C263 ARCHAEOLOGY LATE EAST

Fieldwork Report
Geoarchaeological Evaluation
Plumstead Depot XSW11

Document Number: C263-MLA-T1-RGN-CRG03-50012

Document History:

Revision:	Date:	Prepared by:	Checked by:	Approved by:	Reason for Issue:
1.0	12.05.14	[redacted]	[redacted]	[redacted]	For CRL review
2.0	16.12.14	[redacted]	[redacted]	[redacted]	Incorporate CRL comment
		[redacted]	[redacted]	[redacted]	

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☐	Code 2. Not Accepted. Revise and resubmit. Work may proceed subject to incorporation of changes indicated
☐	Code 3. Not Accepted. Revise and resubmit. Work may not proceed
☐	Code 4. Received for information only. Receipt is confirmed

Reviewed/Accepted by:(signature) [redacted]

Print Name: [redacted] Date: 14.05.15

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Non technical summary

This report covers three geotechnical boreholes carried out by the Museum of London Archaeology (MOLA) on the site of the future Crossrail Plumstead Depot, by C263 Museum of London Archaeology (MOLA). The report was commissioned from MOLA by Crossrail Ltd.

The fieldwork was carried out between 07/04/14 and 08/04/14 and supervised by MOLA Geoarchaeologist. It was recorded under event code (site code) XSW11.

Three window samples afforded opportunities to sample the alluvial sequence above Shepperton Pleistocene Thames gravel. A variable sequence was recorded across the site. The sequence within the window samples on the site shows gravels and sands overlain by clays and sands then peats and sealed by alluvial clays. The elevation of the surface of the Pleistocene/Early Holocene confirms the previous deposit model of a series of braided river channels (LZ3) within a low lying area of the floodplain and separated or fringed by channel bars to later wetlands (LZ2). The northern, eastern and western extent of the channel has been refined by the variously sourced borehole and trench data. The channel is still estimated to be more than 200m wide and up c 3m deep. This feature formed a major part of the floodplain landscape from the Early Holocene, and probably became a major route of drainage and transport. It is possible that the channel forms an abandoned arm of a former course of the Great Breach Dyke, which existed from the Early Holocene into the Bronze Age period.

During the Mesolithic period a channel crossed the area fringed by a terrestrial landscape. This was followed by a rise in sea level by the Early Neolithic, leading to waterlogging and widespread peat formation into the Bronze Age. Within the peat deposits worked timbers were previously recorded in the site adjacent (Crossrail 2013a) which may have formed parts of structures such as trackways, bridges, platforms and jetties constructed to access and traverse the wetlands. No artefacts or structures were recovered on this site during this phase of works. The alluvial deposits are likely to be of Iron Age, medieval and historic date representing inundated floodplain soils.

The site has the potential to provide a high resolution, site specific palaeoenvironmental reconstruction. Data sets such as this need to be integrated and synthesised into their wider environmental context. This will allow broader models derived from the Late East data set as whole to focus down to the human scale in order to understand how the changing landscape would have influenced human behaviour, exploitation of the landscape and changing settlement patterns. Because of this potential the results from Plumstead Depot and the adjacent Plumstead Portal are assessed as being of regional significance when taken in the broader setting of the Late East Crossrail data set.

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1 Introduction

Crossrail is a new cross London rail link project which 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 have 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 new sidings are required adjacent to Plumstead Portal in an area known as Tilfen Land, in the London Borough of Greenwich centred on NGR 545263 179070 (Figure 1). The site is bounded by White Hart Lane to the north and by the existing North Kent Line to the south. To the west lies the Crossrail Plumstead Portal (East) worksite with allotment gardens and sports pitches to the east beyond which lie the commercial buildings of the White Hart Industrial Estate.

The requirements were set out in a SS-WSI Addendum for Geoarchaeological Borehole Investigation at the Plumstead Depot Site (Doc. No. C298-XRL-T1-RGN-CRG07-50001) which complements the original Written Scheme of Investigation for the Plumstead Portal Site (SS-WSI – *C156 Plumstead Portal,* Crossrail, July 2011, Document No C156-CSY-T-RGN-CR148_PT005-00028, Version 4). This document refers to the existing deposit model update (No. C263-MLA-X-RGN-CR148_PT005-50002) and should be read in conjunction with that document. This report details the borehole evaluation investigation carried out, by C263 Museum of London Archaeology (MOLA). All fieldwork was conducted between 07/04/14 and 08/04/14. Archaeological investigations were, directed by MOLA Geoarchaeologist Jason Stewart.

Task	**Principal Contractor**	**dates**
Geoarchaeological borehole sampling 3 terrier rig boreholes.	Balflour Beatty	7-8th April 2014

Table 1: Task Information.

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

The event code (site code) is **XSW11**.

2 Planning background

The overall framework within which archaeological work will be undertaken is set out in the Environmental Minimum Requirements (EMR) for Crossrail (http://www.crossrail.co.uk/railway/getting-approval/environmental-minimum-requirements-including-crossrail-construction-code#.T979khdfFXs).

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 disapplications, 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. The report has been prepared within the terms of the relevant standard specified by the Institute for Archaeologists (IfA, 2008) and the English Heritage Greater London Archaeological Advisory Service for London's guidelines (2014). 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 CR-PN-LWS-EN-SY-00001, 2009.
- Crossrail Code of Construction Practice
- English Heritage Centre for Archaeology Guidelines, Environmental archaeology: a guide to the theory and practice of methods, from sampling and recovery to post-excavation (2002)
- English Heritage, 2004, Geoarchaeology: using earth sciences to understand the archaeological record
- Institute for Archaeologists (IFA) Standards and guidance for watching briefs and field evaluation (IFA 2008 and 2009)
- Museum of London Archaeological Site Manual (1994)
- Museum of London General Standards for the preparation of archaeological archives deposited with the Museum of London (1998)
- C263 ARCHAEOLOGY LATE EAST, Geoarchaeological deposit model: Deposit Model Update and Watching Brief, Plumstead Portal and Plumstead Depot – XSW11, Document Number: C263-MLA-X-RGN-CRG07-50001, 2013

The fieldwork was carried out in accordance with:

- An **Archaeological Method Statement**: MOLA, C263 Archaeology Late East, Method Statement: Geoarchaeological Sampling at the Plumstead Depot, Version 1 Document Number: C263-MLA-X-GMS-CRG03-50001, 2013 The MOLA method statement was prepared in line with the Principal Contractor's method statement
- SS-WSI – Addendum for Geoarchaeological Borehole Investigation at the Plumstead Depot Site, February 2014, Document No C298-XRL-T1-TGN-CRG07-50001-V1.0

The Written Scheme of Investigation (WSI) and Method Statements will be available from the LAARC.

The archaeological and historic background for the Plumstead Portal and Depot site has been presented in the Site Specific Written Scheme of Investigation (Document No. C156-CSY-TRGN- CR148_PT005-00028) and Scoping Assessment; Archaeological Potential at Tilfen Land Plumstead (Document No. C122-OVE-T1-ASM-CR148-50001 Rev 2.0). A geoarchaeological deposit model for the area has also been prepared (Document No. C263- MLA-X-RGN-CRG07-50001). The deposit model identified three principal landscape zones (LZ):

- LZ1 consisting of outcropping Tertiary deposits and gravel units that form the high ground of the valley sides, and which lies outside of the site to the west. This is not present onsite.
- LZ2 defines the typical Thames Holocene floodplain succession, characterised by Late Pleistocene/Early Holocene basal sands and gravels, overlain by prehistoric wetland peats, and sealed by late prehistoric to historic estuarine deposits.
- LZ3 characterising a complex set of deposits in filling a large palaeochannel feature of Early to mid-Holocene date.

LZ3 comprises a 200m wide abandoned channel and major feature within the floodplain landscape. This north-south aligned feature crosses the Plumstead Depot site and has tentatively been interpreted as a tributary channel or arm of the 'Great Breach Dyke' which ran northwards off the higher ground before draining into the River Thames.

Field evaluation including watching briefs, trail trenches and borehole survey was conducted on land to the west of the site during the works at Plumstead Portal (C263 Archaeology Late East Fieldwork Report Evaluation and Watching Brief Plumstead Portal – XSW11**Document Number:** C263-MLA-X-RGN-CR148_PT005-50002) This uncovered a Mesolithic terrestrial land surface obscured by bronze age peat deposits, which in turn were buried by iron age and later alluvial deposits, these were buried by circa. 1.20m thick rubbish dumps used to level the area before the construction of rail track and buildings in the vicinity, including the foundations of a former chimney and furnace and a concrete cooling tower.

5 Geology and topography of site

The geological and topographical setting for the Plumstead Depot site was covered in detail in the geoarchaeological deposit model (Document No C263-MLA-X-RGN-CRG07-50001). This information is summarised below.

The site lies on the southern edge of the alluvial floodplain of the River Thames, towards the south of the site there are outcrops of higher Tertiary Reading and Woolwich beds. The site occupies an ectonal setting between the higher, drier ground of the terrace to the south and the wetland landscapes to the north. The Eocene London Clay is covered by Pleistocene sand and gravel floodplain deposits laid down when the Thames was a fast flowing river comprised of interconnected channels, with sand banks and gravel bars, in a similar fashion to those currently operating in the artic today. These floodplain gravels form the 'Holocene Template' on which Mesolithic activity would have taken place, the areas around channels and lakes providing resources attracting a hunter-gatherer population.

By the Neolithic relative sea level rise had resulted in an increase in river levels causing waterlogging of previously terrestrial surfaces, causing the channels to silt up and peat to form. This would have altered the landscape to one of primarily wetland, crossed by the Thames which would have occupied a single channel.

A geoarchaeological deposit modelling exercise (Document No C263-MLA-X-RGN-CRG07-50001) has identified two landscape zones (LZs) in the area of the site. The two landscape zones are detailed as follows:

- LZ2 is an area of prehistoric peats and waterlogged wetland deposits. Across the zone the basal Shepperton Gravels lie at roughly c.98-99m ATD. They were deposited during a cold climate c. 15000 to 10000 years ago, There is possibility for soil formation on these gravel surfaces, prior to the waterlogging and peat formation induced by the climatic amelioration of the Neolithic to Bronze Age. Previous work on the peat deposits at other sites in South East London have suggested that these peat deposits form in semi terrestrial alder carr woodland. Changes in the location of the tidal head in the Iron Age ushered in a period of minerogenic sediment deposition in a salt marsh and estuarine mudflat environment which continued into the medieval period.

- LZ3 is a north south aligned palaeoenvironmental feature running north south; the surface of the floodplain gravels in this area is at c.96.5m ATD and indicates channel incision into the gravel surface. The gravels are overlain by a variety of sands, silts and organic/peaty deposits which represents fluvial activity within the channel footprint or in the case of the organic deposits episodes of abandonment. These channel deposits are sealed by thick peat deposits overlain by minerogenic alluvium. There is a possibility that this palaeochannel is related to other palaeochannels known in the area such as the Great Breach Dyke and

the palaeochannel discovered at Belmarsh prison.

Modern ground level adjacent to the site lies at c 105.80m ATD.

6 Research objectives and aims

6.1 Objectives of the fieldwork

The overall objectives of the geoarchaeological sampling was to

- Mitigate the impact of ground improvement works across the Plumstead Depot site and inform further intra and inter-site post-excavation analysis
- Identify and record the extent, depth and state of preservation of the surviving Holocene alluvial deposits
- Provide sufficient geoarchaeological data to enhance the existing understanding of the prehistoric and historic landscape development and the potential for past human activity within the area of the site.

The results of this investigation will be combined with the proposed C263 post-excavation programme.

6.2 Research Aims

A number of site specific research aims were stated in the Written Scheme of Investigation. These are;

- to confirm whether the deep low lying gravel feature identified by Fugro Borehole WS454 is channel meander or secondary course of the main Great Breach Dyke Channel;
- to confirm whether the two deeper low lying gravel features identified between Fugro Boreholes WS458 and WS152 represent a channel meander or secondary course of the main Great Breach Dyke channel; and
- to recover samples from the two channel routes highlighted by the Plumstead Portal and Plumstead Depot deposit model (Crossrail 2013, Doc. No. C263-MLA X-RGNCRG07- 50001 Rev. 3.0) in order to investigate their chronological, landscape and palaeoenvironmental setting in comparison with each other and that of the Plumstead Portal site

7 Methodology of site-based and off-site work

7.1 General

Three boreholes were targeted to investigate features identified by the updated deposit model (Document No. C263-MLA-X-RGN-CRG07-50001). The boreholes were drilled by Geotech Ltd and monitored by a geoarchaeologist who recorded the survival, thickness and characteristics of deposits of archaeological interest (e.g. 'made ground', alluvium, gravel) at each location.

The geoarchaeologist wore appropriate PPE, and when monitoring boreholes stood as close as safety permitted to the side of the rig, as directed by the drillers. Plastic sleeved window sample cores were provided to the geoarchaeologist. The laid out cores were examined and logged by the geoarchaeologist, and the samples were taken off-site and retained for future assessment and analysis. Depths of the deposits logged were obtained by conversing with the driller, and final co-ordinates and levels of the boreholes were provided by Balflour Beatty the SI contractors. All monitoring work was carried out in accordance with the method statement (Crossrail 2014, Doc No. C263-MLA-T1-GMS-CRG03-50001).

7.2 Deposit Model construction and Landscape Zones

In order to create and update the deposit model the geotechnical data was entered into a digital (Rockworks 15) database. The three geoarchaeological boreholes were used to update the existing deposit model (Crossrail 2011). This included

- 54 sedimentary logs from geotechnical boreholes, window samples and test pits were included in the original deposit model
- the six geoarchaeological boreholes and data from the east and west ends of the two archaeological trenches from the adjacent Plumstead Portal site (Crossrail 2013a, C263-MLA-X-RGN-CR148_PT005-50002
- A deposit model update added 4 boreholes and 4 window samples (Crossrail 2013c, C263-MLA-X-RGN-CRG07-50001).

The distribution of the data points is illustrated on Figure 2 Distribution of data points.

The geotechnical data was entered into the database with the prefix XRail_Pk'x' with 'x' denoting the package number. The utilities works were entered with the prefix XRail_U, with U denoting utilities. The interventions added as part of this report were given the prefix "Crossrail_". The MOLA data was entered with the prefix MOLA.

Each identified lithological unit (gravel, sand, silt etc) was given a unique colour and pattern allowing cross correlation of the different sediment and soil types across the site. By examining the relationship of the lithological units (both horizontally and vertical) correlations can be made between soils and sediments, and associations grouped together on a site-wide basis. The grouping of these deposits is based on

the lithological descriptions, which define distinct depositional environments, coupled with a wider understanding of the Thames floodplain sequence gained from non-Crossrail archaeological and geoarchaeological investigations undertaken in the surrounding area. Thus a sequence of stratigraphic units, representing certain depositional environments, and/or landforms can be reconstructed both laterally and through time for the site. By this method a series of Landscape Zones (LZ's) can be defined which are determined by characteristic types of deposit sequences made up of one or more of these stratigraphic units. The landscape zones are illustrated on Figure 4 Landscape zones.

The vertical deposit succession has been previously illustrated on the transect drawn across the site (Crossrail 2013a, C263-MLA-X-RGN-CR148_PT005-50002). This figure illustrates a straight line correlation between the stratigraphic units identified within each data point. The original deposit modelling identified 7 major stratigraphic units (Crossrail 2011). In this update to the deposit model only four of these major stratigraphic units are represented. These four units are summarised in the table below, and listed in stratigraphic order from the oldest to the most recent.

Stratigraphic unit	Lithology/Description	Chronology	Environment of deposition
Shepperton Gravel formation	Coarse grained sands and gravels	Late Devensian, c 18–15,000 BP	Cold climate braided river regime
Late Glacial to mid Holocene channel fill complex	Sands and silts, often laminated, organic muds, peat lenses	Late Glacial to mid Holocene 15–3,000 BP	Freshwater single thread meandering channel
Wetland peats	Wood and reed peats, organic muds	Neolithic to Bronze Age *c* 5–3000 BP	Alder carr floodplain woodland, reed swamp and marshland
Alluvium	Gleyed clays and silts	Iron Age to historic, *c* 2000 BP	Overbank flood deposits and intertidal muds

Table 2 Summary of stratigraphic units

An important aspect of the vertical deposit succession is the identification of the pre-Holocene surface. This is essential in defining the major landforms present within the floodplain that may have influenced later sedimentation rates, depositional environments, and landscape development and by consequence areas of anthropogenic activity. In the case of the present study area, by plotting the surface of the basal Pleistocene gravels and earlier Tertiary deposits an indication is given of the undulating topography which existed at the beginning of the Early Holocene (*c* 10,000 BP) (Figure 3 Buried topography of the Early Holocene). This is achieved by

transferring the Rockworks data to Arc GIS v.10 where the Spatial Analyst module is used to generate a surface plot.

7.3 Reliability of the model

Along the line of the portal itself the spread of geotechnical data within the previous deposit model (MOLA 2011) gives a good representation of the nature of the deposits and topography. The present data set forms a South-East to North-West linear spread, allowing the deposits to be characterised along what is essentially a single vertical slice. This results in a reliable model within the site area and to the east and west but reduced reliability at the far north of the site due to the lack of geotechnical data from beyond the site; however the inclusions of boreholes to the north-west and south east of borehole 9 in the model should limit any issues. This is particularly relevant when trying to attribute an orientation to the channel features identified within LZ3 but is mollified by the addition of the additional points added as part of this and previous updates. The monitored works has helped to outline the channel edges and channel orientation (LZ3).

8 Results

See Figure 2 Distribution of data points for borehole locations.

8.1 Borehole 7

Photo 1 Borehole 7 Looking East

Borehole 7					
Location				Plumstead Depot	
London Grid coordinates				95963.465 33290.342	
Surface Level (m ATD)				101.5	
Holocene natural observed (alluvium/peat)				101	
Pleistocene natural observed (gravels)				95.95	
Top (m)	**Base (m)**	**Top (m ATD)**	**Base (m ATD)**	**Description**	**Interpretation**
0.00	0.50	101.50	101.00	Brick rubble and builders crush	Pilling Mat
0.50	1.00	101.00	100.50	Grey brick and light reddish brown clay	Weathered historic alluvium

1.00	1.95	100.50	99.55	Firm light yellow brown clay with frequent iron staining	Made ground.
1.95	2.00	99.55	99.50	Firm blue grey silty clay	Historic estuarine alluvium
2.00	2.30	99.50	99.20	Large concrete and brick fragments	Backfill (due to poor retrieval)
2.30	3.00	99.20	98.50	No retrieval , hole collapsed and water pressure broke liner	Backfill (due to poor retrieval)
3.00	3.35	98.50	98.15	Wet soft mixed dark blue grey fine slightly sandy silt clay	Late glacial to mid Holocene channel complex
3.35	3.45	98.15	98.05	Light yellowish grey silty fine sand	
3.45	3.65	98.05	97.85	Loose wet light blue grey slightly silty medium to coarse sands with occasional rounded to subrounded medium gravels	
3.65	3.82	97.85	97.68	Very compact light blue grey slightly silty medium sand	
3.82	3.95	97.68	97.55	Mid orangey brown compact clayey fine to medium sand with occasional fine to medium gravels	

3.95	4.00	97.55	97.50	Mid orangey brown wet silty clay with rare medium subrounded sand	
4.00	4.85	97.50	96.65	Coarse beige sand with medium subrounded gravels	
9.00	5.00	92.50	96.50	Coarse orangey brown sands and medium to coarse subangular to subrounded gravels	
5.00	5.35	96.50	96.15	Fine gravels and occasional medium subangular to subrounded gravels	
5.35	5.55	96.15	95.95	Coarse sand	
5.55	6.00	95.95	95.50	Medium subangular to subrounded gravels and coarse sands	Pleistocene River Terrace Gravels

8.2 Borehole 8

Photo 2 Sediment cores during recording

Plumstead Depot (XSW11) Borehole 8					
Location				Plumstead Portal	
London Grid coordinates				95963.465	33290.342
Surface Level (m ATD)				101.5	
Holocene natural observed (alluvium/peat)				100.74m ATD	
Pleistocene natural observed (gravels)				95.94m ATD	
Top (m)	Base (m)	Top (m ATD)	Base (m ATD)	Description	Interpretation
0.00	0.45	101.50	101.05	Pilling mat	modern ground surface

0.45	1.70	101.05	99.80	Soft mid yellowish brown iron stained silty clay	Weathered historic alluvium
1.70	1.87	99.80	99.63	Soft blue grey clay	Weathered alluvium
1.87	2.05	99.63	99.45	Very dark brown-black well formed peat, very slightly silty	Wetland
2.05	3.12	99.45	98.38	Soft mid reddish brown oxidising to dark reddish brown peat with occasional plant fragments	
3.12	3.18	98.38	98.32	Gritty very dark grey highly organic silt	
3.18	3.40	98.32	98.10	Wet loose tan/green medium sands and small angular gravels	Late glacial to mid Holocene channel complex
3.40	3.55	98.10	97.95	Compact mid grey brown slightly silty coarse sands	
3.55	3.70	97.95	97.80	wet loose mid grey brown silty medium sand with occasional small rounded gravels	
3.70	3.90	97.80	97.60	Firm light yellowish grey compact fine sandy silt	
3.90	4.00	97.60	97.50	Firm mid light orange brown slightly silty medium sand	
4.00	4.30	97.50	97.20	Light brownish orange sandy silt	
4.30	4.70	97.20	96.80	Light brownish orange silty sand with rare fine gravels	
4.70	5.00	96.80	96.50	Light brownish orange fine to small sub angular to sub rounded gravels in filed with coarse sands	River terrace gravels

8.3 Borehole 9

Photo 3 Borehole 9 during drilling looking east

Borehole 9					
Location				Plumstead Depot	
London Grid coordinates				96192.11 33569.95	
Surface Level				105.80m ATD	
Holocene natural observed (alluvium/peat)				99.20m ATD	
Pleistocene natural observed (gravels)				Not Observed	
Top (m)	Base (m)	Top (m ATD)	Base (m ATD)	Description	Interpretation
0.00	1.30	105.80	104.50	Mid blue grey sandy silty clay with mortar and cbm fragments	Made ground
1.30	2.00	104.50	103.80	Loose black clinker	Made ground
2.00	3.00	103.80	102.80	Loose mid grey brown sandy loam and yellow and pink brick fragments	Made ground

3.00	4.00	102.80	101.80	Clinker , sandy loam and pink brick fragments smelly	Made ground
4.00	5.00	101.80	100.80	Loose grey clinker with large fragments of yellow brick , red brick, granular mortar and broken glass	Made ground
5.00	6.60	100.80	99.20	Silty brick rubble	Made ground
6.60	7.00	99.20	98.80	stiff firm blue grey silty clay	Alluvium

Borehole collapsed back to 5.40m and further drilling caused an obstruction to be pushed into hole and the borehole refused at 7.00m BGL.

9 Discussion

9.1 Landscape zones

Three major landscape zones were identified in the previous deposit model (Crossrail 2013c). The topographic plot of the early Holocene surface (Fig 3) indicates the form of the landscape features and the landscape zones (Fig 4) clearly define the likely boundaries of the differing areas of potential. These were:

LZ1 consisting of outcropping Tertiary deposits and gravel units that form the high ground of the valley sides and is unchanged from the previous deposit model and exists c. 600m outside the western boundary of the site (Crossrail 2013c).

LZ2 defining the typical Thames Holocene floodplain succession, characterised by Late Pleistocene/Early Holocene basal sands and gravels, overlain by prehistoric wetland peats, and sealed by late prehistoric to historic estuarine deposits and shows some slight changes from the previous deposit model (*ibid*).

LZ3 characterising a complex set of deposits in filling a large palaeochannel feature of Early to mid-Holocene date and shows some slight changes from the previous deposit model (*ibid*).

Changes to these landscape zones in respect to the monitored boreholes and window samples are discussed in greater detail in the sections below.

9.2 High ground of the valley sides (LZ1)

LZ1 is located c 700m from the western end of the Plumstead Depot site. It consists of an area of high ground with an elevation ranging from c 106m ATD in the west sloping eastwards to c 102m ATD. This higher relief topography is created by raised Tertiary deposits consisting of the Woolwich Beds, underlain by Thanet sands. This zone is covered in detail in the original deposit model (Crossrail 2011) but does not lie within the Plumstead Depot area.

9.3 Prehistoric peats and wetland floodplain deposits (LZ2)

9.3.1 Late Pleistocene / Early Holocene (18,000 - 15,000 BP)

LZ2 covers the very western limits and portions of the eastern end of the Plumstead Depot area. It defines a zone of alluvial/fluvial sediments and organic wetland deposits mainly associated with the Holocene floodplain. BH8 falls within the eastern end of this zone, to the limits of this landscape zone and LZ3 (Figure 4 Landscape zones).

The basal deposits noted consist of coarse sandy gravels that can be attributed to the Late Devensian Shepperton Gravel formation (Gibbard, 1994). The main phase of aggradation for these sediments occurred between 18,000 to 15,000 BP following

the Last Glacial Maximum of the Dimlington stadial. The sediments are indicative of a cold climate braided river regime, which consisted of higher relief channel bar macroforms interspersed with low lying multiple channel threads. The irregular gravel topography created by the mosaic of gravel bars and low lying channel threads influenced later channel patterns and morphology across the floodplain.

The surface of this undulating gravel topography lies at 96.8m ATD within BH8. The sedimentary records note an accumulation of sands and fine silts above the gravels. As noted in previous works the silty sands appear to grade down into gravel and sands of the underlying Shepperton Gravels. This indicates a continuous phase of sedimentation, albeit within a channel system where stream power, sediment supply and discharge rates were reduced. The channel complex deposits were encountered from 98.32m ATD.

These Late Glacial/Early Holocene interface sediments reflect a change in the fluvial conditions and channel morphology influenced by climatic forcing and amelioration (Törnqvist, 2007). During this time the Thames would have adopted fewer channels within a partially braided channel system. With continued climatic stabilisation into the Early Holocene, and an overall reduction in discharge into the fluvial system many of these former channel threads will have become isolated and formed pools of standing water and marshy areas across the floodplain surface.

One lithic was recovered from the surface of the sands during the Plumstead Portal evaluation and the context samples for further lithic recovery (Crossrail 2013a, C263-MLA-X-RGN-CR148_PT005-50002). In addition, a possible Early Holocene soil horizon with charcoal inclusions was identified and sampled for micromorphology.

9.3.2 Mesolithic (12,000 - 4,000 BC)

Across the majority of this zone it is likely that the gravel and sand deposits formed a fully terrestrial land surface by the Mesolithic period. Within Plumstead Depot these land surfaces would have formed atop bank and mid-channel bars, part of the silts and sand of the channel complex sediments. By the Early Neolithic this dry floodplain surface would have begun to experience the upstream impact of allogenic forcing (i.e. Holocene climate change, and relative sea level rise) on the lower Thames basin. Previous time depth estimates for this process of increased ground waterlogging due to rising sea level have suggested that by 5,600BP land surfaces above 97–96m ATD started to become waterlogged (Stafford et al 2012, Bates and Whittaker 2004). The ‘ponding back’ effect of rising sea levels in the lower Thames estuary, caused ground waterlogging in the upper freshwater reaches of the basin, leading to widespread peat formation by a process of paludification.

9.3.3 Neolithic to Bronze Age (4,000-600 BC)

A peat unit is recorded within BH8. Previous work suggests that it is likely that pollen analysis will show that the lower part of the peat unit displays evidence of fully

terrestrial Neolithic woodland consisting predominately of oak, elm and hazel. The upper part of the peat, which is commonly dated to the Bronze Age, may represent a transition to wetter floodplain woodland dominated by alder with some oak still surviving but this needs confirming (Sidell et al, 2000, Grant et al, 2011).

Within BH8 the peat measures 1.31m thick from 99.63m ATD. This compares well with previous records from the northern part of LZ2 and the Plumstead Portal area where this peat unit measures between 0.05 and 2.3m in thickness, with the upper horizon occurring between 99–100m ATD. The log descriptions from similar deposits in the adjacent Portal site commonly describe this as humic clay to woody and fibrous peat, suggesting a varied formation within stagnant backwater pools and densely wooded floodplain environments. The Plumstead Portal evaluation trenches recorded worked timbers (Crossrail 2013a, C263-MLA-X-RGN-CR148_PT005-50002) which may have formed parts of structures such as trackways, bridges, platforms and jetties constructed to access and traverse the wetlands. Two Neolithic timber structures were also recently discovered c 400m to the north of the portal within the grounds of Belmarsh prison. One of these structures was thought to be a north to south aligned trackway, and may have been linking up to the higher ground of the Tertiary outcrops just to the south of the portal footprint.

The sediment logs across this zone record a gradual transition from Neolithic/Bronze Age peat formation to alluvial minerogenic sedimentation from about 99m ATD, with the Plumstead Depot logs suggesting 99m to 100m ATD. This marks a switch to fully estuarine conditions, and the formation of mudflat or saltmarsh environments within an intertidal zone.

9.3.4 Iron Age (650 BC)

During the Iron Age the majority of the floodplain became fully intertidal, with woodland cover now restricted to the drier interfluves and raised terrace (Sidell et al, 2000, Wilkinson, 2000).

This estuarine inundation continued into the historic periods, gradually raising and levelling the flooding surface and removing any topographic relief that remained. As the surface topography was raised regular tidal inundation became less frequent and tidal mudflats gradually transformed into seasonally inundated floodplain soils. Previous deposit models suggested that the alluvial deposits do not survive in any of the LZ2 Plumstead Depot's interventions and they may have been truncated during the historic period (Crossrail 2013c). However, BH8 does record 1.87m of surviving alluvial clay from 101.5m ATD. In some areas possible historic tidal creeks may have eroded away the clay deposits.

9.3.5 Modern (1800 AD –present)

Overlying all sediments across the Plumstead Depot area was a series of dumps and make-up layers from 2m to 6.8m thick, the area is shown on historic maps as being

vacant until after the Second World War when there is some suggestion of industrial use (refuse or slag heap) and modern remediation and ground works (Ground Contamination Assessment Doc No. C122-OVE-T1-RGN-CR148-50001). The layers of made-ground generally heterogeneous in nature and in most areas are for the purposes of making up and levelling were consequently removed and replaced with a piling mat.

9.4 Channel feature (LZ3)

LZ3 represents a major feature within the floodplain landscape that covers the majority of the western half and eastern edge of Plumstead Depot area. BH7 and BH9 lie within LZ3. However, BH9 was unable to reach the basal deposits despite numerous attempts at redrilling due to the extremely loose and unconsolidated nature of the made ground which in this area was of significant depth in comparison to BH7 and BH8 .This means that the presence of the channel arm cannot be conclusively proved in this location.

Although the height of the alluvium is significantly lower in this area, it may hint at the possibly of channel activity in this area, but the poor nature of recovery means this is only a possibility. Although minor channels and creeks of unknown chronology are likely in LZ2, the fills of these ‘discrete’ features are largely indistinct from the alluvial intertidal deposits. LZ3, in comparison forms a large incised meander plain measuring in excess of 200m across, in-filled with a complex set of variable deposits. The topographic plot of the early Holocene surface (Fig 3) indicates the form of this feature and the landscape zones (Fig 4) clearly define its likely boundaries. A small cluster of boreholes aligned north to south within this zone, indicate that this channel feature may extend on a roughly north to south axis. This and the previous Plumstead Depot work confirm this rough alignment but adds more detail and suggests other channel routes.

This feature undoubtedly formed a major part of the floodplain landscape from the Early Holocene, and probably became a major route of drainage when the other early Holocene channels became abandoned. The basal sediments within this channel fill complex consist of relatively coarse silts and sands, then becoming more variable and difficult to correlate higher in the profile. The fluvial bedding of silts and sands are visible in the window sample core BH7, and to some degree BH8. The full depth of the channel fills measure from 1 to 4m thick in the Plumstead Depot area generally and within BH7 2.55m thick from 98.5m ATD.

The previous deposit model (Crossrail 2011) associated the north to south alignment of the channel feature with a tributary channel running off the higher ground towards the south, the ‘Great Breach Dyke’. It is possible that the channel defined within LZ3 forms an abandoned arm of a former course of the Great Breach Dyke, which existed from the Early Holocene into the Bronze Age period. Interestingly a large palaeochannel was also identified on the Belmarsh site also flowing on a north south axis. This could lead to speculation that the Belmarsh channel and the LZ3 channel

are associated.

Across the wider area the complex of channel fills is overlain by peat deposits which measure up to 1.4m in thickness with an upper surface occurring between 99 and 100 m ATD. These peats are likely to be contemporary with the Bronze Age peat formation in LZ2, given the similar elevation. However, whereas the peats within LZ2 formed as a result of allogenic forcing and resultant paludification, the peats across LZ3 may have developed by a different agency driven by the formation, action and migration of the channels in this area. Detailed palaeoenvironmental analysis specifically pollen, diatom and ostracod analysis will be able to investigate the different agencies involved. Even considering the Plumstead Depot' data the peats previously identified at Plumstead Portal (Borehole 4, Crossrail 2013a, C263-MLA-X-RGN-CR148_PT005-50002) are still considered very low, with a base at 97.07m ATD and may indicate very early abandonment of the eastern fringe of the channel. Radiocarbon dating of this unit should be a priority in order to provide a chronology for the channel fill complex. However, no peats survive within either Bh7 or BH9 and the only peats identified within these works were to edge of LZ3 within the limits of LZ2. Generally the peats uniformly seal the channel fills and suggest that the channel finally became completely abandoned. Eventually this peat formation ceased, as the zone was inundated by intertidal muds. Intertidal and alluvial clays are evident in BH7 and BH9. Up to 2.5m of weathered clay was recorded within BH7 from 101m OD. The characteristics and chronology of these intertidal deposits are consistent with that recorded in previous deposit models (Crossrail 2013c), where these alluvial units measure up to 2m in thickness from *c.* 101m ATD.

This feature was a major waterway and would therefore have provided a useful means of transport and access through the wetlands and out into the wider Thames estuary. Despite a moderate to high potential for timber structures and artefacts associated with river management and exploitation only one worked timber was located during the evaluation at the adjacent Plumstead Portal (Crossrail 2013a, C263-MLA-X-RGN-CR148_PT005-50002).

This work has added some detail to the possible form and course of this early Holocene channel. Three main routes appear to be indicated (CH1 to CH3, Figure 3 Buried topography of the Early Holocene) and were separated by two in channel bars located on higher areas of gravel (GB1 and GB2, Figure 3 Buried topography of the Early Holocene). The widest route appears to be the western (CH1) within the early Holocene multi-channel system or a later meandering network of channels.

10 Statement of potential archaeology

Excavation on the Plumstead Portal site, adjacent to the Plumstead depot site, has already shown that there is good geoarchaeological survival of early prehistoric to historic alluvial sediments. The Plumstead Depot site, and specifically the deposits within BH8, will undoubtedly add to the potential information already provided by recorded sequences and retained samples from the Plumstead Portal evaluation and geoarchaeological boreholes, thus furthering understanding of the sub-surface deposits in the Late East Crossrail route and the Plumstead Depot site.

Although good sequences have been limited to the south-eastern edge of the Depot site (BH7 and BH8) any sequences recorded or sediments sampled in LZ2 (BH8) have a high potential for palaeoenvironmental and topographic evidence. The peats and organic deposits will preserve pollen and plant macro fossils useful for past landscape and palaeoecological reconstruction on both an intra and inter site basis, and provide dating material to ascertain a chronological framework. The minerogenic deposits will preserve molluscs, ostracods, diatoms and foraminifera which can be utilised to reconstruct the fluvial depositional environments and identify the transition from freshwater to brackish river systems.

The channel fills and overlying deposits within the channel (LZ3, BH7) towards the south-central area of the site, provides a thick deep sequence but is predominantly sands and clays. Therefore, the potential preservation of a long record of palaeoenvironmental change extending back to the early part of the Holocene is relatively low. In addition these highly active parts of the channel are more likely to have reworked and disturbed earlier sediments, giving less resolution and reliability to palaeoenvironmental reconstructions.

A considered assessment of sequences and samples recovered from the Depot site need to be carried out in conjunction with other sample sets taken from Plumstead Portal and different alluvial sites along the Late East route. This will allow a targeted approach to the investigation of distinctive deposit sequences. Once all fieldwork has been completed samples sets can be selected for further work based on topographic location, likely chronological resolution and deposit succession variations.

The timbers from the adjacent Plumstead Portal site and at Belmarsh Prison to the north of the site illustrate the potential for future recovery of worked wood and the remains of wooden structures from the Plumstead area in general. Plumstead Portal provided some evidence for woodworking but left little potential for the detailed study of tool marks or comparisons with woodworking technologies identified on other sites in the area, such as at Belmarsh Prison. In addition, there was little potential to recover remains of wooden structures within the borehole works on the Plumstead Depot site. Therefore, any future works in adjacent sites may provide further remains that have the prospect to inform on these wood working technologies in addition to nature of wood selection by humans and even past woodland management.

The archaeological remains are assessed as being of local significance in terms of the development of this part of London, increasing to regional significance when

placed within the wider context of the Late East data set.

11 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).

The accurate assessment of the resource is dependent upon the processing and assessment of the samples taken. At this time, their principle significance would appear to be as part of the wider geo-archaeological investigations in this part of the Crossrail project, where they might have a direct impact upon interpreting prehistoric and medieval landscapes.

12 Recommendations for appropriate mitigation strategy

It is recommended that the assessment, analysis of the geoarchaeological samples and the publication and dissemination of the results of the analysis will provide appropriate mitigation for this site.

13 Publication and dissemination proposals

Evaluation 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 from Plumstead Depot will also be included in the East Area Geo-archaeology Report (CRL12), where two specific themes from Sect 5.7 of the Crossrail Central Archaeology Updated Project Design for Post-excavation Works (Doc No. CR-XRL-T1-STP-CR001-50001 will be addressed.

14 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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16 Acknowledgements

The fieldwork was commissioned and managed for Crossrail by [redacted] and [redacted]

All geoarchaeological investigations were supervised by the author. The MOLA Contracts Managers were Elaine Eastbury and Michael Smith.

17 NMR OASIS archaeological report form

1 OASIS ID: molas1-179282

Project details	
Project name	C263 ARCHAEOLOGY LATE EAST Fieldwork Report Geoarchaeological Evaluation Plumstead Depot XSW11
Short description of the project	This report covers three geotechnical boreholes carried out by the Museum of London Archaeology (MOLA) on the site of the future Crossrail Plumstead Depot, by C263 Museum of London Archaeology (MOLA). The report was commissioned from MOLA by Crossrail Ltd. The fieldwork was carried out between 07/04/14 and 08/04/14 and supervised by MOLA Geoarchaeologist Jason Stewart. It was recorded under event code (sitecode) XSW11. Three window samples afforded opportunities to sample the alluvial sequence above Shepperton Pleistocene Thames gravel. A variable sequence was recorded across the site. The sequence within the windows samples on the site shows gravels and sands overlain by clays and sands then peats and sealed by alluvial clays. The elevation of the surface of the Pleistocene/Early Holocene confirms the previous deposit model of a series of braided river channels (LZ3) within a low lying area of the floodplain and separated or fringed by channel bars to later wetlands (LZ2). The northern, eastern and western extent of the channel has been refined by the variously sourced borehole and trench data. The channel is still estimated to be more than 200m wide and up c 3m deep. This feature formed a major part of the floodplain landscape from the Early Holocene, and probably became a major route of drainage and transport. It is possible that the channel forms an abandoned arm of a former course of the Great Breach Dyke, which existed from the Early Holocene into the Bronze Age period.
Project dates	Start: 07-04-2014 End: 08-04-2014
Previous/future work	Yes / Not known
Any associated project reference codes	xsw11 - Sitecode

Type of project	Field evaluation
Site status	None
Current Land use	Vacant Land 1 - Vacant land previously developed
Monument type	CHANNEL Mesolithic

Project location

Country	England
Site location	GREATER LONDON GREENWICH WOOLWICH Crossrail Plumstead Depot
Postcode	SE18
Study area	20000.00 Square metres
Site coordinates	TQ 545276 178949 50.9391876051 0.199651679772 50 56 21 N 000 11 58 E Point
Height OD / Depth	Min: -6.50m Max: 5.00m

Project creators

Name of Organisation	MOLA
Project brief originator	Crossrail
Project director/manager	Elaine Eastbury
Project supervisor	Virgil Yendell
Type of sponsor/funding body	Crossrail Ltd
Name of sponsor/funding body	Crossrail

Project archives

Physical Archive Exists?	No

Physical Archive recipient	LAARC
Digital Archive recipient	LAARC
Digital Media available	"Database","GIS"
Paper Archive recipient	LAARC
Paper Media available	"Notebook - Excavation',' Research',' General Notes"

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	C263 ARCHAEOLOGY LATE EAST Fieldwork Report Geoarchaeological Evaluation Plumstead Depot XSW11
Author(s)/Editor(s)	Yendell, V. Stewart, J.
Date	2014
Issuer or publisher	MOLA
Place of issue or publication	London
Description	Ring bound client report

Entered by	Jason Stewart (jstewart@mola.org.uk)
Entered on	3 December 2014

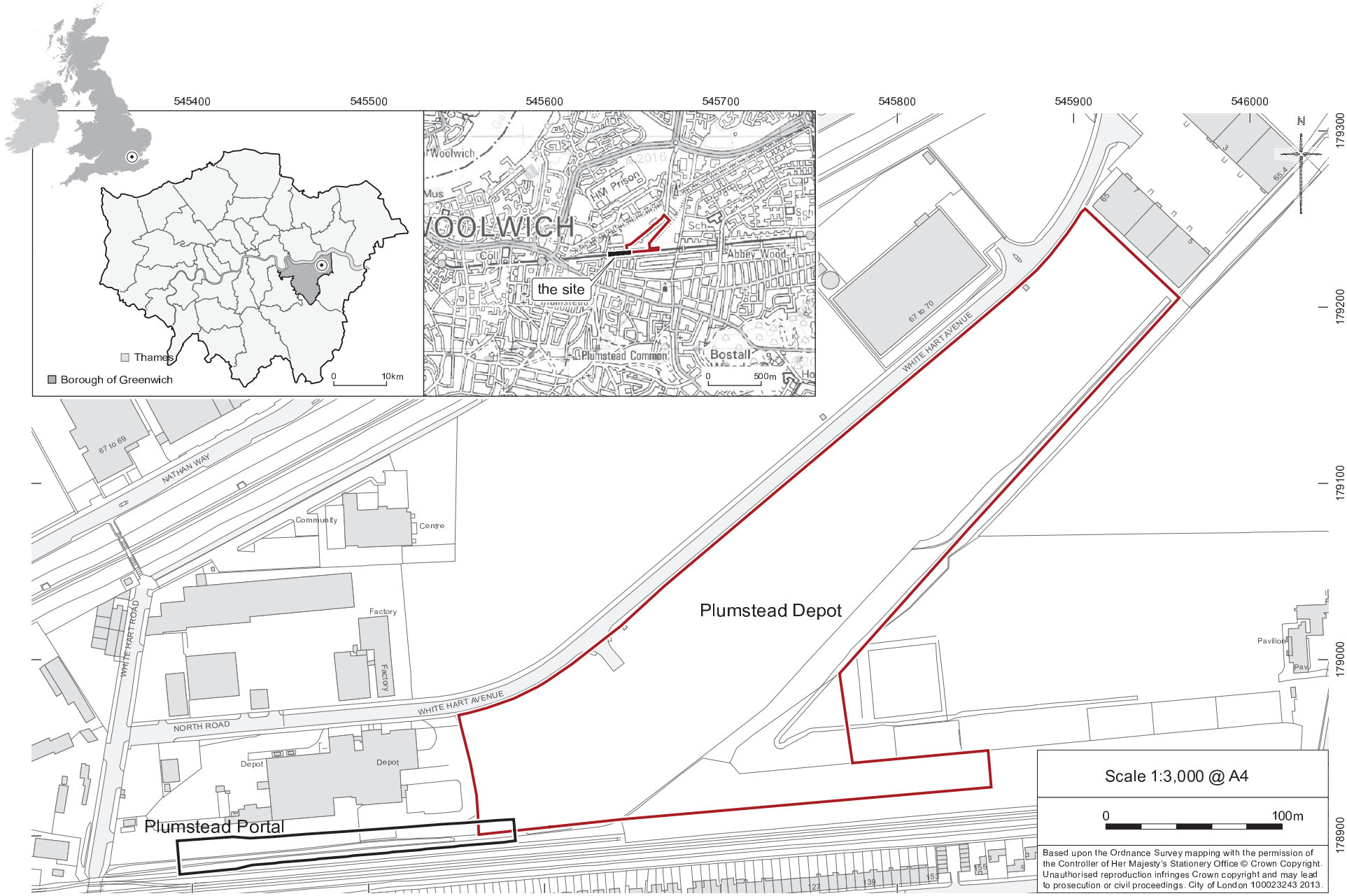

Fig 1 Site location

MULTI1051GEO13#01

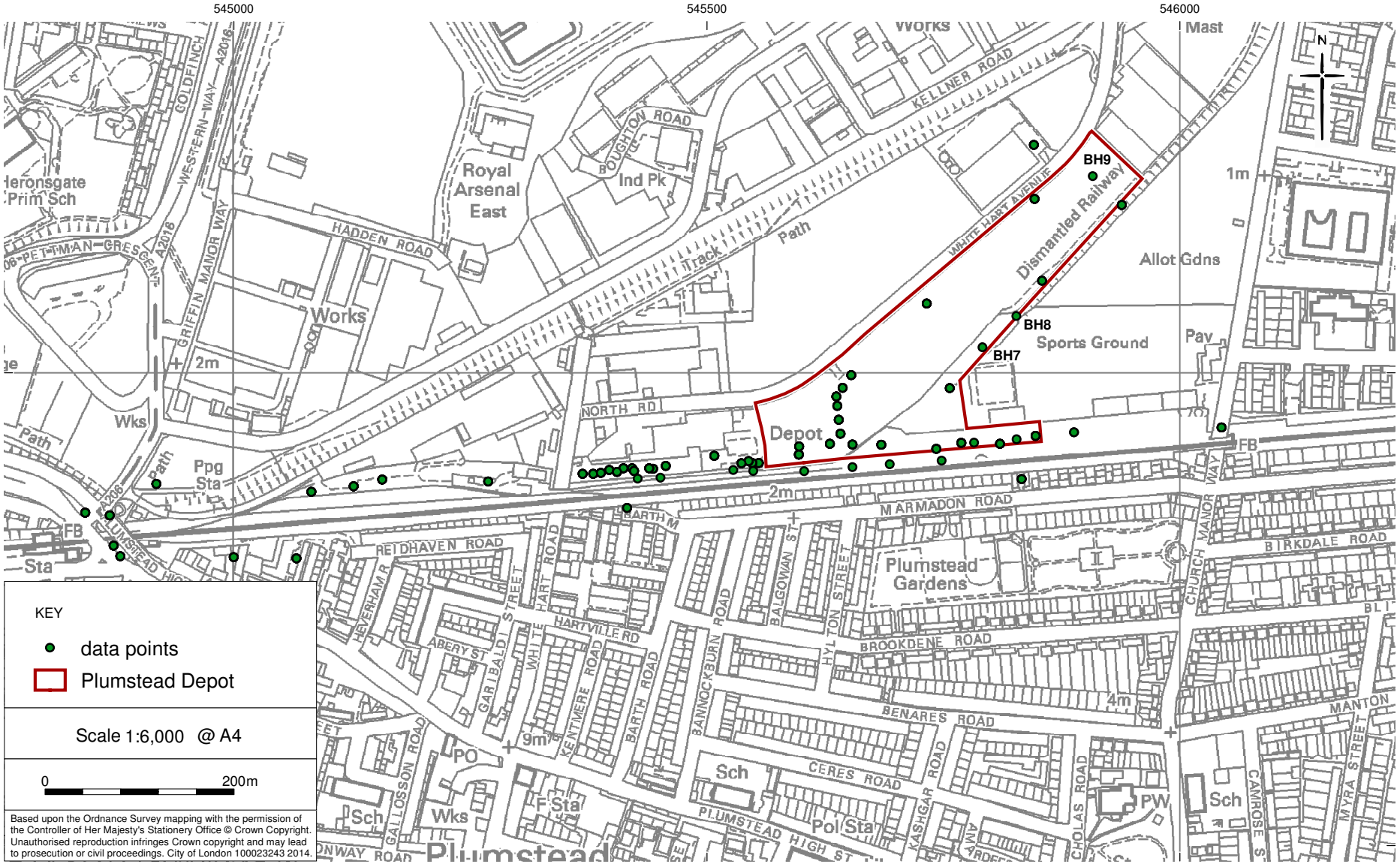

Fig 2 Distribution of data points

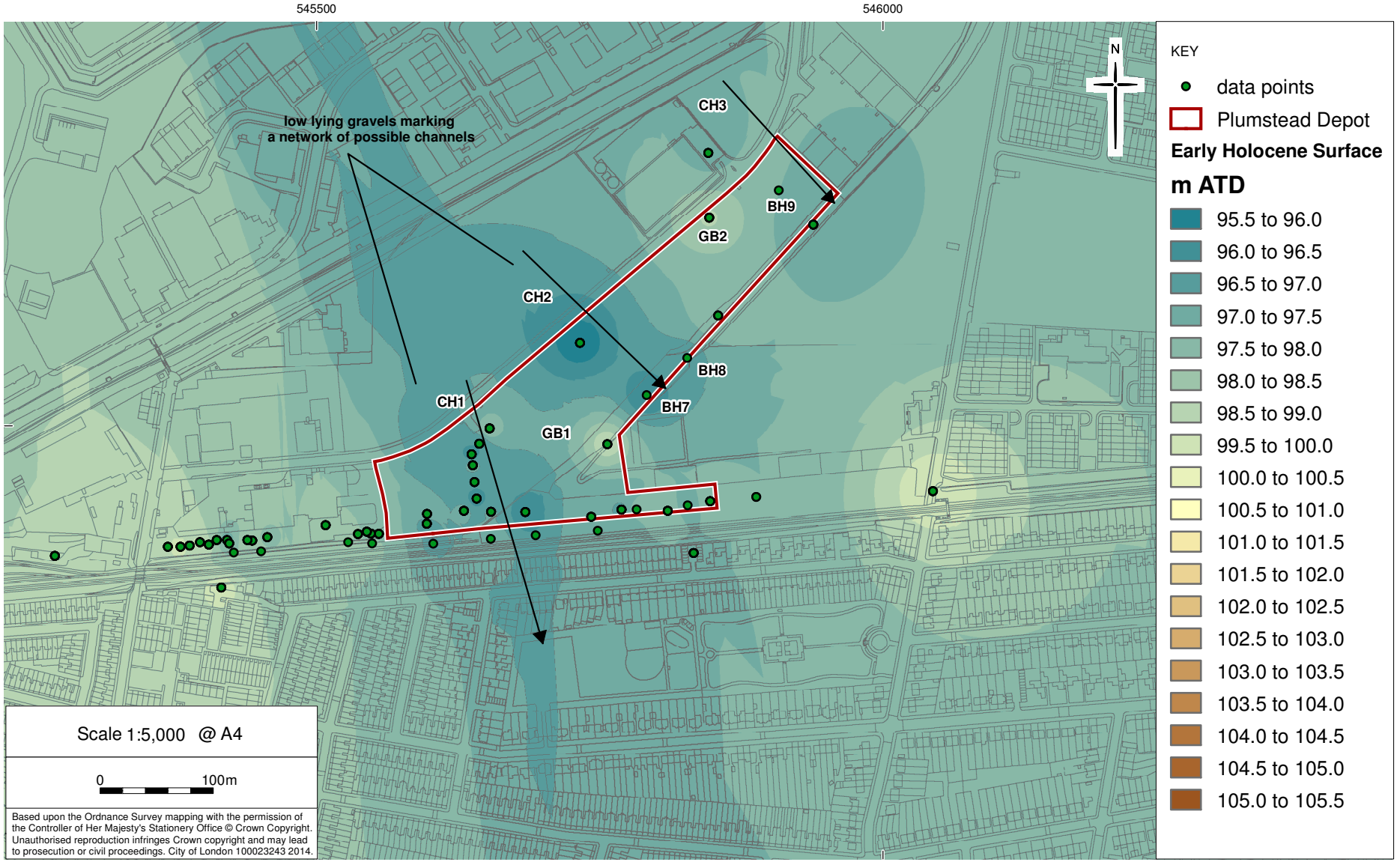

Fig 3 Buried topography of the Early Holocene

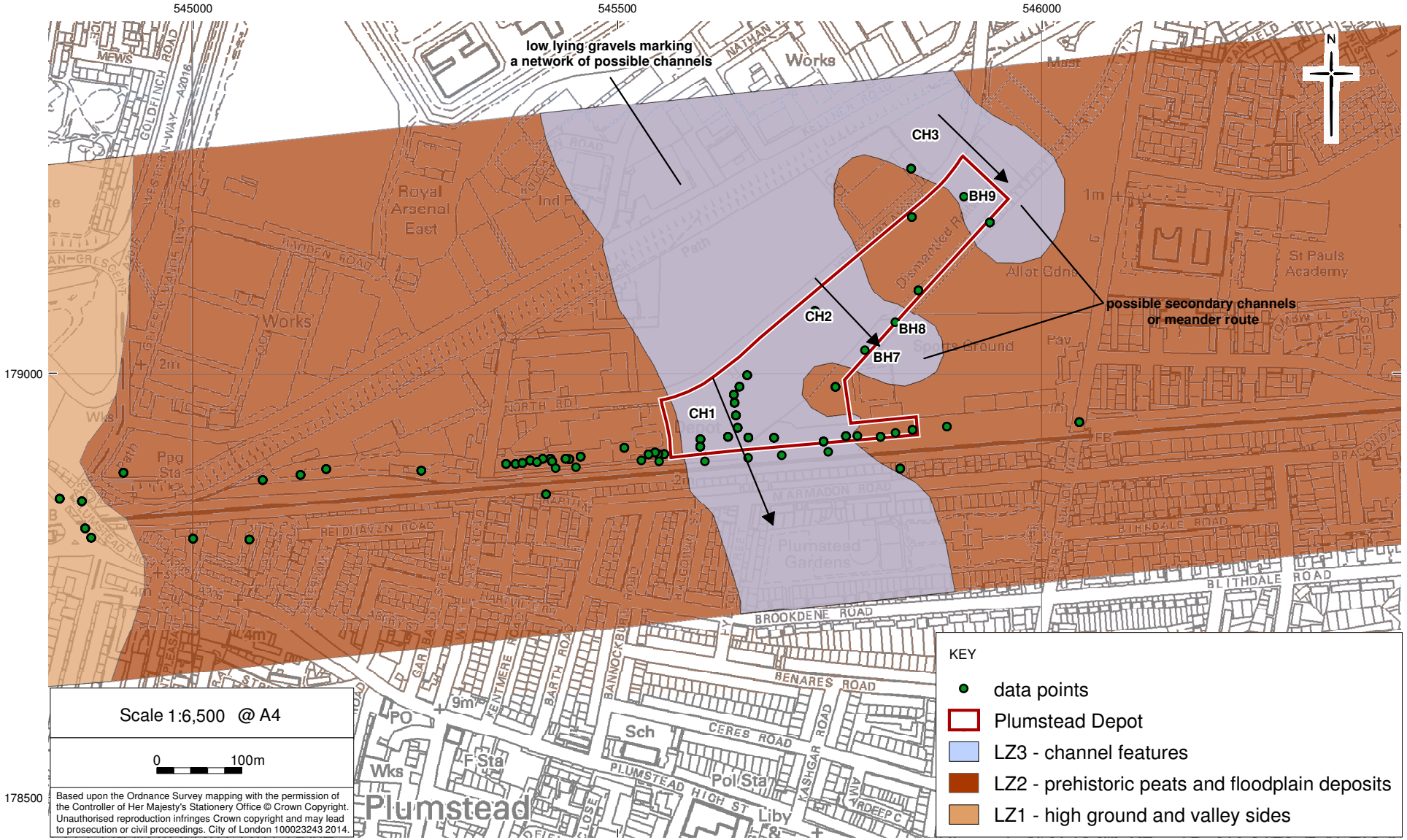

Fig 4 Landscape zones