatica, Typha angustifolia type and Cyperaceae.

Ferns: Pteridium aquilinum (27%) is most important with peaks at. Small numbers of Equisetum, Dryopteris type and Polypodium are present.

Miscellaneous: Reworked geological palynomorphs are present throughout but especially from *c* 36cm to 28cm.

Interpretation: This profile is dominated by herb pollen with few trees and shrubs. As such, this clearly shows an open environment in proximity to the site although fluvial transport of the silt and contained pollen may also play a part in the assemblage.

Grass (Poaceae) pollen with other herbs such as ribwort plantain (Plantago lanceolata) and possibly other taxa which are not definable to a lower taxonomic level, indicate that grassland (possibly pasture) was important locally. Cereal pollen is, however, also present throughout and testifies to the use of arable crops. The pollen may, however, derive directly from cultivation or from secondary sources such as crop processing activities, processed and dumped waste or from domestic waste including human and animal faecal material.

As noted, there is little evidence of woodland, with tree and shrub pollen in extremely small numbers. Where these occur, they are wind-pollinated taxa (anemophilous) such as oak, hazel pine and alder and thus, may come from a far distance. However, the dominance of on-site pollen will also have a swamping effect on such regional taxa.

The on-site habitat may show aquatic phases of standing water with macrophytes such as yellow water lily (Nuphar) and pondweed (Potamogeton) fringed by typical marginal aquatics (sedges, water plantain, marsh marigold and bull rush and/or reed mace). This is commensurate with the stratigraphy showing phases of silt accretion or higher energy sand and gravel deposition. More detailed analysis should provide greater resolution of the on-site habitat changes.

Summary and conclusions

The following principal points have been made:

- This study was carried out to establish if sub-fossil pollen is present in these profiles and, if so, to provide preliminary information on the habitat at time of deposition.

- Pollen has been extracted and identified from the majority of samples analysed. However, pollen was absent in the basal samples of Section 38 and overall was generally sparse and poorly preserved.

- The pollen spectra from both sections are dominated by herbs with few trees and shrubs.

- The on-site habitat was probably a herb dominated (grass-sedge) fen floodplain. There is no evidence of carr (alder/willow) floodplain woodland.

- Poaceae are dominant with a range of grassland taxa, especially Lactucoideae (dandelion types). The latter are, however, also a strong indication of poor pollen preserving conditions and consequent differential preservation in favour of this robust taxon. This is especially evident in the lower levels of the North facing profile.

- Both profiles have a continuous presence of cereal pollen suggesting arable cultivation. Secondary sources (crop processing and domestic waste) should also be considered.

- The taphonomy of the pollen is complicated by the possibility of fluvial transport and also reworking of older sediment. This is the case with substantial numbers of pre-Quaternary palynomorphs in parts of the sections.

- Where trees occur, these are predominantly wind-pollinated taxa with propensity for long distance dispersion. The small numbers of arboreal pollen here indicate little if any local tree growth in proximity to the site.

- Overall, the pollen spectra are typical of the historic period for London.

Due to the poor pollen preservation, no additional work is suggested since it is unlikely that any worthwhile additional data would be forthcoming.

Geoarchaeological discussion

The site lies within the floodplain of the Walbrook Valley, atop the Shepperton Gravels. The surface of the London Clay and the overlying Pleistocene sandy gravels rise outside of the site to the east and west (*c* 111–113m ATD, Figure 22 and Figure 23) and towards the higher edges of the valley (likely the Taplow Gravel formation). Within the site the surface of the Pleistocene gravels range from *c* 107–108m ATD with variable alluvial deposits sealing them. The palaeo-ecological results for the two assessed sections, MHS1 north-facing (section 38) and MHS1 south-facing (section 37), will be discussed below individually and any relevant findings extrapolated to the other recorded sequences in sections below that.

A transect placing the site's subsurface deposits within their landscape position is presented in Figure 22 and a topographic plot of the surface of the gravels, the early Holocene topography is presented in Figure 23.

Trench MHS1 North facing (section 38)

Facies 1: In the north facing section of trench MHS1 the lowest deposit encountered was London Clay which forms the underlying solid geology of the site. The Shepperton gravels, contexts [1442] and [1441], overlie the London Clay, with some of the lowest recorded onsite (*c* 107.5m ATD) being recorded in the Utilities Corridor trench (see below).

Facies 2: Overlying these deposits are sands and gravelly clays ([1446], [1453], [1444] and [1443]), the lithologically mixed and varied particle size of these deposits has previously indicated their semi-terrestrial riparian nature. Diatoms were either fragmented or absent from these contexts and the differential preservation of pollen in favour of robust types with substantial numbers of pre Quaternary palynomorphs also provided poor results. Both the diatom and pollen remains could be a result of fluvial transportation/reworking and support a disturbed channel edge to the west of the valley.

Facies 4: Overlying these is an organic silt, context [1430], which is consistent with the slowing down of fluvial energy and the forming of in situ semi-terrestrial muds. On top of these deposits are gravelly or sandy banded and bedded deposits [1445] and [1391]. These are suggestive of a return to higher energy deposition possibly indicating initial flood events across the floodplain (context [1445]) and later historic river channels (context [1391]). The latter, formed part of a wider deposit to the west which contained human skulls of Roman date. The better preserved pollen from these apparently non-reworked channel/ channel edge deposits showed a significant reduction of the pre-Quaternary and the initial formation of an on-site herb fen to alluvial floodplain with latter suggestions of arable (cereal levels were at a consistent but low level) to disturbed grassland. Context [1430] preserved diatoms suggestive of a non-marine high salt content in a flowing water environment. Diatoms from context [1445] showed little evidence for a high salt content and possible pooling waters. The diatom evidence from the upper deposit, context [1391], recorded little evidence of

the active channel but appears to record the later drying out and soil formation adjacent to ephemeral water courses or pools.

The level of the gravel in this section indicates it lies on the Walbrook Valley floodplain and as such a priority is to identify any routes of the early Holocene Walbrook or associated tributaries. Late glacial melt-waters definitely flowed through the area of the site and formed the Walbrook Valley but the precise location and chronology of the routes of Walbrook water courses has been difficult to ascertain on other sites (MOLA 2014). The lower deposits in the sequence are indicative of an early Holocene date and show a degree of reworking that suggests they lay to the eroding edge of a channel. Once this period of likely early prehistoric landscape instability ceased, fen vegetation formed in a mudflat environment. Subsequent flood events gave way to more consistent, higher energy flow and deposition forming a stabilised river bank, on which the later Roman activity appears to have taken place.

Trench MHS1 South facing (section 37)

Facies 1: The south facing section does not record any London Clay, but Pleistocene gravels [1432] were recorded from 106.25m ATD downwards.

Facies 3: The surface of underlying gravels is slightly lower in this area of site, and the overlying sandy silt [1432] appears to be an in-channel moderately low energy fluvial deposit, indicating the natural infilling of a route of part of the early Holocene multi-channel Walbrook.

Facies 4: Overlying deposits signified vegetated channel margins [1429], mudflats [1426], a return to vegetated channel margins [1431], and channel or flood deposition subsequently forming a channel bank or bar [1403] and [1402]. The pollen record for these deposits shows little discernible variation with the pollen dominated by nearby grassland and herbs with few trees or shrub. Arable land is likely in the vicinity with some possible cereal cultivation/processing onsite or at least the dumping of faecal matter. Some aquatic plants are indicated, attesting to a near channel location.

The diatom remains can only add a limited amount of information as they are absent from [1403] and below. Those retrieved from [1402] and above record a probable freshwater environment but many of the species are not specific to freshwater. To the upper part of the sequence diatoms that are more tolerant of drying out are recorded and probably represent the proposed bank and bar formation, which would have created slightly higher drier ground.

The level of the gravel in this section is the lowest recorded onsite and MHS1 was initially suggested as the route of the early Holocene Walbrook or an associated tributary. Complimentary to the south facing section (discussed above), the channel silting up deposit [1432] recorded here is more indicative of fluvial deposition than the reworked deposit recorded to the base of the aforementioned south facing section. The lower deposits in the sequence are indicative of an early Holocene date, possibly very early, and could recorded the late glacial slackening flow of meltwaters as much as they could represent prehistoric channel migration. The pollen remains do not preserve strong evidence of the earlier fen recorded in the north facing section but instead records a grassland environment with some evidence of arable and cereal cultivation. The dominance of grass and the indirect evidence of human cultivation and activity, which was only recorded in the upper (likely late prehistoric to historic) part of the north facing section may suggest that these deposits and therefore the silting up of this channel occurred in the late prehistoric to historic period.

Open Cut Sewer trench (Section 26; not illustrated)

Facies 3: Section 26 shows a channel cut [1097] into natural Pleistocene floodplain gravels [1100]. This is infilled with layers of sands and gravels [1099] & [1048

] which would have formed the channel's river bed.

Facies 4: These deposits are overlain by a peaty silty clay layer [1096] which indicates channel marginal wetland conditions. This change in deposits could be due to channel migration away from the site area, water management, or as the knock-on effect of change in base levels (sea level change) during the Holocene. This semi-terrestrial surface was occasionally flooded as indicated by the presence of the clay deposit [1095] and the mixed clays and gravels of [1094]. These floodplain channel deposits are sealed by a wetland peaty clay [1093], indicative of further waterlogging and flooding.

Utilities Corridor trench (Section 16; Figure 10)

The utilities corridor was situated along the southern end of the site. The section sampled (section 16 and 21) forms two tangential faces on the eastern side of the floodplain as it rises to the valley edge. Section 16 ran east to west across the site with section 21 running north to south off section 16. Section 16 is further divided into section 16 (west) representing late Pleistocene to early Holocene channel deposits and section 16 (centre) which represents Holocene channel marginal deposits (Table 19 and Table 20).

Facies 1: The Eocene London Clay [1065], which forms the basal geology, slopes from 106.50m ATD in the east to 106.10m ATD in the west along the whole of section 16. In section 16 (west), overlying [1065], are a series of pebbly sandy deposits [1064] [1063] [1062] [1061], indicating channel bedload deposits (late Pleistocene to early Holocene).

Facies 3: In section 16 (west), one of the basal facies 1 context sampled is [1061], which links laterally to the upper bedload deposits of the main channel. Context [1048] (section 16 centre), a dark grey sandy gravelly clay, which infills a depression in [1061] on the eastern side of the rising floodplain to the main channel, could represent a pond or minor channel infill.

Facies 4: Overlying [1048] is the peaty layer [1032] which indicates the development of a marsh next to the channel.

Facies 5: The marsh deposits and occasionally the basal contexts in some parts of the sections fine upwards into silty clay deposits (slightly organic) [1045], [1036] and [1035] (section 16 centre) and [1052] (section 16 west) representing quieter fluvial conditions prevailing. Overlying these deposits is [1034] a firm dark grey clayey sand with gravel, CBM, mortar, shell and straw which is thought to represent an anthropogenic dump deposit on the river floodplain.

Utilities Corridor trench (Section 21; Figure 11)

Facies 5: In section 21, the basal context sampled is [1042] a mid-yellowish brown sandy clay with gravels and represents the primary fill of cut [1043], a possible water management channel across the floodplain. Overlying [1042] was [1041] a mid-brown grey plastic clay which represents a standing water deposit that was subject to water level fluctuation leading to iron staining. Adjacent to the cut feature, are natural silt deposits [1019] and [1018] sampled in monolith <37> and <38> which represent semi terrestrial floodplain over-bank deposits.

Conclusion and recommendations

The subsurface data was added into the MOLA City of London database and provided an informative landscape context for the site (Figure 22 and Figure 23). The site wide deposit sequence has been characterised into five facies summarised below.

- Facies 1: includes the basal solid (London Clay) and drift (Shepperton gravels) geology. The surface elevation of this facies provides the early Holocene topography and confirms the site's landscape position on the floodplain of the Walbrook.
- Facies 2: these are fluvially reworked sediments to the west of the site and likely to the west of the single to multiple threads of the Walbrook that would have crossed the floodplain and site. Situated on the edge of the channels these deposits represent unstable bankside deposits that have been eroded, reworked and mixed by the energy of the river.
- Facies 3: are sands and silts laid down within the possible multiple channel threads of the Walbrook as those channels became redundant and migrated across the floodplain. These deposits could be of a late prehistoric date accumulating in a freshwater fen environment but on the whole they appear to be of a predominantly historic date occurring in a landscape dominated by nearby grassland with associated evidence for arable and cereal cultivation.
- Facies 4: is characterised by peats and clays indicating backwater to wet channel marginal areas such as mudflats, vegetated wetlands and on the whole being replaced by a seasonally inundated alluvial floodplain. In some cases these environments would have been contemporaneous with some of the active channels (facies 3) whilst in other cases the fen marshland would have succeeded the active channel as it was later succeeded by the grassy alluvial floodplain. As such, this facies could be of a later prehistoric to historic date.
- Facies 5: is similar to the upper portion of facies 4, being the historic alluvial floodplain. However, it is distinguished from facies 4 by its elevation, with the deposits extending a good 1-3m above the level facies 4 survives to. This facies is restricted to the utilities corridor trench where the historic sub-surface deposits were less truncated. As mentioned above these deposits are likely to represent the seasonally inundated alluvial floodplain but of a later, solely historic date. The historic date is confirmed by distinct phases of anthropogenic dumping evident from the CBM etc inclusions in some of the deposits. The waterlogged nature and periodic flooding of this historic floodplain is confirmed by [1043], a possible water management channel cut across the floodplain and also highlights the attempts of past human populations to manage the Walbrook River and its floodplain.

The facies give an outline of the landscape evolution of the site and conforms to the general landscape evolution typical of Thames tributary valleys. However, the nature of the deposits and the level of palaeoenvironmental preservation within them provides little potential for further work. Due to the poor pollen preservation, no additional work was suggested as the likelihood that any worthwhile additional data would be forthcoming is slim. There is further potential for diatom analysis of only one of the eight samples, D3 from [1444] in the north facing section. But considering this is from deposits within unstable bank edges likely reworked by the channel there seems little point in analysing it in isolation.

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19.14 The Coffin Furniture

Adrian Miles

Introduction

Coffin furniture, all in the form of coffin grips (handles), was recovered from seven contexts (see Table 24).

All are of the same type (type 3), a simple right-angled form, which is the earliest dated form commonly found. Although precise dating is not possible from this site, dated examples have been found at other sites (1687–1720 at St Paul's Cathedral (site code SAT00; Wroe-Brown 2001) and 1735–9 at Chelsea Old Church (site code OCU00; Cowie et al 2008). Julian Litten also suggests that type 3 coffin handles are confined to the period 1650–1750 (Litten, pers comm).

Only those from [1179] show any decoration, in the form of a central moulded knop.

This example may merit further investigation, should it be possible to more tightly date the associated burials.

Context	Form	Type	Date
1104	Grip	3	1650–1750
1133	Grip	3	1650–1750
1154	Grip	3	1650–1750
1171	Grip	3	1650–1750
1179	Grip	3	1650–1750
1183	Grip	3	1650–1750
1195	Grip	3	1650–1750

Table 24 Coffin furniture from XSM10

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19.15 Tree-ring Spot Dates

Ian Tyers

Introduction

Seven samples from oak timbers excavated from Crossrail Broadgate Ticket Hall, Liverpool Street were submitted for dendrochronological assessment and analysis. Four of the oak timbers were successfully dated, and are from the early 2nd century AD .

Methodology

Each dendrochronological sample was supplied as a complete cross section.

Each dendrochronological sample was assessed for the wood type, the number of rings it contained, and whether the sequence of ring widths could be reliably resolved. For dendrochronological analysis, samples usually need to be oak (Quercus spp.), to contain 50 or more annual rings, and the sequence needs to be free of aberrant anatomical features, such as those caused by physical damage to the tree whilst it was still alive. Standard dendrochronological analysis methods (see eg English Heritage 1998) were applied to each suitable sample. The sequence of ring widths in each sample were revealed by preparing a surface equivalent to the original horizontal plane of the parent tree with a variety of bladed tools. The width of each successive annual growth ring was revealed by this preparation method. A complete sequence of the annual growth rings in the suitable samples were then measured to an accuracy of 0.01mm using a micro-computer based travelling stage. The sequence of ring widths was then plotted onto semi-log graph paper to enable visual comparisons to be made between the sequences and reference data. In addition, cross-correlation algorithms (eg Baillie & Pilcher 1973) were employed to search for positions where the ring sequences were highly correlated. Highly correlated positions were checked using the graphs and where these were satisfactory, these locations were used to identify the calendar dates of the measured series.

The t-values reported below were derived from the original CROS algorithm (Baillie & Pilcher 1973). A t-value of 3.5 or over is usually indicative of a good match, although this is with the proviso that high t-values at the same relative or absolute position need to have been obtained from a range of independent sequences, and that these positions were supported by satisfactory visual matching.

The tree-ring analysis initially dates the rings present in the sample. An interpretation of these dates relies upon the nature of the final rings in the sequence. Oak timber contains two types of wood, heartwood and sapwood; the latter is on the outside of the tree and thus contains the most recent growth rings. Sapwood is softer and is not always preserved under archaeological conditions. If the sample ends in the heartwood of the original tree, a terminus post quem (tpq) date for the felling of the tree is indicated by the date of the last ring plus the addition of the minimum expected number of sapwood rings which are missing. This tpq may be many decades prior to the actual date that a tree was felled, particularly where poor preservation or other loss of outer heartwood has occurred. Where some of the outer sapwood or the heartwood/sapwood boundary survives on the sample, a date range for the felling of a tree can be calculated by using the maximum and minimum number of sapwood rings likely to have been present. The sapwood estimates used

here are a minimum of 10 and maximum of 46 annual rings, where these figures indicate the 95% confidence limits of the range. If bark-edge survives then a felling date can be directly utilised from the date of the last surviving ring.

Results

The submitted material comprised seven oak (Quercus spp.) samples. All of these samples contained measurable tree-ring sequences. All of the samples retained identifiable sapwood, none retain identifiable bark-edge. 6 of the samples were thin planking from two Roman gates, contexts [1423] and [1428]. All seven samples were measured successfully (Table 25). Comparisons between these seven series identified two planks from gate [1423] were derived from a single tree (Diagram 6). Cross-matching to reference chronologies identified that 4 of the series were of early 2nd-century Roman date (Table 26).

The four dated timbers were planks derived from two Roman gates, two from each gate. The tree-ring results indicate the four dated gate planks are broadly contemporaneous (Diagram 7). The end dates of these four samples vary between AD 90 and AD 110, with the four heartwood/sapwood transitions dated to AD 88 & AD 89 from gate [1423] and both at AD 96 from gate [1428]. The close proximity of the dates prevents the ability to identify if one of these gates is earlier than the other. The observable diversity of sapwood number between trees and within a single tree means that either of these gates could be earlier than the other one, or they could be contemporaneous. If the stratigraphy suggests that they are from different periods or unrelated structures then gate [1423] can be expected to date from *c* AD 99–134, and gate 1428 from *c* AD 110–142. If the results can be combined they indicate both are from the period *c* AD 110–134.

All of the dated series cross-match to most datasets from contemporaneous sites in London. These timbers can therefore be assumed to be originally derived from trees grown in the London region.

Diagram 6 The tree-ring sequences from 1423 1 (black) and 1423 2 (red). These are derived from a single tree, t value 14.23. The composite sequence constructed from these is used in Table 26.

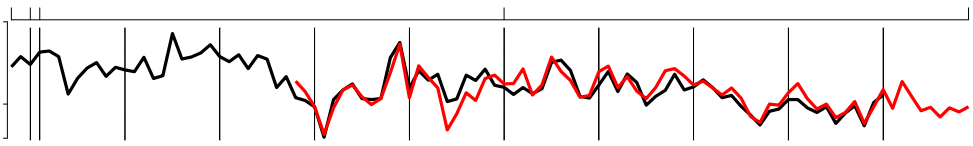

Diagram 7 Bar diagram showing the dating positions of 4 Roman oak tree-ring samples from Crossrail site XSM10. Interpretations are based on the minimum and maximum typical amounts of sapwood for London oaks, using a 10-46 ring sapwood estimate. Heartwood (white bars), sapwood (hatched bars)

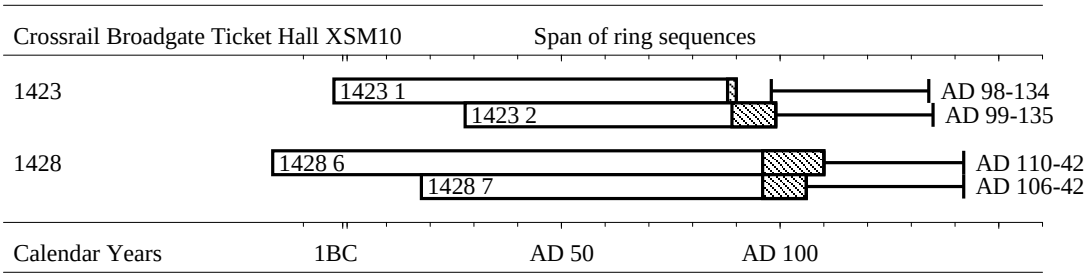

Table 25 7 oak (Quercus spp.) samples from Crossrail site XSM10. Interpretations using a 10–46 ring sapwood estimate.

Context Sample	Size (mm)	Rings	Sap	Date of measured sequence	Interpreted result
1423 1	155 x 5	93	2	3 BC– AD 90	AD 98–134
1423 2	95 x 5	72	10	AD 28– AD 99	AD 99–135
1423 4	170 x 5	120	4	undated	-
1428 5	165 x 5	120	16	undated	-
1428 6	165 x 5	127	14	17 BC– AD 110	AD 110–142
1428 7	135 x 10	89	10	AD 18– AD 106	AD 106–142
1295	125 x 110	86	11	undated	-

Table 26 Showing example t values (Baillie & Pilcher 1973) between the composite 1423 1 & 1423 2 sequence and the 2 other dated timbers from Crossrail site XSM10, and 6 independent site series representative of the London composite sequence.

1423 1+2	1428 6	1428 7	
5.14	6.24	4.46	Guys Hospital St Thomas St GHL89 (unpubl.)
5.96	7.62	4.15	Blossoms Inn Gresham St GHT00 (Crone & Tyers 2002)
6.23	7.39	5.64	Guildhall Yard GYE92 (Tyers 2001)
7.28	6.90	5.03	Regis, King William St KWS94 (Tyers & Boswijk 1996)
5.90	5.06	4.78	52-63 London Wall LOW88 (Nayling 1990)
5.27	6.08	4.98	Suffolk, Upper Thames St SUF94 (Tyers & Boswijk 2001)

19.16 Timber

Damian Goodburn

Quantification and assessment

Site archive: quantification and description

The following table provides a summary of the historic waterlogged woodwork found.

Material	Length	Volume(approx)	Count	Count as % of total
Timber	Mostly under 2m long mix of light and heavy structural woodwork	*c* 1.5 m2	12 converted timbers of post- med date. 22 Roman gate elements, 2 Roman foundation piles. Total 36	Approx 87%
Roundwood	4 cleft pole stakes, 1 whole pole stake tip	Volume total *c* 300mm x 200mm	Total 5	Approx 13%
Reused			Approx. 50 % of total of timber elements	
Total				NA

Table 27 Woodwork

Introduction

The historic organic bounty of the infilled Walbrook Valley

The location of the excavation and watching brief area in part of the buried Walbrook Valley complex of low lying marshy land and water channels, suggested that waterlogged ancient woodwork was likely to be found. This was likely even though the area lay just outside the historic City walls and was only intensively developed in post-medieval times. A long series of excavations in this area by MOLA have demonstrated the richness of the valley area within the Roman City itself, it has recently been described as like a ‘Pompeii of the north’.

Terms of reference of this summary report

This brief report sets out to summarise the woodworking details of the woodwork found such as, species range, methods of working, likely function etc. For the lay out and stratigraphic position of the woodwork discussed here readers must consult the main site assessment report.

Methodology

The woodwork found was planned at 1:20, basic context descriptions were made and photographs taken. The depth of excavations and shoring concerns, together with some areas being sampled by tunnelling by specialist contractors, meant that access and time constraints existed in some excavation areas.

The large post-medieval foundation piles were recorded on-site, once lifted from the excavation trench, but the other woodwork was washed and recorded off-site at the MOLA stores. The depth of burial and shoring works unavoidably caused some damage to some of the woodwork, causing cracking in situ and making lifting of the wafer thin timbers of the boarded gates in particular extremely difficult. In that case, after full planning, the timbers were lifted onto supporting boards and the largest least damaged elements were lifted double-wrapped and transported off site for specialist recording.

The detailed timber records were made following established procedures laid down in the Museum of London Excavation Manual which is in-line with the procedures laid out in the English Heritage Guidelines on Waterlogged Wood (Spence 1990, Brunning 1996). The records include pro-forma ‘Timber sheets’ and detailed scale drawings on gridded film. Following recording, a sub-sample of seven oak timbers suitable for tree-ring study (with over 50 annual rings) were slice sampled and six have been dated (section 19.15). Two species ID samples were taken of two smaller roundwood elements that could not easily be visually identified as oak or one of the elms.

Roman woodwork

Three stakes [1338], [1339] and [1340] were found in a row under an early Roman road. It is likely from their close spacing that these stakes were the lower parts of wattle fence stakes, rather than stakes for marking out the line of the road which would not need to have been set closely. [1338], [1339] and [1340] were all split, or ‘cleft’ out of small oak logs or ‘poles’. They were either quarter or 1/8th sections up to 75mm across and survived up to a maximum of 0.52m high, in the case of stake [1340]. The tips were axe cut to a scalloped multi-facetted point. They had a maximum of *c* 23 annual rings and so were not suitable for tree-ring dating.

It was considered that if the stake line was part of a boundary fence it might just be that they were just pre-Roman. However, such rustic oak cleft stakes are commonly found on waterlogged Roman period sites in London and its wider hinterland, particularly those of early date (eg early structures recently excavated by MOLA at 8–10 Moorgate and Bloomberg London sites).

Stake [1092] was thought to be associated with the group of three. It is a small cleft oak stake, identical to those of the first mentioned group, and was in similar condition. It seems likely that this item was of similar date to the previous group.

Two very rare, light wooden structures were recorded in MHS1, which proved to be very large parts of two similar boarded gate leaves [1423] and [1428]. Initially, when first partially exposed, these structures appeared to have been part of a collapsed

section of vertically boarded fence ('pale fence'), such as have been found partially preserved on several waterlogged London sites (Goodburn and Goffin et al 2011, 431). However, following careful excavation, the area of light boarding was found to be extensive and was clearly the covering of two light, virtually identical, gates or doors. These had been reused to form a light timber platform (see Photo 5). The better preserved was gate [1428], which survived to its total width of 0.95m and probably close to its original height at 1.75m long or high. It was clad with seven wafer thin boards or wide 'pales' of fine cleft oak, such as were typically used in pale fencing in Roman London. The boards used on both gates were between 160 and 175mm wide and only 7–9mm thick and must have been fine 1/128th cleft sections. These were made by very skilled woodsmen using specialist tools, still used for making traditional fencing components and laths, a splitting tool called a 'froe' and holding device called a 'break'.

Gate [1428] had a slightly more robust and much better preserved, oak frame work surviving under the boards, including a main upright post 110mm wide and 45mm thick. This had an integral hinge, and three lap-jointed cross pieces, secured by iron nails. The cross pieces were also lap jointed and nailed into a lighter upright on the far side. The height of gate [1428] included a wooden horn-like projection on the main gate frame upright. This was part of a simple wooden hinge mechanism called a 'har hinge' and still seen in some historic barn doors today in England. The same upright was found to have two relict joints, showing that it had been used twice before being used in the gate, making a total of four occasions of use. The first use was as part of a piece of joinery including carefully tenoned in rail timbers, a broken tenon of which survived. Original joinery layout marks also survived.

Gate [1423] was much less well preserved, but the framing was clearly lighter and included at least one cross batten of light roundwood. The pales were set slightly overlapping and were lightly secured with small iron nails through that overlap in both gates.

The use of the second hand timbers and very light components suggests that these gates, (or possibly barn doors?) were very cheaply built and not designed to last very long. These structures are possibly from an agricultural setting. Very few Roman period gates or doors have been found in the Britannia province. In London, the remains of two more domestic-style board and batten doors have been found, also boarded with cleft oak, but more heavily made at the No1 Poultry and Drapers Gardens sites (Goodburn and Goffin et al 2011, 424, Ridgeway 2009,11). Smaller sections of two more elaborate panelled doors have also been found in London, including very recently on the Bloomberg London site. Elsewhere, a slightly heavier gate was found at Vindolanda close to Hadrian's wall, but no details of this structure have been published (Birley 1977, 41).

Two small oak pile tips were found piercing the reused gates. These piles [1424] and [1425] were made of cleft oak log sections and are typical of Roman foundation piles for timber buildings. They are thought to represent truncated building activity rather later than the deposition of the gates. Neither pile tip had sufficient annual rings for tree-ring dating or sapwood, so a C14 sample was taken from the outer heartwood rings of pile tip [1425] to use if finds dating was not successful.

Dating

Three samples, including sapwood from the outer part of the parent oaks, were taken from the boarding of each gate. These samples were successfully tree-ring dated providing a combined felling date range of *c* 110–134 A (section 19.15). This dating was a little later than initially thought likely, but would fit with the evidence for the

multiple re-use of some of the gate timbers. This dating is particularly important as it provides a date after which (TPQ) for the human skeletal material found over the gravel deposit dumped on the gate surface (9.2 and 12.3).

Post-medieval woodwork

Fragments of a land tie assembly (or 'land anchor', or 'back brace') including three oak timbers was found in the corner of trench MHS2-100. Although only a small part of a timber structure, the assembly is very diagnostic of a simple support for a substantial revetment to the edge of a large ditch known on historic maps of the area. The form and size of this revetment support implies the existence of a ditch revetment of at least one metre in depth originally, possibly with buildings set close to its edge. Most ditches away from London's rivers are simply revetted by simple pile and plank or wattlework walls.

Timber [1293] was the long horizontal main land tie beam made of pit-sawn oak. It was a box quartered squared beam with sapwood on one corner and clear pit-saw marks on at least two faces. The landward end was accessible and had a partly bevelled end which may have been a felling cut. The beam had a square through hole which held a horizontal, sawn oak, lock bar, timber [1294]. This assembly would have been anchored to the land behind the ditch with at least one pair of small piles. Only one of these [1295] lay safely inside the trench and was lifted for more detailed recording and sampling. This timber was sawn out of a knotty, squared baulk of oak, ending up 'box quartered'. Each face had clear surviving pit saw marks, a technique of sawing adopted in London around 1400 on current archaeological dating, but becoming more commonly used from the 16th century (Goodburn and Minkin 2002, Blatherwick and Bluer 2009, 101). Part of the taper of the pile was formed by sawing with only the very tip being axe hewn. The pile had its original sawn top and a total length of 1.34m and cross section of 160mm by 110mm.

Discussion

Stratigraphically, this assembly was found, along with the 17th-century cemetery wall rebuild (see also 19.17), above the marsh deposits foundation. From a woodworking technology point of view, it would be most likely to be of a 16th- to 17th-century date. Piles of oak and elm timber with tapers, at least partially pit-sawn, have been found on several post-medieval sites in Greater London; for example during recent excavations at London Bridge Station. Although this sampled timber had around 80 annual rings and full sapwood, a tree-ring date could not be obtained.

The bulk of the post-medieval timbers found were clearly wall foundation piles that had supported the Bedlam Hospital cemetery wall of broadly 16th-century date. A total of eight were exposed at various times, with four only partially accessible in section. It was possible to lift four large and somewhat irregular, examples of elm (ie one of our native elm species; timbers [1359], [1360], [1363], [1362]). The shape and dimensions varied considerably, with the longest [1362] surviving 1.85m long and the largest in cross-section being [1360], which was *c* 360 by 200mm. Methods of conversion also varied, but all involved pit-sawing sections of timber from axe-hewn baulks of elm; these still had rounded 'waney' natural corners. The axes used had blades up to 100 mm wide. In one case, the taper had been partially formed using the pit-saw and the final tip was axe-hewn to a square cross-section. In-situ, the remains of a decayed plank sill beam, that would have supported the masonry wall above, had also survived.

Dating the pile group

The use of elm foundation piles and sill planks for masonry walls in this way is well known across the wet zones of Greater London from the 16th to early 18th centuries. Elm is not suitable for tree ring dating because of its irregular lateral growth habit. Although commonly found from the 16th century to early 18th century used as converted timber, it has only very rarely been found used in earlier historic London region structures, probably due to the effects of endemic elm diseases, such as that common today. It was also a tough, but cheap timber compared to oak, and often used combined with second hand oak for cheapness. On technological and species grounds, therefore, a date of the 16th to early 17th century is most likely.

Of the four piles probably from this group, only samples from the section [1434], [1435] and [1436] were clearly elm, whilst [1433] was of decayed oak, possibly a second hand timber. It seems very likely that these timbers were part of the same building activity.

Conclusion

The amount of waterlogged historic woodwork found during this project was modest, but has considerable potential to add to both the story of the historic use of the site just outside the historic core of London and a number of other areas. These other areas include little known areas of Roman carpentry in the making of simple boarded gates, and aspects of early Roman joinery practice surviving as features in the reused timbers in the gate frames. The nature of the fine cleft boarding of the gates also adds to our knowledge of how this semi mass-produced timber product was used in the north-western parts of the empire.

Finally, the post-medieval woodwork mainly informs aspects of the development of the site but also provides evidence of how new materials such as elm and the technology of pit-sawing were applied to civil engineering in timber.

Significance of the data

Woodwork

Most of the woodwork found is of local importance as a sample of such work just outside the City in the Roman and post-medieval periods. However, the finding of two largely complete boarded Roman gates, or light barn type doors, is of regional and indeed national importance. Only four other rather different types of door structures of Roman date have been found in the London region and one close to Hadrian's Wall at Vindolanda, so we must acknowledge these are rare woodwork finds. Above all it must be remembered that finds of any form of Roman woodwork are still comparatively rare, although much of the material world of Roman Britain was built of roundwood and timber.

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19.17 Worked Stone

James Wright

Site archive: finds and environmental, quantification and description

Table 28 Finds and environmental archive general summary

Building material	Seven worked stones were recovered from site. Five of these warranted recording, and of these one stone was fractured into three pieces and another into four pieces. The remaining two stones were noted, but did not warrant full recording, as they could not produce sufficient information. All stones were retained.

The worked stone

Introduction/methodology

All of the worked stone has been recorded using the standard worked stone recording forms used by MOLA. The stones were photographed and where appropriate a 1:1 or 1:2 profile drawing was made, a 1:1 rubbing or a scaled plan drawing was made. Fabric analysis was undertaken with a x10 binocular microscope and a comparison was made with the MOLA stone library. The information on the recording forms has been added to an Oracle database.

The medieval period

Moulded stones

[Context 1296] is a fragment of moulded oolitic limestone similar in character to that quarried at Grange Hill and Oathill in Gloucestershire (Photo 26). The stone is so fragmentary that it is no longer possible to determine its original purpose within the built environment; however it is potentially part of the jamb of a door surround. This conclusion also fits with the level of weathering that this stone has experienced, which suggests that it was once at least partially open to the elements (although it is possible that this could be secondary use weathering).

Its size and moulding forms suggest a medieval or early modern date, although it is unlikely to date past the first quarter of the 17th century.

A possible V-shaped banker mark was recorded on a face with a corona moulding (Photo 27).

Photo 26 Context [1296]

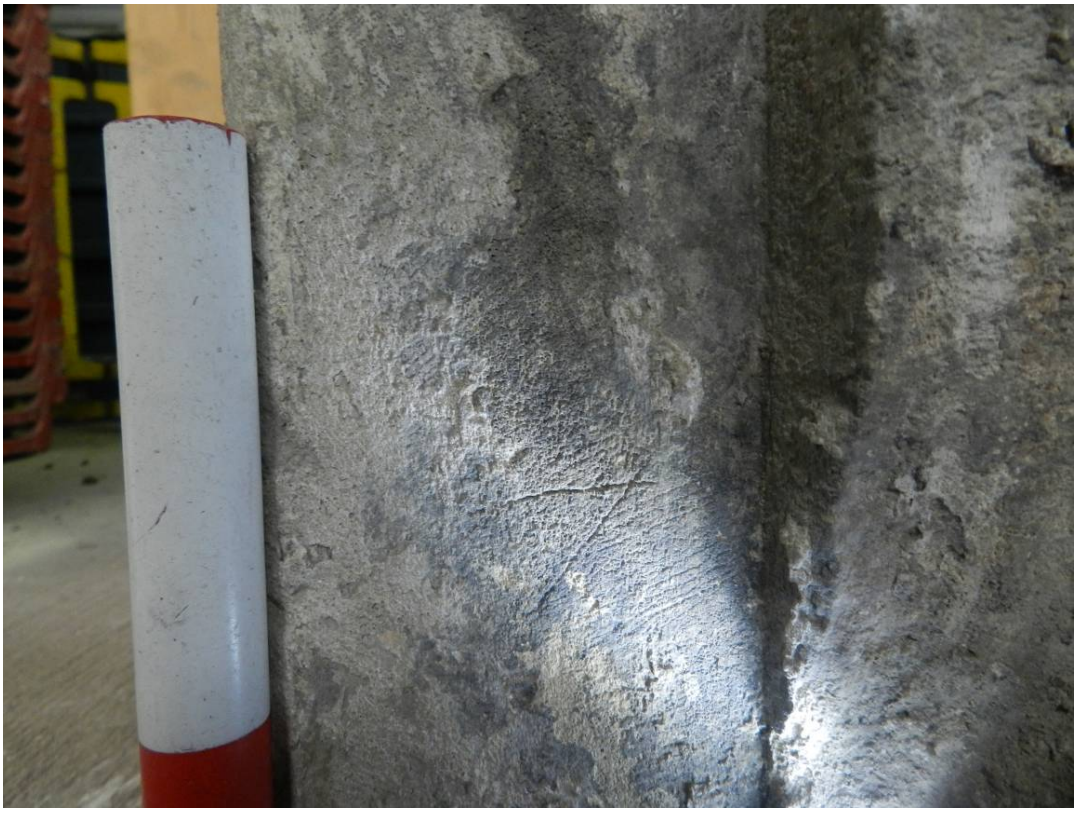


Photo 27 Banker mark on context [1296]

Context [1299] (Photo 28) is a fragment of moulded oolitic Bath limestone, similar in character to that mined at Box in Wiltshire. This stone is a very heavily weathered and fragmented section of window mullion, which still has a recognisable external nose moulding as well as its internal rebates. The glazing channels have both been weathered away and no longer survive.

Its size and moulding forms suggest a medieval or early modern date, although it is unlikely to date past the first quarter of the 17th century.

Photo 28 Context [1299]

The post-medieval period

Gravestones

Two fragmentary gravestones were recovered from the core of a post-medieval wall (Contexts [1115] and [1135]), see 9.2.1.

Context [1115] consists of three fragmentary pieces of slate similar to that quarried at Berwyn, Denbeighshire (Photo 29). The fragments all interlock, but do not represent a complete stone. On the reverse face, the stone has a chamfer cut along one side and the entire face has been dressed roughly, indicating that it was never intended to be seen. The thickness and surface wear suggests that the stone was a ledger slab, which was laid horizontally, and flush with the ground level around it.

Subsequent wear may therefore relate to footfall, which has polished the surface and reduced the inscription to a very truncated appearance which is not coherently legible. A partial inscription reads:

HERE ALSO

W[?]LLI

OF CABT[?]IA

& SAMVELL

PACK &

The use of the words “HERE ALSO” along with the wear on the upper part of the stone suggests that several people were memorialised by this stone and that alongside the principal incumbent, there may be up to three other individuals represented here: one probably called William, another with the first name Samvell and a third with the surname Pack. The use of the letter “V” in “SAMVELL” is an archaic form of “U”.

No date appears on the ledger however the use of the double-V version of the letter W indicates that this stone was cut during the second half of the 17th or very early-mid- 18th century. Given the re-use of the stone in an 18th-century wall along with context [1115], the balance of probability suggests that this ledger is also 17th-century. The double-V version of the letter W may also have an apotropaic function of warding off evil spirits from the grave and may reflect the folk beliefs of either the mason or patron or possibly both.

Photo 29 Context [1115]

Context [1135] consists of four fragmentary pieces of Portland base bed limestone from Dorset (Photo 30). The fragments all interlock but do not represent a complete stone. The reverse face of the stone is fair faced and was clearly meant to be visible. The thickness and decorative scheme on the front face suggests that the stone was a vertical headstone.

The inscription reads:

SARAH LONG

N

WIFE OF S[E]FTO

LONG WHO DYED

MAY TH[E] [?]2

1672 AIG[ED]

[17?] WITH

The use of the word “WITH” at the end of the inscription indicates that Sarah Long may have been also buried with another person(s), or may be relating to a formulaic such as “WITH HOPE” etc.

The stone is approximately 80% complete and is characteristic of the very low headstones of the late 17th and early 18th century which were laid directly into the earth. Such stones often featured two or three carved scrolls above the lettering. There is an indication of this in the breakage scarring of the stonework, as well as a complete carved ring in the centre immediately above the name. The lettering panel also has evidence of a sunken channel running around it, which would have given emphasis to the text.

The date is very precise and probably read “MAY THE [1]2” or “[2]2” 1672. Sarah Long, wife of Sefton Long, ‘founder’, has recently been identified in the burial records for the inhabitants of the parish of St Giles Cripplegate (Marit Leenstra, pers comm), in preliminary stages of a Crossrail documentary research project for the Broadgate burials.

The letter-cutting is very crude and belies some evidence that the mason was illiterate given that the letter “N” on three occasions is reversed and in the case of the word “SEFTON” the mason was unable to resolve the spacing satisfactorily and placed the “N” above the “O”.

The double-V version of the letter W occurs on three occasions and may also have an apotropaic function of warding off evil spirits from the grave. It may reflect the folk beliefs of either the mason or patron or possibly both.

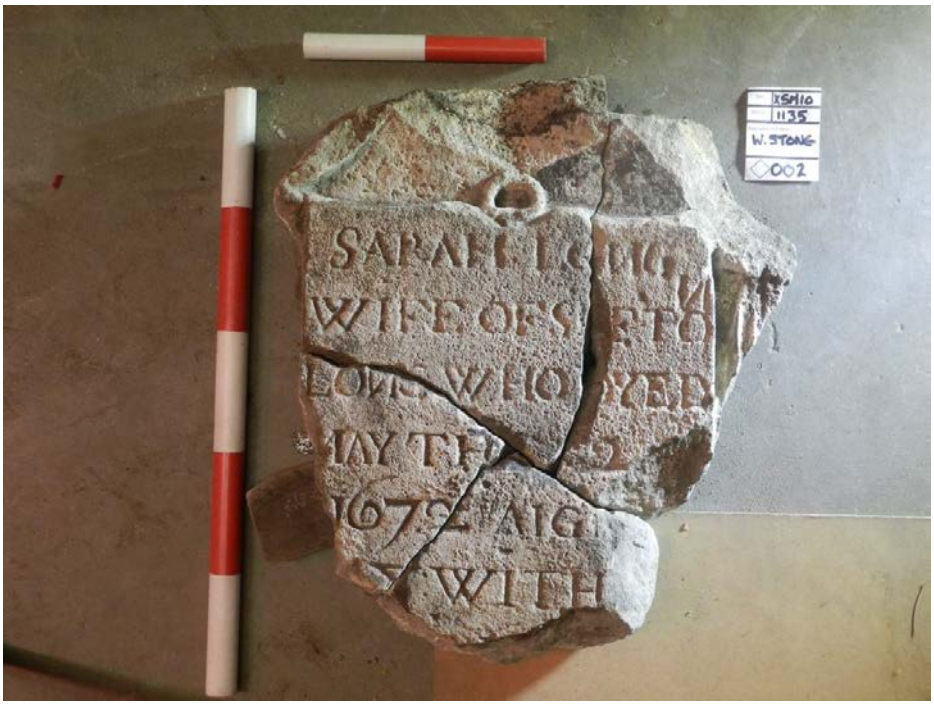


Photo 30 Context [1135]

Unknown date

Ashlar masonry

Context [1297] (Photo 31) is a fragment of ashlar masonry in Lower Carboniferous Crag Hill sandstone quarried at Hazeldean in Northumberland. The stone is very weathered on its face, although there is evidence of a batted finish. Part of the joint survives and has a boastered tooling. The area of the stone that is fractured also displays heavy weathering, which is indicative of its re-use.

Photo 31 Context [1297]

Analysis of potential

The material all relates to an east–west post-medieval wall, recorded as part of a possible outbuilding inside the cemetery grounds, which contained stonework from earlier periods. There are two stones which have characteristic medieval or early modern mouldings and two gravestones which can be firmly located in the second half of the 17th century, but reused in the 18th century. It is difficult to relate the moulded stones to a previous structure, as it is not clear from where they originated. They could have come, conceivably, from a wider area, but it is possible that they may have come from the late medieval hospital on the site. The gravestones almost certainly relate to a previous burial ground on the site, prior to the Bethlehem burial ground as laid out in the mid-18th century.

It is interesting to note that there are a number of petrologies represented, with material being imported from quarries as disparate as Gloucestershire, Dorset, Wiltshire, Northumberland and Wales. This variety of material is not unusual within London, which is an area poor in quality building stone, yet rich in finance and infrastructure - particularly the sea routes which are made accessible by the Thames estuary. There is potential for relating the headstone of Sarah Long to a documentary and genealogical history for the period of the late 17th century.

Significance of the data

Whilst moulded stone always represents a significant investment of income and therefore relates to a high status structure, it is not possible to say precisely what the function, location or specific date or dates of these buildings was. The significance of the moulded stone is therefore low.

The post-medieval gravestones relate to an early burial ground opened as a non-parochial cemetery in 1568/9 on land taken from the Bethlehem Hospital. The latest burials recorded to date are from 1714, although it is conceivable that interments were made into the mid-18th century. The reuse of the late 17th-century gravestones relates to an early encroachment into the cemetery by the built environment and consequently they were probably reused less than a century after the initial interment. The significance of the gravestones is therefore considered to be medium to high.

19.18 The Coins

Julian Bowsher

See Specialist Report Tables, Table 36 for coin catalogue.

Roman

Introduction

Twenty-five coins and tokens were found during the most recent phase of fieldwork. All of the pieces came from within the range of Contexts [1017] to [1448]; six of the coins were unstratified. 21 were identified as Roman and 20 of these could be identified. The standard categorisation of Roman coin periods is that defined by Richard Reece and is presented here. The coins have been fully catalogued and entered on the MOLA coin database.

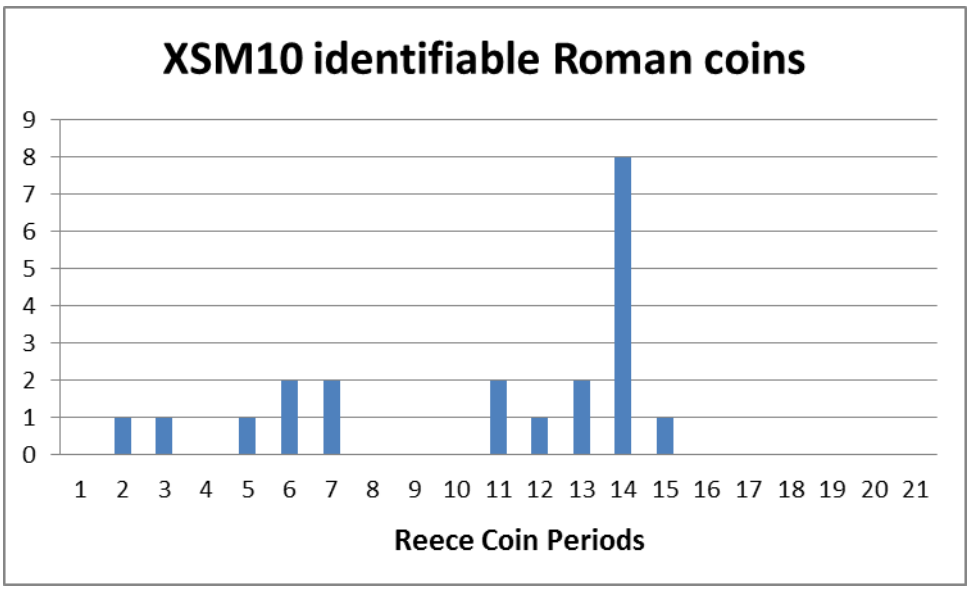


Diagram 8 Reece coin periods

Reece Coin Period	Date	Quantity
1	Up to 43	0
2	43-54	0
3	54-68	1
4	69-96	0
5	96-117	1
6	117-138	2
7	138-161	2
8	161-180	0

9	180-192	0
10	193-222	0
11	223-238	2
12	238-259	1
13	260-275	2
14	275-296	8
15	296-317	1
16	317-330	0
17	330-348	0
18	348-364	0
19	364-378	0
20	378388	0
21	388-402	0
Total		20

Table 29 Chronological periods

As seen above, the coins range from the mid- 1st century to the early 4th century AD. The unidentified piece <461> is so worn and battered that there is only an indication of 1st-century date (or even late 1st-century BC). Most of the coins came from fills and dumps, with none from the Walbrook Channel deposits.

The road has been generally assigned to the mid- 2nd to early 4th centuries. The make-up [1322] contained a coin of Trajan which was very worn and could indeed have circulated will into the second half of the 2nd century AD. A dump over the road [1314] contained a very worn and battered silver coin (denarius) that may date from the 1st century, and is therefore likely to be residual.

Roman ditch fill [1023] produced a coin of Hadrian <381>, but a later ditch fill [1041] produced the earliest coin from the site – a coin of Nero <387> which may have circulated just into the 2nd century, but not later so is likely to be residual and corroborates a 2nd to 3rd century floruit of activity at the site. Other later Roman dumps [1352] and [1390] contained early <418> and later <419> 3rd century coins.

The large marshy deposit [1193] has been assigned to the post-Roman period, but contains a particularly homogenous coin assemblage of the 3rd century. Most are 'barbarous radiates' of *c* AD 275–285 which will have circulated for only 30 odd years, but it does suggest that the site had seen some activity within this period.

The unstratified coins, denoted +, contained coins dating from the mid-2nd to the early 4th centuries. Nevertheless, these coins compare chronologically very well with the stratified assemblage and must be regarded as still forming part of the numismatic profile of the site, being merely disturbed by later activity on the site.

Taken together, the coin assemblage suggests and corroborates the stratigraphic and ceramic dating for the site. The location moreover further corroborates the coin data (at least) with the known 'North Walbrook Cemetery' excavations just to the north-west.

Post-medieval

Photo 32 Gold mezzo-zechino

> Gold coin

XSM10, <328>, [1034].

Leonardo Loredan, AD 1501–21; mezzo-zecchino. Diam 17mm; Wt 1.76g. Ax 10; Wr B.

Obv LE.LAVRE DVX SMVENET, Doge r, kneeling before St Mark l. Rev EG[O] SVM LVX MVNDI, Christ standing in starred marquise shaped panel. Pierced.

The coin (Photo 32), minted in Venice between 1501 and 1521, was found in post-medieval reclamation dumps over the Moorfields marsh. The dumps pre-date the burial grounds that were established in the mid-16th century, so the probable loss of the coin was almost contemporary with its use. The coin has been pierced for suspension, so was therefore no longer used as currency; instead, it was probably worn as a pendant. The discovery of the Venetian coin itself is unusual, with very few having been found in the London area.

The ducat, later called the zecchino, and its 'half' were gold coins minted in Venice from the late 13th to the late 18th century. The obverse legend is an abbreviation of 'Leonardo Lauredano, Dux, sacra moneta Venetiae' (Leonardo Loredan, Doge, Sacred Money of Venice). St Mark is the patron saint of Venice and he is shown passing the flag of office to the Doge. The obverse legend 'ego sum lux mundi', (I am the light of the world) is from Jesus' discourse with the Pharisees (John 8:12).

Leonardo Loredano (1436–1521) was elected Doge in 1501, the same year his famous portrait was painted by Bellini (now hanging the National Gallery, London). Loredano claimed descent from a prestigious ancient Roman family and enhanced Venice, not just through his steadfast leadership in times of battle, but through his patronage of the arts, but also through his financial acumen.

Venetian coins were valued throughout Europe and silver pieces minted under Loredan are commonly found in Britain, almost certainly through the extensive Venetian trading markets. His gold is much rarer and this particular piece was valued so much by a Venetian visitor, or perhaps a Tudor Londoner, that it was pierced so as to be worn as a keepsake and symbol of wealth, before being lost in the Moorgate mud for 500 years. Loredan's memory is still kept alive by modern copies of his gold coins being made in Yemen as decorative items.

19.19 Specialist Report Tables

Table 30 Building Material

Listed below is a summary of the building material in each context:

Context	Fabric (where recorded)	Type	Context Date
[0]	-	Floor	1480–1600
[1017]	3046	Brick	1500–1600
[1017]	-	Floor - Flemish	
[1017]	-	Floor - Penn	
[1017]	-	Peg	
[1017]	2815	Imbrex	
[1019]	2815	Tegula	AD 50–160
[1023]	2815	Tegula, box-flue	AD 140–300
[1023]	2815?	Brick	
[1023]	2453	Tegula	
[1023]	2454	Tegula	
[1023]	3060	Brick	
[1023]	3100	RPWP	
[1024]	-	Tegula, imbrex	AD 50–160
[1024]	2454	Tegula	
[1027]	2815	Tegula, imbrex	AD 50–160
[1027]	2454	Imbrex	
[1027]	3100	RPWP	
[1034]	-	Pantile	1800–1900+
[1034]	-	Peg tile	
[1034]	-	Stoneware pipe	
[1034]	-	Floor - Penn	
[1036]	2815	Tegula, imbrex	
[1045]	2815	Tegula, imbrex, brick	
[1045]	2454	Tegula	
[1066]	2276	Peg	1500–1700
[1066]	3033	Brick	
[1068]	2459B	Tegula	AD 120–250
[1072]	2815	-	AD 120–250
[1072]	2459B	Tegula	
[1074]	2815	Brick	AD 50–160

[1081]	2815	Tegula	AD 50–160
[1103]	3033	Brick	1550–1666/1700
[1105]	3033	Brick	1550–1666/1700
[1107]	3032	Brick	1666–1900
[1108]	3032	Brick	1800–1900
[1109]	3032?	Brick	1750–1900
[1110]	3032	Brick	1750–1900
[1112]	3032	Brick	1666–1900
[1113]	3032, 3033	Brick	1600–1700
[1117]	-	Peg	1480–1800
[1135]	-	Floor – Tin-glazed	1600–1650
[1145]	3033	Brick	1500–1600
[1146]	3033	Brick	1500–1600
[1150]	-	Floor - Penn	1350–1390
[1150]	-	Peg	
[1154]	-	Drain	1500–1800
[1156]	-	Delft wall tile	1740–1760
[1156]	2271	Peg	
[1156]	2459B	Flue	
[1169]	-	Peg	1180–1800
[1191]	-	Floor - Flemish	1480–1600
[1215]	3033	Brick	1500–1600
[1291]	2815	Brick	AD 50–160
[1301]	2815	Imbrex, brick, box-flue	AD 50–100
[1301]	3121	Roofing?	
[1311]	2815	Tegula	
[1314]	2815	Tegula	AD 50–160 (or medieval)
[1314]	-	Brick	
[1314]	-	Floor? Tile	
[1318]	3105	Rubble	AD 50–1800
[1323]	2815	Brick	AD 50–160
[1342]	3032	Brick	1800–1900
[1343]	2271, 2816	Peg	1180–1800
[1345]	2454	Imbrex	AD 50–160
[1345]	2815	Tegula	

[1347]	3031	Brick	1300–1480
[1347]	2815	Brick	
[1366]	2454	Tegula	AD 50–80
[1369]	2815	Tegula	1180–1800
[1369]	-	Peg	
[1384]	3090	Peg	1180–1800
[1391]	2815	Brick, imbrex	AD 50–160
[1395]	2815	Tegula, imbrex	AD 50–160
[1395]	2454	Imbrex	
[1397]	2815	Tegula, brick	AD 50–160
[1397]	2454	Tegula, imbrex	
[1397]	-	Brick	
[1432]	2454	Tegula	AD 50–80
[1448]	2815	Tegula	AD 50–160

Table 31 Roman Human Bone: Summary of Disarticulated Bone

Context	Body area	Elements present	Sex	Age	Pathology	Comments	MNI adult	MNI subadult
1314	Skull	Right temporal	Undetermined	Adult	-	Dark staining. Possible Roman context	1	0
1314						**MNI**	**1**	**0**
1322	Skull	Right parietal	Undetermined	Adult	-	-	1	0
1322						**MNI**	**1**	**0**
1337	Upper limb	Right ulna	Undetermined	Adult	-	-	1	0
1337						**MNI**	**1**	**0**
1352	Upper limb	Left ulna	Undetermined	Adult	-	Possible Roman context	1	0
1352						**MNI**	**1**	**0**
1391(1)	Skull	Mandible	Male	26–35 years	-	C14 dating tooth 47: Cal date (2 sigma) BC 40 - AD 80	1	0
1391(2)	Skull	Mandible	Male	26–35 years	-	Matches 1391(7)	1	0
1391(3)	Skull	Mandible	Male	26–35 years	-	Matches 1391(5). C14 dating tooth 38: Cal date (2 sigma) AD 130 - 320	1	0

1391(4)	Skull	Mandible	Male	18–25 years	-	Matches 1391(6). C14 dating tooth 48: Cal date (2 sigma) AD 220 - 380	1	0
1391(5)	Skull	Frontals	Male	Adult	-	Surface damage, tide mark	1	0
1391(6)	Skull	Frontals, parietals, temporals, occipital	Intermediate	26–35 years	Porotic hyperostosis, caries, enamel hypoplasia	Surface polishing	1	0
1391(7)	Skull	Frontals, parietals	Male	Adult	Cribra orbitalia	Orange concretions	1	0
1391(8)	Skull	Frontals, parietals, temporals, occipital	?Female	Adult	Porotic hyperostosis	Surface polishing and striations, orange concretions	1	0
1391(9)	Skull	Frontals, parietals, occipital	?Male	Adult	Cribra orbitalia	Orange staining, tide mark	1	0
1391(10)	Skull	Frontals, parietals, left temporal, occipital	?Female	Adult	-	Orange staining, tide mark	1	0
1391(11)	Skull	Frontals, right parietal, right temporal, occipital	?Male	Adult	Porotic hyperostosis	Orange staining, tide mark	1	0
1391(12)	Skull	Frontals, parietals, occipital, left maxilla	Intermediate	18–25 years	Porotic hyperostosis, caries	Surface polishing	1	0
1391(13)	Skull	Right frontal, right	?Female	26–35 years	-	Tide mark	1	0

		maxillary, right zygomatic						
1391(14)	Skull	Frontals and occipital	Intermediate	Adult	Cribra orbitalia	Surface polishing and orange concretions	1	0
1391(15)	Skull	Frontals	Male	Adult	Porotic hyperostosis, button osteoma	Polished endocranium	1	0
1391(16)	Skull	Frontals	Male	Adult	-	Surface polishing and orange concretions	1	0
1391(17)	Skull	Frontals, right parietal, nasal bones	Intermediate	Adult	Blunt force trauma	Surface polishing and orange concretions	1	0
1391(18)	Skull	Occipital	Undetermined	Adult	-	Light brown colour	1	0
1391(19)	Skull	Occipital	Undetermined	Adult	Porotic hyperostosis	Light brown colour	1	0
1391	Skull	5 x right frontal	Undetermined	Adult	-	-	5	0
		4 x left frontal	Undetermined	Adult	-	-	4	0
		3 x right parietal	Undetermined	Adult	-	-	3	0
		3 x left temporal	Undetermined	Adult	-	-	3	0
		2 x occipitals	Undetermined	Adult	-	-	2	0
		Right zygomatic	Undetermined	Adult	-	-	1	0
	Torso	5 x right ribs	Undetermined	Adult	-	-	1	0
		8 x left ribs	Undetermined	Adult	-	-	1	0
		6 x unsided ribs	Undetermined	Adult	-	-	1	0

		2 x thoracic vertebrae	Undetermined	Adult	Osteophytes, Schmorl's nodes	-	1	0
		2 x lumbar vertebrae	Undetermined	Adult	Schmorl's nodes	-	1	0
		3 x sacral vertebrae	Undetermined	Adult	-	-	1	0
	Upper limb	Right scapula	Undetermined	Adult	-	-	1	0
		Left scapula	Undetermined	Adult	-	-	1	0
		Right clavicle	Undetermined	Adult	-	-	2	0
		2 x right humerus	Undetermined	Adult	-	-	2	0
		2 x left humerus	Undetermined	Adult	-	-	2	0
		Right radius	-	Subadult		-	0	1
		Right radius	Undetermined	Adult	-	-	1	0
		Left radius	Undetermined	Adult	-	Dark stained and polished	1	0
		Left ulna	Undetermined	Adult	-	-	1	0
	Lower limb	2 x right ilium	Male	36–45 years	-	-	2	0
		Right ilium	Male	Adult	-	-	1	0
		Right ilium	?Female	Adult	-	-	1	0
		Left ilium	Male	36–45 years	-	-	1	0
		Right ischium	Male	Adult	-	-	1	0
		Right ischium	Male	36–45 years	-	-	1	0

		Right ischium	?Female	Adult	-	-	1	0
		Left ischium	Male	36–45 years	-	-	1	0
		Right pubis	Male	36–45 years	-	-	1	0
		Right pubis	?Female	Adult	-	-	1	0
		2 x right femur	Undetermined	Adult	-	1 x dark staining	2	0
		5 x left femur	Undetermined	Adult	-	-	5	0
		2 x right tibia	Undetermined	Adult	-	-	2	0
		Left tibia	Undetermined	Adult	-	-	1	0
		Right fibula	Undetermined	Adult	-	-	1	0
		2 x left fibula	Undetermined	Adult	-	-	2	0
		2 x left 4th metatarsal	Undetermined	Adult	-	-	2	0
		Left 5th metatarsal	Undetermined	Adult	-	-	1	0
1391						**MNI**	**18**	**0**
1393	Upper limb	Right clavicle	Undetermined	Adult	-	-	1	0
1393						**MNI**	**1**	**0**
1395	Skull	Mandible	Undetermined	Adult	-	Dark staining	1	0
1395						**MNI**	**1**	**0**
1397	Lower limb	Right tibia	Undetermined	Adult	-	-	1	0

1397						**MNI**	**1**	**0**
1403	Skull	Left parietal	Undetermined	Adult	-	-	1	0
1403						**MNI**	**1**	**0**
1437(1)	Skull	Cranium minus nasal bones	Male	26–35 years	Impacted 3rd molars	C14 dating tooth 47: Cal date (2 sigma) AD 80 - 380, polishing	1	0
1437(2)	Skull	Frontals, parietals, occipital, temporals	?Male	Adult	Porotic hyperostosis	White stain	1	0
1437(3)	Skull	Frontals, parietals, occipital, temporals, nasal bones	?Male	Adult	-	Polishing, srcatch marks, tide mark	1	0
1437(4)	Skull	Frontals, parietals, occipital, temporals	?Male	Adult	Bathrocephalic	Polishing, scratch marks, tide mark	1	0
1437(5)	Skull	Maxillae, parietals, occipital, temporals, left zygomatic	?Male	Adult	-	Orange staining, srcatch marks, tide mark	1	0
1437(6)	Skull	Frontals, parietals, occipital, left temporal	?Male	Adult	-	White, orange and dark brown stains, striations	1	0
1437(7)	Skull	Frontals, parietals,	?Male	Adult	-	White, orange and dark	1	0

		occipital, right temporal				brown stains, striations		
1437(8)	Skull	Parietals, occipital	?female	Adult	-	White staining, striations	1	0
1437(9)	Skull	Frontals, parietals, temporals, occipital	?Male	Adult	Cribra orbitalia	Orange stains	1	0
1437(10)	Skull	Cranium minus right maxilla and nasal bones	?Male	Adult	Enamel hypoplasia	Orange concretions	1	0
1437(11)	Skull	Frontals, parietals, occipital, temporals	?Male	Adult	-	Severe post-mortem damage	1	0
1437(12)	Skull	Frontals, parietals, occipital, left temporal	?female	Adult	-	-	1	0
1437(13)	Skull	Frontals, parietals, occipital	Intermediate	Adult	-	Severe post-mortem damage	1	0
1437(14)	Skull	Cranium	?Male	Adult	Caries, enamel hypoplasia	Diffuse post-mortem damage	1	0
1437(15)	Skull	Cranium	?Male	Adult	Porotic hyperostosis, cribra orbitalia, enamel hypoplasia, periapical lesion		1	0
1437(16)	Skull	Frontals, parietals, occipital,	Male	Adult	Porotic hyperostosis	Diffuse post-mortem damage	1	0

		temporals						
1437(17)	Skull	Frontals, parietals, occipital, temporals, nasal bones	?Male	Adult	-	Orange stains	1	0
1437(18)	Skull	Mandible	Undetermined	Adult	Caries	Orange stain	1	0
1437(19)	Skull	Parietal, occipital, right temporal	?Male	Adult	-	-	1	0
1437(20)	Skull	Frontals and parietals	?Male	Adult	-	-	1	0
1437(21)	Skull	Frontals	?Male	Adult	-	-	1	0
1437	Skull	2 x right temporals	Undetermined	Adult	-	-	2	0
		Left temporal	Undetermined	Adult	-	-	1	0
		3 x occipitals	Undetermined	Adult	-	-	3	0
	Torso	2 x left ribs	Undetermined	Adult	-	-	2	0
		Lumbar vertebra	Undetermined	Adult	Schmorl's nodes	-	1	0
	Upper limb	Right clavicle	Undetermined	Adult	-	Orange stains	1	0
1437						**MNI**	**21**	**0**
1438	Skull	Cranium minus right squamous temporal	Male	Adult	Tooth 27 fracture	Dark staining, slight blue stains	1	0

1438						**MNI**	**1**	**0**
1440	Lower limb	Right femur	Undetermined	Adult	-	Dark staining	1	0
		Right tibia	Undetermined	Adult	-	Dark staining	1	0
1440						**MNI**	**1**	**0**
1448	Upper limb	Right humerus	Undetermined	Adult	-	-	1	0
	Lower limb	Left femur	Undetermined	Adult	-	-	1	0
		Right tibia	Undetermined	Adult	-	-	1	0
		Left tibia	Undetermined	Adult	-	-	1	0
		Right fibula	Undetermined	Adult	-	-	1	0
1448						**MNI**	**1**	**0**
						Total MNI	**36**	**1**

Animal Bone

Table 32: Animal bone from selected contexts

	CONTEXT						TOTAL
SPECIES	**[1391]**	**[1396]**	**[1430] {90}**	**[1437]**	**[1438]**	**[1448]**	
frog or toad			10				**10**
chicken	2						**2**
cattle	1	1				6	**8**
cattle-sized						18	**18**
sheep		1				1	**2**
sheep/goat	1				1	3	**5**
sheep-sized						6	**6**
pig						1	**1**
horse	19	5		10	2	9	**45**
dog	4					1	**5**
deer, red	1						**1**
deer, roe	1					2	**3**
TOTAL	**29**	**7**	**10**	**10**	**3**	**47**	**106**

Table 33: Animal bone from selected contexts

CONTEXT	SPECIES	BONE	MODIFICATION	DESCRIPTION
1391	cattle	scapula	butchery	split lateral side
1391	horse	rib	pathology	break/poorly-healed
1448	cattle	scapula	butchery	split lateral side
1448	cattle-sized	scapula	butchery	split lateral side
1448	cattle-sized	rib	butchery	chopped medial side
1448	cattle-sized	rib	butchery	chopped
1448	pig	scapula	butchery	knife-cut posterior
1448	sheep/goat	radius	butchery	chopped mid-shaft

Table 34 Animal bone from selected contexts/ measurements and stature (after von den Driesch 1976 and von den Driesch & Boessneck 1974

CONTEXT	SPECIES	BONE	MEASUREMENT	VALUE (mm)	STATURE (m)
1391	chicken	metatarsal	greatest length	71.6	
1391	dog	tibia	greatest length	145.5	0.425
1396	horse	metacarpal	lateral length	215	1.378
1396	sheep	metatarsal	greatest length	150	0.681
1438	horse	metacarpal	lateral length	219	1.404
1438	horse	metatarsal	lateral length	256	1.364
1448	cattle	metacarpal	greatest length	184.5	1.135
1448	horse	metatarsal	lateral length	234	1.247
1448	horse	metatarsal	lateral length	237	1.263
1448	horse	metatarsal	lateral length	245	1.306
1448	horse	tibia	lateral length	292	1.273
1448	sheep	metacarpal	greatest length	126.6	0.619

Table 35: Summary of botanical assessment data

A: abundance, D: diversity (1 = occasional, 2 = moderate, 3 = abundant)

					chd	chd	chd	chd	wlg	wlg	
Sample		proc	flot		grain	chaf	seeds	wood	seeds	misc	
sample	context	vol.(l)	vol.(ml)	proc	A D	A D	A D	A D	A D	A D	Comments
32	1018	30	200	F					2 2	2 2	WET. V FINE-ONLY MOLLUSCS IN >2MM
33	1019	20	150	F				1 1	3 3	3 1	WET. MARGINAL WETLAND SPP, ROOTS
35	1029	15	20	F					1 1	3 1	WET. ROOTS/ROOTLETS. DISCARDED
42	1041	20	80	F				1 1	3 3	3 2	WET. WET5LAND PLANTS, MANY MOLLUSCS
43	1042	15	80	F	1 1			1 1	3 3	3 1	WET. MOSTLY MARG WETLAND SPP.
44	1034	30	1000	F	1 1			2 1	3 3	3 3	WET. 2 BAGS. V MANY DIPSACUS SEEDS
				W				1 1	1 1		MANY NUTSHELLS, SOME FRUIT STONES
45	1035	30	800	F				1 1	3 2	3 1	WET. USUAL WETLAND ETC SEEDS
				W					1 1		FEW CERATOPHYLLUM SEEDS
46	1037	20	120	F					3 2	3 1	WET.MOST AQUAT/WETLAND SPP.
47	1036	40	1600	F			1 1	2 1	3 3	3 3	WET.V RICH.FEW FOODS,BOX LVS
				W					1 1		FEW FOODS, INCL ?OLE
51	1052	30	50	F				1 1	3 3	3 3	WET. MOSTLY AQUATIC/WETLAND
52	1054	20	50	F				2 1	2 2	3 2	WET. ROOTLETS, FEW SEEDS
53	1047	40	800	F				1 1	3 3	3 3	WET. MOSTLY WETLAND SPP.
56	1063	?	100	F						3 1	WET. DECAYED WOOD,ROOTS. DISCARDED
57	1063	20	200	F					1 1	3 1	DECAYED WOOD/ROOTS. DISCARDED.
58	1066	30	1200	F				3 1	3 3	3 3	WET. ORGANIC BUT SEEDS SPARSE. ROSEMARY
				W				1 1	1 1		SOME FOODS INCL 1 OLE

59	1068	20	150	F					3 3	3 3	WET. MOST AQU/WETLAND SPP.
				W			1 1				1 VITVI
60	1070	20	200	F					3 3	3 2	WET. FEW FOODS, WETLAND SPP.
61	1071	20	150	F					3 3	3 3	WET. WETLAND & DRY SPP.
62	1072	20	200	F				1 1	3 3	3 1	WET. DRY & WET GRND SPP.
63	1073	20	400	F					3 3	3 3	WET. MANY MOLLUSCS. MOD DIV SEEDS
64	1074	20	400	F				1 1	3 2	3 1	WET. MOSTLY AQU/WETLAND SPP, LOW DIVERSI
65	1085	20	800	F					3 3	3 2	WET. SML WOOD FRAGS, SEEDS V SPARSE
66	1096	20	350	F				1 1	2 2	3 1	WET. MOSTLY MOSS
69	1150	30	120	F				1 1	3 2	3 2	WET. MUCH CLINKER, SPARSE FOODS ETC.
				W					1 1		FEW FOODS
70	1169	40	600	F				1 1	2 2	2 2	WET. CLUMPS HAIR/FIBRE
				W				1 1	1 1		NUTS & FRUITS INCL ALMOND?
71	1177	40	150	F				1 1	3 3	3 3	WET. FOODS, HOPS, SOME WILD
				W				1 1			
72	1187	40	70	F				1 1	3 3	3 2	V MANY MOLLUSCS & SEEDS
74	1177	10	80	F					3 3	3 2	WET. MANY MOLLS. WETLND SEEDS+SOME FLAX
75	1193	40	300	F					3 3	2 2	WET. MOSTLY WETLAND SPP.
76	1335	40	300	F				1 1	2 2	3 1	WET. MOSTLY WOOD FGS, INCL ROUNDWOOD
77	1337	40	500	F					2 1	3 3	2 BAGS. WET. LEAF LITTER?
78	1187	20	300	F					3 2	3 2	WET.STRAW?, SOME ARABLE WEEDS
				W				1 1			
79	1345	20	80	F					2 1	3 1	WET. MOSTLY MOLLUSCS
80	1343	20	300	F				1 1	3 3	3 3	WET. STEMS, A WEEDS
				W					1 1		FRUIT & NUT, 4 OLE,CANS,ILEAQ,CND

81	1373	20	150	F				1 1	3 3	3 2	WET. STEMS, MIXED SEEDS
				W					1 1		FEW FOODS
82	1369	20	600	F				1 1	3 2	3 2	WET.STEMS & MANY GRASS SEEDS
				W					1 1		FEW FOODS INCL 4 OLE
83	1397	30	200	F		1 1	1 1	2 1	2 2	3 1	WET.
84	1401	10	70	F				1 1	3 2	3 2	WET. V FINE SEDIMENT
89	1403	10	20	F				1 1	2 2	3 1	WET. V FINE (MOST <1MM).WETLAND
90	1430	60	250	F					3 2	3 1	WET.
				W					1 1		FEW FOODS
93	1429	20	60	F				1 1	2 2	3 2	WET. MANY CAREX SEEDS
95	1437	20	600	F		1 1		1 1	3 2	3 1	WET.
97	1432	10	300	F					1 1	3 1	WET. JUST SOFT LUMPS WOOD. DISCARDED
99	1446	3	10	F					1 1	3 2	WET.FEW SEEDS
101	1442	5	20	F					1 1	3 1	WET. ALL ROOTS.

Table 36 Coin Catalogue

Roman coins

> Silver coin

<461>, [1314] period , .

c 1st *c* BC / AD ; denarius. Diam 17mm; Wt 2.84g. Ax 6; Wr E.

Obv head r. Rev palm tree, with ?figure l. Very worn and battered. Possibly an eastern coin.

> Copper-alloy coin

<387>, [1042] period , .

?Nero, AD 64–8; *as*. Diam 25mm; Wt 6.94g. Ax ?6; Wr E.

Obv head r. Rev ?standing figure. Although it is clearly from the 1st century AD , the identification with Nero is based on the vague head shape visible on the obverse.

> Copper-alloy coin

<462>, [1322] period , .

Trajan, AD 98–117; *sestertius*. Diam 33mm; Wt 22.60g.; Wr E.

Obv]TRAIAN AVG[, laur head r. Rev illegible, smoothed.

> Orichalcum coin

<381>, [1023] period , .

Hadrian, AD 119–21; *sestertius*. Diam 34mm; Wt 25.98.g. Ax 5; Wr B.

Obv IMPCAESARTRAIANVS H AD RIANVSAVG, laur head r. Rev [PONTM]AX TRPOTCOS III, S C, Felicitas standing l, holding caduceus and cornucopia. RIC II, 411 no. 563A, Rome.

> Orichalcum coin

<383>, [1046] period , .

Hadrian, AD 134–8; *sestertius*. Diam 33mm; Wt 27.56g. Ax 6; Wr E.

Obv [H AD RIANVS AVGCOSIIIPP], laur head r. Rev S C, Diana standing l, holding bow and arrow. RIC III, 439 no. 777, Rome. Possible traces of obverse legend make this much more likely than the similar RIC III, 429 no. 692.

> Copper-alloy coin

<463>, [1322] period , .

Antoninus Pius, AD 151–2; *as*. Diam 25mm; Wt 9.96g. Ax 6; Wr D.

Obv [AN]TONINVSAVGPI [, laur head r. Rev SA LV[S] A[, S C, Salus standing l, feeding snake rising from altar. cf RIC III, p137–9.

> Copper-alloy coin

<416>, [+] period , .

Antoninus Pius, *c* AD 151–61; *as*. Diam26 mm; Wt 8.60g. Ax 12; Wr D.

Obv [ANTONI]NVSAVG PIVS , laur bust r. Rev [ ] [S] C, possibly Salus standing l.

> Silver coin

<454>, [1193] period , .

Septimius Severus, AD 201; *denarius*. Diam 18mm; Wt 3.21g. Ax 12; Wr C.

Obv SEVERVSAVG PARTMAX, laur head r. Rev RESTITVTO RIVRBIS, Severus standing l, sacrificing over altar, holding spear. RIC IV, pt I, 113 no. 168.Rome.

> Silver plated coin

<418>, [1352] period , .

(Geta), *c* AD 200–2; irregular. Diam 19mm; Wt 3.74g. Ax 5; Wr D.

Obv PSEPTGETA CAESPONT, dr bust r. Rev RECTOR ORBIS, Sol standing l, holding globe and spear reversed. cf RIC IV, pt I, 314n. Though the obverse (p 218) and reverse (pp 218, 233 and 262) were used separately under Caracalla.

> Copper-alloy coin

<458>, [1193] period , .

(Gallienus), *c* AD 257; irregular. Diam 22mm; Wt 2.36g. Ax 6; Wr D.

Obv cuir, radiate bust r. Rev emperor standing l, holding spear, receiving wreath from Victory standing r. crowning emperor with wreath. Traces of crude legend on both faces, cast copy. Reverse type must be either *Victoria Avg* or *Victoria Part*. (RIC 5, pt 1, 104 no. 450 or 453).

> Copper-alloy coin

<414>, [+] period , .

c AD 238–59; radiate. Diam *c* 20mm; Wt 1.72g. Ax ?; Wr D.

Obv IMPCA[ ]VG, bust r, possibly radiate. Rev traces of legend and a central feature, possibly a bust – which would give a reverse axis of 12. Due to the highly corroded state of this coin, and lack of detail on the x-radiograph, no definitive identification can be made though it appears to be 3rd century in style.

> Copper-alloy coin

<459>, [1193] period , .

Tetricus I, AD 271–4; radiate. Diam 16mm; Wt 3.04g. Ax 12; Wr C.

Obv radiate bust r. Rev ?Laetitia standing l (? *Laetitia Augg*).

> Copper-alloy coin

<415>, [+] period , .

(Tetricus I), AD 275–85, irregular. Diam 16mm; Wt 2.42g. Ax 6; Wr C.

Obv IMP[ ]PFAVG, radiate bust r. Rev [SALV]S A[VG] Salus standing l, feeding snake from patera and holding transverse sceptre.

> Copper-alloy coin

<420>, [1390] period , .

(Tetricus I), AD 275–85, irregular. Diam 15mm; Wt 2.06g. Ax 12; Wr D.

Obv]RICVS[, radiate bust r. Rev ?Salus standing l, (?*Salus Augg*).

> Copper-alloy coin

<419>, [1390] period , .

(Tetricus I), AD 275–85, irregular. Diam 14mm; Wt 0.94g. Ax 12; Wr D.

Obv]VSAVG, radiate bust r. Rev ?Hilaritas standing l, with cornucopia (?*Hilaritas Augg*).

> Copper-alloy coin

<456>, [1193] period , .

(Tetricus II), AD 275–85; irregular. Diam 16mm; Wt 1.43g. Ax 12; Wr D.

Obv CPIVE[, radiate bust r. Rev sacrificial implements (*Pietas Augg* or *Augustor*).

> Copper-alloy coin

<453>, [+] period , .

AD 275–85, irregular. Diam 14mm; Wt 0.90g. Ax ?12; Wr E.

Obv radiate bust r. Rev]VG figure standing l, with ?transverse sceptre.

> Copper-alloy coin

<457>, [1193] period , .

Carausius, AD 287–93; radiate. Diam 22mm; Wt 3.94g. Ax 12; Wr C.

Obv IMPCARAVSIVSPFAVG, cuir dr radiate bust r. Rev [PA]X AVG, Pax standing l, F/O//[ML], RIC V pt ii, 472 no.101.London.

> Copper-alloy coin

<455>, [1193] period , .

Carausius, AD 287-93; radiate. Diam 24mm; Wt 4.04g. Ax 12; Wr C.

Obv IMPCCARAVSIVSPFAVG, cuir, dr, radiate bust r. Rev PAX AVG, Pax standing l, S/C//C, off centre. RIC V pt ii, 490 no.303.

> Copper-alloy coin

<460>, [1193] period , .

(Carausius), AD 287–93; irregular. Diam 18mm; Wt 1.21g. Ax 12; Wr E.

Obv radiate bust r. Rev ?Pax standing l, holding olive branch and sceptre.

> Copper-alloy coin

<417>, [+] period , .

Licinius, AD 316; *nummus*. Diam 19mm; Wt 2.66g. Ax 6; Wr C.

Obv IMPLICINIVS[PFA]VG, laur, cuir bust r. Rev GENIO POPROM, Genius standing l, holding patera and cornucopia. T/[F]//ATR. RIC VII, 173 no.119. Trier.

> Lead seal

<385>, [1034] period , .

ruler, date; denomination. Diam mm; Wt 5.12g. Ax ; Wr .

Obv . Rev . medieval

> copper-alloy jetton

<485>, [1369] period , .

Tournai, *c* 14th 15th c; jetton. Diam 31mm; Wt .g. Ax ; Wr .

Obv . Rev . reference

Other XSM10 coins

> Copper-alloy coin
<4>, [3] period , .
ruler, date; denomination. Diam mm; Wt .g. Ax ; Wr .
Obv . Rev reference

> Copper-alloy coin
<85>, [300] period , .
Severus Alexander, 228–31; *denarius*. Diam mm; Wt .g. Ax ; Wr .
Obv . Rev reference

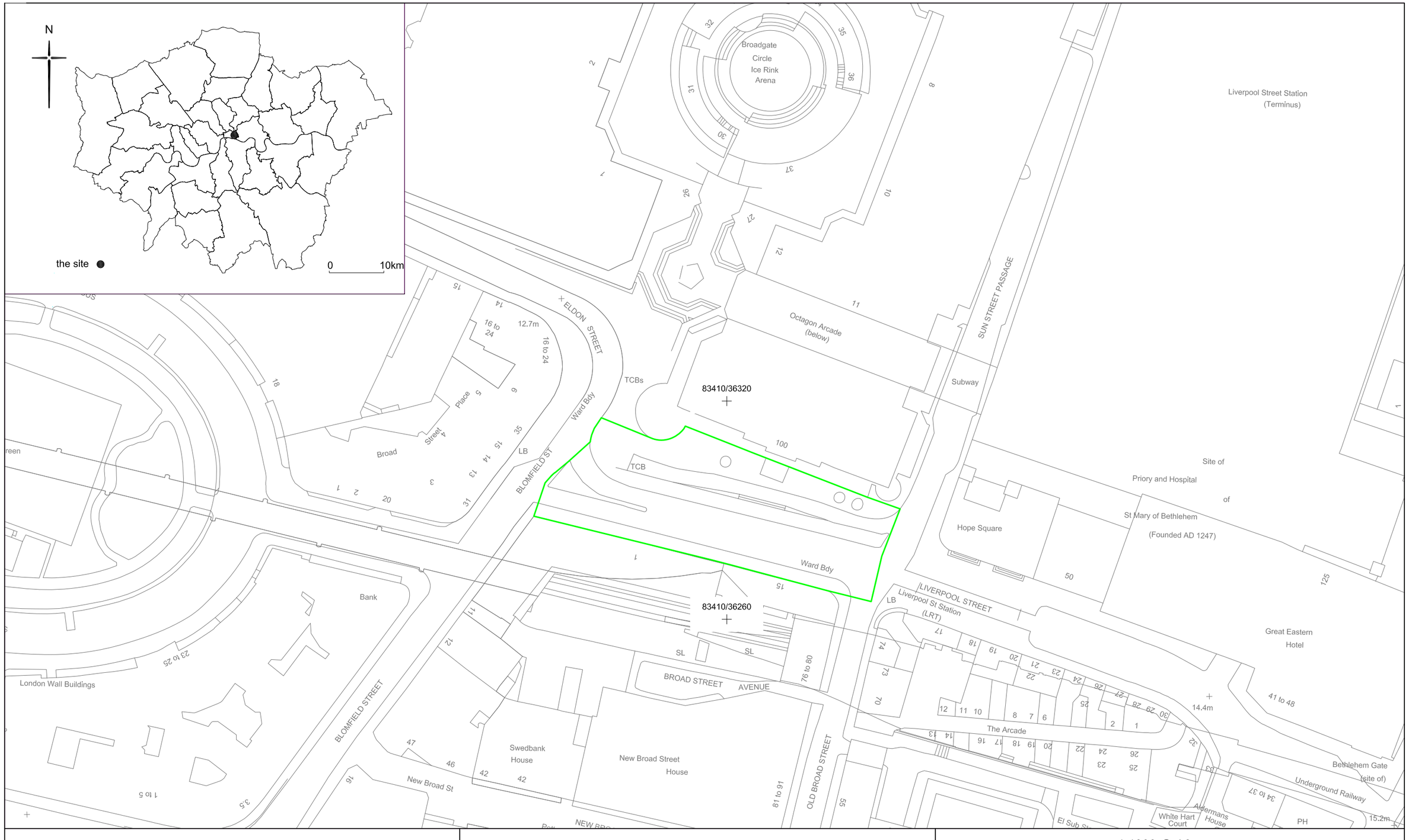


Fig 1 Site location

Site Code: XSM10

Site outline

1:1000 @ A3

0 50m

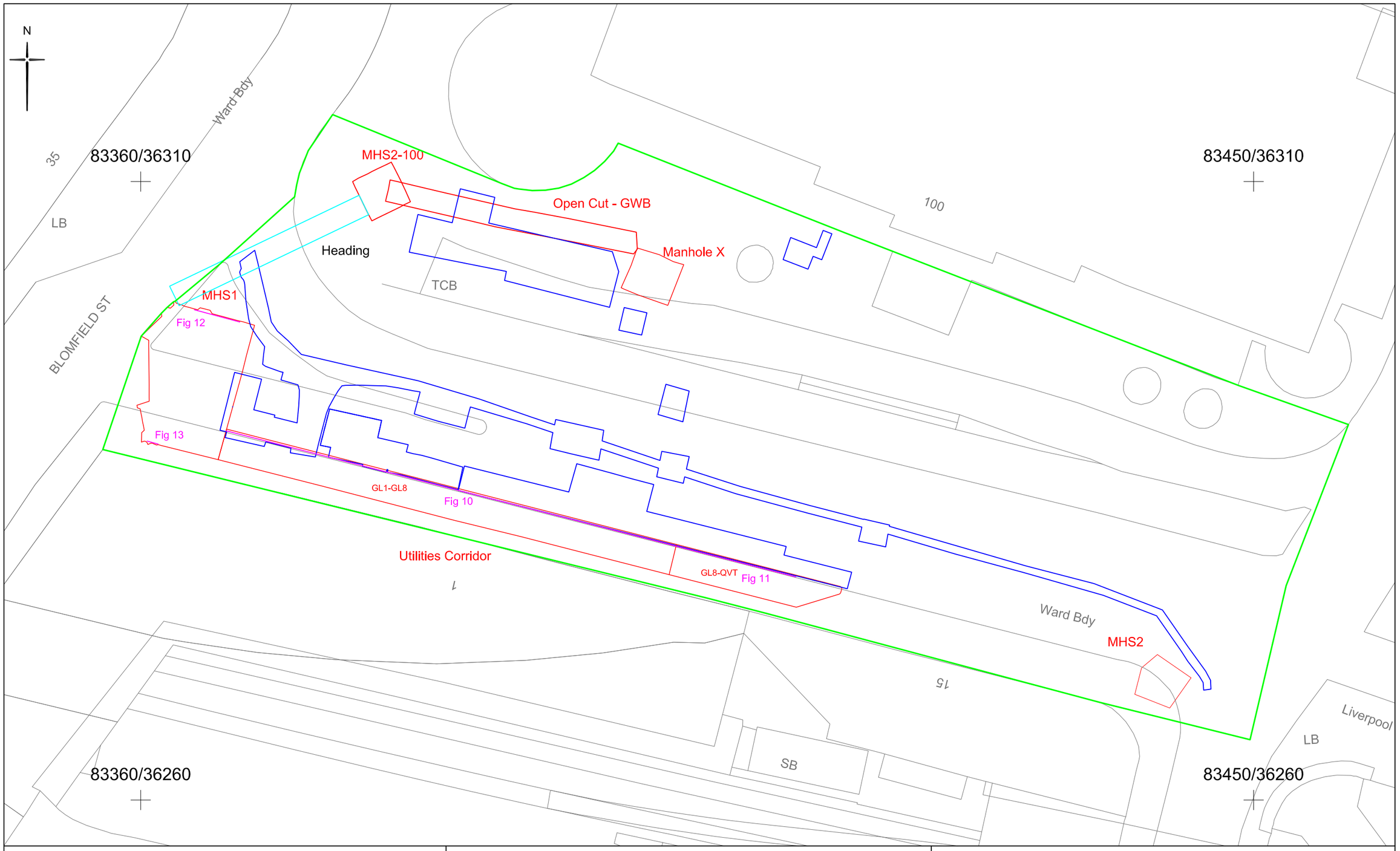


Fig 2 Location of archaeological interventions

Site Code: XSM10

Site outline
Trench edges 2013
Previous archaeological interventions
Sections
Sewer heading

1:300 @ A3

0 15m

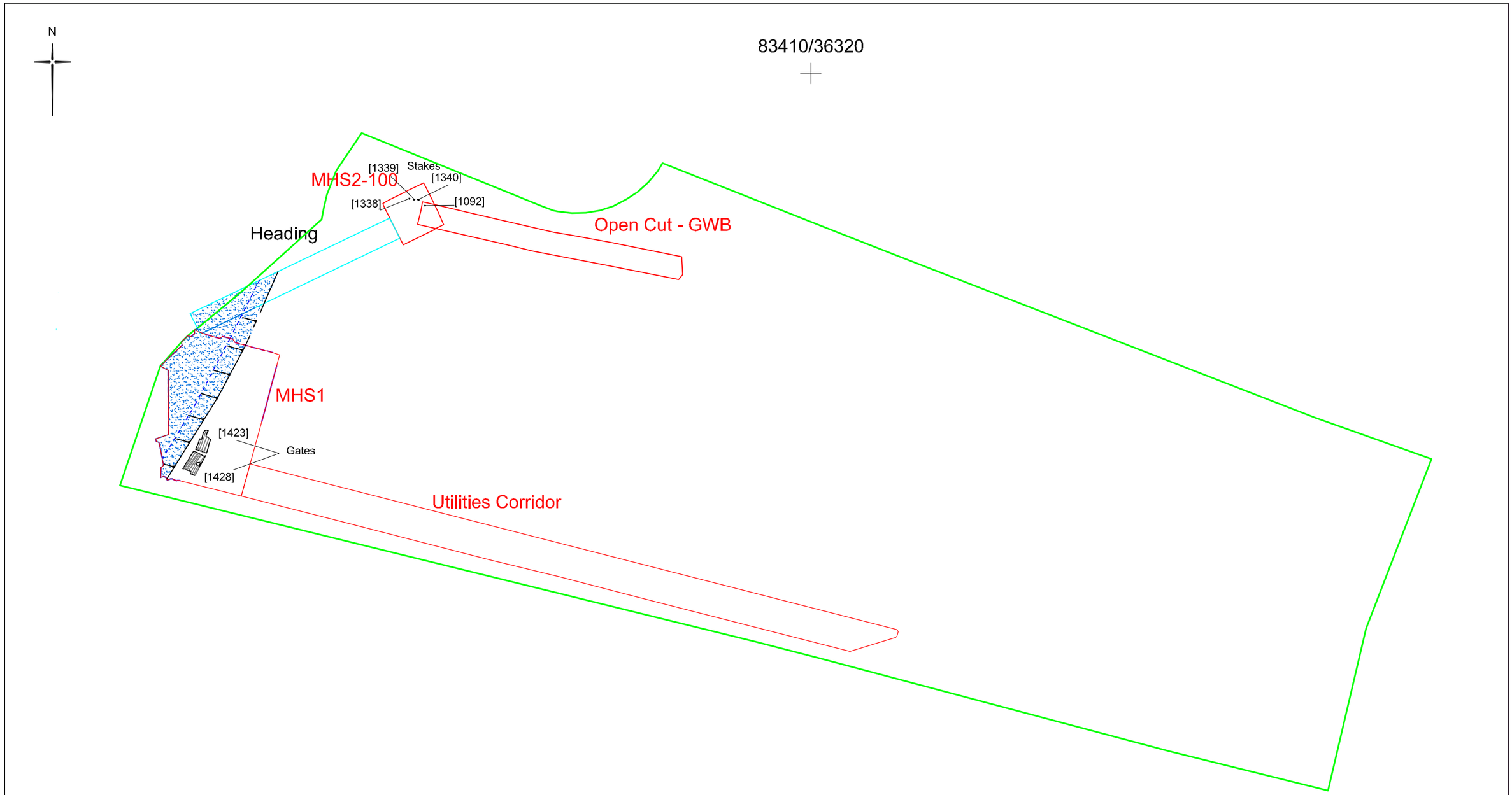


Fig 3 Early Roman activity

Site Code: XSM10

Site outline
Trench edges 2013
Sewer heading
Channel projection
Channel area seen

1:300 @ A3

0 15m

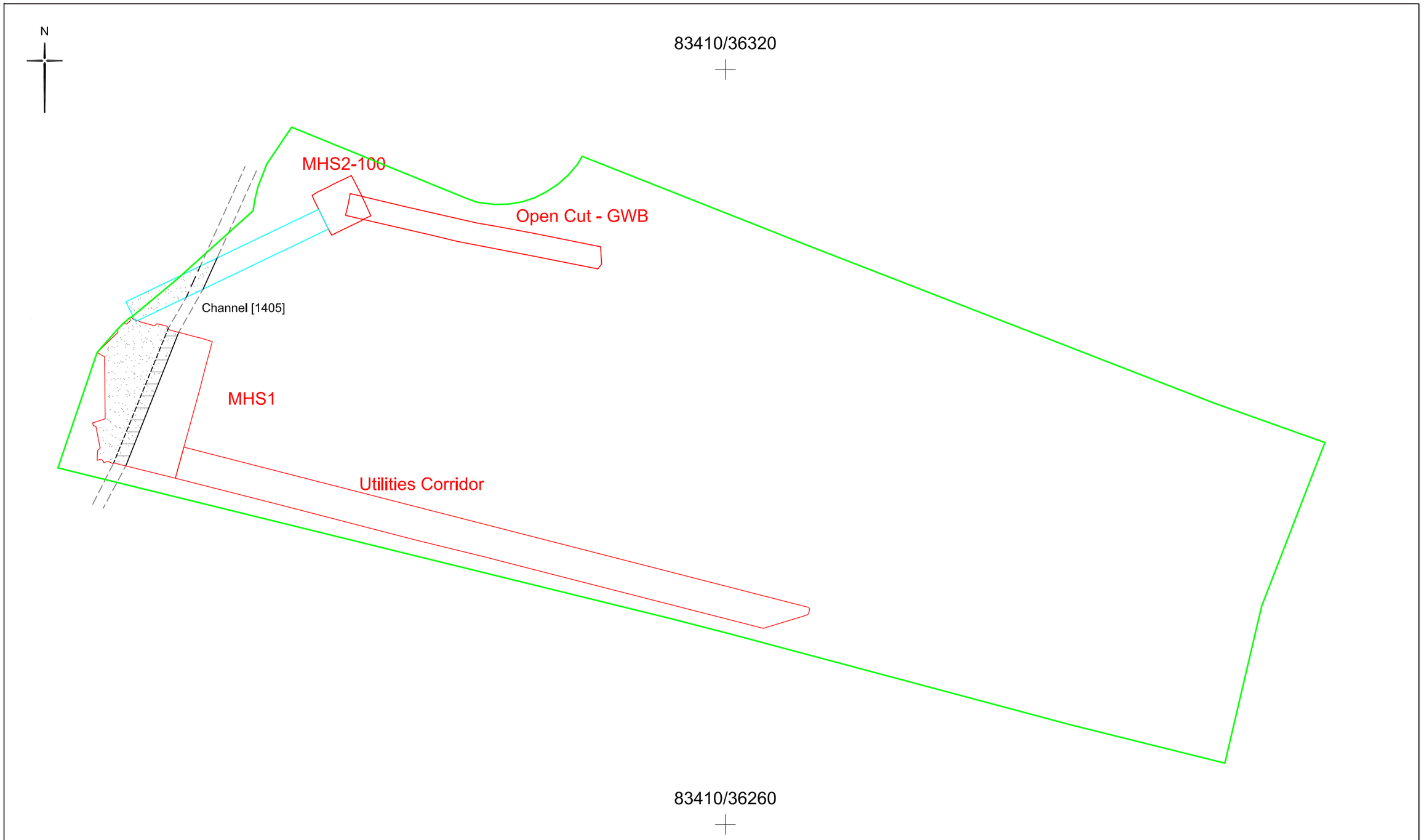


Fig 4 Later Roman Walbrook channel

Site Code: XSM10

Site outline
Trench edges 2013
Water channel
Water channel extension known

1:300 @ A3

0 15m

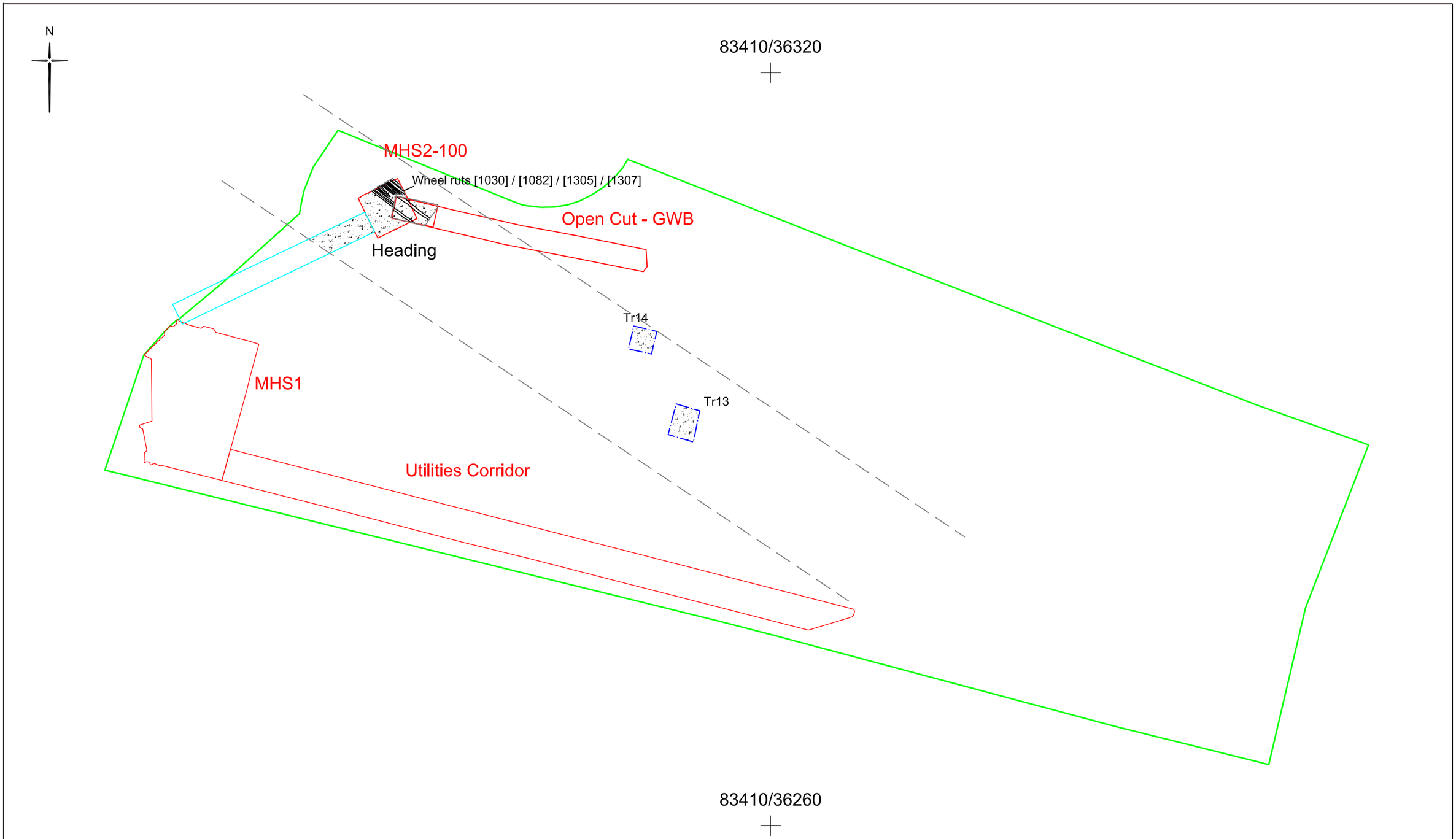


Fig 5 Roman road

Site Code: XSM10

Site outline
Trench edges 2013
Sewer heading
Trench edges 2010/11
Projected line of road
Roman road

1:300 @ A3

0 15m

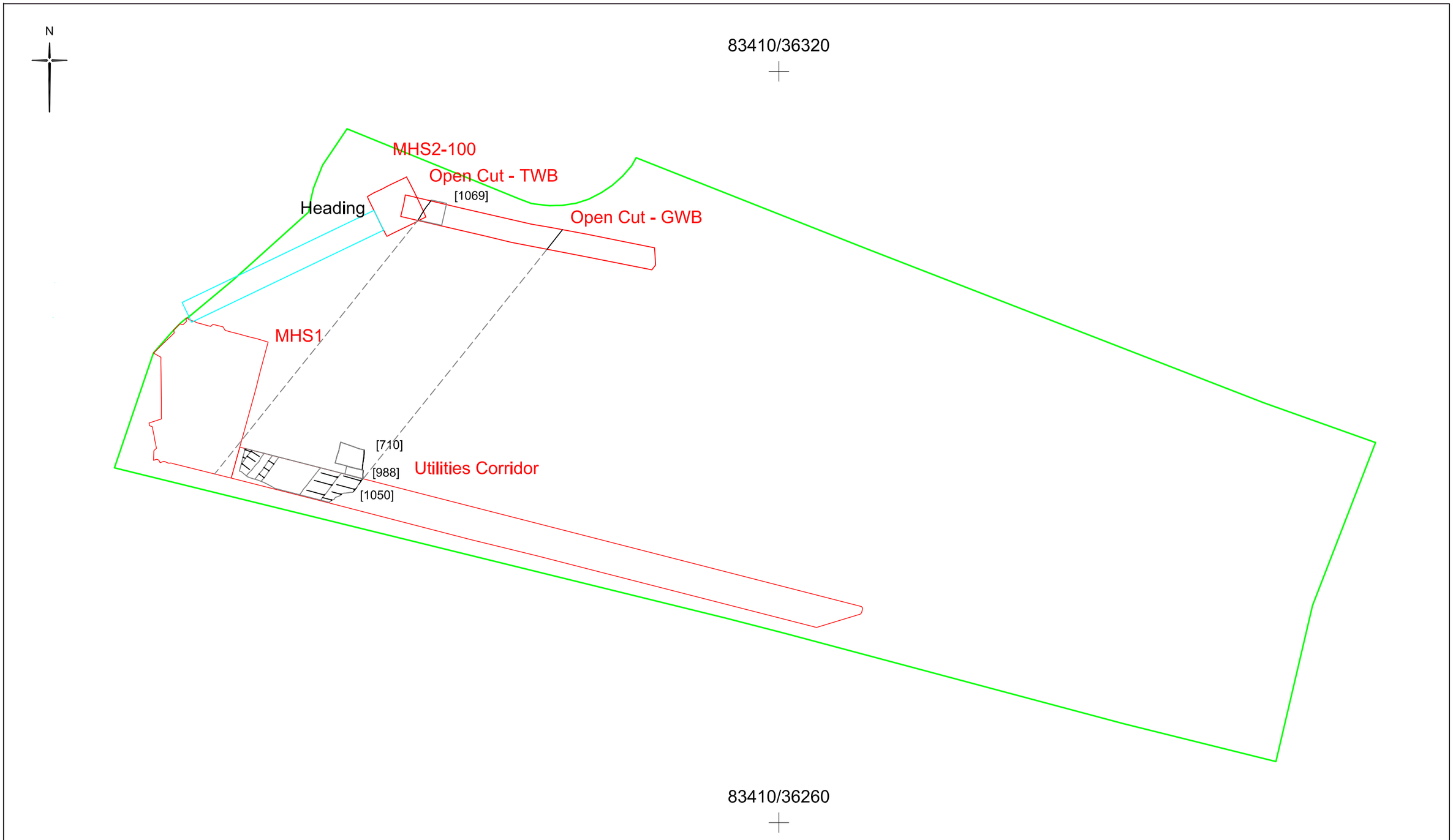


Fig 6 Possible canalised Walbrook

Site Code: XSM10

Site outline
Trench edges 2013
Sewer heading

1:300 @ A3

0 15m

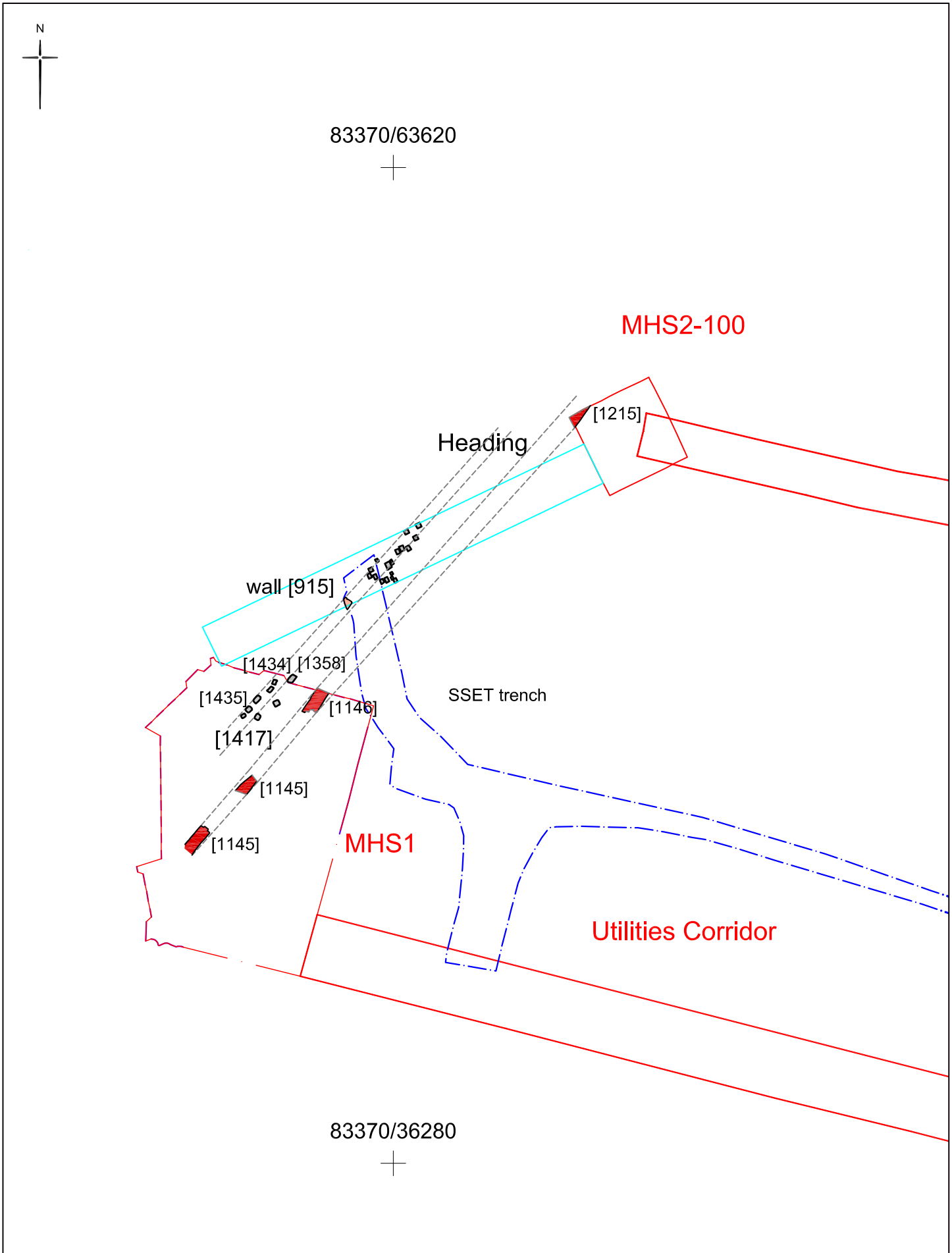


Fig 7 Bethlehem Hospital cemetery walls

Site Code: XSM10

Trench edges 2013
Trench edge 2011
Projected wall line
16th-century wall
18th-century wall
16th-century timber piles

1:200 @ A4

0 10m

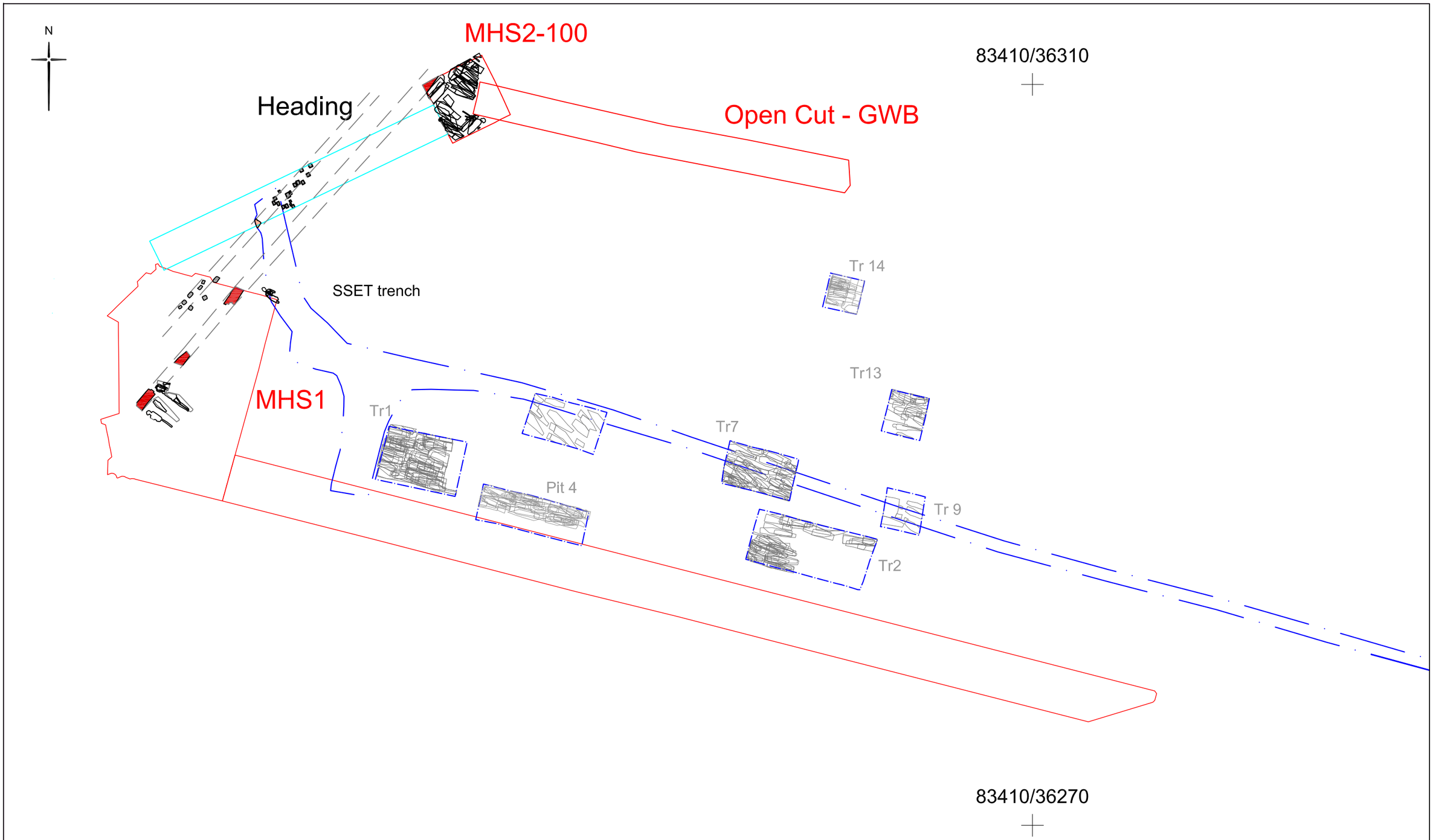


Fig 8 Bethlehem Hospital cemetery walls and burials

Site Code: XSM10

Trench edges 2013
Trench edge 2010/11
Projected wall line
16th-century wall
18th-century wall
16th-century timber piles

1:200 @ A3

0 10m

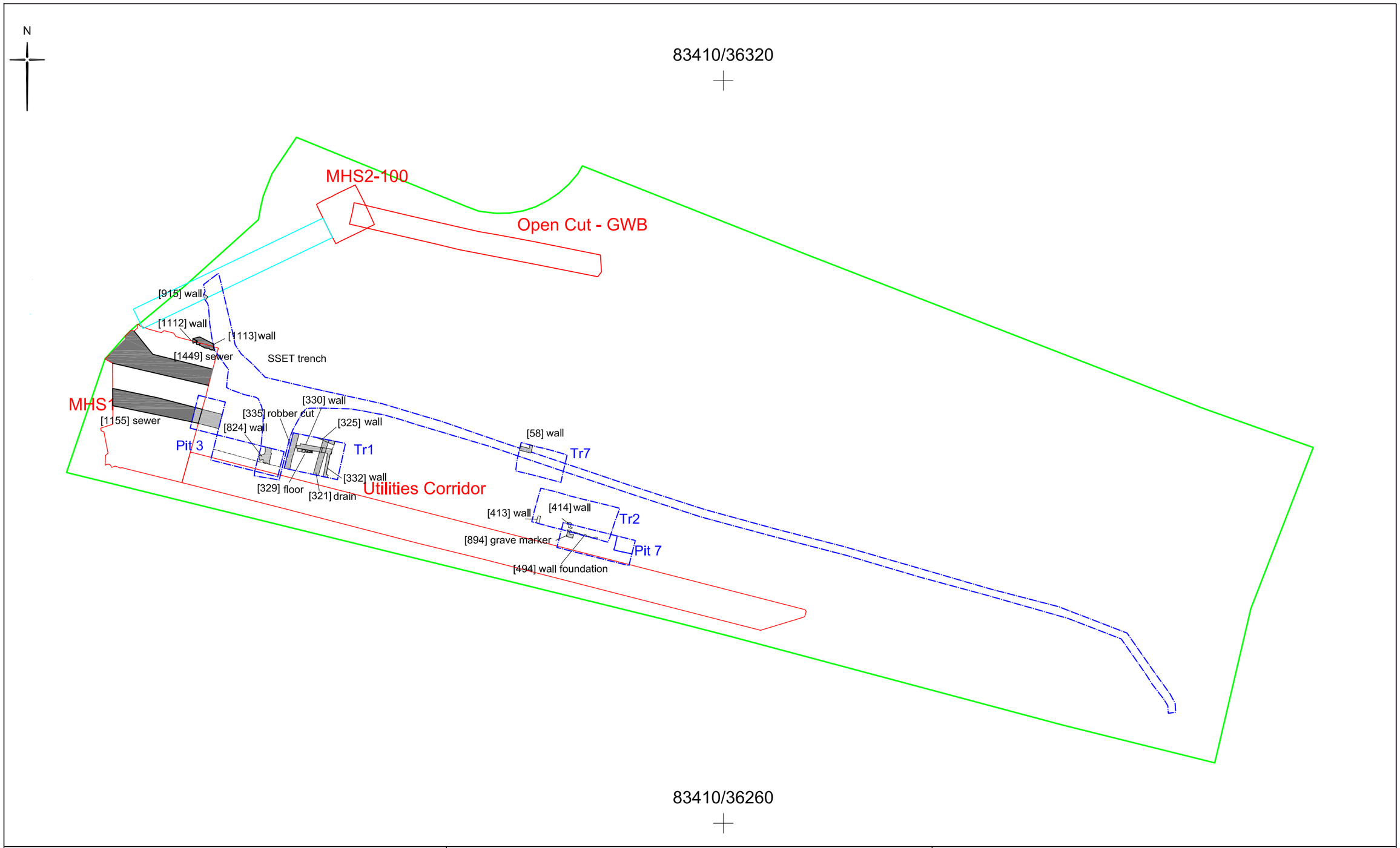


Fig 9 Post-medieval brick structures

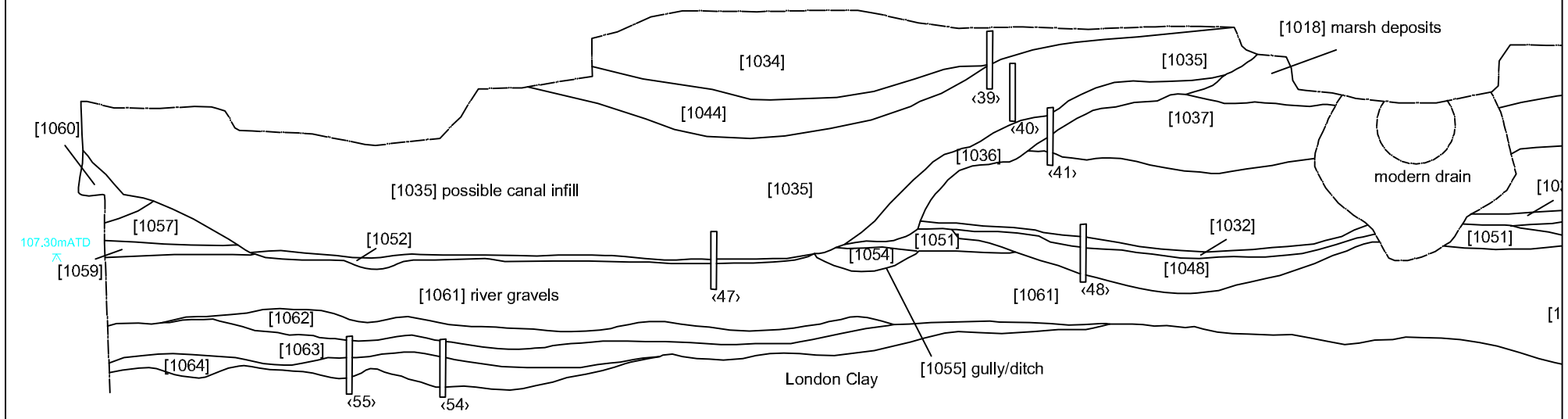
Site Code: XSM10

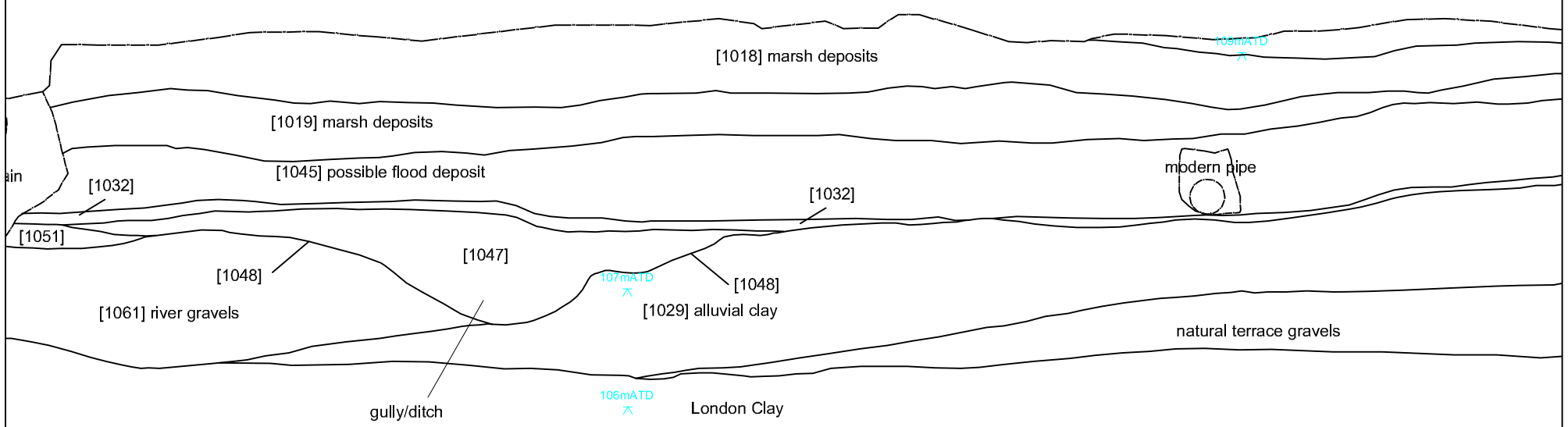
Trench edges 2013
Trench edge 2010/11

1:300 @ A3

0 15m

W (533018.19/181604.91)





E (533054.79/181596.50)

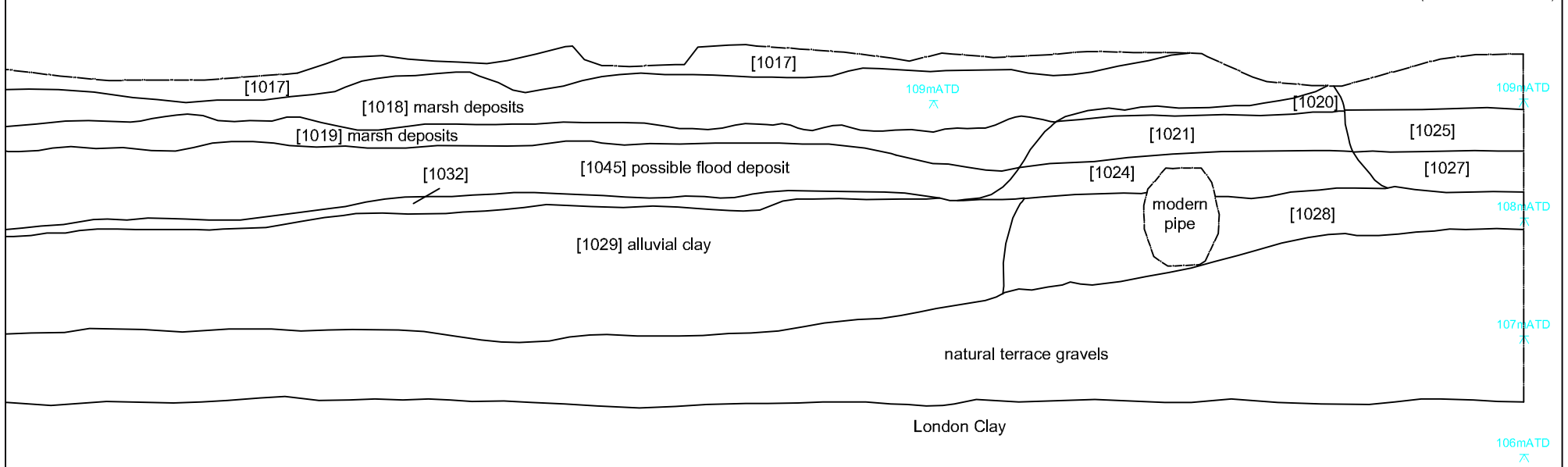


Fig 10 Utilities corridor GL1 - GL8 section 16 (see Fig 2)

Site Code: XSM10

Limited of excavation
Truncation
[1045] Archaeological features
(41) Samples
109mATD Height Above Tunnel Datum (m ATD)

0 1:50 @ A3 3.5m

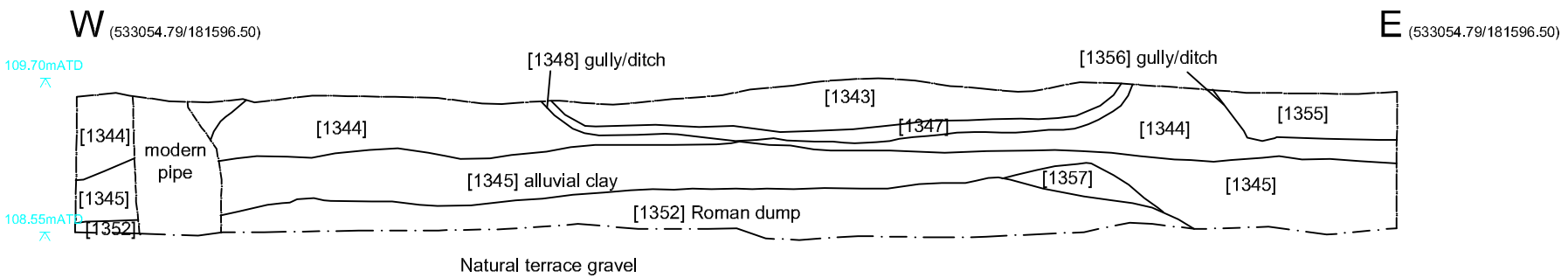


Fig 11 Utilities corridor GL8 - QVT section 31 (see Fig 2)

Site Code: XSM10

Limited of excavation

Truncation

[1045] Archaeological features

107mATD Height Above Tunnel Datum (m ATD)

0 1:50 @ A4 3.5m

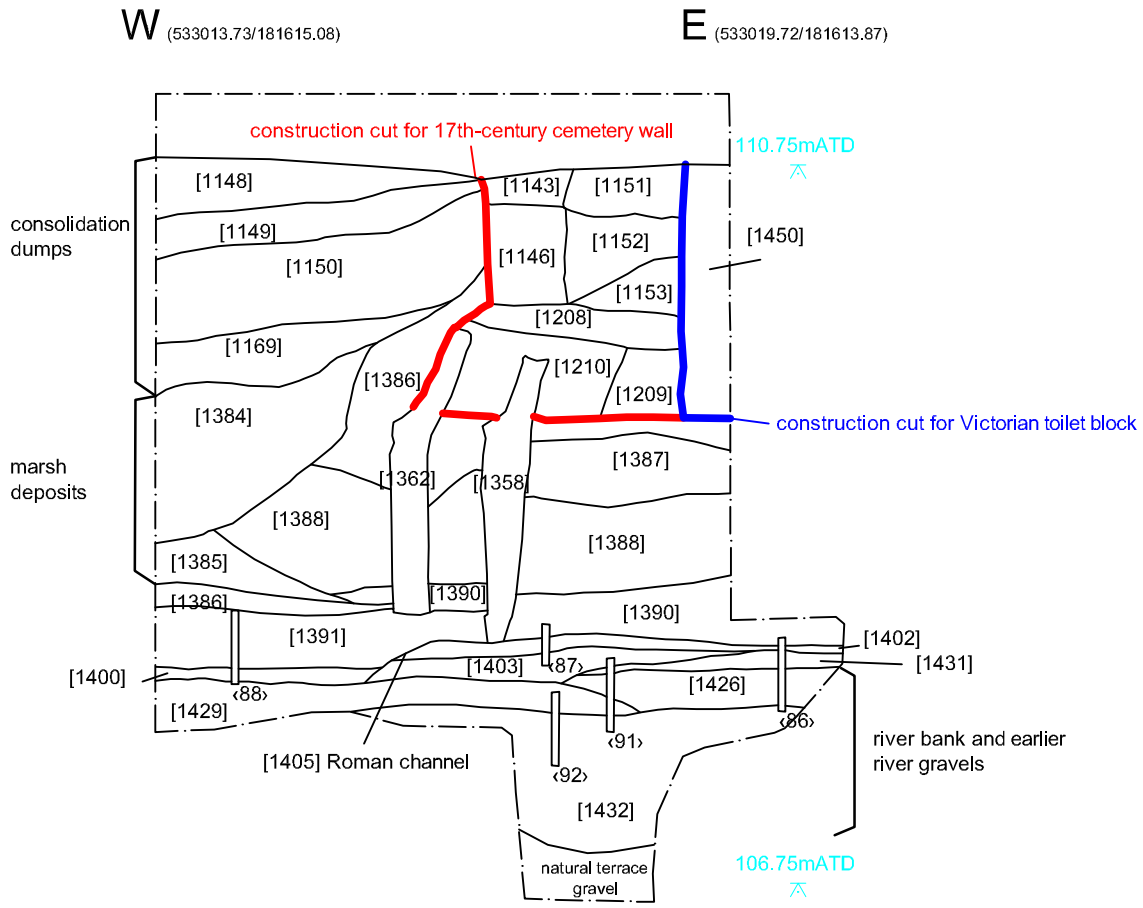


Fig 12 MHS1 section 37 (see Fig 2)

Site Code: XSM10

Limited of excavation

[1045] Archaeological features

‹41› Samples

10.24mOD Height Above Tunnel Datum (m ATD)

1:50 @ A4

0 2.5m

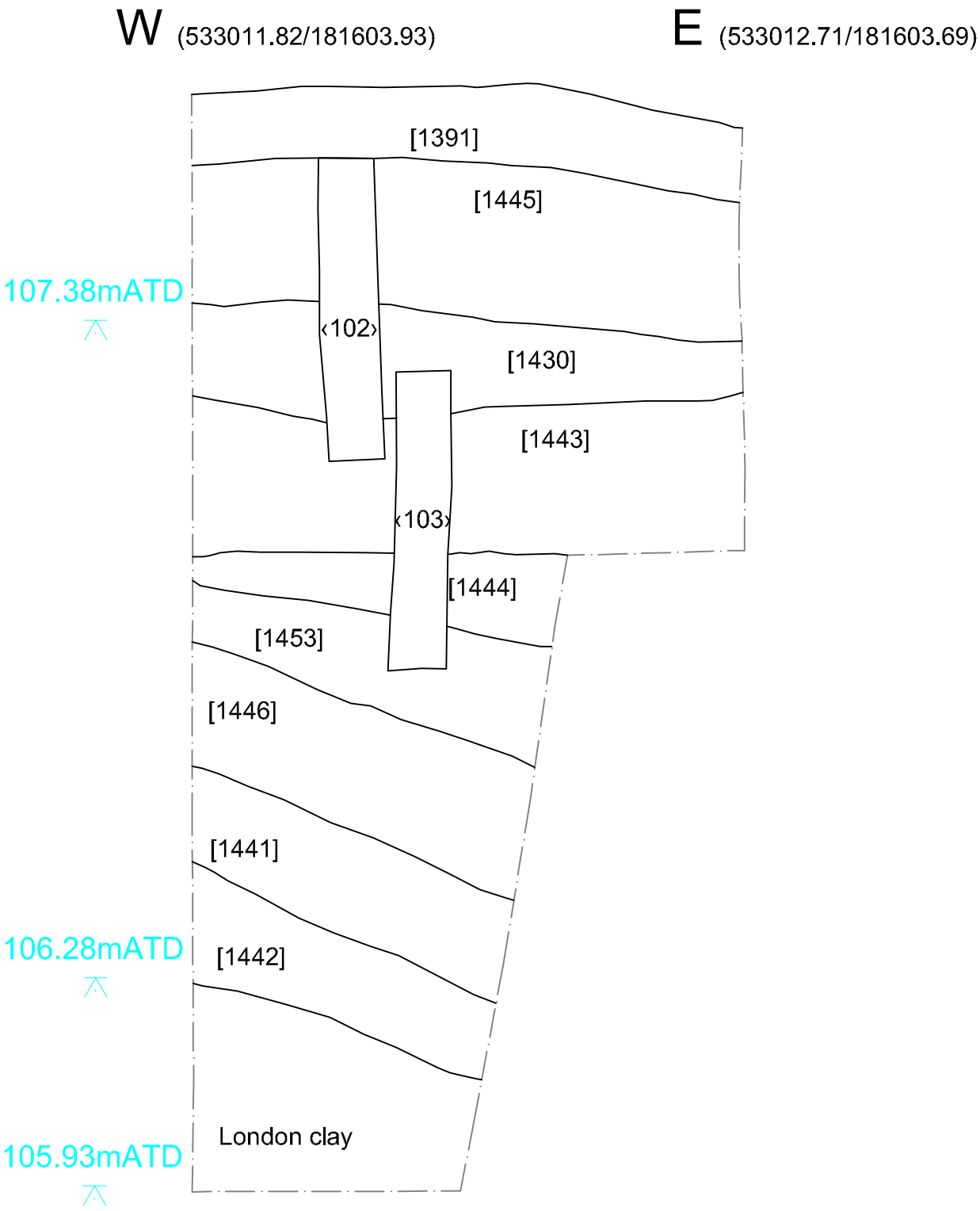


Fig 13 MHS1 section 38 (see Fig 2)

Site Code: XSM10

Limited of excavation
[1043] Archaeological features
‹41› Samples
10.24mOD Height Above Tunnel Datum (m ATD)

1:10 @ A4

0 0.5m

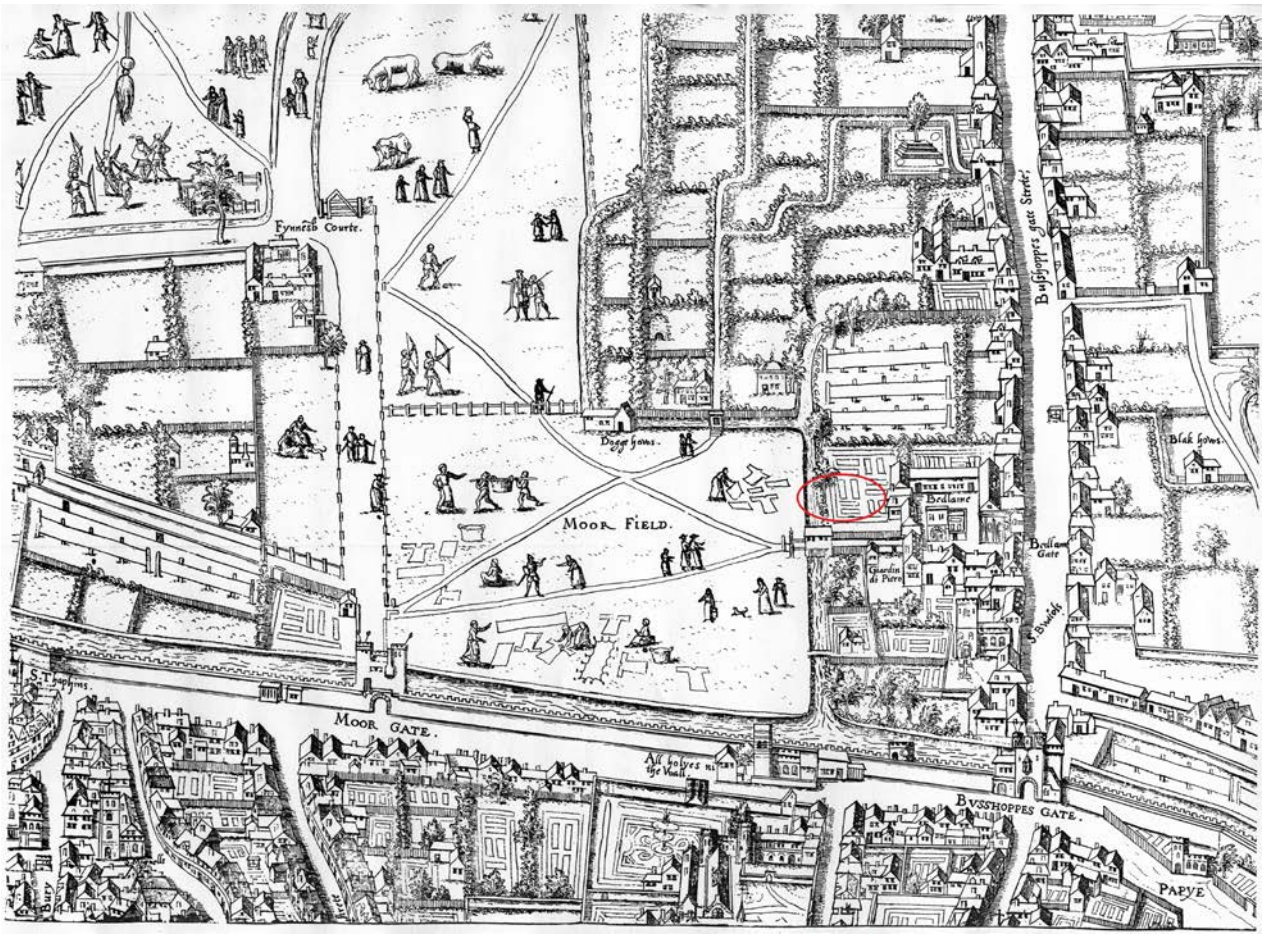


Figure 14 The 'Copperplate Map' of 1553

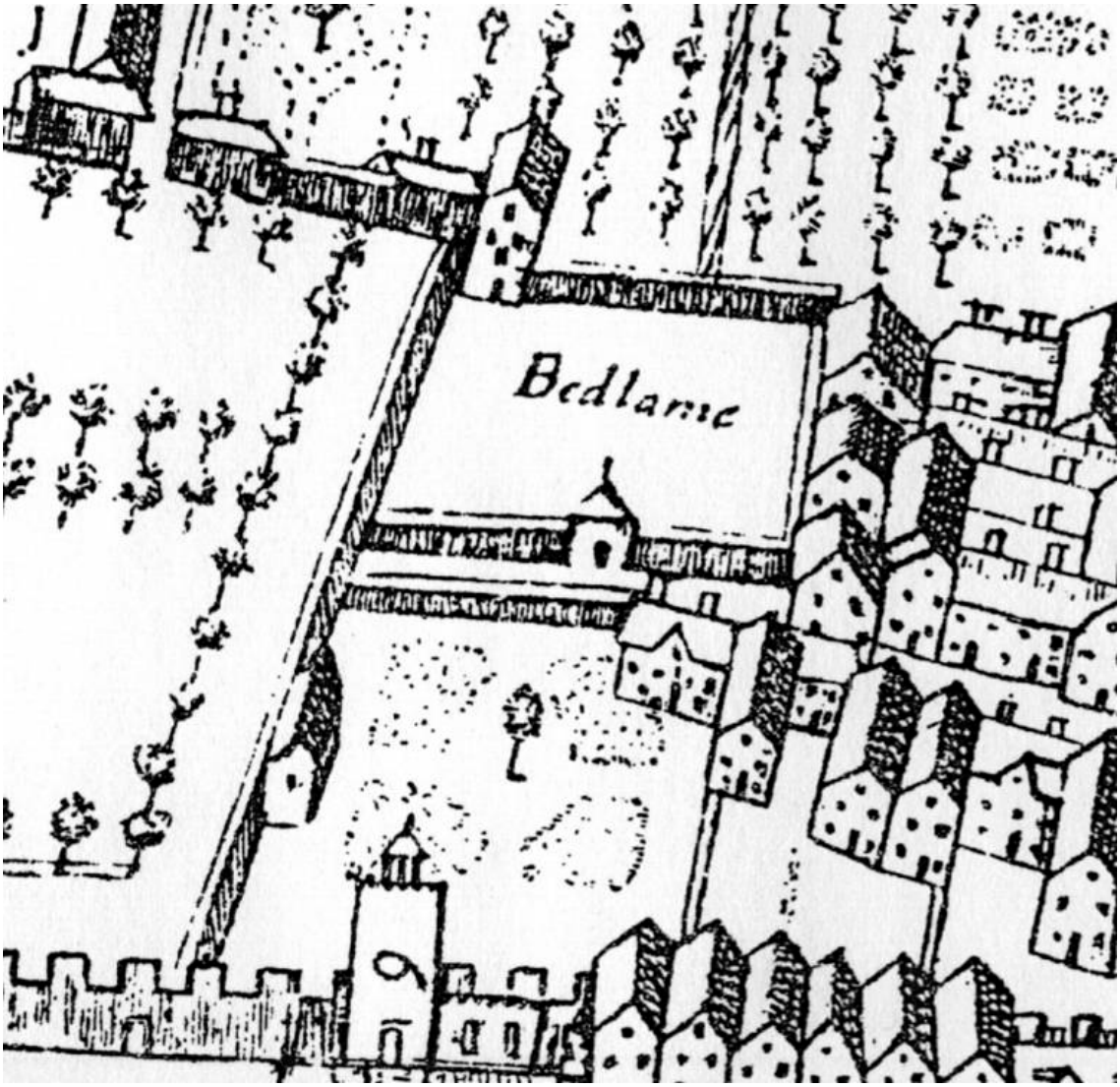


Figure 15 Faithorne and Newcourt's map of 1658

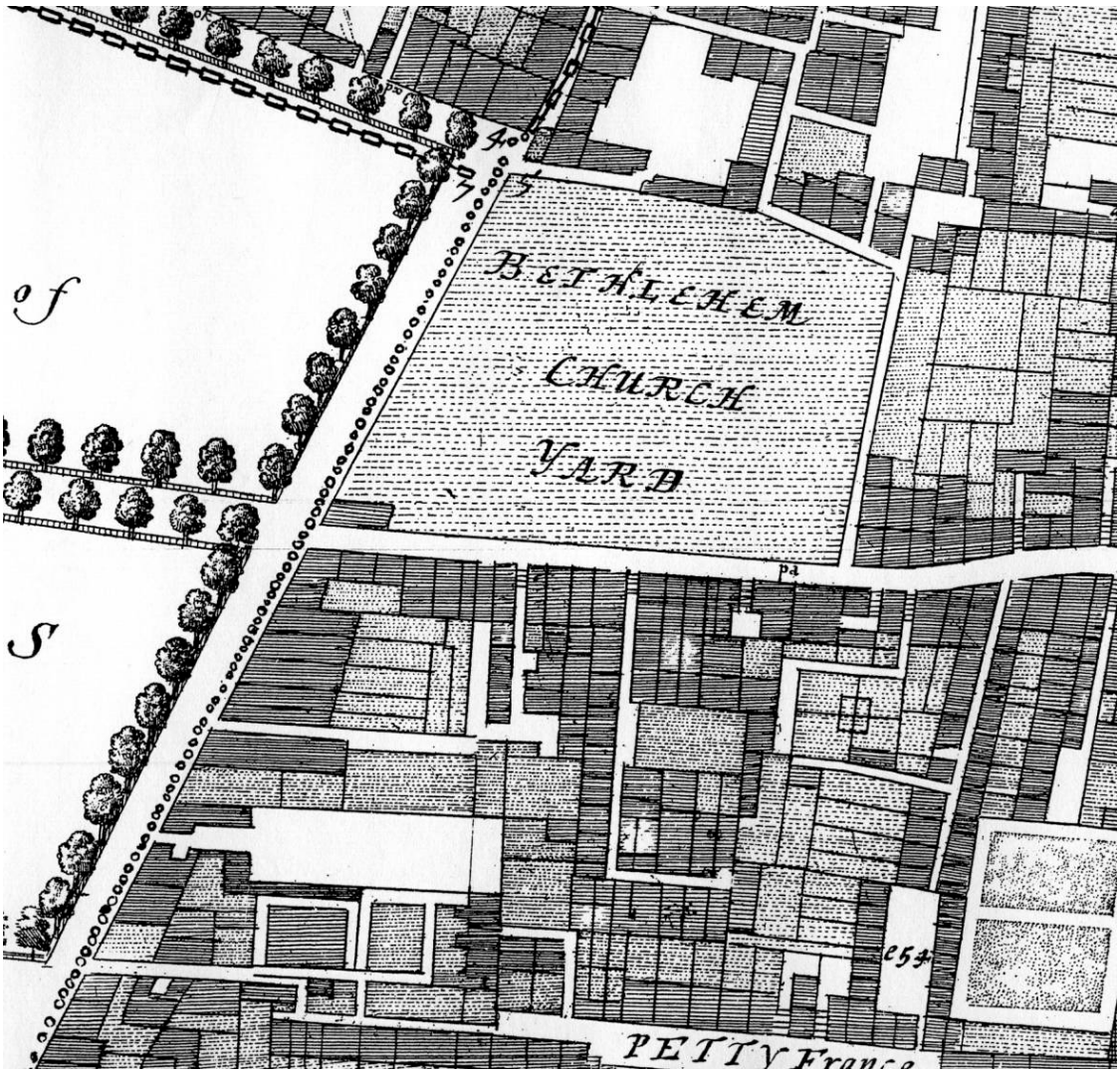


Figure 16 Ogilby and Morgan's map of 1676

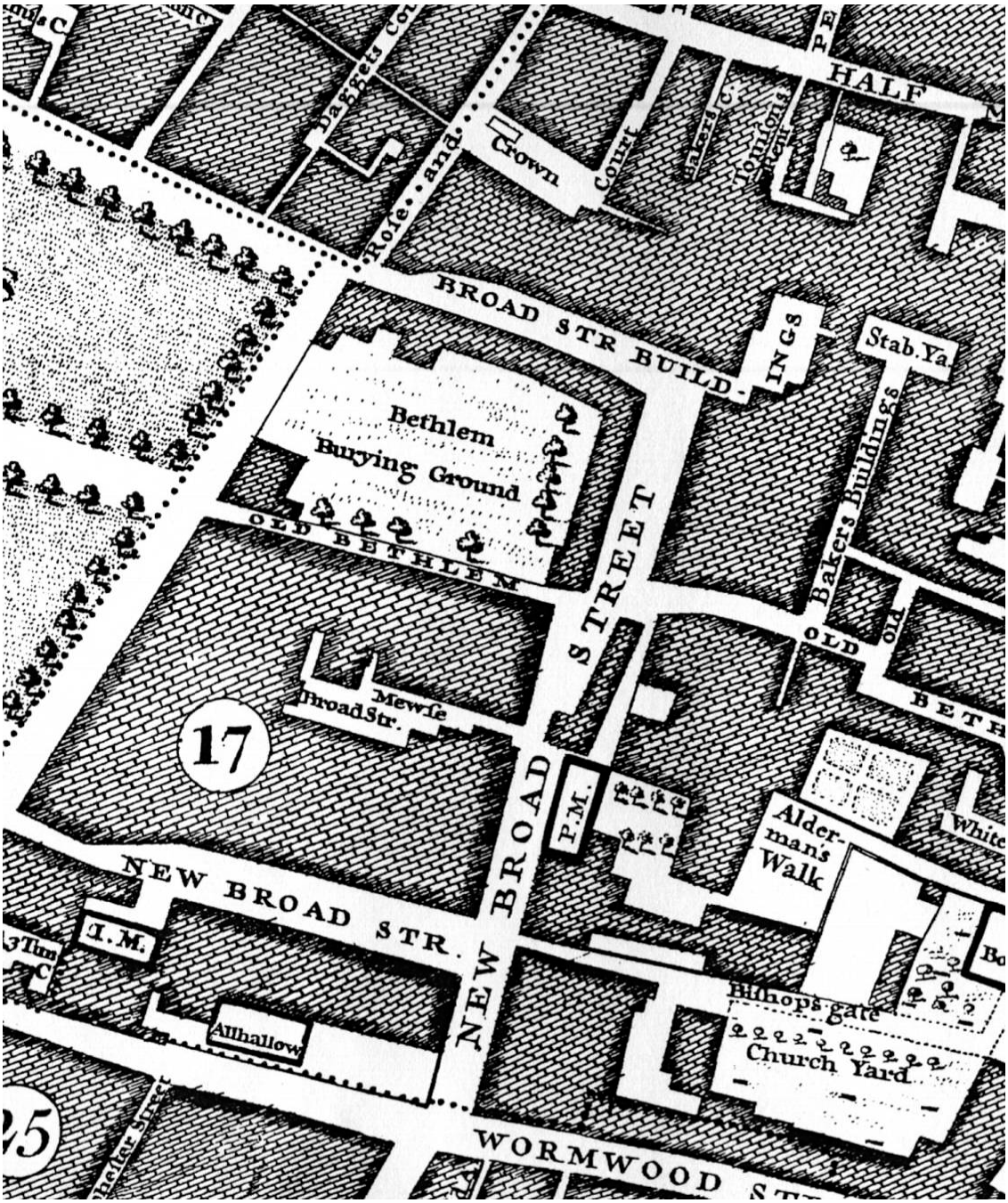


Figure 17 Rocque's map of 1746

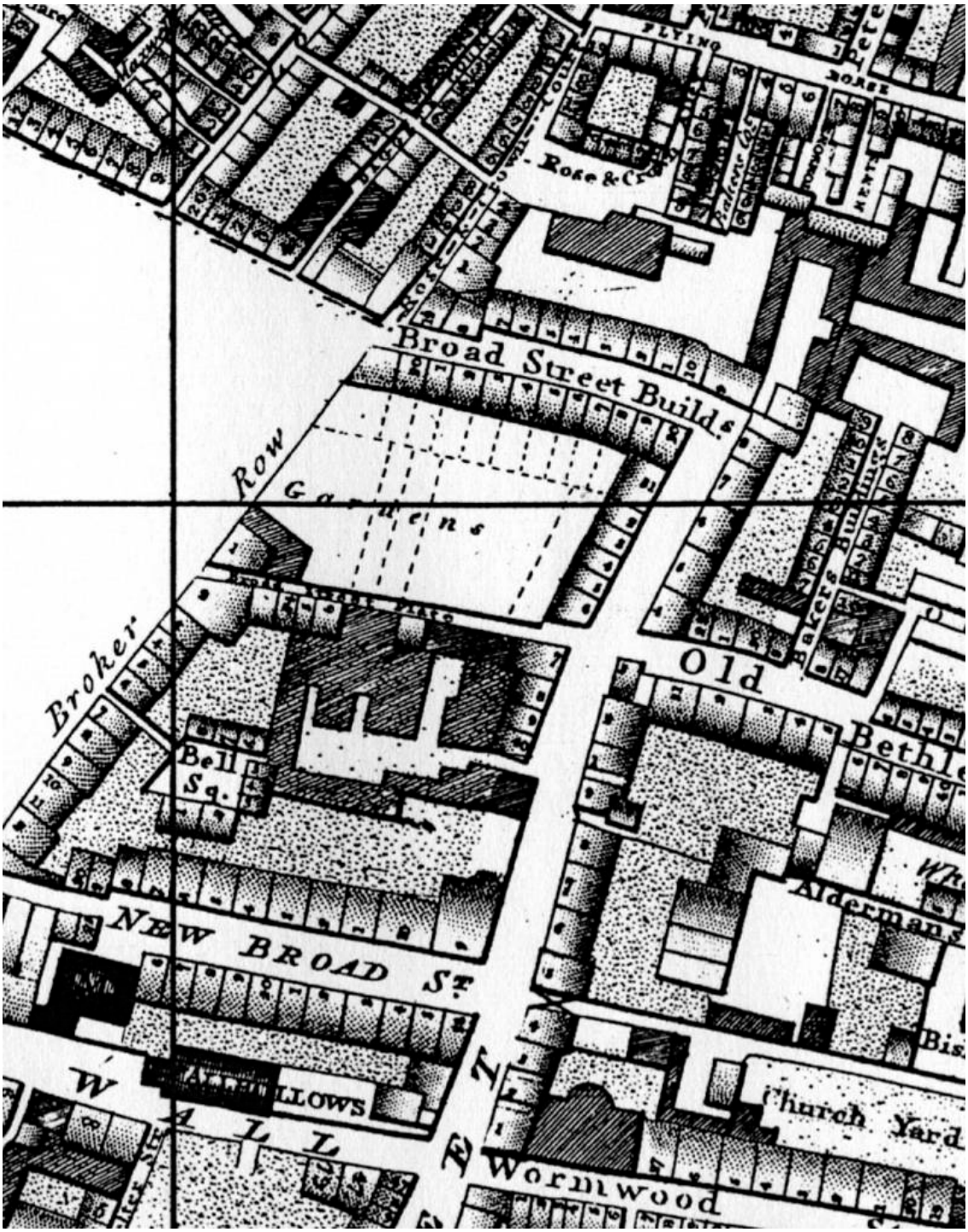


Figure 18 Horwood's map of 1799

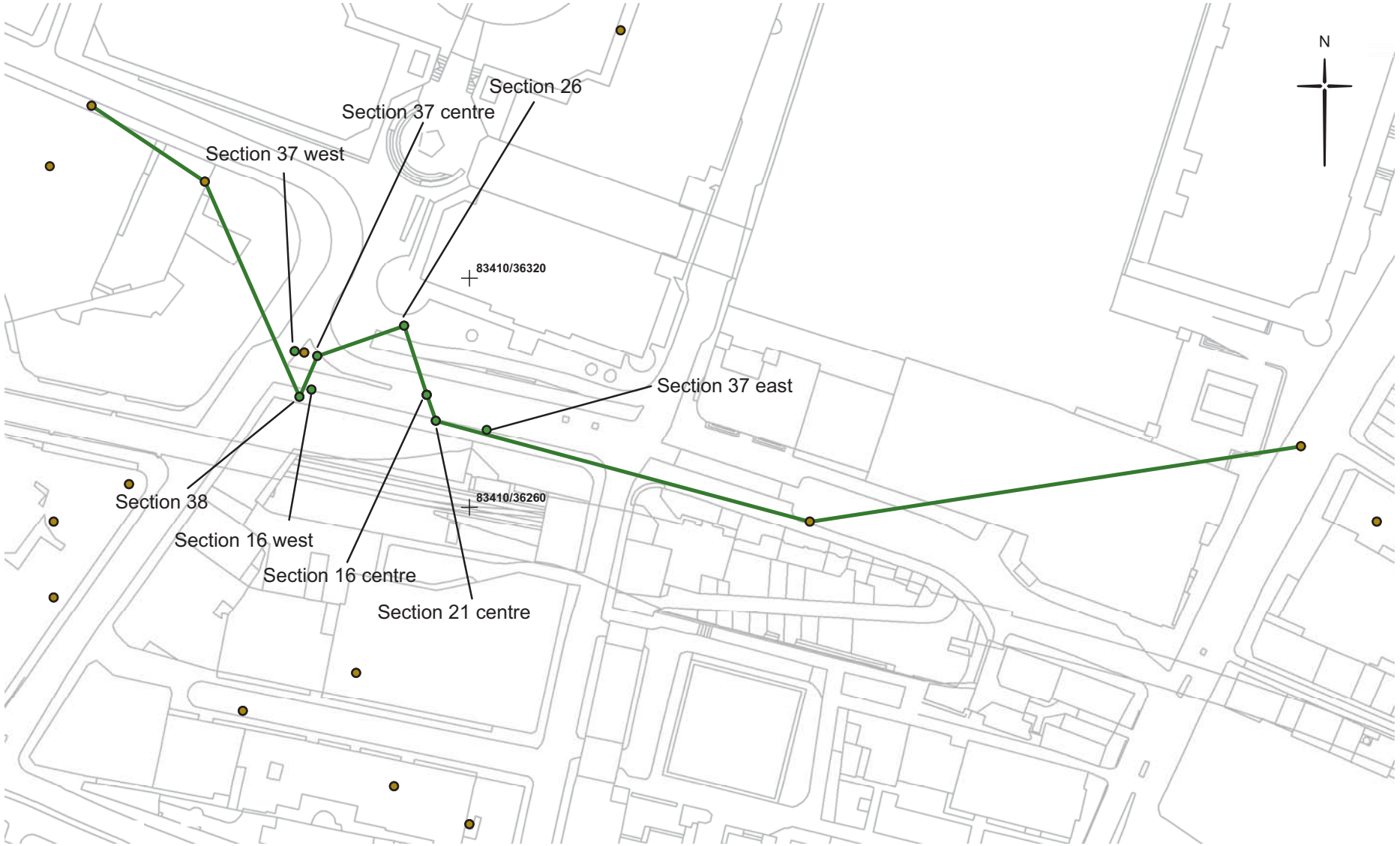


Fig 19 Data point and transect location

Site Code: XSM10

XSM10 data points
MOLA data points
transect
site outline

0 1:1,500 @ A4 100m

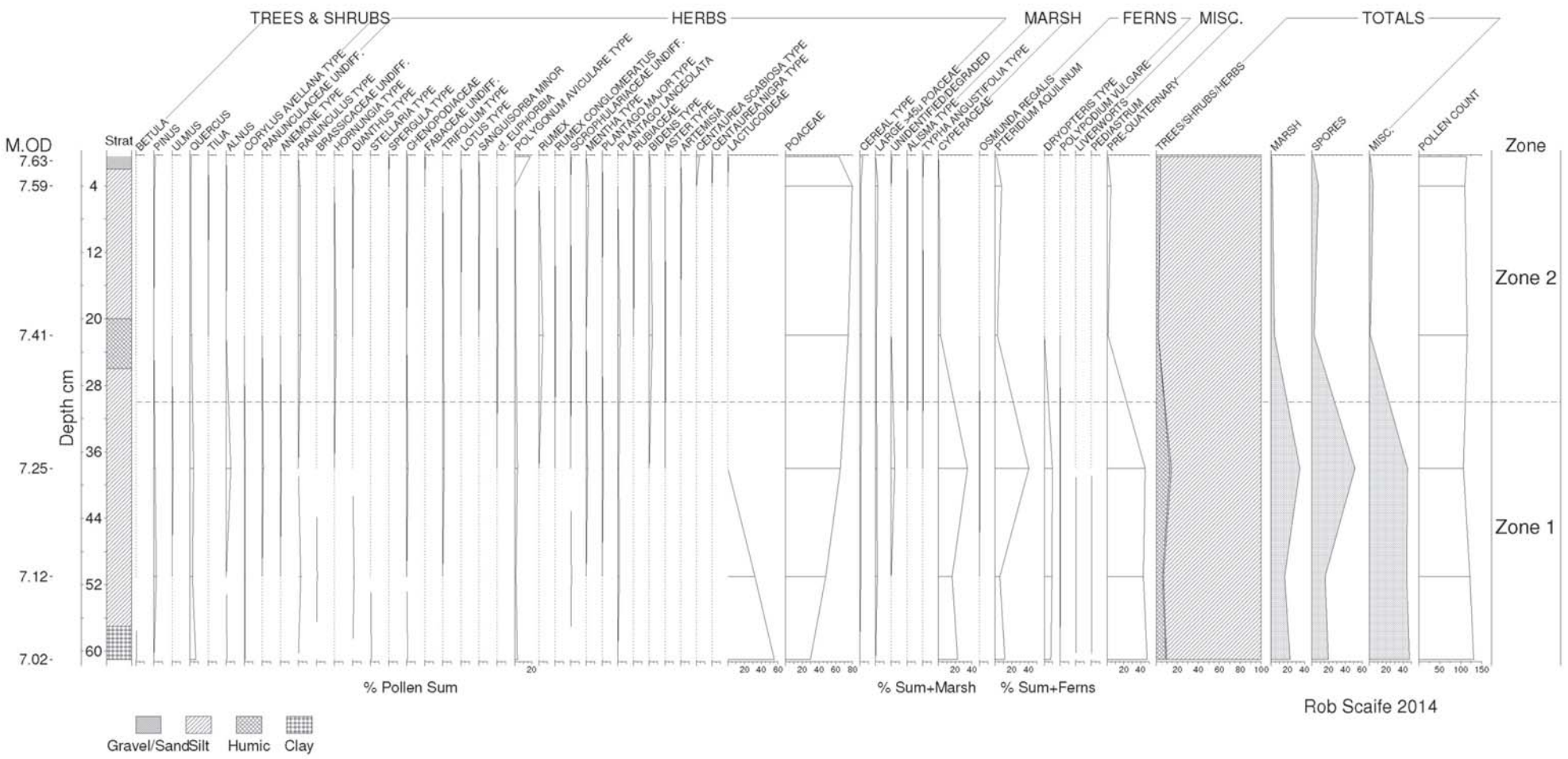


Fig 20 Pollen diagram - MSH1 north facing section

Site Code: XSM10

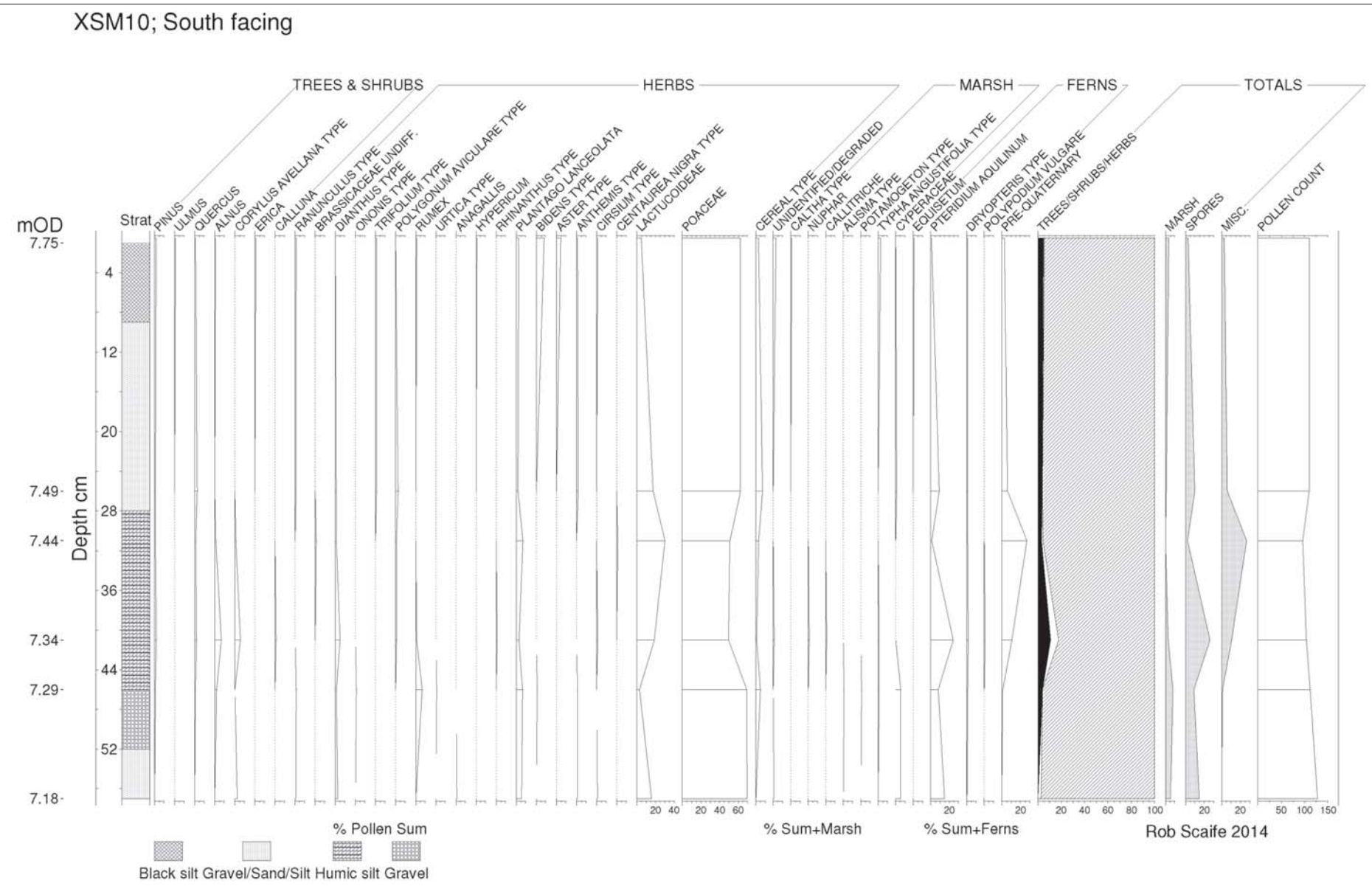


Fig 21 Pollen diagram - MSH1 south facing section

Site Code: XSM10

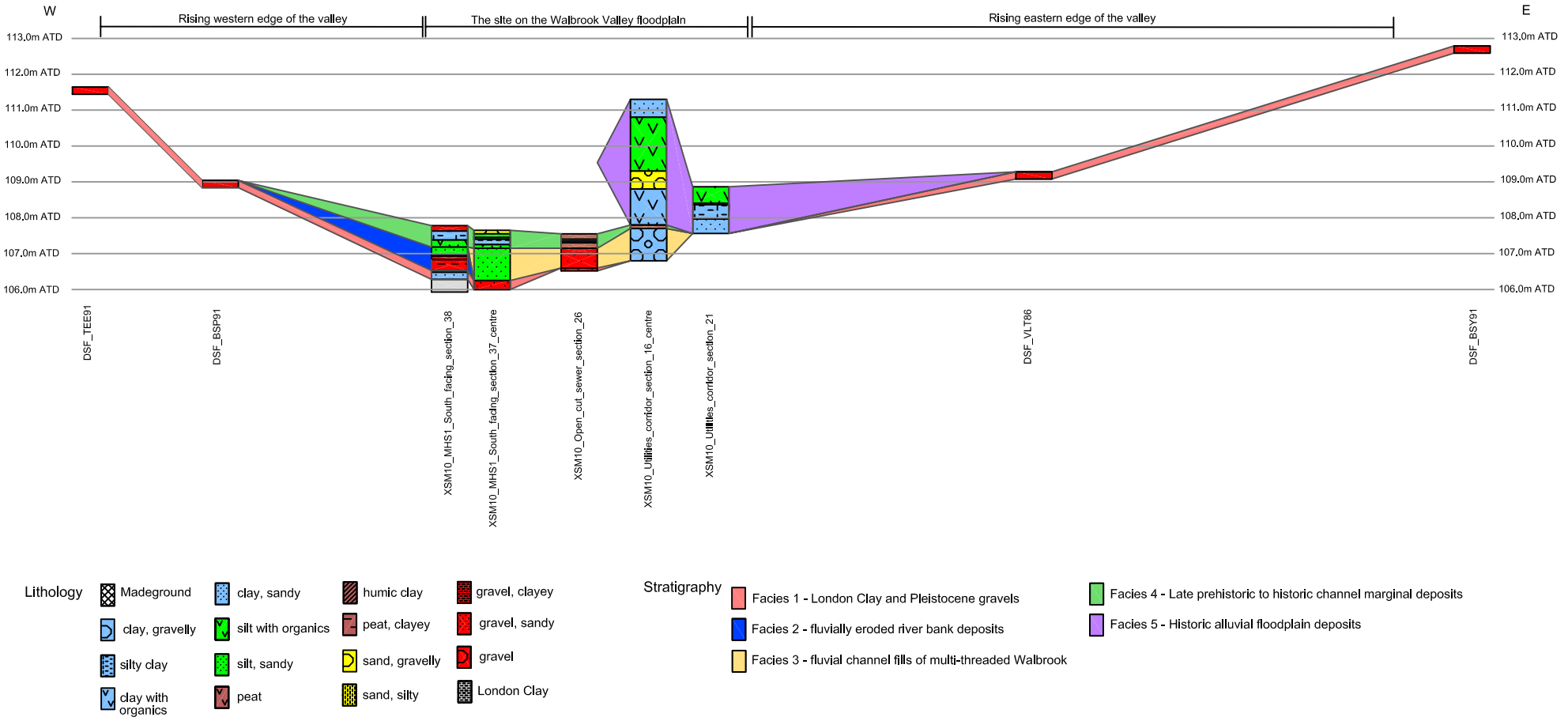


Fig 22 West to east transect

Site Code: XSM10

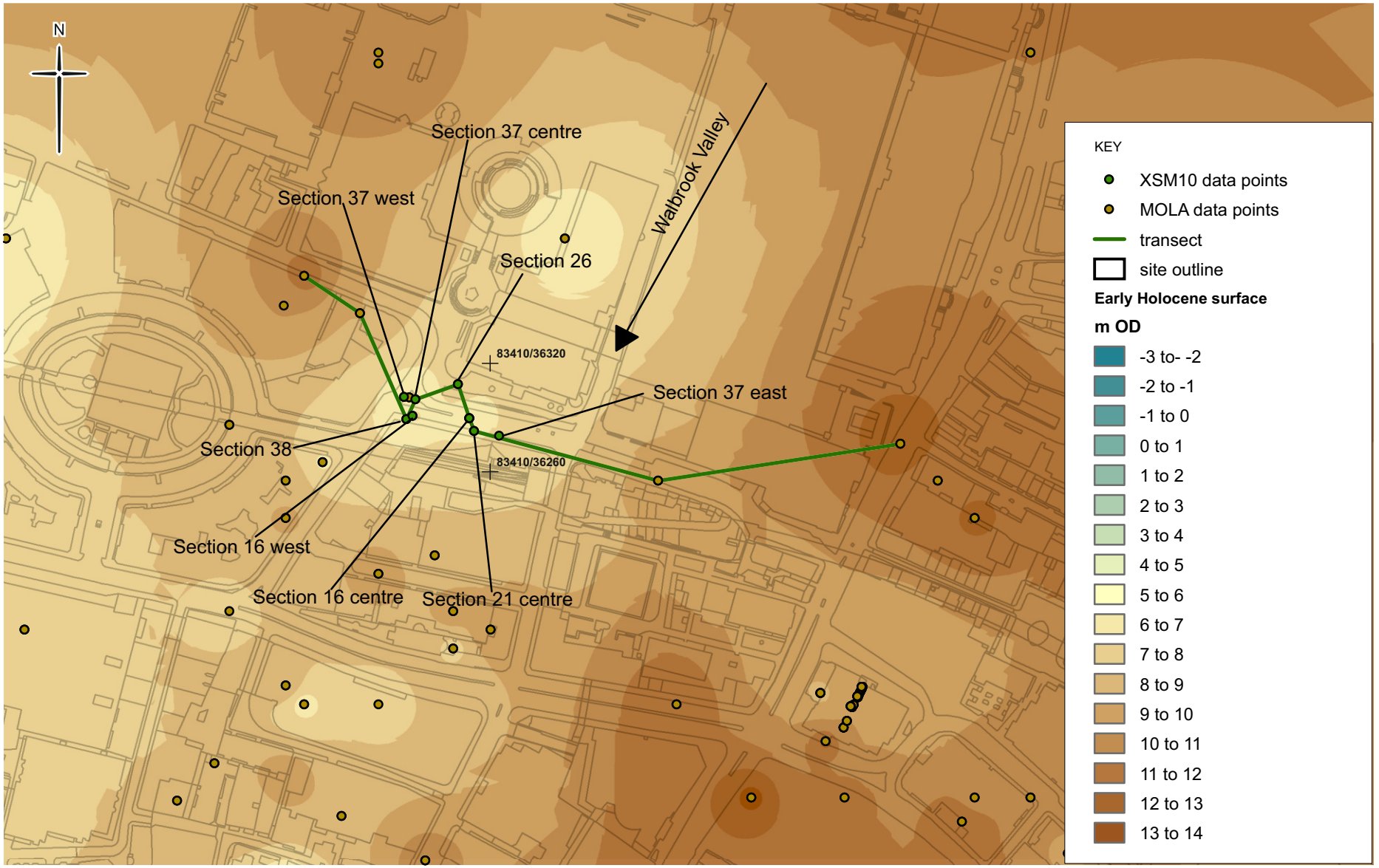


Fig 23 Early Holocene surface

0 1:3,000 @ A4 100m

Site Code: XSM10