The Greenwood Centre, Camden

Land Quality Statement

For

Keir

Project Number:

12291

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1.0 SUMMARY OF ACTIONS

HUMAN HEALTH	Material used with the upper surface 600mm in areas of soft landscaping will require validation in accordance with the remediation specification.
CONTROLLED WATERS	No remediation works are required with respect to controlled waters.
BUILDINGS AND STRUCTURES/ SERVICES	The site has been classified as Characteristic Situation 1, whereby gas protection in relation to bulk gasses are not required. However a notional risk has been identified in relation to VOCs. As such a Detailed Quantitative Risk Assessment for vapours (vDQRA) should be undertaken. In absence of this, installation of a VOC barrier membrane is considered necessary. In addition, an assessment for protection of water supply pipes should be conducted.
SITE WORK CONTROLS	A watching brief for contamination should be undertaken and documented by the Contractor throughout groundworks. A Contamination Method Statement is required to detail the relevant provisions by the Contractor. This should include the scope and recording requirements of: the watching brief; Installation of a VOC barrier membrane (unless proven not necessary); materials management; the validation of any soils used in landscaping areas; actions for unforeseen contamination; waste management; and, controls for works which could affect the environment (CIRIA C692). It is noted that asbestos containing materials (ACM) have occasionally been identified in the soils at the site. Type II Asbestos Surveys are available for the buildings, which should be reviewed as necessary, together with surveys of any other on site buildings, prior to demolition.
REGULATORY APPROVAL	This document should be submitted to the Regulators (Environment Agency and Local Planning Authority) for comment via the planning process, in order to discharge conditions relating to desk study and site investigation. Thereafter a Method Statement for Contamination and verification reporting process require approval.
WASTE	This report does not address the classification of waste soils. The soil results, and those of the Waste Acceptance Criteria analysis, can however be utilised as a basis for such assessments, although additional testing may be required. It is noted that such assessments are required to accord with the Environmental Permitting and Planning Legislation and also to control costs during development.
GEOTECHNICAL ACTIONS	Preliminary geotechnical recommendations provided should be verified in a Geotechnical Design Report once structural details of the proposed development are confirmed. Excavation of Foundation inspection pits to establish the footings of adjacent structures is recommended. Consideration of the possible effect due to construction of the proposed basement on surrounding structures and infrastructure should be given. This could be summarised within a Ground Movement Assessment. A review of requirements of Camden Borough Council should be undertaken with respect to the previously submitted BIA.
DOCUMENTATION	The Contractor is required to submit this document, prepare a Contamination Method Statement in accord with the planning conditions, Verification Report, Materials Management Plan, Waste Classification Assessments and Health and Safety documentation.

2.0 EXECUTIVE SUMMARY

SITE LOCATION	The site is located at Greenwood Place, London, NW5, in the London Borough of Camden, approximately 200m north west of Kentish Town Station. It is proposed to demolish the existing Greenwood Day Centre and construct a new three storey community centre with a single storey basement.
ENVIRONMENTAL SETTING	The geological sequence at the site comprises Made Ground over London Clay, although locally Alluvial deposits were encountered overlying the London Clay. The overall environmental sensitivity of the site is considered to be **Low** comprising: - Hydrogeology (**Low**): The site is situated on Unproductive Strata. - Hydrology (**Low**): There are no significant surface water receptors within 500m of the site. - Sensitive Land Uses (**Low**): There are no sensitive land uses within 500m of the site.
CURRENT USE AND HISTORY	The entire site currently comprises the building of the former Greenwood Day Centre. The site historically comprised unidentified buildings, which were demolished when a bottle store was constructed in 1915. The bottle store was then converted to a heavy chemicals warehouse in the 1950s before being demolished to make way for the Greenwood Day Centre by 1973. Immediate surrounding land use has historically been of a predominantly industrial nature. Railway sidings historically bound the site to the south west which were formed in an area of cutting.
GEOTECHNICAL HAZARDS	Hazards identified from ground investigation: - Localised areas of highly compressible Alluvium associated with the former tributary of the River Fleet. - Areas of deep, variable Made Ground. - Potential running sand conditions associated with gravel / sand horizons in both made and natural ground. - The presence of claystone layers and concretionary limestone nodules within the London clay. - Medium to high volume change potential soils. - The potential for shallow groundwater or water bearing strata with a shallow piezometric level. - The potential for obstructions associated with previous phases of development. - Ground conditions are aggressive to buried concrete. - Retaining walls and level changes around the site boundary. - Adjacent infrastructure and buildings imposing surcharge loads adjacent to proposed basement. - Unexploded Ordinance (UXO). - Buried Services.
CONTAMINATION ISSUES	A generic quantitative risk assessment has been completed. This has identified a generally **LOW-MODERATE** risk from contamination. Elevated concentrations of metals and PAHs, have been encountered in soils; however the absence of soft landscaping breaks the pathway to sensitive receptors across the bulk of the site. Asbestos containing soils have been encountered at shallow depth (<1.0m). Concentrations of VOCs have been found to be elevated in a number of locations, including chlorinated solvents of Tetrachloroethene and Trichloroethene.
GEOTECHNICAL RECOMMENDATIONS	The development area should be amenable to bored cast in-situ and Continuous Flight Auger (CFA) piles. The presence of claystone bands up to 400mm thick will restrict certain piling methods. Casing is likely required through Made Ground and

	Alluvium (where present). CFA piles may require cutting down in the area of the basement. An embedded retaining wall is required for basement formation. The basement slab should be designed to withstand appropriate hydrostatic and heave pressures. A suspended floor slab is anticipated required. A design CBR of 3% is recommended along with proof rolling. An ACEC of AC-4 is recommended. Soakaway drainage will not be feasible. A ground movement assessment should be undertaken in order to assess suitability of sheet piles and temporary propping arrangements at the proposed development and estimate how basement construction impacts surrounding structures.
ENVIRONMENTAL RECOMMENDATIONS	A Vapour Detailed Quantitative Risk Assessment should be undertaken to inform the risks from VOCs identified. Should this not be completed, a membrane which provides protection from VOCs is considered necessary. In areas of soft landscaping the surface 600mm of material should be validated as suitable for use in accordance with the remediation specification. A watching brief should be undertaken during site works for any unforeseen sources of gross contamination.

3.0 INTRODUCTION

3.1. Appointment and Scope

3.1.1. This report has been produced by Campbell Reith Hill LLP (CampbellReith) on behalf of Keir (the Client) to summarise environmental and geotechnical information relating to the Greenwood Centre, Camden, London (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.

3.1.2. The report 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 and Phase 2 exploratory data in order to provide:

a) a conceptual model for the site ground conditions (soil, water and gas);

b) a generic quantitative risk assessment (human health, controlled waters and gas);

c) outline recommendations for land contamination issues;

d) a geotechnical evaluation; and,

e) geotechnical design recommendations.

3.1.3. The contamination appraisal is intended to identify remedial requirements necessary to permit the redevelopment of the site as a community centre.

3.1.4. This assessment considers the objectives of the National Planning Policy Framework 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). This also requires adequate site investigation information, prepared by a competent person (with the minimum requirement comprising a desk study and site reconnaissance).

3.1.5. It should be recognised that further appraisals, investigations, specification and validation may be required to accord with the recommendations stated herein. It is noted that these appraisals do not consider wider development issues, with cost implications, such as waste classification.

3.1.6. The geotechnical appraisal has been carried out in accordance with Eurocode 7. Sections 3 to 6, 8 and 10, together with Appendix C, comprise the Ground Investigation Report. Preliminary geotechnical recommendations are presented in Section 12 and these should be verified in a Geotechnical Design Report once structural details of the proposed development are confirmed.

3.1.7. The report is based on a site investigation commissioned for this project and a review of readily available information as referenced. The desk study information is presented in Appendix B. The draft site investigation report produced by Geosphere Environmental Ltd is contained in Appendix C. A site visit was undertaken as part of preparation of this report. An update of this report is required following receipt of the final factual site investigation report.

3.2. Previous Investigations

3.2.1. CampbellReith produced a Preliminary Land Quality statement dated April 2016 (report ref: AEDsrm-11167-300415-LQS-F3) for the wider site area, including land to the north west of the site around the Highgate Centre. The purpose of this report is to describe and interpret ground information from areas of the Greenwood Centre where access was restricted during prior investigation. Consequently this report excludes any geotechnical or environmental recommendations for the Highgate centre.

3.2.2. A Basement Impact Assessment has been produced by CampbellReith (report ref: AEDaed11167-200315BIA-F2) to assess the impact of the proposed basement on surrounding structures, infrastructure and ground water. It should be noted that the dimensions of the basement have changed following production of the aforementioned report.

3.2.3. The following site specific information, based upon reports produced by others, has been reviewed and is referred to:

TABLE 3.1: Existing Site Specific Information

Report Title		Author	Ref.
Desk Study Report, The Highgate Centre, Greenwood Place, London, NW5 (ref J10098)	June 2010	Geotechnical & Environmental Associates (GEA)	A
Historic Environmental Assessment, Greenwood Place, Kentish Town, London, NW5	June 2010	Museum of London Archaeology	B
Topographical Survey for Greenwood Place (ref B7106)	May 2010	Engineering Land & Building Surveys	C

4.0 SITE DESCRIPTION

4.1. Site Location

4.1.1. The site location is presented in Figure 1. The site is located at Greenwood Place, London, NW5, in the London Borough of Camden (NGR 528840E, 185400N), approximately 200m north-west of Kentish Town Station.

4.1.2. The site is bound to the north by Deane House, Lensham House to the east, a car park to the south, and Murphy's yard and a rail line to the west.

4.2. Site Layout

4.2.1. A site reconnaissance was undertaken by a representative of CampbellReith on 18th December 2015. The former Greenwood Place Community Centre Building covers the bulk of the site. There is a footway around the southern end of the building, to a small timber deck area and the access continues around the south west border of the building.

4.2.2. The site boundary includes a small additional rectangular area which is a part of Deane House. At the time of the site works, there was a wall in tact along the Greenwood Centre Boundary. In addition, the southern part of the centre is not internally connected to the main community centre building.

4.2.3. A previous site visit conducted when the Greenwood Day Centre was active noted the following;

- Boiler Room (off site) located towards the bottom of the 'Mail Out' community space which covers part of the ground floor footprint of Deane House.

4.3. Topography

4.3.1. The site has a gentle gradient up from the south west; however, there are significant changes in level at the site boundaries, the most notable of which being Murphy's Yard, to the south west of the site, at a level of approximately 33.70m AOD. To the south west of the Greenwood Centre is a pathway at 34.10m AOD with two sets of steps up to Greenwood Place at 36.65m AOD. This change in level is accommodated by brick and mass concrete retaining walls. The ground floor level of the Greenwood Centre is approximately 37.05 to 37.20m AOD and is constructed on soil which is supported by these retaining walls along the south west.

4.4. Surrounding Land-Use

4.4.1. The site is set in an area of mixed use and a description of the main surrounding land uses is summarised in Table 4.1.

Table 4.1: Summary of Surrounding Land-Uses

Direction	Description
North-west	Converted warehouses and offices.
North-east	A&A Self Storage, Lensham House, 19 Greenwood Place. A one to three storey brick building used as a self-storage facility. Construction / structural details can be found in [B].
South-east	Kentish Town Christ Apostolic Church and its boundary wall which are listed.

Direction	Description
	Beyond this is the HMV Forum, which is also listed.
South-west	'Murphy's Yard' is present to the south west of the site. Approximately 75m south west is a railway line.

4.5. Site After-Use Proposal

4.5.1. The proposed site redevelopment is shown on PCKO architects plans contained within Appendix A.

4.5.2. It is proposed to demolish the existing Greenwood Day Centre and construct a new one to three storey community centre with a single storey basement beneath the north west part of the building. At the time of writing this report, basement levels and development proposals were under development. Current proposal involves a finished basement floor level of circa 3.96m bgl and an underside of slab level of 4.56m bgl. Locally where the swimming pool is proposed the underside of basement slab will extend to a maximum depth of 5.76m. This results in a maximum retained height of approximately 5.16m below existing ground level. It is currently proposed to construct the basement by utilisation of a load bearing sheet piled wall.

4.5.3. The development is classified as Geotechnical Design Category 2 with reference to Eurocode 7.

5.0 ENVIRONMENTAL SETTING

5.1. Geology

5.1.1. The site geology and potential geotechnical hazards are summarised in Tables 5.1 and 5.2. The associated references are listed at the rear of the report. The geological sheet for the area [1] and the GroundSure Report [2] indicate that the geology comprises London Clay to around -10m AOD i.e around 50m below ground level (bgl). An area of 'Worked Ground' is shown on geological mapping on the western corner of the site, which would suggest it has a minimum thickness of 5.0m. It is also likely that Made Ground will be present overlying the London Clay in the remainder of the site, although this is likely to be of a lesser thickness than the 'Worked Ground' as it is not shown on geological mapping.

TABLE 5.1: Summary of Background Geology

Strata	Depth to Base (m bgl)	Description
Made Ground / Worked Ground	Unknown	Man-made granular and cohesive soils of unknown thickness, associated with historical development of the site.
Alluvium	Unknown	A former tributary of the River Fleet is anticipated to be present beneath the site [4]. It is therefore possible that Alluvial deposits may be present on site overlying the London Clay.
London Clay	50m bgl	Firm brown clay, becoming stiff to very stiff blue silty clay with depth.

5.1.2. One historic BGS borehole record, located 85m to the south east, has also been obtained. The borehole was sunk to 9.0m bgl in 1962 and encountered a geological sequence of Made Ground over London Clay. Made Ground was recorded to 1.0m bgl over 1.0m of weathered London Clay, underlain by London Clay to the base of the borehole.

TABLE 5.2: Summary of Geotechnical Hazards

Hazard	Distance	Description	Ref.
Former Tributary of the River Fleet	On site	A former tributary to the River Fleet is located beneath the site. It is possible that compressible Alluvial deposits may be present beneath the site. It is believed that this has been culverted and diverted off site, as discussed in Section 4.	4
Former Structures	On site	There is the potential for obstructions, relic basements and an increased thickness of Made Ground to be present on site.	-
Retaining Walls and Level Changes	On site	Retaining walls are present along the north eastern, south eastern and south western site boundaries. The effect of the proposed development on these retaining walls needs to be considered.	-
Worked Ground	On site	A railway locomotive shed and associated railway lines were constructed in cuttings adjacent to the south western site boundary. An area of 'Undivided Worked Ground' encroaches into the western corner of the site, which is likely to be associated with the construction of the railway. There is therefore the potential for a significant thickness of Worked Ground to be present on site.	2
Shrink / Swell	On site	'Moderate' hazard. The London Clay is known to have a high	-

Hazard	Distance	Description	Ref.
Clay		volume change potential and trees were noted during the site walkover. Therefore near surface soils may be desiccated in the region of trees on site.	
Aggressive Soil	On site	The London Clay, Alluvium and materials derived from it can naturally contain elevated concentrations of minerals that can be aggressive to buried concrete.	6
Shallow Groundwater	On site	Perched water above the London Clay, associated with the former tributary of the River Fleet, may be present.	-

5.1.3. The GroundSure Report has identified a 'very low' or 'no hazard' risk to the following ground stability hazards: landslides, running sands, faults, landslips, ground dissolution of soluble rocks, compressible deposits, coal and non-coal mining & associated cavities, natural cavities, and brine or gypsum extraction. However, it is possible that compressible Alluvial deposits may be present beneath the site associated with the former tributary of the River Fleet.

5.2. Seismicity

5.2.1. Clause 3.2.1(1),(2),(3) in the National Annex to BS EN 1998-1:2004 Eurocode 8: Design of structures for earthquake resistance states that in the absence of a project-specific assessment, to adopt the reference ground acceleration for a return period of 2500 years given by the seismic contour map in PD 6698. The map shows that the PGA (peak ground acceleration) for the site is in the region of 0.00 – 0.02g, which indicates a **Very Low** seismicity.

5.3. Hydrogeology

5.3.1. The site hydrogeology is summarised in Table 5.3 and the associated references listed at the rear of the report.

TABLE 5.3: Summary of Hydrogeology

Type	Distance	Description	Ref.
Superficial Aquifer	On site	None shown on the hydrogeological map.	2
Bedrock Aquifer (London Clay)	On site	Unproductive strata – rock layers or drift deposits that have negligible significance for water supply or river base flow.	2 & 3
Source Protection Zone	>1000m	None located within 1km of site.	2
Groundwater Abstractions	655m S	Two boreholes at Kentish Town Sports Centre, Prince of Wales St. Licence no. 28/39/0091. Details: Process water, drinking, cooking, sanitary, washing and laundry use.	2

5.3.2. The Chalk, located at depth, is a 'Principal Aquifer' [3]. However, the intervening low permeability London Clay is likely to act as an aquitard, thus protecting the Chalk, unless compromised.

5.3.3. The site is considered to have a **Low** sensitivity with respect to hydrogeology.

5.4. Hydrology

5.4.1. The site hydrology is summarised in Table 5.4 and the associated references listed at the rear of the report.

TABLE 5.4: Summary of Hydrology

Type	Distance	Description	Ref.
Surface Waters	>500m	No surface water features within 500m of site. However, an extended culvert, the Regent's Canal, is shown running north west to south east 210m west of the site.	2 & 3
Surface Water Abstractions	>1000m	None located within 1km of site.	2

5.4.2. Reference to the Lost Rivers of London book [4] indicates that a tributary of the former River Fleet ran through the site. This former tributary is believed to have been diverted and culverted as discussed in Section 4.

5.4.3. A Flood Risk Assessment is presented under a separate cover.

5.4.4. The site is considered to have a **Low** sensitivity with respect to hydrology.

5.5. Radon

5.5.1. Reference to BRE 211 document [7] and the National Radiological Protection Board (NRPB) Atlas [8] has shown that the site does not fall within an area where basic or full radon protection measures are necessary for domestic dwellings, nor is it situated in an area requiring a geological assessment for such measures. As such, a **LOW** risk is adjudged in relation to radon.

5.6. Sensitive Land-Uses

5.6.1. Reference to the Magic website [12] indicates two Grade II listed buildings; the Christ Apostolic Church, which is 20m south-east of the site and the Forum which is located 70m south-east of the site.

5.6.2. The Magic website [12] and GroundSure report [2] do not indicate any other sensitive land uses within 500m of the site.

6.0 SITE HISTORY AND INDUSTRIAL SETTING

6.1. Site History

6.1.1. Information relating to the site history has been obtained by reference to the GroundSure report [2] and is summarised for the site and its surroundings in Tables 6.1 and 6.2.

TABLE 6.1: Site History

Date	Development
1872	The site comprises soft landscaping/ communal gardens/ allotments, with part of **Prospect Place** covering the south of the site.
1894-1896	Site layout largely unchanged.
1915-1916	A '**Bottling Store**' to the north has been extended southwards into the north-west quadrant of the site. Prospect Place is no longer shown and a new building is shown in its place in the south west.
1936	Site layout remains unchanged.
1952	The 'Bottling Store' is now labelled as '**Heavy Chemicals Warehouse**' on site. A platform is indicated in connection with this. The footprint of the building in the south west has been extended north west.
1963-1968	The 'Heavy Chemicals Warehouse' is now only labelled as a '**Warehouse**'. Part of the building in the south west of the site has been demolished.
1973-2012	The site layout is as existing with the two **day care centres** and an area of soft landscaping in the north east of the site.

TABLE 6.2: Adjacent Land History

Date	Development
1872	Residential properties and gardens north, east and south, and a **railway line** west.
1894-1896	Two '**Bottling Stores**' are shown 20 and 70m north-west. A '**Coal Shed**' is labelled 40m south-west. Slopes are shown down to the railway sidings to the south west adjacent to the south-western site boundary. '**Kentish Town Sheds (Locomotive)**' are shown 120m north-west. A '**Smithy**' and a '**Laundry**' are shown 45m north and 55m north-west of the site respectively. An '**Omnibus Company's Stables**' are labelled 75m south-east.
1915-1916	The **railway sidings** have now been extended towards the site and now bound the site to the south-west. The footprint of the **locomotive sheds** has doubled, expanding to the north. The 'Omnibus Company's Stables' and 'Smithy' are no longer labelled.
1936	The area immediately north of the site now houses a number of unmarked buildings. A '**Depository**' and '**Warehouse**' are labelled 25m north-west. The 'Laundry' 45m north is now labelled a '**Warehouse**'. A '**Wallpaper Factory**', '**Warehouse**', '**Piano Works**' and '**Furniture Factory**' are labelled 80m north-west, 90m east, 150m north-east and 220m north-east of the site respectively.
1952	The buildings north east of the site are now labelled as '**Coachbuilding Works**'. The '**Bottling Stores**' to the north-west are now labelled as a '**Garage**' and '**Wallpaper Factory**' and the '**Warehouse**' 25m north-west is now labelled a '**Cabinet Works**'. '**Welding Works**' are shown 100m south-east. A '**Naphtha Store**' is labelled adjacent to the railway sidings 220m south-west. Two '**Garages**' and a '**Motor Body Factory**' are shown 150m east, 190m south-east and 160m east respectively.
1963-1968	A large amount of the railway sidings to the south west are no longer shown and the area is now labelled a '**Civil Engineering Depot**'. The remaining railway lines are labelled '**Dismantled Railway**'. The '**Wallpaper Factory**' to the north west is now only labelled a '**Factory**'. The '**Depository**' and '**Cabinet Works**' are now labelled as a '**Clothing Factory**' and '**Exhibition Works**' respectively. The '**Coachbuilding Works**'

Date	Development
	in the centre of the site is also labelled as an '**Exhibition Works**'. The buildings adjacent to the south-western site boundary are no longer shown. Vacant land is shown on the northern side of Highgate Road to the immediate north-east of the site.
1973-1977	A new building has been constructed north east of the site, which is labelled a '**Warehouse**'. The area of land to the south-west of the site is now labelled as a '**Depot**' and only the area to the north-west is labelled as a '**Civil Engineering Depot**'. All the industries previously mentioned are now labelled as '**Works**'. A 'Roof Car Park' is labelled 25m north-west. The 'Naphtha Store' is no longer labelled.

6.1.2. Anecdotal evidence provided under Ref [A] indicates that these buildings were owned by Imperial Chemical Industries (ICI) Ltd, who were involved in the production of chemicals, explosives, fertilisers, insecticides, dyestuffs, non-ferrous metals, fabrics and paints, as well as the development and production of pharmaceuticals. However, the buildings onsite are considered unlikely to have been involved in any form of production and to have been mainly used for storage.

6.2. Liaison with Regulatory Authorities

6.2.1. A summary of consultation with Regulatory Authorities is provided under Table 6.3 below. Correspondence is contained within Appendix B.

TABLE 6.3: Summary of Consultations with Regulators

Regulator	Date Issued	Response Received	Key Findings/ Outcomes
Environmental Health Officer -London Borough of Camden	23/11/2012	29/11/2012	The site has not been determined as contaminated land under Part IIA of the Environmental Protection Act 1990. However, LB Camden has identified the site as having the potential to be contaminated land through its previous use. Historical land uses at or within 100m of the site include: chemical works, depository (depot); laundry; welding works; coach building works; railway land; garage; unknown industrial use; unknown warehouse; smithy; and, bottling works. It is highly likely that asbestos contamination will be present on site.
	02/07/2013 & 14/08/2013	14/08/2013	An enquiry was made to the EHO in order to establish the exact nature of the historical heavy chemical warehouse on the west of the site. The EHO confirmed that the council holds no further information.
Information Manager – Transport for London	13/11/2012	14/11/2012	The response confirmed that there are no underground assets within 50m of the site.
Communication Officer – Crossrail	13/11/2012	08/01/2013	The site falls outside the safeguarding zone of Crossrail 1 and 2.
Petroleum Officer	13/11/2012	25/03/2013	No petroleum tank records found.

6.3. Unexploded Ordnance (UXO)

6.3.1. 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' [9] and the assessment matrices presented in Tables 5.1 – 5.3 therein.

6.3.2. A review of the London County Council Bomb Damage Maps 1939-1945 [10] indicates that the site lies in an area that was subject to moderate bombing during the Second World War. The document indicates that one terrace building on the north west of the site suffered 'General Blast Damage' and the depository located to the immediate north was 'Seriously Damaged but Repairable at Cost'. Additionally, the coal shed and locomotive sheds, to the south and west of the site respectively, suffered 'General Blast Damage'. Otherwise, the remaining buildings on site and in the immediate surrounding area were not recorded as damaged.

6.3.3. By reference to Table 5.1, the potential for aerial delivered ordnance to have landed on the site is considered to be high. However, with reference to Tables 5.2 and 5.3, it is noted that the site has undergone significant post war redevelopment, particularly during the early 1970s when the day centre buildings were constructed.

6.3.4. At this stage, taking into account the level of post-war development and the survival of buildings on site throughout the war period, the risk of encountering UXOs is considered to be **LOW**.

6.3.5. Notwithstanding the above information, UXO hazards should be included as part of the health and safety briefing and tool box talks during the works, such that if any suspicious articles are found, they can be quickly identified and treated appropriately by specialist inspection.

6.4. Tunnels and Infrastructure

6.4.1. CIRIA Report SP69 [5] indicates that a storm relief sewer runs north to south beneath Highgate Road adjacent and that a main sewer runs close to the western boundary of the site. Reference to the London County Council Main Drainage Plan No. 2 [11] also shows both of these sewers at the same location: a storm relief sewer beneath Highgate Road to the east of the site; and, a main sewer to the west of the site. However, the main sewer to the west of the site is labelled the 'Fleet Sewer'.

6.4.2. Statutory services plans have been obtained for the site by Engineering Land and Building Surveys Limited in January 2013. These should be referred to with regards to the proposed development. Whilst the Thames Water plans show no significant water or sewer pipes on site, it is noted that a large diameter (1.22m) storm relief sewer at approximately 10m bgl is located beneath Highgate Road, believed to be the storm relief sewer indicated in [5] and [11]. The Thames Water Plans suggest that the main sewer ('Fleet Sewer') is located at least 40m to the west of the site. It is recommended that the location of this sewer is confirmed with Thames water in due course.

6.4.3. Plans provided by Thames Water and the survey data provided by the client also show an additional sewer and water supply pipework beneath the road pavement to the north east of Greenwood Place.

6.4.4. By reference to information held locally by CampbellReith, the site is remote from scour hollows, EDF deep cable tunnels, Royal Mail and government communication tunnels. Regulatory responses from Crossrail and London Underground indicate that site is remote from any of their assets and infrastructure.

6.5. Current Industrial Setting

6.5.1. A review of Contemporary Trade Entries has been completed by reference to the GroundSure report [2] and potential sources of contamination within 150m of the site are listed in Table 6.4.

Table 6.4: Summary of Potentially Contaminative Trade Entries (<1000m from site)

Name	Distance	Address	Classification
Registered as 'Active'			
A&A Business Centre	10m NE	19 Greenwood Place, London, NW5 1LB	Container & Storage – Transport, Storage & Delivery
London Undercover	100m NE	Unit 1-4 Deane House, 27 Greenwood Place, NW51LB	Consumer Products/ Luggage, Bags & Travel – Consumer Products
Alan Pharmaceuticals	25m NW	33 Greenwood Place, NWS 1LB	Medical Equipment, Supplied & Pharma – Industrial Products
Works	30m NW	(Unspecified Address) NW5	Unspecified Works or Factory – Industrial Features
Kentish Town Fire Station	85m E	Kentish Town Fire Station, 20 Highgate Road, NW5 1NS	Fire Brigade Station – Central & Local Government
Millennium Design Ltd.	40m NW	Linton House, 39-51, Highgate Road, London, NW5 1RT	Clothing, Components & Accessories – Consumer Products
Zooid Picture Ltd.	40m NW	Linton House, 39-51, Highgate Road, London, NW5 1RT	Published Goods – Industrial Products
Works	110m NE	(Unspecified Address) NW5	Unspecified Works or Factory – Industrial Features
Charles Wilson Engineers Ltd.	130m E	11-15 Fortress Road, London, NW5 1AD	Construction & Tool Hire – Hire Services
Piano Warehouse Ltd	140m NE	30a Highgate Road, London, NW5 1NS	Musical Instruments – Consumer Products
Court Davis Joinery Ltd	150m NE	30a Highgate Road, London, NW5 1NS	General Construction Supplies - Industrial Products
Works	100m NE	(Unspecified Address) NW5	Unspecified Works or Factory – Industrial Features
Works	100m N	(Unspecified Address) NW5	Unspecified Works or Factory – Industrial Features
Electricity Sub Station	100m NW	(Unspecified Address) NW5	Electrical Features – Infrastructure & Facilities

6.5.2. Table 6.5 summarises identified industrial features which may present a potential source of contamination to the site by reference to the GroundSure report [2].

Table 6.5: Industrial Setting

Type	Distance	Descrption
Part A(2) and Part B Activities & Enforcements (≤250m)		
Perk Clean 20 Fortress Road, Kentish Town, NW5 2HB	120m E	Historic Part B Permit for Dry Cleaning processes. No enforcement details or dates are recorded against this entry, however, this has since been re-registered as Active; suggesting that this premises has been operating for a period spanning two permit consents as a minimum.
M & A Coachworks II 1-36 Fortress Grove, Kentish Town, NW5 1LE	135m E	Current Part B Permit for Vehicle Re-spraying processes. No enforcement details or dates are recorded against this entry.
Zappeo Dry Cleaners 310 Kentish Town Road, NW5 2TH	145m SE	Current Part B Permit for Dry Cleaning processes. No enforcement details or dates are recorded against this entry.
Post Office Vehicle Services, Unit A, Kentish Town Business Park, Regis Road, NW5 3RR	165m S	Historic Part B Permit for Vehicle Re-spraying processes. This entry is recorded twice; however, neither record contains enforcement details or dates.
J Murphy & Sons Ltd. 81 Highgate Road, NW5 1TS	165m NW	Current Part B Permit for Vehicle Refinishing processes. There is also a record for a superseded (historic) permit at this address for the same process. Neither records contain details on the enforcement dates.
The Kleen Machine Kentish Town, PO16 8UG	265m SE	Historic Part B Permit for Dry Cleaning Processes. No enforcement details or dates are recorded against this entry.
Sites Determined as Contaminated Land under Part IIA EPA 1990		
8 Ascham Street; 15-23,27,33 and 37-41 Falkland Road; 15a, 25-29 and 35 Lady Margret Road; and, 42,44 and 48 Leverton Street, NW5 2PU	220m E	Former metal plating works. Lead and Cadmium potential contaminants. Remediated. Land Identified as 'Contaminated Land' in 2011.
Environment Agency Licensed Waste Sites		
Camden London Borough Council Recycling Centre Regis Road, Kentish Town, London, NW5 3EP	260m S	Household Waste Amenity Site <25,000 tonnes/year (recorded annual tonnage of 7,793 tonnes). Regis Licence Number: CAM001. EPR Reference: EA/EPR/DP3091NK/V003. Operator Camden London Borough Council. Waste Management Licence Number: 80349. The licence was issued on 10/12/1996, modified on 25/01/2002 and effective from 11/05/2012.

6.6. In addition to the above data, research did not establish the presence of any of the following at or within 500m of the site:

- Historical IPC Authorisations;
- Part A(1) and IPPC Authorised Activities;
- Water Industry Referrals (potentially harmful discharges to the public sewer);

- Red List Discharge Consents (potentially harmful discharges to Controlled Waters);
- Red List 1 Dangerous Substances Inventory Sites;
- Red List 2 Dangerous Substances Inventory Sites;
- Licensed Discharge Consents;
- Planning Hazardous Substance Consents & Enforcements;
- COMAH & NIHHS Sites;
- Environment Agency current or historical landfill data;
- Operational and non-operational landfill sites sourced from Landmark;
- BGS/DoE non-operational landfill sites;
- Local Authority landfill sites; or,
- Underground High Pressure Oil and Gas Pipelines.

6.6.1. Also, research did not establish any of the following at or within 250m of the site:

- Category 3 or 4 Radioactive Substance Licences;
- List 2 National Incidents Recording System Entries; or,
- List 1 National Incidents Recording System Entries.

7.0 PRELIMINARY CONCEPTUAL MODEL

7.1. Introduction

7.1.1. 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. This information has been utilised to design the site investigation considering the proposed end use.

7.2. Classification of Risk

7.2.1. 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 7.1. 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 7.1: 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

7.3. Potential Sources of Contamination

7.3.1. Table 7.2 summarises the potential contamination sources 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, industry profiles and anecdotal information.

TABLE 7.2: Potential Sources of Contamination

Feature on or near site	Potential Contaminant
On site	
Made Ground, due to previous development and worked ground relating to the rail line to the west	ACM, G, M, TPH, PAH, VOCs
On site boiler room	TPH, PAH, ACM
COSHH Store located within Greenwood Day Centre.	Domestic Cleaning products
Bottling Store/ Factory directly present.	ACM, TPH, PAH, M

Feature on or near site	Potential Contaminant
c.1911 – 1952.	
Heavy Chemicals Warehouse c.1952 – 1967.	VOCs, TPH, PAH, G
Off site	
Coach building Works north of site. c.1952-1967.	G, M, TPH, PAH, solvents
Wallpaper Factory located 75m to the west of the site c.1936 – 1952.	M, Acids & Alkalis, VOCs, PAH, TPH, ACM.
Active Contemporary Trade Directory Entries (within 100m of site)	ACM, G, M, TPH, PAH, VOCs
Notes: M – Metals. PAH – Polyaromatic Hydrocarbons. TPH – Total Hydrocarbons. VOC – Volatile Organic Compounds. ACM – Asbestos Contaminant Materials. G – Ground gas source. R – Radon gas.	

7.4. Anecdotal Evidence

7.4.1. A 'heavy chemicals warehouse' was historically present to the north of the site dated from mapping 1952 - 1967. Anecdotal evidence detailed in Appendix B indicates that these buildings were owned by Imperial Chemical Industries (ICI) Ltd; who were involved in the production of chemicals, explosives, fertilisers, insecticides, dyestuffs, non-ferrous metals, fabrics and paints, as well as the development and production of pharmaceuticals. However, the buildings onsite are unlikely to have been involved in any form of production and mainly used as storage.

7.4.2. With respect to the potential contamination resulting from the historical wallpaper Factory to the west of the site, Consultation to the DoE Industry Profile for Textile Works and Dye Works (1996) includes a section on 'Treatments to Fibres, Yarns & Fabric'. It is unclear whether the factory produced materials in-house or whether the factory simply 'assembled' fabrics – in which case the potential for contamination to have been generated is relatively reduced.

7.5. Receptors and Exposure Pathways

7.5.1. Potential risks have been identified based on the proposed site use, the receptors and potential pathways by which the receptor/s may be exposed to the contaminant source/s. These are presented in Table 7.3 and have been used to inform the site investigation.

TABLE 7.3: Risk Assessment of Potential Pollutant Linkages

Receptor	Pathway	Risk
End Users	Ingestion of soil / dust	Moderate – High
Neighbours		Moderate
Construction Workers		
End Users	Inhalation of soil / dust	Moderate
Neighbours		
Construction Workers		
End Users	Inhalation of vapour from soil / dust / water	Moderate
Neighbours		Low
Construction Workers		
End Users	Dermal contact with soil / dust / water	Moderate
Neighbours		Low

Receptor	Pathway	Risk
Construction Workers		Moderate
End Users	Consumption of vegetables / plants	No pathway – no planting areas proposed.
End Users	Migration of soil gases/vapours to confined spaces / structures	High
Construction Workers		Moderate
Building		
Surface Waters	Migration of water borne contaminants	Very Low
Neighbours		Very Low
Groundwater Aquifer	Leaching of contamination from Made Ground	Low
End Users	Movement of contaminants to engineered structures (water pipes)	Moderate

7.6. Targeted Pollutant Linkages

7.6.1. The identified pollutant linkages targeted as part of the site investigation are detailed in Table 7.4.

TABLE 7.4: Targeted Pollutant Linkages

Issue	Exploration
Contamination of shallow soils from historical site activities.	General site coverage.
Ground gas generation from Made Ground.	Ground gas monitoring installations monitoring using conventional techniques and passive diffusive tubes for VOC testing.

7.6.2. The findings of the intrusive investigation of the potential contaminant sources and pathways are reported herein. This has informed the Generic Quantitative Risk Assessment presented in Section 9.0 and the subsequent discussion of risk in Section 11.0.

8.0 SITE INVESTIGATION

8.1. Previous Ground Investigation (2012)

8.1.1. During 2012 CampbellReith commissioned Ground Engineering Ltd to conduct a ground investigation for the previous scheme, including some additional areas to the east of the site. This included Highgate Day Centre, but not Lensham House. One cable tool borehole and one windowless sampler borehole were progressed in the road to the east of the Greenwood Centre, and one windowless sampler was progressed within the southern part of the Greenwood Centre Building.

8.1.2. Borehole referenced as BH2 in the 2012 ground investigation has been referenced by Geosphere Environmental mainly as DCSBH2, or in the groundwater results this is referenced OBH2. These are the same location. Relevant boreholes are included within Appendix B.

8.2. Ground Investigation (2016)

8.2.1. During the spring of 2016 Geosphere Environmental conducted a ground investigation. The exploratory locations from this works, and the historical locations referred to within this report, are detailed in Table 8.1 and presented in Figure 2. The factual site investigation report is contained within Appendix C.

8.2.2. The originally planned borehole BH3 was not undertaken due to encountering a concrete obstruction. Consequently WS102 was undertaken within the proximity.

TABLE 8.1: Standpipe Summary

Exploratory Hole	Response Zone (m bgl)	Strata Encountered	
DCSBH2/ OBH2	1.00 – 4.15	0.00 – 0.42	Road pavement materials.
		0.42 – 1.00	Made Ground (cohesive).
		1.00 – 3.70	Made Ground (Alluvial deposits).
		3.70 – 4.15	Reworked London Clay.
DCS1	1.00 – 3.00	0.00 – 0.24	Road pavement.
		0.24 – 0.65	Made Ground (granular).
		0.65 – 2.00	Made Ground (cohesive).
		2.00 – 3.00	Made Ground (Alluvial deposits).
DCS4	1.00 – 2.00	0.00 – 0.20	Concrete.
		0.20 – 0.56	Made Ground (granular).
		0.56 – 0.70	Concrete.
		0.70 – 1.50	Made Ground (cohesive).
		1.50 – 2.00	Reworked London Clay.
BH01	1.00 – 10.00	0.00 – 5.00	Made Ground.
		5.00 – 10.00	London Clay (Suspected Volatile odour on surface).
BH02	1.00 – 10.00	0.00 – 2.00	Made Ground.
		2.00 – 10.00	London Clay.
WS102	1.00 – 5.00	1.00 – 3.40	Made Ground.
		3.40 – 5.00	London Clay.

8.3. Groundwater Observations

8.3.1. Groundwater strikes were not encountered during excavation of exploratory holes during the site investigation. The exception to this is within foundation inspection pits FIP3 and FIP4 which encountered seepage of groundwater at 1.70m and 1.35m bgl respectively.

8.3.2. BH1 and BH2 in the northern site section were dry on the 3no. monitoring visits undertaken to date. Monitoring in WS102 showed a ground water level at a maximum of 2.0m bgl. Groundwater monitoring of previously installed groundwater standpipes showed groundwater at a maximum level of 1.40m bgl. Groundwater monitoring was undertaken during April and May 2016 and consequently it is envisaged that monitored levels will be at a moderate level.

8.3.3. It is possible that groundwater strikes were not observed in all boreholes during drilling due to slow groundwater ingress. Some monitored groundwater levels also showed increase with time, which would suggest that an equilibrium level had not been reached.

8.3.4. It is therefore likely that localised groundwater is residing at shallow depth in the Made Ground at approximately 1.00 to 2.50m bgl.

8.4. Geotechnical Testing

8.4.1. In-situ testing was undertaken for geotechnical purposes and samples were obtained for appropriate laboratory analysis. Site and Laboratory based geotechnical testing is summarised within the Geosphere Ltd report contained in Appendix C.

8.4.2. Moisture content determinations on disturbed samples, including those obtained by dynamic continuous sampling apparatus, may not be wholly representative due to disturbance arising from the sampling process. In addition, 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.

8.4.3. Triaxial tests undertaken on highly fissured samples and samples that have experienced disturbance during sampling can result in low values of shear strength being recorded and results have been compared to published data and in situ test results to allow any anomalous data to be identified. Test results are discussed in Section 10.

8.4.4. Olfactory and visual evidence of potential contamination is summarised in Table 8.2. Gravel of brick and concrete was encountered in all Made Ground on the site, and only contamination in excess of this is detailed below.

TABLE 8.2: Summary Evidence of Contamination

Exploratory Hole	Depth (m bgl)	Stratum/ Comment	
OBH2	0.00 – 0.05	Made Ground	Asphalt.
	0.42 – 1.00	Made Ground	Gravel of ash.
	1.00 – 3.10	Made Ground	Gravel of ash. Occasional black organic patches.
DCS1	0.00 – 0.05	Made Ground	Asphalt.
	0.39 – 0.65	Made Ground	Gravel of ash.
	0.65 – 3.10	Made Ground	Gravel of coal and ash.
DCS4	0.70 – 1.00	Made Ground	Firm black clay. Gravel of ash and coal.
	1.00 – 1.50	Made Ground	Gravel of ash.

Exploratory Hole	Depth (m bgl)	Stratum/ Comment	
BH01	0.10 – 1.10	Made Ground	Gravel of clinker.
	1.30 – 4.00	Made Ground	Gravel of clinker and coal.
	5.00 – 7.50	London Clay	Suspected volatile odour in upper layers.
BH02	0.10 – 1.20	Made Ground	Gravel of wood and glass. Suspected ACM.
	1.30 – 2.00	Made Ground	Gravel of Charcoal.
FIP 1	0.12 – 1.10	Made Ground	Gravel of clinker.
FIP 2	0.80- 0.86	Made Ground	Band of black clinker and charcoal.
	1.00 – 1.40	Made Ground	Gravel of clinker.
	1.40 – 1.50	Made Ground	'Moderate organic odour' (Suspected VOCs).
HA 1 (FIP2)	0.10 – 1.40	Made Ground	Gravel of charcoal.
	1.40 – 1.50	Made Ground	'Moderate natural organic odour' (Suspected VOCs).
FIP 3	0.20 – 1.20	Made Ground	Gravel of clinker.
WS101	1.30 – 2.10	Made Ground	Gravel of charcoal.
	5.00 – 6.00	London Clay	Moderate suspected volatile odour with depth.
WS102	0.45 – 0.65	Made Ground	Gravel of charcoal and clinker.
	0.65 – 1.40	Made Ground	Gravel of charcoal and clinker, 'moderate natural organic odour' (Possible VOCs)
	1.40 – 3.40	Made Ground	Gravel of charcoal and clinker, black speckling.
CBR 3	0.10 – 0.60	Made Ground	Gravel of clinker.

8.4.5. The ground investigation contractor returned to site to obtain a sample from FIP 2 1.4 – 1.5m bgl to enable VOC testing of this material. This location is labelled HA1.

8.4.6. Visual and olfactory evidence of VOC contamination is summarised on Figure 3.

8.4.7. Table 8.3 summarises the chemical suites that were analysed based upon the preliminary conceptual model and observed site conditions.

TABLE 8.3: Laboratory Tests (Environmental)

Test type	Frequency
SOIL	
CampbellReith Hazardous Properties Assessment (HPA) Suite – pH, moisture content, total sulphate, sulphide, phenols monohydric, total cyanide, arsenic, cadmium, chromium, nickel, lead, mercury, selenium, copper, zinc, speciated polyaromatic hydrocarbons (PAHs), gasoline range organics (GRO) (C6 – C10) and extractible petroleum hydrocarbons (EPH) (C10 – C25, C25 – C40).	18
Total Organic Carbon	4
Total Petroleum Hydrocarbons - Working Criteria Group (TPH WCG)	3
Asbestos screen	21
VOC and SVOC target list (Modified US EPA 8270)	3
WATER	
CampbellReith Mandatory Water Suite – arsenic, cadmium, chromium, copper, nickel, zinc, lead, mercury, boron, selenium, hexavalent chromium, soluble sulphate, sulphide,	3

Test type	Frequency
free sulphur, speciated (16) PAHs, phenols, thiocyanate, Total TPH and pH.	
Total Petroleum Hydrocarbons - Working Criteria Group (TPH WCG)	3
VOCs Target List only	3
Gas	
Passive Diffusive Tubes – 'Top 15' VOC analysis	6

9.0 GENERIC QUANTITATIVE RISK ASSESSMENT

9.1. Assessment Framework

9.1.1. Subsequent to the identification and quantification of contaminant species in soils, waters and gases, it is necessary to select a method for assessing their significance in view of the current and proposed future use of the land. The initial assessment comprises comparison of identified contaminant levels to generic screening values that have been prepared to assess the risk to human, controlled water and gas risk receptors. The guidance used to provide this initial screening is listed in Table 9.1.

9.1.2. With respect to Human Health Risk Assessment the selection of screening values has been based upon the proposed reuse as a community centre whereby a residential land use scenario has been adopted for the assessment of soils. It should be noted that a residential scenario is considered to be inherently conservative, particularly with regards to the exposure of potential contamination to the receptor. The assessment assumes a Soil Organic Matter (SOM) content of 1.0% based on average site derived SOM data from the Made Ground.

9.1.3. Controlled Water Risk Assessment has been undertaking using as available Environmental Quality Standards (EQS) for the protection of aquatic life due to the site's location on an Unproductive Aquifer. The specific legislation and/or guidance that dictate the water quality standards adopted are contaminant specific and these are referenced in the Summary of Water Analysis table. The water quality standards have been chosen in accordance with section 4.2 of the EA's Remedial Targets Methodology as informed by the EA's Groundwater Protection: Principles and Practice (GP3), August 2013, version 1.1).

9.1.4. For further detailed information on the current Regulations and selection of appropriate threshold values, please refer to the rear of this report text.

TABLE 9.1 Generic Quantitative Screening Values

	Key Guidance
SOIL	LQM/CIEH S4ULs for Human Health Risk Assessment.*
	Defra Development of Category 4 Screening Levels Main Report and Appendix H.
	Environment Agency, Soil Guideline Values based upon Contaminated Land Exposure Assessment Model (CLEA) and the CLEA 1.06 software. SGV Reports SC050021/SGV.
	Generic Assessment Criteria based upon Environment Agency CLEA Version 1.06 software. Environment Agency Science Reports SC050021 SR2/SR3, Toxicological Reports SC050021/Tox. EA Toxicological Reports 1-25.
	Generic Assessment Criteria published by CL:AIRE. The Soil Generic Assessment Criteria for Human Health Risk Assessment. December 2009.
	Defra Development of Category 4 Screening Levels Main Report and Appendix H
	Generic Assessment Criteria based upon Environment Agency CLEA UK Beta Version 1.0. Environment Agency Toxicological Reports: 1-25.
WATER	Groundwater (Water Framework Directive) Direction 2006
	Water Environment (Water Framework Directive) Regulations 2003
	River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Direction 2010
	UK Environmental Quality Standards for the protection of aquatic life.

Key Guidance	
	EC and UK Drinking Water Standards.
	WHO Drinking Water Standards.
	Background Water Quality.
GAS	CIRIA C748, 'Guidance on the use of plastic membranes as VOC vapour barriers'.
	CIRIA C735, 'Good practice on the testing and verification of protection systems for buildings against hazardous ground gases'.
	BS 8576:2013, 'Guidance on investigations for ground gas – permanent gases and VOCs'
	CIRIA Report C665, 'Assessing Risks Posed by Hazardous Ground Gases to Buildings'
	CIRIA Report C682, 'VOCs Handbook: investigating, assessing and managing risks from inhalation of VOCs at land affected by contamination'
	British Standard BS:8485, 2007, 'Code of practice for the characterization and remediation from ground gas in affected developments'.
	CIRIA Report 150 'Methane Investigation Strategies'.
	BRE 414 'Protective Measures for Housing on Gas Contaminated Land', 2001.
	The Building Regulations 2000, Approved Document C, Section 2. Updated 2004.
	BR211, 'Radon: Guidance on Protective Measures for New Buildings', 2007.
	Health Protection Agency Publication HPA RPD-033, 2007,' Indicative Atlas of Radon in England and Wales.

9.2. Soil

9.2.1. The statistics associated with soil analysis are summarised in Table 9.2. The Mean Value (95%ile) and Maximum Value Tests were undertaken on the sample population for those parameters exceeding the screening levels. If required the Maximum Value Test was undertaken to identify any potential localised areas of increased risk or 'hotspots'. Where the 95%ile exceeds the screening values, these results are highlighted and discussed. The remainder are not considered indicative of significant contamination for the proposed end use.

9.2.2. The statistical assessment has treated the site as a single averaging area and screened in its entirety. The screening exercise below has treated the data as a single data set. This is considered appropriate due to the proposal to include a basement to the west of the site. Detailed plans showing the extent and depth of the basement were not available at the time of writing.

9.2.3. Although a number of soil samples have been tested for VOCs and SVOCs, the samples were obtained at depths of greater than 1m bgl, and therefore have not been included within the soil screening below.

TABLE 9.2: Summary of Soil Analysis

Contaminant	Units	Exceeding	Max	95%ile	Tier 2 Screen
Metals					
Arsenic	mg/kg	0/ 18	53	18.25	640
Cadmium	mg/kg	0/ 18	2.4	0.95	190
Chromium	mg/kg	0/ 18	52	32.62	8600

Contaminant	Units	Exceeding	Max	95%ile	Tier 2 Screen
Copper	mg/kg	0/ 18	25200	3871.57	68000
Inorganic Mercury	mg/kg	0/ 18	1.62	0.85	1100
Nickel	mg/kg	0/ 18	54	28.19	980
Lead	mg/kg	1/ 18	**4710**	192.71	2300 B
Selenium	mg/kg	0/ 18	2	1.31	12000
Vanadium	mg/kg	0/ 4	75	77.11	9000 C
Inorganics					
Cyanide	mg/kg	0/ 18	1	0.93	22.14 C
Organics					
Phenol (Total)	mg/kg	0/ 16	0.3	0.26	440
Benzene	mg/kg	0/ 4	0.01	0.01	27
Toluene	mg/kg	0/ 4	0.01	0.01	56000
Ethylbenzene	mg/kg	0/ 4	0.01	0.01	5700
o - Xylene	mg/kg	0/ 4	0.01	0.01	6600
m & p - Xylene	mg/kg	0/ 4	0.01	0.01	6200
MTBE	mg/kg	0/ 1	0.01	NC	28 E
Hydrocarbons					
TPH >C6-C40	mg/kg	0/ 17	80	22.22	1195
Total Petroleum Hydrocarbons Criteria Working Group					
Aliphatics C5 – C6	mg/kg	0/ 3	<0.1	NC	23[A]
Aliphatics C6 – C8	mg/kg	0/ 3	<0.1	NC	47[A]
Aliphatics C8 – C10	mg/kg	0/ 3	<0.1	NC	11[A]
Aliphatics C10 – C12	mg/kg	0/ 3	<1	NC	53[A]
Aliphatics C12 – C16	mg/kg	0/ 3	<1	NC	237[A]
Aliphatics C16 - C21	mg/kg	0/ 3	<1	NC	17,697[A]
Aliphatics C21 – C35	mg/kg	0/ 3	<1	NC	17,697[A]
Aromatics C5 – C7	mg/kg	0/ 3	<0.1	NC	259[A]
Aromatics C7 – C8	mg/kg	0/ 3	<0.1	NC	607[A]
Aromatics C8 – C10	mg/kg	0/ 3	<0.1	NC	18[A]
Aromatics C10 – C12	mg/kg	0/ 3	<1	NC	93[A]
Aromatics C12 – C16	mg/kg	0/ 3	<1	NC	450[A]
Aromatics C16 – C21	mg/kg	0/ 3	5.2	NC	928[A]
Aromatics C21 – C35	mg/kg	0/ 3	6.9	NC	1328[A]
Speciated Polyaromatic Hydrocarbons					
Naphthalene	mg/kg	0/ 19	0.16	0.08	190
Acenaphthylene	mg/kg	0/ 19	0.25	0.09	83000
Acenaphthene	mg/kg	0/ 19	0.63	0.14	84000
Fluorene	mg/kg	0/ 19	0.13	0.06	63000
Phenanthrene	mg/kg	0/ 19	1	0.34	22000
Anthracene	mg/kg	0/ 19	0.51	0.14	520000
Fluoranthene	mg/kg	0/ 19	1.6	0.45	23000

Contaminant	Units	Exceeding	Max	95%ile	Tier 2 Screen
Pyrene	mg/kg	0/ 19	1.2	0.37	54000
Chrysene	mg/kg	0/ 19	1	0.28	350
Benzo (a) anthracene	mg/kg	0/ 19	0.83	0.23	170
Benzo (b) fluoranthene	mg/kg	0/ 19	0.87	0.27	44
Benzo (k) fluoranthene	mg/kg	0/ 19	0.72	0.21	1200
Benzo (a) pyrene	mg/kg	0/ 19	0.53	0.20	35
Indeno (1,2,3 - cd) pyrene	mg/kg	0/ 19	0.43	0.15	500
Benzo (ghi) perylene	mg/kg	0/ 19	0.45	0.14	3900
Dibenzo (ah) anthracene	mg/kg	0/ 19	0.11	0.05	3.5
Other					
Asbestos	NA	5/21	Detected		

Tier 2 Screening Values based on a residential without plant uptake end use. Assuming 1.0 % SOM. AGAC from CLEA V1.06 at 1.0% SOM. BSGV/GAC based on CLEA UK Beta Version at 3.0% SOM. XOral GAC used, no inhalation GAC derived (inhalation data not available). SSoil Saturation limit used as a cap to GAC due to high value of oral GAC and absence of inhalation GAC (No data available). 1 GAC for aliphatic C8-C10 2 GAC for aliphatic C10-C12. 3GAC for aromatic C21-C35. NA Not Applicable. NC Not Calculated. *Outliers identified using the maximum value test (omitted from the 95th percentile concentration).# 95th percentile recalculated using Chebychev method.

TABLE 9.3: List of exceedances

Contaminant	Location	Depth (m bgl)	Concentration (mg/kg)
Lead	WS102 (BH3)	0.5	4710

9.2.4. Elevated concentrations of lead exceeding the screening criteria occurred only in WS102. The 95%ile did not exceed the screening criteria; therefore it is not considered that lead contamination presents a site wide risk.

9.2.5. Concentrations of other contaminants noted above did not exceed the screening criteria. It should be noted that three volatile organic compound samples were tested on the site for potential ground gas risks and not screened above due to the depth at which they were sampled.

9.3. Water Analyses

9.3.1. Water samples were obtained from only DCS1, OBH2 and WS102.

9.3.2. The results of the groundwater analyses have been compared to the values contained within the references detailed in Table 9.1 for freshwater quality. The statistics associated with groundwater analysis is included in Table 9.4. In addition, VOC concentrations that have been recorded above laboratory detection limits but do not have Tier 2 Screening Values have been listed.

TABLE 9.4: Summary of Water Analysis

Contaminant	Units	Exceeding	Max	50th%	Tier 2 Screen
Metals					
Arsenic	µg/l	0/ 3	1	1.00	50
Boron	µg/l	0/ 3	473	330.00	2000

Contaminant	Units	Exceeding	Max	50th%	Tier 2 Screen
Cadmium	µg/l	1/ 3	**0.3**	0.23	0.25[O,16]
Chromium	µg/l	1/ 3	**15**	**5.67**	4.7[5]
Copper	µg/l	0/ 3	6	4.33	28[O,16]
Inorganic Mercury(4)	µg/l	3/ 3	0.1^	0.1^	0.05 [O,16]
Nickel	µg/l	0/ 3	14	9.33	20 [O,16]
Lead	µg/l	0/ 3	2	1.33	7.2[O,16]
Selenium	µg/l	0/ 3	4	2.33	10[E]
Zinc	µg/l	0/ 3	49	17.67	125[O,16]
Inorganics					
Cyanide	µg/l	0/3	<100^	<100^	1[N]
Organics					
Phenol (Total)	µg/l	0/ 3	<30	<30	7.7[O,16]
TPH <C6 – C40	µg/l	0/ 3	50^	50^	25
Benzene	µg/l	0/ 3	1	1.00	10[O,16]
Toluene	µg/l	0/ 3	2	1.67	50[O,16]
Ethylbenzene	µg/l	0/ 3	1	1.00	20[5]
m & p - Xylene	µg/l	0/ 3	1	1.00	30[O,16]
o - Xylene	µg/l	0/ 3	1	1.00	30[O,16]
Poly-aromatic Hydrocarbons (PAH's)					
Acenaphthylene	µg/l	-	2	1.67	-
Acenaphthene	µg/l	-	2	1.67	-
Anthracene	µg/l	3/ 3	2^	1.67	0.1[11]
Benzo (a) anthracene	µg/l	-	2	1.67	-
Benzo (a) pyrene	µg/l	3/ 3	2^	1.67	0.05[11]
Benzo (b) fluoranthene	µg/l	3/ 3	2^	1.67	0.03[11]
Benzo (ghi) perylene	µg/l	3/ 3	2^	1.67	0.002[11]
Benzo (k) fluoranthene	µg/l	3/ 3	2^	1.67	0.03[11]
Chrysene	µg/l	-	2	1.67	-
Dibenzo (ah) anthracene	µg/l	-	2	1.67	-
Fluorene	µg/l	-	2	1.67	-
Fluoranthene	µg/l	3/ 3	2^	1.67	0.1[O,16]
Indeno (1,2,3 - cd) pyrene	µg/l	3/ 3	2^	1.67	0.002[11]
Naphthalene	µg/l	0/ 3	2^	1.67	2.4[O,16]
Phenanthrene	µg/l	-	2	1.67	-
Pyrene	µg/l	-	2	1.67	-
Volatile Organic Compounds (VOCs)					
1,1,1 - Trichloroethane	µg/l	0/ 3	1	1.00	100
1,1,2 - Trichloroethane	µg/l	0/ 3	15	5.67	400
1,2 - Dichloroethane	µg/l	0/ 3	2	2.00	10
cis 1,2 - Dichloroethene	µg/l	2/ 3	**2299**	**1019.00**	50
Chloroform	µg/l	1/ 3	**31**	11.00	12
Carbon tetrachloride	µg/l	0/ 3	1	1.00	12
Dichloromethane	µg/l	0/ 3	5	5.00	20
Hexachlorobenzene	µg/l	3/ 3	**2**	**1.67**	0.01
Hexachlorobutadiene	µg/l	3/ 3	**1**	**1.00**	0.1
Pentachlorophenol	µg/l	3/ 3	**2**	**1.67**	0.4
Styrene	µg/l	0/ 3	1	1.00	50
Trans - 1,2 - Dichloroethene	µg/l	3/ 3	**18**	**8.33**	0.05
Tetrachloroethene	µg/l	2/ 3	**40**	**18.67**	10
Trichloroethene	µg/l	3/ 3	**2717**	**1225.67**	10
Vinyl chloride	µg/l	3/ 3	**1872**	**628.33**	0.5

Contaminant	Units	Exceeding	Max	50th%	Tier 2 Screen
Di - n - octyl phthalate	µg/l	-	20	16.67	-
Chloromethane	µg/l	-	10	10.00	-
bis (2 - ethylhexyl) phthalate	µg/l	-	4	3.33	-
Bromochloromethane	µg/l	-	5	5.00	-
Bromodichloromethane	µg/l	-	10	10.00	-
1,1 - Dichloroethene	µg/l	-	8	4.00	-
1,2,3 - Trichlorobenzene	µg/l	-	3	3.00	-
1,2,4 - Trichlorobenzene	µg/l	-	3	3.00	-
1,2 - Dibromo - 3 - Chloropropane	µg/l	-	2	2.00	-

Source: Environmental Agency Chemical Standards for Water: 5Council Directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (Dangerous Substances Directive) - List II substances: Council Directive 76/464/EEC. 15WHO Guidelines for Drinking Water Quality. Third Edition (2004). 16Priority Substance Directive 2008, (2008/105/EC). 18 WHO background document for Development of Guidelines for Drinking Water Quality (Odour Threshold). ESurface Waters (Abstraction for Drinking Water) (Classification) Regulations 1996: S.I. 1996/3001. FSurface Waters (Dangerous Substances) (Classification) Regulations 1989: S.I. 1989/2286. GSurface Waters (Dangerous Substances) (Classification) Regulations 1992: S.I. 1992/337. JSurface Waters (Dangerous Substances) (Classification) Regulations 1998: S.I. 1998/389 NWater Supply (Water Quality) Regulations 2000: S.I. 2000/3184, as amended byS.I. 2001/2885. ORiver Basin Districts Typology, Standards and Groundwater threshold values (WFD) (England & Wales) Directions 2010. ***Based on WHO DWS for Aromatic C10-C12. #Based on water hardness and a cyprinid fish.

9.3.3. Slightly elevated concentrations of chromium and cadmium were encountered in shallow soils.

9.3.4. Concentrations of total PAH were not encountered above laboratory detection limits. Elevated concentrations of TPH were also not encountered.

9.3.5. Elevated concentrations of VOCs have been encountered; however considering the absence of receptors near the site, these are not considered significant with regards to risks to controlled waters.

9.4. Ground Gas Assessment

Gas monitoring 2013

9.4.1. During the previous ground investigation works, four monitoring visits were conducted on 13th, 20th, and 29th May and 3rd June 2013 to monitor for hazardous ground gas. An additional visit was made on 13th June to monitor BH2 only. Recorded barometric pressures ranged between 1001mb on 29th May and 1028mb on 3rd June 2013. The installations contain response zones within the strata as indicated in Table 8.1, to reflect general ground conditions across the site.

9.4.2. During the gas monitoring in 2013, there were no elevated readings from BH2, DCS1 or DCS4 where carbon dioxide exceeded 1.5%, methane 1% and/or oxygen fell below 18%.

9.4.3. Nominal VOC concentrations were recorded in DCS1 (0.4ppm) and DCS4 (0.4ppm) during the monitoring visit of 13th May. No visual or olfactory indications of VOC contamination were identified during the 2013 site investigation at these locations.

Gas monitoring 2016

9.4.4. Three monitoring rounds were conducted on 27th April, 13th May and 19th May 2016. The ground gas monitoring included locations progressed in 2013. Passive diffusive tubes were installed into the six installations between the dates of 13th and 19th March. DCS4 was not monitored during the first monitoring round.

9.4.5. Elevated readings where carbon dioxide exceeded 1.5%, methane 1% and/or oxygen fell below 18% are detailed in Table 9.5.

TABLE 9.5: Summary Gas Concentrations and Flow Rates

Borehole	Date	Gas Concentration (%)			Average Flow Rate (l/hr)
		CO2	CH4	O2	
DCS1	27/04/16	4.9	<0.1	8.8	-0.1
OBH2		2.7	<0.1	18.3	-0.1
DCS1	13/05/16	3.7	<0.1	15.8	-0.5
OBH2		5.2	<0.1	15.3	-0.3
DCS1	19/05/16	5.3	0.1	15.0	+0.5
OBH2		5.3	0.1	12.3	+0.4

9.4.6. Based upon the guidance presented in Table 9.1, an assessment has been made of the requirements for gas protection that considers sources of gas generation, gas flows and concentrations, and potential exposure routes. This is summarised below:

- Potential on-site source of generation. Carbon dioxide generation is suggested from areas of Made Ground, particularly the area of 'worked ground' in the west of the site. The previous land use as a 'Heavy Chemicals Warehouse' is considered a likely source of VOCs.
- Potential off-site Source of generation. Any Made Ground and backfilled areas local to the site e.g. 'worked ground' to the west of the site.
- Gas Flows. A maximum flow rate of 0.5 l/hr will be applied during calculation of the GSV.
- Exposure Routes. Gas at the site primarily presents a concern following ingress into confined spaces both during and after construction.

9.4.7. The Gas Screening Value (GSV) has been calculated using the maximum carbon dioxide concentration of 5.3% v/v and a maximum flow rate of 0.5 l/hr. The GSV of 0.0265 l/hr for carbon dioxide indicates that the site is classified as a CIRIA Characteristic 1. Based on information presented herein, gas protection measures are not considered a requirement for protection from bulk gases. The risk from VOCs is assessed separately below.

9.5. Volatile Organic Compounds (VOCs)

9.5.1. Following recommendations detailed within the previous Land Quality Statement (2013), it was recommended that further VOC assessment was undertaken. VOC concentrations recorded using a photo ionisation detector (PID) during monitoring visits are presented in Table 9.6.

TABLE 9.6: PID measurements during monitoring rounds

	PID measurement (ppm)		
Borehole	27/04/16	13/05/16	19/05/16
BH1	241	326	406
BH2	9.0	19.0	12.0
WS102	15.0	28.0	<0.1
DCS1	3.0	5.0	3.0

Borehole	PID measurement (ppm) 27/04/16	13/05/16	19/05/16
OBH2	1.0	3.0	23.0
DCS4	-	<0.1	<0.1

9.5.2. The passive diffusive tubes were attached to the headworks at each installed location in order to characterise the risks to future site users. The tubes were installed for seven days, prior to being and transported to the Gradko UKAS accredited lab. The full results are presented in the Geosphere Factual Report. The analysis conducted was a semi quantitative analysis of the top 15 VOCs present.

9.5.3. The results have been compared against modified health criteria values (HCVs) that have been calculated in accordance with The VOC Handbook, CIRIA C682 (A9.3.2) which presents a methodology for calculating modified HCVs for VOCs. The Tolerable Daily Intake (inhalation) values (taken from The LQM/CIEH S4ULs for Human Health Risk Assessment, 2015) have been converted for the most sensitive receptor (considered to be a seventeen year old female) using the body weight and inhalation value (taken from the EA Technical background to CLEA Model, Science Report Science Report SC050021/SR3).

9.5.4. The most elevated VOC concentrations that were consistently recorded across the site are presented in Table 9.7.

TABLE 9.7: VOC concentrations from passive diffusive tubes (mg/m^3)

VOC	HCV	DCSBH2	DCS1	BH2	BH1	WS102	DCS4
Tetrachloroethene	0.0520	**1.429**	**5.66**	**2.32**	**12.907**	ND	**2.283**
Trichloroethene	0.0027	**0.916**	**1.963**	**5.129**	**10.373**	**4.293**	**2.291**
1,2,4-Trimethylbenzene	0.0095	ND	**0.0177**	**0.31**	**0.272**	**0.3418**	**0.0374**
cis-1,2-Dichloroethylene	0.0006^	**0.10532**	**1.289**	ND	ND	**0.597**	**0.01**
Trans 1,2-Dichloroethylene	0.0006^	**0.0081**	**0.024**	ND	ND	ND	ND
1-ethyl-3-methyl-Benzene,	0.006*	**0.00888**	**0.035**	**0.306**	**0.247**	**0.309**	**0.028**

^ The calculated HCV for these contaminants has used the TDI for 1,2 Dichlorothane

* The calculated HCV for these contaminants has used the TDI for Benzene

9.5.5. The maximum concentrations of Trichloroethene and Tetrachloroethene are three and four orders of magnitude higher than the HCVs. It should be noted that where alternative tolerable daily intake values have been used for to calculate HCVs as an assumed worse case given the absence of contaminant specific values.

9.5.6. The concentrations identified in the passive diffusive tubes are associated with the headspace of borehole installations, which is considered likely to have higher concentrations of VOC vapours due to the existence of a preferential pathway up the standpipe. For the vapours present to reach the receptors within the proposed building, gases must migrate through soils, floor slab, and into the building. It is considered likely that these factors may reduce detected concentrations by several orders of magnitude. A Detailed Quantitative Risk Assessment for vapours (vDQRA) would be required to prove this.

9.5.7. VOC concentrations have been identified in the groundwater present on the site (to the east of the site). The current and future use of the site does not include sources of VOC contamination, therefore the source of VOCs is considered to be residual soil/ groundwater contamination.

9.5.8. A notional risk from VOCs has been identified. A vDQRA is recommended to establish the risk of the identified concentrations considering the effects of vapour migration, building construction and potential source removal.

9.5.9. Should this not be conducted, a VOC barrier membrane should be installed in the structure in accordance with CIRIA C735 and C748.

10.0 GEOTECHNICAL EVALUATION

10.1. Ground Conditions

10.1.1. The ground conditions encountered during the site investigation generally consisted of Made Ground over London Clay. Suspected alluvial deposits were noted within some locations across the site overlying London Clay, however were absent in others. The general distribution of each stratum is shown in Table 10.1.

TABLE 10.1: Soil Profile

Stratum	From (m bgl)	To (m bgl)	Thickness (m)	Description
Made Ground	0.00	1.30 - 5.00	1.30 – 5.00	Highly variable, typically comprising of granular deposits overlying cohesive deposits. Granular deposits typically comprise of brown clayey SAND and GRAVEL. Gravel is angular fine to coarse, brick, flint, concrete, wood, glass and clinker. Sand is fine to coarse. Cohesive deposits are typically dark brown and orange, slightly sandy, slightly gravelly CLAY. Gravel is typically angular to sub-rounded, fine to coarse, flint, brick and charcoal. Sand is fine to coarse
Suspected Alluvium	0.30 - 3.10	1.80	0.70 - 1.80+	Soft to firm, brown and orange brown, mottled gravelly CLAY with subangular rounded flint gravel. Identified as London Clay or Potential Made Ground on Geosphere Ltd logs. Identified during previous ground investigations as Alluvium.
Weathered London Clay	2.00 – 7.50	3.10 – 7.50	0.40 – 2.90	Typically described as firm, brown, grey and orange mottled CLAY.
London Clay	3.10 – 7.50	>25.45	>17.95	Typically described as stiff, dark grey, silty CLAY with occasional fine white fossil fragments and bands of claystone.

10.1.2. The ground model as encountered in Table 10.1 broadly agrees with the conditions anticipated from desk study based research and previous investigations in the locality.

10.2. Made Ground

10.2.1. Made Ground was encountered from surface to depths of between 1.00 and 5.00m bgl. The Made Ground was heterogeneous in nature and comprised both cohesive and granular deposits. Granular Made Ground typically overlies cohesive Made Ground.

10.2.2. Granular deposits typically comprise of brown clayey sand and gravel. Gravel is angular fine to coarse, brick, flint, concrete, wood, glass and clinker. Sand is fine to coarse.

10.2.3. Cohesive deposits are typically dark brown and orange, slightly sandy, slightly gravelly CLAY. Gravel is typically angular to sub-rounded, fine to coarse, flint, brick and charcoal. Sand is fine to coarse.

10.2.4. SPTs were undertaken in Made Ground by the contractor within window sample WS102 only. These recorded uncorrected SPT 'N' values ranging from 0 to 11.

10.2.5. Due to the highly heterogeneous nature of Made Ground deposits characteristic values have not been provided.

10.3. Suspected Alluvium

10.3.1. Brown and orange mottled clay with sub-angular to course flint is recorded on the Geosphere logs as London Clay or Potential Made Ground which is suspected to be alluvium deposited by the former tributary of the River Fleet.

10.3.2. Where encountered, the suspected Alluvium was generally described as very soft grey slightly gravelly sandy organic clay with occasional black organic patches. Natural medium dense brown slightly clayey very sandy gravel was also occasionally encountered during previous investigations which are suspected to relate to flow channels.

10.3.3. The occasional presence of manmade materials in this stratum could be explained by such materials sinking into it.

10.3.4. Two Standard Penetration Tests (SPT) were undertaken in the suspected Alluvium which recorded uncorrected SPT 'N' values in the range of 8 to 11, indicative of a low to medium strength material.

10.3.5. Three SPT tests were undertaken during the previous investigation in the cohesive Alluvium which recorded uncorrected SPT 'N' values in the range of 2 to 3, indicative of a very low strength material. One uncorrected SPT 'N' value of 15 was recorded in the granular Alluvium, suggesting a medium dense state.

10.3.6. Due to the paucity of alluvial deposits encountered and sampled by the site investigation contractor during the recent site investigation, the summary of alluvial deposits provided below is extracted from the CampbellReith report AEDsrm-11167-300415-LQS-F3.

10.3.7. One Particle Size Distribution test was undertaken on a granular sample of the Alluvium using wet sieve analysis and sedimentation by pipette, which indicated clayey silty sandy gravel, which is in agreement with the field description.

10.3.8. One undrained shear strength determination was undertaken on a 100mm diameter on a sample from this stratum using triaxial apparatus which recorded a value of 54kPa, indicating a medium strength material.

10.3.9. Table 10.2 details a summary of soil parameters for the Alluvium.

TABLE 10.2: Summary of Soil Parameters for Suspected Alluvium

Soil Parameters	Range of results	Characteristic value[1]
Liquid Limit (%)	55 – 56	55
Plastic Limit (%)	20 – 22	20
Plasticity Index (%)	34 – 35	35
Modified Plasticity Index (%)[2]	32 – 35	35
Plasticity	CH (High Plasticity)	CH (High Plasticity)
Volume Change Potential (NHBC)	Medium	Medium
Moisture Content (%)	22 – 27	25
SPT ' N' Values	2 – 15	3

Undrained Shear Strength (kN/m^2)	54	40
Density (kN/m^3)	N/A	18

1 Cautious estimate

2 Based on the procedures given in Chapter 4.2 of the NHBC Standards.

10.4. London Clay / Weathered London Clay

10.4.1. The London Clay was described as stiff, becoming very stiff, fissured grey clay with occasional sand size selenite crystals and orange brown silt partings. With depth, the stratum becomes very stiff to hard with rare gravel size pyrite nodules and an absence of selenite.

10.4.2. The London Clay is weathered within its upper horizons to a firm, mottled brown and grey, fissured CLAY.

10.4.3. A 400mm claystone band was encountered within borehole BH02 at between 13.2 to 13.6m bgl. Occasional claystone bands were also occasionally recorded on Geosphere logs, however specific depths to these claystone bands were not presented.

10.4.4. Concretionary limestone nodules were recorded during the previous ground investigation between 1.25 and to 12.45m bgl. These were described as gravel size calcareous concretions nearer to surface, however appeared to be larger in some areas and a single nodule was encountered between 12.30 and 12.45 underlying an area of the Highgate Centre. It is envisaged that these nodules could be present within areas underlying the Greenwood Centre.

10.4.5. The SPT 'N' values and triaxial test results both generally increase with depth and together suggest a relationship of C_u=5xN to be broadly appropriate. On this basis, the SPT and triaxial test data are represented graphically on Figure 4, from which the following C_u profile for the London Clay is derived.

$$C_u = 80 + 7z, \text{ where z is the depth below 6m}$$

10.4.6. Table 10.3 details a summary of soil parameters for the London Clay.

TABLE 10.3: Summary of Soil Parameters London Clay

Soil Parameters	Range of results	Characteristic value[1]
Liquid Limit (%)	65 – 76	74
Plastic Limit (%)	26 – 29	28
Plasticity Index (%)	39 – 47	46
Modified Plasticity Index (%)[2]	39 – 47	46
Plasticity	CH – CV	CV
Volume Change Potential (NHBC)	High	High
Moisture Content (%)	20 – 39	30
SPT ' N' Values	8 – 46	See discussion above
Undrained Shear Strength (kN/m^2)	80 – 349	See discussion above
Density (kN/m^3)	19.6 - .20.5	20

1 Cautious estimate taking into account findings of the previous site investigation.

2 Based on the procedures given in Chapter 4.2 of the NHBC Standards.

10.5. Buried Concrete

10.5.1. Seventeen soil samples, comprising five from the Made Ground, two from the Alluvial deposits, and ten from the London Clay were subjected to pH and water soluble sulphate determinations.

With reference to BRE Digest SD1 (2005 Ed), the results indicate a DS-1 class for the Alluvial deposits DS-2 for the Made Ground and a DS-3 class for London Clay. pH values ranged between 7.9 and 8.3, with a characteristic value of 8.0.

10.5.2. Three samples of Made Ground, two samples of Alluvial deposits and six samples of London Clay were subjected to total sulphur and acid soluble sulphate content testing to allow an assessment to be made in relation to the potential thaumasite form of concrete attack. Numerous oxidisable sulphides values calculated were in excess of 0.3% for the London Clay. This suggests that the London Clay could be associated with a risk from this form of concrete attack. A modification to DS-4 class is therefore currently proposed for the London Clay under certain situations as outlined in BRE Digest SD1.

10.5.3. Three samples of groundwater obtained during the monitoring programme were subjected to sulphate and pH determinations as a part of the environmental analysis. The highest recorded value was 2905 mg/l which suggests, with reference to the BRE Digest a DS-3 classification. Although scheduled, no pH testing was undertaken or presented within the Geosphere Ltd factual report. The highest recorded value encountered as a part of the previous investigation was 3400 mg/l and measured pH values ranged from 6.5 and 7.0, which suggests, with reference to the BRE Digest a DS-4 classification.

11.0 REVISED CONCEPTUAL MODEL

11.1.1. Guidance for contaminated land advocates the assessment of risk by determining the presence of pollutant linkages and weighting the likelihood of harm occurring with the potential severity of that harm. The framework is set out in various publications by the DETR, Environment Agency, Institute for Environment and Health, NHBC and CIRIA.

11.1.2. Tables 7.2 - 7.4 indicate the potential contaminants, pollutant linkages and receptors that have been considered at the site. Following the investigation of these and Generic Quantitative Risk Assessment (for human health, controlled waters and gas) a qualitative risk assessment for each receptor is presented below in Tables 11.1 - 11.5. For the purpose of this assessment, the descriptions of risk presented in Table 7.1 have been used which take into account the magnitude of the source contamination identified, likelihood of exposure via a pathway and significance of harm likely to result on the given receptor.

TABLE 11.1: Groundworkers (Assuming Basic PPE)*

Pathway	Risk	Comment
Ingestion of soil / dust	Low - Medium	Redevelopment or maintainance of the site may involve ground workers coming into contact with the underlying soils and water. Asbestos was identified in a number of samples tested during the ground investigation. The contractor's method statement should consider the associated Health and Safety controls that are appropriate in light of the Control of Asbestos Regulations 2012. Specialist advice should be sought. Normal Health and Safety precautions associated with a site where potential contamination may exist (of the levels identified), are likely to mitigate the general risk. There is a potential risk if previously unforseen contamination is later found to be present.
Inhalation of soil / dust	Low - Medium	
Inhalation of vapour from soil / dust / water	Low - Medium	
Dermal contact with soil / dust / water	Low - Medium	
Migration of soil gases to confined spaces	Low - Medium	
Migration of water borne contaminants	Low - Medium	

* *Separate assessments are required in relation to asbestos risk.*

TABLE 11.2: End Users during Occupation

Pathway	Risk	Comment
Inhalation of dust	Low	Shallow soils have not been found to be significantly contaminated. Bulk gases have not been found to be significantly elevated, however elevated concentrations of VOCs have been identified whereby either vapour DQRA is required, or suitable mitigation measures may be required. Organic resistant pipework may be required for water supply pipes.
Ingestion of soil/dust	Low	
Inhalation of vapour from soil / dust / water	Low	
Dermal contact with soil / dust / water	Low	
Migration of soil gases to confined spaces/structure	Medium (VOC)	
Migration of water borne contaminants	Low	
Leaching of contamination from Made Ground	Low	
Movement of contaminants to engineered structures (e.g. water pipes)	Low – Medium (VOC)	

TABLE 11.3: Controlled Waters

Pathway	Risk	Comment
Migration of water borne contaminants	Low	Elevated concentrations of metals and VOCs have been encountered within the groundwater at the site. However, given the site location on Unproductive Strata and distance to significant surface water receptors, identified concentrations are not considered to pose a significant risk to Controlled Waters.
Leaching of contamination from Made Ground	Low	

Table 11.3: Buildings

Pathway	Risk	Comment
Leaching of contamination from Made Ground	Low	Consideration will be required with respect to potable supply pipework due to the presence of Made Ground which has been shown to contain hydrocarbons (i.e. PAHs). Liaison with the water supply provider will be required to determine if remedial actions are required.
Movement of contaminants to engineered structures (e.g. water pipes)	Low – Medium	
Migration and accumulation of flammable gases beneath the building footprint.	Low - Medium	Methane was not been encountered at the site. However, further ground gas monitoring will be required in order to confirm the conclusions herein.

TABLE 12.5: Offsite Receptors

Pathway	Risk	Comment
Dermal contact with soil / dust / water	Low	Site investigation and subsequent chemical analysis has not identified the presence of gross soil or groundwater contamination that would otherwise be considered to present a risk to off-site receptors. In addition, a continuous groundwater body has not been identified beneath the site that could act as a migration pathway.
Inhalation/ingestion of dust	Low	
Inhalation of vapour from soil / dust / water	Low	
Migration of soil gases to confined spaces/structure	Low	
Movement of contaminants to engineered structures (e.g. water pipes)	Low	

12.0 GEOTECHNICAL CONCLUSIONS AND RECOMMENDATIONS

12.1. Summary

12.1.1. It is proposed to demolish the existing structure on site and construct a new three storey community centre with a single storey basement beneath the north-west part of the building. In part this is to house a hydrotherapy pool. The finished floor level for the pool is anticipated to be in the region of 5.16m bgl and the floor slab to the pool is anticipated to be approximately 600mm thick. Swimming pools are typically sensitive to ground movements and this must be considered in the design of the associated foundations and retaining walls. Redevelopment also includes minor areas of new parking and a green roof space.

12.1.2. Once development proposals are finalised, the conclusions given within this report should be re-assessed to ensure they are still current.

12.1.3. The ground investigation has identified a number of geotechnical risks, which are discussed below, along with outline geotechnical design advice and recommendations for further work.

12.1.4. Further ground investigation may be required, in particular further investigations for neighbouring foundations to establish the impact of basement excavation on neighbouring properties. Once the proposals have been sufficiently developed, the conclusions and recommendations of this report should be reviewed and a Geotechnical Design Report in accordance with Eurocode 7 should be prepared.

12.1.5. The UXO risk is considered to be **LOW**. However, UXO hazards should be included as part of the health and safety briefing and tool box talks during the works, such that if any suspicious articles are found, they can be quickly identified and treated appropriately by specialist inspection.

12.2. Key Considerations

12.2.1. This report has identified the following geotechnical risks at the site:

- Localised areas of highly compressible Alluvium associated with the former tributary of the River Fleet.
- Areas of deep, highly variable Made Ground.
- Potential running sand conditions associated with gravel / sand horizons in both made and natural ground.
- The presence of claystone layers and concretionary limestone nodules within the London clay.
- Medium to high volume change potential soils.
- The potential for shallow groundwater or water bearing strata with a shallow piezometric level.
- The potential for obstructions associated with previous phases of development.
- Ground conditions are aggressive to buried concrete.
- Retaining walls and level changes around the site boundary.

- Adjacent infrastructure and buildings imposing surcharge adjacent to proposed basement.

12.3. Foundations

12.3.1. As described in Section 8, the site is underlain by Made Ground over London Clay. Alluvial Deposits are locally encountered overlying the London Clay. Perched groundwater is present within Made Ground and Alluvium.

12.3.2. Without treatment Made Ground and Alluvial deposits are not considered suitable founding strata due to their high variability and poor load bearing and settlement characteristics. Consequently it is envisaged that a piled foundation will be required.

12.3.3. The development area should be amenable to bored cast in-situ and Continuous Flight Auger (CFA) piles. The advice of a reputable piling specialist, experienced in the ground conditions considered present here, should be sought. They should be responsible for the selection of the appropriate piling equipment and the final design of the piles.

12.3.4. Driven piles are unlikely to be suitable due to the residential setting of the site.

12.3.5. Claystone bands (up to 400mm thick) have been encountered during site investigations. These may cause obstructions to pile bores and may restrict the use of CFA piling methods and potentially sheet piling methods (dependent on depth).

12.3.6. Bored piles would require casing to support the pile bore through the Made Ground and Alluvial deposits. There is also the potential risk to bore pile stability from seepages in the London Clay (seepage is often recorded within claystone bands), which may require the use of a bentonite slurry or other suitable support fluid.

12.3.7. Dependant on construction sequence and development proposals CFA piles would require additional cutting down in the area of the proposed basement, which would not necessarily be the case for bored piles. The length of CFA piles is generally limited to 25m for smaller diameter piles (<400mm) and 30m for larger diameter piles (>600mm), which should be taken into account when determining the number of piles under heavily loaded areas.

12.3.8. As a result of excavation to form the basement, piled foundations may experience tension prior to application of the building loads. The magnitude of the tensile forces thus generated, and associated reinforcement requirements will need to be determined once the sequence of construction has been established. However, immediate and total heave pressures in the region of 52 and 115kPa are anticipated.

12.3.9. Whilst the final design of the piles is the responsibility of the piling contractor, for preliminary guidance purposes, indicative total design resistances for straight shafted bored or CFA piles constructed from existing ground level are given in Table 12.1. These would require consideration against appropriately factored design actions as detailed in EC0 and EC7. Note that piles constructed bearing from basement level will have differing design resistances.

TABLE 12.1: Indicative Total Design Resistances for Bored / CFA Piles

Pile diameter	Total Design Resistance (kN) Pile length		
	15m	**20m**	**25m***
450mm	375	650	950

*Note: 25m CFA piles may not be possible within area of basement if initiated from existing ground level

12.3.10. These estimates are based on the following assumptions:

- Pile design after Eurocodes.
- From 0m to 6m Made Ground - no contribution to design resistance.
- From 6m+ London Clay - Cu profile as defined in Section 11.0 (Cu capped at 250kPa), adhesion factor = 0.5, bearing capacity factor (Nc) = 9, bulk density = 20 kN/m^3.
- Groundwater at 1m bgl.
- Partial factors on actions and 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 (to be confirmed in the GDR in due course).
- The self-weight of the pile and the weight of soil removed/displaced during pile construction approximately cancel each other.
- No working pile tests carried out.
- Pile spacing of at least 3 x pile diameter.

12.3.11. The piling specialist may choose to adopt alternative parameters to those outlined within this report; however, their suitability should be verified by an experienced geotechnical engineer. 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 may enable increased capacities or shorter piles to be adopted. The risk of additional water strikes to those encountered in the investigation cannot be discounted.

12.4. Basement Design

12.4.1. The proposed development includes a single storey basement beneath the northern section of the site.

12.4.2. An open cut excavation is not considered feasible given the restricted working area. As a result, embedded retaining walls in the form of either sheet piles, a reinforced concrete basement constructed using temporary sheet piles, or a secant / contiguous piled wall are required at the proposed development site.

12.4.3. At the time of writing this report, basement levels and development proposals were under development. The current proposal involves a finished basement floor level of circa 3.96m bgl and an underside of slab level of 4.56m bgl. Locally where the swimming pool is proposed the underside of basement slab will extend to a maximum depth of 5.76m. This results in a

maximum permanent retained height of approximately 5.16m below existing ground level. It is currently proposed to construct the basement by utilisation of a load bearing sheet piled wall. Given below are preliminary comments and design guidance.

12.4.4. It is recommended that the retaining walls are designed with close liaison between the designer and Main Contractor with respect to sequencing, propping and tolerable ground movements. The design will need to consider adjacent structures and services, groundwater observations, ground conditions, heave etc and the final depth of the basement. Soil parameters for the long term design of permanent embedded retaining walls are provided in Table 12.2.

TABLE 12.2: Retaining Wall Design Parameters

Stratum	Bulk Density (kN/m^3)	Angle of Internal Friction (critical) φ'_{crit} (deg)	Effective Cohesion c' (kN/m^2)	Undrained Shear Strength (kPa)	Young's Modulus (kN/m^2)
Made Ground	18	28	N/A	N/A	3,000
London Clay Formation	20	20	1.5	$Cu = 80 + 7z^1$	$E'_H = 68,800 + 6,000z^1$

[1] z is the depth below 6.00m bgl.

12.4.5. The effective angle of internal friction (critical), φ'_{crit}, and effective cohesion, c', values for the strata in Table 12.1 have been estimated by reference to BS8002:2015 'Code of Practice for Earth Retaining Structures'. The exceptions to this are the values for the London Clay, which are based on Chandler & Skempton. The horizontal Young's Modulus in the London Clay has been derived from $E'_H=1.23E_{Vu,}$ where $E_{Vu}=700Cu$ which is also based on Chandler & Skempton.

12.4.6. The temporary works engineer will need to consider the variability of the soils and the presence of surrounding infrastructure and hence the need for any support or underpinning. The designer may choose to adopt alternative parameters to those outlined above; however, their suitability should be verified by an experienced geotechnical engineer.

12.4.7. The site is in close proximity to existing structures and infrastructure. Therefore, for any proposed basements, consideration would need to be given to their construction and any resulting ground movements in the surrounding area. This can be assessed by a ground movement assessment. If it is shown that ground movements caused by installation of a sheet pilled wall causes unacceptable damage to adjacent structures, a stiffer contiguous or secant pilled wall will be required.

12.4.8. CIRIA Report C580 suggests that any buildings and infrastructure within a distance of four times the excavation depth could experience ground movements. Therefore for the current scheme this could have an effect up to approximately 20 to 25m away. As a rule of thumb, vertical and horizontal ground movements at the back of low stiffness retaining walls supporting excavations in London Clay are generally 0.35% and 0.40% of the excavation depth respectively, indicating that ground movements at the wall may be in the order of 20 to 25mm, reducing to zero approximately 20 to 25m away from the basement wall. If a high stiffness retaining wall is utilised horizontal and vertical ground movements at the wall may be in the order of 9 to 5mm. Consequently a detailed ground movement assessment is required to assess the degree of propping and stiffness of the retaining wall required and anticipated impact on adjacent structures, foundations and infrastructure.

12.4.9. The retaining structure must be capable of retaining water due to the presence of a groundwater recorded within stand pipe piezometers at a shallow depth during monitoring.

12.4.10. Surcharge loads imposed from the adjacent structures and infrastructure should be considered during design of retaining walls.

12.4.11. Groundwater was not recorded on logs during construction of boreholes, however was monitored at a minimum depth 1.40m bgl. It is therefore likely that localised groundwater is residing at shallow depth in the Made Ground at approximately 1 to 2.50m bgl. For the design of basements and retaining walls, an equilibrium groundwater level of 1.00m bgl is suggested.

12.4.12. As the site is in the London Borough of Camden, a Basement Impact Assessment was required. This was previously undertaken and submitted, however development proposals have altered since submission. At the time of writing this report discussions were being undertaken with the London Borough of Camden in regard to any additional requirements. It will also be necessary for the design and construction of basement to comply with the Party Wall Act.

12.5. Basement Slabs

12.5.1. The basement slab will need to be designed to withstand heave pressures and stress relief in the underlying London Clay caused by excavation of the basement. Based on an underside of basement slab of 4.56m bgl and the basement founded in the London Clay, it is anticipated that average long term heave pressures will be in the order of 41kN/m^2, assuming half of the heave occurs prior to casting the basement slab. Heave pressures will be locally greater where either overlying natural ground is of a greater height (i.e. in north eastern section) or where excavations are deeper (e.g swimming pool). Based on a proposed underside of basement slab of 5.76m bgl, the maximum long term heave pressure exerted on the basement slab will be in the order of 52kN/m^2.

12.5.2. Consequently it will be necessary to design the basement slab for effects of heave, and it will likely be necessary to utilise heave protective measures. The degree of heave could be assessed in more detail by a detailed ground movement assessment.

12.5.3. The design of the basement slab should also consider appropriate hydrostatic pressures. London Clay is relatively impermeable; however, construction methodology will likely create permeable pathways. It is anticipated that maximum hydrostatic pressure on the basement slab will be approximately 55kN/m^2.

12.5.4. Floor slabs shall also be designed in accordance with BS8012 'Protection of structures against water from the ground' which requires that consideration is given to the highest likely water table that may occur during the life time of the building.

12.6. Ground Floor slabs

12.6.1. Due to the thickness of Made Ground and Alluvial deposits, suspended ground floor slabs are recommended. However, should ground treatment be adopted, ground bearing floor slabs could be considered.

12.6.2. In the region of any existing or proposed trees, Chapter 4.2 of the NHBC Standards should be referred to with respect to the minimum void dimension required under floor slabs for medium to high volume change potential soils.

12.7. Road Pavements

12.7.1. With reference to TRL Report 1132, the Atterberg Limit tests on cohesive samples of Made Ground indicate a CBR value of 3% may be appropriate for preliminary design. To achieve this value it is recommended that the road formation level is proof rolled, inspected and any soft or loose material is removed and replaced with compacted granular fill. The CBR value provided above assumes a thin road pavement, high water table and average construction conditions. The CBR value could be refined by further testing.

12.7.2. A flexible road pavement construction is recommended due to the high volume change potential soils at the site. Geogrids may be required to control settlements in Made Ground.

12.8. Buried Concrete

12.8.1. In the consideration of sulphate attack on buried concrete, reference has been made to BRE Special Digest 1 which classifies the site as a brownfield site with mobile groundwater conditions. Additionally, as the London Clay can be pyrite bearing, it has also been necessary to assess the potential for the thaumasite form of attack. The results of the concrete classification tests to date have indicated a DS-4 classification, which together with the pH values, indicates that an ACEC AC-4 class should be adopted.

12.9. Drainage

12.9.1. The ground conditions render the use of soakaway drainage unfeasible.

12.9.2. In the region of trees, Chapter 4.2 of the NHBC Standards should be referred to with respect to the minimum potential ground movements to be accommodated for new drainage, based on medium to high volume change potential soils.

12.10. General Construction Advice

12.10.1. It should be possible to use conventional excavators to form excavations in the soils encountered during the investigation. However, hard surfacing, old foundations, relict basement construction and the like, may require the use of breaking apparatus.

12.10.2. For any load bearing formations, careful inspection should be undertaken to ensure placement in competent natural strata unless ground treatment has been carried out and properly validated. Any soft spots identified should be excavated and replaced with compacted granular fill or lean mix concrete. Concrete should be placed as soon as possible following excavation to avoid softening of the ground. A similar recommendation is also made for road pavement formations, although compacted granular fill could be used instead of concrete.

12.10.3. 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. Such fill should be placed and compacted to an engineering specification, unless treatment by vibro stone or vibro concrete columns is to be adopted. The

same recommendations are made for excavations that may be required to remove soil contamination.

12.10.4. In areas of road pavements and hard standing, relic subterranean structures should be broken down to around 1.0m 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.

12.10.5. In excavations, the stability of the Made Ground and Alluvial deposits cannot be relied upon, even in the short term. Support or battering of any 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.

12.10.6. It is anticipated that groundwater seepages encountered at shallower depths in excavations could be controlled by pumping from screened sumps.

12.11. Recommendations for Further Work

12.11.1. Outline geotechnical design recommendations are given above. However, there are a number of potential geotechnical risks which require further investigation and analysis to facilitate detailed design. Further investigation should comprise:

- Potential excavation of Foundation inspection pits to establish the footings of surrounding structures. Alternatively a worst case design scenario could be utilised.
- Consideration of the possible effect of the proposed basement on surrounding structures and infrastructure. This should be summarised within a Ground Movement Assessment.
- A review of findings provided within this report once development proposals and proposed levels are finalised.
- A review of requirements of Camden Borough Council with respect to the previously submitted BIA.

13.0 ENVIRONMENTAL CONCLUSIONS AND RECOMMENDATIONS

13.1.1. The site is considered to lie in area of Low environmental sensitivity, and the land use is also low sensitivity as a community centre with very minimal soft landscaping.

13.2. Overview of Key Issues

13.2.1. Desk study and subsequent site investigation and chemical analysis has identified the following key contamination issues at the site:

- Soils: Elevated concentrations of lead have been encountered in the shallow Made Ground soils in isolated areas on the site.
- Groundwater: Elevated concentrations of metals and VOCs have been encountered in the groundwater beneath the site. Given the site location on Unproductive Strata and distance to significant surface water receptors, these are not considered to pose a risk to Controlled Waters. However, further consideration will be required with respect to: health and safety during construction for buildings, structures and human health.
- Ground gas: The site is classified as a CIRIA Characteristic Situation 1 with respect to bulk gases. However the measured concentrations of a number of VOCs exceeded the toxicity screening.

13.2.2. A number of actions will be required to address land contamination issues at the site and these are described below. These relate to:

- Remedial Recommendations and Options Appraisal
- Remediation and Verification Control Documents
- Regulatory approval
- Waste Management

13.3. Outline Remedial Recommendations

13.3.1. The following section details outline remedial recommendations. These should be considered in light of the recommendations for any further works presented above which could lead to their modification. Detailed remedial works should be confirmed on completion of the additional ground investigation and risk assessment works and finalised in a Groundworks / Remediation Specification.

13.4. End Users

13.4.1. The qualitative assessment generally identified a **LOW** risk posed by contamination identified on site. This is principally related to the low level of exposure by which the receptor would be exposed to contamination on site.

13.4.2. If any excavations are generated on site which require filling with material sourced from an off-site location, these should be backfilled with imported chemically validated soils and in accordance with the appropriate Remediation and/or Groundworks Specification compiled by the Engineer.

13.4.3. Imported or site won materials used for soft landscaped areas will require provision for testing in accordance with the Remediation Specification, compliance with an agreed set of limiting values will be required. Records as detailed within the Remediation Specification should be maintained to certify the source, chemical suitability and appropriate placement of the soils.

13.5. Construction Workers

13.5.1. The qualitative assessment identified a **LOW-MODERATE** risk to construction workers who may come into contact with contaminated soils and waters, although are they likely to be exposed in the short-term only. The Site Health and Safety Plan should consider worker protection from skin contact, ingestion and inhalation of contaminants and vapours, working in confined spaces below ground and follow guidance for working on sites affected by contamination.

13.5.2. It is noted that asbestos in soils has been identified in 5 of 21 samples. Whilst the information collected does not indicate its widespread occurrence it should be considered as a possibility in the Made Ground and the contractor's method statement should consider the associated Health and Safety controls that are appropriate in light of the Control of Asbestos Regulations 2012. Specialist advice should be sought in this regard. Type II Asbestos Surveys are available for the buildings, which should be reviewed as necessary, together with surveys of any other on site buildings prior to demolition.

13.5.3. In order to achieve satisfactory control, CampbellReith recommend that Health and Safety provisions in accordance with HSE Publication HS (G) 66 and CIRIA Report 132 are considered. The Contractor must also control matters such as any contracted CDM responsibilities.

13.6. Controlled Waters

13.6.1. The qualitative assessment identified a potentially **LOW** risk for surface waters and groundwater due to the distance to the nearest surface water receptor and the presence of Unproductive Strata beneath the site.

13.6.2. Taking into account the above information remedial works are not required for controlled waters.

13.7. Ground Gas

13.7.1. The ground gas risk assessment for bulk gases indicates that the site can be classified as a CIRIA Characteristic Situation 1 whereby gas protection measures are not considered necessary for bulk gasses.

13.7.2. Elevated VOC concentrations have been identified during monitoring and are associated with VOCs in groundwater and made ground on site.

13.7.3. Modified Health Criteria Values (calculated using CIRIA C682) indicate a number of exceedances of preliminary risk assessment values that consider inhalation risk to human receptors. As such a notional risk is present.

13.7.4. A supplementary detailed calculation should be made to establish the implications of these concentrations considering the vapour migration pathways and form of building structure.

Should this not be completed, a VOC barrier membrane should be installed and verified across the footprint of the building in accordance with CIRIA 735 and 748.

13.7.5. CIRIA C682 and C716 detail the process of determining appropriate mitigation and measures may include source reduction/ removal, prevention of exposure pathways and receptor management.

13.7.6. Considering the building footprint covers the bulk of the site, and observed VOC concentrations are reasonably consistent across the site, receptor management is not considered a viable option.

13.7.7. Visual and olfactory observations of volatiles in soils were encountered in FIP 2 and BH1 in the north west of the site, and WS102 in the south of the site. The proposed development includes a basement swimming pool in the north west of the site, which is highly likely to remove a volume of source material in this area.

13.7.8. When designing gas protection measures, off site receptors should be considered, especially those in Deane House, where installation of a VOC barrier gas membrane across the Greenwood Centre building may increase the gas concentrations below the bordering building.

13.8. Services

13.8.1. The presence of TPH and PAH concentrations in the soil and localised occurrence of VOCs in water indicate a possible need for protection of public water supply pipework, such as the use of organic resistant pipework. The infrastructure designer should assess requirements for pipework with respect to soil contamination and consult statutory utility companies and relevant guidance as necessary. Guidance on this topic is presented in UKWIR Report 'Publication UKWIR Report Ref 10/WM/03/21: Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites - Final Project Report'.

13.9. Remediation and Verification Control Documents

13.9.1. Following on from the recommendations made herein, in order to control the environmental works on site and the collection of records required for the Verification Report, a Remediation/ Groundworks Specification will be required. The Specification should detail necessary requirements for inspections, record keeping, and actions for unforeseen contamination and detail the requirements for the control of imported material and waste management.

13.9.2. The specification will require submission to the Local Authority for review and approval as part of the planning process, to fulfil the requirements of the anticipated land quality planning condition. Additional discussions may be required with the NHBC and/or Building Control; such matters are not detailed herein. Once approved it will be the Contractor's obligation to fulfil the agreed requirements of the Specification.

13.9.3. Whilst not anticipated from the work to date, should the groundworks encounter fuel tanks, removal of any such features is required in accordance with an appropriate tank removal specification and Contractor's method statements which meet the requirements of the appropriate Environment Agency Pollution Prevention Guidelines (PPG).

13.9.4. It will be the Contractor's responsibility to collate the records as detailed within the specifications for submission to the Engineer for inclusion with the Site Verification Report on

the completion of works. The Verification Report will be required for submission to the Regulators via the planning process for discharge of the anticipated land contamination planning condition.

13.10. Regulatory Approval

13.10.1. In order to fulfil requirements of Planning Policy it is likely that this document will require submission and approval by the Regulatory Authorities (Local Authority and Environment Agency). As such this document should be submitted as part of the planning process and discussion held with the Regulators as to 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.

13.10.2. Failure to submit the required documentation could result in refusal to discharge associated land quality planning conditions.

13.11. Waste Management

13.11.1. A hazardous properties assessment of waste soils has not been undertaken as part of this report and is recommended as a basement is proposed for the site. The soil results can however be utilised as a basis for such assessments, however additional testing may be required.

13.11.2. All waste related activities must be undertaken in accordance with the Waste Management and Landfill Regulations. Any proposed reuse of materials must be in accordance with the Waste (England and Wales) Regulations 2011. With respect to waste soils disposal, as a minimum, the following information should be collected and retained by the Contractor for subsequent validation:

- source and origin of the waste;
- information on the process producing the waste;
- European Waste Catalogue code and characteristics of material;
- for hazardous waste, definition of the relevant properties according to the Hazardous Waste Directive (Annex III 91/689/EC);
- confirmation that waste is not prohibited waste;
- appearance of the waste;
- landfill class; and,
- Duty of Care records including full and completed chain of custody documentation.

13.11.3. The final waste classification is the responsibility of the Contractor and should be determined in conjunction with the receiving landfill and in liaison with the Environment Agency (and their technical guidance). It is noted that, depending on the landfill selected, additional soils testing information and independent verification of the materials of the materials being received by the landfill may be required.

13.11.4. As the correct classification of waste is likely to have a significant impact on the redevelopment budget, the waste classification should be reviewed independently by a consultant at an early stage in the project management stage. In addition, contractors should be asked to confirm that their tenders consider the full requirements of the Landfill Directive and associated waste legislation. This is to ensure waste is correctly classified and costed at the inception of the project.

13.11.5. The Landfill Directive states that all hazardous and non-hazardous waste requires treatment prior to disposal to landfill. Treatment must provide a 'three – point step'. As such, provision for treating (including physical separation) should be made for all arisings that are likely to be classified as hazardous or non-hazardous so that each of the above three requirements are met.

13.11.6. A separate assessment should be made for the rate of Landfill Tax (where applicable) in accordance with HMRC Excise Notice LFT1.

TECHNICAL REFERENCES

Ref.	Title	Type
1	Sheet 256 North London, Geological Survey of England and Wales 1:50,000	Geological Map
2	EMapSite GroundSure, EnviroInsight, GeoInsight and MapInsight report packages Ref: EMS-184935_271161 dated 8th November 2012	GroundSure Report
3	Environment Agency Website (http://www.environment-agency.gov.uk)	Website
4	Barton N. J., The Lost Rivers of London: A Study of Their Effects Upon London and Londoners, and the Effects of London and Londoners on Them, 3rd Edition, 7th December 1992	Publication
5	The Engineering Implications of Rising Groundwater Levels in the Deep Aquifer Beneath London.	CIRIA Special Publication 69
6	Building Research Establishment (BRE) Special Digest (SD) 1, Concrete in Aggressive Ground, 3rd Edition, 2005	BRE Publication
7	Radon: Guidance on Protection Measures for New Dwellings. 2007.	BRE Publication BR211
8	HPA NRPB R290. Radon Atlas of England. 2002.	NRPB Radon Atlas
9	CIRIA C681 – Unexploded Ordnance (UXO): A Guide for the Construction Industry	Publication
10	London County Council Bomb Damage Maps, London Topographical Survey, 2005.	Publication
11	London County Council Main Drainage Map 2: Main, Intercepting, Storm Relief, and Outfall Sewers. Pumping Stations and Outfall Works. November 1930.	Drainage Map
12	MAGIC Website [www.magic.gov.uk]	MAGIC 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. The most recent and significant revision was in July 2008, with the withdrawal of guidance documents CLR7 to 10, which previously underpinned the CLEA Framework. 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. More recent revisions have been made in September 2009 to CLEA V1.05 and October 2009 to CLEA 1.06 risk assessment software.

In the absence of a comprehensive list of SGVs, CampbellReith have generated Generic Assessment Criteria (GAC) utilising CLEA 1.06 and the associated software. Contaminant specific toxicological data for GACs has been obtained from Environment Agency and DEFRA toxicological reports where available, or secondary 'authoritative literature references (as detailed in Appendix A of SR2).

In the case of lead, the absence of a Regulator endorsed toxicological endpoint from which to derive a Health Criteria Value makes the derivation of a GAC problematic. However, GACs have been produced based on a Tolerable Daily Intake value of 3.6 ug/kg/bw/day which has been extrapolated from JECFA's (Joint FAO/WHO Expert Committee on Food Additives) provisional tolerable weekly intake of 25 ug/kg which studies indicated would lead to a blood lead concentration of 5.7 ug/dL for a 10kg child, which has been assumed as being below the level generally associated with effects on intellectual performance.. This is considered a suitable course of action until further guidance is published.

The GACs within the CL:AIRE Publication 'The Soil Generic Assessment Criteria for Human Health Risk Assessment', December 2009 have been applied where CLEA compliant CampbellReith GACs are not available.

Where CLEA compliant SGVs or GAC are not available reference may also be made to GAC derived using the CLEA UK model (beta version) or other values. These are currently used for cyanide. Where referred to, the non-compliant standing of these values is considered.
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Selection of Appropriate [Tier 2] Soil Screening Values

The CLEA model is based upon defined exposure scenarios and three generic land uses are defined within the model. 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 or without plant uptake).**

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.

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[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.

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)[2].

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]

[2] 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.

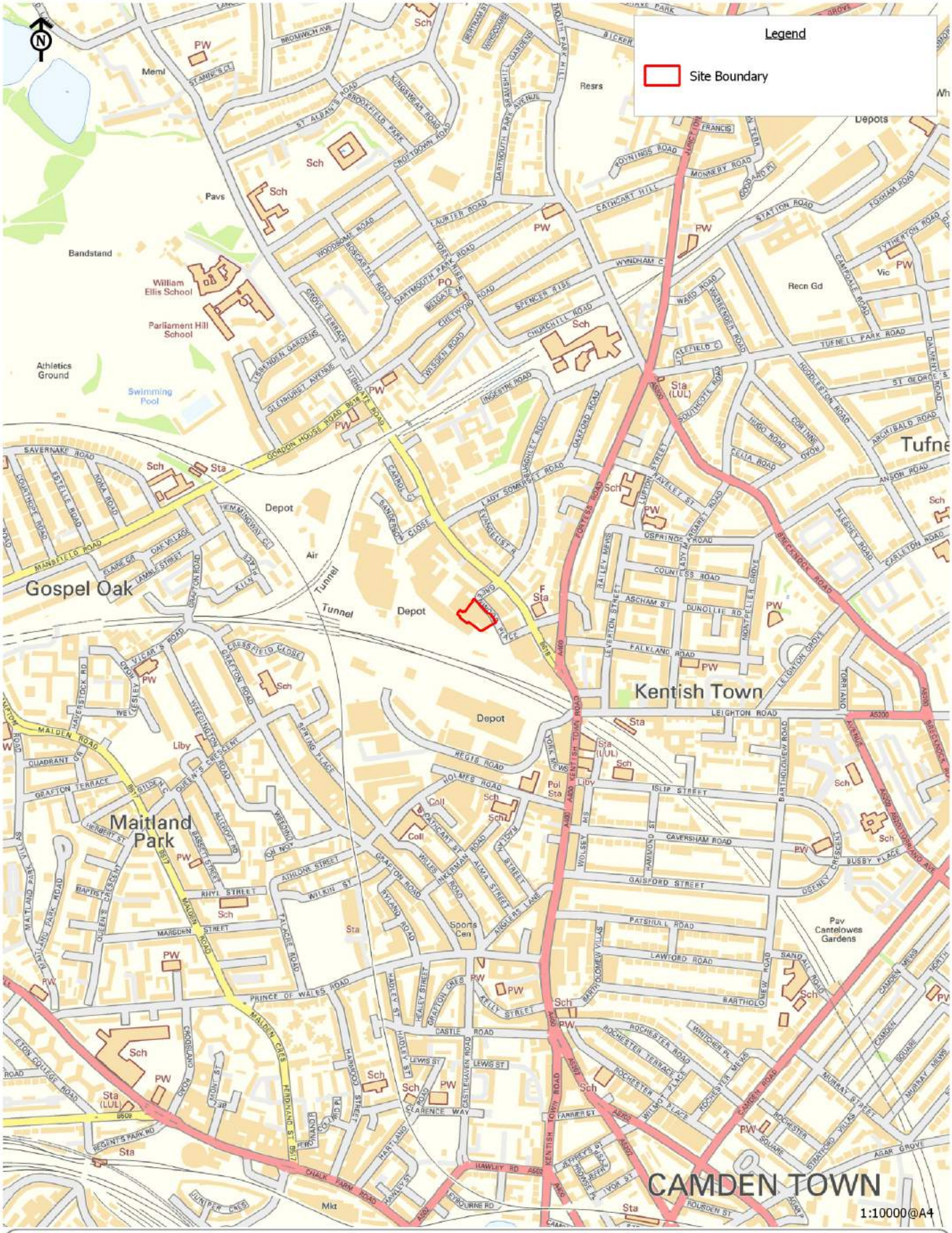
No potential risk
There is no potential risk if no pollution linkage has been established.

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



Greenwood Place

Client: Greenwood Place, Camden

Figure 1:
Site Location

Scale: 1:10000@A4
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Job Number: 12291
Drawn by - Checked by: RC - JHC
Drg No - Status/Revision: GIS002 - A
File location: N:\12250 - 12274\12291 R - The Greenwood Centre\Project_Workspaces (pdf in Outputs)
Date (Revision History): 07/01-2015 (A, First Issue, 07/01/15, RC)

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Legend

Site Boundary

Historic Exploratory Hole Location

Borehole

Window Sample

Exploratory Hole Location, 2016

Borehole with Monitoring Well

Dynamic Cone Pentrometer

Foundation Inspection Pit

Foundation Inspection Pit and Hand Auger

Window Sample

Window Sample and Dynamic Probe with Monitoring Well

Exploratory hole positions are approximate as surveying of positions was not undertaken as per Geosphere Environmental Ltd drawing 1665, GI - 002 / Rev 0 (Jun 2016)

DCS1
M BH02
FIP1
M BH01
FIP2 + HA1
FIP3
FIP4
WS101
M WS102
CBR4
BH2
DCS4
CBR3
Community Centre
HALL
PROJECT "MAIL OUT"
ZEN ROOM
ART ROOM
ARCHIVE
STORE
TV ROOM
OFFICE
DAY CENTRE
TABLE TENNIS ROOM
PLAY ROOM
CAFETERIA
KITCHEN
W.C.
TRAINING ROOM
BEDROOM
ELECTRONICS
RECEPTION
FORMER HOSTEL
FEMALE TOILET
LAUNDRY
SUB STATION
MAIL OUT
SWITCH ROOM
COUNCIL BOILER ROOMS
GREENWOOD PLACE

1:2500@A3

0 5 10 15 20 m

1:250@A3

Greenwood Place

Client: Greenwood Place, Camden

Figure 2:
Exploratory Hole Location Plan

Scale:	1:250@A3, Insert@1:2500
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Existing Layout plan provided by PCK Architects, drawing number PL 150 (Feb 2013)	
Job Number:	12219
Drawn by - Checked by:	RP - DM
Drg No - Status/Revision:	GIS004 - B
File location:	N:\12250 - 12274\12291 R - The Greenwood Centre\Project_Workspaces (pdf in Outputs)
Date (Revision History):	05/07/2016 (A, First Issue, 27/06/15, RC; B, Updated SI Locations, 05/07/16, RP)

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Legend

Site Boundary

Exploratory Hole Location, 2016

Borehole with Monitoring Well

Dynamic Cone Pentrometer

Foundation Inspection Pit

Foundation Inspection Pit and Hand Auger

Window Sample

Window Sample and Dynamic Probe with Monitoring Well

Historic Exploratory Hole Location

Borehole

Window Sample

DCS1

5 - 6 mbgl - 'Moderate suspected volatile odour with depth'

WS101

M BH02

FIP1

5 mbgl - 'Suspected volatile odour'

M BH01

FIP2 + HA1

1.4 - 1.5 mbgl - 'Moderate natural organic odour'

FIP3

FIP4

M WS102

CBR4

BH2

CBR2

DCS4

CBR3

Community Centre

CAFETERIA

KITCHEN

TRAINING ROOM

PLAY ROOM

HALL

PROJECT "MAIL OUT"

ZEN ROOM

ART ROOM

ARCHIVE

STORE

TABLE TENNIS ROOM

TV ROOM

OFFICE

DAY CENTRE

BEDROOM

ELECTRONICS

RECEPTION

FORMER HOSTEL

FEMALE TOILET

LAUNDRY

SUB STATION

COUNCIL BOILER ROOMS

MAIL OUT

SWITCH ROOM

W.C.

1:2500@A3

0 5 10 15 20 m

1:250@A3

Greenwood Place

Client: Greenwood Place, Camden

Figure 3:
Visual and Olfactory Observations of VOC contamination

Scale:	1:250@A3, Insert@1:2500
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Date (Revision History):	28/06/2016 (A, First Issue, 28/06/15, RC)

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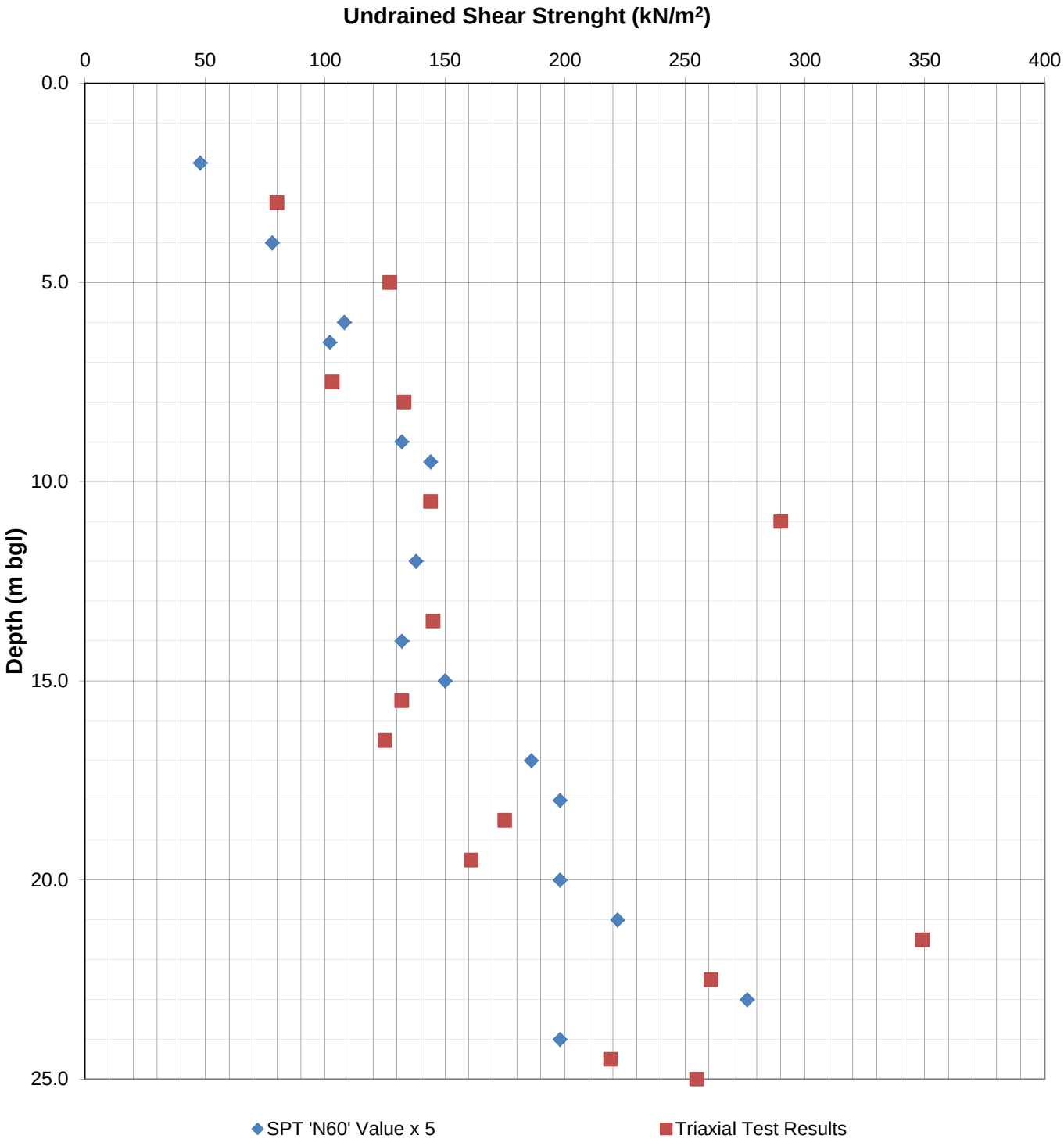
Undrained Shear Strength Vs Depth

Client	**Keir**	**Job No.**	**12991**
Site	**Greenwood place**	**Date Drawn**	**20/06/2016**



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Rev.	A	3

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SYMBOLS KEY:

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- Altro Whiterock / Dulux Trade Paint (Whiterock 560-1430mm from ffl)
- Altro Whiterock (Full height)
- Domus Tilling (Primary tile)
- Domus Tile (Feature Tile)
- Exposed Brickwork
- Existing Brickwork
- Fairfaced Blockwork

NOTES:

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ARCHITECTS INTERIOR DESIGNERS
MASTER PLANNERS URBAN DESIGNERS

CLIENT: Kier Group

PROJECT: Greenwood Centre

DRAWING TITLE: Ground Floor Wall Finishes Layout

STATUS: COMMENT

SCALE	1:100@A1 1:200@A3	DRAWN BY	JF
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DRAWING NO.	1213_WD345	REVISION	/

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- Existing Brickwork
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CLIENT: Kier Group

PROJECT: Greenwood Centre

DRAWING TITLE: First Floor Wall Finishes Layout

STATUS: COMMENT

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- Exposed Brickwork
- Existing Brickwork
- Fairfaced Blockwork

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CLIENT: Kier Group

PROJECT: Greenwood Centre

DRAWING TITLE: Second Floor Flooring Layout

STATUS: COMMENT

SCALE	1:100@A1 1:200@A3	DRAWN BY	JF
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DRAWING NO.	1213_WD347	REVISION	/