Providing Ground Solutions

GHR Construction Limited & 45 Holmes Road Limited

45 Holmes Road, London

Geo-environmental desk study and interpretative report

January, 2016

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EXECUTIVE SUMMARY

CGL has been commissioned by GHR Construction Ltd & 45 Holmes Road Limited to produce a geo-environmental desk study and interpretative report for the site at 45 Holmes Road, London.

The site is currently occupied by a former industrial building, which is currently used for mixed commercial purposes. It is proposed that a podium be constructed over the existing roof and eight residential units be constructed thereon.

The site is located in an area of mixed residential and commercial usage and limited potential for off-site contamination was identified. Potential on-site sources of contamination include chemicals from the site's former use as a bus depot and various manufacturing processes, above-ground storage tanks and possible asbestos within the building structure / stockpiled material.

An intrusive investigation of one cable percussion borehole and four window sample boreholes confirmed the presence of site-wide lead contamination within the Made Ground and a 'hotspot' of benzo(a)pyrene contamination within window sample borehole WS2 (based on a residential without plant uptake land use). No asbestos was identified in the six samples tested.

No elevated ground gases were identified during six gas monitoring visits. Groundwater was identified at depths from 1.18mbgl and 5.89mbgl, though this is thought to indicate a gradual percolation of perched groundwater from sand lenses within the London Clay into the monitoring installation, or possibly from inundation from surface water. No site-wide shallow groundwater table is anticipated.

The Made Ground soils are 'not-hazardous' for waste disposal purposes and available test results suggest that the Made Ground could be disposed of as inert waste.

The hardstanding of the proposed development will mitigate the risk from residual ground contamination and as such further protection is not required. PE water pipes can generally be used at typical pipeline depths of 0.75mbgl and 1.35mbgl though metal pipes or barrier pipes may be required in the location of WS2 to mitigate the risks from organic contaminants identified at 1.5mbgl.

Buried concrete within the Made Ground should be designed to Design Sulfate Class DS-1 and ACEC Class AC-1s whereas weathered London Clay or undisturbed London Clay Formation should be designed to Design Sulfate Class DS-2 and ACEC Class AC-1s.

If the London Clay Formation is exposed to the air during construction works, buried concrete should be designed to DS-3 and AC-2s.

1. INTRODUCTION

CGL has been commissioned by GHR Construction Limited & 45 Holmes Road Limited to produce a geo-environmental report in order to support a planning condition (Condition 12) relating to the proposed redevelopment scheme at 45 Holmes Road in London. The planning condition is as follows:

12 At least 28 days before development commences:

(a) a written programme of ground investigation for the presence of soil and groundwater contamination and landfill gas shall be submitted to and approved by the local planning authority in writing; and

(b) following the approval detailed in paragraph (a), an investigation shall be carried out in accordance with the approved programme and the results and a written scheme of remediation measures [if necessary] shall be submitted to and approved by the local planning authority in writing.

(c) The remediation measures shall be implemented strictly in accordance with the approved scheme and a written report detailing the remediation shall be occupation.

Reason: To protect future occupiers of the development from the possible presence of ground contamination arising in connection with the previous industrial/storage use of the site in accordance with policy CS5 of the London Borough of Camden Local Development Framework Core Strategy and policy DP26 of the London Borough of Camden Local Development Framework Development Policies.

CGL has completed a Phase 1 desk study review and Phase 2 intrusive investigation to assess the potential risk from ground contamination beneath the site. This report presents details of the site investigation and includes:

- A review of historical environmental data to determine potential contamination risks arising from the site setting, past development and local industry.
- Factual data obtained from the intrusive ground investigation, including details of site works, borehole logs, monitoring records and laboratory and in-situ results.

- A source-pathway-receptor risk assessment to assess potential risks to human health, controlled waters, vegetation and buildings and structures arising from contaminants and ground gas on site and recommendations for remediation, where required.

2. SITE LOCATION AND DESCRIPTION

2.1 Site location

The site is located in north London, within the London Borough of Camden. The site is approximately 200m south west of Kentish Town underground rail station and 300m north east of Kentish Town West overground station. The A400 (Kentish Town Road) runs north-south approximately 180m east of the site. The National Grid Reference for the approximate centre of the site is 528800E, 185000N. The site location is shown in Figure 1.

2.2 Site description

The site occupies an area of approximately 1200m^2 and, at the time of the CGL walkover in January 2014, consists of a mixed use building of up to three storeys, with car parking areas along the eastern side of the site. The building was formerly entirely occupied by a picture frame manufacturing company, however parts of the building are now used for other purposes, including as a dance studio.

The site and local surrounding topography slope gently towards the south. According to the local Ordnance Survey map, ground level on Holmes Road is approximately 35mAOD. Access is from Holmes Road, 30m to the north.

The site is located within a mixed commercial and residential part of London. It is bounded by terraced housing and multi-storey flats along the south west and south east boundaries, a former hostel for the homeless (under renovation/redevelopment at the time of the walkover in 2014) along the north east boundary and a commercial warehouse and multi-storey office/apartment block along the north west boundary.

Planning documents accessed from the Camden Council planning website show that the hostel on the north eastern site boundary was undergoing renovation works, which included the demolition of the southernmost buildings on that site and construction of a new two storey hostel accommodation.

2.3 Proposed development

It is understood that the proposed development will comprise the retention of the existing commercial units and the construction of a podium above the existing roof level

supporting eight residential units. The surrounding ground will be covered in hardstanding, with no soft landscaping, and will include associated cycle storage.

The proposed development plans are included in Appendix A.

2.4 Site walkover

A site walkover survey was undertaken on Tuesday 14th January 2014. The majority of the site was occupied by a large single storey warehouse building containing a mix of workshop, studio and office areas. Access to the site, off Holmes Road to the north, runs between an old hostel building on the east and a modern multistorey office/apartment block on the west.

The external areas to the building were all covered by concrete or tarmac hardstanding in good condition, with the exception of a strip of exposed soil with a row of small trees, located around the south east corner of the building. This land was adjacent to the back gardens of terraced housing along Inkerman Road, separated by a chain-link fence. A large manhole cover and a metal storage container labelled 'highly inflammable' and 'paint' were also noted along this patch. The south east corner of the site also housed a shed and corrugated roofing (mixture of plastic and non-plastic panels) which crossed the alley between the hostel and on-site building. Some of the non-plastic roof panels were also seen discarded on the ground and may potentially have contained asbestos. There were various building materials stored in this area including tiles, bricks and general rubble. Photographs from the site visit are presented in Appendix B.

3. HISTORICAL DEVELOPMENT

3.1 Sources of information

The historical development of the site has been traced using old Ordnance Survey maps dating from 1870-2012. The distances quoted are approximate and are taken from the site boundaries. The historical maps are presented in Appendix C.

3.2 Summary of development

The historical development of the site and surrounding area is summarised in Table 1.

Table 1. Summary of the development of the site and surrounding area

Year	*On Site*	*Off Site*
1870-1884	The site was occupied partly by residential buildings and their back gardens and one larger building encroaching the western side of the site. The centre of the site served as a courtyard with access from *Mansfield Place* to the north (now known as Holmes Road) and a lamppost was also noted here.	The wider area surrounding the site was occupied by housing and commercial properties and the street layout was similar to that of the present day. A *Public House* was located ~20m north east of the site adjacent to *Mansfield Place*. Two railway lines were located ~200m west and ~200m north east of the site respectively, as per the present day railways. A *Coal Depot* was located 100m north west of the site.
1894-1911	The site was no longer occupied by any buildings except for one in the south west corner. The rest of the land was an open yard designated as *London General Omnibus Company's Depot*.	A *Naphtha Store* and *Tanks* of unknown content were located 240m north west of the site. A *Tramway* ran along the present day Kentish Town Road. A line of *Cattle Pens* was located 200m north of the site.
1916-1962	The building in the south west corner has been removed and a small cluster of rectangular buildings were developed in the centre of the site, possibly associated with the adjacent *Casual Wards*.	A vehicle *Weighbridge Machine* was shown at the entrance to the site access just off Holmes Road. The *Casual Wards* building (known more recently as a hostel for the homeless) was developed next to the eastern boundary of the site. A *Royal Mail Yard* and *Taxicab Service* were developed in the land next to the north western boundary of the site. A *Laundry* was located 30m east of the site. *Public Baths & Wash Houses* were developed ~180m south of the site. A *Bottling Store* and *Locomotive Shed* were located ~400m north of the site and

Year	*On Site*	*Off Site*
		various other factories and manufacturing businesses developed within 500m of the site. These include a *Glassworks*, *Metal works* and *Paper works* within the vicinity of the *Coal Depot*.
1968-1975	The cluster of small buildings in the centre of the site has been removed and a large building addressed '45' was developed in the south west half of the site in a similar layout to the present day structure.	The *Taxicab Service* was changed to a *Packing Case Factory* and a number of *Tanks* of unspecified contents were located along the boundary of the adjacent *Royal Mail Yard*. A *Primary School* was developed 30m east of the site; the *Laundry* no longer existed.
1980-2012	No significant change except that the on-site building was extended from the north corner to match the present day layout of the building, labelled as a *Works*.	No significant change except for the development of a *College* 80m west of the site. The *Coal Depot* to the north west was re-designated as a *Council Depot* and by 2012 this is no longer noted.

4. ANTICIPATED GROUND CONDITIONS

4.1 Published geology

The British Geological Survey (BGS) 1:50,000 scale sheet for North London[1] indicates that the site is underlain by London Clay, followed by the Lambeth Group and then the Thanet Sand Formation. At depth, these strata overlie Cretaceous Chalk. Locally to the site, the London Clay is anticipated to be approximately 40m thick and both the Lambeth Group and Thanet Sand Formation together are anticipated to be approximately 20m thick.

The London Clay typically consists of blue-grey-brown stiff clay, which can be silty and/or sandy in certain areas, especially towards the base. The Lambeth Group consists mainly of stiff to very stiff, multi-coloured, mottled clay, sometimes sandy or silty with occasional sandstone and conglomerate beds. The Thanet Sands are typically yellow-brown fine grained sands, but are sometimes clayey with nodular flints lower down in the formation.

4.2 Unpublished geology

The BGS holds records of twelve historical boreholes from three locations within 300m of the site. The borehole records and a borehole location plan are presented in Appendix C and the records are summarised in Table 2 below.

Table 2 Summary of BGS historical borehole records

BH record reference	Distance (m)	[bearing]	Base of BH (mbgl)	Groundwater level (mbgl)	Depth to top of stratum (mbgl)					
					Made Ground	Alluvium	London Clay Formation	Lambeth Group	Thanet Sand	Upper Chalk
TQ28SE24	290	S	137.16	-	-	-	0.0	39.0	-	61.5
TQ28SE1560 (BH1)	190	SW	137.16	56.86	-	-	0.0	39.3	59.1	61.9
TQ28SE1560 (BH2)	190	SW	146.5	-	0.0	-	0.3	38.1	61.0	62.6
TQ28SE128 (BH2)	200	NW	12.5	6.4	0.0	-	5.7	-	-	-
TQ28SE128 (BH3)	200	NW	14.5	5.0	0.0	-	3.6	-	-	-
TQ28SE128 (BH4)	200	NW	12.5	3.0	0.0	-	3.2	-	-	-
TQ28SE128 (BH5)	200	NW	17.7	DRY	0.0	-	5.7	-	-	-
TQ28SE128 (BH7)	200	NW	9.5	3.4	0.0	3.1	4.6	-	-	-
TQ28SE128 (BH8)	200	NW	13	2.8	0.0	2.9	3.8	-	-	-
TQ28SE128 (BH10)	200	NW	15.2	DRY	0.0	-	1.3	-	-	-
TQ28SE128 (BH11)	200	NW	8.0	DRY	0.0	-	2.0	-	-	-

[1] British Geological Survey (1994) North London, England and Wales sheet 256. Solid and drift edition. 1:50,000

BH record reference	Distance (m) [bearing]	Base of BH (mbgl)	Groundwater level (mbgl)	Depth to top of stratum (mbgl)					
				Made Ground	Alluvium	London Clay Formation	Lambeth Group	Thanet Sand	Upper Chalk
TQ28SE128 (BH12)	200 NW	13.5	DRY	0.0	1.2	2.0	-	-	-

Some of the boreholes in this area (TQ28SE128 BH7, BH8 and BH12) encountered 1.2m to 3.1m of alluvium (sandy gravelly clay), which is thought to be indicative of the presence of the historical River Fleet, which flowed through this area up to 50m from the site boundary.

4.3 Previous investigations

A previous site investigation[2] was conducted in 2000 for the construction of a basement at the neighbouring property along the north west of the site (55-57 Holmes Road). The investigation included 3 borehole logs (2 with standpipe piezometers into London Clay) and geotechnical data.

The geology recorded in these borehole logs shows Made Ground up to 0.3mbgl and London Clay up to 18mbgl. Up to 12mbgl the London Clay is described as firm and stiff/turning very stiff and fissured silty plastic clay pockets. Between 12 and 18mbgl the London Clay is described as stiff-very stiff, laminated and fissured silty plastic clay.

One of the boreholes recorded standing water at a depth of ~5.6mbgl a month after installation. This would correspond to a slow seepage of groundwater occurring within the London Clay, and below the proposed foundation depth for 45 Holmes Road.

According to Camden Council planning records[3], a number of other surrounding properties have basements, including 65-69 Holmes Road to the north west of the site, which has or is due in the near future to have a part single, part double storey basement. The borehole locations for 55-57 Holmes Road are shown in Figure 2.

[2] Report on a site investigation at 55-57 Holmes Road, London NW5 for PES Group Ltd, (2000). *Southern Testing Laboratories Ltd*
[3] Planning Records, Camden Council. [online]: http://camden.gov.uk/ccm/navigation/environment

4.4 Hydrogeology and hydrology

The Environment Agency has produced an aquifer designation system consistent with the requirements of the Water Framework Directive. The designations have been set for superficial and bedrock geology and are based on the importance of aquifers for potable water supply, and their role in supporting surface water bodies and wetland ecosystems.

The Environment Agency does not designate the site or the wider Camden area as a Groundwater Source Protection Zone[4]. There are no superficial deposits underlying the site and the underlying London Clay bedrock is classed as an unproductive stratum for groundwater. The Environment Agency flood map[5] shows that the site and surrounding area does not fall within a Flood Warning or Flood Alert zone.

The identified BGS boreholes at the former coal depot (TQ28SE128: records from 1978) suggest the presence of some perched water within the Made Ground and thin layers of gravelly clay between this Made Ground and the London Clay, which also yielded water seepage. These boreholes only range in depth from ~8-18mbgl and therefore do not extend into the underlying Lambeth Group or Thanet Sand Formation. The borehole at the former Baths House (TQ28SE1560: records from 1907) shows only ~0.3m of Made Ground followed by 38m of London Clay. Water was struck at ~55mbgl within the (formerly known as) Reading Beds of the Lambeth Group.

An EnviroInsight report was obtained from GroundSure Ltd to provide information on the environmental setting of the site. The following points were noted from this report.

- There are no surface water features within 250m of the site.
- There is one subsurface culvert located approximately 39m south west of the site, running NW-SE.

According to historical river maps, the former River Fleet once flowed through the Kentish Town area. It ran closest to the site approximately 50m north west, flowing south west before meandering SSE towards the Thames.

[4] Environment Agency [online]. Groundwater Source Protection Zones map: http://apps.environment-agency.gov.uk/wiyby/default.aspx
[5] Environment Agency [online]. Flood Map for Planning (from Rivers and Sea): http://apps.environment-agency.gov.uk/wiyby/default.aspx

5. ENVIRONMENTAL SETTING

5.1 Environmental disclosure report

An EnviroInsight report was obtained from GroundSure Ltd to provide information on the environmental setting of the site and possible sources of ground contamination. A GeoInsight report was also obtained from the same source to provide additional information on ground conditions. A summary of the key points identified are set out below. The full reports are presented in Appendix E and Appendix F.

5.2 Pollution incidents

Only one recorded pollution incident is located within 0.5km of the site. The incident involved minor impact to the land only due to household waste. There has been one recorded contaminated land site under Part IIA of the EPA (1990) within 0.5km of the site. It was located 413m north east of the site and was identified in 2011. The site was a metal plating works with lead and cadmium contamination and has since been remediated.

5.3 Pollution Prevention and Control

Only one recorded trade entry has received an enforcement notification, in 2007 involving a business of unknown activity 202m west of the site.

5.4 Waste

There have been 2 recorded waste treatment, transfer or disposal sites within 250m of the site, both linked to a metal depot in the vicinity of the historic coal depot to the north west.

There are two recorded Environment Agency waste licenses within 250m of the site. These are both relate to one site located 129m northwest (Regis Road Recycling Centre, Camden LBC) dealing with household waste.

5.5 Discharge consents and abstraction licenses

There are 5 groundwater abstraction licenses and 2 potable water abstraction licenses located within 0.5km of the site, all related to a sports centre located 266m south of the site. There are 2 surface water abstraction licenses located within 1km of the site, both sourced from the Regents Canal approximately 990m south of the site.

No Environment Agency licensed discharge consents are recorded within 500m of the site.

5.6 Ground workings

There is one recorded historical surface ground working within 250m of the site dated from 1869; a cutting located 215m north. There are 8 recorded historical subsurface ground workings within 500m of the site. These are all tunnelling features located 400-450m north west of the site.

There are 3 records of historical mining activity within 1km of the site, all located approximately 530m north west of the site and designated as unspecified shafts.

There are no other recorded mining activities or natural cavities within 1km of the site.

5.7 Local land use

There is one current land use contemporary trade entry located on-site. This relates to the stretcher frame manufacturing works. There are 38 contemporary trade directory entries within 250m of the site. These generally include unspecified works, warehouses, depots and electrical substations.

No sensitive land uses such as nature reserves or adopted green belt are located within 1km of the site.

5.8 Geological hazards

The risk to the site from shrinking/swelling clay deposits is identified as moderate. This relates to ground conditions of predominantly high plasticity. Trees or shrubs should not be planted near to buildings without expert advice.

The risk to the site from collapsible deposits or landslides has been classed as very low.

The risk identified to the site from compressible deposits, dissolution features or running sand is negligible.

5.9 Radon

The property is not in a radon affected area, as less than 1% of properties are above the Action Level. Therefore, no radon protective measures are necessary.

5.10 Regulatory enquiries

The site is located greater than 100m away from the nearest London Underground line and therefore contact with London Underground Limited is not deemed necessary. No buried fuel tanks have been identified at the site during the desk study phase and therefore London Fire and Emergency Planning has not been consulted at this stage.

The Camden London Borough Council Building Control and Environmental Health Officer were contacted on the 16th January 2014 to request information on the local ground conditions, but were unable to provide additional information regarding the site.

5.11 Unexploded Ordnance risk assessment

London County Council Bomb Damage mapping[6] was consulted by CGL as part of the desk study. No bomb damage is indicated to have occurred on site, but a row of neighbouring houses along the south east boundary received damage ranging from complete destruction to general, non-structural blast damage.

[6] Saunders, A., 2005. *The London County Council Bomb Damage Maps 1939-1945*. London Topographical Society and London Metropolitan Archives.

6. PRELIMINARY RISK ASSESSMENT

6.1 Introduction

Historical contamination of land may present harm to human health and the environment. Current UK legislation stipulates that the risk associated with potential land contamination is assessed and remediated, if necessary. Under the Town and Country Planning Act 1990 (as amended), potential land contamination is a "material planning consideration", together with the National Planning Policy Framework (March 2012), which means that a planning authority must consider contamination when it prepares development plans or consider individual applications for planning permission. It is the responsibility of the developer to carry out the remediation where it is required and satisfy the Local Authority that the remediation has been carried out as agreed.

Additionally, Part IIA of the Environmental Protection Act 1990 requires that a significant source-pathway-receptor linkage exists to determine a site as contaminated land. This means that there has to be a contaminant present, a receptor that could be harmed by this contaminant, and a pathway linking the two. Part IIA deals with the contamination risk from a site in its current use, however the planning system requires that the proposed use is considered. Where remediation is carried out under the planning system, it should be ensured that the site is in such a condition that it would still not meet the definition of contaminated land under Part IIA.

6.2 Preliminary conceptual site model

A preliminary conceptual site model and risk assessment have been compiled for the site to identify the potential sources of contamination and the significance of potential pollution linkages.

6.2.1 Potential sources

Potential contamination sources can include current and historical activities both on the site and from neighbouring land. The following potential sources have been identified at the site:

Made Ground and ground gas/vapours – Made Ground is likely to be present under the site hardstanding. The Made Ground may be variable in thickness and chemical nature. There is the potential for contaminants associated with the former land use as the *omnibus depot* and the more recent use as a *frame manufacturing works* (e.g. asbestos from the

site redevelopment, heavy metals, total petroleum hydrocarbons (TPH) and other organic contaminants (e.g. polycyclic aromatic hydrocarbons; PAH), which could potentially generate ground gas/vapours.

Building structure – Given the age of the current building on-site, asbestos containing materials may be present within the structure. Asbestos may also be present within discarded roof panels in the south east of the site.

Above ground storage – The metal container believed to be a paint store is an example of a potential above ground source of contamination on the site. However, the container appears to be well sealed and there are no signs of leakage. No other above ground storage containers have been identified.

Off-site sources – Historical and current local land uses may provide a source of ground gas and/or soil/leachate contamination. Neighbouring taxicab, laundry and packaging services and the former coal depot to the north west are among the previous land uses local to the site that may have left behind contamination. The unspecified above ground storage tanks located around the adjacent Royal Mail yard circa 1970 are also to be noted. Potential contaminants may include: heavy metals, hydrocarbons and solvents. The site some 400m from the subject site, which was investigated under Part IIA, has since been remediated and should no longer be a source of metal contamination.

6.2.2 Potential pathways

The potential migration pathways that may be present at the site include:

Ingestion & inhalation – contamination within Made Ground, if exposed during construction can result in the ingestion or inhalation of contaminated soils and ground gases;

Ground gas/vapour migration – ground gases/vapour could migrate through the soil matrix into proposed buildings.

Direct contact – direct/dermal contact with contaminated soils or groundwater can result in the uptake of contaminants through the skin or permeation of contaminants through building materials (i.e. buried concrete/plastic water pipes);

Root uptake – uptake of phytotoxic contaminants by plants and vegetation;

Groundwater migration – leaching from potential contamination in the soils or off-site Made Ground may impact the groundwater and subsequently migrate to surface water bodies along the upper boundary of the London Clay.

6.2.3 Potential receptors

Based on the current and intended use for the site, the potential receptors to contaminants are considered to be:

Site occupants (current & future) – considered to be at risk from possible shallow contamination and ground gas/vapour accumulation within buildings.

Construction workers – could be affected by contamination within the Made Ground or building fabric during ground works and refurbishment/demolition. Such persons are likely to be in close contact with potentially contaminated materials.

Vegetation & plants – primarily at risk from phytotoxic contaminants such as copper and zinc;

Controlled waters – groundwater is not likely to be present beneath the site. Surface water bodies could be at risk from the infiltration and migration of possible contaminants, if present.

Buildings & structures – buried concrete and services, such as plastic water supply pipes, can be at risk from chemically aggressive ground. Ground gases and vapours may also permeate through the soils and accumulate in buildings and structures, presenting an explosive risk.

6.3 Preliminary qualitative risk assessment

A preliminary qualitative risk assessment has been undertaken based on the findings of the desk study review, the Conceptual Site Model and the potential pollutant linkages that may exist at the site in accordance with Contaminated Land Report (CLR) 11[7]. The risks identified are in accordance with the DEFRA and Contaminated Land Report (CLR) 6[8], site prioritisation and categorisation rating system which is summarised in Table 3 below.

[7] The Environment Agency (2004) *Model Procedures for the Management of Land Contamination*, CLR 11
[8] M.J. Carter Associates (1995) *Prioritisation and Categorisation Procedure for Sites which may be Contaminated*, Department of the Environment, CLR 6

Table 3. Risk Rating Terminology

Risk Rating	Description
High Risk	Contaminants very likely to represent an unacceptable risk to identified targets Site probably not suitable for proposed use Enforcement action possible, Urgent action required
Medium Risk	Contaminants likely to represent an unacceptable risk to identified targets Site probably not suitable for proposed use Action required in the medium term
Low Risk	Contaminants may be present but unlikely to create unacceptable risk to identified targets Site probably suitable for proposed use Action unlikely to be needed whilst site remains in current use
Negligible Risk	If contamination sources are present they are considered to be minor in nature and extent Site suitable for proposed use No further action required

Table 4. Preliminary qualitative risk assessment

Source/Medium	Receptor	Potential Exposure Route	Risk Rating
Explosive / asphyxiating gases from underlying soils/Made Ground, if present and off-site sources	Internal building spaces, current and future occupiers	Migration of gases through to the surface via permeable soil horizons and breaks in hardstanding resulting in accumulation of gases/vapours within building spaces.	Low
Organic/inorganic contaminants (e.g. PAH, TPH, metals, etc.) within underlying soils or Made Ground, if present	Current site occupiers	Direct ingestion of soil & dust Inhalation of particulates and vapours, indirect ingestion and dermal contact	Low
Organic/inorganic contaminants (e.g. PAH, TPH, metals, asbestos etc.) within underlying soils or Made Ground, if present	Future site occupiers	Direct ingestion of soil & dust Inhalation of particulates and vapours, indirect ingestion and dermal contact	Negligible
Asbestos within site structures / underlying soils/Made Ground	Construction workers and current site occupiers	Direct ingestion of soil & dust Inhalation of particulates & vapours, indirect	Low to medium

		ingestion and dermal contact	
Organic/inorganic contaminants e.g. hydrocarbons, asbestos, metals etc. within Made Ground and shallow soils.	Plants and Vegetation	Root uptake	Low
	Buildings & infrastructure	Direct contact with underground concrete structures and water supply pipes	Low to medium
	Construction workers and current/future site occupants	Direct ingestion of soil & inhalation of asbestos fibres (if present) which may become airborne if the building structure is disturbed	Low
	Surface water bodies	Leaching from the soils and lateral migration of contaminants through the groundwater to off-site receptors such as surface water bodies.	Negligible

The risk assessment above was used to scope the Phase 2 intrusive investigation, which is discussed in the following sections.

7. PRESENT GROUND INVESTIGATION

7.1 Fieldwork

An intrusive investigation was undertaken between 24th June and 1st July 2014. The investigation comprised one rotary percussive borehole (BH1) to 25 metres below ground level (mbgl), and four window sampler boreholes (WS1 to WS4) to a maximum depth of 5mbgl with follow-on dynamic probing in two boreholes (WS1 and WS4) to 10mbgl. The investigation was broadly undertaken in accordance with the requirements of BS 5930:1999[9]. Due to the presence of the existing building and site occupants, the locations of the exploratory holes were limited to available external areas surrounding the building.

The borehole arisings were recorded and representatively sampled by a suitably qualified engineer from CGL in order to obtain samples for laboratory testing and to characterise the near surface ground conditions across the site. Soil samples were obtained for chemical and geotechnical laboratory analysis. Standpipes were installed in boreholes BH1, WS1 and WS4 to enable subsequent gas and groundwater monitoring to be undertaken.

A plan showing the exploratory hole locations is presented in Figure 3 and the borehole logs are presented in Appendix G.

7.2 Monitoring

Six ground gas monitoring visits have been undertaken at the site, on 9th, 23rd and 29th July and 6th, 12th and 18th August 2014. Copies of the monitoring records are presented in Appendix H.

7.3 Laboratory testing

7.3.1 Chemical

Thirteen representative soil samples were submitted to i2 Analytical Limited (a UKAS and MCERTS accredited laboratory) for chemical testing. The analysis included the following determinants.

- Soil Organic Matter (SOM);

[9] BS 5930:1999*; Code of practice for site investigations, Incorporating Amendment 2*, British Standards Institute. 1999.

- Heavy metals including; arsenic, barium, beryllium, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium, vanadium and zinc;
- Total Petroleum Hydrocarbons (TPH) and Polycyclic Aromatic Hydrocarbons (PAH);
- Total monohydric phenols;
- Total cyanide;
- Sulfate;
- Asbestos;
- pH determination;
- BRE design sulfate class; and
- One waste acceptance criteria test

The laboratory analysis results are presented in Appendix I.

8. GROUND AND GROUNDWATER CONDITIONS

8.1 Ground conditions

The ground conditions encountered on site were found to correspond to the nearby historical investigations and are summarised in Table 5.

Table 5. Summary of ground conditions

Stratum	Depth to top of stratum (mbgl)	Typical thickness (m)
MADE GROUND Concrete (typically 0.14m to 0.2m thick) over dark brown slightly silty fine to coarse sand (WS1, WS2 and WS3 only)	0.0	0.5 to 1.7
MADE GROUND Dark black brown slightly gravelly sandy clay. Sand is fine to coarse. Gravel is fine to coarse subrounded to subangular of brick and chalk. (Not encountered in WS2) Second layer of concrete encountered in BH1 at 0.3mbgl to 0.4mbgl.	0.14 to 0.8	0.8 to 1.5
Soft to firm becoming stiff dark orange brown mottled grey slightly silty CLAY. 5.2mbgl: becoming extremely closely fissured with occasional fine selenite crystals noted. [WEATHERED LONDON CLAY FORMATION]	1.1 to 1.7	10.4
Stiff dark brown grey slightly silty CLAY with rare subangular fine to medium flint and occasional fine to medium selenite crystals. 19.0mbgl to 19.5mbgl: very strong grey very fine grained claystone. [LONDON CLAY FORMATION]	11.6	Proven to 25mbgl

The ground conditions encountered on site comprised 1.1m to 1.7m of variable Made Ground overlying Weathered London Clay Formation and London Clay Formation soils to a proven depth of 25mbgl.

No visual or olfactory evidence of contamination was noted within the soils during the ground investigation, other than the inert building rubble-type materials within the Made Ground.

8.2 Groundwater

No groundwater was encountered during drilling, however it is noted that water was added to aid drilling, which may have masked water ingress.

Groundwater was encountered during the subsequent monitoring visits. The groundwater depths recorded are summarised in Table 6.

Table 6. Summary of recorded groundwater depths

Date	Depth to groundwater (mOD) [mbgl]		
	BH1	**WS1**	**WS4**
09/07/14	29.11 [5.89]	30.09 [4.91]	30.08 [4.92]
23/07/14	30.10 [4.90]	31.73 [3.27]	31.49 [3.51]
29/07/14	32.76 [2.24]	30.66 [4.34]	30.87 [4.13]
06/08/14	33.40 [1.60]	30.99 [4.01]	31.73 [3.27]
12/08/14	33.72 [1.28]	31.97 [3.03]	31.82 [3.18]
18/08/14	33.82 [1.18]	31.88 [3.12]	32.17 [2.83]
Depth to base of monitoring well (mbgl)	11.00	5.00	5.00

The groundwater levels in the window sampler boreholes are considered likely to be due to very slow seepage through the Made Ground. The increase in level in BH1 may potentially be due to surface water ingress during rainfall events. This may also represent slow seepage from sand lenses that were noted within the London Clay.

It is noted that the monitoring records are broadly consistent with the findings of nearby historical boreholes, which recorded groundwater at between 2.8mbgl to 6.4mbgl within the London Clay.

8.3 Ground gas

Six rounds of ground gas monitoring have been undertaken at the site between July and August 2014. Atmospheric pressure was 1005mb to 1018mb during the visits and the local pressure system was falling during the initial four visits, and rising during the final two. The monitoring records are presented in Appendix G, and the findings of the monitoring are summarised below:

- Maximum carbon dioxide concentration: 2.4% v/v;

- Maximum methane concentration: <0.1% v/v;
- Maximum flow rate: 0 l/hr;
- Minimum oxygen concentration: 14.9% v/v; and
- Maximum VOC concentration: 15.1ppm.

A gas screening value (GSV) of 0.0 l/hr has been calculated for the site based on the results of the ground gas monitoring, indicating that the site conforms to Characteristic Situation 1[10] and no ground gas protection measures are therefore required in the development.

8.4 Sulfate and pH conditions

A summary of the pH and sulfate results of the soils beneath the site are summarised in Table 7 below. The laboratory data is included in Appendix H.

Table 7. Sulfate and pH results

Strata	Water soluble sulfate (g/l)[a]	Acid soluble sulfate (%)	Total potential sulfate (%)	pH
Made Ground	0.043	0.052 – 0.47	*	7.5 – 9.6
London Clay Formation	0.36 – 2.4	0.084 – 0.7	0.114 – 0.9	7.7 – 8.8

* NA = not applicable; a – leachate equivalent result

The test results indicate that buried concrete at the site within the Made Ground should be designed to Design Sulfate Class DS-1 and ACEC Class AC-1[11]. Weathered London Clay or undisturbed London Clay Formation should be designed to Design Sulfate Class DS-2 and ACEC Class AC-1s. If the London Clay Formation is exposed to the air during construction works (thereby causing potential for the oxidation of pyrite), buried concrete should be designed to DS-3 and AC-2s.

[10] CIRIA C665. Assessing risks posed by hazardous ground gases to buildings.
[11] BRE Special Digest 1. Concrete in aggressive ground.

9. CONTAMINATION ASSESSMENT

9.1 Risks to human health (long-term chronic risks)

Seven of the thirteen soil samples were submitted for total soils chemical testing. The laboratory test results have been compared against the published Soil Guideline Values (SGVs) for the *"Residential (without plant uptake)"* land-use category to assess the risk to human health from chemical contamination in the soils. These assessment criteria are considered appropriate due to the absence of private gardens or communal soft landscaping within the proposed development. In addition, the criteria are considered conservative as the proposed end use is mixed use with commercial units on the ground floor and the residential units located above ground level. The summary soil contamination tables are included in Appendix J.

Exceedances of lead were noted in all samples of Made Ground, aside from at WS1 (0.5mbgl), and in the sample of shallow natural soil. Statistical analysis on the laboratory test results indicates that lead is therefore likely to be present in the Made Ground across the site at levels which exceed the recommended guidance criteria.

Benzo(a)pyrene exceeded the assessment criterion at WS2 (2 Made Ground samples from this location). As no exceedances were noted in the other locations tested, it is considered that this result is representative of a localised 'hotspot' of contamination and is not indicative of a site-wide source.

It should be noted that the recorded levels of lead and benzo(a)pyrene are below the GAC for commercial land use (2,300mg/kg and 36mg/kg respectively).

No asbestos was detected during screening of six soil samples.

It is understood that the majority of impacted soils will remain after construction. Excavations will occur during foundation and floor slab construction. However, based on the proposed development remaining soils will be capped with hardstanding, which will mitigate the risk to future site occupants.

9.2 Controlled waters assessment

The risk to surface water bodies is considered to be negligible due to the distance from the site to the nearest water body (Regent's Canal at 850m south of the site), the generally low

levels of contamination identified and the perched nature of the groundwater beneath the site.

9.3 Ground gas assessment

Due to the limited contamination and ground gas/vapour encountered in the intrusive investigation, subsequent monitoring visits and the assessment in Section 8.3 based on CIRIA C665, the risk to buildings and structures and future occupants from ground gas/vapour is considered to be negligible.

9.4 Waste classification

The six soil samples tested have all been classified as not-hazardous for waste disposal purposes. One waste acceptance criteria (WAC) test was undertaken on a single sample of the Made Ground from BH1 at 1mbgl, which indicates that Made Ground is suitable for disposal at an inert landfill.

Chemical testing of the London Clay from WS1 at 1.2mbgl confirms that it has not been adversely impacted by chemical contamination and as such the London Clay can be disposed as listed inert waste as it is uncontaminated.

9.5 Water pipe assessment

In general accordance with UKWIR[12] guidance, the risk posed to water supply pipes from soil contamination has been assessed. Seven soil samples have been assessed against the criteria for poly ethylene (PE), wrapped steel, wrapped ductile iron, copper and barrier pipes. It has been assumed that buried pipes will be placed between 0.75mbgl and 1.35mbgl.

The site generally conforms to the chemical limits for the use of PE pipes at typical pipeline depths. It should be noted that exceedances of total volatile organic compounds (VOCs) and EC10-EC16 aliphatic and aromatic hydrocarbons were noted in WS2 at 1.5mbgl. If pipelines are required at this depth, and assuming the contamination hotspots are not removed then wrapped steel pipes will be acceptable.

Of the 13 pH tests carried out, 9 were noted to exceed the criteria for the use of copper pipes.

[12] UK Water Industry Research. Guidance for the selection of water supply pipes to be used in brownfield sites.

A summary of the relevant testing data is included in Appendix J.

10. REFINED RISK ASSESSMENT

10.1 Introduction

This section re-evaluates the risks to potential receptors based on the chemical contamination identified from the ground investigation. Potential receptors have been assessed with reference to the Part IIA regime and associated with DEFRA guidance. As with the Part IIA regime, under the planning regime all receptors (human, controlled waters, ecology, crops/livestock and buildings), where applicable, have been considered if there is the potential for them to be adversely affected by exposure to contamination. CGL's approach and rationale to assessment criteria adoption for this site is presented in Appendix I.

A summary of the risk assessment is presented below in Table 8 and a conceptual site model illustrated in Figure 4.

Table 8. Semi-quantitative risk assessment

Source/Medium	Receptor	Potential Exposure Route	Risk Rating
Explosive / asphyxiating gases from underlying soils/Made Ground and off-site sources	Internal building spaces, current and future occupiers	Migration of gases through to the surface via permeable soil horizons and breaks in hardstanding resulting in accumulation of vapours within building spaces.	Negligible *(based on low gas concentrations recorded during monitoring)*
Organic/inorganic contaminants (e.g. PAHs, hydrocarbons, metals, asbestos, etc.) within underlying soils/groundwater or Made Ground	Current site occupiers	Direct ingestion of soil & dust Inhalation of particulates and vapours, indirect ingestion and dermal contact	Low *(due to commercial use and limited soft landscaping)*
	Future site occupiers	Direct ingestion of soil & dust Inhalation of particulates and vapours, indirect ingestion and dermal contact	Negligible *(due to commercial use of ground floor and hardstanding cover)*
	Construction workers	Direct ingestion of soil & dust Inhalation of particulates & vapours, indirect ingestion and dermal contact	Low to medium
	Plants and Vegetation	Root uptake	Negligible *(no soft landscaping proposed as part of the development)*
	Buildings & infrastructure	Direct contact with underground concrete structures and water supply pipes	Low *(assuming the buried concrete appropriately designed and appropriate material used for water supply pipes)*
Organic/inorganic contaminants including hydrocarbons and metals within Made Ground, shallow soils and groundwater	Surface water bodies	Lateral migration of contaminants through the groundwater to off-site receptors such as surface water bodies (e.g. Regents Canal)	Negligible *(due to the limited contamination present, the perched nature of the groundwater and the distance to the Regents Canal)*

10.1.1 Risks to human health

Aside from exceedances of lead and benzo(a)pyrene, no elevated concentrations of contaminants were recorded in the samples and no asbestos was detected. In addition, the site is currently mostly covered with hardstanding, removing the pathway to the current

occupants. It is also understood that the proposed development will also be covered in hardstanding, thus removing the pathway to future site occupants. There is therefore considered to be a low risk to current site occupants and a negligible risk future site occupants due to ground contamination.

The risk to construction workers is considered to be low to medium, given the potential for increased proximity with contaminated soils. However, it is considered that this risk may be mitigated through use of appropriate personal protective equipment (PPE). It is further noted that the guidance criteria have been developed with regard to long-term exposure and are potentially onerous with regard to short-term exposure such as would be experienced by a construction worker.

Negligible concentrations of ground gas were recorded during the six monitoring visits undertaken and the site conforms to Characteristic Situation 1, i.e. no ground gas protection required. The risk to human health due to ground gas is therefore considered to be negligible.

10.1.2 Risks to buildings and structures

Due to the limited contamination and ground gas encountered in the intrusive investigation, the risk to buildings and structures is considered to be low, assuming the correct concrete design class is used.

Due to the contamination identified within WS2, a low risk is posed to water pipes. This can be mitigated through the use of metal or barrier pipes.

10.1.3 Risks to vegetation and plants

Due to the limited contamination encountered in the intrusive investigation, the risks to plants and vegetation are considered to be negligible. In addition, no planting is proposed for the future development.

10.1.4 Risks to surface water bodies

The risk to surface water bodies is considered to be negligible as no surface water features are noted close to the site.

11. GEOENVIRONMENTAL RECOMMENDATIONS

11.1 Contamination and remediation

Given that the proposed development is to include the covering of the entire site footprint with hardstanding, then it is considered that no additional remediation is required to mitigate the risks posed from soil contamination.

Given that the site conforms to the ground gas Characteristic Situation 1, then no specific gas protection measures are required.

Therefore, no remediation strategy is required as part of the proposed development.

11.2 Material management

11.2.1 Re-use and recycling

It should be noted that the management of construction waste should be carried out in accordance with Waste (England and Wales) Regulations 2011. This places an emphasis on the Waste Hierarchy, which requires an avoidance of waste in the first instance followed by reducing the volume that requires disposal after it has been generated.

If reuse of materials, including excavated Made Ground is appropriate, it could be accomplished through waste exemptions, environmental permits or through the Development Industry Code of Practice[13], depending on the material in question. The latter has been developed to enable earthworks on site using site won material and this is done with a Materials Management Plan. The Materials Management Plan includes details of where materials/arisings will be generated and how they will be used within the limits of the Code of Practice, without posing a risk to human health or the environment.

For granular material, including crushed concrete, reuse can also be through the WRAP (Waste & Resources Action Programme) Protocol. This is a formalised quality control procedure for the generation of recovered aggregates from recovered inert granular waste.

[13] CL:AIRE. *The Definition of Waste: Development Industry Code of Practice*. Contaminated Land: Application in Real Environments. Version 2. March 2011.

11.2.2 Waste disposal

All material bound for disposal to landfill will require characterisation in accordance with the Hazardous Waste Regulations 2005 and disposed in accordance with the requirements of the Landfill Regulations (2002, as amended) and the Environmental Protection (Duty of care) Regulations, 1991. 1no. WAC test indicates that the Made Ground is likely to be suitable for disposal as inert waste, as can uncontaminated, natural soils.

It should be noted that in May/June 2012 HMR&C issued Briefs 15/12 and 18/12 clarifying how construction spoil and excess soils will be assessed for landfill tax purposes. Detailed accurate descriptions of waste will be required for all waste to support the landfill tax assessment. Uncontaminated naturally occurring soils will remain inert by default and eligible for the lower rate of landfill tax.

11.3 Discovery strategy

It is recommended that a watching brief is maintained by the Main Contractor. Where unexpected gross contamination, such as oily material or material of an unusual colour or odour is encountered during redevelopment the following discovery strategy is recommended:

1. Work to cease in that area.

2. Notify geoenvironmental engineer, to attend site and sample material for appropriate analysis. Notify Contaminated Land Officer of the Local Authority or Environment Agency as appropriate.

3. Geoenvironmental engineer to supervise the excavation of contaminated material, if required, which should be placed in a bunded area and covered to prevent rainwater infiltration.

4. Where required, soil samples should be obtained by the geoenvironmental engineer from both the excavated material, and the soils in the sides and base of the excavation to demonstrate that the full area of contamination has been excavated. In-situ testing should be undertaken on the sides and base of the excavation to assess the presence of residual contamination in the soils.

5. On receipt of chemical test results, the soils may be appropriate classified for disposal, or treatment if appropriate, and dealt with accordingly.

6. To facilitate appropriate waste disposal and potential re-use of materials all excavated soils should be segregated and stockpiled depending on their soils classification.

7. Detailed records of the stockpile sizes, source and location should be kept and regularly updated to allow materials to be easily tracked from excavation until leaving the site or reused, as appropriate.

8. Records of excavated areas and the results of chemical testing should be incorporated within a verification report for the remediation works for submission to the local authority.

11.4 Asbestos survey

In order to prevent further site contamination or risks to human health it is recommended that an asbestos survey be carried out and, if identified, asbestos is stripped and removed from site by a specialist contractor prior to any demolition or refurbishment works.

11.5 Buried services

In accordance with current UKWIR[14] guidance and the results obtained during the ground investigation, the use of poly ethylene (PE) water supply pipes is acceptable across the site at likely depths of water pipe installation (typically 0.75 to 1.35mbgl). At depths greater than this, the use of metal pipes or barrier pipes may be required to prevent possible permeation of residual organic contaminants identified within WS2 at 1.5mbgl into drinking water supplies. This should be confirmed with the local water supply company.

11.6 Buried concrete

In accordance with BRESP1 buried concrete at the site within the Made Ground should be designed to Design Sulfate Class DS-1 and ACEC Class AC-1 whereas weathered London Clay or undisturbed London Clay Formation should be designed to Design Sulfate Class DS-2 and ACEC Class AC-1s.

If the London Clay Formation is exposed to the air during construction works (thereby causing potential for the oxidation of pyrite), buried concrete should be designed to DS-3 and AC-2s.

[14] UK Water Industry Research (2010). *Guidance for selection of water supply pipes to be used in brownfield sites.*

11.7 Water supply pipes

Poly ethylene (PE) pipes are acceptable if laid at depths not exceeding 1.35m. If pipelines are required at greater depth than this then wrapped steel, wrapped ductile iron, or barrier pipes will be sufficient; this is based on chemical exceedances within WS2 at 1.5mbgl. Alternatively, this contamination hotspot could be preferentially removed under supervision of a suitably qualified geo-environmental engineer.

The use of copper pipes is not recommended due to general site wide exceedances of pH.

11.8 Health and safety

All site works should be undertaken in accordance with the guidelines prepared by the Health and Safety Executive (HSE, 1991)[15] and CIRIA Reports 132[16] and C650[17]. All work will also be carried out in accordance with the Contractor's Construction Health and Safety Plan.

During the redevelopment, precautions should be taken to minimise exposure of workers and the general public to potentially harmful substances. Attention should also be paid to restricting possible off-site nuisance such as dust and odour emissions. Such precautions should include, but not be limited to:

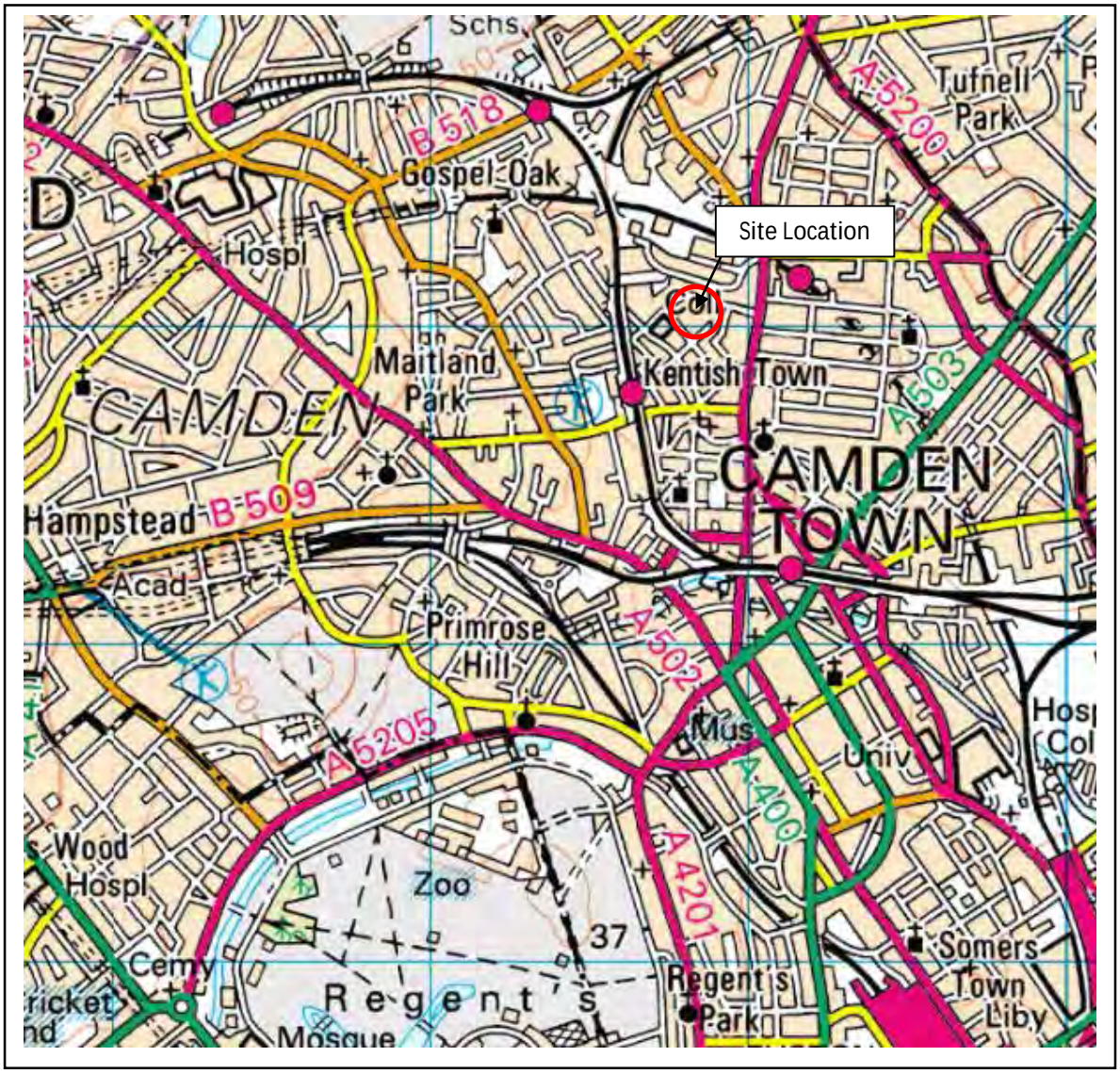
1. Personal hygiene, washing and changing procedures.
2. Personal protective equipment, including disposal overalls, gloves, respiratory protective equipment (RPE), etc.
3. Measures to avoid surface water ponding and positive collection and disposal of all on-site run off.
4. Regular cleaning of all site roads, access roads and the public highway dust suspensions methods (e.g. water spraying), if necessary.
5. No operatives will enter unshored or otherwise protected excavations deeper the 1.2m or if there is any instability.

[15] HSE (1991). Protection of Workers and the General Public during the development of contaminated land. Guidance Note HS(G)66, Health and Safety Executive, HSMO 1991.
[16] CIRIA (1996). A guide for safe working on contaminated sites. Steeds JE, Shepherd E & Barry DL. CIRIA Report 132.
[17] CIRIA (2005) Environmental good practice – Site guide, 2nd Edition. CIRIA C650.

The site has been identified as having a low risk of encountering UXO. It is noted that multiple bomb strikes were noted in the surrounding areas, however due to post-war redevelopment of the site, it is likely that any potential UXO would have aleady been identified beneath the site.

If not already undertaken, and asbestos survey should be undertaken prior to any refurbishment works at the site, and if identified, an appropriate method statement and materials management plan be produced for the removal of hazardous/asbestos containing waste.

FIGURES



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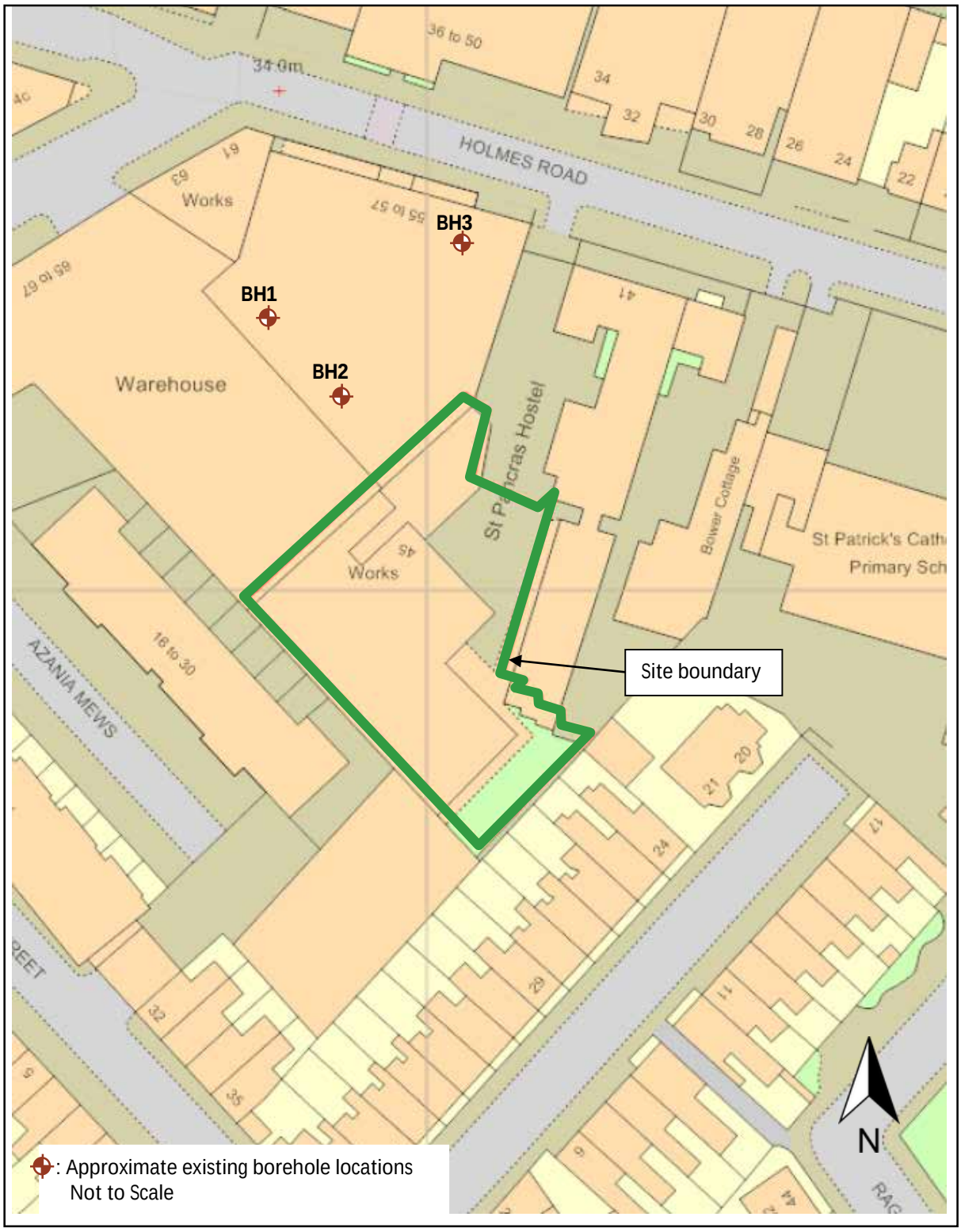
Client	Project	Job No
GHR Construction Limited & 45 Holmes Road Limited	**45 Holmes Road, London**	**CG/08696B**
CGL	Title: **Site location plan**	**Figure 1**



Client	Project	Job No
GHR Construction Limited & 45 Holmes Road Limited	**45 Holmes Road, London**	**CG/08696**
CGL	Title: **Adjacent site investigation borehole location plan**	**Figure 2**

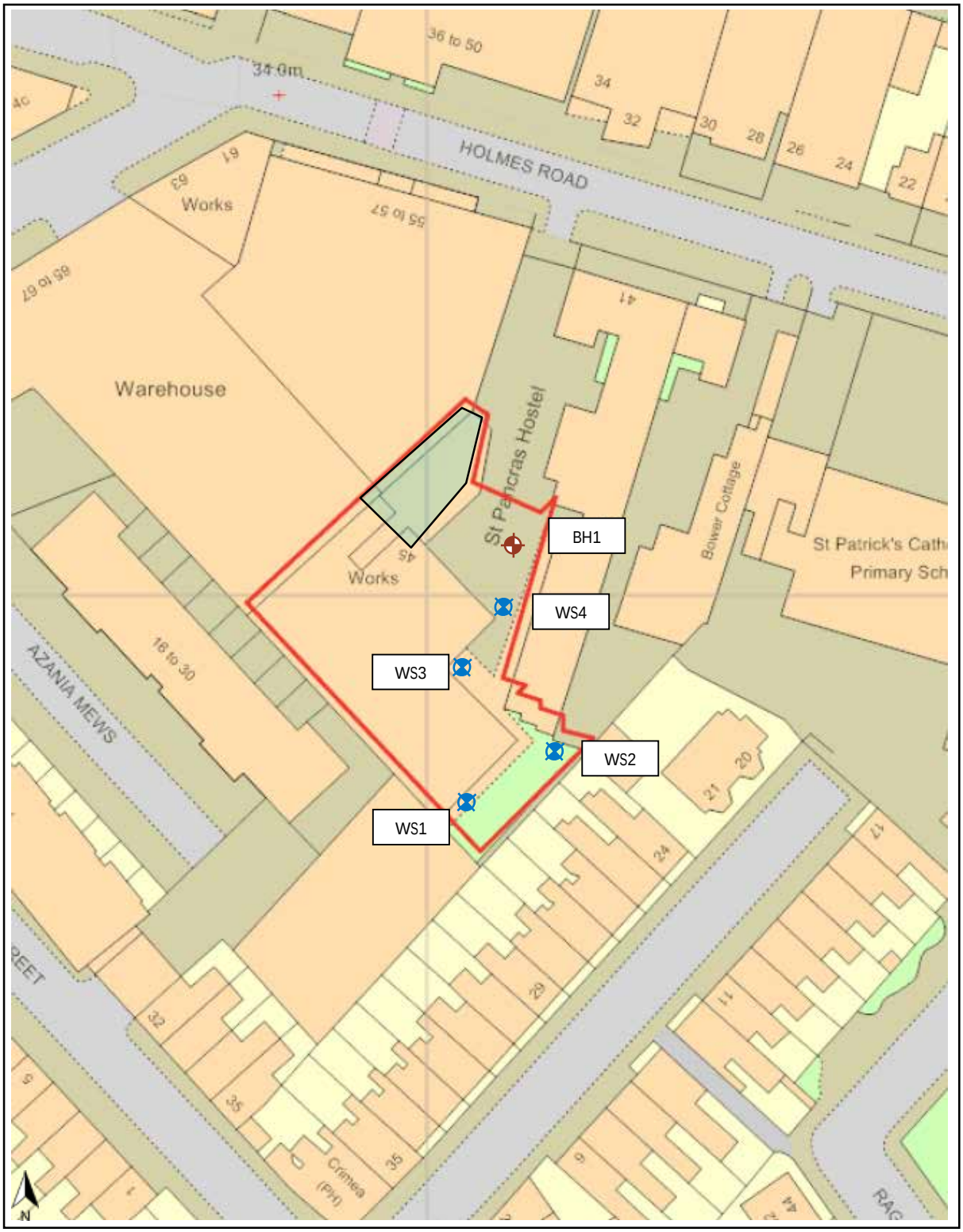


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Figure provided by the client

Client	Project	Job No
GHR Construction Limited & 45 Holmes Road Limited	**45 Holmes Road, London**	**CG/08696B**
CGL	Title: **Site layout and exploratory hole location plan**	**Figure 3**

Sources

1. Organic/inorganic contamination within underlying soils (benzo(a)pyrene and lead)
2. Asbestos from the building fabric

Pathways

i. Direct contact
ii. Root uptake

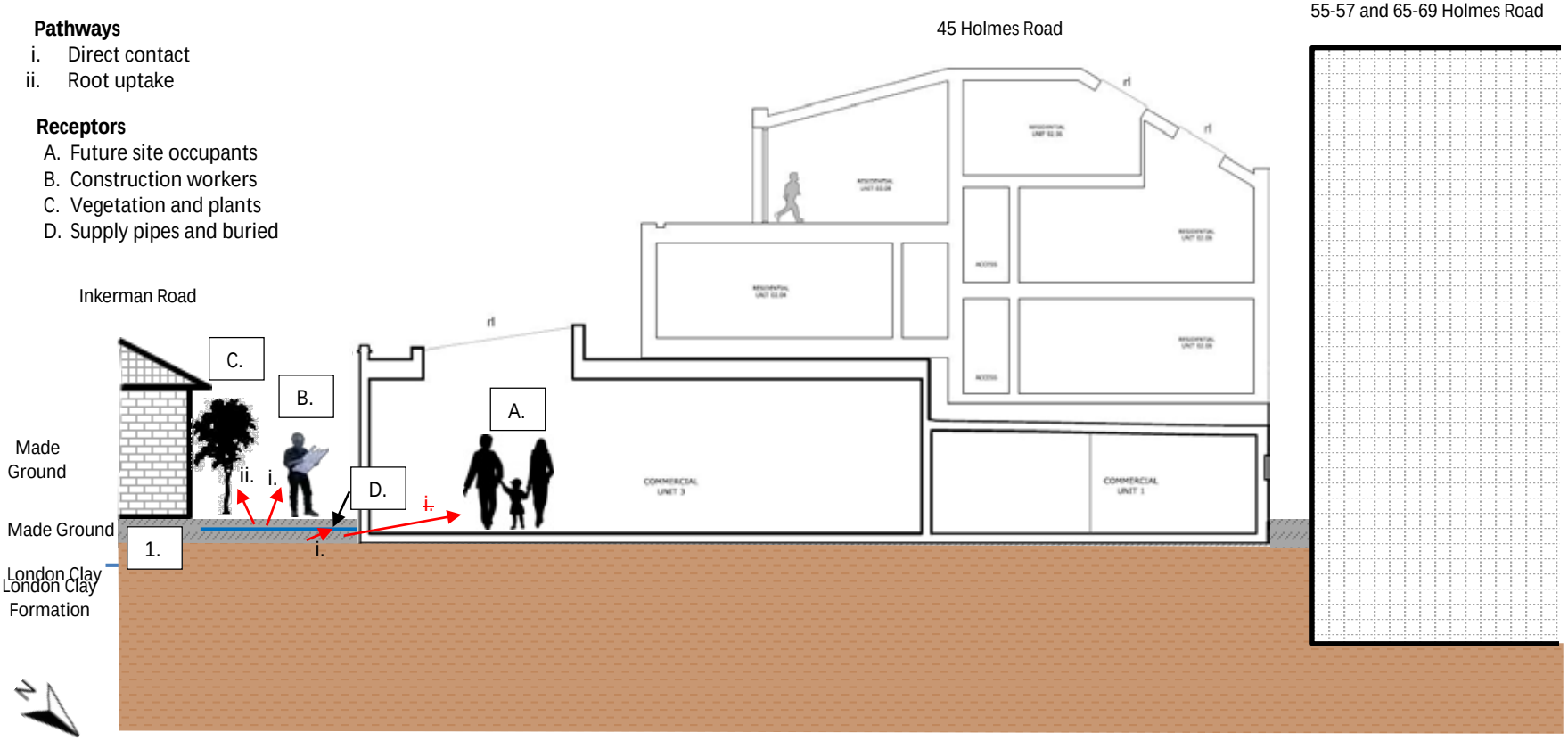
Receptors

A. Future site occupants
B. Construction workers
C. Vegetation and plants
D. Supply pipes and buried

~~i.~~ Contamination pathway for future site occupants has been removed by the proposed site-wide hardstanding

- No remediation required
- No proposals for landscaping
- Asbestos survey required prior to demolition/ refurbishment

55-57 and 65-69 Holmes Road (existing basements to approx. 6mbgl-7mbgl)



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Client	Project	Job No
GHR Construction Ltd & 45 Holmes Road Limited	**45 Holmes Road, London**	**CG/08696B**
CGL	Title: **Conceptual site model**	**Figure 4**