



Package C152 Pudding Mill Lane Portal

Archaeology Site-Specific Written Scheme of Investigation

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Contents

1	Executive Summary	5
2	Project Background	7
2.1	Introduction	7
2.2	Site Description.....	7
2.3	Summary of Previous Crossrail Studies.....	9
2.4	Geology and Topography.....	10
2.5	Archaeological and Historical Development of the Site.....	11
3	Construction Impacts and Mitigation	17
3.1	Summary.....	17
3.2	Enabling Works (Stage 1).....	21
3.3	Advanced Works (Stage 2).....	22
3.4	Main Works (Stage 3).....	22
3.5	Main Works (Stage 4).....	23
3.6	Main Works (Stage 5).....	23
3.7	Outline Evaluation and Mitigation Design	23
4	Aims and Objectives	25
4.1	Research Aims	25
4.2	Objectives of the Investigation	26
5	Scope of the Investigation.....	27
5.1	Prior to Enabling Works (CRITICAL).....	27
5.2	Enabling Works	27
5.3	Advanced Works	30
5.4	Main Works	30
5.5	Non-Listed Built Heritage Assessment and Recording.....	31
5.6	Consultation	34
6	Programme	35
6.1	Introduction	35
6.2	Archaeological Investigation at Pudding Mill Lane	35
7	Specification for Evaluation & Mitigation (including Watching Brief)	37
7.1	Generic Standards	37
7.2	Health and safety	40
7.3	Location and ground elevation of interventions and survey grids	40
7.4	Specification for geo-archaeological investigation (coring and boreholes)	41
7.5	Specification for watching brief.....	42
7.6	Specification for archaeological investigation.....	48

7.7	Specific Requirements for the excavation of trial trenches or pits.....	51
7.8	Archaeological science	52
8	Deliverables	56
8.1	Archaeological Contractors Method Statement.....	56
8.2	Site Archives	57
8.3	Digital Data	57
8.4	Interim Statement.....	58
8.5	Survey Report.....	59
8.6	Trial Trench Evaluation and Watching Brief Reports	59
8.7	SMR/HER Summary Sheet	61
8.8	Summary Report	62
8.9	Post-excavation assessment.....	62
9	Site Monitoring & Progress Reports.....	63
10	Personnel requirements	64
11	References and glossary of terms.....	65
	Annex 1 – Plans and other illustrations.....	68
	Figure 1 Elements of the Pudding Mill Lane portal works	8
	Figure 2 1867 Ordnance Survey 1:2500 map	12
	Figure 3 Trench location plan (MoLAS-PCA 2008)	14
	Figure 4 EWMA Utility trial trenches.....	15
	Figure 5 Gravel topography identified in the draft geo-archaeological deposit model (Wessex Archaeology 2010)	16
	Figure 6 Pudding Mill Lane Worksite.....	20
	Figure 7 City Mill River Worksite	21

1 Executive Summary

The Crossrail Specialist Technical Reports: Assessment of Archaeological impacts (Part 1-6), published in February 2005 in support of the Crossrail Environmental Statement, identified the archaeological potential of the Pudding Mill Lane area and the potential impacts of the Crossrail Scheme.

Detailed Desk-Based Assessment (DDBA) has subsequently been undertaken for the main construction elements and associated worksites at Pudding Mill Lane.

The Pudding Mill Lane portal is located about 1km south-west of Stratford Station. The majority of the Crossrail works fall within the London Borough Newham, although a small area falls within the London Borough Tower Hamlets. Historically the area has been industrial since the mid 19th century and the industrial character of the area is still evident today with a wide range of small and medium sized light industrial premises. The Crossrail worksites comprise the Pudding Mill Lane worksite and associated 'satellite' worksites e.g. City Mill River worksite.

At Pudding Mill Lane the bored tunnel section of the Crossrail scheme finishes and the line rises to the surface in a cut and cover structure to link with the Great Eastern Mainline (GEML) tracks. The key Crossrail design elements at the Pudding Mill Lane are:

- Tunnel Boring Machine (TBM) chamber/Emergency Intervention Point (EIP) shaft;
- Cut and cover tunnel;
- Covered ramp;
- 4 Span underpass;
- New elevated station and retained railway embankment for the Docklands Light Railway (DLR);
- DLR viaduct;
- Bridges over Marshgate Lane, the Northern Outfall Sewer (NOS) and City Mill River (CMR);
- Up-line Electric Loop retaining wall;
- River Lea protection works;
- National Grid (NG) 400kV cable diversion works; and
- EDF 11kV cable diversion;

Each of these design elements has the potential to impact on archaeological deposits. At Pudding Mill Lane there is a high potential for palaeo-environmental evidence and Post-medieval industrial remains.

There is moderate to high potential for prehistoric settlement archaeology, such as preserved timber structures, cut features, land surfaces and associated palaeo-environmental evidence. There is a low potential for Medieval, early prehistoric, Romano-British and Saxon archaeology.



An archaeological evaluation was carried out in 2008 by MoLAS-PCA within Planning Delivery Zone 8 (PDZ8) of the Olympic, Paralympic and Legacy Transformations Planning Applications.

PDZ8 included four trenches located within the Crossrail worksites to the north-east of Pudding Mill Lane road. The evaluation identified prehistoric activity within the Crossrail worksites at Pudding Mill Lane.

A first draft geo-archaeological assessment and deposit model has been prepared by Wessex Archaeology based on Package 25 geotechnical and geo-archaeological borehole investigations. The results of the assessment have been used to update the evaluation and mitigation strategy in this WSI.

The archaeological evaluation will comprise a series of 5 trenches within the footprint of the Pudding Mill Lane worksite and will be carried out following demolitions as part of the **Phase 1** Enabling and Advanced Works.

The results of the field evaluations at Pudding Mill Lane will inform a strategy for archaeological mitigation comprising *preservation-by-record* (archaeological watching brief and/or excavation), which will be undertaken as part of the **Phase 1** Enabling and Advanced Works/Phase 2 Main Works.

A Level II English Heritage Survey of Marlborough House/Gate House and the adjacent north-east light shed building was carried out by Wessex Archaeology prior to demolition. The report for this survey is currently in preparation.

Targeted Watching Brief will be carried out on the western side of the River Lea to record surviving elements of the River Lea Wall and wharf. Targeted Watching Brief is also required at the excavation of the NG 400kV cable trough and jointing pit; and during ground lowering in advance of piling the DLR Station.

A general watching brief carried out on Enabling Works Managing Agent (EWMA) utility test trenches along Barbers Road identified surviving alluvial deposits and post-medieval red brick structural remains possible relating to the former Soap Works. Further General Watching Brief is required during Enabling and Advanced Works at the EDF 11kV cable diversion; realignment of Barbers Road and associated service diversions.

Initial consultation has taken place with David Divers of the Greater London Archaeological Advisory Service (GLAAS) with regard to the archaeological strategy at the site and will continue as the methodology develops.

Enabling Works commence in April 2010. Main Works are programmed for March 2011 to February 2016.

2 Project Background

2.1 Introduction

2.1.1 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/the-railway/getting-approval/parliamentary-bill/environmental-minimum-requirements-including-crossrail-construction-code>). The requirements being progressed follow the principles of Planning Policy Guidance Note 16 on archaeology and planning (1990). Accordingly the nominated undertaker or any contractors will be required to implement certain control measures in relation to archaeology before construction work begins.

2.1.2 The strategy for archaeological works has been set out in the Crossrail Generic Written Scheme of Investigation (WSI) (Doc no. CR-PN-LWS-EN-SY-00001). The Generic WSI presents the strategy for archaeology design, evaluation, mitigation, analysis, dissemination and archive deposition that will be adopted for the design and construction of Crossrail and provides a general statement of objectives, standards and structure for the planning and implementation of archaeological works.

2.1.3 This site specific WSI addresses the works required for Pudding Mill Lane portal.

2.2 Site Description

2.2.1 The proposed Pudding Mill Lane portal site is located immediately east of the River Lea primarily in the London Borough of Newham about 1km south-west of Stratford Station. It lies in close proximity to the southern part of the London 2012 Olympic site and less than 1km from the main Olympic stadium. Liaison between Crossrail and the Olympic Delivery Authority (ODA) has been ongoing, resulting in a coordinated design approach at Pudding Mill Lane.

2.2.2 The area is crossed by existing infrastructure including rail lines, roads and rivers. The Great Eastern Main Line (GEML) railway embankment site lies immediately to the north of the portal site and carries rail services into and out of Liverpool Street. There is also an existing Docklands Light Railway (DLR) station at Pudding Mill Lane (PML) located on the GEML embankment.

2.2.3 Rivers and watercourses enclose the Pudding Mill Lane area to the east, west and south. The River Lea is to the west – a canalised navigable tributary of the Thames - and City Mill River to the east, are part of a system of tidal and semi tidal waterways that feed into the River Lea Navigation.

2.2.4 Historically the area has been industrial since the mid 19th century when mills and factories were established close to numerous waterways. The industrial character of the area is still evident today with a wide range of small and medium sized light industrial premises but the area is already changing significantly with large parts of the surrounding area cleared for Olympic construction.

2.2.5 At Pudding Mill Lane the bored tunnel section of the Crossrail scheme finishes and the line rises to surface in a cut and cover structure to link with the Great Eastern Main Line (GEML) tracks (see Figure 1). The key elements of the permanent works for Pudding Mill Lane portal comprise:

- a cut and cover tunnel;
- a covered portal ramp structure;
- an Emergency Intervention Point (EIP);
- a 4-span underpass; and
- bridges over Marshgate Lane, the Northern Outfall Sewer (NOS) and City Mill River.
- Protection works for the River Lea, which involves construction of a coffer dam to allow tunnel excavation under the river.
- The DLR tracks will be realigned and a new station provided to the south of the existing station.

2.2.6 Also included will be a relocated station and retained railway embankment for the DLR and a new retained railway embankment for the Great Eastern Main Line (GEML) up electric loop.

2.2.7 Other design elements include the diversion of National Grid 400kV cable circuits, and the EDF 11kV cable circuits, local highway reconfiguration, landscaping and drainage.

2.2.8 The location of the Crossrail works at Pudding Mill Lane shown in Figure 1 below and Drawing Number C152-SWN-C2-DDA-CR094_PT002_Z-95002 (Annex 1).

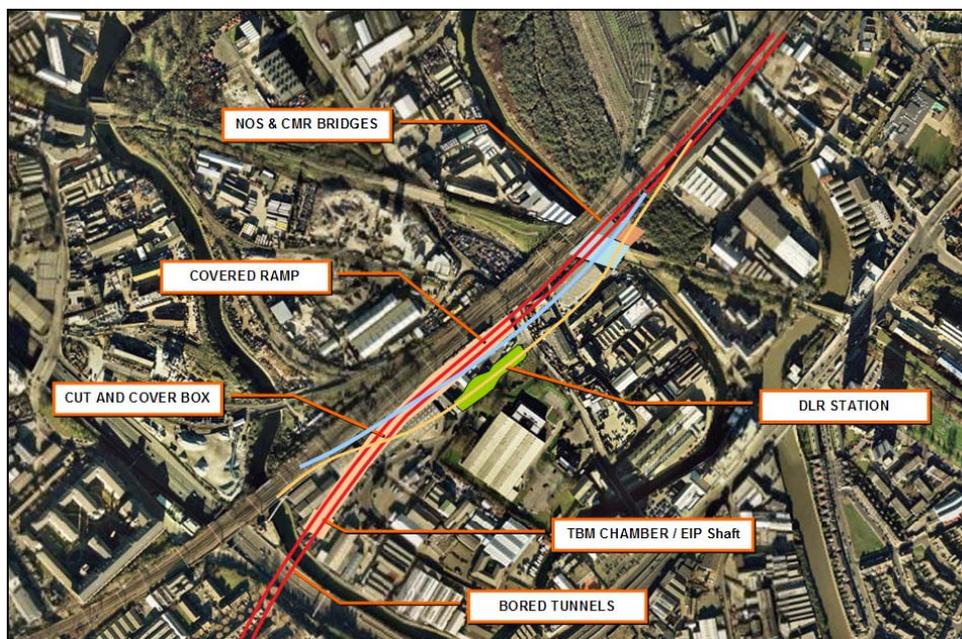


Figure 1 Elements of the Pudding Mill Lane portal works

2.2.9 The Crossrail works at Pudding Mill Lane will be located within the Pudding Mill Lane worksite and associated 'satellite' worksites e.g. City Mill River worksite. The Pudding Mill Lane worksite will serve the construction of the cut and cover box and realignment of Barbers Road and will be bound to the west by the River Lea, to the north by the DLR

alignment and to the south by the Olympic site offices off Barbers Road. The existing Barbers Road will be closed to the public and will form part of the worksite. Site offices will be established on the site of the former Marlborough House, now demolished. This worksite will continue to be used for the main works after completion of the advanced works.

2.2.10 The City Mill River satellite worksite will be required for the construction of the above ground bridges over City Mill River. There is no direct access to the City Mill River area from the Pudding Mill Lane worksite due to the Northern Outfall Sewers (NOS) which are located in a raised embankment and form a barrier for plant access. The only road access is off Warton Road and Bridgewater Road.

2.2.11 A further worksite area will be established at the River Lea. The Crossrail bored tunnels will be constructed under the River Lea with low cover to the existing river bed. Therefore some form of protection to the river during the tunnel drives is required. It is currently proposed to construct a concrete protection slab from inside temporary cofferdams built within the river. The existing river bed would be dredged and replaced with concrete pumped in from the river bank. There is a requirement to maintain navigation of the River Lea at all times, so the works will be split into two halves with a temporary cofferdam installed on the eastern side of the River (London Borough Newham) followed by one on western side (London Borough Tower Hamlets).

2.3 Summary of Previous Crossrail Studies

2.3.1.1 Desk Based Work

2.3.2 The general archaeological potential in the area of the Crossrail worksites for Pudding Mill Lane portal is described in the Crossrail Archaeological Impact Assessment and the Specialist Technical Reports: Assessment of Archaeological impacts (Part 1-6), published in February 2005 in support of the Crossrail Environmental Statement. In 2006 an Archaeology Programming Assessment outlined the scope and approximate timings of potential archaeological works across the entire Crossrail route. This has been superseded by a Detailed Desk Based Assessment (DDBA) of the site (Document Number CR-SD-CT1-EN-SR-00001), which informed this WSI.

2.3.2.1 Fieldwork Reports

- MoLA - Progress Reports from EWMA utilities trial trenches at Barbers Road (June 2009)
- Wessex Archaeology - Former Works Premises Historic Building Recording, Ref: 72211.01 (September 2009). *This report is currently being updated.*
- Wessex Archaeology – Interim Geo-archaeological Statement, Ref: 72212.02 (October 2009)
- Wessex Archaeology – Geo-archaeological Assessment Report, Ref: 72212.05 (March 2010). *This report is currently in draft status.*

2.4 Geology and Topography

2.4.1 This summary is based on the following studies, which provide a general overview of the geology of the Crossrail worksites at PML:

- Crossrail Geotechnical Desk Study for Bow Common to PML (Document Number 1D0101-C1G10-00505);
- C152 Pudding Mill Lane Portal RIBA D Geotechnical Baseline Report (Document Number C152-SWN-C2-RGN-CR094_PT002-00004);
- Crossrail, 2008, MDC3 Archaeology, Geo-archaeological deposit model: Pudding Mill Lane;
- Crossrail, 2010, C152 Pudding Mill Lane Portal Contaminated Land Assessment Report (Document Number C152-SWN-C2-RSI-CR094_PT002-00002);
- Norwest Holst Soil Engineering, 2009, Report on a ground investigation for Crossrail Package 25 Pudding Mill lane, Volume 1 – 3.

2.4.2 Refer to drawing number C152-SWN-C2-DDB-CR094_PT002_Z-95002 (Annex 1) for geological cross-sections and the locations of the boreholes mentioned in the text.

2.4.3 Present ground levels vary considerably due to railway and other construction, from c 101m to 105m Above Tunnel Datum (ATD) in the floodplain to the east of the River Lea, rising up to 104m to 110m ATD on the gravel terraces.

2.4.4 Geo-archaeological assessment carried out by Wessex Archaeology shows that the site lies mainly on alluvium within the floodplain of the River Lea. The gravel topography underlying the site comprises intercutting braided channels with raised gravel areas between them. The geo-archaeological assessment identified one such island in the central section of the site with a high point roughly between chainage 14500 and 14700. The assessment also identified peats and organic alluvial deposits site-wide but concentrated in areas of lower gravel topography in the eastern and western parts of the site (Wessex Archaeology 2010).

2.4.5 The raised gravel areas enabled settlement and other activity as the surrounding landscape became increasingly wet and marshy due to water level rise and reduced flow gradient (Wessex Archaeology 2010).

2.4.6 The geo-archaeological assessment report (draft) describes the geoarchaeology of the site (Figure 5) in greater detail based on historic, Olympic and Package 25 geotechnical investigations. See also the Detailed Desk Based Assessment (Document Number CR-SD-CT1-EN-SR-00001).

2.4.7 Boreholes in the area indicate that to the west of the River Lea the land rises quite steeply with the top of the London Clay at about 105 ±1m ATD overlain by River Terrace Deposits. Boreholes have not identified alluvial deposition on the west side of the River Lea.

2.5 Archaeological and Historical Development of the Site

2.5.1 Please refer to the following drawings for the locations of boreholes and archaeological sites mentioned in this section (see Annex 1):

- Geotechnical boreholes and section: C152-SWN-C2-DDB-CR094_PT002_Z-95002
- Archaeological sites: C152-SWN-C2-DDA-CR094_PT002_Z-95002
- Geo-archaeological boreholes: C152-SWN-C2-DDA-CR094_PT002_Z-95003

2.5.2 Superficial Deposits comprising Made Ground, Alluvium and River Terrace Deposits (RTD) overlie the London Clay at Pudding Mill Lane. Geotechnical borehole data from in and around the site demonstrates that Made Ground is present to depths of 100.21m ATD. Made Ground overlies Alluvium, the surface of which lies at depths of between 104.61 and 101.16m ATD. The depth of alluvium varies according to the extent of truncation by post-medieval and modern Made Ground deposits. The top of the RTDs were encountered at depths of between 103.05 and 97.71m ATD and are on average c.3.82m in thickness. There is the potential for localised deepening of Superficial Deposits due to the proximity of the River Lea and historical tributaries. The ground level around the site varies between 103.05 and 106.92m ATD, due to the railway embankment and other construction, the floodplain and the gravel terraces. The natural geology of the area is less varied, with the top of the London Clay at a consistent level (approx 96.00m ATD) across the site.

2.5.3 The geo-archaeological deposit model of the site identifies a raised area across much of the central section of the site with a high point immediately west of the new DLR station. In the eastern part of the site at Pudding Mill Lane and Marshgate Lane a deeper channel area has been identified during work for the Olympics as being part of the course of the palaeo-Lea (Wessex Archaeology 2010). A similar deeper channel area is present in the south-western extent of the site in the area of the TBM Chamber/EIP Shaft.

2.5.4 The construction of the railway and embankment in the 19th century resulted in rapid industrialisation of the area. By the close of the 19th century the site had already contained a gas works stretching from the River Lea to Pudding Mill Lane and tar and tanning works. The site has been occupied by a soap works, ink manufacturers, engineering works, printing works, colour and dye works, textile works, brewery works rope works, mills an electricity generating station and a number of other light industrial businesses. These buildings represent the industrial development on the site but are not thought to be of particular importance in terms of the wider context of the industrial development of London and the UK. The extent of disturbance caused by cellaring and foundations associated with former buildings is unknown.

2.5.5 A general watching brief (GWB) was carried out to monitor EWMA utilities test trenching on Barbers Road (Figure 3 shows the locations of these trenches). The results of the GWB showed alluvial deposits reworked with modern (19th century) fill in PML2; 4; and 5 (Figure 4) and PML1 and 2 included post-medieval red brick structural remains, possibly relating to the former Soap Works at that location. It is therefore possible that

other 19th century structural remains survive at PML, such as the house with formal gardens shown on historic mapping from 1867 to just prior to World War II (Figure 2).



Figure 2 1867 Ordnance Survey 1:2500 map

- 2.5.6 Information from archaeological interventions in the vicinity demonstrates mixed levels of truncation by Post-medieval and Modern activity. Just south of the PML, site HNB06 identified alluvial deposits at 102.80 to 102.00m ATD beneath Medieval and Post-medieval deposits. To the south-west (PAY05) alluvial deposits were encountered at 105.10m ATD; to the east (HIF06) at 102.40m ATD; to the northeast (VYC04) 3m of alluvium was encountered; and to the north (DAC03) alluvial deposits containing a Roman timber jetty were identified at c.102.30m ATD. Contrastingly, a number of sites in the surrounding area (BGJ07, FWT07, BBP07, GHP93, FAF01, OL-00305 and WKN06) demonstrated Made Ground and RTDs only, with no alluvial deposits surviving. EWMA test trenches PML2; 4; and 5 (Figure 3) on Barbers Road identified alluvial deposits reworked with modern (19th century) fill.
- 2.5.7 Archaeological investigation taking place to c.1km north at the Stratford City Development has identified possible Bronze Age settlement activity including cremations. These generally corresponded to raised gravel areas within the Lea Valley. It is possible that similar gravel highs within the Pudding Mill Lane site could contain similar deposits.
- 2.5.8 An archaeological evaluation was carried out in 2008 by MoLAS-PCA within Planning Delivery Zone 8 (PDZ8) as part of the Olympic, Paralympic and Legacy Transformations Planning Applications. PDZ8 also falls within the Crossrail worksites at Pudding Mill Lane. The evaluation comprised seven trenches, the locations of which are shown in Figure 3.
- 2.5.9 The PDZ8 evaluation results correspond with the geo-archaeological deposit model with regard to the prehistoric landscape at this part of the site, with trench PDZ8.01/5.40(C) demonstrating that a channel existed in the east of the site and trench PDZ8.04/5.35(C) also confirming the presence of a higher gravel area around Marshgate

Lane and Pudding Mill Lane. The cultural evidence identified in Trench PDZ8.04/5.35 confirms that the raised area was a focus for human activity in late prehistory.

- 2.5.10 Trench PDZ8.04/5.35(C) demonstrated multiple phases of human activity in late prehistory on the higher gravel island zones as alluvial and higher energy deposits encroached on these occupied areas. The environment in the area comprised raised gravel islands surrounded by wetland, which were dry until the Roman period (MoLAS-PCA 2008).
- 2.5.11 As the river channels dried a more stable marsh environment of wet woodland developed (MoLAS-PCA 2008). Such marshland was unattractive to human activity, indeed, it is not until the early post-medieval period that evidence for cultural activity is again encountered in the area. From the early post-medieval period onwards the area exhibits evidence for human activity, including pastoral use (Trench PDZ8.04/5.35(C)) despite evidence for flood events.
- 2.5.12 In the 19th and 20th centuries layers of re-deposited alluvium demonstrate the early ground raising that occurred prior to the landscaping that resulted in the topography of the site today (MoLAS-PCA 2008).
- 2.5.13 The results of the PDZ8 evaluation correlate with the Crossrail geo-archaeological deposit model developed for the site, which has identified that the raised gravel areas within the deeper channels were a focus for activity by people in late prehistory (see Figure 5).
- 2.5.14 Geotechnical boreholes clearly demonstrate surviving Made Ground, Alluvium and RTDs at varying depths across the length of the site, which could potentially contain archaeological deposits. Should archaeological remains survive, there is the following potential:
- High potential for Post-medieval industry including the foundations of the former buildings on site including the Soap Works, Gas Works, Tar Works, a house with formal gardens; and the remains of a timber yard;
 - High potential for geo-archaeological and palaeo-environmental evidence within the alluvial river/marsh sequence, located in the off-island areas;
 - Moderate potential for Medieval settlement and industry;
 - Moderate to High potential for late prehistoric remains, comprising evidence for dry land activity such as Bronze Age and Iron Age artefacts and features (in particular on raised gravel islands); and wetland activity such as Prehistoric artefacts, timbers, land surfaces and associated palaeo-environmental evidence;
 - Evidence for Palaeolithic, Mesolithic and Neolithic activity was not identified in the PDZ8 evaluation, there is therefore a low potential for evidence from these periods to be encountered at Pudding Mill Lane;
 - Low potential for Roman remains on the terrace gravels and in the alluvial sequence;
 - Low potential for Saxon activity.

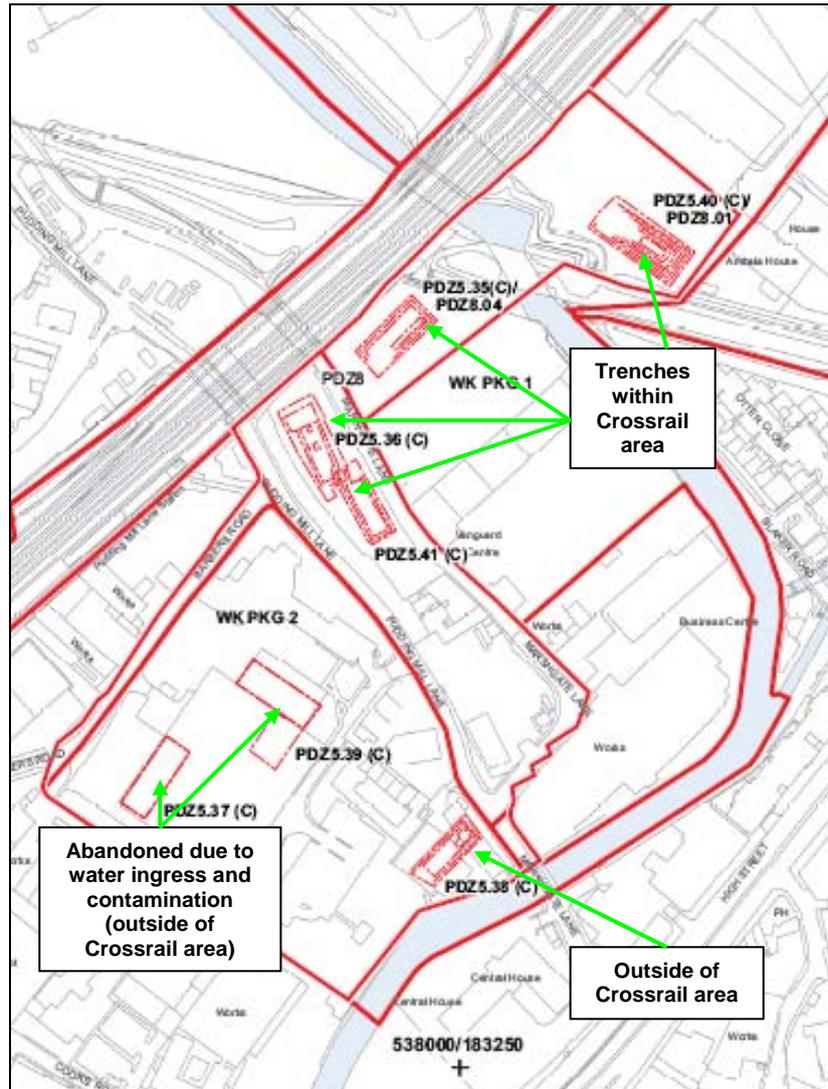


Figure 3 Trench location plan (MoLAS-PCA 2008)

2.5.15 The small to medium scale light industrial warehouse buildings with accompanying areas of hardstanding and grass that occupy most of Pudding Mill Lane are unlikely to have basements and deep foundations (Crossrail 2007). The River Lea/Blackwall Tunnel Northern Approach Retaining Wall has a known foundation toe depth of 92.90m ATD. Known utilities, largely beneath Barbers Road, Pudding Mill Lane and Marshgate Lane, and on both banks of the River Lea, will have resulted in localised disturbance within the Made Ground.

2.5.16 There are existing utilities on the site which have also resulted in localised disturbance within the Made Ground, notably an 11kV cable route which passes through the centre of the site (Drawing Number C152-SWN-C2-DDA-CR094_PT002_Z-95002 – Annex 1) and the North London Flood Relief Sewer, running immediately east of Pudding Mill Lane.

2.5.17 In summary, geotechnical boreholes, previous archaeological interventions, the PDZ8 archaeological investigation, Greater London Sites and Monuments Record (GLSMR) data, a geo-archaeological deposit model and the results of a watching brief at EWMA test trenches along Barbers Road indicate that archaeological remains may survive within the Made Ground, Alluvium and River Terrace Deposits that are present across the site,

however, the nature and extent of these remains is unknown in the area to the south-west of Pudding Mill Lane road.

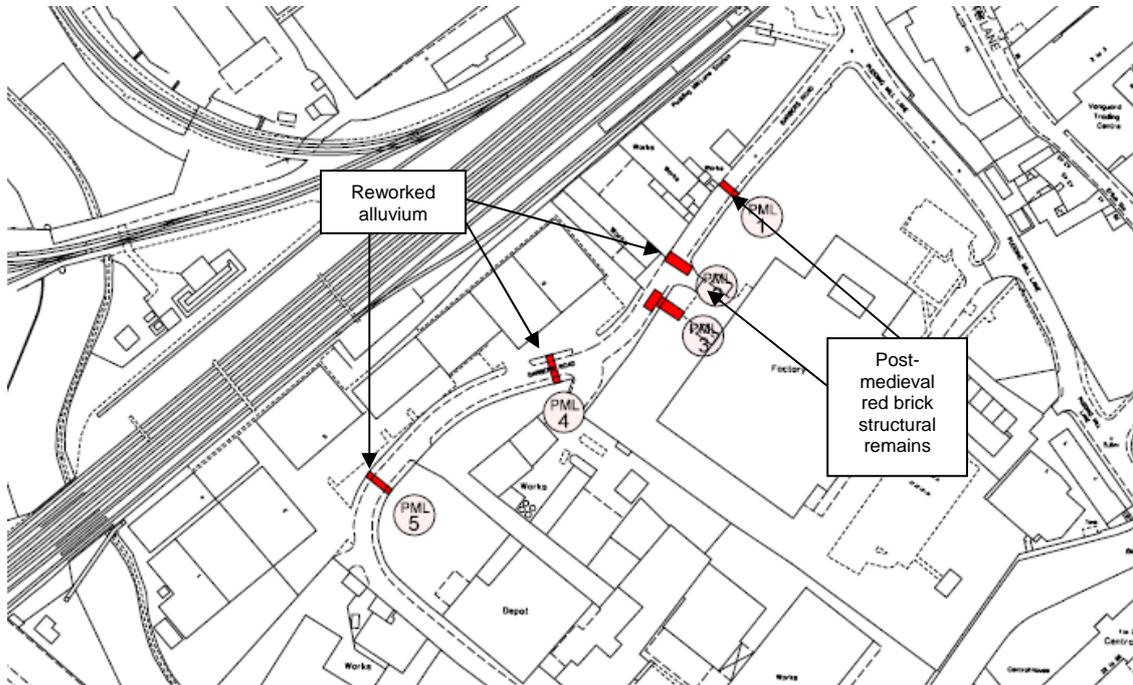


Figure 4 EWMA Utility trial trenches

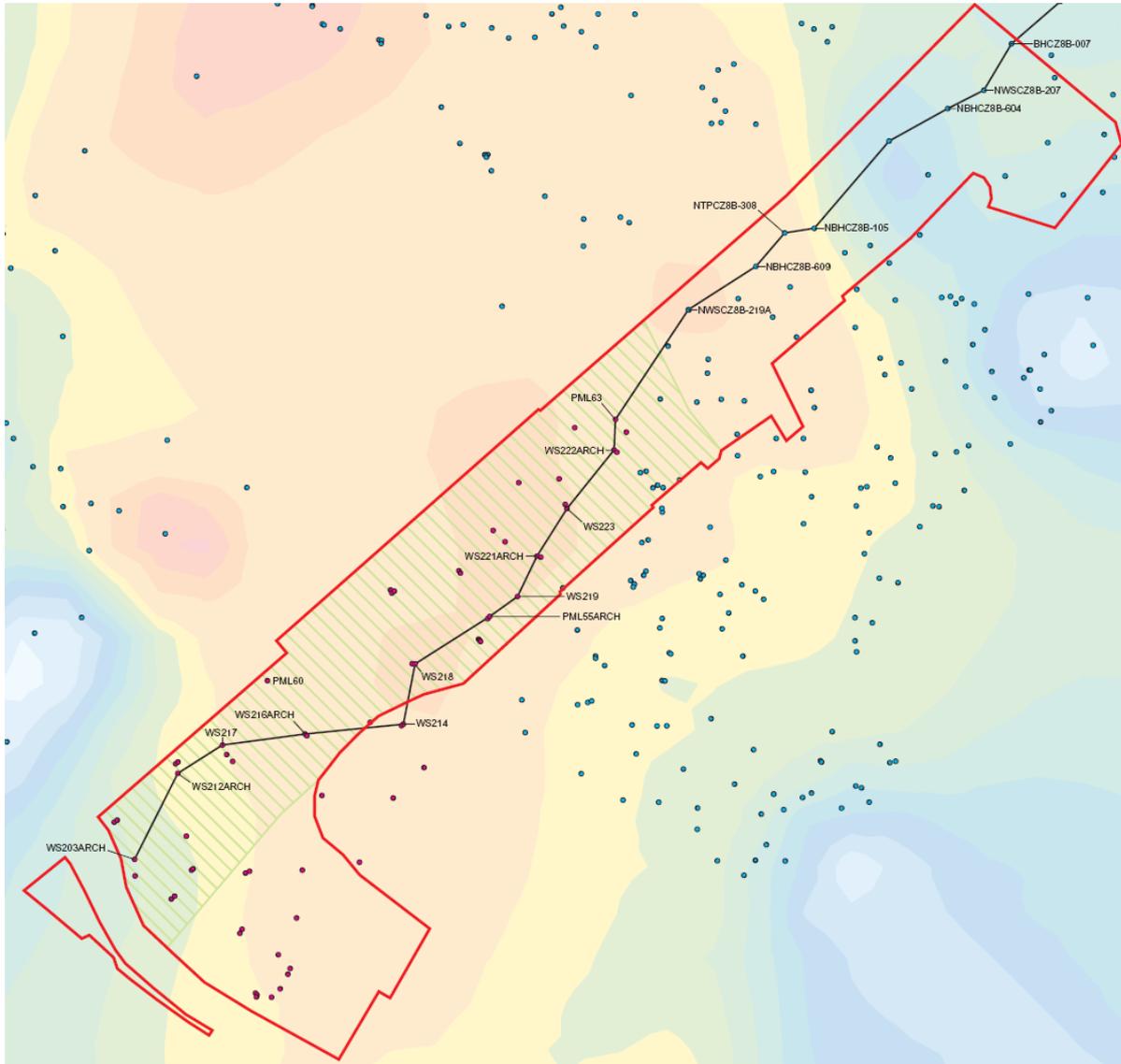


Figure 5 Gravel topography identified in the draft geo-archaeological deposit model (Wessex Archaeology 2010)

3 Construction Impacts and Mitigation

3.1 Summary

3.1.1 There is potential for archaeological remains to survive within the Crossrail worksites for Pudding Mill Lane at the locations of the following construction activities:

3.1.1.1 Tunnel Boring Machine (TBM) chamber/Emergency Intervention Point (EIP) shaft

The Emergency Intervention Point (EIP) chamber, which will temporarily act as a TBM Chamber during the works, will be formed on three sides with diaphragm walls. The eastern side of the reception chamber will abut the reinforced concrete trough carrying the 11kV cable diversion and also form the start of the cut and cover tunnel. A temporary sheet pile wall will be formed across the eastern end to enable its early construction. The chamber will be excavated by bottom-up technique with temporary props installed at two levels. A 1.5m thick reinforced concrete base slab will be cast at 89mATD formation level forming a permanent prop and shall be founded into the UMB of the Lambeth Group. The toe level of the diaphragm wall shall extend to 81mATD and into the LMB/Upnor Formation.

3.1.1.2 Cut and cover tunnel

The cut and cover tunnel will extend approximately 300 metres eastwards from the TBM chamber. The southern wall along this length will be constructed from diaphragm wall, installed to a depth of 81m ATD, but stepping up to 83m ATD then 87m ATD as the tracks rise up. The northern wall will be also constructed from diaphragm wall over a length of around 130 metres from the TBM chamber. Beyond this point it will change to a secant piled wall. Bottom-up construction techniques will be adopted when forming the cut and cover tunnel with two levels of temporary props being used over the western half and a single row on the eastern section.

Excavations will be carried out in the Made Ground, Alluvium and River Terrace Deposits, London Clay and Harwich Formation. Near the TBM Chamber excavations will also occur into the Upper Mottled Beds of the Lambeth Group. It is expected that Superficial Deposits and the Harwich Formation will be water bearing.

3.1.1.3 Covered ramp

The northern wall of the ramp will be constructed from secant piles in continuation of the secant pile wall of the cut and cover tunnel. The secant pile wall ends at the western side of Pudding Mill Lane where a four span underpass will carry the Crossrail tracks. The secant piles will be 1050mm diameter installed to a toe level which steps up from 83m ATD to 87m ATD. These piles will be founded into the Lower Lambeth Group (Upnor, LMB, LSB and LTB). The southern wall is an in-situ reinforced concrete wall supported on discrete 750mm diameter piles to be installed to a depth of 87m ATD. The diaphragm wall will be replaced by these piles as the base slab by this point is above the existing ground level.

3.1.1.4 Four Span underpass

Between Pudding Mill Lane and the west side of Marshgate Lane the covered ramp runs over a four span underpass which carries the Crossrail and Electric Upline NR track. Each of the underpass walls will be founded on 750mm bored piles and will extend into the Lambeth Group (UMB/LTB and potential Sand Channel) at a toe level of 79mATD.

- DLR station and 6-span viaduct

The new DLR station foundations will consist of 750mm and 900mm diameter bored piles. The western abutment will both support the end of the station bridge structure and will also act as a retaining wall for the 6m of fill placed behind it. Due to the close grouping of the pile caps at the DLR Station that there will be ground lowering at this location up to approximately 2.5m Below Ground Level.

A six span viaduct is required to carry the DLR along its new alignment from the new Pudding Mill Lane Station, over Marshgate Lane to the Northern Outfall Sewer Bridge. The viaduct, including the Marshgate Lane Bridge, will consist of 900mm diameter bored piles founded at 81 to 85mATD and into the LMB/Upnor Formation of the Lambeth Group. Any ground lowering in advance of piling is likely to be discrete and confined to the footprint of the pile caps.

- DLR retaining wall

A reinforced soil retaining wall will be constructed to support the new DLR lines west of the new Pudding Mill Lane Station. Stone column ground improvement will be undertaken down to the River Terrace Deposits to improve the Made Ground and Alluvium strata beneath the footprint of the wall and retaining earthworks.

- Up-Line Electric Loop retaining wall

An L-shape cast in place reinforced concrete retaining wall founded on bored piles will be constructed in an east-west direction to support the relocated NR Up Electric line. The piles will be founded into the Lambeth Group. The earth fill required between the new and existing retaining walls will be sourced from excavated materials and/or materials imported to the site.

- Bridges over Marshgate Lane, the Northern Outfall Sewer (NOS) and City Mill River(CMR)

The three Marshgate Lane bridges will separately carry the two Crossrail tracks and the NR's Up Electric track. The bridge foundations will be supported on 750mm diameter bored piles beneath the east abutments at a toe level of 80 to 81mATD and 900mm diameter bored piles beneath the west abutments at toe levels of 83mATD. The piles are likely to be founded into the LMB/Upnor Formation of the Lambeth Group.

The two bridges over the Northern Outfall Sewers will carry the Crossrail / Up-Electric Loop tracks on the northern bridge and the DLR tracks on the southern bridge. All piles will be 750mm diameter with toe levels of 80mATD into the LMB/Upnor Formation of the Lambeth Group.

- River Lea protection works

The River Lea works comprise a 1m thick mass concrete protection slab to the river bed to increase the overburden above TBM's heading and to provide increased stability of the tunnel during driving. Removal of existing river wall piles encroaching into the tunnel drives also needs to be removed as part of the works.

Initially a cofferdam will be established to the east following the completion of the 400Kv cable diversion. This is currently planned to be removed prior to the Olympic shutdown. Post Olympics a cofferdam will be established to the west.

- 3.1.1.5 National Grid (NG) 400kV cable diversion works (Drawing number C152-SWN-C2-DDA-CR094_PT002_Z-95002 – Annex 1).
- 3.1.2 There will also be utilities diversions and protective works in the streets around the worksites, in particular the EDF 11kV cable diversions (Drawing number C152-SWN-C2-DDA-CR094_PT002_Z-95002 – Annex 1).
- 3.1.3 It is currently intended that to the immediate south of the TBM Chamber and EIP and overlying part of the 400kV cable trough will be a Traction & Bulk Supply Point (C124). The final location of the Traction & Bulk Supply Point is uncertain and will require assessment when the design has been sufficiently progressed.
- 3.1.4 The Crossrail works at Pudding Mill Lane are divided into Enabling Works and Main Works. Enabling works are defined as those works that are required to facilitate the Main Works, and as such are required prior to the start of the Main Works programme. Within the category of Main Works there are also Advanced Works, which are those parts of the Main Works that need to be advanced from their current programme start dates, so as to complete the works at Pudding Mill Lane within the current project time frame. The Advance Works do not include Enabling Works but will in most cases run parallel to them. Set out below is a summary of the relevant Enabling, Advanced and Main Works that could affect archaeology at Pudding Mill Lane.
- 3.1.4.1 Enabling Works
- Establishment of Pudding Mill Lane worksite
 - National Grid (NG) 400kV cable diversion works.
 - EDF 11kV cable diversion.
 - Barbers Road realignment and associated utilities diversions.
- 3.1.4.2 Advanced Works
- Worksite establishment.
 - River Lea protection works.
 - Pile foundations for the new DLR station and viaduct and associated ground lowering.
 - Piling of new DLR retaining wall.
 - Continuation of the Barbers Road realignment and utilities diversions.
 - Continuation of the EDF 11kV cable diversion works.
 - Continuation of National Grid (NG) 400kV cable diversion works.
- 3.1.4.3 Main Works
- TBM chamber/EIP shaft.
 - Cut and cover tunnel.

- Covered ramp.
- Span underpass.
- New elevated station and retained railway embankment for the Dockland Light Railway (DLR).
- DLR Viaduct.
- Bridges over Marshgate Lane, the Northern Outfall sewer and City Mill River.

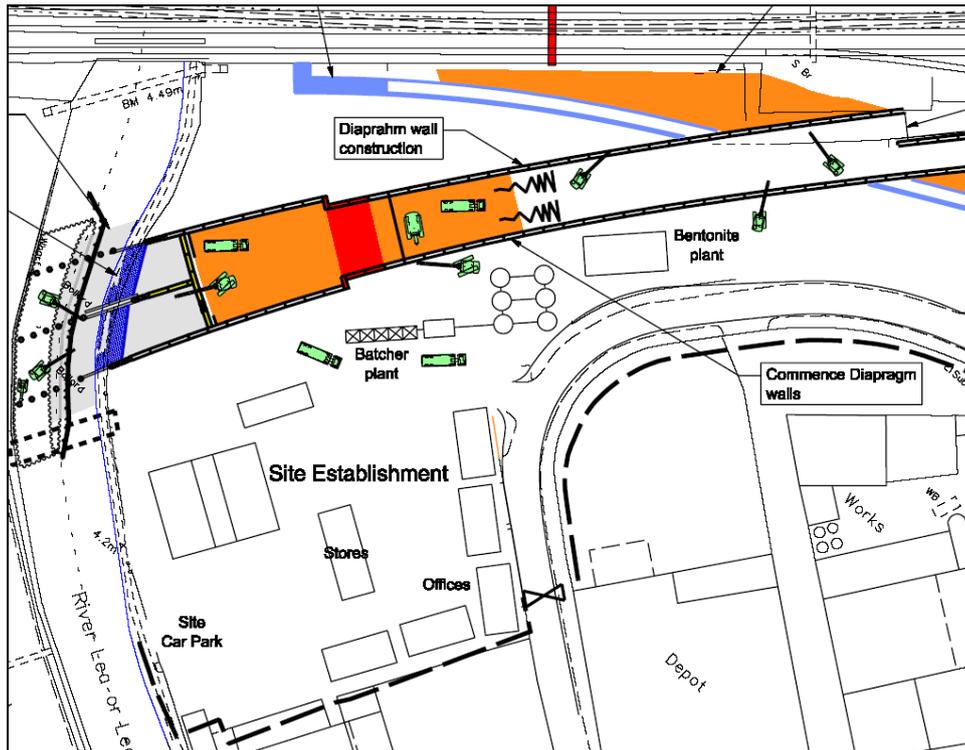


Figure 6 Pudding Mill Lane Worksite

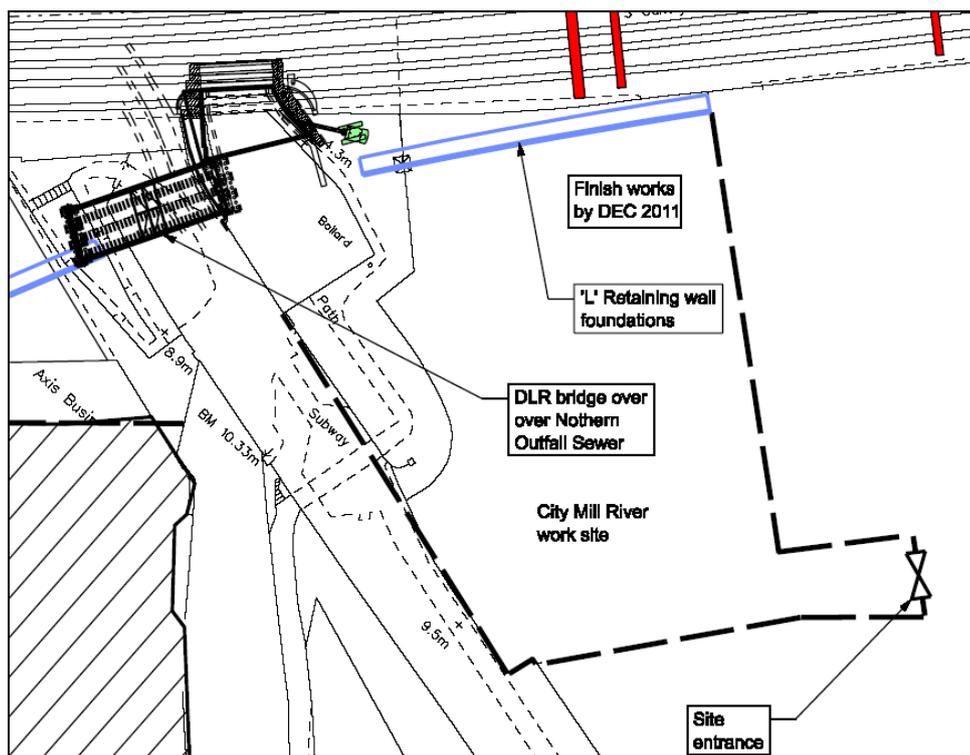


Figure 7 City Mill River Worksite

3.1.5 The predicted impacts to surviving archaeological remains are set out below. Refer to Construction stage drawings C152-SWN-C-DDA-CR094_PT002_Z-95000 to 95008 (Crossrail 2009b) for the following construction stages:

3.2 Enabling Works (Stage 1)

3.2.1 Establishment of the Pudding Mill Lane worksite, initially comprising a small area off Barbers Road may partially remove archaeological remains within upper levels of the Made Ground.

3.2.2 All buildings on site have been demolished, please refer to section 5.5.

3.2.3 Utility diversion works are required at various locations at Pudding Mill Lane. The following works have the potential to partially or completely remove archaeological remains within the Made Ground and Alluvial deposits:

- National Grid 400kV Cable Diversion: National Grid 400kV twin-circuits located in the tow path on the east bank of the River Lea are at risk of from the Crossrail tunnels, therefore, the NG cables will be diverted through the Heron Industrial Estate between the River Lea and the EIP Shaft. The National Grid 400kV cable diversion and associated jointing pit will completely remove archaeological deposits in the Made Ground and Alluvium up to c.2.5m Below Ground Level (BGL).
- EDF 11kV Cable Diversion on to new alignment and remove redundant troughing: Existing 11kV cables are required to be diverted over the new Crossrail cut and cover box and will entail a section of the cut and cover box to be constructed as part of the advance works (see below for details of diaphragm wall and box construction). The new cable route will run through the Heron Industrial Estate and

into the realigned Barbers Road and will partially or completely remove archaeological deposits along its route.

- Realignment of Barbers Road and associated utilities diversions will partially or completely remove archaeological deposits within the made ground.

3.3 Advanced Works (Stage 2)

3.3.1 Mobilisation for advance works will require the establishment of both the main Pudding Mill Lane worksite and “satellite” worksites. These activities may partially remove archaeological remains within upper levels at the Pudding Mill Lane worksite.

3.3.2 River Lea works, including the protection slab and walls to the river will completely remove archaeological remains at that location, in particular in relation to surviving elements of the western River Lea wall and wharf.

3.3.3 Pile foundations for new DLR station and viaduct will completely remove archaeological remains within the footprint of the piles and pile caps. Ground lowering in the area of the DLR Station piles has the potential to remove archaeological deposits in the alluvial layer to a depth of approximately 2.5m bgl.

3.3.4 Piling of new DLR “L” shape retaining wall (Ch 14180 – 14580) will completely remove archaeological remains within the footprint of the piles and pile caps.

3.3.5 Piling for the DLR bridges over the City Mill River (CMR) and the Northern Outfall Sewer (NOS) will completely remove archaeological remains within the footprint of the works.

3.3.6 Continuation of the EDF 11kV cable diversion works, over the cut and cover tunnel, will partially or completely remove archaeological remains along its route. A 20m length of the cut and cover section will be constructed early using the diaphragm wall technique and temporary sheet piling. The ground will be excavated between the walls down to the level of the roof slab of the main cut and cover tunnel (approximately 6m below existing ground level) and the reinforced concrete roof slab constructed. The excavation will then be backfilled with suitable engineering fill ready for the placement of the power cable ducting.

3.3.7 Continuation of the National Grid (NG) 400kV cable diversion works.

3.3.8 Completion of diaphragm walls to the cut and cover tunnel.

3.3.9 Continuation of the Barbers Road realignment and associated utilities diversions.

3.4 Main Works (Stage 3)

3.4.1 Completion of new DLR “L” shape retaining wall construction will partially or completely remove archaeological deposits in its footprint.

3.4.2 Secant pile walls for the cut and cover box (from west to east) and excavation of the box will completely remove archaeological remains at that location.

3.4.3 Sheet piling ends of the diaphragm wall cut and cover box at the DLR crossover will completely remove archaeological remains within the footprint of the works.

- 3.4.4 Construction of the retaining wall between Marshgate Lane and City Mill River will partially or completely remove archaeological deposits within its footprint.
- 3.4.5 Construction of the foundations for the DLR viaduct between Marshgate Lane and City Mill River will partially or completely remove archaeological deposits within its footprint. Ground lowering in advance of piling is likely to be confined to the footprint of the pile caps.

3.5 Main Works (Stage 4)

- 3.5.1 Completion of the cut and cover box section may completely remove surviving archaeological deposits within its footprint.

3.6 Main Works (Stage 5)

- 3.6.1 Installation of secant piling for northern retaining wall to covered ramp will completely remove archaeological remains within their footprint.
- 3.6.2 Excavation of the cut and cover box and covered ramp behind the secant piled wall will completely remove archaeological deposits at that location.

3.7 Outline Evaluation and Mitigation Design

- 3.7.1 The impact to archaeological deposits from the construction of the Traction & Bulk Supply Point, currently intended to be located to the south of the EIP Chamber, will require assessment when design is sufficiently developed. The evaluation and mitigation strategy will be updated as required.
- 3.7.2 A geo-archaeological investigation formed part of the scope of the Package 25 geotechnical investigations at Pudding Mill Lane worksite in order to determine the palaeoenvironmental potential; update the existing geo-archaeological deposit model of the site; and inform the next phase of field evaluation (trial trenching).
- 3.7.3 The geo-archaeological investigation comprised open tube sampling (U100/U4 sampling) at 14 locations across the Pudding Mill Lane worksite to the south-west of Pudding Mill Lane road (the locations of the geo-archaeological boreholes are shown on Drawing Number C152-SWN-C2-DDA-CR094_PT002_Z-95003 (Annex 1).
- 3.7.4 The results of the geo-archaeological investigation have been provided in a draft geo-archaeological assessment report prepared by Wessex Archaeology. The finalised assessment report will include recommendations for further environmental sampling which will form part of the mitigation strategy for the site.
- 3.7.5 Trial trench evaluation is proposed at selected sites to establish the presence or absence of archaeological remains and inform a mitigation strategy. Five trial trenches are proposed, the locations are shown on Drawing Number C152-SWN-C2-DDA-CR094_PT002_Z-95004. The precise number and design of these trenches will be subject to health and safety requirements.
- 3.7.6 General watching brief is required during enabling and advanced works at the EDF 11kV cable diversion and establishment of the Pudding Mill Lane worksite.
- 3.7.7 A general watching brief is required at the Barbers Road realignment and related utility diversion works

- 3.7.8 Targeted watching brief will be carried out during enabling works on the western side of the River Lea to record surviving elements of the River Lea Wall and wharf.
- 3.7.9 Targeted watching brief is required at the excavation of the NG 400kV cable trough and jointing pit.
- 3.7.10 Targeted watching brief is required at ground lowering in advance of piling at the DLR Station.
- 3.7.11 The above archaeological works are shown on drawing number: C152-SWN-C2-DDA-CR094_PT002_Z-95004 (Annex 1).
- 3.7.12 A Level II English Heritage survey has been carried out at Marlborough House/Gate House and the north light shed, Cook's Road. See Non-Listed Built Heritage (section 5.5).

4 Aims and Objectives

4.1 Research Aims

4.1.1 Research themes, derived from *A Research Framework for London Archaeology 2002* (Nixon et al, 2003) have been identified in the Crossrail Specialist Technical Reports: Assessment of Archaeological impacts (Part 1-6) (Crossrail 2005). The Pudding Mill Lane portal location in the Lea Valley means that data collected from archaeological investigation and mitigation may contribute to the following research themes:

- Understanding London's hydrology, river systems and tributaries and the relationship between rivers and floodplains;
- Understanding the relationship between landscape, river and settlement;
- Using the understating that comes from reconstructing London's past to contribute to wider environmental studies about contemporary concerns such as: climate change; sea level fluctuations; flood defence initiatives; links between pollution, health and quality of life;
- Understanding the reasons for evolution of the road systems, street layouts, river crossings and ferries, and their importance as engines of development and change;
- Understanding the nature and meaning of the deposition of metalwork in the Thames and at the headwaters of river tributaries;
- Understanding how water supply and drainage provision were installed and managed;
- Studying the correlation between sites associated with watercourses and meander bends, so as to understand the origin of settlements; and
- Understanding the evolving character of development in central London, in comparison to other riverine settlements.

4.1.2 Furthermore, the potential at Pudding Mill Lane for geo-archaeological and palaeoenvironmental deposits to be recovered will contribute to the following themes:

- The development of models for understanding the significance of geomorphology, ecology, ecosystems and climate, hydrology, and vegetational and faunal development, on human lives;
- Characterising changing climatic conditions, and air and water quality and pollution, throughout the archaeological record, towards understanding its implications for how people behaved;
- The Mesolithic/Neolithic transition: understanding the significance of horticultural experimentation at this time, and the transition from hunter-gatherers into farmers; and

- Understanding what London's past environments meant to different groups and individuals.

4.1.3 Any evidence for Post-medieval industrial activity will contribute to the following themes:

- Charting how and why different parts of London developed as specialist producers, and understanding the implications of this for London as a world city;
- Establishing how daily work and life in London reflected and contributed to the rise of London as the commercial centre of the British Empire, and to its continued eminence as a world city thereafter; and
- Examining the success with which small towns in the London region adapted to the capital's growth.

4.2 Objectives of the Investigation

4.2.1 The overall objectives of the investigation are to establish the nature, extent and state of preservation of any surviving archaeological remains that will be affected by the development.

4.2.2 Specifically, archaeological investigations have the potential to recover:

- Prehistoric land surfaces and occupation evidence formed in alluvial deposits, sealed by alluvial deposition from the marshy meadowland environment of the Medieval period onward;
- Organic artefacts and structures associated with wetland exploitation from late prehistory onwards;
- Palaeo-environmental and geo-archaeological deposits providing information about the course of ancient rivers; environmental remains; and riverside/wetland remains from the Late Glacial to the present;
- Evidence of Post-medieval pastoral and industrial activity and for the ground raising and landscaping of the area;
- Evidence for Medieval settlement and industry; and
- There is also low potential for Saxon activity.

5 Scope of the Investigation

5.1 Prior to Enabling Works (CRITICAL)

5.1.1 The impact to archaeological deposits from the construction of the Traction and Bulk Supply Point, probably to be located to the south of the TBM Chamber/EIP will require assessment when sufficient design detail has been developed. The evaluation and mitigation strategy will be updated as required.

5.1.2 The results of a general watching brief carried out during EWMA utilities test trenching on Barbers Road are summarised in section 2.5.

5.2 Enabling Works

5.2.1 General Watching Brief

5.2.1.1 A general watching brief shall be carried out on enabling works at the following locations:

- EDF 11kV cable diversion; and
- Establishment of the Pudding Mill Lane worksite.
- Barbers Road realignment and related utilities diversions.

5.2.2 Targeted Watching Brief

5.2.2.1 A Targeted Watching Brief is required at the following location:

- The excavation of the NG 400kV cable trough and jointing pit.

5.2.3 Trial Trench Evaluation

5.2.3.1 Based on the information provided in the draft geo-archaeological assessment, five trial trenches are proposed. The trenches are targeted for the reasons set out in Table 3 below. The locations of the trial trenches are shown on drawing C152-SWN-C2-DDA-CR094_PT002_Z-95004.

Trench Number & Size	Archaeological potential	Approximate Levels (mATD)
1 (30x5m at base)	Former industrial buildings particularly a former Soap Works, shown on Stanford's map of 1862. Edge of the river valley, trench to identify transition from the higher drier ground to a deeper channel area.	Ground: 104±1 Top alluvium: 102±2 Top RTDs: 100±2

2 (30x5m at base)	Remains of building with formal gardens visible on 1867 OS mapping. Potential prehistoric activity on raised gravel area and surrounding area of sandbanks and wetland.	Ground: 104±1 Top alluvium: 102±2 Top RTDs: 100.5±1
3 (5m x 5m)	Former industrial buildings including a gas works and soap works shown on Stanford map of 1862 and the 1896 OS respectively. Potential prehistoric activity on raised gravel island. targets possible edge of the highest area.	Ground: 104±1 Top alluvium: 102±2 Top RTDs: 100.5±1
4 (5m x 5m)	Former industrial buildings including a gas works, tar works and soap works shown on Stanford map of 1862 and the 1896 OS respectively. Potential prehistoric activity on raised gravel island - located on the highest gravel levels.	Ground: 105 ±1 Top alluvium: 102±2 Top RTDs: 99±2
5 (5m x 5m)	Former industrial buildings including a gas works, tar works and soap works shown on Stanford map of 1862 and the 1896 OS respectively. Potential prehistoric activity on raised gravel island - located on the highest gravel levels.	Ground: 105 ±1 Top alluvium: 102±2 Top RTDs: 99±2

Table 1 Trial Trench Locations and Approximate Depths

5.2.3.2 Trial trenching will take place in two phases:

- Phase I will comprise trenches 3, 4 and 5.
- Phase II will comprise trenches 1 and 2 and will take place after the installation of Diaphragm Walling.

5.2.3.3 The Principal Contractor will determine a safe method ensuring stability of the excavation. The precise number and design of these trenches will be subject to health and safety requirements.

5.2.3.4 Depths of trenching will vary however it is estimated that the trenches will be up to c.4-4.5m in depth.

5.2.3.5 All trenches are expected to encounter post-medieval structural remains within the made ground relating to the industrial development of the site. Post-medieval remains are to be recorded and then removed as appropriate, in order that the earlier archaeological remains can be effectively evaluated.

5.2.3.6 Trenches 1 and 2 have a greater potential for palaeoenvironmental sequences due to the depths of deposits in the off-island areas. Refer to section 7.8.15 to 7.8.24.

5.2.4 Constraints

5.2.4.1 The constraints outlined below are shown on Drawing Number C152-SWN-C2-DDA-CR094_PT002_Z-95004.

Contamination

- 5.2.4.2 Package 25 ground investigations have identified that concentrations for the majority of samples were below commercial/industrial; guideline values at the site, with impacts above guideline values largely restricted to the Made Ground and to a lesser extent, Alluvium and River Terrace Deposits (Crossrail 2010).
- 5.2.4.3 Impacts were generally outside of the proposed Crossrail works, with the exception of elevated concentrations of lead within the location of the proposed DLR station and viaduct works (Gray's Waste Yard) and in WS203 (within the EIP shaft) and elevated concentrations of total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene, and xylenes (BTEX) and polyaromatic hydrocarbons (PAHs) in the location of the proposed viaduct works (Crossrail 2010).
- 5.2.4.4 To minimise hazards trial trenches have been located away from boreholes with observed contaminants, where possible.

Water Ingress

- 5.2.4.5 Water ingress is expected within the Made Ground and as the excavation removes the alluvial deposits. Water in the terrace gravels is confined by the lower permeability alluvium. The piezometric pressure in the terrace gravels would result in water levels rising to about 102 mATD should the 'seal' provided by the alluvium be broken. Currently piezometric pressure within the river terrace gravels is balanced by the weight (ground pressure) of the alluvium, as the excavation deepens and this weight is removed it is likely to result in ground heave and water ingress to the trench followed by abandonment of the trench. The groundwater within the Made Ground and terrace gravels is contaminated. The excavations with water ingress would also result in the movement of contaminants in the area. A potential solution to minimize ingress could be to sheet pile through the gravels and into the London Clay, effectively sealing the excavation area. While there would still be water ingress, this solution would limit the volume of contaminated water to be removed and also prevent the movement of contaminants from outside the excavation.
- 5.2.4.6 The Principal Contractor will determine a safe method in terms of water ingress and contamination.

11kV Cable

- 5.2.4.7 The existing 11kV cable route is located within the proposed cut and cover tunnel and covered ramp. Trial trenches have been located at least 5m from the existing 11kV cable route. The location of known services are shown on Drawing Number C152-SWN-U-DDA-CR094_PT002_Z_95000 (Annex 1)

DLR Retaining Wall

- 5.2.4.8 Trial trenches have been located at least 5m from existing retaining walls.

5.2.5 PDZ8 – Olympics

- 5.2.5.1 The impacts in the area to the north-east of Pudding Mill Lane road, evaluated for the Olympics (PDZ8), are confined to piling for the DLR Viaduct. The location of these piles largely coincides within the PDZ8 trenches and as such no further evaluation or excavation is required.

5.2.6 Further Mitigation

5.2.6.1 Results of the archaeological evaluation will inform the mitigation design, and will constitute preservation-by-record (e.g. archaeological excavation and/or watching brief). Archaeological mitigation (if required) would be undertaken commensurate with the enabling works and main works. These mitigation measures are described in the Crossrail Archaeology Generic Written Scheme of Investigation (Crossrail 2007).

5.3 Advanced Works

5.3.1 General Watching Brief

5.3.1.1 A General Watching Brief shall be carried out at the following location:

- Continuation of the Barbers Road realignment and related service diversions.

5.3.2 Targeted Watching Brief

5.3.2.1 A Targeted Watching Brief shall be carried out at the following location:

- During demolition and groundworks on the western side of the River Lea to record the remains of the wharf identified on historic mapping (section 5.5).
- Continuation of the NG 400kV cable trough and jointing pit.

5.3.3 Further Mitigation

5.3.3.1 Results of the archaeological evaluation will inform the mitigation design, and will constitute *preservation-by-record* (e.g. archaeological excavation and/or watching brief). Archaeological mitigation (if required) would be undertaken commensurate with the enabling works and main works. These mitigation measures are described in the Crossrail Archaeology Generic Written Scheme of Investigation (Crossrail, 2007).

5.4 Main Works

5.4.1 Targeted Watching Brief

5.4.1.1 A Targeted Watching Brief shall be carried out at the following location:

- Ground lowering in advance of piling the DLR Station, in particular when alluvial layers are encountered.

5.4.2 Further Mitigation

5.4.2.1 Results of the archaeological evaluation will inform the mitigation design, and will constitute preservation-by-record (e.g. archaeological excavation and/or watching brief). Archaeological mitigation (if required) would be undertaken commensurate with the enabling works and main works. These mitigation measures are described in the Crossrail Archaeology Generic Written Scheme of Investigation (Crossrail, 2007).

5.4.2.2 Nb. Event codes are to be agreed between the Crossrail Central Archaeologist and GLAAS. Event codes to be inserted into Section 5 of the SS-WSI.

5.5 Non-Listed Built Heritage Assessment and Recording

5.5.1 Non-listed built heritage assessment and recording forms part of the archaeological mitigation strategy for Crossrail. The definition of non-listed built heritage adopted follows Information Paper D22 Archaeology and encompasses above ground historic features and structural elements of historical interest.

5.5.2 Two main groups are:

- Non-listed buildings proposed for demolition in conservation areas; and
- Historic street furniture and materials falling within a worksite and being temporarily or permanently impacted upon by the works.

5.5.3 The detailed scope for this element of works includes:

- Important non-listed buildings of historic interest proposed for demolition in conservation areas (as set out in Information paper D18, Listed Buildings and Conservation Areas);
- Important non-listed historic street furniture and materials;
- Other important non-listed buildings and structures of historic interest outside conservation areas (i.e. the standing walls at Stepney Green), locally listed station buildings and railway structures and any industrial and defence archaeology of significance.

5.5.4 The Crossrail Environmental Statement and supporting Specialist Technical Reports define the baseline built heritage resources (both statutorily protected and non-listed) across the route, the potential significant impacts, mitigation and any residual impacts after that mitigation is employed (Crossrail 2005).

5.5.5 An assessment of the Pudding Mill Lane worksite was undertaken to identify any non-listed built heritage (NLBH) to be demolished as part of the Enabling Works. The assessment identified the level of mitigation works required. The results of the assessment are outlined in Table 4. The bracketed figure references in Tables 2 and 3 are shown on drawing number C152-SWN-C2-DDA-CR094_PT002_Z-95001 (Annex 1).

5.5.6 Those buildings identified as requiring mitigation prior to demolition have now been recorded by Wessex Archaeology, the report is in preparation. Refer to Table 2 below for the buildings which have been recorded.

Name [Figure Ref]	Image	Description	Significance	Status	Mitigation/ Further Investigation
Marlborough House/Gate House, Cook's Road [1 & 2]		<p>Late 19th century gatehouse with early 20th century extensions to the rear and east. Industrial building including office and workshop to west [1] and north-light shed to east [2]. Constructed from whitewashed brick with some retention of original fixtures and fittings.</p>	<p>Not listed and not located within a conservation area; however, the gatehouse has historic interest in the development of the Pudding Mill Lane area, being part of a now demolished soap works. Marlborough House was part of a later development and was constructed before the First World War to be used as an armaments building</p>	Demolished	A English Heritage Level II survey has been undertaken.
Remnants of the Brush and fibre works [4]		<p>Late 19th century remains of a Brush and Fibre Works. To the south west are the remains of a heavily altered side office room, now used for storage. To the north of this are the remains of two external walls with cast iron windows and partially glazed brick walks. Internal remains of internal structural 'I' beams are also extant.</p>	<p>The remaining structures have lost their original context due to the extensive loss of historic fabric and insertion of new industrial units.</p>	Demolished	No mitigation required
Rendering plant [5]		<p>1920s rendering plant featuring louvres and fibrous corrugated roof. Re-fronted with mid twentieth century block.</p>	<p>Although dating to the 1920s, the building is of little architectural merit or functional merit due to the extensive removal of internal fittings as part of its conversion to a transport yard.</p>	Demolished	No mitigation required

Name [Figure Ref]	Image	Description	Significance	Status	Mitigation/ Further Investigation
Historic remnants of wharf (now River Lea wall) [6]		<p>Stone lined section of canalised River Lea wall dating to the early 20th century.</p> <p>Extent is identical to the boundary of the timber yard that first appears on 1914 OS map and is likely therefore to be contemporary with it. Possibly used to supply the Bryant & May match factory to the east.</p> <p>Later shown on 1937 OS mapping as 'Wharf'.</p>	Part of the historic development of the canalised River Lea, and sole surviving element of the timber yard that once occupied the site.	To be partially demolished by River Lea Protection Works.	Targeted Watching Brief

Table 2 Non-Listed Built Heritage Buildings at Pudding Mill Lane

5.5.7 Street furniture surveys were carried out by Crossrail's Enabling Works Managing Agent (EWMA), which identified all elements of street furniture at Pudding Mill Lane. The results of the EWMA survey were reviewed to identify street furniture of historic significance. Table 3 sets out the street furniture of historic interest identified at Pudding Mill Lane.

5.5.8 No mitigation is required at Pudding Mill Lane in relation to street furniture.

Name [Figure Ref]	Image	Description	Significance	Status	Mitigation/Further Investigation
Gatepost to Waste Recycling Centre [3]		Cast iron gatepost with ball finial. Formerly part of a continuous railing.	Not listed and not within a conservation area. Has some historic interest being part of the entrance to the demolished late 19th century Saw Mill complex, but stylistically typical of its date.	No impacts	Does not warrant further investigation due to its loss of context.

Table 3 Historic Street Furniture Identified within the Pudding Mill Portal



5.6 Consultation

- 5.6.1 An initial meeting between the FDC Archaeologist and the Greater London Archaeological Advisory Service (GLAAS) officer David Divers took place on 13 January 2010.
- 5.6.2 Further consultation between the FDC Archaeologist and GLAAS will take place as the archaeological design develops.

6 Programme

6.1 Introduction

6.1.1 Site-specific evaluation and mitigation measures are presented using the following phasing:

- **Works completed** – Archaeological evaluation, mitigation or English Heritage surveys already carried out or under way.
- **CRITICAL phase** advanced archaeological works which need to be undertaken prior to the Enabling Works (this may apply to very significant archaeological remains where complex mitigation is required and where early site access is required)
- **Phase 1** archaeological works to be undertaken commensurate with the programme of Enabling Works
- **Phase 2** archaeological works to be undertaken commensurate with the main construction works
- **Phase 3** archaeological works to be undertaken after the main construction phase (e.g. post excavation assessment, analysis, publication and dissemination).

6.2 Archaeological Investigation at Pudding Mill Lane

6.2.1 The impact to archaeological deposits from the construction of the Traction and Bulk Supply Point will be assessed when the design has developed. The evaluation and mitigation strategy will be updated as required.

WORKS COMPLETED

6.2.2 The geo-archaeological investigation and subsequent update of the geo-archaeological deposit model has been carried out alongside Package 25 geotechnical investigations in September 2009. At the time of writing, the geo-archaeological deposit model is being finalised by Wessex Archaeology.

6.2.3 A level II English Heritage Survey of Marlborough House and north light shed has been undertaken by Wessex Archaeology in early 2010. The report is in preparation.

ENABLING WORKS – PHASE 1

6.2.4 Archaeological general watching brief is required during the following Enabling Works activities:

- EDF 11kV cable diversion, July 2010 to March 2011.
- The establishment of the Pudding Mill Lane worksite (March 2011).
- Barbers Road realignment and associated service diversions (April 2010 to May 2011).

6.2.5 Archaeological targeted watching brief is required during the Enabling Works during the following activities:

- Excavation of the NG 400kV cable trough and jointing pit (August to October 2010).

6.2.6 Trial trench evaluation will occur in two phases:

- Phase I (trenches 3, 5 and 5) will occur in mid 2010
- Phase II (trenches 1 and 2) will occur after diaphragm walling of the EIP and Cut and Cover Tunnel respectively (July 2010 to March 2011)

6.2.7 Archaeological trial trench evaluation will take c. 4-8 weeks on site, dependant on when areas are available; with c.4 weeks for reporting.

6.2.8 The results of the evaluation will inform the mitigation design and will comprise *preservation-by-record* (e.g. archaeological excavation and/or watching brief). Mitigation will be programmed according to feasibility in the construction sequence and could occur at Phase 1 Enabling Works and/or Phase 2 Main Works.

ADVANCED WORKS – PHASE 1

6.2.9 Archaeological general watching brief is required during the following Advanced Works activity:

- Continuation of the Barbers Road realignment and associated service diversions (April 2010 to May 2011)

6.2.10 Archaeological targeted watching brief is required during the following Advanced Works activity:

- During demolition and groundworks on the western side of the River Lea (October 2012 to Oct 2013).
- Continuation of the NG 400kV cable trough and jointing pit (August to October 2010).

MAIN WORKS – PHASE 2

6.2.11 Archaeological targeted watching brief is required during the following Main Works activity:

- Ground lowering in advance of piling for the DLR Station (April to June 2011)

7 Specification for Evaluation & Mitigation (including Watching Brief)

7.1 Generic Standards

7.1.1 The archaeological evaluation and mitigation works and scope of any archaeological scientific methods shall be designed and undertaken in accordance with the Generic WSI and relevant best practise guidance (and any subsequent revisions) i.e.:

- Crossrail standards and specifications;
- Institute for Archaeologists – Standard and Guidance for archaeological field evaluation, 2008 (revised);
- Institute for Archaeologists – Standard and Guidance for archaeological excavation, 2008 (revised);
- Institute for Archaeologists – Standard and Guidance for an archaeological watching brief, 2008 (revised);
- Museum of London collections and archive policies and guidance;
- English Heritage – Geoarchaeology, 2007;
- English Heritage - Archaeological Science at PPG16 interventions: Best Practice Guidance for Curators and Commissioning Archaeologists, 2003;
- GLAAS Archaeological Guidance Papers 1999;
- Corporation of London archaeology guidance – Planning Advice Note 3, 2004;
- Museum of London Archaeology Service site recording manual (MOLAS 1994);
and
- English Heritage – Understanding Historic Buildings – A guide to good recording practice, 2006

Potentially nationally important remains

7.1.2 Where unexpected, potentially nationally important archaeological remains (as defined in the Crossrail Environmental Minimum Requirements and Generic WSI) are identified during the works, the Archaeology Contractor shall undertake works in accordance with the Environmental Requirements (archaeology) section of the relevant package Works Information and shall adhere to procedures as set out in the SS-WSI.

7.1.3 The Archaeology Contractor shall submit details of their procedure for excavating and recording potentially nationally important remains in the Archaeology Contractor's Method Statement.

7.1.4 Details shall be in accordance with Crossrail procedures and include how relevant parties are to be informed of such discoveries, the criteria to be utilised by the

Archaeology Contractor in the assessment of the significance of such discoveries and the timescales to be adhered to.

- 7.1.5 As a result of the discovery of unexpected, potentially nationally important archaeological remains, the SS-WSI will be updated by the Design Archaeologist and reissued by the Project Archaeologist to incorporate any additional specific primary fieldwork event aims.

Human Remains

- 7.1.6 Certain aspects of the normal legal procedure for the removal of human remains (and associated monuments) from burial grounds has been modified by Schedule 15 to the Crossrail Act 2008. However for other aspects, normal legislation applies.
- 7.1.7 Where human remains are identified, all subsequent works must be undertaken in accordance with relevant legislative and environmental health requirements as set out in the Environmental Requirements (archaeology) section of the relevant package Works Information.
- 7.1.8 Crossrail procedures for dealing with discoveries of human remains shall identify any specific individual roles or actions that are relevant to the works. Details shall include how relevant parties are to be informed of such discoveries, the criteria to be utilised in the assessment of the significance of such discoveries, the application process for licences and the timescales to be adhered to.
- 7.1.9 The Archaeology Contractor shall confirm how the requirements set out in the SS-WSI will be implemented as part of their procedure for excavating and recording human remains in the Archaeology Contractor's Method Statement. This should incorporate best practice guidance e.g. Council for the Care of Churches (1999) and English Heritage (2002 and 2002a).
- 7.1.10 At sites known in advance to have a high risk of encountering human remains, provision shall be made by the Archaeology Contractor for site inspection by a recognised specialist.
- 7.1.11 Should human remains be discovered, the Archaeology Contractor shall notify the Project Archaeologist immediately so that these procedures can be implemented. This notification may be initially made personally or by telephone but shall be confirmed in writing within 24 hours of discovery.
- 7.1.12 The Principal Contractor will be required to cease all works at that location until further instruction is provided by the Project Archaeologist. The Archaeology Contractor shall undertake an initial in situ observation and assessment of the remains and shall advise the Project Archaeologist of the course of action required.
- 7.1.13 Lifting of human skeletal remains shall be kept to the minimum which is compatible with an adequate evaluation or excavation. Notwithstanding this, the Archaeological Contractor shall ensure that all burials are planned/photographed in-situ and that appropriate samples have been recovered prior to any lifting.
- 7.1.14 Visible grave goods and other obvious artefacts, shall be recorded and lifted before the end of the working day to avoid the risk of vandalism and theft. Where this is not feasible or appropriate, the Archaeology Contractor shall ensure, on liaison with the Project Archaeologist that adequate site security is provided by the Principal Contractor.

As a minimum, this will require a 24 hour comprehensive security regime until sensitive remains have been recorded and lifted.

7.1.15 As a result of the discovery of unexpected, potentially nationally important archaeological remains, the SS-WSI will be updated by the Project Archaeologist to incorporate any additional specific primary fieldwork event aims.

Treasure Act

7.1.16 The Treasure Act 1996 defines 'Treasure' as:

- Any object at least 300 years old when found which is: not a coin, but has metallic content of which at least 10% is precious metal; or
- One of at least two coins with at least 10% precious metal content;
- One of at least 10 coins;
- Any object at least 200 years old designated as treasure by the Secretary of State;
- Any object which would have been 'Treasure Trove';
- Any object found with any of the above.

7.1.17 The Treasure (Designation) Order 2002 extends the definition of treasure to include:

- Finds of at least two base metal objects (other than coins) of prehistoric date; and
- Any object (other than a coin) of prehistoric date with any precious metal content.

7.1.18 All finds falling within the definitions of treasure shall be reported immediately to the Project Archaeologist and all subsequent works must be undertaken in accordance with the relevant legislative requirements as set out in the Environmental Requirements (archaeology) section of the relevant package Works Information.

7.1.19 Crossrail procedures for dealing with Treasure finds shall identify any specific individual roles or actions that are relevant to the works. Details shall include how relevant parties are to be informed of such discoveries, the criteria to be utilised in the assessment of the significance of such discoveries and the timescales to be adhered to.

7.1.20 To protect the finds from theft, the Archaeology Contractor shall record the finds and remove them to a safe place. Where recording and removal is not feasible or appropriate on the day of discovery, the Archaeology Contractor shall ensure, on liaison with the Project Archaeologist that adequate site security is provided by the Principal Contractor.

7.1.21 Subject to the Provisions of the Treasure Act 1996, all material that is defined as Treasure is vested in the franchisee or, if none, the Crown.

7.1.22 With respect to Treasure finds, a reward may be payable to the finder, the landowner and/or the occupier. The Crown usually offers finds to a museum.

7.2 Health and safety

7.2.1 The Archaeology Contractor shall undertake the works in accordance with the Employer's Health and Safety requirements and the Principal Contractor's Health and Safety Plan. Where specific health and safety constraints or requirements for the Archaeology Contractor's method of work are required, these are set out below and shall be addressed in the Archaeology Contractor's Method Statement (in the Health and Safety Plan).

7.2.2 No ground intervention or other survey shall be made prior to approval of the Archaeology Contractor's Health and Safety Plan, Method Statement and Risk Assessment by the CDM co-ordinator and/or Principal Contractor responsible for the works.

7.2.3 Hand excavation or other remote sensing method may be required prior to any mechanical excavation in the first instance to locate any known or suspected below ground hazards. The Archaeology Contractor's Method Statement and Risk Assessment shall take account of any design information (including the Designer's and Principal Contractor's Risk Assessment) pertaining to above ground hazards such as buildings and other structures or public rights of way and below ground hazards such as services, utilities and infrastructure and shall contain a site specific Risk Assessment for unknown below ground hazards such as contaminants including unexploded ordnance. All appropriate mitigation measures shall be in place prior to commencement of any ground intervention or other survey.

7.2.4 Trial trench excavation method and earthworks support design, shall conform to Health and Safety legislation and safety standards as well as incorporating current engineering best practice, where appropriate.

7.3 Location and ground elevation of interventions and survey grids

7.3.1 The spatial extent of the investigation(s) shall be set out by the Principal Contractor or Archaeological Contractor (as required by works information) in accordance with the setting out co-ordinates supplied by the Project Archaeologist. All spatial setting out and recording shall be in accordance with The London Survey Grid Standard (formerly Crossrail Survey Grid). See Crossrail standard CR-STD-010.

7.3.2 Interventions shall be located to a horizontal accuracy of +/-500mm in relation to the detail illustrated in the contract drawing(s). The corner points of each excavation or the centre point of each soil core location shall be set out with a Total Station Theodolite or other suitable automated equipment referenced from approved Permanent Ground Marker (PGM) data supplied to the Archaeology Contractor by the Project Archaeologist. The positions of the trenches and survey points shall be verified by the Archaeology Contractor taking additional check measurements to additional known-location points of detail.

7.3.3 Surface heights shall be recorded and related to PGMs or approved Ordnance Survey Bench Marks (OSBM). The full descriptions and locations of PGMs and OSBMs known to the Employer will be supplied to the Archaeology Contractor by the Project Archaeologist. Levelling accuracy between OSBMs/PGMs and site TBMs shall be within $10 \text{ mm} \sqrt{k}$: where 'k' is the total distance levelled in kilometres. Each TBM shall be levelled

as part of a closed loop starting and finishing on approved OSBMs or Crossrail PGMs. Where more than one TBM is required per site the Archaeology Contractor shall establish the TBMs as part of the same closed loop.

7.3.4 The Archaeology Contractor shall include details of their surveying methodology within their Method Statement (see Section 8), including the setting out of the grid and how they intend to provide the project grid co-ordinates to the Project Archaeologist with the Survey Report.

7.3.5 The Archaeology Contractor shall ensure that all trench or excavation limits, and significant archaeology detail are surveyed 'as dug' in relation to the project grid before leaving the site. Ground level height data shall be recorded for each intervention. Survey methodology and a detailed survey record shall be provided to the Project Archaeologist within the Survey Report.

7.4 Specification for geo-archaeological investigation (coring and boreholes)

7.4.1 Specification for geo-archaeology investigation shall be in accordance with English Heritage guidance and, where instructed by the Project Archaeologist, advice from the English Heritage regional scientific advisor.

7.4.2 The scope of any required laboratory analysis and proposed presentation of results shall be agreed with the Project Archaeologist, as appropriate to the context and scope of the investigation. Where required, laboratory analysis shall be addressed in the Archaeology Contractor's Method Statement.

7.4.3 Open tube sampling (U100/U4 Sampling) shall be used at each survey location (14 in total) to establish a measured stratigraphic profile, soil descriptions, and recover sediment samples for on- or off-site processing (according to the requirements of each SS-WSI). The proposed methodology and equipment type to be used to fulfil the aims of the investigation shall be set out in the SS-WSI and specified in the Archaeology Contractor's Method Statement. Hand excavation shall precede power assisted methods where specified in the approved Archaeology Contractor's Method Statement and/or Risk Assessment.

7.4.4 Each soil core sample hole shall be assigned a unique number by the Project Archaeologist. The Archaeology Contractor shall not vary this number unless agreed by the Project Archaeologist in writing.

7.4.5 Soil core sample holes shall be drilled and reinstated in accordance with the SS WSI, Works information, or other instruction from the Project Manager to protect the groundwater, minimise contamination pathways and/or address any other residual hazards. Each worksite location shall be reinstated in full prior to leaving the site.

7.4.6 Soil cores shall be drilled to sufficient depth to record the surface of the recorded floodplain gravels. Should significant obstruction be encountered within the predicted depth to impenetrable deposits, an additional hole shall be drilled at a distance of 1.0m from the survey point in a direction at the discretion of the event supervisor (if feasible). Should the additional hole encounter an obstruction of a similar nature the circumstances shall be recorded and the holes ceased.

7.4.7 Sample diameter shall be selected in consideration of local ground conditions but should be in the range of 50mm to 100mm depending on strata. Sampling tube length

should be capable of retrieving minimum sample length of 400mm and maximum of 2000mm.

- 7.4.8 The Archaeology Contractor shall log the stratigraphic sequence in the field through close observation of sample contents. The logging is to follow conventional standards and include colour (Munsell colour coding), grain size, sorting, roundness/angularity, composition, fabrics, structure, compaction, fossil content (including archaeological artefacts), visible floral/faunal inclusions, secondary characteristics, unit contacts, and general observations. The sedimentary record shall be recorded through use of graphic logs and written description by the Archaeology Contractor's suitably qualified geo-archaeologist.
- 7.4.9 Wherever practicable, soil samples shall be processed and recorded on-site by the Archaeology Contractor's suitably qualified environmental archaeologist to enable identification of archaeological remains, palaeo-environmental content and potential. Any such works shall be undertaken in accordance with the Principal Contractor's environmental requirements for the site (in particular any relevant consents relating to discharge of water). In cases where on-site sample processing is not practicable, samples shall be investigated and recorded by the Archaeology Contractor at their own premises, as agreed with the Project Archaeologist).
- 7.4.10 Samples judged by the environmental specialist to contain palaeo-environmental indicators or cultural remains shall be retained for off-site (or further) processing. Samples shall be wet-sieved through 5mm and 1mm mesh sequentially. Results shall be reported at the weekly progress meetings with the Project Archaeologist and shall inform the survey strategy.
- 7.4.11 Each (sub)sample shall be recorded with a unique sample record number, cross-referenced to a unique soil core sample number, and a written description of the processing record made on a standard environmental recording pro-forma. Sample flots shall be recovered for further analysis at the discretion of the Contractor's environmental archaeologist. Sample residues shall be retained for further off-site processing if showing significant potential for further analysis.
- 7.4.12 Soil profile data shall be entered into a field computer for daily mapping of sub-surface topography, utilising topographic survey software. On-site interpretation of contiguous deposits shall be made to provide a sub-surface site plan to inform the survey strategy and weekly progress meetings with the Project Archaeologist.
- 7.4.13 A colour photographic record utilising 35mm film or digital format shall be made of the site survey works whilst they are in progress to graphically demonstrate each activity. Significant soil core samples shall be photographically recorded (in colour), prior to processing. These may include significant contacts revealed in the sample window or deposits containing significant palaeo-environmental or cultural assemblages. All records shall be cross-referenced to the unique soil core sample number.
- 7.4.14 The Archaeology Contractor shall provide a detailed methodology for stratigraphic recording and presentation of results, sample recovery, sample processing and recording within their Method Statement.

7.5 Specification for watching brief

Scope of Watching Brief

- 7.5.1 Watching brief, as defined in the Generic WSI, is a programme of archaeological monitoring (i.e. observation, investigation and recording) which is carried out by a suitably qualified archaeologist during site investigations (e.g. geotechnical test pits, boreholes and utilities trial trenches) and construction works. The purpose of a watching brief is to identify the potential of any archaeological remains that are uncovered in the course of the works and record them appropriately (as far as is reasonably practicable). The watching brief shall result in the preparation of an ordered archive which will be incorporated into the post-excavation works and into publication of the project results.
- 7.5.2 The Archaeology Contractor shall undertake the watching brief for all areas of ground disturbance which may potentially contain archaeological remains as set out in the SS-WSI. This shall include any activities (including those associated with site set-up and demolition) undertaken by the Principal Contractor that involve the removal of modern material, made ground and topsoil, subsoils, and superficial geological deposits such as alluvium and colluvium.
- 7.5.3 Areas that have been previously subject to archaeological excavation and which are known not to contain significant deposits (for example tunnels, cuttings, and areas of known large-scale modern disturbance) shall be excluded from the scope of the watching brief, unless stated otherwise in the SS-WSI. Areas that have been subject to previous assessment and evaluation (e.g. geophysical survey, surface artefact collection, geotechnical survey, trial trenching etc.) shall be included within the watching brief, as appropriate.
- 7.5.4 Two classes of watching brief are set out in the Generic WSI:
- i. A general watching brief shall comprise observation and recording of the Principal Contractor's works without constraint on their working methods.
 - ii. A targeted watching brief shall comprise observation and recording of the Principal Contractor's works with specific operations carried out under the supervision of the Archaeology Contractor. Under targeted watching brief, the Archaeology Contractor may impose constraints on, or require changes to, the Principal Contractors' or his sub-contractor's method of working to enable the archaeological investigation to take place alongside construction works.
- 7.5.5 Targeted watching brief shall be used for areas of known occasional, dispersed features which are either not considered to be of sufficient significance to warrant archaeological investigation in advance of construction, or where access prior to construction has not been possible and where, as a result, there is a possibility of unexpected discoveries
- 7.5.6 Except in cases where unexpected, potentially nationally important, archaeological remains are discovered, the targeted watching brief shall be designed and implemented so as to avoid adverse impact on the construction programme, wherever practicable.
- 7.5.7 The Principal Contractor shall make allowance in their activity programme for the completion of any targeted or general watching briefs as set out in the SS-WSIs.
- 7.5.8 The specification for watching briefs (general and targeted) are set out below:

Scope of Targeted Watching Brief - Constraints on Principal Contractor's Methodology

- 7.5.9 In archaeologically sensitive areas, where the need for a targeted watching brief has been identified in the SS-WSI, the Principal Contractor will strip soils (which may include

modern made ground, topsoil, subsoil, alluvium and colluvium) using a 360 degree excavator and toothless ditching bucket under the supervision of the Archaeology Contractor. The Principal Contractor will limit their tracking of vehicles and plant within areas specified in the SS-WSI and/or as instructed by the Project Archaeologist. The Principal Contractor will facilitate mapping and sampling of deposits by the Archaeology Contractor through use of agreed plant, a site share agreement and careful liaison between the Archaeology Contractor's supervising archaeologist and the Principal Contractor's site supervisor.

Specification for watching brief

- 7.5.10 The Archaeology Contractor shall undertake a general watching brief during enabling works at the 11kV cable diversion and establishment of the Pudding Mill Lane worksite; and during advanced works at the realignment of Barbers Road and associated service diversions in the areas illustrated on drawing C152-SWN-C2-DDA-CR094_PT002_Z-95004 (Annex 1).
- 7.5.11 The Archaeology Contractor shall undertake a targeted watching brief during enabling works at the excavation of the NG 400kV cable trough and jointing pit; during advanced works during demolition and groundworks on the western side of the River Lea and during the continuation of the NG 400kV cable trough and jointing pit; and during ground lowering in advance of piling at the DLR station. See Drawing Number C152-SWN-C2-DDA-CR094_PT002_Z-95004 (Annex 1).
- 7.5.12 The Works to be carried out by the Archaeology Contractor shall consist of two parts:
- a) Watching brief ('observation') following, and without interruption to, the progress of the Principal Contractor by a core team of archaeologists.
 - b) Investigation of archaeology and remains of quaternary geological importance undertaken either:
 - by the core team, following the progress of the Principal Contractor; or
 - by additional archaeologists (the 'support team'), to be deployed to investigate unanticipated archaeological remains, where appropriate.

- 7.5.13 The Archaeology Contractor's core team shall consist of the Archaeology Contractor's key person (the field director) and other appropriately experienced archaeologists commensurate with the scale and nature of the Principal Contractor's works.
- 7.5.14 The core team shall undertake the observation and any required investigation such as they may reasonably be able to undertake.
- 7.5.15 The Archaeology Contractor's support team shall consist of additional experienced archaeologist. The size of the support team shall be commensurate with the scale and programme of the Principal Contractor's works. The Archaeology Contractor shall be required to supply teams of 5 and 10 persons within 24 and 48 hours notice respectively.
- 7.5.16 The Archaeology Contractor's core and support teams shall be advised where necessary by specialists, as appropriate and as agreed with the Project Archaeologist.
- 7.5.17 The Archaeology Contractor shall record the following observations on a daily basis. The record shall consist of, as a minimum:
- The Event Code and chainage/location of the area observed;
 - The date(s) of the observation;
 - Personnel employed on site;
 - A description of the construction works observed;
 - The works (sub) contractor and personnel undertaking and supervising the construction activity;
 - Depths and extents of excavation works observed;
 - Measure of confidence that any archaeological remains would have been observed and reasons;
 - The areas and horizons (both those containing archaeological or remains of quaternary geological importance and those which do not) unaffected by construction activity (with special reference to archaeological sites identified for preservation in situ);
 - The reasons why any particular area of the works was not observed, and noting those areas not subject to disturbance from construction;
 - Location and description of any archaeological remains; and
 - Location and description of any modern remains.

Investigation undertaken during watching brief

- 7.5.18 An appropriate sample shall be excavated from cut features and other archaeological remains of importance. Sampling of cut features shall include feature inter-sections to establish relative chronologies. The extent of sampling shall be determined by the Archaeology Contractor in liaison with the Project Archaeologist (and as discussed with the relevant local authority and English Heritage, and a quaternary specialist, if necessary) but may, for instance, include the sample excavation of a selected number of deposits (both layers and negative, cut features), recording of structural remains, drawn sections and profiles, and/or be aimed at recovering sufficient information to determine function, form, and date. Any specific variations from this specification shall be indicated in The Archaeology Contractor's Method Statement.
- 7.5.19 Heights for all deposits shall be related to approved Permanent Ground Markers (PGMs) or approved Ordnance Survey Bench Marks (OSBM), where reasonably accessible. Levelling accuracy between OSBMs/PGMs and site Temporary Bench Marks (TBMs) shall be within 10 mm k : where 'k' is the total distance levelled in kilometres. Each TBM shall be levelled as part of a closed loop starting and finishing on approved OSBMs or URL PGMs. Where more than one TBM is required per site, the Archaeology Contractor shall establish the TBMs as part of the same closed loop. The Archaeology Contractor shall prepare a record of their surveying methodology for inclusion in the archive.
- 7.5.20 It may not be possible to clean and record the archaeological profile of geotechnical test pits, due to health and safety or access constraints. Every effort shall be made to establish the presence or absence of archaeological deposits by establishing the absolute ordnance datum (AOD) for the height of significant deposits, including the depth of modern intrusions, key stratigraphic components and natural deposits.

Recording standards

- 7.5.21 The archaeological remains shall be recorded to best practice standards, recognising the special circumstances of a watching brief which demand flexibility in order to achieve archaeological objectives and requirements within the construction environment.
- 7.5.22 The recording is to include as a minimum:
- The written record of individual context descriptions on appropriate pro-forma.
 - The drawn record shall normally include, plans and section drawings of appropriate features, structures and individual contexts (1:50 1:20 or 1:10). Isolated archaeological remains (artefacts) may be spot located in plan and a height provided where possible. Deposits which are regular in plan (pits and ditches) may be located though co-ordinates, annotated with dimensions, and may be recorded digitally.
 - Other appropriate drawn and written records shall also be produced (for environmental sampling etc.).
 - The photographic record shall consist of monochrome prints/negatives and colour transparencies. A 35mm format (film or digital) SLR camera is acceptable for all site photography. The Archaeology Contractor shall maintain a minimum of two 35mm SLR cameras on site at all times during working



hours. The photographic record shall include photographs and transparencies of archaeological features, appropriate groups of features, structures, and quaternary deposits. Each photograph and transparency shall clearly show details of the above. Each photograph and transparency shall include an appropriate graduated scale, a north arrow, and a header board detailing (as a minimum) the event code and context/feature number. In addition, the Archaeology Contractor shall take appropriate record photographs to illustrate work in progress.

7.6 Specification for archaeological investigation

- 7.6.1 A sufficient sample of the archaeological features and deposits revealed must be sampled/or fully excavated to allow the resolution of the aims and objectives of the work. Structures, features, or finds which might reasonably be considered to merit preservation in-situ shall not be unduly damaged.
- 7.6.2 Where modern foundations are likely to be present, the SS-WSI shall identify whether they should be left in-situ for the purposes of the evaluation or removed. Where it is clear that modern foundations have truncated certain archaeological levels they should be removed to assess lower archaeological levels. The Archaeology Contractor shall take all reasonable care to ensure that any damage is limited as far as practicable. If significant damage is likely to occur the work shall be suspended and the Project Archaeologist informed so that a technical solution can be agreed with the Project Manager.
- 7.6.3 The location and objectives of the trial excavations set out in Section 5 of the SS-WSIs have been established in consultation with the projects' statutory consultees.
- 7.6.4 Each trial excavation has been assigned a unique ID number by the Project Archaeologist. The Archaeology Contractor shall not vary this number unless agreed by the Project Archaeologist in writing.
- 7.6.5 The dimensions of each trial excavation in plan, inclusive of the trench support system employed (if required) to secure personnel entry to the excavation, shall be set out in the SS-WSI. Trial excavations shall be excavated to the base of the alluvial sequence or to a depth specified in the SS-WSI (Section 5). This shall be dependent on the agreed objectives of the excavation.
- 7.6.6 Temporary works and any required hand investigation to address below ground hazards shall be carried out by the Principal Contractor under supervision by the Archaeology Contractor in accordance with their approved Method Statement and Risk Assessment. All subsequent trial excavations shall be excavated by the Principal Contractor under supervision by the Archaeology Contractor using a mechanical excavator with toothless ditching bucket, except where the nature of the made ground or surface of the pits is such that an alternative bucket or means of breaking out prior to excavation is required (and the Project Archaeologist has agreed an alternative method).
- 7.6.7 All machine work and demolition of below-ground obstructions (e.g. removal of basement slabs) shall be carried out by the Principal Contractor under supervision by the Archaeology Contractor. The Principal Contractor shall cease work when archaeological evidence is revealed and allow the Archaeology Contractor to undertake investigation, as appropriate. An excavator shall not be used to cut arbitrary trial trenches down to natural deposits without regard to the archaeological stratification.
- 7.6.8 All undifferentiated topsoil, or overburden of recent origin, shall be removed down to the first archaeological layer. An exception to this would be where a focused soil-sampling strategy is proposed to record and collect data from reworked soil contexts above recognisable stratified archaeological contexts. If a mechanical excavator is to be used to remove modern overburden, such as floor slabs or recent levelling layers, this shall be undertaken in spits of 0.20m-0.5m depth (dependant on specific site conditions), moving along the length of the trench or area. The Archaeology Contractor's supervising archaeologist shall use their professional judgement to determine the appropriate depth of each spit and will advise the Principal Contractor accordingly. Any variations to the

excavation methodology shall be at the discretion of the supervising archaeologist and recorded in writing for inclusion in the final report to the Project Archaeologist.

- 7.6.9 Each spit shall be examined carefully to assist the recovery of any archaeologically significant artefacts and thus to determine when to cease machining.
- 7.6.10 The archaeological level shall be cleaned in plan by the Principal Contractor using a wide blade, ditching bucket or similar, with no teeth. If the machine has to re-enter the trench care will need to be taken to ensure that it does not damage underlying remains.
- 7.6.11 The Archaeology Contractor shall undertake hand excavation and cleaning of any archaeologically significant horizons, to fulfil the aims of the work. Within alluvial sequences the Archaeology Contractor shall pay particular attention to establishing the vertical extent of layers of archaeological potential and shall be aware that horizons of cultural activity may be interdigitated with horizons of sterile alluvium. The Archaeology Contractor shall supervise the excavation of each test pit in such a manner so as to allow a cumulative or continuous section to be recorded.
- 7.6.12 The Archaeology Contractor's excavation, sampling and recording policy shall be included in the Archaeology Contractor's Method Statement. This is to include, as a minimum:
- The recording of individual contexts on appropriate pro-formas;
 - Excavation plans at 1:50 scale; planning and section drawing of appropriate single contexts and features (usually at 1:20 scale for plans and 1:10 scale for inhumations and sections);
 - Photographs; and other appropriate drawn and written records; and
 - Permanent Ground Markers (PGM's), any temporary benchmarks and approved OS benchmarks shall be indicated on the relevant plans.
- 7.6.13 The Archaeology Contractor's survey and recording policy shall meet the following requirements:
- All levels shall be recorded to London Grid standards and reduced to OS datum;
 - All trial pit locations shall be electronically surveyed with reference to the London Grid and Crossrail PGM's upon the completion of fieldwork by the Archaeology Contractor;
 - The locations of trial pits shall be plotted on appropriate scale plans related to the London Grid and labelled with six figure eastings and northings; and
 - The electronic survey record shall be retained with the project archive.
- 7.6.14 In alluvial sequences, each trial excavation shall be excavated to the base of the alluvial sequence, and shall be appropriately shored and kept free of water by the Principal Contractor to allow 'person entry' to the excavations i.e. to allow the Archaeology Contractor to undertake investigation and recording to fulfil the aims of the work.
- 7.6.15 The Archaeology Contractor shall identify any temporary works and dewatering requirements associated with the archaeological investigation in the Archaeology Contractor's Method Statement and shall agree the detailed arrangements for such with

the Principal Contractor. The Archaeology Contractor will be required to undertake works in accordance with the Principal Contractor's arrangements for matters such as off site-spoil disposal or storage, on-site facilities and services. Relevant requirements shall be incorporated in the Archaeology Contractor's Method Statement.

7.6.16 Where areas of extensive archaeological stratification are encountered, trial trenches shall not be fully excavated. However, the horizontal and vertical extent of archaeological stratification shall be assessed by the Archaeology Contractor through implementation of an appropriate strategy including, either the excavation of features cut into horizontal stratification, limited test pitting or auguring. The aim shall be to recover suitable stratigraphic, finds and environmental samples from the full, intended depth of the trench, as far as is practicable. The exact methodology may need to be determined by the Archaeology Contractor during the excavation of individual trenches and agreed with the Project Archaeologist.

7.6.17 A sufficient sample shall be excavated from cut features and other archaeological deposits to fulfil the aims of the work. Sampling of cut features shall include feature intersections to establish relative chronologies.

Recording systems

7.6.18 The trial excavations shall be recorded by the Archaeological Contractor to the standards of current best practice. The recording systems adopted during the investigations must be fully compatible with those published by the Museum of London Archaeology Service (MoLAS 1994 3rd ED) and Museum of London (MoL 1998).

7.6.19 The recording is to include, as a minimum:

- At least one representative section at (1:10 or 1:20 scale) of each trial excavation from ground level to the base of the excavation;
- The written record of individual context descriptions on appropriate pro-forma;
- Plans at appropriate scales (1:10 or 1:20);
- Single context planning if appropriate; and
- Photographs and other appropriate drawn and written records.
- Other sections, including the half-sections of individual layers or features shall be drawn as appropriate to 1:10 or 1:20.

7.6.20 Site plans shall identify both London Grid and OS co-ordinates. A 'site location plan', indicating site north shall be prepared at 1:1250. Individual 'trench plans' or 'excavation area plans' at 1:200 (or 1:100) shall be prepared which show the location of archaeology investigated in relation to the investigation area.

7.6.21 Section drawings shall be located on the relevant plan and both London Grid and OS co-ordinates recorded. The locations of the OSBM or PGM bench markers used and any site TBM shall also be indicated.

7.6.22 A record of the full extent in plan of all archaeological deposits as revealed in the investigation shall be made; these plans shall be on polyester based drawing film, and be at a scale of 1:10 or 1:20 unless otherwise agreed with the Project Archaeologist. 'Single context planning' shall be used on deeply stratified sites. Drawing information shall be digitised for eventual CAD applications. The GLSMR will accept Autocad DXF or .DWG

format of extent of site and location of major features with the completed Sites and Monuments Report Form.

- 7.6.23 A 'Harris matrix' stratification diagram shall be employed to record stratigraphic relationships (Harris 1993). This record shall be compiled and fully checked by the Archaeological Contractor during the course of the excavations. Spot dating shall be incorporated onto this diagram during the course of excavations.
- 7.6.24 Recording of structural evidence revealed below ground level will vary according to the level of special interest of the structure and its relationship to below-ground archaeology. Structures of little or no significance shall be noted on a site plan. Detailed element detail drawings of important features revealed in investigations may be required in accordance with the aims and objectives of the investigation.
- 7.6.25 The Archaeology Contractor shall agree the appropriate level of recording and analysis for discovered standing structures with the Project Archaeologist, in accordance with the Crossrail procedure for non-listed built heritage recording (Document CR-PN-PRW-EN-PD-00010). The Archaeology Contractor shall revise the Archaeological Contractor's Method Statement to reflect any additional requirements for built heritage recording.
- 7.6.26 The photographic record shall consist of monochrome prints/negatives and colour transparencies. A 35mm format SLR camera (film or digital) is acceptable for all site photography. The Archaeology Contractor shall maintain a minimum of two 35mm SLR cameras on site at all times during working hours. The photographic record shall include photographs and transparencies of archaeological features, appropriate groups of features, and structures. Each photograph and transparency shall clearly show details of the above, and may require the use of artificial lighting to achieve suitable definition. Each photograph and transparency shall include an appropriate graduated scale, a north arrow, and a header board detailing (as a minimum) the project event code and context/feature number. In addition, the Archaeology Contractor shall take appropriate record photographs to illustrate work in progress.
- 7.6.27 The transparencies shall be mounted in suitable frames for long-term curation in preparation for deposition with the archive. Digital photography and video recording may be appropriate in some circumstances and the Archaeology Contractor shall set out proposals for such recording in the Archaeology Contractor's Method Statement for approval by the Project Archaeologist.
- 7.6.28 Where appropriate a photogrammetric record or laser scan record shall be made of complex structures, features and horizons, liable to be damaged in the course of the investigation, such as buildings or parts of buildings. Appropriate technical specification and scales shall be specified in the SS-WSI and addressed in the Archaeology Contractor's Method Statement.

7.7 Specific Requirements for the excavation of trial trenches or pits

- 7.7.1 The Archaeology Contractor or Principal Contractor (as required by the Works Information) shall ensure that water is discharged and arisings from archaeological excavations are stored in accordance with the Principal Contractor's environmental protection requirements (as set out in the package Works Information and their Environmental Management Plan) and any relevant consents for the worksite. The Project Manager shall monitor discharge rates and if necessary conductivity of discharge waters to ensure compliance.

- 7.7.2 Should any material be excavated that is deemed to be contaminated or potentially contaminated it shall be investigated, controlled (e.g. placed separately from clean material) and removed from the site in accordance with the Principal Contractor's environmental protection requirements (as set out in their Environmental Management Plan).
- 7.7.3 The Archaeology Contractor shall ensure, in liaison with the Project Archaeologist that adequate protection is provided for any archaeological remains. Any specific archaeological requirements relating to backfilling shall be included by the Archaeology Contractor in their Method Statement.
- 7.7.4 The trenches shall be pumped dry by the Principal Contractor and any necessary protection measures for archaeological remains (in addition to those for below ground infrastructure, services or utilities) shall be completed prior to backfilling. Backfilling and reinstatement shall be undertaken by the Principal Contractor as specified in the package works information and in accordance with the approved Archaeology Contractors Method Statement or other instruction from the Project Archaeologist and/or Project Manager. Generally, all backfill material shall consist of non-toxic, uncontaminated, non-putrescible, natural and inert material which shall be compacted and (if necessary) tested (dynamic compaction test or other) in accordance with a specification provided by the Project Manager. Surface conditions shall be reinstated to the required standard.
- 7.7.5 In order to protect any waterlogged remains during the works, the Archaeology Contractor may identify a requirement for trial excavations to be allowed to refill with water overnight. In such cases, the Archaeology Contractor shall request approval from the Project Manager and shall ensure that any hazards to staff or 3rd parties are minimised.

7.8 Archaeological science

- 7.8.1 The strategy for sampling archaeological and palaeo-environmental deposits and structures (which can include soils, timbers, pollen, diatoms, animal bone, human bone etc.) will be developed by the Project Archaeologist in consultation with English Heritage Regional Science Advisor and the Archaeology Consultant. On-site work and off-site analysis of the processed samples and remains will be undertaken by the Archaeology Contractor's environmental archaeologist as specified in the Archaeology Contractor's Method Statement.
- 7.8.2 The finds retrieval policies of the appropriate recipient museum will be adopted. In accordance with the collection and retention strategy set out in SS-WSI, all finds (artefacts and ecofacts) visible during excavation shall be collected and processed by the Archaeology Contractor. In some cases, sampling may be the most appropriate strategy. Finds shall be appropriately packaged and stored under optimum conditions, as detailed in the RESCUE/UKIC publication First Aid for Finds (Watkinson and Neal 1998).
- 7.8.3 Where there is evidence for industrial activity, macroscopic technological residues (or a sample of them) shall be collected by hand. Separate samples (c. 10ml) shall be collected for micro-slugs (hammer-scale and spherical droplets). Reference should be made to the Centre for Archaeology Guideline on Archaeometallurgy (English Heritage 2001). Assessment of any technological residues shall be undertaken.
- 7.8.4 Where appropriate, samples shall be taken for scientific dating (for example radiocarbon dating, OSL, thermoluminescence at the evaluation stage). This may apply where dating by artefacts is insecure or absent, and where dating is necessary for

development of the SS-WSI for subsequent mitigation strategies. Procedures and specifications shall follow English Heritage guidance (English Heritage 2008b).

- 7.8.5 Buried soils and sediment sequences shall be inspected and recorded on site by the Archaeology Contractor's geoarchaeologist, since field inspection may provide sufficient data for understanding site formation processes. Procedures and techniques presented in the English Heritage documents Environmental Archaeology (English Heritage 2002) and Geoarchaeology (English Heritage 2007) shall be followed. Samples for laboratory assessment shall be collected where appropriate, following agreement with the Project Archaeologist.
- 7.8.6 Deposits shall be sampled for retrieval and assessment of the preservation conditions and potential for analysis of biological remains following English Heritage guidance (English Heritage 2002). The sampling strategy shall include a reasoned justification for selection of deposits for sampling, and shall be developed by the Archaeology Contractor's environmental archaeologist or recognised bioarchaeologist in liaison with the Project Archaeologist. Flotation samples and samples taken for coarse-mesh sieving from dry deposits shall be processed at the time of the fieldwork wherever possible, to permit variation of sampling strategies if necessary. Sampling strategies for wooden structures shall follow the methodologies presented in Brunning (1996).
- 7.8.7 Artefacts, biological samples and soils shall be assessed for evidence of site and deposit formation processes and taphonomy and especially for evidence of recent changes that may have been caused by alterations in the site environment.
- 7.8.8 Assessment of finds assemblages shall include x-radiography of all iron objects (after initial screening to exclude obviously recent debris) and, where appropriate, non-ferrous artefacts (including all coins). Where necessary, active stabilisation /consolidation shall be carried out to ensure long-term survival of the material, but with due consideration to possible future investigations.
- 7.8.9 Once assessed, all material shall be packed and stored in optimum conditions, as described in First Aid for Finds (Watkinson and Neal 1998). Waterlogged organic materials shall be processed in accordance with: Guidelines for the care of waterlogged archaeological leather (English Heritage/Archaeology Leather Group 1995) and Waterlogged wood: the recording, sampling, conservation and curation of structural wood (Brunning 1996).
- 7.8.10 Samples for absolute dating shall be submitted promptly to the supply laboratory proposed by the Archaeology Contractor or other supplier as instructed by the Project Archaeologist. Delivery times shall be agreed to ensure that the results are available to aid development of specifications for subsequent mitigation strategies in the SS-WSI. Where it is proposed to date human remains, the time limits for reburial imposed by Schedule 15 of the Crossrail Act (for remains removed from burial grounds) or set out in the relevant burial licence under the Burial Act 1857 (in all other cases) shall be adhered to.
- 7.8.11 Processing of all soil samples collected for biological assessment, or sub-samples of them, shall be completed as soon as reasonably practicable. The preservation state, density and significance of material retrieved shall be assessed by the Archaeology Contractor's recognised specialist. Special consideration shall be given to any evidence for recent changes in preservation conditions that may have been caused by alterations in the site environment. Unprocessed sub-samples shall be stored in appropriate conditions in accordance with the Archaeology Contractor's Method Statement.

- 7.8.12 Samples collected for geo-archaeological assessment shall be processed promptly by the Archaeology Contractor's specialist, particularly where storage of unprocessed samples is thought likely to result in deterioration. Appropriate assessment shall be undertaken as agreed with the Project Archaeologist. Where preservation in situ is a viable option, consideration shall be given to minimising the possible effects of compression and loading on the physical integrity of the site and any hydrological or chemical impacts of the proposed construction works (English Heritage 2002).
- 7.8.13 Animal bone assemblages, or sub-samples of them, shall be assessed by the Archaeology Contractor's specialist with reference to English Heritage guidance (English Heritage 2002).
- 7.8.14 The results from any specific investigations in Archaeological Science shall be included in the Site Archive and presented in the evaluation report or final fieldwork report. Reports shall include sufficient detail to permit assessment of potential for analysis. They shall include tabulations of data in relation to site phasing and contexts, and include non-technical summaries. The objective presentation of data shall be clearly separated from interpretation i.e. recommendations for further investigations, (both on samples already collected, and at future excavations), shall be clearly separated from the results and interpretation.

Generic specification for Environmental Sampling

- 7.8.15 Appropriate features and deposits shall be sampled to retrieve palaeo-environmental and economic indicators. The Archaeology Contractor shall make provision for the sampling of a wide range of contexts for potential assessment and analysis for plant and animal micro/macro fossils and soils/sediments in order to fulfil the aims set out in the SS-WSI.
- 7.8.16 The Archaeology Contractor shall use ten litre plastic buckets (with lids and handles), or strong polythene bags (double bagged) secured at the neck, for the recovery of bulk 'disturbed' environmental samples. An adhesive label recording the project event code, context number and sample information shall be securely fixed to a vertical face of the bucket only or attached to the neck of the bag. Labels shall be completed with an indelible ink pen. A duplicate non-adhesive label shall be inserted within the bucket or between the polythene bags.
- 7.8.17 The selection, preparation for and methods of taking samples together with their size, presentation and processing shall be in accordance with current best practice (e.g. IFA Standard and Guidance for Artefact and Environmental Study, Collection, Research and Conservation 2008d; English Heritage –Geoarchaeology, 2007; English Heritage - Archaeological Science at PPG16 interventions: Best Practice Guidance for Curators and Commissioning Archaeologists, 2003).
- 7.8.18 The Archaeology Contractor shall be responsible for the protection of all samples and finds and for their transport (including loading and unloading) to the Archaeology Contractor's facilities or other location as agreed with the Project Archaeologist. Samples shall be protected at all times from temperatures below 5 and above 25 degrees Celsius and from wetting and drying out due to weather exposure.
- 7.8.19 Bulk samples shall normally be in the range of 10-60 litres. The size selected will depend on the likely density of macrofossils in the soil. The lower end of the range (10-20 litres) will be suitable for the recovery of macrofossils from waterlogged deposits. For non-waterlogged deposits the sample volume is likely to be in the middle to higher range

(20-40 or 40-60 litres) dependant upon site activity, conditions and preservation. The residue of soil left in the bottom of any inhumations after the removal of human remains shall be retrieved for bulk processing. Vessel or pit fills containing human remains shall be processed as bulk samples to ensure the maximum retrieval of cremated bone. Cremation vessels and deposits of placed human bone within cut features may require excavation in spits. The fill residues from the excavation of these features shall be bulk sampled to ensure maximum retrieval of cremated bone, associated small finds and floral and faunal remains. All work shall be undertaken in compliance with the generic Crossrail standards for Human Remains (see Section 7A) which may require the reburial of human remains within a specific timeframe.

- 7.8.20 For 'bulk disturbed' samples the limits of the sample zone shall be recorded and identified on plan.
- 7.8.21 The Archaeology Contractor shall use appropriately sized monolith or kubiena boxes for the recovery of 'undisturbed' monolith samples for geo-archaeological study (pollen, other microfossil and micromorphological studies etc). Care shall be taken to ensure that wherever possible only newly exposed sections are sampled to avoid contamination, desiccation and decalcification. This sampling shall be undertaken under supervision of the Archaeology Contractor's environmental specialist. Boxes shall be wrapped neatly and tightly in bin-liners or plastic sacks and secured with rubber bands. A label shall be attached to the outside (in duplicate) with site name and code, feature/context number and depths of sample.
- 7.8.22 The Archaeology Contractor shall record the depth of the 'undisturbed' monolith at the top and the bottom of the sample. There shall be a 50mm overlap between each monolith. This information shall be plotted onto a section drawing at an appropriate scale, with all levels reduced to heights relative to Ordnance Datum. Where the sample crosses archaeological context boundaries these shall be noted on the sample recording pro-forma.
- 7.8.23 Where it is not possible to insert monolith boxes, the Archaeology Contractor shall take a vertical series of small 'spot' samples. Samples shall be at 20mm vertical intervals with no more than 10mm depth being sampled. In the case of deposits with a low organic content it may be necessary to take as much as 5g or even 20g per sample. If so, sampling shall be extended laterally at a given depth in 10mm deep spits.
- 7.8.24 Where appropriate, the Archaeology Contractor shall take contiguous column samples for the retrieval of macrofossils. The individual sub-samples will be of 1-10kg, depending on the nature of the deposit and the category of material to be retrieved. Where several specialists are involved it may be necessary to take separate sub-samples for a range of palaeo-environmental evidence, for example, insects, molluscs and seeds, to ensure that adequate sub-samples are available for specialist assessment.

8 Deliverables

8.1 Archaeological Contractors Method Statement

8.1.1 The Archaeology Contractor shall provide a detailed Method Statement for the works for the Project Archaeologist's approval. The Method Statement shall be prepared in association with the Principal Contractor, taking account of their Environmental Management Plan and other relevant site information provided by them and requirements for the works set out in the Works Information (e.g. relating to health and safety, security, engineering design requirements and attendances). The Method Statement shall include, as appropriate:

- a) A resource plan and programme and CV's;
- b) The Archaeology Contractor's IT capability and proposed IT plan (including specific survey methods for on-site recording of stratigraphic profiles and sub-surface topographic modelling);
- c) The Archaeology Contractor's approach to Archaeological Science;
- d) The methods for survey and setting out works;
- e) The methods to address the specific event types required (trial trench, area excavation etc);
- f) The safe method of working whilst excavating trenches or pits including any temporary works required;
- g) The method for disposing of water from trenches and test pits in waterlogged ground;
- h) Site management plan to include details of the method for preparing safe access route to the working areas, the proposed site accommodation, services and welfare;
- i) The retention and disposal policies for samples and artefacts recovered during the work;
- j) The method for excavating and recording inhumations and cremations in compliance with the generic Crossrail standards for Human Remains (see Section 7.1);
- k) The method for preparation of the required reports, archive and all associated deliverables;
- l) The procedures for assessment of potential for analysis (post excavation assessment); analysis and publication proposals;
- m) The method for preparation of the digital dataset, digital drawings, and digital report deliverables;
- n) The Archaeology Contractor's methods and approach for undertaking the site based works and off site processes to completion.
- o) The Health and Safety Plan and Site-Specific Risk Assessment (including unexploded ordnance);
- p) The Quality Assurance Plan;
- q) The procedures for on- and off- site security and emergency response plan (including environmental incidents);

- r) The method for complying with project generic and site specific environmental and consent requirements; and
- s) The Archaeology Contractor's requirements and specification for services and facilities and attendances required to be supplied by the Principal Contractor or the Employer.

8.2 Site Archives

- 8.2.1 The site archive shall be organised to be compatible with other archaeological archives in London, or where outside the greater London area, any specific requirements of the receiving museum. This requirement for archival compatibility includes computerised databases.
- 8.2.2 For London archives, individual descriptions of all archaeological strata and features excavated or exposed shall be entered onto prepared pro-forma recording sheets which include the same fields of entry on the recording sheets of Museum of London Archaeology. Sample recording sheets, sample registers, finds recording sheets, registered finds catalogues and photographic record cards shall also follow the Museum of London Archaeology equivalents.
- 8.2.3 Archives shall be prepared to conform with current best practise (e.g. Brown and Duncan 2007; Institute of Field Archaeologists 2008f) The archive shall cover all finds, samples and records (drawn, written, photographic and electronic) collected and produced during the works. The archive shall be indexed and internally consistent. The Archaeology Contractor shall complete the site archive and submit to the Project Archaeologist within 8 weeks of completion of a fieldwork event.
- 8.2.4 The site archive shall be deposited by at a museum to be confirmed by the Project Archaeologist.

8.3 Digital Data

- 8.3.1 The Archaeology Contractor shall produce a digital data archive of all primary field data produced during the works in accordance with ADS guidelines (Richards and Robinson 2001).
- 8.3.2 The Archaeology Contractor shall prepare and provide field and laboratory data, evaluation or excavation trench and phasing plans showing archaeological features recorded, and report text in digital form, as well as in paper form. Consideration should be given to recording electronic plans during fieldwork.
- 8.3.3 The digital archive for each fieldwork event shall be copied to CD-R or DVD (recordable laser disc) and submitted to the Project Archaeologist for archiving in the Employer's document management system.
- 8.3.4 Final reports, site plans and other illustrations shall be prepared in accordance with the Employer's Information Management standards and procedures.
- 8.3.5 All data files submitted shall be scanned by a virus detection programme updated to the most current version. The disk label shall clearly indicate:
- Confirmation that this check has been carried out (including details of the virus checking programme name and version used) and that the submission is virus free.

- Fieldwork event name and code.
- Supplier company name, date and QA details (as a minimum, the name, position and signature of the approver).

8.3.6 Prior to commencing the works, the Archaeology Contractor shall submit an example hard copy and data output of each of the data formats required (i.e. data, graphic, CAD and text) produced by their current software, for approval by the Project Archaeologist. The Archaeology Contractor shall inform the Project Archaeologist of any changes or upgrades made to approved software prior to processing any works data. The sample disk shall include data from a previous real job or jobs.

8.3.7 A sequential numbering of data issues shall be rigorously adhered to so that no data versions are submitted out of sequence. The organisation of the data prior to submission shall be the responsibility of the Archaeology Contractor. The Archaeology Contractor shall ensure that data originating from different sources within the Archaeology Contractor's organisation is compatible with the project requirements. The Archaeology Contractor shall nominate one person to the Project Archaeologist who is the main point of contact for matters relating to the digital data submissions.

8.3.8 Where errors or inconsistencies are noted in the data, by either the Project Archaeologist or Archaeological Contractor they shall be corrected by the Archaeology Contractor and a corrected data file issued to the Project Archaeologist. When a change or addition is made to the data within an issue, a complete data group shall be re-issued, not just the changed fields. This may not require complete replacement of the whole data set which includes other previous issues.

8.3.9 Where any changes are made to a data record between digital data submissions, the Archaeology Contractor shall record the date of the change and the name of the person carrying out the change. The Archaeology Contractor shall ensure that each data amendment is carried out correctly.

8.3.10 The Archaeology Contractor shall make two identical copies of the digital archive. The first copy shall be retained by the Archaeology Contractor until the expiry of the Contract maintenance period. The second copy shall be issued to the Project Archaeologist.

8.3.11 A digital archive for each Crossrail site (incorporating individual event archives) shall be submitted to a regional or national data archive as agreed with the service provider by the Employer.

8.4 Interim Statement

8.4.1 Within 7 days of completion of a trial trench evaluation or watching brief fieldwork event, or as otherwise instructed to do so, the Archaeology Contractor shall submit an Interim Statement to the Project Archaeologist.

8.4.2 The Interim Statement shall be brief, and the information contained commensurate with the timescale for production. The report shall not duplicate effort to be utilised at a later date and shall draw on the data gathered during the initial assessment undertaken during fieldwork.

- 8.4.3 A site plan indicating all as-dug investigations shall be provided. Key stratigraphic profiles and topographic templates of the major stratigraphic units shall be provided.
- 8.4.4 The Interim Statement including illustrations shall be submitted as a single PDF file to the Project Archaeologist. CAD drawing files shall also be submitted.
- 8.4.5 The Interim Statement text shall be submitted in hard copy and as an MS Word *.document in accordance with the Employer's information management standards and procedures.
- 8.4.6 The Interim Statement shall include an approved report title sheet and QA page (to be supplied by the Employer).
- 8.4.7 The following shall appear in the footer or header of each Interim Statement:
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- 8.4.8 Copies of the Interim Statement shall be provided by the Project Archaeologist to David Divers (English Heritage) the London Boroughs of Newham and Tower Hamlets for comment.

8.5 Survey Report

- 8.5.1 The Archaeology Contractor shall provide a written and graphic survey report for the works upon completion of fieldwork. Evidence shall be provided for check measurements and results of levelling for establishment of TBM's. The survey report shall be submitted by the Archaeology Contractor to the Project Archaeologist within 2 weeks of the completion of fieldwork.
- 8.5.2 The Archaeology Contractor shall prepare and submit 'as excavated' site area outlines and levels in accordance with Crossrail standard CRS-SDT-05. Each drawing shall identify the relevant event code and sub-site division, if applicable.

8.6 Trial Trench Evaluation and Watching Brief Reports

- 8.6.1 The trial trench evaluation report and watching brief reports shall be prepared by the Archaeology Contractor within 6 weeks of the completion of the fieldwork (unless this is varied by the Project Archaeologist). All reporting shall follow the standard structure set out in City of London Planning Advice Note 3 and IFA standards i.e.:

Contents list

Non technical summary

1. Introduction
2. Planning background
3. Previous work(s) relevant to archaeology of site (DBA, DDBA, surveys etc)
4. Geology and topography of site
5. Research objectives and aims
6. Methodology of site-based and off-site work

7. Results and observations including quantitative report, stratigraphic report(including any constraints on site).
8. Assessment of results against original expectations (using criteria for assessing national importance i.e. period, relative completeness, condition, rarity, and group value) and review of evaluation strategy
9. Statement of potential of archaeology
10. Conclusions and recommendations for appropriate mitigation strategy
11. Publication and dissemination proposals (in addition to fieldwork report)
12. Archive deposition
13. Bibliography
14. Acknowledgements
15. Sites & Monuments Record form
16. A3 plans

8.6.2 The Trial Trench Evaluation and Watching Brief reports shall provide illustrated factual statements and statements of importance with associated assessment of potential for further fieldwork and/or analysis of the archive. All reporting shall utilise information collected during archaeological fieldwork and from any other appropriate sources agreed with the Project Archaeologist.

8.6.3 The Trial Trench Evaluation and Watching Brief reports shall include sections detailing the background to the project, any previous relevant research and investigation, location and topography/geology, a description of the methodology employed and the techniques adopted. Where relevant, these sections shall include location plans with scale and grid co-ordinates.

8.6.4 Each component of the works (e.g. stratigraphic/structural, artefactual and environmental/economic) shall be supported by a statement setting out:

- A quantification of the resource (tabulated and cross referenced as appropriate);
- Provisional dating and evidence for residuality and intrusiveness;
- The range of material, including sampling and/or taphonomic biases; and
- The condition of the material, including preservation bias.

- 8.6.5 The stratigraphic statement shall include: a description of the geomorphology and sedimentation record of the survey area; a description of the fieldwork results (brief context descriptions supported by plans and sections as necessary, with levels related to Ordnance Datum); a trench summary table indicating depths of all major stratigraphic units, and their boundaries. Photographs shall be included where appropriate.
- 8.6.6 The Archaeology Contractor shall produce a subsurface model(s) and profiles to illustrate the extent, character and depth of the major stratigraphic topology identified. The model shall be correlated with previous works within the survey area in order to inform the mitigation design. The processing software and presentation format of the data shall be included in the Archaeology Contractor's Method Statement for approval by the Project Archaeologist.
- 8.6.7 The assessment of results and statement of potential shall include the Archaeology Contractor's conclusions based on the recorded data, e.g. the site class represented, site/feature function and relevant parallels. The statement shall also comment on the potential of the data to address the projects' research themes. As appropriate, comment shall be made on the site as a whole and the individual components (e.g. artefactual, palaeo-environmental, economic). The statement shall utilise the criteria laid down by the Secretary of State for Culture, Media and Sport Criteria for Scheduling, to establish importance.
- 8.6.8 In reporting the results of the works, the accuracy of the original expectations and the appropriateness of the methods adopted shall be assessed by the Archaeology Contractor in order to illustrate what level of confidence can be placed on the information. The Project Archaeologist will use that information as the basis for developing any further mitigation strategy and/or further analysis and publication.
- 8.6.9 The Trial Trench Evaluation and Watching Brief reports shall be illustrated with a site location plan, survey location plans as appropriate (to include archaeological interpretation of results), and individual trench and area plans identifying archaeological features exposed and investigated.
- 8.6.10 When submitted at after trial trench evaluation, the evaluation report shall set out an outline recommendation for mitigation. This may include preservation in situ and/or further investigation and recording of the remains and/or watching brief. The development of a detailed mitigation strategy shall be progressed by the FDC Archaeologist in liaison and the Project Archaeologist in liaison with the Project Manager's engineering design team, the Archaeology Contractor, and the English Heritage Regional Science Advisor and GLAAS officer (David Divers), as appropriate.
- 8.6.11 Copies of the Trial Trench Evaluation and Watching Brief reports shall be provided by the Project Archaeologist to David Divers (GLAAS) and the London Boroughs of Newham and Tower Hamlets for comment.
- 8.6.12 The following shall appear in the footer or header of each report:

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8.7 SMR/HER Summary Sheet

- 8.7.1 The Archaeology Contractor shall complete a GLSMR Summary Sheet for the works (i.e. one per fieldwork event). The Summary Sheet shall be included in the Trial Trench Evaluation and Watching Brief reports.

8.8 Summary Report

- 8.8.1 A short summary report of no more than 500 words (the Summary Report) for the works shall be prepared by the Archaeology Contractor for submission to the Project Archaeologist for subsequent publication within London Archaeologist or another local (county) journal or publication outlet specified by the Project Archaeologist.
- 8.8.2 The Archaeology Contractor shall submit the draft Summary Report to the Project Archaeologist for approval within 8 weeks of the completion date of the fieldwork event. The Archaeology Contractor shall allow two weeks in the programme of works for the Project Archaeologist to provide comments. The Archaeology Contractor shall include any amendments required by the Project Archaeologist in the final Summary Report which shall be submitted within one week of receiving the Project Archaeologist's comments on the draft report.
- 8.8.3 The Summary Report shall be submitted as an MS Word *.document in accordance with the Employer's information management standards and procedures.

8.9 Post-excavation assessment

- 8.9.1 If instructed by the Project Archaeologist, the Archaeology Contractor shall undertake a post-excavation assessment of the site archive and submit a report of their findings to the Project Archaeologist for approval. Assessment of potential for analysis shall be undertaken in accordance with English Heritage guidelines.
- 8.9.2 The Archaeology Contractor shall provide details of its current post excavation assessment procedures with their Method Statement.

9 Site Monitoring & Progress Reports

- 9.1.1 Prior to commencing the works the Archaeology Contractor shall agree a programme of weekly written progress reports and periodic progress meetings with the Project Archaeologist an/or Project Manager and shall be represented at such meetings to the satisfaction of the Project Archaeologist. The Archaeology Contractor shall provide information describing progress on-site to date, the processing of samples and artefacts and feedback from any initial assessment.
- 9.1.2 The LB Newham, the LB Tower Hamlets and David Divers (English Heritage) shall be informed in writing at least one week in advance of commencement of fieldwork by the Project Archaeologist.
- 9.1.3 Periodic updates on the progress of the Crossrail archaeology programme shall be submitted to the external consultees by the Project Archaeologist. The Archaeology Contractor shall provide information to the Project Archaeologist as requested to inform this reporting.
- 9.1.4 The Project Archaeologist shall arrange and convene monitoring site visits by the external consultees, as appropriate. There shall be no unauthorised access to the works in any other circumstances. Any visits to the works shall be in accordance with the Principal Contractor's health and safety, site access and security requirements.
- 9.1.5 The Archaeology Contractor may propose that archaeological excavation be carried out as an extension to evaluation works, if the scope of such work is readily incorporated into the SS-WSI. The detailed method for this work shall be agreed between the Archaeology Contractor and the Project Archaeologist at a site meeting and subsequently in writing between the Project Archaeologist and the relevant external consultees.

10 Personnel requirements

- 10.1.1 The Archaeology Contractor shall provide project personnel of experience as described below. The personnel shall be approved by the Project Archaeologist. Approval may be withdrawn by the Employer at their discretion and in accordance with the contract conditions.
- 10.1.2 The Archaeology Contractor shall submit CVs of all proposed personnel including any specialists, but excluding site technician grades, to the Project Archaeologist for approval if this has not already been done as part of the pre-qualification process.
- 10.1.3 The works shall be managed, directed and staffed by appropriately qualified and experienced personnel. The Archaeology Contractor's Key Person shall possess at least ten years relevant experience.
- 10.1.4 The excavation, sampling and recording of the works shall be directed in the field by a Fieldwork Director who is a Member of the Institute of Field Archaeologists (MIFA). The Fieldwork Director shall be on site throughout the fieldwork stages.
- 10.1.5 The Archaeology Contractor's project team shall include a historic buildings specialist and an environmental archaeologist suitably qualified in archaeological science and geo-archaeological sediment description methods, and on site sample processing and assessment techniques.
- 10.1.6 The Archaeology Contractor's project team shall be staffed by technician grades with minimum six months experience in appropriate aspects of excavation and recording.
- 10.1.7 Specialist staff employed on any aspect of the works, including post-excavation assessment or analysis of any kind including the writing of reports, shall be suitably qualified and shall be supervised by personnel with a minimum of ten years of relevant experience in their field (this may be inclusive of post-graduate studies).
- 10.1.8 Specialist staff shall be available, normally at 24 hours notice, for the duration of the works to provide advice on any specialist tasks to be undertaken.

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Annex 1 – Plans and other illustrations

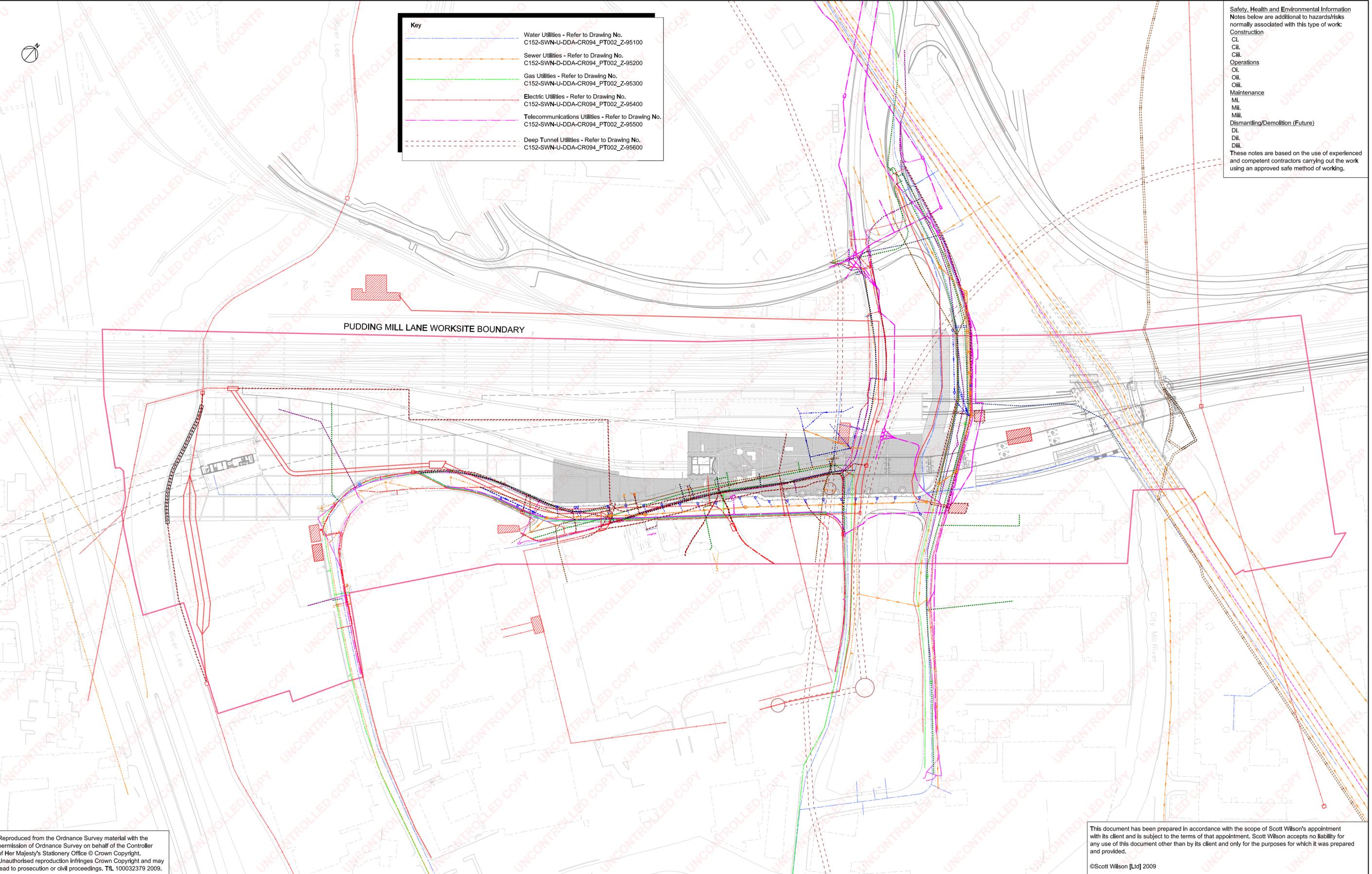
Key

- Water Utilities - Refer to Drawing No. C152-SWN-U-DDA-CR094_PT002_Z-95100
- Sewer Utilities - Refer to Drawing No. C152-SWN-D-DDA-CR094_PT002_Z-95200
- Gas Utilities - Refer to Drawing No. C152-SWN-U-DDA-CR094_PT002_Z-95300
- Electric Utilities - Refer to Drawing No. C152-SWN-U-DDA-CR094_PT002_Z-95400
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- Operations
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- Oii.
- Maintenance
- Mi.
- Mii.
- Dismantling/Demolition (Future)
- Di.
- Di.
- Diii.

These notes are based on the use of experienced and competent contractors carrying out the work using an approved safe method of working.

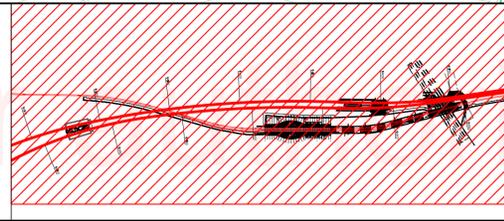


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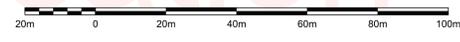
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Rev.	Date	Description	EG	SJ	CR
			By	Chkd	App
P01	20/10/2009	First Issue			

- Notes**
- Confirmation of all survey data must be obtained from the Crossrail survey team.
 - Coordinates to the London Survey Grid. All levels to Ordnance Datum Newlyn. See Crossrail standard CR-STD-010.
 - All dimensions are in metres unless specified otherwise.



- Not all utilities (including LUL & DLR) have been shown on this drawing.
- Depths of utilities are unknown unless noted otherwise.



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 London
 E14 5LQ
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Contract: **Putdng Mill Lane Portal Design (Incl DLR Works)**
 Originator: **Scott Wilson Limited**
 Location: **Putdng Mill Lane Portal**
 Title: **Public Utilities Overview**

By: E.GOZDOWSKI
 Chk: S.JOHN AGER
 App: C.RIDING

Scale: 1:1000 @ A1
 Drawing and CAD file No: C152-SWN-U-DDA-CR094_PT002_Z-95000
 Rev: P01
 Sublicity: S4

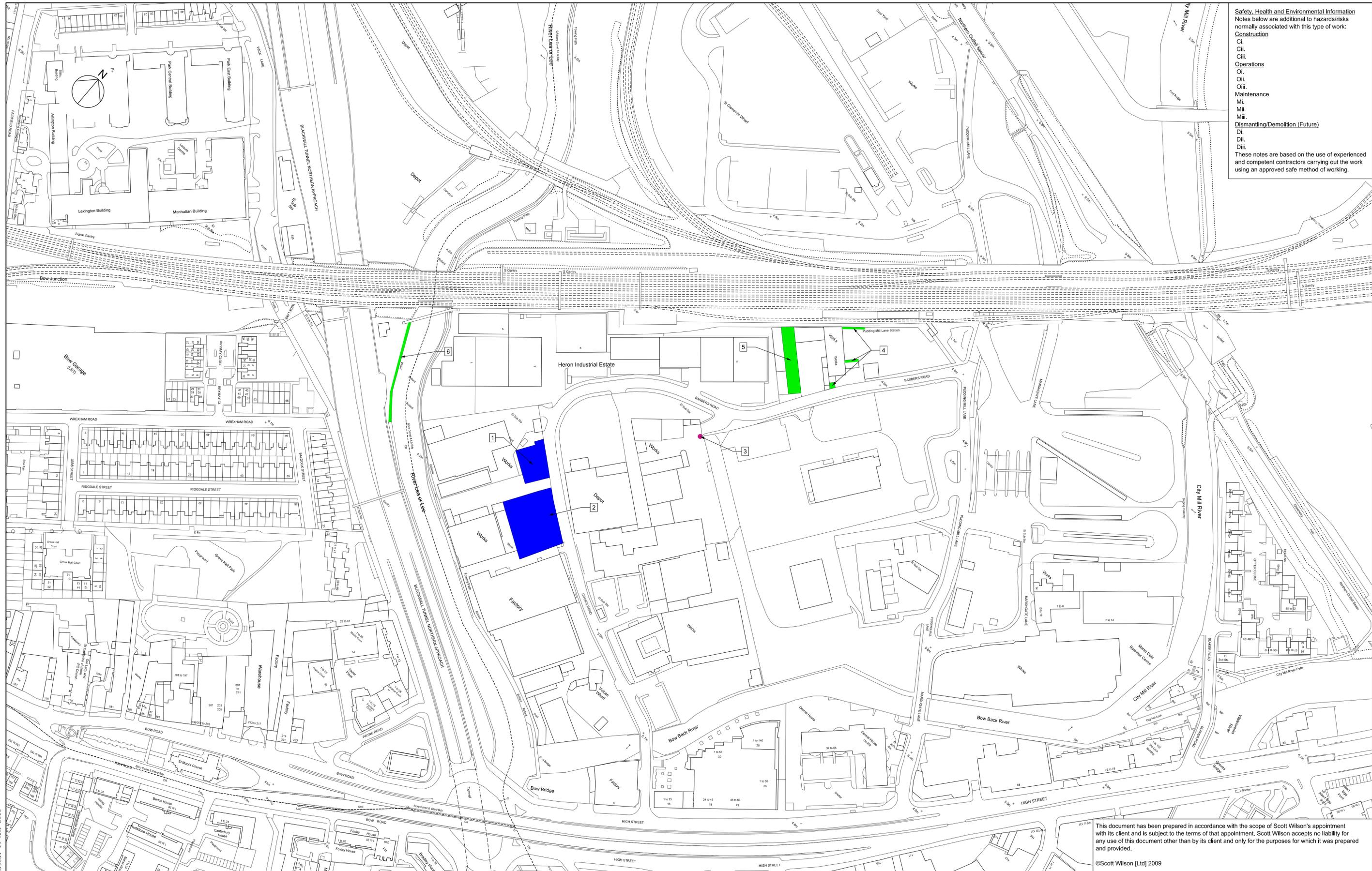
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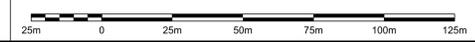
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P01	03/12/2009	First Issue		PD	MC	GW
P02	13/05/2010	Updated to show recorded buildings		DO	MC	GW

Notes	
	Non Listed Historic Building
	Historic Street Furniture
	Level 2 English Heritage Survey Undertaken



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 Originator: **Scott Wilson Limited**
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 Title: **Non Listed Built Heritage Location Plan**

By: **D. OUTEN**
 Chk: **M. COURT**
 App: **G. WILSON**
 Auth: **G. WILSON**

Scale: **1:1250 @ A1** Drawing and CAD file No: **C152-SWN-C2-DDA-CR094_PT002_Z-95001** Rev: **P02** Suitability: **S4**

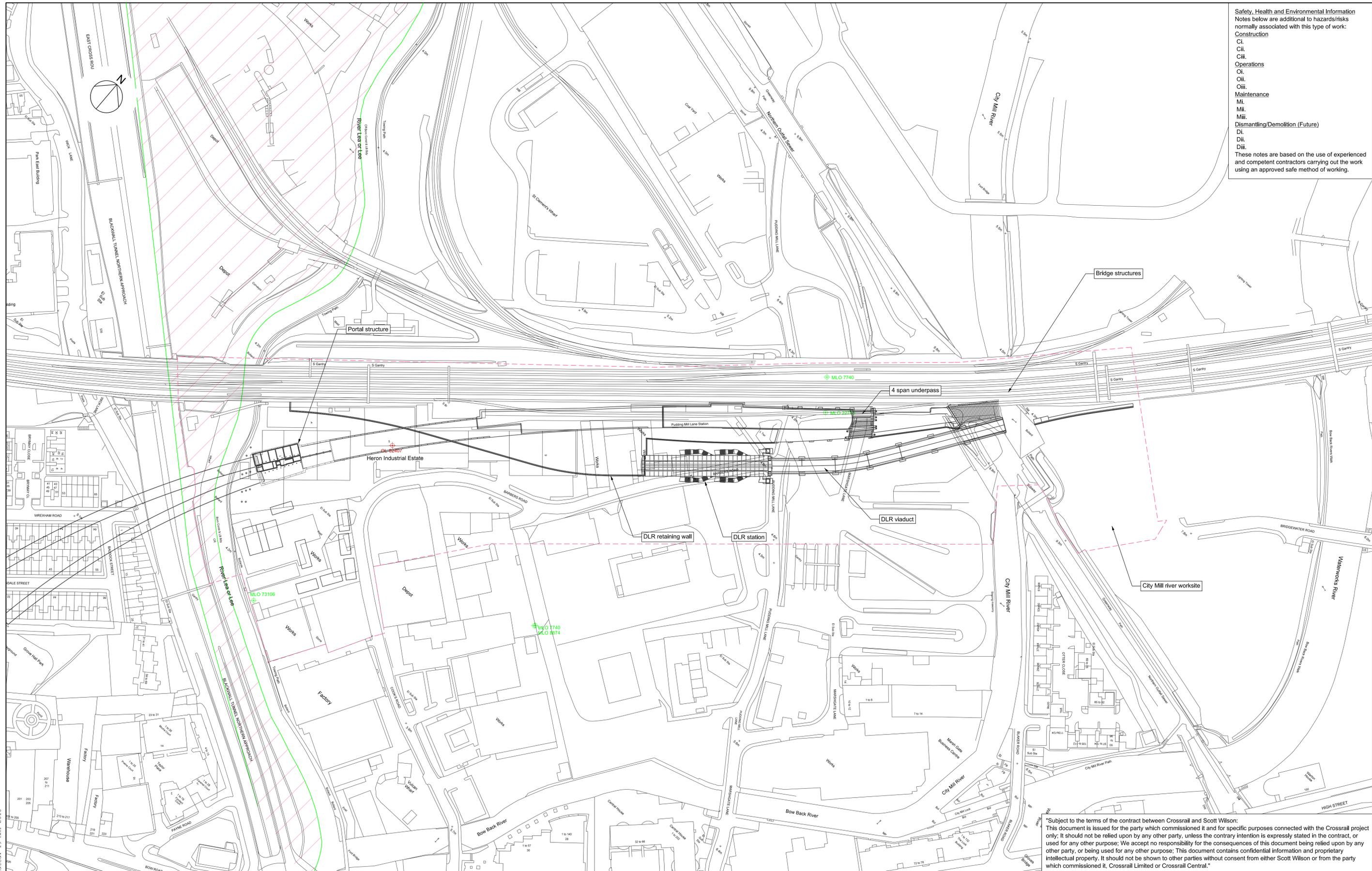
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P01	03/12/2009	First Issue			PD	MC	GW
P02	13/05/2010	Updated to show new site boundary			DO	MC	GW

Notes

- + Greater London Sites and Monuments Record
- + Site Codes
- Archaeological Priority Zone



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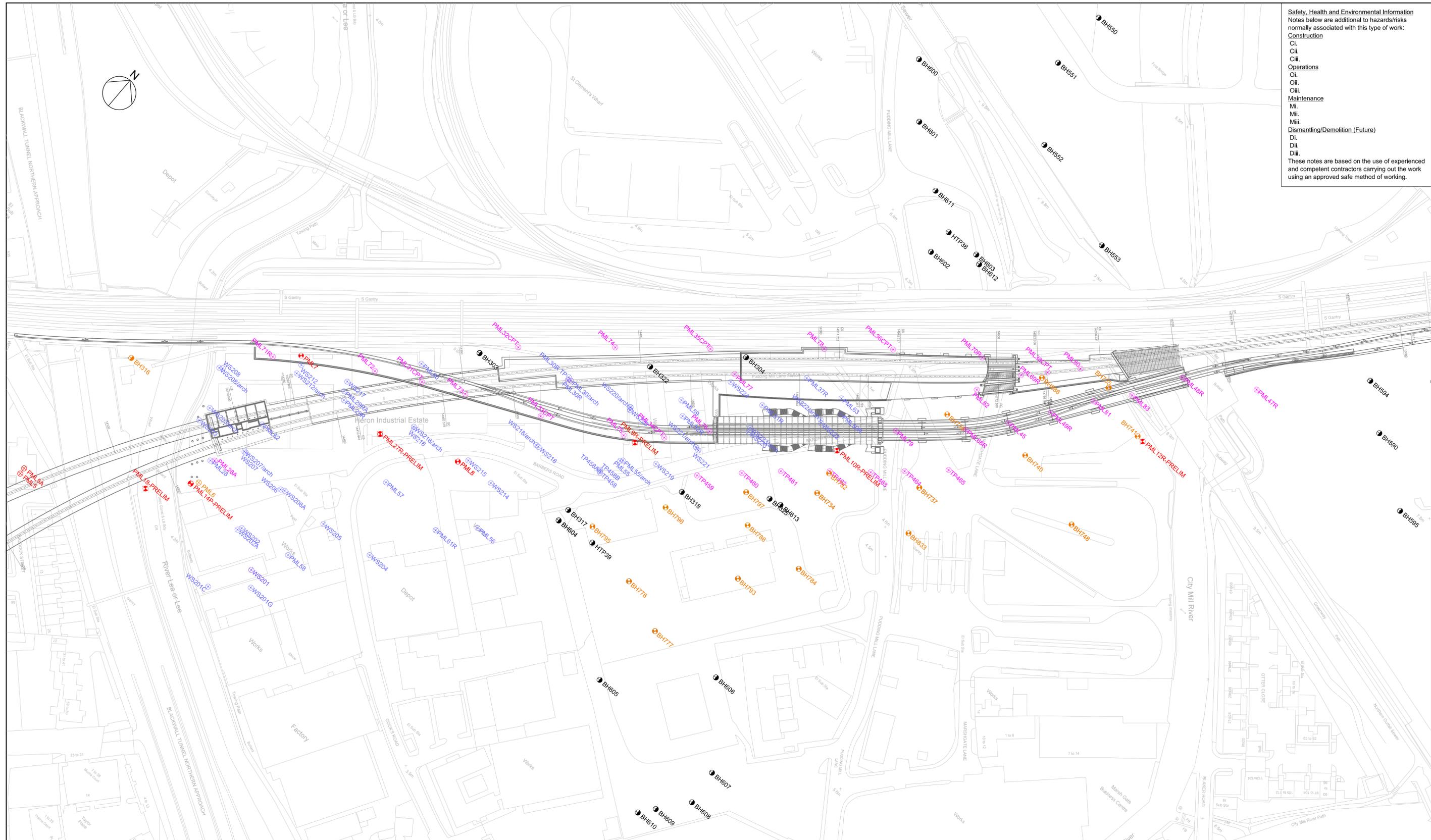
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	Originator: Scott Wilson Limited	
Crossrail Limited 25 Canada Square Canary Wharf London E14 5LQ	Title: Archaeological Base Line	
	Location: Puttling Mill Lane Portal	
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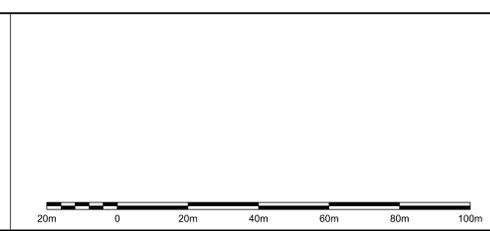


KEY

- CROSSRAIL BOREHOLES PACKAGE 8 (NW5G L) (2005)
- CROSSRAIL BOREHOLES PACKAGE 12
- PROPOSED BOREHOLES PACKAGE 25A - FURTHER GROUND INVESTIGATION (SEE SEPERATE SHEET)
- CROSSRAIL BOREHOLES PACKAGE 25
- THIRD PARTY BOREHOLES
- SELECTED ODA BOREHOLES

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	<p>Title: Borehole Location Plan</p>	<p>Scale: 1:1000@A1 Drawing and CAD file No: C152-SWN-C2-DDA-CR094_PT002_1-95000 Rev: P01 Suitability: S4</p>

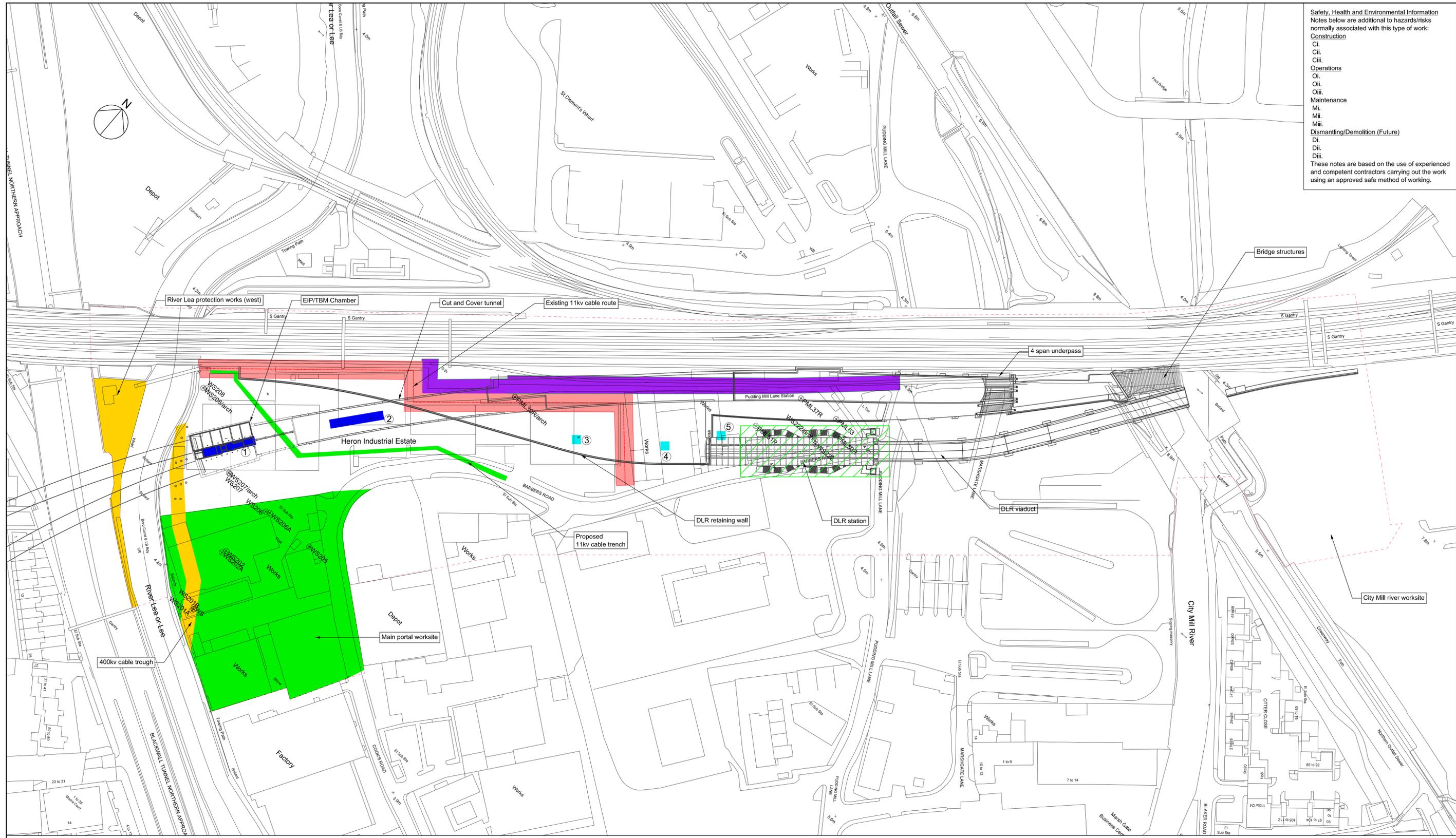
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 General Watching Brief	 Trial Trench 30m x 5m	 Crossrail Worksite Boundary
 Targeted Watching Brief	 5m Exclusion Zone Around 11kv Cable	 Boreholes exhibiting observed contamination
 5m Exclusion Zone Around Retaining Wall	 5m x 5m Trench	 Possible Area of Ground Lowering in Advance of Piling for DLR Station

Rev.	Date	Description	By	Chkd	App	Auth
P01	03/12/2009	First Issue		PD	MC	GW
P02	18/05/2010	Updated to show final trench locations, constraints and updated site boundary		DO	MC	GW

Notes



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