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SITE INVESTIGATION REPORT

72-76 EVERSHOLT STREET

LONDON NW1

Report Reference No. C11881

On behalf of:-

Nekton Investments Limited
Regent House
72-76 Eversholt Street
London
NW1 1BY

October 2009

NEKTON INVESTMENTS LIMITED

***ADS* CONSULTANCY**

CONSULTING STRUCTURAL ENGINEERS

REPORT ON A SITE INVESTIGATION

AT

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INTRODUCTION

Nekton Investments Limited, the client, intends to add a five-storey extension, including a basement, to Nos.72-76 Eversholt Street, London NW1.

Details of the proposed building loads were not finalised at the time of report preparation but the extension was expected to consist of a steel frame with concrete foundations from basement level. It is understood that anticipated column loads are expected to be in the order of 600kN.

Ground Engineering Limited was instructed by the client to carry out a site investigation comprising a desk study into the former uses of the site and a ground investigation under the direction of Consultant Structural Engineers, *ADS* Consultancy. The ground investigation was to determine the nature and geotechnical properties of the underlying soils in relation to the foundation design and construction of the extension. In addition, a contamination assessment was to be included within the scope of this investigation.

LOCATION, TOPOGRAPHY AND GEOLOGY OF THE SITE

Eversholt Street (A4200) runs south-east to north-west from the A501, Euston Road, along the north-eastern side of Euston mainline railway station within the London Borough of Camden, London NW1. Nos.72-76 Eversholt Street is a single block called Regent House, which is located on the north-eastern side of the street, some 300m north of the Euston Road and immediately to the north of the junction of Eversholt Street with Drummond Crescent. The site is centred at National Grid Reference TQ 2959 8286.

At the time of the investigation the approximately square 15m wide site was mainly occupied by a five-storey brick building, which was in use at ground and basement levels as offices, and as residences on the upper floors. The rearward, eastern half of the plot was occupied by a single-storey office building and a small concrete-surfaced courtyard. An approximately 2.75m deep basement was present beneath Regent House and the adjoining single-storey structure, which is to be replaced by the new extension.

The site was bounded to the west and south by the Eversholt Street and Drummond Crescent footpaths; to the north by shops and a church; and to the east by a Police Garage, which ran along the northern side of Drummond Crescent.

The site and immediate area was devoid of vegetation.

Eversholt Street stands at an approximate elevation of 21mOD on ground that slopes down gently towards the east.

The 1935 geological map for the area at 1:10,560 scale is based on the 1920 Ordnance Survey London Sheet V NW and shows the site to be directly underlain by the solid geology of the London Clay.

A well record on this map about 250m south of the site details the following sequence:

Made ground – 0m to 2.4m below ground level (bgl)

London Clay – 2.4m to 16.7m bgl

Reading Beds – 16.7m+ bgl

The 2006 geological map for the area at 1:50,000 scale, Sheet 256, also shows the site to be underlain by the solid geology of the London Clay Formation but at the northern end of an area of 'worked ground' on the eastern flank of Euston railway station.

Previous ground investigations by Ground Engineering within 250m of the site have confirmed between 2m and 4m of made ground mantling the solid geology London Clay and the underlying strata of the Lambeth Group (formerly Woolwich and Reading Beds) at about 18m below ground level.

HISTORY OF THE SITE

Historical maps dating between 1813 and the present day have been reviewed as part of this desk study. Selected map sheets are reproduced in Appendix 1 with relevant descriptions given below.

Richard Horwood's Plan of London was published in 1813 (Figure A) and shows the site within an area of open ground at the northern end of Margarets (now Eversholt) Street, which had been set out but was only developed as far north as Drummond Street. The ground to the north-east and immediate north-west of the site was developed with terraced dwellings lining the southern side of Charles Street and Clarendon Square, respectively. The land to the west was marked as Pond Field and the enclosed St. James's Chapel Burying Ground.

Greenwood's 'Map of London' was published in 1827 (Figure B) and has the present day road network in place with Drummond Crescent depicted with dwellings along its northern side and buildings detailed within the site fronting onto the renamed Seymour (now Eversholt) Street. Opposite the site, to the west, a short road called Duke Street extended into the former Pond Field, which remained open ground at this date.

Stanford's 'Library Map of London and its Suburbs' was published in 1862 and shows the site in little detail (Figure C). This map does show the Euston mainline railway station, which had opened in 1837 and greatly expanded during the 1840s, to the west of Seymour Street occupying most of the former Pond Field. The surrounding area was almost entirely developed by the time of this survey.

The 1st Edition Ordnance Survey (O.S.) map for the area was published in 1870 at the 1:2500 scale (London Sheet XXV). This shows (Figure D) the present day site to be occupied by a row of three buildings facing Seymour Street with rear yards and outbuildings. The adjacent sites to the east and north were occupied by terraced dwellings and their rear gardens. On the western side of Seymour Street the former buildings had been cleared back to Euston Station to make space for additional platforms.

The 1894-96, 2nd Edition O.S. map (Figure E) for the area (London Sheet IL) at the same scale as the 1st, has the site and most of the surrounding area unchanged from 1870. The exception was the enlargement of Euston railway station so that it extended up to the Seymour Street frontage opposite the site. To the north of the site Clarendon Square had been redeveloped.

The 1916, 3rd Edition O.S. map (London Sheet V.5), shows the site unchanged (Figure F) from the previous survey.

The 1939-45 Bomb Damage Map (Figure G) shows the site to have been affected by general blast damage but the adjacent sites to the north and east had been more severely affected. This map details the removal of the terraced housing along the eastern half of Drummond Crescent and its replacement by a single garage building. Similarly, former closely packed terraced housing to the south of Drummond Crescent had been replaced by residential blocks.

The 1951 edition of the 1:10,560 scale map TQ 28 SE (Figure H) shows the buildings to the immediate north of the site to have been removed, presumably the result of World War II bomb damage, and the apparent replacement of all of the terraced dwellings to the east of the site and their replacement with a single structure. The site is shown to be occupied with buildings but it is unclear (due to the scale) whether or not these were the same as those detailed on Figure G. Seymour Street had been renamed as Eversholt Street by this date.

The 1953 edition of the 1:1250 scale map TQ 2982 NE (Figure I) has the site depicted as Regent House for the first time and the adjacent site to the east to be a large garage building, which extended along the whole of the northern side of Drummond Crescent. The ground immediately to the north of the site was vacant but the Prince Arthur public house, Nos.80 and 82 Eversholt Street, remained.

The 1957, 1:10,560 scale map for the area, sheet TQ 28 SE (Figure J) has the site unchanged, as does the 1968 revision of this map (Figure K). The latter map does show the partial clearance of the buildings in front of Euston railway station, which itself was demolished and rebuilt during the 1960s. The replacement station was opened in 1968.

On the 1970 edition of the 1:2500 scale sheet TQ 2982 (Figure L) the site is unchanged; the garage site to the east is denoted as a Vehicle Depot; the site to the north has been redeveloped as St. Aloysius R. C. Church and apparently extends around the Prince Arthur public house through to Phoenix Road; the rebuilt railway station is depicted, and several new residential blocks had been constructed adjacent Eversholt Street to the north and south of the site.

The 1974, 1:10,000 scale map for the area, sheet TQ 28 SE (Figure M) has the site as it was in 1970, as does the 1991 revision (Figure N) of the same map.

The undated location map included on page 2 of the Environmental Searches report presented in Appendix 2 shows the site as it was at the time of this investigation in 2009 and unchanged from the 1990s.

In summary, the site was first developed between 1813 and 1827 when a row of three adjoining buildings with rear yards and outbuildings were built adjacent what was later called Eversholt Street. These buildings remained until shortly after the Second World War when they were replaced by the five-storey block, Regent House, and its rearward single-storey extension.

ENVIRONMENTAL SEARCHES

Appendix 2 contains information derived from Environmental Databases for a radius of up to 250m from the site. The information contained includes data sets held by Landmark Information Group and contributors include the Environment Agency, Local Authority, British Geological Survey, Ordnance Survey, English Nature and the Coal Authority.

The results obtained are presented in summary form together with a detailed search on selected areas of enquiry based on the summary details.

Current Land Use

The following is a brief summary of the main points for the current land use:

Landfill Survey: There are no (0) recorded current or former landfills licensed, by the Environment Agency under Part II of the Environmental Protection Act 1990, on site or within 250m of the site.

Waste Treatment, Transfer and Disposal: There are no (0) recorded sites licensed by the Environment Agency under Part II of the Environmental Protection Act 1990, to transfer, dispose and treat controlled waste within 250m of the site.

Statutory Authorisations

Local Authority Pollution Prevention and Controls: There are no (0) recorded authorisations on this site, by the Environment Agency under Part I of the Environmental Protection Act 1990, subjecting a site to Local Authority pollution prevention and controls. There are three (3) authorisations within 250m of the site, two (2) of which are for dry cleaners and the other is for a car rental company.

Contaminated Land Register Entries & Notices: There are no (0) entries or notices on the Contaminated Land Register recorded on, or within 250m of, the site.

Keeping of Radioactive Substances: There are no (0) recorded sites registered by the Environment Agency under the Radioactive Substances Act 1993, to keep or use radioactive materials on, or within 250m of, the site.

Discharge Consents

Discharges to Water: There are no (0) recorded consents issued by the Environment Agency to discharge water to water courses within 250m of the site.

Water Industry Act Referrals: There are no (0) recorded referrals under the Water Industry Act within 250m of the site.

Industrial Processes

IPC Regulations: There are no (0) recorded sites authorised by the Environment Agency, under Part I of the Environmental Protection Act 1990, to carry out processes subject to Integrated Pollution Control (IPC) or Integrated Pollution Prevention and Control (IPPC) within 250m of the site. Nor are there any recorded IPC Registered Waste Sites.

Storage of Hazardous Substances

Control of Major Accidents: There are no (0) recorded sites regulated by the Health and Safety Executive, under the Control of Major Accident Hazards (COMAH) regulations 1999, within 250m of the site.

Explosives Sites: There are no (0) recorded explosives sites within 250m of the site.

Storage of Dangerous Substances: There are no (0) recorded sites regulated, by the Health and Safety Executive for storing specific dangerous substances under the NIHHS regulations 1982, within 250m of the site.

Storage of Hazardous Substances: There are no (0) recorded sites subject to hazardous substances consents granted, by the relevant local authority under the Planning (Hazardous Substances) Act 1990, within 250m of the site.

Contraventions

Local Authority Pollution Prevention & Control Enforcements: There are no (0) recorded enforcements by the Local Authority under Part I of the Environmental Protection Act 1990.

Enforcement and Prohibition Notices: There are no (0) recorded enforcements and prohibition notices issued by the Environment Agency under Part I of the Environmental Protection Act 1990.

Pollution Incidents to Controlled Water: There are no (0) recorded incidents on or within 250m of the site.

Prosecutions: There are no (0) recorded prosecutions by the Environment Agency under Part I of the Environmental Protection Act 1990 relating to either authorised processes or controlled waters, on or within 250m of the site.

Potentially Contaminative Uses

Contemporary: There is one (1) recorded potentially contaminative use listed for the site address, an inactive scaffolding company, and fourteen (14) within 250m of the site. The latter are primarily associated with the nearby railway station but also include dry cleaners, a printers and a builder's merchants.

Fuel Station Entries: There are no (0) recorded fuel station sites on, or within 250m of, the site.

Miscellaneous

Mineral Sites: There are no (0) recorded mineral sites on the British Geological Survey database within 250m of the site.

Historical Land Use

The following is a brief summary of the main points for the historical land use:

Potentially Contaminative Uses

Historical Tanks and Energy Facilities: There are no (0) recorded historical tanks and energy uses listed for the site address. There are twelve (12) entries recorded for a number of potential tanks and electricity sub-stations within 250m of the site, the most notable of which is for (presumably fuel) tanks within the adjacent Vehicle Depot (Police Garage) to the immediate east of the site.

Past Land Use: There are no (0) recorded historical potentially contaminative uses listed for the site address and two (2) listed within 250m of the site. The latter are both related to railways.

Potentially Infilled Land

Former Marshes: There are no (0) recorded former marshes within 250m of the site.

Potentially Infilled Land: There are no (0) areas of potentially infilled land recorded within 250m of the site.

Site Sensitivity

The following is a brief summary of the main points for the sensitivity section:

Pathways

Groundwater Vulnerability: The site is designated as being underlain by a Non-Aquifer of negligible permeability.

Drift Deposits: The site is recorded as not being covered by drift deposits.

Flood Risk: The site is reported as not being within an area where flooding from rivers or sea occurs, and consequently is not within an area that benefits from flood defences.

Environmentally Sensitive Receptors

None of the information relating to the various environmental settings listed in the database indicates that the site lies within 250m of a sensitive area.

Nearest Surface Water Feature: There are no recorded surface water features within 250m of the site.

Abstraction Licences: There are no (0) recorded groundwater abstraction licences issued, by the Environment Agency in accordance with the Water Resources Act 1991, within 250m of the site.

Other Factors

The following is a brief summary of the main points for the other factors section:

Brine Compensation Area: The site is not within a Brine Compensation Area.

Coal Mining: The site is not within a coal mining area.

Radon Affected Area: The site lies within an area where less than 1% of homes are above the BRE action level for radon.

Radon Protection Measures: The site lies within an area where no radon protection measures are required for new dwellings in accordance with BR211.

Natural Subsidence Risk: According to the British Geological Survey the on-site risk due to the natural subsidence hazard of Shrinking or Swelling Clay Ground is rated as moderate; the risk of Landslides is rated as very low; whilst Running Sand, Collapsible Ground, Compressible Ground. Ground Dissolution, Shallow Mining and are recorded as 'No Hazard'.

PRELIMINARY RISK ASSESSMENT

In order to assess the risks associated with the presence of ground contamination the linkages between the sources and potential receptors to contamination need to be established and evaluated. This is in accordance with the Environmental Protection Act 1990, which provides a statutory definition of Contaminated Land. To fall within this definition it is necessary that, as a result of the condition of the land, substances may be present on or under the land such that

- *Significant harm is being caused or there is a significant possibility of such harm being caused; or*
- *Pollution of controlled waters is being, or is likely to be, caused*

There are three principal factors that are assessed whilst undertaking a qualitative risk assessment for any site. These are the presence of a contamination source, the existence of migration pathways and the presence of a sensitive target(s). It should be noted that it is necessary for each element of source, pathway and target to be present in order for exposure of a human or environmental receptor to occur.

UK Government guidance on the assessment of contaminated land, requires risk to human health and the environment to be reviewed using source – pathway – target relationships. If each of these elements is present, the linkage provides a potential risk to the identified targets. ***Contaminants or potential pollutants*** identified as ***sources*** in relation to the identified previous uses are listed below in Table 1.

Table 1: Identified Potential Contaminant Sources

Contaminant Source	*Comments*
Drainage	Effluent from existing drains could provide a contaminant source.
Soil Beneath Site	Contamination may be present within made ground beneath the site.
Soil Gas	Potential soil gas generated from made ground or underlying natural strata.
Ground Contamination Outside Site Boundary	Ground contamination migrating from adjoining sites.

A ***Pathway*** is defined as one or more routes through which a receptor is being, or could be, exposed to, or affected by, a given contaminant.

Potential ***Target or Receptors*** fall within the categories of Human Health, Water Environment, Flora and Fauna, and Building Materials.

There are a number of possible pathways for the contaminants identified on the site to impact human and/or environmental receptors and these are summarised in Tables 2 and 3.

Table 2: Human Receptors and Pathways

Human Receptor-Mechanism	*Typical Exposure Pathway*
Human Inhalation	Breathing Dust and Fumes Breathing Gas emissions
Human Ingestion	Eating -contaminated soil, for example by small children -plants grown on contaminated soil Ingesting dust or soil on fruit or vegetables Drinking contaminated water
Human Contact	Direct skin contact with contamination Direct skin contact with contaminated liquids

Table 3: Water Receptors and Pathways

Receptor-Water Environment	*Typical Exposure Pathway*
Groundwater The site is underlain by a Non-Aquifer.	Surface infiltration of atmospheric waters into the soils beneath the site could wash or dissolve potential contaminants and migrate to underlying groundwater. Contamination leads to restriction/prevention of use as a resource, for example, drinking water, and can have secondary impacts on other resources, which depend on it.
Surface Water There are no surface water features within 250m of the site.	Surface infiltration of atmospheric waters into the soils beneath the site could wash or dissolve potential contaminants and laterally migrate. Contamination leads to a restriction/prevention of use: -as drinking water resource -for amenity use Effects on aquatic life

Preliminary Conceptual Model

Assessment of the potential linkage between ground contamination sources, human and environmental receptors have been assessed based on the desk study research documented in the preceding sections of this report.

A generalised preliminary conceptual model relative to the construction phase and completed development is presented below in Table 4.

Table 4: Preliminary Conceptual Model Relative to Construction/Future Use of Site

Receptors	Pathway	Estimated Potential for Linkage with Contaminant Sources			
		Drainage	Soil Beneath Site	Soil Gas	Ground Contamination Outside Site Boundary
Human Health – ground workers	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Low likelihood	Low likelihood	Low likelihood	Unlikely
Human Health – users of completed development	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Unlikely	Unlikely	Low likelihood	Unlikely
Water Environment	Migration through ground into surface water or groundwater	Low likelihood	Low likelihood	Unlikely	Low likelihood
Flora and Fauna	Vegetation on site growing on contaminated soil	Low likelihood	Low likelihood	Unlikely	Low likelihood
Building Materials	Contact with contaminated soil	Low likelihood	Low likelihood	Unlikely	Low likelihood

Key to Table 4

Estimated Potential for Linkage with Contaminant Source	Definition
High likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	There is a pollution 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.
Low likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such an event would take place, and is less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.
N/A	Not Applicable

SITE WORK

A single window sample borehole and five trial pits were scheduled to be undertaken on this site at the positions requested by the Engineer. In light of on-site conditions two of these excavations were not undertaken due to time constraints.

Window Sample Borehole

The 10.00m deep window sample borehole (WS 1) was undertaken on 1st September 2009. The borehole position was within the basement and was chosen following a CAT scan. A hole was initially cored through the concrete floor slab using diamond drilling techniques.

The window sampling equipment consisted of 1.00m long drive-in samplers of specially constructed and strengthened 87mm to 47mm diameter steel sample tubes with a plastic core-liner. The samplers were driven into the ground from the base of the cored hole by an automatic trip hammer weighing 63.50kg falling freely through 750mm. Upon extraction a continuous profile of the soil was obtained in the plastic liners inserted in the samplers.

Standard penetration tests were undertaken in the window sample borehole at 1.00m intervals in order to give an indication of the in-situ relative density/shear strength of the material The test was made by driving a split spoon sampler 50mm diameter and 35mm bore into the soil at the base of the borehole by means of an automatic trip hammer weighing 63.50kg falling freely through 750mm. The penetration resistance was determined as the number of blows required to drive the tool the final 300mm of a total penetration of 450mm into the soil ahead of the borehole.

No recovery was achieved from the sampler driven into the base of the borehole from 9.00m to 10.00m below basement floor level. In order to assess the apparent soil cohesion of the soils at 10.00m depth a solid cone point of 50mm diameter was driven to 10.00m after which a standard penetration test was undertaken.

On completion of WS 1, a 50mm diameter plastic standpipe was installed to 7.00m depth. The annulus around the standpipe was backfilled with pea gravel with a bentonite seal placed around the top of the installation within 1.00m of ground level. A gas tap was installed in the top of this standpipe. A protective steel stopcock cover was concreted into the ground flush with the surface over the installation.

The borehole record gives the descriptions and depths of the various strata encountered, results of the in-situ tests, details of all samples taken and the groundwater conditions observed during boring, on completion and subsequently in the WS 1 standpipe.

Trial Pits

Three hand dug trial pits (TPs 1 to 3) were also excavated within the existing basement on 1st September 2009 at the positions depicted on the site plan at the rear of this report. These pits were broken through the concrete floor slab using hydraulic and electric breakers, excavated using hand tools to uncover foundations, and then extended using hand auger tools. The pits were completed at 1.40m (TP 2) and 1.60m (TPs 1 and 3) depth. As a result of the time taken to penetrate the surface layer of concrete, which was locally 0.55m thick, it was not possible to undertake the two other scheduled trial pits. The exposed strata were logged and sampled by a Geotechnical Engineer.

Four additional pits (TPs 4 to 7) were subsequently excavated by the client and have been recorded separately by the Engineer. One of these excavations (TP 4) was re-excavated by the client to expose the column's foundation after which a Geotechnical Engineer attended site on 6th October 2009 and extended the pit using hand auger equipment. This extended pit was abandoned at 2.40m below basement floor level on a concretionary limestone obstruction.

Small disturbed samples of soil were taken at regular intervals throughout the trial pits and placed in polycarbonate pots pending chemical testing.

In the extended TP 4 an immediate assessment of the apparent soil cohesion was made using a Pilcon hand shear vane. The average of three readings was recorded at each position

The trial pit records give the descriptions and depths of the various strata encountered, details of all samples taken, results of the in-situ tests and the groundwater conditions observed during excavation. Sketch sections and plans of the foundations exposed are detailed on the pages after the relevant pit records. Following completion, the trial pits were backfilled in compacted layers with the excavated spoil.

Monitoring

Return visits were made to site during October 2009 in order to monitor methane, carbon dioxide and oxygen gas levels in the WS 1 standpipe. Ambient pressures and flow rates were recorded together with the depth to groundwater. The latter has been added to the borehole record, whilst the gas/groundwater results are presented in Appendix 3.

LABORATORY TESTING

The samples were inspected in the laboratory and assessments of the soil characteristics have been taken into account during preparation of the exploratory hole records. The plastic liners recovered from the window sample borehole were logged and sub-sampled in the laboratory by a Geotechnical Engineer. The soil sample descriptions are in accordance with BS5930:1999.

The chemical testing schedule was devised by Ground Engineering for a broad suite of potential contaminants, based on the known former site uses, and current commercial (offices) use.

The geotechnical test results are presented following the exploratory hole records, whilst the results of the chemical tests are presented in Appendix 4.

Geotechnical Testing

The index properties of a selected soil sample were determined as a guide to soil classification and behaviour. The liquid limit was determined by the cone penetrometer method.

Test specimens were prepared at full diameter from selected undisturbed samples removed from the liners. Immediate undrained triaxial compression tests were made on each sample at full diameter at a cell pressure approximately equivalent to the overburden pressure for that sample's depth. The moisture content and bulk densities of the specimens were also determined. A hand vane test was undertaken on one of the prepared samples, which was not suitable for triaxial testing. Additional hand vane tests were also carried out within the window sample liners.

An indication of the settlement characteristics of a selected sample of clay was obtained from tests in the consolidation apparatus or oedometer. These tests were performed on a 75mm diameter sample, about 19mm thick, contained in a steel ring. The sample was saturated and the swelling pressure balanced prior to applying a constant load with drainage at both ends.

When primary compression was complete, the load was increased and this repeated for three increments of load. The sample was then unloaded in equal stages. The rate and total amount of consolidation were continually monitored using a computer controlled E.L.E. Datasystem 7 Unit. The results were plotted and analysed by the computer for each increment of load to obtain the coefficients of compressibility (m_v), and of consolidation (c_v), which govern the amount and rate of settlement, respectively.

Selected samples of soil were analysed to determine the concentration of soluble sulphates. The pH values were also determined using an electrometric method.

Chemical Testing

Four soil samples recovered from the exploratory holes were tested for total concentrations of arsenic, cadmium, chromium, lead, mercury, selenium, nickel and benzo[a]pyrene (the CLEA suite), together with speciated polyaromatic hydrocarbons (PAH), boron, copper and zinc, phenols, total and free cyanide, hexavalent chromium, sulphate, sulphide and pH. The soil samples were also tested for organic content.

A single sample of slightly organic clay from TP 1 was also tested for total petroleum hydrocarbons (TPH).

GROUND CONDITIONS

The ground conditions encountered were broadly as expected from the geological records and site history with the site covered by a variable thickness of made ground associated with the construction of the existing building and its basement. Beneath this made ground some of the exploratory holes encountered a soft slightly organic Pond Deposit. Firm London Clay was found beneath the made ground or Pond Deposit, and became stiff with increasing depth. This stratum was found to at least 9.00m below basement floor level.

Made Ground

The surface layer at the five exploratory holes of this investigation consisted of a 0.25m to 0.38m thick concrete basement floor slab. This floor was a composite slab consisting of a 0.10m or 0.15m thick surface layer of concrete screed on a plastic membrane, which covered a 0.05m thick layer of polystyrene insulation and then a second layer of concrete. The base of the floor slab was generally at 0.25m to 0.38m below basement floor level, but locally in TP 2 increased to a depth of 0.55m.

In WS 1 and TP 1, the floor slab had been cast on a sand and gravel sub-base layer of concrete, brick and flint. This sub-base was 0.07m and 0.25m thick, respectively.

Beneath these surface layers the borehole and trial pits encountered a soft or firm brown and grey mottled slightly sandy, slightly gravelly clay with a gravel fraction of brick, flint and concrete. This clay fill was proved to 0.70m below floor level in WS 1 but adjacent the foundations in the trial pits it was proved to 0.80m (TP 3) and 1.20m (TPs 1, 2 and 4).

Below these depths in the borehole and TPs 1, 3 and 4 this clay fill covered a firm, locally stiff (TP 4) or soft, brown and orange brown mottled slightly sandy clay with occasional black carbonaceous traces. In TP 1 this clay contained occasional gravel size calcareous concretions but in TP 4 rare brick and ash fragments were recorded within it. This 'older' clay fill was absent in TP 2 and proved to depths between 1.00m and 1.50m below floor level in the other exploratory holes.

The base of the made ground was proved at a depth of 1.20m in TP 2.

Pond Deposit

In TPs 1, 3 and 4 the made ground covered a soft brown, grey and grey green mottled slightly organic clay with rare angular flint gravel and, in TP 4, occasional black carbonaceous traces. Trial pits TP 1 and 3 were completed in this Pond Deposit, which was found to be 0.70m thick and proved to 2.20m below floor level in TP 4. These organic sediments were not encountered within WS 1 and TP 2, beneath the southern part of the extension footprint.

London Clay

The solid geology of the London Clay was encountered at 1.00m (WS 1) and 1.20m (TP 2) beneath the southern part of the site and at 2.20m (TP 4) near its centre. This stratum was initially weathered to firm brown, orange brown and grey mottled clay with occasional silt partings, and was found to at least the base of TP 2 at 1.40m depth and TP 4 at 2.40m below floor level. The latter was abandoned on a cobble size nodule of concretionary limestone. In the borehole this weathered horizon was closely fissured and also contained a concretionary limestone nodule at its base at 3.00m depth.

Below 3.00m in the borehole the London Clay continued as stiff, closely fissured, grey brown clay. A thin band of concretionary limestone was present within this stratum at 4.10m and a medium gravel size pyrite nodule was noted at 5.20m. The borehole was completed in London Clay at 9.00m and the driven cone point (SPT(C)) from that depth appeared to remain within stiff to very stiff clay to at least 10.45m below floor level, approximately 13.20m below ground level.

Groundwater

The five relatively shallow foundation inspection pits were dry throughout excavation and on completion.

Water was met in WS 1 as a seepage within the London Clay at 3.00m depth, associated with the concretionary limestone nodule, and again at 7.00m below basement floor level. On completion a water level was recorded at 8.78m depth, just above the base of the 9.00m deep borehole.

Excavation Stability

The sides of the trial pits were reported to be stable during excavation.

Evidence of Contamination

Based on inspection the made ground contained occasional fragments of brick, concrete and, in TP 4, ash. No visual or olfactory evidence of hydrocarbon contamination was detected in the samples recovered by this investigation.

Existing Foundations

The foundations to the columns against which the trial pits were excavated were found to be concrete pad foundations 0.40m to 0.82m thick, which were based at 1.20m (TPs 1 and 2) and about 0.80m (TPs 3 and 4) below basement floor level. These bases were founded on clay fill (TPs 1, 3 and 4) or weathered London Clay (TP 2). Trial pit TP 4 also uncovered a concrete strip footing, which was based on clay fill at 0.60m depth. This 0.15m thick footing projected 0.30m from the wall that it supported.

In light of the casting of most of these foundations on clay fill a check was made to establish whether or not these pads were indeed pile caps. A 1m long metal pin was driven horizontally beneath the exposed foundation in TP 4 and piles were not encountered at this position.

COMMENTS ON THE GROUND CONDITIONS IN RELATION TO FOUNDATION DESIGN AND CONSTRUCTION

The investigation found a cover of made ground beneath the basement floor associated with the construction of the existing structure, which was underlain locally initially by an organic Pond Deposit and partly by the firm solid geology of the London Clay. New foundations will need to be taken down through the organic soft clay whilst the initially mediocre bearing properties of the London Clay would require large bases to support the proposed column loads. The London Clay became stiff with increasing depth and would provide a suitable stratum into which piled foundations could be installed.

It would appear that some of the foundations of the existing single and five-storey structures have been constructed on made ground that was locally underlain by soft organic clays. The building was constructed approximately sixty years ago and does not appear to have suffered damage due to excessive total or differential settlement, although this is likely to be a function of the rigidity of the concrete and steel structure and the reduction in overburden pressure resulting from the construction of the 2.75m deep basement.

Foundation Depths

The exploratory holes entered natural ground at 1.00m to 1.50m below basement level, 3.75m to 4.25m below ground level across this small site.

Large scale processes of natural sedimentation allow a certain degree of confidence to be placed in the absence of important variation of the engineering properties of natural soils across sites. By contrast, made ground, whose history is not completely known, must, despite any amount of investigation, inevitably present the possibility of conditions existing which could not be accepted when considering the material as a bearing stratum.

The existing foundations and hence building loads are, in some part, currently placed on the made ground and although these loads have been applied for many years there could still be the potential for increased settlement if additional loads were placed upon them.

The made ground was locally underlain by a soft, slightly organic Pond Deposit. This clay has poor bearing properties and would be expected to be of high compressibility, so it should not be considered a suitable bearing stratum to support the proposed extension.

The underlying London Clay was found to have a modified plasticity index of 43% and so is rated as having a high moisture and volume change potential. In open ground, well away from trees, a minimum foundation depth of 1.00m below finished or existing ground level would be required. This minimum depth requirement would be more than exceeded as the new foundations are to be constructed from basement level.

Bearing Capacity

The results of the in-situ penetration and laboratory triaxial compression strength tests indicate that a maximum safe bearing capacity on the firm London Clay of only $85kN/m^2$ could be applied on square pad foundations at 1.00m below basement level. This value incorporates a factor of safety of 3.0 against general shear failure.

At that depth and using this value a column load of 600kN would need a 2.65m wide square pad foundation to support it. Deeper square foundations could be slightly smaller as the maximum safe bearing capacity at 2.00m below basement floor level would be $135kN/m^2$, with the same factor of safety, and so the 600kN column load could be supported on a 2.10m wide square base.

Consolidation settlement of such bases would be in the order of 15mm to 20mm but would take perhaps one year to be 90% complete. Such movement would be differential to the existing structure.

Such large foundations are unlikely to practical within this small site, particularly when constructed within the existing basement, and so a piled foundation scheme is likely to be adopted.

Excavations

The base of foundation excavations should be inspected on completion to ensure that the condition of the soil complies with that assumed in design. Should pockets of inferior material be present, they should be removed and replaced with well graded hardcore or lean mix concrete The excavated surface should be protected from deterioration and a blinding layer of concrete used where foundations are not completed without delay.

Water was met within the London Clay at 3.00m below basement level but a standing water level was subsequently recorded in the standpipe at about 1.65m below the basement floor. Water 'perched' within the overlying made ground may well be encountered during the winter months or following periods of heavy rainfall, but was not recorded during this investigation. In the clay soils encountered water should be dealt with by pumping from sumps.

Safety precautions will be necessary where personnel are to enter excavations, when the sides should be closely supported. The stability of the made ground and natural soils should not be relied upon even in the short term.

Piled Foundations

In the event that piled foundations are preferred, the ground conditions are considered suitable for bored or CFA, but not driven piles as the vibrations during installation of driven piles could damage the adjacent structures. The advice of specialist piling contractors should be sought as to their preferred method of pile installation in these conditions on this restricted site.

Preliminary working loads for a single bored pile may be estimated for design and cost purposes using pile bearing coefficients, which are based on the following assumptions.

1) The ultimate load on a pile would be the sum of the side friction/adhesion acting on the pile shaft together with the end bearing load.

2) The pile bearing properties within the made ground and Pond Deposit are ignored.

3) In the London Clay the shaft adhesion and end bearing would be a function of the apparent cohesion values obtained from the triaxial compression tests and derived from the standard penetration tests.

4) A factor of safety of at least 2.0 would be used to assess pile working loads. If test loading of selected piles were not practical the factor of safety would be increased to at least 2.5.

Item	**Ultimate Pile Bearing Value kN/m^2**
Shaft adhesion/friction in ground to 2m below basement level (bbl)	Nil
Average shaft adhesion in London Clay, 2m to 4m bbl	35
Average shaft adhesion in London Clay, 4m to 9m bbl	50
Average shaft adhesion in London Clay below 9m bbl	75
End bearing in London Clay at 8m bbl	950
End bearing in London Clay at 10m bbl	1350

Using these coefficients it is estimated that a single 450mm diameter bored pile installed to 10m depth would have an anticipated working load of 310kN, with a factor of safety of 2.5, so a capped pair of such piles would be necessary to support the envisaged column load of 600kN. Increasing the pile diameter to 600mm would increase the available working load to 450kN for a 10m long pile with the same factor of safety.

Different pile lengths, or diameters, from those detailed above would give different available working loads, which could be tailored to suit the working loads required. Piles taken down below 10m would be below the depth of information obtained by this investigation, which was limited by the size of drilling rig that could access the site/basement. Based on previous experience close to this site very stiff London Clay would be expected to continue to about 15m below basement floor level and then very stiff and hard clays of the Lambeth Group could be encountered.

If the determined pile bearing properties of the London Clay below 9m are assumed to prevail to 15m below basement level then a single 13m long bored pile at 600mm diameter would be expected to have a working load of 600kN. In order for a single 450mm diameter pile to have a 600kN working load it would need to be taken to perhaps 17m below basement level and so would be likely to be based in the underlying very stiff/hard clays of the Lambeth Group. Although such strata would have favourable pile bearing properties there would be a risk that these strata included water-bearing layers of sand, which could then require a bored pile to be cased through such layers, with resulting additional cost to the client. Casing would not be required should a continuous flight auger (CFA) method of pile installation be feasible on this site.

A piling specialist should undertake final design of piles.

Basement

It is understood that the existing basement is to be maintained at its current depth beneath the extension. The existing basement floor slab would appear to be of a more than adequate composite construction for use within the redevelopment.

Buried Concrete

Sulphate analysis of the soil samples tested gave results in Design Sulphate Classes DS-1, DS-2 and DS-3 of the BRE Special Digest 1, Table C2 (2005) presented in Appendix 5. The pH results were between 7.6 and 11.4 and so mildly alkaline to alkaline.

Using the worst-case DS-3 soluble sulphate results and the recorded pH values an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-3 would be considered appropriate for buried concrete on this site, as detailed in the above cited BRE document.

COMMENTS ON THE CHEMICAL TEST RESULTS

The results of the laboratory chemical testing from the investigation have been compared to CLEA Soil Screening Values (SSV) which have been used as screening tools for use in the assessment of land affected by contamination.

CLEA Soil Screening Values based on CLEA model v1.04 (SSV)

Atkins Limited have derived ATRISKsoil SSVs based on the 2009 new guidance (SC050021/SR3 (the CLEA Report) and SC050021/SR2 (the TOX report)) for residential with plant uptake, residential without plant uptake and park land uses. They have based these on the default assumptions provided in the CLEA report which, it is understood, will be used in development of future Soil Guideline Values by DEFRA and the Environment Agency. Atkins SSVs for 6% soil organic matter (SOM) have been derived using CLEA model v1.04. These are provided under licence to Ground Engineering Limited, and respective toxicology reports and technical details on the derivation of the SSVs can be provided on request.

Soil Assessment

The following standard land uses form the basis of the assessment in relation to soils:

- Residential uses with and without plant uptake, representative of most sensitive land usage such as private and communal gardens.
- Commercial and industrial usage representative of buildings and areas covered by hardstanding, representative of commercial/industrial usage.

The intended purpose of the SSV is as "intervention values" in the regulatory framework for assessment of human health risks in relation to land use. These values are not binding standards, but are intended to inform judgements about the need for action to ensure that a new use of land does not pose any unacceptable risks to the health of the intended users.

In summary Table 5 compares the test results with the SSVs in relation to the specified usage. The numbers of test results, which exceed these values, are also provided.

Table 5: Comparison of Chemical Test Results with SSVs

Determinand	Number of Samples	Min Value (mg/kg)	Max Value (mg/kg)	Number of Samples Exceeding Soil Screening Criteria SSV			Measured 95th Percentile (mg/kg)	Soil Screening Criteria SSV			
				Residential with plant uptake	Residential without plant uptake	Commercial/ Industrial		Assessment Method	Residential with plant uptake (mg/kg)	Residential without plant uptake (mg/kg)	Commercial /Industrial (mg/kg)
Arsenic	4	11	18	0	0	0	18.76	SSV	32	32	640
Cadmium	4	0.10	0.34	0	0	0	0.33	SSV	8	30	294
Chromium	4	24	45	4	2	0	48.64	SSV	14	38	330
Lead	4	51	640	1	1	0	669.92	SSV	322	444	6830
Mercury	4	0.13	6.10	0	0	0	5.67	SSV	11	14	410
Selenium	4	<0.2	0.54	0	0	0	0.51	SSV	350	595	13000
Nickel	4	22	42	0	0	0	43.37	SSV	130	130	1800
Phenols	4	<0.3	<0.3	0	0	0	<0.3	SSV	1930	33500	174000
Benzo[a]pyrene	4	<0.1	<0.1	0	0	0	<0.1	SSV	2.4	2.4	22
Boron	4	0.9	1.7	0	0	0	1.60	-	*	*	*
Copper	4	23	60	0	0	0	59.76	SSV	4020	8370	109000
Zinc	4	58	260	0	0	0	236.01	SSV	17200	46800	917000
Free Cyanide	4	<0.5	<0.5	0	0	0	<0.5	SSV	34	34	34
Sulphide	4	1.7	3.0	0	0	0	3.11	-	*	*	*

Discussion of Results and Statistics

The results of the laboratory analysis indicate the made ground locally contains elevated concentrations of chromium and lead, which exceeded the residential soil screening criteria. None of the recorded concentrations exceeded the screening values for a commercial/industrial end use.

Measured total chromium concentrations were between 24mg/kg and 45mg/kg and four samples exceeded the residential with plant uptake SSV of 14mg/kg. The toxicity of chromium depends upon its oxidation state, which generally comprises trivalent and hexavalent forms. Trivalent compounds are stable and most naturally occurring chromium is in the trivalent (chromic) state. Hexavalent chromium (chromate) rarely occurs naturally and the presence in soil is most likely to be from pollution. Hexavalent chromium is significantly more toxic than the trivalent form, and consequently the SSV assumes that all the chromium is present in the hexavalent form. The hexavalent chromium test results for the four samples analysed were all less than 5mg/kg, a concentration well below the SSV of 14mg/kg, and therefore the measured chromium concentrations would not be considered to present a significant risk to residential with plant uptake usage.

Statistical analysis, based on the mean value test, indicates that the US95 values for lead exceeded the corresponding screening values for residential end uses.

With the results of chromium discounted, the maximum value test was carried out on the lead test data in order to determine whether or not the highest value obtained was part of the same population, or a statistical outlier. A summary is presented in Table 6 below.

Table 6: Maximum Value Test

Determinand	Max Value mg/kg	T Calc Value	5% T-Critical Value (4 samples)
Lead	640	0.85	1.46

The results show the T-Calc Value for lead is less than the respective 5% T-Critical Value and so the highest value determined is part of the same population.

The results of this analysis indicate that the made ground across the site would fail residential soil screening criteria, due to the presence of lead within the near-surface fill of TP 1.

The made ground across the site falls within the soil screening criteria for a commercial/industrial end use.

Hydrocarbon Pollution in Soil

Although visual and olfactory evidence of organic soils was detected from some of the soils beneath this site, the single total TPH soil result was <10mg/kg and so indicates that hydrocarbon contamination was not present in the soil tested.

SOIL GAS MONITORING RESULTS

Two return visits to monitor gas levels at this site were made in October 2009 to record the concentrations of landfill type gases (methane, carbon dioxide and oxygen) in the standpipe installed in WS 1. The results are presented in Appendix 3. The recorded concentration of methane and carbon dioxide were both below the 0.1% detection limit of the monitoring apparatus. Comparison of these monitoring results to the Building Research Establishment (BRE) guidance, BR 212, indicates that the methane result was well below the 1.0% BRE threshold, whilst the carbon dioxide result was well below the 1.5% BRE threshold. The recorded oxygen concentration was similar to atmospheric conditions. The in-situ measurement confirmed a negligible gas emission rate with a recorded flow rate of less than 0.1l/hr.

Assuming a minimum positive flow rate of say 0.1l/hr, the results give a Gas Screening Value (GSV) of 0.0001l/hr and the concentrations of methane and carbon dioxide consequently fall into a Characteristic Situation 1, based on the modified Wilson & Card classification from CIRIA C665 'Assessing Risks Posed by Hazardous Ground Gases to Buildings' (2007). Characteristic Situation 1 requires no special precautions to protect against gas infiltration.

However, the presence of slightly organic clay soils beneath parts of this site would make it advisable to maintain the existing well-constructed, composite basement floor slab, which already incorporates a plastic membrane. Final reinstatement of the foundation inspection pits undertaken within the basement should include the restoration of the membrane at these positions.

UPDATED CONCEPTUAL MODEL

Assessment of the potential linkage between ground contamination sources, human and environmental receptors have been assessed based on the desk study research and the intrusive ground investigation documented in the preceding sections of this report.

A generalised conceptual model, updated following the intrusive works, monitoring and testing, and targeted to provide coverage across the site, relative to the construction phase and completed development, is presented below in Table 7.

Table 7: Updated Conceptual Model Relative to Construction and Future Development

Receptors	Pathway	Estimated Potential for Linkage with Contaminant Sources			
		Drainage	Soil Beneath Site	Soil Gas	Ground Contamination Outside Site Boundary
Human Health – ground workers	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Low	Moderate	Low	Very Low
Human Health – users of completed development	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	N/A	Very Low	Very Low	Very Low
Water Environment	Migration through ground into surface water or groundwater	N/A	Very Low	Very Low	Very Low
Flora and Fauna	Vegetation on site growing on contaminated soil	N/A	Very Low	Very Low	Very Low
Building Materials	Contact with contaminated soil	N/A	Very Low	Very Low	Very Low

Key to Table 7

RISK	Definition
Very High	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, or, there is evidence that severe harm to a designated receptor is currently happening. The risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) and remedial works may be necessary in the short term and likely over the long term.
Moderate	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, or if any harm were to occur it is more likely that the harm would be relatively mild.
Low	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild
Very Low	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.
N/A	Not Applicable because the proposed development will remove the source.

COMMENTS ON GROUND CONTAMINATION IN RELATION TO PROPOSED DEVELOPMENT

Anticipated exposure scenarios relating to the site and future redevelopment works including remedial options as applicable, in the context of the conceptual model, are discussed as follows.

This investigation may not have revealed the full extent of contamination on the site and appropriate professional advice should be sought if subsequent site works reveal materials that may appear to be contaminated.

Contaminated Soil

The site is underlain by between 1.00m and 1.50m of made ground. The made ground contained statistically elevated concentrations of lead. These concentrations exceeded residential soil screening criteria. None of the contaminants tested for statistically exceeded their respective screening values for a commercial/industrial land use.

Existing Drainage

Redundant foul or surface water drain runs, should be removed from beneath the site and precautions should ensure that any remaining effluent is directly disposed off-site. The integrity of existing drainage should be checked, and where they are to be retained, any damaged sections should be replaced prior to development. The latter measures should remove any future risk to human health and to the water environment.

Human Health - Construction Workers

The localised presence of lead contamination within the made ground soils indicates that there is a moderate risk that a pathway could develop affecting groundworkers during the construction phase of development.

No special precautions would be required during the development of the site by workers who may come into contact with the soil during groundworks, providing standard precautions are adopted which should generally include the procedures given by the Health and Safety Executive (The Blue Book) HS(G)66.

For the protection of workers during groundworks the following is recommended:

a) Limit repeated or prolonged skin contact with soils by wearing gloves with sleeves rolled down.

b) Washing facilities should be made available to groundworkers, so as to minimise the potential for inadvertent ingestion of soil.

c) If any soils are revealed which are different to those encountered by this ground investigation, the advice of a specialist should be sought in view of classifying the material and ascertaining its risk to groundworkers.

Dust suppression measures such as 'damping down', could also be adopted to prevent the spread of soil contaminants.

Human Health - Users of Completed Development

The risk of the encountered ground contamination affecting the site users when present beneath buildings and permanent areas of hardstanding would be considered to be very low. This is because it would be highly unlikely that the general site users would normally be able to penetrate the building basement floors or walls, which would be necessary for them to uncover any contaminated soils beneath the site.

Soil Gas

According to database information, there are no active landfills within influencing distance of the site and no significant thicknesses of putresible or peaty matter were encountered by the exploratory holes in the made ground.

The gas monitoring has determined that a Wilson and Card Characteristic Situation 1 would apply and that no special precautions are required to protect the proposed development from ingress of soil gases. However, as mentioned previously it would be considered prudent to maintain and restore the membrane within the existing basement floor slab.

Water Environment

Significant soil contamination was not identified by the investigative works and 'perched' water was recorded at about 1.65 below basement level. It is considered unlikely that the proposed development would impact the quality of the water environment.

Off-Site Disposal of Soil Arisings

Excavated material and excess spoil should always be classified prior to removal from site as required by 'Duty of Care' (Environmental Protection Act. 1990) legislation. This means that material has to be given a proper description and waste classification prior to removal. The certificates of chemical analysis should be sent to the Environmental Agency or a suitably licensed waste disposal contractor for classification of the material prior to disposal off-site during the development works.

It is expected that clean arisings from foundation excavations into the natural soils across this site would also fall into the inert category under the European Waste Catalogue description 'Soil and Stones', EWC code 17 05 04 with restrictions excluding topsoil and peat.

REMEDIATION STRATEGY

Summary of Proposed Works

The proposed development is to remove the existing single-storey building with basement and replace it with a five-storey extension, including basement. The existing site is detailed on the site plan at the rear of this report. The proposed site layout has yet to be finalised and will need to be provided by the client in due course. This plan will need to clearly identify that no areas of gardens, 'soft' landscaping and flowerbeds, are envisaged.

Contaminated Soil

On the basis of the work carried out, laboratory testing indicates that the samples of made ground tested contained statistically elevated concentrations of lead in excess of the SSV for residential gardens end uses. Statistical treatment of the data indicates that the made ground tested from beneath this site would therefore be considered to potentially present a risk of significant harm to human health in the context of Part IIA of the Environmental Protection Act (1990) with respect to an unlikely private or communal gardens usage.

Remediation

Remediation of the soils beneath the site would not be considered necessary, as any remaining and new basement floors and walls will prevent contact between any contaminated ground and the site end users.

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