CampbellReith
consulting engineers

The Hoxton Holborn, Holborn

199 – 206 High Holborn

London

WC1V 7BD

Interpretative Geotechnical Report

For

Ennismore Capital

Project Number:

10795

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1.0 EXECUTIVE SUMMARY

SITE LOCATION	The site is situated at The Hoxton, 199-206 High Holborn, London, WC1V 7BD. It is approximately 0.16 Ha in size and is centred on an approximate National Grid reference 530400, 181450.
GEOLOGICAL SETTING	The geological sequence at the site comprises Made Ground underlain by River Terrace Deposits, London Clay and the Lambeth Group.
CURRENT USE AND HISTORY	The site comprises a five storey hotel with a service yard to the rear accessible from Newton Street. Historically the site was occupied by numerous buildings of unknown use until 1983 when they were demolished and replaced by the hotel. It is proposed to build a raised five-storey bedroom wing extension over the rear service yard and an additional rooftop storey on the Newton Street wing. The service yard will therefore remain, with the proposed extension constructed above it.
GEOTECHNICAL HAZARDS	The following geotechnical hazards are present on site: · The presence of extended thicknesses of soft and compressible ground associated with Made Ground and Alluvium; · The potential for the Made Ground to contain obstructions; · The presence of the Crossrail 1 tunnel beneath the site, the presence of London Underground Ltd (Central Line) 20m buffer zone under the northern part of site and the Royal Mail Tunnel under New Oxford Street, approximatively 30m north west of site. · The potential for the Made ground, London Clay, Lambeth group and material derived to be aggressive to buried concrete. · The potential for differential movement between the existing and the proposed structure. · The potential for Lambeth Group to contain hard bands, possibly containing sub-artesian water under significant pressure that may hamper pile installation. · A medium risk of encountering UXO.
GEOTECHNICAL RECOMMENDATIONS	A piled solution is recommended. As piling in the Lambeth Group can be problematic it would be preferable to ensure piles toe above this stratum. Consultation with Crossrail and London Underground is required. Due to the residential nature of the site, driven piles are not likely to be permitted. An ACEC class of AC-3 should be adopted for any concrete in contact with the Made Ground and London Clay. A detailed UXO risk assessment is required.
ENVIRONMENTAL RECOMMENDATIONS	There is no contamination related risk to future users due to the absence of any relevant pollutant linkages. Soil results are available to inform ground-worker health and safety; and waste soil classification. Although a formal waste classification assessment has not been carried out it is noted that one sample would be classified as hazardous waste. Further sampling is recommended to confirm classification prior to off-site disposal.

2.0 INTRODUCTION

2.1. Appointment and Scope

2.1.1. This report has been produced by Campbell Reith Hill LLP (CampbellReith) on behalf of Ennismore Capital (the Client) to summarise geotechnical information relating to High Holborn, London, WC1V (hereafter referred to as the site). The references and limitations associated with this report follow the main text. Figures showing the location of the site, it boundaries and the development proposals are presented in Appendix A.

2.1.2. The report has been produced in general accordance with the procedures for ground investigation, interpretation and reporting set out BS 5930:2015, and BS EN 1997 (Eurocode 7). The objective of the report is to summarise Phase 1 Desk Study information and collate and interpret Phase 2 exploratory data in order to provide:

a) a conceptual model for the site ground conditions

b) a geotechnical evaluation; and,

c) outline geotechnical design recommendations.

2.1.3. The geotechnical appraisal has been carried out in accordance with Eurocode 7. Sections 3, 4 and 5, together with Appendix C comprise the Ground Investigation Report. Section 6 provides geotechnical design recommendations.

2.1.4. A Desk Study was undertaken to inform the ground investigation. The report, dated November 2016 and referenced GHad-10795-091216-DTS F1.doc, is presented in Appendix B. This was submitted as part of the planning application reference 16/10952/COFUL to discharge Phase 1 of planning condition 28.

2.1.5. Given the findings of the desk study limited geo-environmental testing was undertaken, primarily to provide factual data to assist contractors in determining health and safety requirements to provide information to assist with waste classification. A brief appraisal of geo-environmental matters is given in Section 7.

2.1.6. This report is also based on a recent ground investigation by Dunelm Geotechnical & Environmental Ltd, commissioned for this project and a review of readily available information as referenced. The factual report produced by Dunelm, dated October 2017 and referenced M516 Factual Report on Site Investigation for Land at Hoxton Hotel, Holborn, is contained in Appendix C.

3.0 SITE DESCRIPTION

3.1. Site location

3.1.1. The site location is presented in Figure 1. The site is situated at The Hoxton, 199-206 High Holborn, London, WC1V 7BD. It is approximately 0.16 Ha in size and is centred on an approximate National Grid reference 530400, 181450.

3.1.2. The site is bound to the north by High Holborn and to the east by Newton Street. To the south lies a thirteen-storey residential apartment block separated by the single-lane service entrance. West of the hotel, separated by a narrow alleyway (Dragon Yard), is the five-storey Holborn Town Hall 'The Connection'. Green Dragon House is located south west of the hotel, adjacent to the service yard, and is a three-storey mixed-use building. The presence or absence of basements in these buildings is unknown.

3.2. Site layout

3.2.1. A site walkover was undertaken as part of the Desk Study by a representative of CampbellReith on 3rd November 2016 and supplemented by a site visit during the ground investigation works on 25th August 2017. An annotated site layout is presented in Figure 2. The service yard is currently in use by the hotel and the following items were identified in the yard: a large diesel power generator, two wooden storage sheds, a fixed bicycle rack, waste bins and laundry bins. The diesel generator appeared to be in good working order with no visible staining on adjacent ground surface. A single mature tree is located in the yard approximately 10m tall. No soil is exposed on site. Refer to the desk study report in Appendix B for a detailed description.

3.3. Proposed Development

3.3.1. The proposed site redevelopment is shown in Figure 3. It is proposed to build a raised five-storey bedroom wing extension over the rear service yard, and an additional rooftop storey on the Newton Street wing. The service yard will therefore remain, with the proposed extension constructed above it. The single mature tree will be removed as a result of the development.

4.0 SITE DESCRIPTION

4.1. Summary Desk Study Findings

The desk study has suggested that the following potential geotechnical hazards may exist at the site:

- The presence of extended thicknesses of soft and compressible Made ground and Alluvium.
- Potential for the Made ground to contain relic foundation or obstructions.
- The presence of the Crossrail 1 tunnel beneath the site, the presence of London Underground Ltd (Central Line) 20m buffer zone under the northern end of site and the Royal Mail Tunnel under New Oxford Street, approximatively 30m north east from the site. The approximate locations of these features are depicted in Figure 4.
- The potential for differential movements between the existing and the proposed structures.
- Potential for the Made Ground, London Clay, Lambeth Group and material derived to be aggressive to buried concrete.
- Potential for the Lambeth Group to contain hard bands or water under significant sub-artesian pressure that may hamper piling operations.
- A medium UXO risk.

The central line 20m buffer exclusion zone shown in Figure 4 partially clips the very northern part of the site boundary. No penetrative ground investigation was undertaken within this buffer with the area of investigation located approximately 1m to the south of this buffer.

4.2. Scope of Works

4.2.1. The exploratory locations are shown on Figures 2 and 3. The scheduled site work comprised:

- 1 no. rotary cored boreholes to a maximum depth of 40m bgl (BH1);
- 3 no. windowless sampling boreholes (DCS1 – DCS3);
- 1 no. foundation inspection pit.

4.2.2. BH1 was terminated at a depth of 0.90m due to a concrete obstruction and relocated to BH1A. DCS1 was terminated at a depth of 0.70m bgl due to a concrete obstruction, as was DSC1A at a depth of 1.15m bgl. DCS1B was terminated at 0.90m bgl as a 75mm diameter black cable was encountered. DCS2 was terminated at 0.80m bgl due to encountering a concrete obstruction and relocated to DCS2A where the hole was terminated at 3.60m bgl due to refusal. DCS3 was terminated at 2.45m bgl due to a refusal.

4.2.3. DCS1 and DCS2 were relocated and drilled using rotary open hole apparatus with SPT's at 1m intervals to a depth of 6.30 and 6.45m bgl and named DCS1C and DCS2B respectively.

4.2.4. With the exception of BH1A the exploratory holes were backfilled on completion with a bentonite grout in pellet form.

4.2.5. The ground conditions encountered with respect to the monitoring installations are summarised in Table 4.1. Four visits have been made to site on 12th, 25th September and on 11th and 26th October 2017 to monitor gas and water levels within the installations and to obtain samples.

TABLE 4.1: Standpipe Summary

Exploratory Hole	Response Zone (m bgl)	Strata Encounterd
BH1A s[*1]	13.20 – 14.50m	London Clay
BH1A d[*1]	39.00 – 40.00m	Lambeth Group
DCS1C	4.20 – 5.00m	River Terrace Deposits
DCS2B	4.80 – 5.50m	London Clay[*2]

*[1]s=shallow; d=deep. *[2]Originally logged by the site Engineer as River Terrace Deposits

4.3. Groundwater Observations

4.3.1. Groundwater observations undertaken during the site works and monitoring visits are summarised in Table 4.2.

4.3.2. A flushing medium was used in exploratory holes BH1A, DCS1C and DCS2B that could have masked groundwater strikes.

TABLE 4.2: Groundwater Observations

Exp Hole	Water Strikes				Standing Water Level During Monitoring			
	Struck		Rose to		Shallowest		Deepest	
	m bgl	m AOD	m bgl	m AOD	m bgl	m AOD	m bgl	m AOD
BH1A s	–	–	–	–	4.30	19.00	5.25	18.05
BH1A d	–	–	–	–	39.20	-15.95	39.25	-16.00
DCS1C	–	–	–	–	3.85	19.40	4.05	19.20
DCS2B	3.30	19.90	3.30	19.90	3.35	19.85	3.65	19.55

4.4. Geotechnical Testing

4.4.1. In-situ testing was undertaken for geotechnical purposes and samples were obtained for appropriate laboratory analysis. Testing and sampling is detailed in the Dunelm factual report in Appendix C.

4.4.2. The evaluation of geotechnical test results is subject to certain constraints as described below, which has been considered in section 5.

4.4.3. Standard penetration tests (SPTs) display a considerable amount of scatter even after the conversion to 'N_{60}' as per Eurocode 7. Where SPT results record refusal before full penetration has been achieved, the SPT N values have been determined by extrapolation based on section 10.2.4 of Ciria Report 143 prior to conversion to 'N_{60}'.

4.4.4. In total thirty three SPT tests were undertaken during the Ground Investigation. Elevated SPT 'N_{60}' values can be recorded due to encountering bricks, gravels, cobbles, obstructions or hard bands. These are considered to be attributed to the following elevated SPT results:

- DCS2B at 5.20m bgl (18.00m AOD) and 6.00m bgl (17.20m AOD) in the London Clay;
- BH1A at 39.00m bgl (16.25m AOD) in the Lambeth Group.

4.4.5. The following SPTs straddle a strata boundary and they have been discounted from subsequent analysis:

- DCS2A from 2.00 to 2.45m bgl (21.25 – 20.85m AOD) and from 3.00 to 3.45m bgl (20.25 – 19.85m AOD).

4.4.6. These 'N' values are not considered representative of the stratum as a whole and has been discounted from subsequent analysis.

4.4.7. Geotechnical laboratory testing is summarised in Table 7.4.

TABLE 4.3: Laboratory Tests (Geotechnical)

Test type and reference (BS 1377: 1990 unless stated)	Number
Moisture Content (Part 2:3.2).	41
Bulk Density (BS EN ISO 17892-2).	13
Liquid and plastic limits and plasticity index (Part 2:4.3, 4.4, 5.2 and 5.4)	8
Particle size distribution - wet sieving (Part 2:9.2)	5
Single stage 100mm UU triaxial compression test (Part 7)	11
Anisotropically consolidated undrained triaxial test on 100mm diameter samples, with small strain measurements (Part 8, as modified by CampbellReith Specification)	3
Organic Matter Content (estimated from Total Organic Carbon testing*))	2
Water soluble sulphate content 2:1 aqueous extract (BRE SD1 2005)	20
Total sulphur content (BRE SD1 2017)	1
Acid soluble sulphate content (BRE SD1 2017)	1
Soil pH (BRE SD1 2017)	20
Sulphate content in groundwater (BRE SD1 2017)	6
Groundwater pH (BRE SD1 2017)	6

*TOC testing involving removal of IC by acidification and the use of Carbon Analyser

4.4.8. Moisture content determinations on disturbed samples, including those taken from cable tool boreholes, may not be wholly representative due to sample disturbance. Similarly, obtaining coarse grained soils for particle size distribution analysis from cable tool boreholes can result in a loss of fine materials due to the nature of the sampling process.

4.4.9. The evaluation of the plastic limit during the Atterberg limits test is open to a certain degree of subjectivity and it can be influenced by the experience of the operator in assessing the thread breaks and the diameter required from the British Standard.

4.4.10. Both determinations of undrained shear strength and stiffness in triaxial tests can be affected by sample disturbance. Whilst this is minimised by the use of high quality coring and suitable sample preparation to obtain Class 1 samples, it cannot be fully eliminated. The results can also

be affected by the presence of fissures. The application of a suitable confining pressure in the tests can reduce this, although fissures can still affect some results.

4.5. Environmental Testing

4.5.1. The CampbellReith Desk Study concluded that the risk to future users and underlying Secondary A Aquifer from potential contamination was low. Samples have been taken to inform ground worker health and safety and for waste classification.

5.0 GEOTECHNICAL EVALUATION

5.1. Ground Conditions

5.1.1. The ground conditions encountered during the site investigation consisted of Made Ground over the River Terrace Deposits and the London Clay. The London Clay in turn was underlain by the Lambeth Group. The general distribution of each stratum is shown in Table 5.1.

TABLE 5.1: General Soil Profile

Stratum	From		To		Thickness (m)
	(m bgl)	(m AOD)	(m bgl)	(m AOD)	
Made Ground	Ground Level	23.20 – 23.50	2.40 – 4.80	18.40 – 22.60	2.40 – 4.80
River Terrace Deposits	3.40 – 4.20	18.40 – 22.60	5.00 – 5.80	17.50 – 18.30	0.80 - 1.70
London Clay	4.80 – 5.80	17.45 – 18.40	26.70	-3.43	20.90
Lambeth Group	26.70	-3.45	>39.80	<-16.45	>13.10

5.1.2. The ground model as encountered in Table 5.1 broadly agrees with the conditions anticipated. However, in DCS2B the River Terrace Deposits were not encountered and the Made Ground directly overlies the London Clay. Alluvium was encountered from 2.40 to 3.40mbgl (20.85 – 19.85m AOD) in borehole DCS2A only.

5.2. Made Ground

5.2.1. Made Ground was encountered in all of the exploratory holes from ground level and proven to depths between 2.40 and 4.80m bgl (18.40 to 22.60m AOD). Bituminous Macadam was encountered from Ground Level to 0.20m bgl.

5.2.2. Four exploratory holes were unable to penetrate the Made Ground due to concrete obstructions:

- BH1 at 0.90m bgl (22.50m AOD);
- DCS1 at 0.70m bgl (22.60m AOD);
- DCS1A at 1.15m bgl (22.15m AOD);
- DCS2 at 0.80m bgl (22.45m AOD);

5.2.3. DCS1B terminated at 0.90m bgl (22.30m AOD) due to encountering a 75mm diameter black cable.

5.2.4. DCS3 and DCS2A terminated at 2.45 and 3.60m bgl (21.10 and 18.60m AOD) respectively due to refusal in dense strata.

5.2.5. The Made Ground was heterogeneous in nature, generally comprising granular material. The granular Made Ground was generally described as a light brown to dark brown, very loose to very dense silty, sandy gravel. The gravel fraction was generally described as rounded to angular and comprised brick, concrete, flint and chert. Cobbles or boulders were commonly recorded, specifically at the following locations:

- Low cobble content of bricks were recorded in BH1 between 0.10 and 0.90m bgl (23.17 and 22.52m AOD);
- Medium cobble content is recorded in BH1a between 0.15 and 1.20m bgl (23.10 and 22.10m AOD);
- Medium cobble and boulder content of brick, concrete and bituminous bound gravel was recorded in DCS1A between 0.25 and 1.15m bgl (22.95 and 22.15m AOD);
- Medium cobble content of concrete and bituminous bound gravel is recorded in DCS1B between 0.30 and 0.85m bgl (22.90 and 22.35m AOD);
- Low to medium cobble content of concrete was recorded in DCS1 between 0.20 and 0.70m bgl (23.00 and 22.69m AOD;
- Medium cobble content in DCS1C between 0.15 and 2.20m bgl (23.15 and 21.10m AOD);
- Medium cobble and boulder content in DCS2 of angular concrete between 0.40 and 0.80m bgl (22.85 and 22.45m AOD);
- Medium cobble content in DCS2A between 0.10 and 1.20m bgl (23.15 and 22.05m AOD);
- Low cobble content of brick in DCS2B between 0.15 and 1.20m bgl (23.10 and 22.00m AOD) and 2.40 and 3.20m bgl (20.80 and 20.00m AOD);
- Medium cobble content of brick and concrete between 0.10 and 1.70m bgl (23.45 and 21.85m AOD).

5.2.6. In BH1A grey concrete was logged from flush returns from 2.30 and 2.60m bgl (20.95 to 20.65m AOD) and in DCS1C concrete was logged from 4.20 and 4.80m bgl (19.00 to 18.40m AOD).

5.2.7. In DCS2A between 1.20 and 2.40m bgl (22.05 to 20.85m AOD) and in DCS2B between 2.40 and 3.35m bgl (22.80 – 19.90m AOD), a cohesive fraction was recorded and the Made Ground was described as a soft to firm dark, sandy gravelly clay. Between 1.20 and 2.40 (22.05 and 20.85m AOD) the Made ground was described as slightly organic, containing reworked topsoil. Root fragments were recorded at 2.20m bgl (20.65m AOD), chalk and small asphalt fragments were recorded at 2.30m bgl (20.75m AOD).

5.2.8. Six moisture content determinations were undertaken in samples from the granular fraction of the Made Ground. The values recorded ranged between 3.3 and 18.4%.

5.2.9. One Total Organic Carbon (TOC) test was undertaken in the cohesive part of the Made Ground from DCS2A, where the borehole log recorded the possible presence of organic material. The results showed a TOC value of 0.90%, an estimated organic matter content of 1.03% and a moisture content of 7.7%. Such results are not indicative of a significant organic content.

5.2.10. Five PSD tests were undertaken in the granular Made Ground which recorded the following proportions of material:

Gravel : 63 to 75%

Sand : 18 to 32%

Clay + Silt : 0 to 11%

5.2.11. Based on CIRIA C760 [1] given the angularity of the particles and the results of the particle size distribution test, an angle of shearing resistance, ø ', of 34º for the granular Made Ground is considered to be an appropriate characteristic value, along with a drained cohesion, c', of 0kN/m^2.

5.2.12. Twelve SPT 'N_{60}' values between 2 to 112 were recorded in the granular Made Ground. One SPT N_{60} value of 2 was recorded in the cohesive Made Ground. The range of SPT values are indicative of the highly variable nature of the Made Ground and the amount of cobbles and, on occasion, boulders of concrete and brick that were recorded.

5.3. Alluvium

5.3.1. Alluvium was encountered in borehole DCS2A only from 2.40 to 3.40m bgl (20.85 to 19.85m AOD). It was described as firm, greenish brown, sandy, slightly gravelly clay. The gravel fraction comprised fine to coarse, sub-angular flint and chalk. The presence of amorphous organic matter and decayed rootlets was noted but the proportion of such materials was not recorded by the contractor logging engineer.

5.3.2. Two moisture content determinations were undertaken in the Alluvium with recorded values of 7.7 and 23%. One Total Organic Carbon test was carried in the Alluvium, which provided a value of 0.90% with the testing laboratory provided a consequent estimation of the organic matter content of 1.56%. Such results are not indicative of a significant organic content.

5.3.3. One Atterberg Limits determination was undertaken in the Alluvium which recorded a Plasticity Index of 26% with a medium volume change potential (NHBC).

5.4. River Terrace Deposits

5.4.1. River Terrace Deposits were encountered in all exploratory holes from 3.40m bgl (19.85m AOD) to a maximum depth of 5.80m bgl (17.50m AOD), except in DCS2B where the River Terrace Deposits were absent. However at this location an extended thickness of Made Ground was encountered to 4.80m bgl (18.40 mAOD) in DCS2B.

5.4.2. In BH1A the material was logged from flush returns making any soil description difficult, while in DCS1C and in DCS2A the material recovered was described as dark yellowish brown sandy gravel. The gravel component was described as a fine to coarse, sub-angular to rounded, flint and chert.

5.4.3. Three SPT tests were undertaken in the River Terrace Deposits and an 'N_{60}' characteristic value of 28 was considered appropriate as a cautious estimate.

5.4.4. Based on CIRIA C760 [1] given the angularity of the particles and the results of the particle size distribution test, an angle of shearing resistance, ø ', of 34º for the River Terrace Deposits is considered to be an appropriate characteristic value, along with a drained cohesion, c', of 0kN/m^2.

5.5. London Clay

5.5.1. London Clay was encountered in all of the exploratory holes from 4.80 to 5.80m bgl (17.45 – 18.40m AOD) to a depth of 26.70m bgl (-3.43m AOD). The London Clay was generally described as a stiff to very stiff fissured clay. Between 6.00 and 7.10m bgl (17.30 – 16.20m AOD) the London Clay is described as a firm, slightly sandy, slightly gravelly clay. The presence

of gravel could be due to geological reworking of the London clay as part of deposition of the River Terrace Gravel or could be due to disturbance during drilling. A claystone band was encountered between 13.20 and 13.50m bgl (10.05 – 9.75m AOD).

5.5.2. Discontinuities were recorded in the London Clay. They are described as horizontal to sub-horizontal, very tight to widely spaced, occasionally with sand coatings and soft clay infill.

5.5.3. Nine SPTs were undertaken in the London Clay which recorded 'N_{60}' values in the range of 18 to 54. Six undrained shear strength (Cu) determinations were undertaken on 100mm diameter samples using triaxial apparatus, which recorded values in the range of 57 – 153 kPa. Both the SPT 'N_{60}' values and triaxial tests results generally increase with depth and are shown in Figure 5 and 6.

5.5.4. Based on the above results and reference to 'Standard Penetration Test and the Engineering Properties of Glacial Materials' [2] along with previous experience, a relationship of Cu = 4.5x SPT 'N_{60}' is broadly considered to be appropriate for the London Clay. The results are plotted graphically on Figure 6 along with results for the Lambeth Group. The data suggests the following relationship based on a cautious estimate:

Cu = 75 + 7.96z, where z is the depth below 5m bgl.

5.5.5. Two anisotropically consolidated undrained triaxial tests on 100mm diameter sample, with small strain measurements were undertaken in the London Clay at a depths of 9.15 – 9.40m bgl (14.14 – 13.89m AOD) and 19.70 – 19.95m bgl (3.59 – 3.34m AOD). To determine characteristic values, the results (along with that for the Lambeth Group as discussed below), were compared to the strength related information and with published literature [5, 6, 7]. On this basis, for small strain applications (0.01% strain), the test results support a relationship of Eu=1250xCu, where Eu is the undrained Young's Modulus. It is noted that drained Young's Modulus can estimated using the approximation E'=0.6xEu based on CIRIA Report SP27 'Settlement of Structures on Clay Soils'

TABLE 5.2: Summary of Soil Parameters for London Clay

Soil Parameters	Range of results	Characteristic value[1]
Liquid Limit (%)	62 – 72	69
Plastic Limit (%)	23 – 27	25
Plasticity Index (%)	39 – 46	43
Modified Plasticity Index %)	36 – 46	42
Plasticity	CH	CH
Volume Change Potential (NHBC)	High	High
SPT 'N_{60}' Values	18 – 77	See above
Undrained Shear Strength (kN/m^2)	57 – 153	See above
Undrained Young's Modulus (kN/m^2)	1.23x 10^5 – 1.72x10^5	See above

[1]Cautious Estimate

5.6. Lambeth Group

5.6.1. The Lambeth Group strata were encountered below the London Clay in borehole BH1A from 26.70m bgl (-3.45m AOD) and proven to a depth of 39.80m bgl (-16.45m AOD). The Lambeth

Group was generally described as a multi-coloured or as a grey, very stiff clay or very weak mudstone with sub-horizontal, closely to widely spaced, undulating to stepped roughness, partially opened, clean discontinuities. Occasionally, shell fragments or slightly sandy clay bands are recorded. From 39.50 to 40.00m bgl (16.25 – 16.75m AOD) the Lambeth Group is recorded as a brown clayey sandy gravel, likely the Upnor Formation.

5.6.2. Ten Moisture Content Determination tests recorded values between 9.5 and 26.9%. Three Atterberg Limits determinations were undertaken on the Lambeth Group which recorded Modified Plasticity Index values recorded values between 27 – 38%.

5.6.3. Four SPTs were carried in the Lambeth Group recording 'N_{60}' values generally in the range of 69 to 88. Five undrained shear strength (Cu) determinations were undertaken on 100mm diameter samples using triaxial apparatus, which recorded values in the range of 164 – 515 kPa, showing a high degree of scatter. Both sets of data are presented graphically on figure 6 and collectively they, alongside experience in dealing with this stratum suggest a characteristic Cu value of 310kN/m^2 based on a cautious estimate.

5.6.4. One anisotropically consolidated undrained triaxial test on 100mm diameter sample, with small strain measurements was undertaken in the Lambeth Group at a depth of 30.37 – 30.68m bgl (-7.10 – 7.41m AOD). As outlined above, for small strain applications, collectively, the test results support a relationship of Eu=1250xCu, where Eu is the undrained Young's Modulus. It is noted that drained Young's Modulus can estimated using the approximation E'=0.6xEu based on CIRIA Report SP27 'Settlement of Structures on Clay Soils'

TABLE 5.3: Summary of Soil Parameters for Lambeth Group

Soil Parameters	Range of results	Characteristic value[1]
Liquid Limit (%)	41 - 58	56
Plastic Limit (%)	20 - 23	22
Plasticity Index (%)	18 - 38	34
Modified Plasticity Index (%)	27 – 38	34
Plasticity	CI - CH	CH
Volume Change Potential (NHBC)	Medium	Medium
SPT 'N_{60}' Values	69 - 88	70
Undrained Shear Strength (kN/m^2)	164 – 515	310
Undrained Young's Modulus (kN/m^2)	6.5x10^5	See above

[1]Cautious Estimate

5.7. Buried Concrete

5.7.1. Ten soil samples comprising ten from the Made Ground, one soil sample from the Alluvium, six from the London Clay and three from the Lambeth Group were subjected to pH and water soluble sulphate determinations. With reference to BRE Digest SD1 [3], the results indicate a DS-1 class in the Lambeth Group and in the Alluvium, a DS-2 class in the London Clay, and a DS-3 class in the Made Ground.

5.7.2. One sample from the Alluvium was additional subjected to total sulphur and acid soluble sulphur content testing to allow an assessment to be made in relation to the thaumasite form of

concrete attack. The sample returned is not considered indicative of a significant risk from this form of attack. A modification to the DS class is there not proposed.

5.7.3. Six groundwater samples obtained during the monitoring programme were subjected to sulphate and pH determinations. The resulting BRE Digest Class for the groundwater is DS-2.

5.8. Groundwater Conditions

5.8.1. Groundwater observations during the field and the subsequent monitoring are described in Section 4 and are summarised in Table 4.2.

5.8.2. Monitoring data suggest an equilibrium groundwater level of 4.00m bgl (19.30m AOD), at the base of the Made Ground and top of the River Terrace Deposits. A similar piezometric level was recorded near the top of the London clay. In the Lambeth Group a piezometric level of around -16.00m AOD was recorded, potentially suggesting a separate groundwater regime with the London Clay acting as an aquitard.

5.9. Foundation Inspection Pit

5.9.1. A foundation pit was undertaken adjacent to the south west wall of the pre-existing building to a depth of 2.50m bgl (20.95m AOD). The foundation inspection pit terminated within the Made Ground due to encountering a 250mm diameter pipe. The pipe was encountered 1.50m bgl (21.95m AOD), was encased in concrete and exited laterally from the existing 0.90m wide concrete column of the hotel.

6.0 GEOTECHNICAL CONCLUSIONS AND RECOMMENDATIONS

6.1. Introduction

6.1.1. It is currently proposed to build a raised five-storey bedroom wing extension over the rear service yard of the Hoxton hotel, and an additional rooftop storey on the Newton Street wing as indicated on Figure 3 of Appendix A.

6.1.2. The following unfactored maximum unfavourable compressive permanent and variable actions (loads) are proposed:

- Permanent, 1050kN – compressive, 420kN – tensile
- Variable, 350kN – compressive, 180kN – tensile

6.1.3. The underside of the pile cap is anticipated to be at 22.00m AOD. The ground floor level is anticipated similar to the existing and to comprise asphalt.

6.1.4. Based on the above, the anticipated ground conditions and what is proposed, the development is considered to fall into geotechnical category 2 as defined by BS EN 1997.

6.1.5. The details of the structure and the anticipated loadings are under development at the time of writing this report. A detailed Geotechnical Design Report should be prepared once details are finalised. The primary purpose of this report is to identify risk, allow design development and inform cost estimates.

6.2. Key Considerations

6.2.1. The ground investigation has identified a number of potential geotechnical risks at the site. These are summarised below and discussed in more detail in the following sections.

- The presence of extended thicknesses of soft and compressible Made Ground and Alluvium.
- Potential for the Made ground to contain relict foundation or obstructions.
- The presence of the Crossrail 1 tunnel beneath the site, the presence of London Underground Ltd (Central Line) 20m buffer zone under the northern end of site and the Royal Mail Tunnel under New Oxford Street, approximatively 30m north east from the site. The approximate locations of such features are depicted in Figure 4.
- The potential for differential movements between the existing and the proposed structures.
- Potential for the Made Ground, London Clay, Lambeth Group and material derived to be aggressive to buried concrete.
- Potential for the Lambeth Group to contain hard bands or water under significant sub-artesian pressure that may hamper the piling works.
- A medium UXO risk.

6.3. Foundations

6.3.1. As described in Section 5, the site is underlain by Made Ground to a maximum depth of 4.80m bgl (18.40 m AOD). Alluvium was encountered in DCS2A between 2.40 and 3.40m bgl (20.85 and 19.85m AOD). River Terrace Deposits were generally encountered to 5.80m bgl (18.30m

AOD), but were not encountered in DCS2B. Without treatment, the Made Ground and Alluvium are not suitable founding strata due to their variability and generally poor load bearing and settlement characteristics. The River Terrace Deposits are too deep and not considered to be laterally persistent enough to allow consideration for foundation design. Consideration has therefore been given to a piled solution.

6.3.2. The advice of a reputable piling specialist, experienced in the ground conditions considered here should be sought. They should be responsible for the selection of appropriate piling equipment and the final design of the piles. Given below are preliminary considerations for the design of piled foundation and indicative resistances.

6.3.3. Due to the residential nature of the site, driven piles are not likely to be permitted. The ground conditions are amenable to either CFA or bored piles. However, the following should be taken into account.

6.3.4. Of particular note is the potential for buried obstructions in the Made Ground which may require prior excavation, or pre-boring. There is also the potential for the London Clay and the Lambeth Group to contain hard bands.

6.3.5. The Lambeth Group is inherently variable and can contain hard bands and granular horizons that may contain water under significant pressure. Consequently if possible, it would be prudent to ensure that piles toe above this stratum.

6.3.6. Bored piles would require casing through the Made Ground, Alluvium and River Terrace Deposits to prevent the collapse of the bore. Groundwater was encountered as seepages in the Made Ground and should be considered during piling operations.

6.3.7. It should be noted that the possibility of groundwater strikes additional to those encountered during the ground investigation works cannot be ruled out.

6.3.8. Both bored and CFA piles would generate arisings which would require disposal.

6.3.9. Table 6.1 below provides indicative design resistances for individual piles, which require consideration against appropriately factored design actions as detailed in Eurocode 7.

TABLE 6.1: Indicative Design Resistances for CFA Piles.

Pile diameter (mm)	Design Resistances (kN)* Pile length (m)			
	10	15	20	25
300	**100** *50*	**200** *150*	**350** *300*	**550** *500*
450	**200** *100*	**400** *250*	**700** *500*	**1050** *750*
600	**300** *150*	**600** *350*	**1000** *650*	**1500** *1000*

*Bold figures = compressive design resistance. *Italic* figures = tensile design resistance.

6.3.10. Table 6.1 is based on the following assumptions:

- Characteristic resistances calculated based on LDSA;
- A proposed base of pile cap of 22.00m AOD;

- Made Ground/Alluvium Deposits to 5m bgl (~18m AOD), no support assumed, dry unit weight (γ_{dry}) = 18 kN/m^3, bulk density (γ_{sat}) = 20 kN/m^3;
- River Terrace Deposits – no support assumed due to being laterally absent;
- 5.00 to 25.00m bgl, London Clay - Cu profile as defined in Section 5, adhesion factor α = 0.5, bearing capacity factor (Nc) = 9, (γ_{sat}) = 20 kN/m^3;
- Groundwater level at 3.50m bgl (~19.70m AOD);
- Partial factors on actions, resistances and model factors as required by EC7 (modified by the national Annex) for Design Approach 1;
- Combination 2 of Design Approach 1 being the governing case for design (to be confirmed in the GDR in due course);
- The self-weight of the pile and the weight of the soil removed/ displaced during pile construction approximately cancel each other out;
- No load testing or working of preliminary piles;
- pile spacing of at least 3 x pile diameter; and
- C40 concrete.

6.3.11. The preliminary calculations are based on a moderately conservative appraisal of the ground conditions encountered. The adoption of maintained load tests in accordance with EC7 would enable increased capacities or shorter piles to be adopted. The piling specialist may choose to adopt alternative parameters to those outlined above. However, their suitability should be verified by an experienced geotechnical engineer.

6.4. Third Party Assets

6.4.1. Crossrail 1 tunnel is located beneath the site. The London Underground Ltd (Central Line) 20m buffer zone is located under the northern end of the site boundary and a Royal Mail Tunnel is located under New Oxford Street, approximatively 30m north east from the site. The tunnel service plan and exclusion zones are shown in Figure 4. The proposed development is located in the Crossrail Safety Zone but outside from the London Underground 20m buffer for the Central Line.

6.4.2. The asset owners should be consulted so as to establish any associated constraints to the proposed development and associated construction works. These may affect the foundation layout and may result in the need for a ground movement assessment. They may also require sleeving of piles but this has not been considered in the appraisal above.

6.5. Buried Concrete

6.5.1. In the consideration of sulphate attack on buried concrete, reference has been made to BRE Special Digest 1 which classifies the site as a greenfield site with a mobile groundwater conditions. The results of the concrete classification tests received have indicated a DS-1 for the Lambeth Group, a DS-2 classification in the London Clay and a DS-3 classification in the Made Ground. Together with the pH values, the analysis indicates that an ACEC AC-3 should be adopted.

6.6. Excavations

6.6.1. As described above, the groundwater level at the site is generally assumed to be at 3.50m bgl (~19.70m AOD). Perched water could be locally present above this. Thus it is considered that pumping from sumps should be appropriate for the control of water ingress for excavations to approximately 3.50m bgl.

6.6.2. The stability in excavation faces in the Made Ground, River Terrace Deposits or Alluvium cannot be relied on and allowance should be made for battering faces back to a safe angle of repose, or providing shuttering. Support or battering of the excavation faces to a safe angle of repose will be required for all excavations where man entry is necessary, the nature and extent of which will need to be evaluated under CDM regulations.

6.7. General Construction Advice

6.7.1. Prior to any below groundworks, including piling operations, a detailed UXO risk assessment is required in accordance with CIRIA C681.

6.7.2. Any relic foundations or other subterranean structures beneath the footprint of the proposed buildings should be fully grubbed out. Such excavations should be surveyed and backfilled with an acceptable granular fill placed and compacted to an engineering specification.

6.7.3. In areas of road pavements and hard standing, relic subterranean structures should be broken down to around 1m below finished site level to minimise the risk of differential settlement due to the presence of hard spots. In soft landscaped areas it may be possible to limit such operations to 0.50m bgl.

7.0 ENVIRONMENTAL CONCLUSIONS AND RECOMMENDATIONS

7.1. The CampbellReith Desk Study concluded that the risk to future users and underlying Secondary A Aquifer from potential contamination was low, due to the absence of any relevant pollutant linkages. The logs did not identify any obvious visual or olfactory evidence of contamination such as oily/stained soils and therefore the risk is confirmed as low. Given the lack of risk to future users the environmental assessment was restricted to nominal analytical works to inform risk to ground-workers and waste classification. Three samples of Made Ground soils were analysed for a general suite and although one of these (DCS2A, 0.5m bgl) shows elevated lead, copper and zinc concentrations, these should not pose a risk to ground-workers provided that standard health and safety measures and good working practices are employed. Asbestos was not detected.

7.2. The log descriptions of the Made Ground soils indicate a low organic content and therefore the risk from ground gas is confirmed as low. Although not required as part of the site investigation specification gas monitoring was carried out when the installations were monitored for water level purposes. Ground gas was not detected above the limits of detection and flow rates were not detected. It must be noted that gas bungs were not installed and therefore these results cannot be used in isolation with respect to ground gas risk; however the lack of any significant ground gas source is sufficient to confirm the low risk.

7.3. The soil chemical results of the three samples analysed can be used for information to inform waste classification and disposal, together with the results of the WAC analysis undertaken of two samples of Mace Ground. It should be noted that additional testing may be required, particularly if non-representative soils are uncovered such as those that are stained, odorous or contain asbestos. Although a waste assessment has not been carried out it is noted that the soil sample form DCS2A, 0.5m bgl, would be classified as hazardous waste if excavated for disposal due to the concentration of copper. If these soils are required to be removed from site then additional soil sampling is recommended to confirm waste classification prior to disposal due to the cost implications associated with hazardous waste.

TECHNICAL REFERENCES

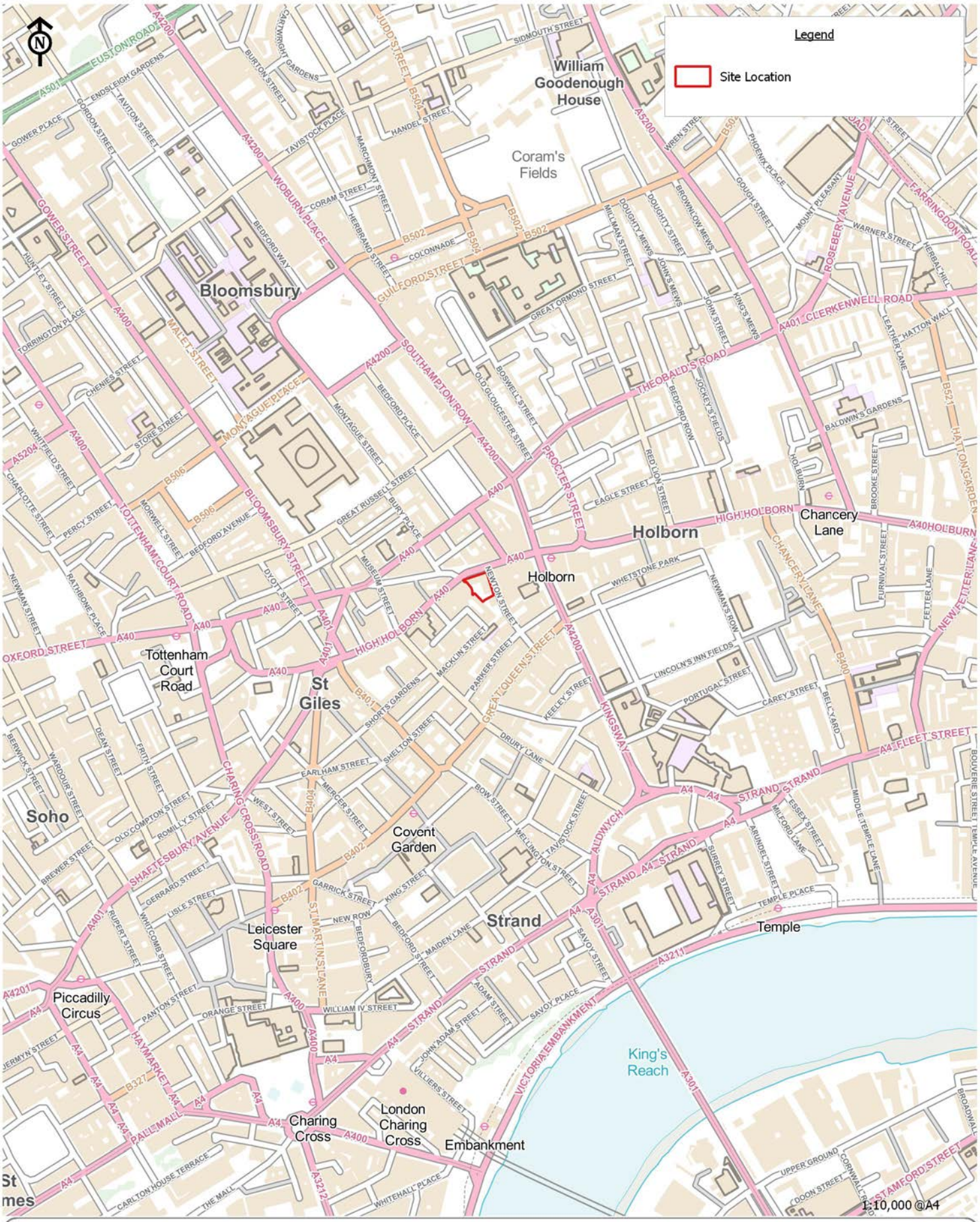
Reference	Reference Title	Type
1	CIRIA C760. Guidance on embedded retaining wall design. 2017	Book
2	The Standard Penetration Test and the Engineering Properties of Glacial Materials	Report
3	Concrete in Aggressive Ground	BRE Special Digest 1
4	CIRIA C583. Engineering in the Lambeth Group. 2004.	Book
5	Non-Linear Soil Stiffness in Routine Design', Atkinson J. H. (2000) Geotechnique 50, No 5, 487-508	Published Paper
6	The Engineering Properties of Mudrocks, Cripps and Taylor, 1981, Q. J. Eng. Geol, Vol14 pp325-346	Published Paper
7	Guidance on Embedded Retaining Wall Design. C760	CIRIA Guide

LIMITATIONS

Environmental & Geotechnical Interpretative Reports

1. This report provides available factual data for the site obtained only from the sources described in the text and related to the site on the basis of the location information provided by the client.
2. Where any data or information supplied by the client or other external source, including that from previous studies, has been used, it has been assumed that the information is correct. No responsibility can be accepted by CampbellReith for inaccuracies within this data or information. In relation to historic maps the accuracy of maps cannot be guaranteed and it should be recognized that different conditions on site may have existed between and subsequent to the various map surveys.
3. This report is limited to those aspects of historical land use and enquiries related to environmental matters reported on and no liability is accepted for any other aspects. The opinions expressed cannot be absolute due to the limit of time and resources implicit within the agreed brief and the possibility of unrecorded previous uses of the site and adjacent land.
4. The material encountered and samples obtained during on-site investigations represent only a small proportion of the materials present on the site. There may be other conditions prevailing at the site which have not been revealed and which have therefore not been taken into account in this report. These risks can be minimised and reduced by additional investigations. If significant variations become evident, additional specialist advice should be sought to assess the implications of these few findings.
5. The generalised soil conditions described in the text are intended to convey trends in subsurface conditions. The boundaries between strata are approximate and have been developed on interpretations of the exploration locations and samples collected.
6. Water level and gas readings have been taken at times and under conditions stated on the exploration logs. It must be noted that fluctuations in the level of groundwater or gas may occur due to a variety of factors which may differ from those prevailing at the time the measurements were taken.
7. Please note that CampbellReith cannot accept any liability for observations or opinions expressed regarding the absence or presence of asbestos or on any product or waste that may contain asbestos. We recommend that an asbestos specialist, with appropriate professional indemnity insurance, is employed directly by the client in every case where asbestos may be present on the site or within the buildings or installations. Any comments made in this report with respect to asbestos, or asbestos containing materials, are only included to assist the client with the initial appraisal of the project and should not be relied upon in any way.
8. The findings and opinions expressed are relevant to those dates of the reported site work and should not be relied upon to represent conditions at substantially later dates.
9. This report is produced solely for the benefit of the client, and no liability is accepted for any reliance placed upon it by any other party unless specifically agreed in writing.

Appendix A: Figures



Hoxton Hotel, Holborn

Client: Ennismore Capital

Figure 1:
Site Location Plan

Scale:	1:10000@A4
CampbellReith OS Copyright:	© Crown copyright. All rights reserved. Licence number 100020027
Contains Ordnance Survey data	© Crown copyright and database right 2016.
Job Number:	10795 - 02
Drawn by - Checked by:	LB - GH
Drg No - Status/Revision:	GIS001 - A
File location:	N:/10750 - 10999/10795 L - High Holborn/02 - Hoxton Holborn/Project_Workspaces (pdf in Outputs)
Date (Revision History):	22/11/2016 (A, First Issue, 22/16/16, LB)

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Hoxton Hotel, Holborn

Client: Ennismore Capital

Figure 2:
Site Layout Plan

Scale: 1:250@A3

Job Number: 10795 - 02
Drawn by - Checked by: LB - JB
Drg No - Status/Revision: GIS009 - B
File location: N:/10750 - 10999/10795 L - High Holborn/02 - Hoxton Holborn/Project_Workspaces (pdf in Outputs)
Date (Revision History): 09/10/2017 (A, First Issue, 28/09/17, LB; B, Updated Layout, 09/10/17, LB)

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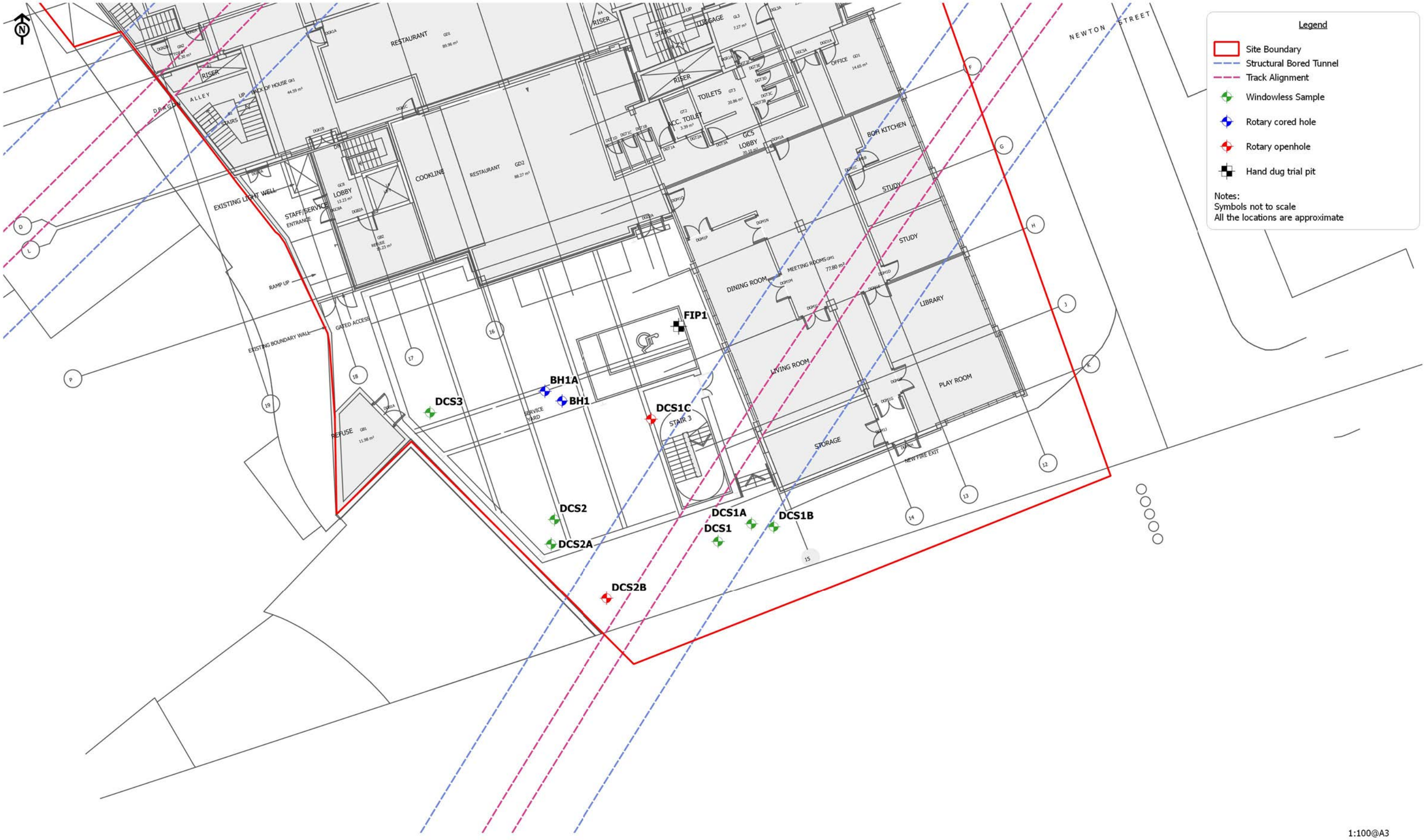

Hoxton Hotel, Holborn

Client: Ennismore Capital

Figure 3:
Proposed Ground Floor and Exploratory Hole Location Plan

Scale:	1:100@A3
CampbellReith OS Copyright:	© Crown copyright. All rights reserved. Licence number 100020027
Crossrail Tunnels based on	CampbellReith CRL1-XRL-R4-DMA-CR086-00003.dwg
Job Number:	10795 - 02
Drawn by - Checked by:	LB - GH
Drg No - Status/Revision:	GIS010 - A
File location:	N:/10750 - 10999/10795 L - High Holborn/02 - Hoxton Holborn/Project_Workspaces/2017 GIR (pdf in Outputs)
Date (Revision History):	16/10/2017 (A, First Issue, 16/10/17, LB)

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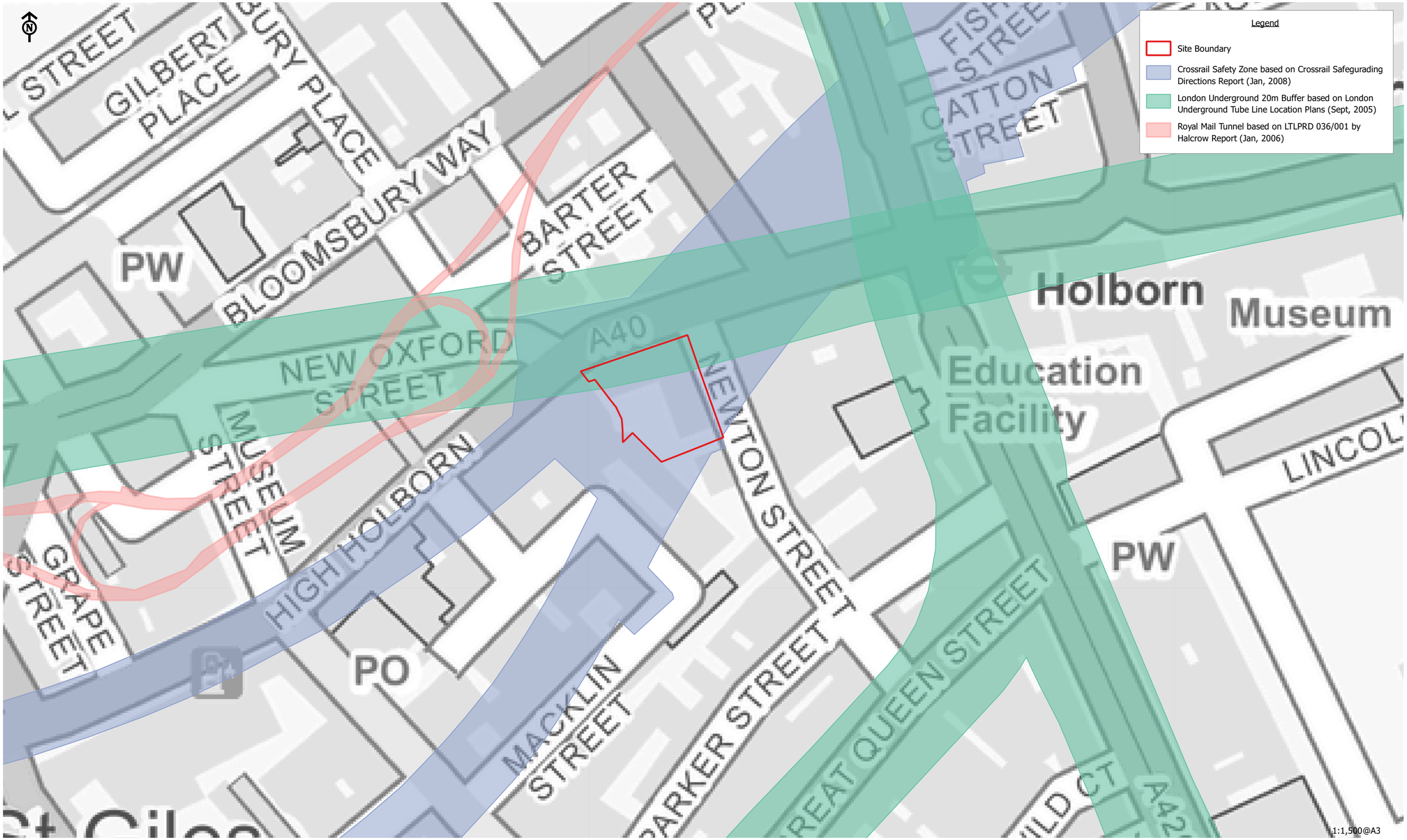

Hoxton Hotel, Holborn

Client: Ennismore Capital

Figure 4:
Approximate Location of Tunnels and Services

Scale: 1:1500@A3
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Job Number: 10795 - 02
Drawn by - Checked by: LB - GH
Drg No - Status/Revision: GIS007 - B
File location: //lo-data1/gis-data/10750 - 10999/10795 L - High Holborn/02 - Hoxton Holborn/Project_Workspaces (pdf in Outputs)
Date (Revision History): 09/10/2016 (A, First Issue, 30/16/16, LB; B, Minor Amendments, 09/10/17, RP)

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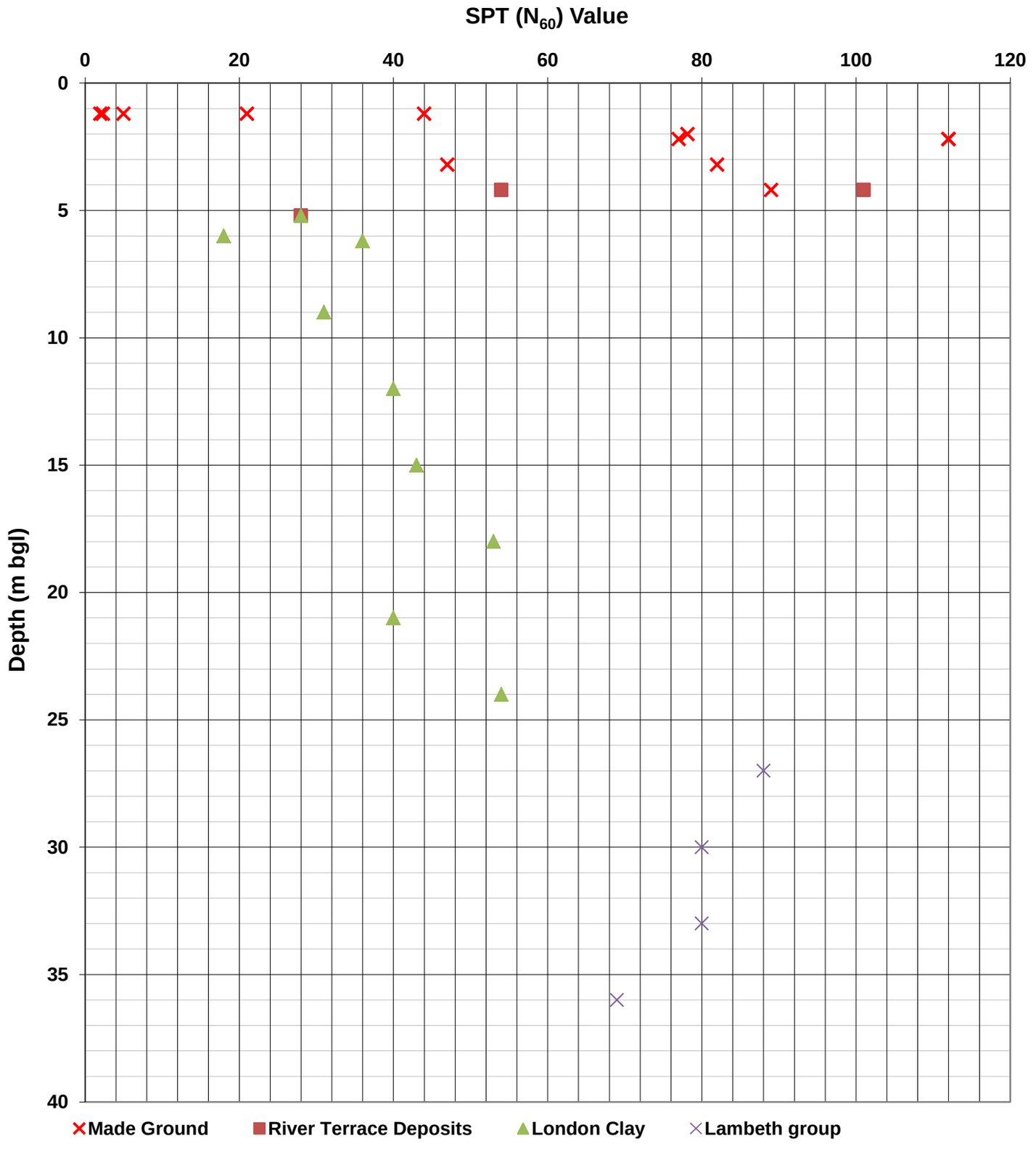
SPT (N_{60}) Value Vs Depth

Client	Ennismore Capital	Job No.	10795
Site	The Hoxton Holborn, 199 - 206 Holborn London, WC1V 7BD	Date Drawn	06/11/2017



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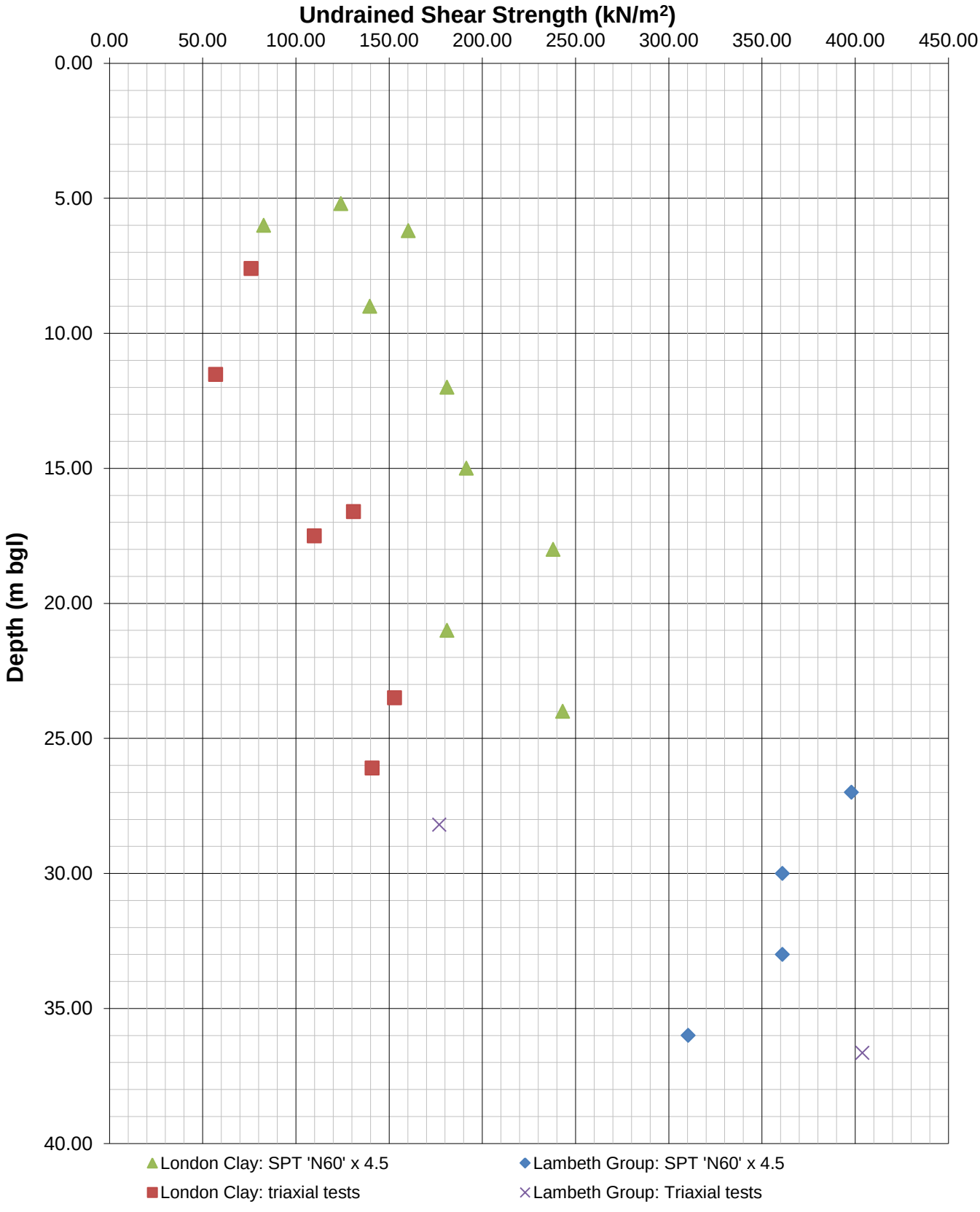
Status	S	Fig:
Rev.	D	5

Undrained Shear Strength Vs Depth

Site	**The Hoxton, Holborn London, WC1V7BD**	**Job No.**	**10795**
Client	**Ennismore Capital**	**Date Drawn**	**16/10/2017**



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Status	C	Fig:
Rev.	A	6

Appendix B: Desk Study Report

The Hoxton, Holborn London WC1V 7BD, Desk Study, for Ennismore Capital,
Project Number: 10795, December 2016.

CampbellReith
consulting engineers

The Hoxton, Holborn
London WC1V 7BD

Desk Study

For

Ennismore Capital

Project Number: 10795

December 2016

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Document History and Status

Revision	Date	Purpose/Status	Author	Check	Review
F1	December 2016	Draft	G Harper / A Phin	S Burr	A Dent

Document Details

Last saved	08/12/2016 12:01
Path	GHad-10795-091216-DTS F1.doc
Author	G Harper BEng (Hons) / A Phin MSci MSc PhD
Project Partner	A Frost, BEng CEng MIStructE MICE FConsE
Project Number	10795
Project Name	The Hoxton, Holborn

Contents

Appendices

1.0 EXECUTIVE SUMMARY

SITE LOCATION	The site is situated at The Hoxton, 199-206 High Holborn, London, WC1V 7BD. It is approximately 0.16 Ha in size and is centred on an approximate National Grid reference 530400, 181450.
ENVIRONMENTAL SETTING	The geological sequence at the site comprises Made Ground over River Terrace Deposits, London Clay, Lambeth Group, Thanet Sand Formation and Chalk. The overall environmental sensitivity of the site is considered to be **Low-Medium** based on the following classifications: Hydrogeological (**Low-Medium**): The site is underlain by a Secondary A Aquifer associated with the River Terrace Deposits. Hydrology (**Low**): The site is not in proximity to any surface water. Sensitive Land Uses (**Low**): The site does not lie within any Designated Ecological or Heritage area, although the site does lie in the Bloomsbury Conservation Area
CURRENT USE AND HISTORY	The earliest available map (1851) shows the site and surrounding area to be developed, with the present day street layout largely in place. The site was redeveloped into the current building footprint arrangement sometime between 1979 and 1983. The current use of the site is as a five-storey hotel with associated service yard. The site is bound to the north by High Holborn and to the east by Newton Street. To the south lies a thirteen-storey residential apartment block separated by a single-lane service entrance. West of the hotel, separated by a narrow alleyway (Dragon Yard), is the five-storey Holborn Town Hall 'The Connection'. Green Dragon House is located south west of the hotel, adjacent to the service yard, and is a three-storey mixed-use building. It is proposed to build a raised five-storey bedroom wing extension over the rear service yard, and an additional rooftop storey on the Newton Street wing. The service yard will therefore remain, with the proposed extension constructed above it.
GEOTECHNICAL HAZARDS	The anticipated geotechnical hazards and constraints at the site comprise: • Tunnels – existing tunnels identified beneath the site; • Made Ground – settlement prone and low strength; • Soil Conditions – potentially aggressive to buried concrete; • Differential movement between existing and proposed structures; • UXO risk is **Medium**; • Buried services and obstructions; and, • Lambeth Group – potential for hard bands and sub-artesian water to be encountered.
CONTAMINATION ISSUES	Contamination issues at the site are generally considered to present a **LOW** risk. Potential sources of contamination are generally limited to the Made Ground from historical redevelopment of the site, and from contamination in groundwater within the Secondary A Aquifer associated with the Lynch Hill Sand and Gravel beneath the site. However, no relevant pollutant linkage exists between these sources and the end users.
RECOMMENDATIONS	Liaison with the relevant asset owners should be undertaken regarding the tunnels identified beneath the site. It is recommended that a detailed UXO desk study is undertaken by a specialist prior to starting any intrusive works at the site.

	A site investigation should be designed and implemented in accordance with BS10175 and BS5930 (+A2:2015) and reported in accordance with current technical guidance. This should provide information on the ground and groundwater conditions. In addition it should consider geotechnical elements in accordance with Eurocode7. During the geotechnical site investigation, a watching brief should be kept for contamination, and samples taken in order to better inform health and safety procedures for ground workers. The investigation could also potentially consider elements such as soils re-use and waste classification.

2.0 INTRODUCTION

2.1. Appointment and Scope

2.1.1. This report has been produced by Campbell Reith Hill LLP (CampbellReith) on behalf of Ennismore Capital (the Client) to summarise environmental and geotechnical desk study information relating to The Hoxton, Holborn, London WC1V 7BD (hereafter referred to as the site). The references and limitations associated with this report follow the main text. Figures showing the location of the site and the development proposals are presented in Appendix A.

2.1.2. The desk study has been produced in general accordance with the procedures for ground investigation, interpretation and reporting set out in DEFRA Contaminated Land Report (CLR) 11, BS 5930:2015, BS 10175:2011 (+A1:2013) and BS EN 1997 (Eurocode 7). The objective of the report is to collate and interpret Phase 1 Desk Study information in order to provide:

a) An overview of the site area including a description of the site's environmental setting;

b) A review of the site's historical an industrial development;

c) A preliminary qualitative environmental risk assessment and conceptual site model;

d) A discussion on the potential geotechnical constraints and development considerations; and,

e) Recommendations for further surveys and reporting.

2.1.3. The Tier 1 contamination appraisal is intended to identify the likely presence of source-pathway-receptor pollutant linkages and provides a qualitative indication of the level of risk posed by potential ground contamination at the site

2.1.4. This assessment considers the objectives of the National Planning Policy Framework (NPPF) which requires information to demonstrate that a site is suitable for its new use (taking account of ground conditions and land instability) and not capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990 (after remediation). The NPPF also requires adequate site investigation information, prepared by a competent person, with the minimum requirement comprising a desk study and site reconnaissance.

2.1.5. It should be recognised that further appraisals, investigations, specifications and validation may be required in order to accord with the recommendations stated herein.

2.1.6. The desk study is based on a site walkover, regulatory consultations and a review of available information as referenced. Desk study information obtained for this report is presented in Appendix B, and photographs taken during the site walkover and presented in Appendix C.

3.0 SITE DESCRIPTION

3.1. Site Location

3.1.1. The site location is presented in Figure 1. The site is situated at The Hoxton, 199-206 High Holborn, London, WC1V 7BD. It is approximately 0.16 Ha in size and is centred on an approximate National Grid reference 530400, 181450.

3.2. Site Layout

3.2.1. A site walkover was completed by a representative of CampbellReith on 3rd November 2016 and forms the basis of the following description. The site comprises a five-storey L-shaped hotel (an original four-storey building with a single-storey extension), with restaurants, bars and cafés at ground level. A single-storey basement covers the entire footprint of the existing structure. The building appears in good condition, with no immediately obvious damage/cracking observable from street level.

3.2.2. Access to the area of the proposed development is via the service entrance along Newton Street and comprises an asphalted service yard. Four manholes were identified within the service yard, located in the north of the service yard running east to west.

3.2.3. The service yard is currently in use by the hotel and the following items were identified in the yard: a large diesel power generator, two wooden storage sheds, a fixed bicycle rack, waste bins and laundry bins. The diesel generator appears to be in good working order with no visible staining on adjacent ground surface. A single mature tree is located in the yard approximately 10m tall. No soil is exposed on site.

3.2.4. The site is generally flat, although there is a slight gradient down towards the south. The site is situated at approximately 24m AOD.

3.3. Surrounding Land-Use

3.3.1. The site is bound to the north by High Holborn and to the east by Newton Street. To the south lies a thirteen-storey residential apartment block separated by the single-lane service entrance. West of the hotel, separated by a narrow alleyway (Dragon Yard), is the five-storey Holborn Town Hall 'The Connection'. Green Dragon House is located south west of the hotel, adjacent to the service yard, and is a three-storey mixed-use building. The presence of basements in these buildings is unknown.

3.3.2. The surrounding area is densely developed. Holborn Underground Station is situated some 130m east of the site, with the Central line known to pass beneath the existing structure. Crossrail will also pass directly beneath the site.

3.4. Site After-Use Proposal

3.4.1. The proposed site redevelopment is shown in Figures 4 to 7. It is proposed to build a raised five-storey bedroom wing extension over the rear service yard, and an additional rooftop storey on the Newton Street wing. The service yard will therefore remain, with the proposed extension constructed above it. The single mature tree will be removed as a result of the development.

4.0 ENVIRONMENTAL SETTING

4.1. Geology

4.1.1. The Envirocheck Report [1], 1:50,000 scale geological sheet for the area [2], and British Geological Survey (BGS) borehole logs consulted [3] indicate that the sequence of the geology underlying the site is Lynch Hill Gravel (River Terrace Deposits), London Clay, Lambeth Group, Thanet Sand Formation, and then Chalk to a significant depth. Made Ground is likely to be present on site given its development history (refer to section 5.1). The associated references are listed at the rear of the report. The site geology is summarised in Table 4.1.

TABLE 4.1: Summary of Anticipated Geology

Strata	Depth to Base (m bgl)	Depth to base (m AOD)	Thickness (m)	Typical Description
Made Ground	4*	19-20*	4*	Unknown, but likely to comprise a mixture of cohesive granular man-made soils.
River Terrace Deposits	4-6	18	1-2	Medium dense or dense brown GRAVEL and SANDS. Can be clayey in part and can contain pockets of clay.
London Clay	c. 27	c. -4	c. 22	Stiff, becoming very stiff at depth, fissured dark grey CLAY, silty in part; lower part sandy. Weathers near the surface to an orange-brown colour and firm consistency.
Lambeth Group	c. 37	c. -14	c. 10	Stiff or very stiff fissured mottled CLAY with SAND and GRAVEL layers.
Thanet Sand Formation	c. 47	c. -24	c. 10	Dense or very dense, green-grey fine-grained SAND.
Chalk	c. 235	c. -215	c. 190	Micritic LIMESTONE with flint nodules, and interbedded calcareous mudstone in lower part.

* whilst the BGS BH records indicated 4m of Made Ground, however this cannot be assured as being the case for the site given their location and the variability inherent of Made Ground.

4.1.2. In the borehole records, the London Clay was noted to contain gypsum (sulphate) crystals and claystone bands. No evidence of chiselling is recorded in the boreholes.

4.1.3. The Envirocheck report indicates that a moderate potential for shrinking or swelling clay is present on site. However, in the opinion of CampbellReith this is unlikely to be the case given the depth to the London Clay and the presence of the overlying River Terrace Deposits, which are likely to be water bearing.

4.1.4. The Envirocheck report indicates that the site is not an area affected by mining. In addition, a 'very low', or 'no hazard' has been identified in relation to the following ground stability

hazards: collapsible ground, compressible ground, ground dissolution, running sands, and landslides.

4.1.5. With reference to CIRIA SP69 [5], there is no published record of a 'scour hollow' within 500m of the site. The nearest recorded site is located on the corner of Grays Inn Road and Calthorpe Street, some 900m from site. In addition, with respect to rising groundwater, the site lies outside the critical area for deep foundations and basements.

4.2. Seismicity

4.2.1. The national forward to BS EN 1998-1:2004+A1:2013 'Eurocode 8: Design of Structures for Earthquake Resistance – Part 1' states there are no requirements in the UK to consider seismic loading, and the whole of the UK may be considered an area of very low seismicity in which the provisions of EN 1998 need not apply.

4.3. Hydrogeology

4.3.1. The site hydrogeology is summarised in Table 4.2 and the associated references listed at the rear of the report.

TABLE 4.2: Summary of Hydrogeology

Type	Distance	Description	Reference
Superficial Aquifer	On site	Secondary A Aquifer of high permeability associated with the River Terrace Deposits.	1 & 4
Bedrock Aquifer	On site	Unproductive Strata of low permeability associated with the London Clay.	1 & 4
Source Protection Zone	>1km	None within 1km of site	1 & 4

4.3.2. British Geological Survey (BGS) borehole logs [3] indicate water was encountered at 5.00 to 5.50m bgl in the River Terrace Deposits, but as no monitoring data was presented this may not be representative of equilibrium conditions.

4.3.3. The site is considered to have a **Low-Medium** Sensitivity with respect to hydrogeology. The sensitivities have been based upon the definitions provided in NHBC R&D66, as amended to include the requirements of the Water Framework Directive and the EA's River Basin Catchment Plans. This is due to the Secondary A Aquifer associated with the Lynch Hill Deposits, possibly providing baseflow to surface water.

4.4. Hydrology

4.4.1. The site hydrology is summarised in Table 4.3 and the associated references listed at the rear of the report.

TABLE 4.3: Summary of Hydrology

Type	Distance	Description	Reference
Surface Water Flooding	On site	Flood Zone 1 (low probability) - Land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%). Potential for groundwater flooding of property to occur at surface and below ground level.	1 & 4
Surface Waters	c. 830m	River Thames to the south east.	1

4.4.2. The site is located in a Flood Zone 1, with a low probability of flooding from rivers, and a low risk of flooding from surface water according to the Environment Agency website. The Envirocheck Report [1] also suggests a low risk of surface flooding however the report also suggests as potential for flooding with respect to groundwaters. It is recommended that a detailed flood risk assessment is commissioned to confirm matters.

4.4.3. The site is considered to have a **Low** Sensitivity with respect to hydrology. The sensitivity has been based upon the guidance detailed for the hydrogeological assessment above.

4.5. Radon

4.5.1. Reference to the joint Public Health England (PHE) and British Geological Society (BGS) Interactive Atlas [6] and BRE 211 document [7] shows that the site is in an area with a Radon Potential Class of 1, and as such radon protection measures are not considered necessary for domestic dwellings. As such, a **Low** risk is determined in relation to radon.

4.6. Sensitive Land-Uses

4.6.1. A review has been made of Designated Ecological and Heritage sites and these are summarised below. The Local Authority may also consider non designated heritage and archaeological sites as significant, and these are not appraised except where noted.

4.6.2. Reference to the Envirocheck Report [1], the EA website [4] and the MAGIC website [8], indicates that the site is not located within any Designated Ecological or Heritage site.

4.6.3. The Thames Estuary Marine Nature Reserve is located 830m to the south east of the site

5.0 SITE HISTORY AND INDUSTRIAL SETTING

5.1. Site History

5.1.1. Information relating to the site history has been obtained by reference to the Envirocheck Report presented in Appendix B, and is summarised for the site and its surroundings in Tables 5.1 and 5.2. It is noted that the additional 'Goad' maps presented in the Envirocheck Report, which span from 1928 to 1970, suggest that the buildings were occupied by a mix of commercial and residential properties.

TABLE 5.1: Site History

Date	Development
1851-	The plan indicates a street layout similar to present day, but provides no further detail.
1875-1878	Numerous buildings are indicated to be present on the site. One of the buildings in the east site is labelled PH (public house).
1895-1920	The public house is no longer labelled. Minor changes to the building layout.
1928-1979	No significant changes to the building footprint.
1979-1983	Building layout has changed to match existing building footprint.
1983-2016	No significant changes to the site.

TABLE 5.2: Adjacent Land History

Date	Development
1851 -1896	The surrounding area is extensively developed, with the present day street layout largely in place. Silver Street and Coal Yard (later Goldsmith Street) are located in the immediate vicinity of the site. A stone yard is present directly south. A foundry is present approximately 80m south west, later labelled as a brass works.
1916-1920	The stone yard is now labelled 'weighing machine'. The brass works is no longer labelled. British Museum Underground Station is shown directly north of the site across High Holborn. This station is believed to have been in use between 1900 and 1933. Holborn Underground Station is shown, having been constructed in 1906, and is approximately 150m east of the site. It is understood that the central line passes beneath the northern portion of the site (beneath the existing structure).
1940	The 1:10 000 plan potentially suggests the presence of ruins in the areas around the site and suggests the absence of a previously existing building.
1952-1953	The weighing machine is now labelled council depot. A mortuary is present approximately 50m south. Ruins still labelled in the vicinity of the site..
1963	The mortuary is no longer present.
2016	No significant changes.

5.2. Liaison With Regulatory Authorities

5.2.1. The site is within Sub Area 8 of the Bloomsbury Conservation Area. The façade of No's 199, 200 and 201 is Grade II Listed. Listed buildings close to the site are shaded in black in Figure 2.

5.2.2. The Building Control department at the London Borough of Camden was contacted and their response did not reveal anything further than what has already been discussed in this report.

5.2.3. A response is awaited from the Environmental Health Officer with respect to any additional records that the London Borough of Camden may have with respect to contamination issues and the like.

5.3. Unexploded Ordnance (UXO)

5.3.1. A preliminary review has been made of the UXO risk presented by the site based upon CIRIA C681 ('Unexploded Ordnance (UXO) – A guide for the construction industry') and the assessment matrices presented in Tables 5.1 - 5.3 therein. The site is situated in central London, an area of high intensity World War 2 bombing.

5.3.2. Reference to the Bombsight Website [11] indicates that the nearest high explosives in the vicinity of the site were found about 100m away from the site. Historical maps and the Bomb Map of London [9] show numerous damaged buildings in the vicinity of the site, with the nearest directly east across from Newton Street.

5.3.3. Piling will be required to support the proposed extension, likely to extend to a significant depth into the ground.

5.3.4. In light of the above review, it is considered that a **Medium** risk of encountering UXO exists for the proposed development.

5.4. Tunnels and Infrastructure

5.4.1. The London Underground Central line pass directly beneath the site.

5.4.2. Crossrail 1 will lie directly beneath the site, with the site within Crossrail 1 safeguarding zone.

5.4.3. Royal Mail tunnels are located to the north west of the site, directly across from High Holborn.

5.4.4. The tunnels and infrastructure identified are presented in Figure 3. Based on readily available information, CampbellReith is not aware of any electrical power tunnels, National Grid tunnels, oil and gas pipelines, or government communication tunnels within 100m of the site.

5.5. Current Industrial Setting

5.5.1. Table 5.3 summarises identified industrial features which may present a potential source of contamination to the site based upon the Envirocheck Report [1]. Unless otherwise stated, only industrial features within 250m have been considered.

TABLE 5.3: Industrial Setting

Type	Distance	Description
Pollution Incidents to Controlled Waters	230m NE	Pollutant: Miscellaneous – Fire water / Foam. Dated: 6 January 1996. Incident Severity: Category 3 – Minor Incident.
Registered Radioactive Substances	100m NE	Name: York Cameras (London) Ltd. Location: 1 Southampton Row. Dated: 1 April 1991. Permit Reference: AR3933.
	225m S	Name: Kings College London. Location: 26-29 Drury Lane. Dated: 29 October 1993. Permit Reference: AR2160.
	235n SE	Name: Cancer Research UK. Location: 61 Lincoln Inn Fields. Dated: 31 March 1991. Permit Reference: AL1032.
Local Authority Pollution Prevention and Controls	250m S	Name: Tuxedo Express. Location: 40 Drury Lane. Dated: 5 September 2007. Description: PG6/46 Dry Cleaning. Status: Permitted.
Contemporary Trade Entries	0 – 250m	Twenty seven active entries including: printers, dry cleaners, cosmetic manufacturers, commercial cleaning services, damp & dry rot control, clothing & fabric manufacturers, and food products.
		Seventy inactive entries including: hospitals, printers, air-conditioning & refrigeration, photographic processors, chemical manufacturers, cleaning services, oven cleaning, pest & vermin control, electrolysis, and waste disposal services.

5.5.2. Research did not establish the presence of any of the following at or within 250m of the subject site:

- discharge consents;
- contaminated land register entries and notices;
- enforcement and prohibition notices;
- integrated pollution controls;
- integrated pollution prevention and control;
- local authority integrated pollution prevention and control;
- local authority pollution prevention and control enforcements;
- waster abstractions;
- prosecutions relating to authorised processes;
- prosecutions relating to controlled waters;
- substantiated pollution incident register;
- water industry act referrals;
- Control of Major Accident Hazards Sites (COMAH);
- explosive sites;
- fuel station entries;
- BGS recorded landfill sites;
- historical landfill sites;
- local authority recorded landfill sites;

- registered landfill sites;
- integrated pollution control registered waste sites;
- licensed waste management facilities (landfill boundaries and locations);
- Notification of Installations Handling Hazardous Substances (NIHHS);
- registered waste transfer sites;
- registered waste treatment or disposal sites;
- planning hazardous substance consents; and,
- planning hazardous substances enforcements.

6.0 CONCEPTUAL MODEL

6.1. Introduction

6.1.1. Current practice for land contamination evaluation involves classification of risk for each of the identified contaminant source-pathway-receptor pollutant linkages. These are summarised below, considering the desk study information obtained.

6.2. Classification of Risk

6.2.1. Risk is defined by the combination of two factors: i) the probability of an occurrence (expressed as a likelihood); and ii) the consequence of it happening (expressed as a severity). The procedure for classifying risk is summarised in Table 6.1. The categories of risk have been based upon those defined in the Guidance for the Safe Development of Housing on Land Affected by Contamination, R&D66: 2008 Volume 1 (Environment Agency, NHBC and CIEH). The categories are defined in the Environmental Risk Assessment Supporting Information section to the rear of this report, together with definitions of the classifications of probability and consequence.

TABLE 6.1: Classification or Risk

Probability (Likelihood)		Consequence			
		Severe	Medium	Mild	Minor
	High likelihood	Very high risk	High risk	Moderate risk	Low risk
	Likely	High risk	Moderate risk	Moderate/low risk	Low risk
	Low likelihood	Moderate risk	Moderate/low risk	Low risk	Very low risk
	Unlikely	Moderate/low risk	Low risk	Very low risk	Very low risk

6.3. Potential Sources of Contamination

6.3.1. Table 6.2 summarises the potential contamination sources– from reference to the Envirocheck report [1] and site walkover – that have been identified on or near the site. The potential contaminant types associated with these is then given based upon a review of CLR 11, and industry profiles. Unless otherwise stated, all are within 250m of the site.

TABLE 6.2: Potential Sources of Contamination

Feature on or near site	Potential Contaminant
Areas of infilling and Made Ground resulting from the historic demolition of the site and surrounding area.	M, H, ACM, GG
Service yard and diesel generator	M, H, VOC
Current and historical industries in the surrounding area including council depot immediately south, printers 60m N and dry cleaners 110m E.	M, H, VOC
Notes: M – Metals. H – Hydrocarbons. VOC – Volatile Organic Compounds. ACM – Asbestos Containing Materials. GG – Ground Gas (methane and carbon dioxide)	

6.4. Receptors and Exposure Pathways

6.4.1. Potential risks have been identified based on the proposed site use, the receptors and potential pathways by which the receptors may be exposed to the contaminant sources.

TABLE 6.3: Receptors and Exposure Pathways

Receptor	Pathway	Risk
End Users	Ingestion of soil / dust	Very Low
Neighbours		Very Low
Construction Workers		Low - Moderate
End Users	Inhalation of soil / dust	Very Low
Neighbours		Very Low
Construction Workers		Low - Moderate
End Users	Inhalation of vapour from soil / dust / water	Low
Neighbours		Very Low
Construction Workers		Low - Moderate
End Users	Dermal contact with soil / dust / water	Very Low
Neighbours		Very Low
Construction Workers		Moderate
End Users	Consumption of vegetables / plants	Not applicable
End Users	Migration of soil gases/vapours to confined spaces / structures	Low - Moderate
Construction Workers		Low
Building		Low - Moderate
Surface Waters	Migration of water borne contaminants	Very Low
Neighbours		Very Low
Groundwater Aquifer	Leaching of contamination from Made Ground	Low - Moderate
	Migration of water borne contaminants from off site	Low
End Users	Movement of contaminants to engineered structures (water pipes)	Low - Moderate
Sensitive Land Use	Uptake by flora / fauna associated with sensitive land use	Not applicable

6.4.2. The diesel powered generator is not considered to represent a significant source of contamination, as it and the surrounding ground were noted to be in good condition. In addition, there is adjudged to be a low risk from migration of water borne contaminants from

off-site considering there are no water abstractions in the surrounding area and no pathway between potential contamination in groundwater and site end users.

6.4.3. The risk to construction workers is based on the assumption that basic health and safety procedures are followed. These procedures should be supplemented by maintaining a watching brief for contamination, including ACM, during groundworks.

6.4.4. Overall, no relevant pollutant linkages exist between the sources identified and the end users of the site.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1. Site Setting and Sensitivity

7.1.1. The site likely has a **Low** hydrological sensitivity, and **Low-Medium** hydrogeological sensitivity associated with the River Terrace Deposits (Secondary A Aquifer). The proposed site end use is of a commercial nature, with the existing service yard remaining, and as such, the sensitivity is considered to be **Low**.

7.2. Site History and Development Proposals

7.2.1. The site and its surrounding land are developed from at least 1851, with numerous buildings occupying the site, including a mix of commercial and residential properties. The current building footprint is evident from around 1983, and appears to essentially remain unchanged.

7.2.2. The site currently comprises a five-storey L-shaped hotel, with a single-storey basement that covers the entire footprint of the existing structure. It is proposed to build a raised five-storey bedroom wing extension over the rear service yard, and an additional rooftop storey on the Newton Street wing. The service yard will remain, with the proposed extension constructed above it. The single mature tree will be removed as a result of the development.

7.2.3. The site is bound to the north by High Holborn and to the east by Newton Street. To the south lies a thirteen-storey residential apartment block separated by the single-lane service entrance. West of the hotel, separated by a narrow alleyway (Dragon Yard), is the five-storey Holborn Town Hall 'The Connection'. Green Dragon House is located south west of the hotel, adjacent to the service yard, and is a three-storey mixed-use building. The presence of basements in these buildings is unknown.

7.2.4. The site is within Sub Area 8 of the Bloomsbury Conservation Area. The façade of No's 199, 200 and 201 is Grade II Listed.

7.2.5. The Central line is known to pass beneath the existing structure. Crossrail will also pass directly beneath the site.

7.3. Geotechnical Conclusions and Recommendations

7.3.1. The geological sequence at the site is anticipated to comprise Made Ground, River Terrace Deposits, London Clay, Lambeth Group, Thanet Sand Formation and Chalk to a significant depth. Based on historical boreholes, the thickness of the Made Ground was 1.0m beneath the single-storey basement. The thickness of the Made Ground is therefore likely to be in the region of 4.0m beneath the service yard.

7.3.2. A ground investigation should be carried out to confirm the ground and groundwater conditions for the design of the foundations. A geotechnical design report should be prepared in accordance with BS EN 1997 (Eurocode 7) once the ground investigation has been completed

and the final scheme details are known. Based on the above, and the anticipated ground conditions discussed in Section 4, the proposed development is considered to fall into geotechnical 3 with respect to Eurocode 7.

7.3.3. The desk study has suggested that the following geotechnical hazards may exist at the site:

TABLE 7.1: Summary of Geotechnical Hazards

Hazard	Distance	Description
Tunnels	On site	London Underground Ltd (Central Line) and Crossrail 1.
Made Ground	On site	The behaviour of Made Ground typically is difficult to predict but typically it has a low strength and is typically associated with large and differential ground movements upon loading .
Aggressive Soil Conditions	On site	London Clay, and materials derived from it, may naturally contain substances aggressive to buried concrete.
Differential movement	On site	The potential for differential movement exists between the existing and proposed structures.
UXO Risk	On site	A **Medium** risk of encountering UXO exists on site.
Existing Structures/Services	On site	There is the potential for obstructions associated with exiting and historic development.
Lambeth Group	On site	Potential for hard bands and for bands containing water under significant pressures to be encountered. Such factors can hamper some forms of pile installation.

7.3.4. So as to establish any associated constraints, liaison with the relevant asset owners should be undertaken regarding the tunnels identified beneath and in close proximity to the site. This process is on-going at the time of writing.

7.3.5. It is recommended that a detailed UXO desk study is undertaken by a specialist prior to starting any intrusive works at the site.

7.4. Environmental Conclusions and Recommendations

7.4.1. The potential sources of contamination are generally limited to Made Ground in relation to historical development of the site, however no relevant pollutant linkages have been identified between Made Ground and the end users of the site. The diesel powered generator and potential for water borne contamination within the Secondary A Aquifer to migrate from off site are not considered to be significant sources.

7.4.2. Considering the site sensitivities as outlined previously, and the proposed development, there is a **LOW** risk in relation to potential contamination within areas of infilling and Made Ground resulting from the historic demolition of the site and surrounding area.

7.4.3. During the geotechnical site investigation, a watching brief should be kept for contamination, and samples taken in order to better inform health and safety procedures for ground workers.

The investigation could also potentially consider elements such as soils re-use and waste classification.

7.4.4. Japanese Knotweed has not been assessed as part of this report.

7.4.5. Land quality assessment is an iterative process and likely to be a condition of planning consent for the redevelopment. As such this document should be submitted as part of the planning process. Discussions should also be held with the Regulators regarding further information required to fulfil any Land Quality Planning Conditions which may be imposed as part of the Planning Consent. It may be that other investigations/ risk assessments/ specifications and verification reporting will be required prior to final condition discharge. Discussions should be held with the relevant Officer at an early stage to ensure all necessary information is obtained and collated for their review and approval.

7.4.6. Failure to submit the required documentation could result in refusal to discharge associated Land Quality Planning Conditions.

TECHNICAL REFERENCES

Reference	Reference Title	Type
1	Envirocheck Report, dated 7 November 2016 (ref: 103704992_1_1)	Envirocheck Report
2	Sheet 256 North London, Geological Maps of England and Wales 1: 50 000 Series, Solid and Draft Edition	Geological Map
3	British Geological Survey website (http://www.bgs.ac.uk)	Website
4	Environment Agency website (http://apps.environment-agency.gov.uk/wiyby/)	Website
5	CIRIA Special Publication 69: The Engineering Implications of Rising Groundwater Levels in the Deep Aquifer Beneath London	CIRIA Publication
6	PHE-BGS digital Indicative Atlas of Radon in the United Kingdom	Website
7	Radon: Guidance on Protective Measures for New Dwellings. 2007.	BRE Publication BR 211
8	Multi Agency Geographic Information for the Countryside website (http://magic.defra.gov.uk/website/magic/)	Website
9	London County Council Bomb Damage Maps. London Topographical Society and London Metropolitan Archives, 2005.	Reference book
10	Concrete in Aggressive Ground	BRE Special Digest 1
11	Bomb Site Website (http://bombsight.org/)	Website

ENVIRONMENTAL RISK ASSESSMENT SUPPORTING INFORMATION

Soil Screening Values

The Environment Agency has published non statutory technical guidance for Regulators and their advisors to assess the chronic risk posed to human health from land contamination, known as the Contaminated Land Exposure Assessment (CLEA) Framework.

The CLEA Framework documents and associated risk assessment model are subject to ongoing technical review. In July 2008 guidance documents CLR7 to 10, which previously underpinned the CLEA Framework, were withdrawn. In January 2009 the Environment Agency published CLEA V1.04 risk assessment software and associated guidance documents[1] as a replacement to the previous CLEA UK Beta Version and documents CLR 7 to 10. Further revisions were made in September 2009 to CLEA V1.05 and October 2009 to CLEA 1.06 risk assessment software.

Soil Guideline Values (SGVs) were produced by Defra/EA and Generic Assessment Criteria (GACs) were produced by CampbellReith and others. These were based on the CLEA model and supporting guidance (SR2 and SR3) and where based on a minimal/tolerable level of risk.

In December 2014 DEFRA released final versions of the C4SLs (Category 4 Screening Levels) for 6 No. contaminants (As, benzene, BaP, Cd, Cr VI and Pb) together with a Policy Companion Document and an Erratum. These represent contaminant soil concentrations which present an acceptable (Low) level of risk, within the context of Part 2A, i.e. they are representative of Category 4 sites. In the Contaminated Land Statutory Guidance (April 2012), sites under Part 2A assessments are categorised 1 - 4, with Category 1 being definitely Part 2A and Category 4 definitely not Part 2A ('where there is no risk or the level of risk posed is low').

The C4SLs were produced using the CLEA model and follow the general approach of SR3, although, changes were made to exposure parameters and to the toxicological basis of the assessments. The C4SLs are based on a low level of toxicological concern (LLTC) and are, by definition, less conservative than Health Criteria Values (HCVs) which are the basis for assessments defined in SR2 and used in the generation of SGVs and GACs. They are, therefore, indicative of a low level of risk.

Since their release, DEFRA have confirmed that C4SLs can be used in the planning regime and DCLG (Department for Communities and Local Government) amended Planning Practice Guidance (PPG) on Land Affected by Contamination (12 June 2014)[2] which stated that C4SLs provide a simple test for deciding when land is suitable for use and definitely not contaminated land'. On 03 September 2014 the Secretary for the Environment, Lord de Mauley, issued a letter (attached) to all Local Authorities which references DCLG's PPG and confirms that C4SLs could be used in planning and provide a simple test for establishing when sites are suitable for use.

LQM/CIEH issued S4ULs in December 2014 for 89 contaminants (metals, BTEX, banded TPH, speciated PAH, chlorinated solvents, phenols, chlorophenols, chlorobenzenes, pesticides and a number of miscellaneous others). The S4ULs have generally adopted the revisions to the exposure modelling that were developed in the production of the C4SLs. Critically, however, they are based on HCVs to produce concentrations which are indicative of a minimal/tolerable level of risk.

S4ULs are therefore used as the preliminary stage of soil assessments since they are indicative of minimal/tolerable level of risk. If these are exceeded then the C4SLs are used (if available) to determine if the risk could be described as low.

Where CLEA compliant S4ULs or C4SLs are not available reference is made to Generic Assessment Criteria (GAC) derived using the CLEA UK model (beta version). These are currently used for cyanide. Where referred to, the non-compliant standing of these values is considered.

[1] Environment Agency Report Ref: SC050021/SR2 - *Human Health Toxicological Assessment of Contaminants in Soil.* January 2009. Environment Agency Report Ref: SC050021/SR3 – *Updated background to the CLEA model.* January 2009.

[2] http://planningguidance.planningportal.gov.uk/blog/guidance/land-affected-by-contamination/land-affected-by-contamination-guidance/

Selection of Appropriate [Tier 2] Soil Screening Values

The CLEA model is based upon defined exposure scenarios and six generic land uses have been established for the C4SLs and S4ULs. These set out a discrete set of circumstances where exposure may occur, including a source, the pathways, and the exposed population.

The three generic land use scenarios used in the development of SGVs are:

- **commercial / Industrial;**
- **allotments; and,**
- **residential with plant uptake,**
- **residential without plant uptake,**
- **public open space (residential)**
- **public open space (parks)**

It is noted that the CLEA screening values are generic and not always applicable. Where the CLEA conceptual model is not appropriate it will be necessary to develop site specific Detailed Quantitative Risk Assessment screening values as a further stage of assessment.

It is noted that the CLEA model does not consider risks from contaminated waters beneath the site to human health and the model also assumes that no free product is present. Should such conditions exist at the subject site the requirement for application of an alternative risk assessment model should be assessed. Alternatively, construction workers are potentially exposed to acute risk and therefore require separate consideration.

Statistical Analysis of Soil Analytical Results

Statistical analysis of soil based analytical results has been undertaken in accordance with CL:AIRE Guidance on Comparing Soil Contamination Data with a Critical Concentration (May 2008). The use of the Mean Value Test and Maximum Value Test is still considered appropriate for site assessments. Although the guidance advocates use of the one - sample t test, this is a variation of the mean value test and establishes the confidence level at which the assessor can determine whether a particular screening level has / has not been succeeded. The mean value test used herein is set at the 95th percentile confidence limit in order to be risk conservative.

The Maximum Value Test is a statistical tool that is used to identify outlier values from a numerical distribution of results for a given determinant. These outlier values can be excluded and considered separately, and the remaining values are then used to calculate upper bound 95th percentile values ($95^{\%ile}$) (Mean Value Test) for comparison with the screening values.

The results are reviewed prior to any statistical analysis in order to determine if zoning of the soils is apparent and hence whether the site requires to be divided into averaging areas. Additional tables are presented where appropriate to reflect distinct ground characteristics relevant to the conceptual model.

Water Screening Values

This assessment considers potential risks to controlled waters (groundwater and surface waters) in relation to risks from any historical contamination. The most stringent test is that defined for Contaminated Land under Part 2A of the Environmental Protection Act, 1990. However, it should be recognised that a wider evaluation of risk is considered within the planning regime and CLR 11.

The Environment Agency has a wider policy agenda for the protection of controlled waters that will impinge upon judgements in relation to land contamination issues. This includes those for the Water Framework Directive and Groundwater Directive and wider legislation for both groundwater, surface water and associated elements (such as fisheries)[3].

The results of water analysis have been compared to screening values selected to assess the potential risk to the identified controlled water receptors in the Conceptual Model. The specific standards utilised for this purpose are considered in the assessment table footnotes and typically comprise: Environmental Quality Standards for the protection of aquatic life; Surface Water Standards; EC, UK and WHO Drinking Water Standards; or Background water quality (where no applicable standard exists).

The initial assessment considers the sensitivity of the receptor in the selection of the screening value. Advice for this purpose has been obtained principally from Environment Agency Technical Advice to Third Parties on Pollution of Controlled Waters for Part 2A of the Environmental Protection Act 1990, No 07/02. EA, 2002. (INFO-RA2-3e), as informed by the EA's GP3.

Where a viable pollutant linkage is considered to be present and the screening criteria exceeded, a Qualitative Risk Assessment is presented with associated recommendations. Depending on the specific objectives, policy and practice of the Environment Agency, discussion of water screening values may be subsequently required.

Definitions of Consequence, Probability and Risk

The following classification has been taken from Guidance for the Safe Development of Housing on Land Affected by Contamination R&D66: 2008 Volume 1 (Environment Agency, NHBC and CIEH.

The key to the classification is that the designation of risk is based upon the consideration of both:

a) **the magnitude of the potential consequence (i.e. severity).**

[takes into account both the potential severity of the hazard and the sensitivity of the receptor]

b) **the magnitude of probability (i.e. likelihood).**
[takes into account both the presence of the hazard and receptor and the integrity of the pathway]

[3] Refer to Environment Agency Publications for Groundwater Protection Policy and Practice (GP3)

Classification of Consequence

Classification	Definition	Examples
Severe	Highly elevated concentrations **likely** to result in "significant harm" to human health as defined by the EPA 1990, Part 2A, if exposure occurs. Equivalent to EA **Category 1** pollution incident including persistent and/or extensive effects on water quality; leading to closure of a potable abstraction point; major impact on amenity value or major damage to agriculture or commerce. Major damage to aquatic or other ecosystems, which is likely to result in a substantial adverse change in its functioning or harm to a species of special interest that endangers the long-term maintenance of the population. Catastrophic damage to crops, buildings or property.	Significant harm to humans is defined in circular 01.2006 as death, disease*, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Major fish kill in surface water from large spillage of contaminants from site. Highly elevated concentrations of List I and II substances present in groundwater close to small potable abstraction (high sensitivity). Explosion, causing building collapse (can also equate to immediate human health risk if buildings are occupied).
Medium	Elevated concentrations which could result in "significant harm" to human health as defined by the EPA 1990, Part 2A if exposure occurs. Equivalent to **EA Category 2** pollution incident including significant effect on water quality; notification required to abstractors; reduction in amenity value or significant damage to agriculture or commerce. Significant damage to aquatic or other ecosystems, which may result in a substantial adverse change in its functioning or harm to a species of special interest that may endanger the long-term maintenance of the population. Significant damage to crops, buildings or property.	Significant harm to humans is defined in circular 01/2006 as death, disease*, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Damage to building rendering it unsafe to occupy e.g. foundation damage resulting in instability. Ingress of contaminants through plastic potable water pipes.
Mild	Exposure to human health **unlikely** to lead to "significant harm". Equivalent to **EA Category 3** pollution incident including minimal or short lived effect on water quality; marginal effect on amenity value, agriculture or commerce. Minor or short lived damage to aquatic or other ecosystems, which is unlikely to result in a substantial adverse change in its functioning or harm to a species of special interest that would endanger the long-term maintenance of the population.	Exposure could lead to slight short-term effects (e.g. mild skin rash). Surface spalling of concrete.

Classification	Definition	Examples
	Minor damage to crops, buildings or property.	
Minor	No measurable effect on humans. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects of damage to buildings, structures and services.	The loss of plants in a landscaping scheme. Discoloration of concrete.

Classification of Probability

Classification	Definition	Examples
High likelihood	There is pollutant linkage and an event would appear very likely in the short-term and almost inevitable over the long-term, or there is evidence at the receptor of harm or pollution.	*a) Elevated concentrations of toxic contaminants are present in soils in the top 0.5m in a residential garden.* *b) Ground/groundwater contamination could be present from chemical works, containing a number of USTs, having been in operation on the same site for over 50 years.*
Likely	There is pollutant linkage and all the elements are present and in the right place which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short-term and likely over the long-term.	*a) Elevated concentrations of toxic contaminants are present in soils at depths of 0.5-1.0m in a residential garden, or the top 0.5m in public open space.* *b) Ground/groundwater contamination could be present from an industrial site containing a UST present between 1970 and 1990. The tank is known to be single skin. There is no evidence of leakage although there are no records of integrity tests.*
Low likelihood	There is pollutant linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a long period such an event would take place, and is less likely in the shorter term.	*a) Elevated concentrations of toxic contaminants are present in soils at depths >1m in a residential garden, or 0.5-1.0m in public open space.* *b) Ground/groundwater contamination could be present on a light industrial unit constructed in the 1990s containing a UST in operation over the last 10 years – the tank is double skinned but there is no integrity testing or evidence of leakage.*
Unlikely	There is pollutant linkage but circumstances are such that it is improbable that an event would occur even in the very long-term.	*a) Elevated concentrations of toxic contaminants are present below hardstanding.* *b) Light industrial units <10 yrs old containing a double-skinned UST with*

Classification	Definition	Examples
		annual integrity testing results available.

Note: A pollution linkage must first be established before probability is classified. If there is no pollution linkage then there is no potential risk. If there is no pollution linkage then there is no need to apply tests for probability and consequence.

For example if there is surface contamination and a principal aquifer is present at depth, but this principal aquifer is overlain by an aquiclude of significant thickness then there is no pollution linkage and the risks to the principal aquifer are not assessed. The report should identify both the source and the receptor but state that because there is no linkage there are no potential risks.

Description of the classified risks

Very high risk
There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without remediation action OR there is evidence that severe harm to a designated receptor is already occurring. Realisation of that risk is likely to present a substantial liability to be site owner/or occupier. Investigation is required as a matter of urgency and remediation works likely to follow in the short-term.

High risk
Harm is likely to arise to a designated receptor from an identified hazard at the site without remediation action. Realisation of the risk is likely to present a substantial liability to the site owner/or occupier. Investigation is required as a matter of urgency to clarify the risk. Remediation works may be necessary in the short-term and are likely over the longer term.

Moderate risk
It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely, that the harm would be relatively mild. Further investigative work is normally required to clarify the risk and to determine the potential liability to site owner/occupier. Some remediation works may be required in the longer term.

Low risk
It is possible that harm could arise to a designated receptor from identified hazard, but it is likely at worst, that this harm if realised would normally be mild. It is unlikely that the site owner/or occupier would face substantial liabilities from such a risk. Further investigative work (which is likely to be limited) to clarify the risk may be required. Any subsequent remediation works are likely to be relatively limited.

Very low risk
It is a low possibility that harm could arise to a designated receptor, but it is likely at worst, that the harm if realised would normally be mild or minor.

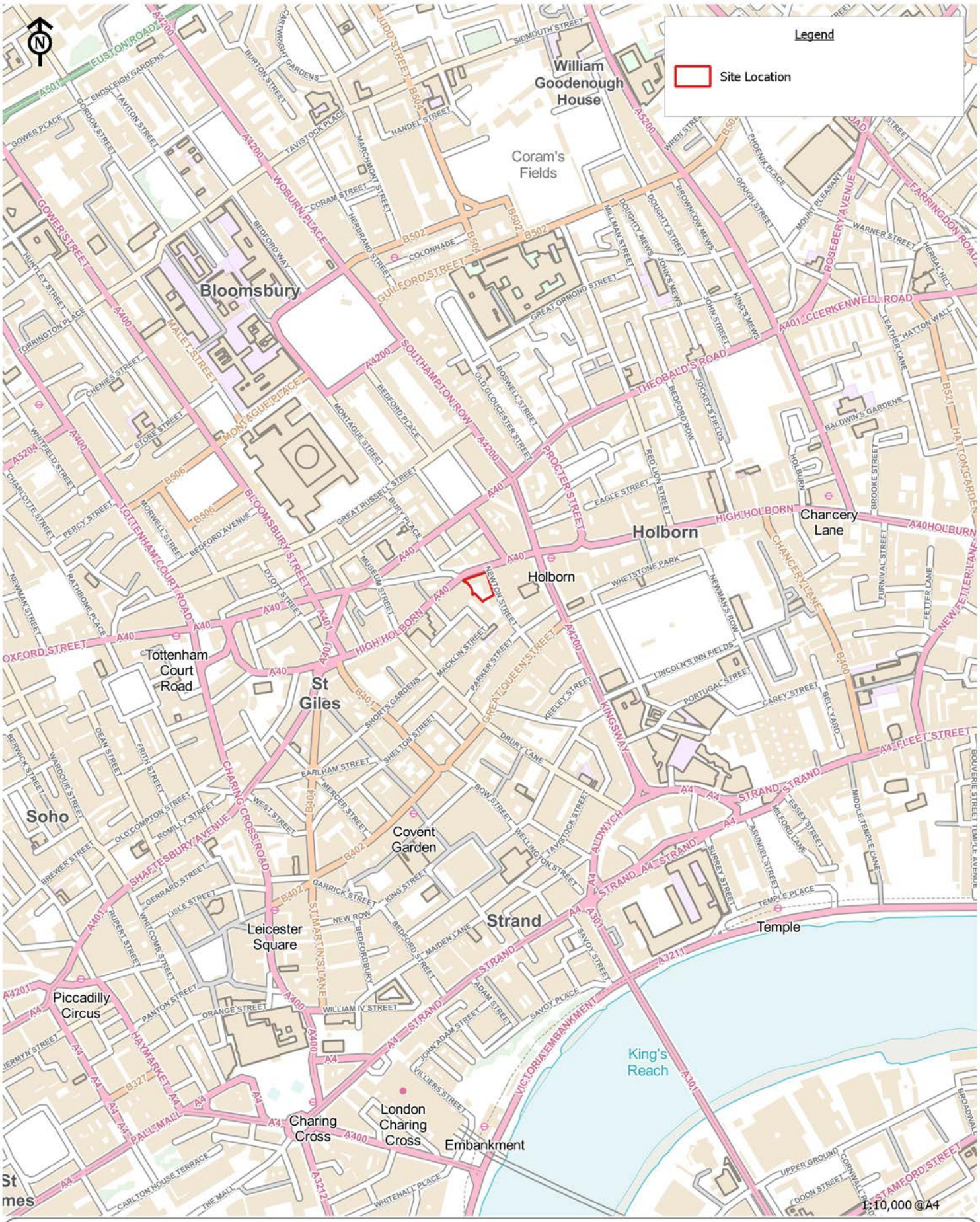
No potential risk
There is no potential risk if no pollution linkage has been established.

LIMITATIONS

Environmental & Geotechnical Interpretative Reports

1. This report provides available factual data for the site obtained only from the sources described in the text and related to the site on the basis of the location information provided by the client.
2. Where any data or information supplied by the client or other external source, including that from previous studies, has been used, it has been assumed that the information is correct. No responsibility can be accepted by CampbellReith for inaccuracies within this data or information. In relation to historic maps the accuracy of maps cannot be guaranteed and it should be recognized that different conditions on site may have existed between and subsequent to the various map surveys.
3. This report is limited to those aspects of historical land use and enquiries related to environmental matters reported on and no liability is accepted for any other aspects. The opinions expressed cannot be absolute due to the limit of time and resources implicit within the agreed brief and the possibility of unrecorded previous uses of the site and adjacent land.
4. The material encountered and samples obtained during on-site investigations represent only a small proportion of the materials present on the site. There may be other conditions prevailing at the site which have not been revealed and which have therefore not been taken into account in this report. These risks can be minimised and reduced by additional investigations. If significant variations become evident, additional specialist advice should be sought to assess the implications of these few findings.
5. The generalised soil conditions described in the text are intended to convey trends in subsurface conditions. The boundaries between strata are approximate and have been developed on interpretations of the exploration locations and samples collected.
6. Water level and gas readings have been taken at times and under conditions stated on the exploration logs. It must be noted that fluctuations in the level of groundwater or gas may occur due to a variety of factors which may differ from those prevailing at the time the measurements were taken.
7. Please note that CampbellReith cannot accept any liability for observations or opinions expressed regarding the absence or presence of asbestos or on any product or waste that may contain asbestos. We recommend that an asbestos specialist, with appropriate professional indemnity insurance, is employed directly by the client in every case where asbestos may be present on the site or within the buildings or installations. Any comments made in this report with respect to asbestos, or asbestos containing materials, are only included to assist the client with the initial appraisal of the project and should not be relied upon in any way.
8. The findings and opinions expressed are relevant to those dates of the reported site work and should not be relied upon to represent conditions at substantially later dates.
9. This report is produced solely for the benefit of the client, and no liability is accepted for any reliance placed upon it by any other party unless specifically agreed in writing.

Appendix A: Figures



Hoxton Hotel, Holborn

Client: Ennismore Capital

Figure 1:
Site Location Plan

Scale:	1:10000@A4
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Job Number:	10795 - 02
Drawn by - Checked by:	LB - GH
Drg No - Status/Revision:	GIS001 - A
File location:	N:/10750 - 10999/10795 L - High Holborn/02 - Hoxton Holborn/Project_Workspaces (pdf in Outputs)
Date (Revision History):	22/11/2016 (A, First Issue, 22/16/16, LB)

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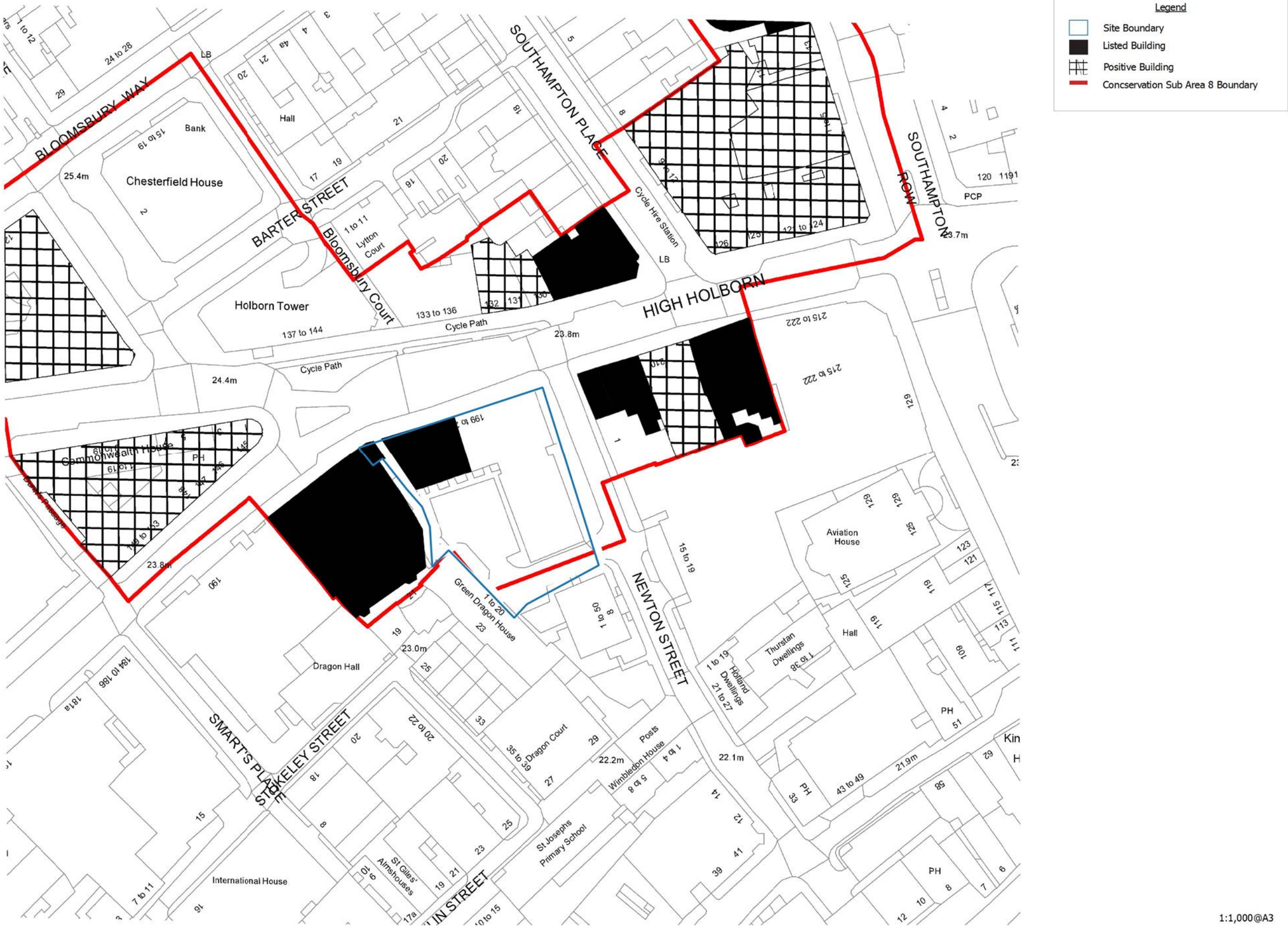

Hoxton Hotel, Holborn

Client: Ennismore Capital

Figure 2:
Listed Buildings

Scale: 1:1000@A3
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Based on EPR Architects drawing 1.2 Bloomsbury Conservation Area Sub Area 8 Plan Extract
Job Number: 10795 - 02
Drawn by - Checked by: LB - GH
Drg No - Status/Revision: GIS002 - A
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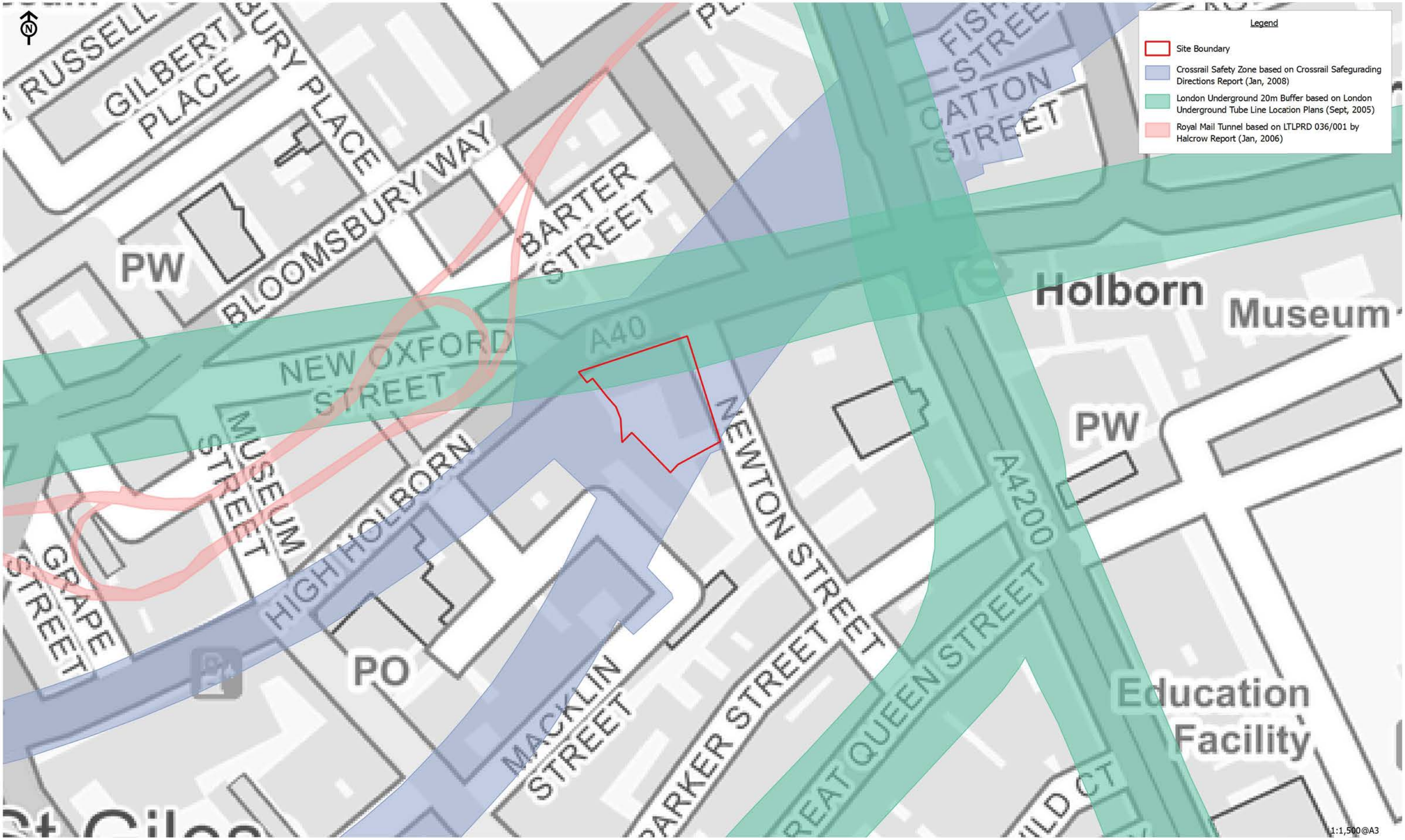

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Figure 3:
Approximate Location of Tunnels and Services

Scale:	1:1500@A3
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Date (Revision History):	30/11/2016 (A, First Issue, 30/16/16, LB)

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Figure 4:
Proposed Ground Floor Plan

Scale: 1:250@A3
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Based on EPR Architects drawing no. 10475-C-00-0400-Z00, Rev 01 (July 2016)
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Drg No - Status/Revision: GIS003 - A
File location: N:/10750 - 10999/10795 L - High Holborn/02 - Hoxton Holborn/Project_Workspaces (pdf in Outputs)
Date (Revision History): 22/11/2016 (A, First Issue, 22/11/2016, LB)

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