LISTERS

Geotechnical Consultants

Higgins Construction PLC

Supplementary Geoenvironmental and WAC Testing Investigation Report

Bourne Estate
HOLBORN
London
EC1N 7SD

Report No: 14.04.016
May 2014

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EXECUTIVE SUMMARY

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Project Engineer:-	**Lee Chippington** – Geoenvironmental Engineer		
Date	May 2014	**Project Reference**	14.04.016
Client	Higgins Construction PLC		
Contact	Mr. Paul Garner	**Client Reference**	
Site Location	Bourne Estate, Holborn, London, EC1N 7SD		
OS Grid Reference	Approximate centre of the site – TQ312819.		
Development Proposals	Two new multi-storey residential blocks with associated access roads, car parking and soft landscaping.		
Published Geology	Superficial Deposits of River Terrace Deposits over solid geology of London Clay Formation over Lambeth Group.		
Topography	The site is mainly flat, however there is an area of soft landscaping in the southern area of the site in which the ground level is approximately 2.0m lower than the ground level across most of the rest of the site. Consequently there is a retaining wall in this area of the site.		
Vegetation	There are many trees in the western area of the site and a few more across the other areas of the site.		
Existing Buildings	There are multi-storey brick residential buildings in the southern (Mawson House) and western (Gooch House) areas of the site. In addition, there are several single storey brick buildings in the central area of the site. Most of these are community buildings, however one is a sub-station.		
Site History	The site has been developed for residential purposes since at least the mid-nineteenth century. It appears to have been affected by bombing during the Second World War and consequently was re-developed during the post war period. By1966 it appears all the current buildings are present, however since then one of the buildings in the central area of the site has been converted from a builder's store into a sub-station.		
Hydrology	There is no on site surface water.		
Hydrogeology	The site is underlain by a Superficial Secondary A Aquifer and by Bedrock Unproductive Strata (London Clay).		
Ground Conditions Encountered	Made Ground generally comprising brown silty gravelly sand containing gravel and cobble sized brick and concrete was encountered across the site from ground level down to depths of generally between 2.9m and 5.1m. Underlying the Made Ground River Terrace Deposits comprising medium dense to dense yellow brown and brown gravely sand was encountered to a depth of 7.7m. Beneath the River Terrace Deposits London clay comprising firm to stiff fissured grey silty clay was encountered to a depth of 22.5m. Underlying the London Clay soils of the Lambeth Group were encountered. These comprised a 0.7m thick band of blue green clayey sand over very stiff variably coloured clay to the full depth of the deepest borehole at 30.0m depth.		
Groundwater Encountered	One groundwater strike was recorded during the site works at a depth of 22.5m within the granular Lambeth Group.		
Ground Contamination	The Made Ground is constaminated with lead across the site.		

Groundwater Contamination	None encountered.
Site Remediation Required	Capping in all areas of soft landscaping.
Soil Gases	No special precautions for carbon dioxide, methane or radon.
Waste Soil Classification	Non-hazardous.
Chemical Attack On Buried Concrete	Design Sulphate Class DS – 2. ACEC Class AC – 3z.

This executive summary should be read in conjunction with report number 14.04.016.

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SUPPLEMENTARY GEOENVIRONMENTAL AND WAC TESTING INVESTIGATION REPORT

INTRODUCTION

A supplementary geoenvironmental and WAC testing investigation has been undertaken for a proposed residential development at the Bourne Estate, Holborn, London, EC1N 7SD. A Site Location and Boundaries Plan is provided in Appendix A.

The Ordnance Survey National Grid reference for the centre of the site is approximately TQ312819.

This report describes the work carried out by Listers Geotechnical Consultants, the ground conditions encountered and discusses their implications with regard to the proposed development. The report presents initial human health and groundwater risk assessments based on a review of a previous Feasibilty Stage Desk Top Study Report and Geoenvironmental Land Quality Statement Report carried out by Campbell Reith Consulting Engineers (reference 10907 and dated March 2012 and November 2012 respectively). The contamination risk assessment has been carried out using the source-pathway-receptor risk assessment methodology.

Instructions to undertake the investigation were received from Mr Paul Garner of Higgins Construction PLC, in their Budget Acceptance Form dated the 16th April 2014.

This report supplements the previous Feasibility Stage Desk Top Study Report and Geoenvironmental Land Quality Statement Report carried out by Campbell Reith Consulting Engineers (reference 10907 and dated March 2012 and November 2012 respectively). We have relied on some of the information within these reports to aid our recommendations. Copies of the previous reports are provided in Appendix D, and this current report should be read in conjunction with the previous reports for full details of the investigations undertaken at the site.

This report has been prepared for the sole use of the client and their professional advisors. This report shall not be relied upon by third parties without the express written authority of Listers Geotechnical Consultants. If an unauthorised third party comes into possession of this report they must not rely on it and the authors owe them no duty of care and skill.

SCOPE OF THE INVESTIGATION

The scope of the investigation was to review the existing Campbell Reith Consulting Engineers' reports referenced above, undertake a walkover survey and provide an assessment of the extent of any soil contamination on the site. A contaminated land risk assessment was undertaken based on the Contaminated Land Exposure Assessment (CLEA) and Environment Agency RTM guidelines.

PROPOSALS

It is proposed to redevelop the site to accommodate two new multi-storey residential blocks with associated access roads, car parking and areas of soft landscaping. A Proposed Development Plan is provided in Appendix A.

SITE INFORMATION AND WALKOVER SURVEY

A walkover survey of the site and its immediate surrounds was undertaken on the 17th April 2014.

The site lies in a mixed commercial and residential area, and is currently occupied by two multi-storey residential buildings, some single storey community buildings and a sub-station and areas for car parking and of soft landscaping. It consists of an irregular shaped parcel of land, with overall measurements of approximately 160m by 110m and covers an area of approximately 1.0 hectare.

The site is generally flat with the surface formed by a mixture of hard standing and soft landscaped areas. The ground level in one area of soft landscaping in the southern area of the site is approximately 2.0m lower than the general ground level across the rest of the site. Consequently, there is an approximately 2.0m high retaining wall in this area of the site. This retaining wall appeared to be in reasonable structural condition at the time of the site walkover.

The northern site boundary is formed by Portpool Lane with residential buildings beyond and the eastern site boundary is formed mainly by residential buildings. The southern site boundary is partly open with a road beyond and formed partly by a fence with a school beyond. The western site boundary is open with a multi-storey commercial building beyond. There is an approximately 1.2m high retaining wall along the southern site boundary with the school beyond. This retaining wall appeared to be in reasonable structural condition at the time of the site walkover.

Part of the southern area of the site is occupied by a brick multi-storey residential building (Mawson House), this overlooks an area of soft landscaping to the west and a childern's playground to the east. The central area of the site is occupied by several single storey brick buildings with an area of soft landscaping to the south of the buildings and hardstanding for ball sports and car parking to the west and north of the buildings respectively. Most of these buildings are community buildings, however one is a sub-station. Part of the western area of the site is occupied by a brick multi-storey residential building (Gooch House) with an area of soft landscaping to its west.

There are many mature trees in the western area of the site and a few more across the other areas of the site. There is no surface water on the site and no obvious signs of contamination were observed during the site walkover.

GEOLOGY

Reference to the British Geological Survey 1:50,000 scale map and other published geological information on the area indicates that the site is likely to be underlain by superficial deposits of River Terrace Gravel over solid geology of Palaeogene age London Clay Formation.

The River Terrace Gravel are post diversionary Thames River Terrace Deposits and generally comprise gravel, but may be sandy clayey in parts. They are generally less than 10m thick in this area. The London Clay is described as clay that may be silty in parts and up to 110m thick in this area.

In this area the London Clay is underlain by Palaeogene age Lambeth Group. This is described as mottled clay with sand and pebble beds and between 8m and 23m thick.

HISTORIC BOREHOLES

The records of the nearest available historic borehole put down to the site have been obtained from the British Geological Survey. These are included in Appendix A with an associated location plan.

Borehole reference TQ38SW682 was located approximately 100m to the east of the centre of the site and drilled in 1959. It records encountering made up ground down to a depth of approximately 0.4m over variable cohesive and granular soils down to a depth of approximately 4.1m. Below this depth the strata becomes predominantly firm to hard blue clay and contains some bands of silty sand down to the base of the borehole at a depth of approximately 12.2m.

PREVIOUS WORK

As part of their investigations Campbell Reith Consulting Engineers undertook a Feasibility Stage Phase I Desk Study, intrusive investigations and geotechnical and geoenvironmental laboratory work. A copy of the associated reports (reference 10907 and dated March 2012 and November 2012) are provided in Appendix D. Below is a summary of the findings of these reports. This information should not be read in isolation, for full details reference should be made to the original reports;

- Based on the geological map for the area the site is likely to be underlain by superficial deposits of River Terrace Gravel over solid geology of London Clay. Historic borehole logs acquired by Campbell Reith Consulting Engineers indicate the likely presence of several metres of Made Ground at the site.
- The earliest Ordnance Survey maps reviewed show the site was already developed mainly for residential purposes by the mid-nineteenth century. The site was re-developed during the early to mid twentieth century with a tower like building being present in the western area of the site. The site appears to have been affected by bombing during the Second World War and most of

the site is labelled as ruins or vacant during the post war period. By 1966 the site had been re-developed with the multi-storey buildings currently on site in the eastern and western areas of the site , i.e., Mawson House and Gooch House and a community centre and builder's store in the central area of the site. Since 1966 some areas of the site have been landscaped and the builder's store in the central area of the site has been converted to a sub-station.

- The site is underlain by a Superficial Secondary A Aquifer (River Terrace Gravel) and Bedrock Unproductive Strata (London Clay). The site is not located within a source protection zone and there are no groundwater abstraction licenses within 250m of the site.
- There are no surface rivers within 250m of the site.
- There are no prosecutions relating to controlled waters within 250m of the site.
- There are no current/historical landfill disposal sites, waste transfer, treatment or disposal sites or sites authorised to carry out processes subject to applications for Integrated Pollution Control or Integrated Pollution Prevention and Control Licenses within 50m of the site. However, there are three processes subject to Local Authority Pollution Prevention and Control within 50m of the site. Two of these relate to operations associated with foundry and metal extraction processes and the other is a dry cleaners.
- No historic or current potentially contaminative trade entries were found on the site, however thirty-five were found within 50m of the site. These include a brewery, glass works, gold refinery works and a tobacco factory. The nearest fuel station was located 350m to the northeast of the site and is labelled as obsolete.
- The site does not lie within an area where new buildings require special radon protection measures.
- The site is within an area known to have sustained serious damage due to bombing during the Second World War. Where the site has undergone development post-war the risk of encountering UXO's was considered moderate and in areas of soft landscaping it was considered high.
- There are no environmentally sensitive land uses within 250m of the site.

CONCEPTUAL MODEL

A preliminary qualitative risk assessment has been carried out by Listers Geotechnical Consultants using the source-pathway-receptor principle. As such, potential sources of contamination and potential receptors were assessed using the Contaminated Land Exposure Assessment (CLEA) Guidelines. The fact that a pathway must exist between a potential source of contamination and a potential receptor for there to be a risk, was taken into account.

The results of the review of Campbell Reith Consulting Engineers's Feasibility Stage Desk Top Study (reference 10907 and dated March 2012) and the walkover indicate that the following potential sources of ground contamination are present at or in close proximity to the site:

- Made Ground associated with bomb damage sustained during the Second World War and subsequent re-development of the site is likely to be present at the site.
- On site spills and leaks from the builder's store previously located in the central area of the site and the sub-station that it was subsequently converted to.
- Contamination associated with exploded ordnance at the site.
- Migration on to the site of contamination from local current and historical industrial land uses.
- Soil gases associated with deep Made Ground at the site.

The following most sensitive receptors have been identified at the site:

Human Health

- End users of the site (residents).
- Surrounding residents.
- Construction and maintenance workers.

Environmental

- Controlled Waters - The underlying Secondary A Aquifer (River Terrace Gravel)

It is considered that a number of potential pathways exist between these potential sources and the above identified receptors.

For the human receptors these include:

- Direct soil ingestion in areas of exposed soil.
- Ingestion of soil attached to homegrown fruit and vegetables.

- Ingestion of fruit and vegetables with contamination uptake.
- Inhalation of indoor and outdoor vapours and dust.
- Dermal contact with contaminated soil.
- Inhalation of soil gases or vapours migrating through permeable strata into the building.

For the environmental receptors the pathways include:

- Migration of contaminants through the unsaturated zone.
- Migration of contaminants through the groundwater.
- Movement of contaminants through drains or services runs.

EXPLORATION AND TESTING

GENERAL

A total of thirteen exploratory holes have been formed at the site, inclusive of three cable percussion boreholes and six dynamic sampler boreholes carried out as part of Campbell Reith Consulting Engineer's investigations between the 6th March and 12th March 2012, and four hand excavated trial pits carried out as part of Listers Geotechnical Consultants' investigations on the 17th April 2014. The logs from both investigations are provided in Appendix B.

Due to the presence and continued use of Mawson House in the southern area of the site, various buildings in the central area of the site and Gooch House in the western area of the site it was not possible to locate any exploratory holes within the footprints of these buildings.

SAMPLING STRATEGY

As part of Listers Geotechnical Consultants' investigation one trial pit (WAC3) was located adjacent to the existing sub-station that was identified as a potential source of contamination in the Initial Conceptual Model. The positions of the rest of the exploratory holes were selected by Campbell Reith Consulting Engineers and Listers Geotechnical Consultants to provide a wide coverage of information on the site area

The positions of all the exploratory holes undertaken at the site as part of Campbell Reith Engineer's and Listers Geotechnical Consultants' investigations can be seen on the Exploratory Hole Location Plan in Appendix A. The results of the laboratory testing from Listers Geotechnical Consultants' investigation are provided in Appendix C, and the results from Campbell Reith Consulting Engineer's investigation are included in their Geoenvironmental Land Quality Statement Report (reference 10907 and dated November 2012), which is provided in Appendix D.

METHODOLOGY

Campbell Reith Consulting Engineer's Investigations

The dynamic sampler boreholes WSB1 to WSB4 were put down using a Premier tracked rig to a maximum depth of 3.45m, and boreholes WSB5 and WSB6 were put down using hand held equipment to a maximum depth of 2.5m. Disturbed samples were taken at regular intervals throughout the boreholes for future laboratory inspection and testing and standard penetration testing was undertaken at 1.0m intervals throughout the boreholes. On completion, boreholes WSB2 to WSB4 were installed with gas and groundwater monitoring standpipes, with the slotted pipe installed within the Made Ground at depths of between 1.0m and 3.0m. The slotted sections of the standpipe were surrounded with pea

gravel and expansive bentonite clay was added around the plain pipes and below the slotted sections to seal the borehole.

Boreholes BHB1 to BHB2A were drilled utilising a standard cable percussion rig at a diameter of 200mm reducing down to 150mm, down to a maximum depth of 30.0m below ground level. BHB2 was terminated at a depth of 0.7m due to encountering a service and borehole BHB2A was located approximately 1.0m from it. Disturbed samples were collected at regular intervals throughout the borehole for future laboratory inspection and testing. Standard Penetration Tests and undisturbed tube samples were taken at 1.0m intervals down to 5.0m depth and at 1.5m intervals thereafter. On completion, boreholes BHB1 and BHB2A were installed with gas and groundwater monitoring standpipe down to a depth of 8.0m. BHB1 had a dual installation with the slotted standpipe within the Made Ground at depths of between 1.0m and 3.0m in one installation and within the natural soils at depths of between 4.0m and 8.0m in the other installation. At BHB2A the slotted pipe was installed within the natural soils at depths of between 5.0m and 8.0m. The slotted sections of the standpipes were surrounded with pea gravel, while expansive bentonite clay was added around the plain pipe and below the slotted section to seal the boreholes.

Listers Geotechnical Consultants' Investigation

Trial pits WAC1 to WAC4 were excavated by hand, and disturbed samples were taken at regular intervals throughout the trial pits for future laboratory inspection and testing.

Engineering and geoenvironmental conclusions given in this report are based on data obtained from these sources but it should be noted that variations, which affect these conclusions, may occur between and beyond the test locations. Also water levels may vary with time.

GROUND CONDITIONS

The site and laboratory test work from Campbell Reith Consultant's and Lister Geotechnical Consultants' investigations revealed that the general succession of strata can be represented by Made Ground over River Terrace Deposits over London Clay over Lambeth Group. It may be summarised as follows:

Made Ground - Encountered at each test location either from ground level or below hardstanding down to proven depths of between 1.1m and 5.1m. Where the base of the Made Ground was penetrated its depth was generally greater than 3.0m, however at one borehole (WSB5) in the southwestern area of the site the depth to the base of the Made Ground was recorded as 1.1m. At the other borehole in this area (WSB6) the borehole was terminated at a

depth of 2.5m still within the Made Ground. The Made Ground was represented in general by brown silty gravely fine to coarse sand containing gravel and occasional cobbles of mainly brick and some concrete.

Full laboratory sieve analyses on samples of the Made Ground revealed them to be mainly gravely fine to coarse sand.

Soil Organic Matter tests revealed organic contents of generally between 1% and 7%.

River Terrace Deposits - Encountered at the three test locations that penetrated the base of the Made Ground (BHB1, BHB2A and WSB5), from depths of between 1.1m and 5.1m down to depths of 7.7m, with an average thickness, where proven, of 3.7m. Represented in general by medium dense to dense yellow brown and brown gravelly medium sand containing gravel of chert.

Full laboratory sieve analyses on samples of the River Terrace Deposits revealed them to be mainly gravely medium sand.

'N' values derived from standard penetration tests in the boreholes ranged from 26 to 35.

London Clay - Encountered at the two deep cable percussive boreholes (BHB1 and BHB2A), from a depth of 7.7m down to a depth of 22.5m. Represented in general by firm to stiff fissured grey silty clay.

Classification tests on selected samples revealed moisture contents ranging from 25% to 32%, with the fines fraction classified as a soil of high volume change potential. See NHBC Building Standards, Chapter 4.2.

Undrained triaxial compression tests undertaken on undisturbed samples revealed shear strengths ranging from 100kPa to 350kPa.

'N' values derived from standard penetration tests in the boreholes ranged from 17 to 28, and generally increased with depth.

The number of blows taken to retrieve the undisturbed U100 tube samples from the boreholes increased with depth and ranged from 46 with 100% recovery at a depth of 9.0m to 100 with a 75% recovery at 19.5m depth.

Lambeth Group - Encountered at the one borehole that penetrated the base of the London Clay (BHB2A) at a depth of 22.5m down to the base of the borehole at a depth of 30.0m. Represented by a 0.7m thick band of blue green clayey sand over very stiff variably coloured clay.

Classification tests on selected samples revealed moisture contents ranging from 19% to 24% with the fines fraction classified as a soil of medium volume change potential. See NHBC Building Standards, Chapter 4.2.

An undrained triaxial compression test undertaken on an undisturbed sample taken from a depth of 25.5m revealed a shear strength 425kPa. The number of blows taken to retrieve this undisturbed U100 tube sample was 100 with a 60% recovery.

The 'N' values derived from standard penetration tests in the boreholes were generally greater than 50.

Sulphate and pH Tests

Soluble sulphate tests carried out on soil samples recovered from Campbell Reith Consulting Engineer's exploratory holes recorded values ranging from <0.003g/l to 1.730g/l, in conjunction with pH values ranging from 4.4 to 11.8.

GROUNDWATER

Only one groundwater strike was recorded during the investigations. This occurred at BHB2A at a depth of 22.5m within the granular Lambeth Group, and was recorded to have risen to a depth of 20.4m after twenty minutes.

GROUND GAS

Ground gas monitoring carried out as a part of Campbell Reith Consulting Engineer's and Listers Geotechnical Consultants' investigations has revealed oxygen levels of between 18.9% and 20.6% by volume, carbon dioxide levels of between 0.0% and 0.5% by volume and no methane. Flow rates ranged between 0.0l/hr and less than 0.1l/hr. These low flow rates are indicative of the soils encountered which did not include significant quantities of organic matter or materials which can decay.

The results of all the gas monitoring carried out at this site as part of Campbell Reith Consulting Engineer's and Listers Geotechnical Consultant's investigations are provided in Appendix B.

GROUND CONTAMINATION ASSESSMENT

SOIL TESTING

As part of Campbell Reith Consulting Engineer's investigation twenty-three samples of the Made Ground and one sample of the natural soils collected on site during their investigation were tested for a range of contaminants. In addition, as part of Listers Geotechnical Consultants' investigation Waste Acceptance Criteria (WAC) Testing was carried out on four further samples of Made Ground collected at the site. Some of the samples to be tested were recovered from the test locations adjacent to the sub-station that was identified as a potential source of contamination in the Conceptual Model earlier in this report.

The suite of testing carried out on the samples was decided upon following consultation of R&D CLR Publications, published as part of the Contaminated Land Exposure Assessment (CLEA), a joint venture between the Department for Environment, Food and Rural Affairs (DEFRA) and the Environment Agency.

The test suite included a range of:-

- Metals and inorganic substances
- Speciated Polyaromatic Hydrocarbons (PAH)
- Benzene, Toluene, Ethylbenzene and Xylene (BTEX)
- Total Petroleum Hydrocarbons (TPH), with Aliphatic/Aromatic hydrocarbon split (A/A split)
- Polychlorinated Biphenyls (PCBs) screening
- Asbestos screening

The soil samples were tested to obtain 'Total' values within the soil.

As part of this investigation Listers Geotechnical Consultants have carried out Human Health and Groundwater Risk Assessments based on the results of the soil testing from both Campbell Reith Consulting Engineer's and Listers Geotechnical Consultants' investigations. The results of the tests from both investigations are provided in Appendix C.

RISK ASSESSMENT GUIDELINES – HUMAN HEALTH

The human health risk assessment has been undertaken using the guidance provided in the Environment Agency's publication CLR11, 'Model Procedures for the Management of Contaminated Land,' published in September 2004. Human health assessment criteria used are based upon the proposed final

land use of the site, in this case to allow a conservative approach the guidelines for 'Residential with plant uptake' have been used.

Soil Guideline Values

Currently in the UK, no statutory limits for the presence of contaminants in soils or groundwater exist. Therefore, the results of the soil samples tested are compared primarily to the Soil Guideline Values (SGVs) where available published from March 2009 by DEFRA and the EA.

The SGVs are baseline ground contamination standards calculated using the CLEA software described below. They are based upon a sandy loam soil type with 6% soil organic matter and give a "*Minimal Risk"* level of protection.

Category 4 Screening Levels (C4SL's)

Published in March 2014 by DEFRA, C4SL's were primarily produced to support the revised Statutory Guidance to support Part 2A of the Environmental Protection Act 1990, which was published in April 2012. This Guidance introduced a new four-category system for classifying land under Part 2A for cases of a Significant Possibility of Significant Harm to human health. Category 1 includes land where the level of risk is clearly unacceptable and Category 4 includes land where the level of risk posed is acceptably low.

With regards to using the C4SL's for planning purposes the DEFRA guidance states:

"The Part 2A regime and the planning regime are inter-linked such that the National Planning Policy Framework states that, "After development, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990," and that, "Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner." The Part 2A Statutory Guidance and accompanying Impact Assessment were developed on the basis that Category 4 Screening Levels could be used under the planning regime, as they would be in Part 2A investigations directly. The estimated benefits that were expected to accrue from the changes to the Part 2A Statutory Guidance and specifically from the use of the new Category 4 Screening Levels were based on this assumption."

Again, they are based upon a sandy loam soil type with 6% soil organic matter but this time give a "*Low Risk*" level of protection. Where it is considered appropriate C4SL's have been used as screening levels within this report.

Generic Assessment Criteria (GAC)

As well as the SGVs and C4SL's, the set of GACs produced by Land Quality Management (LQM) and the Chartered Institute of Environmental Health (CIEH) in 2009 using the CLEA software, are used as a screening tool, as are the GACs produced by CL:AIRE (Contaminated Land: Applications In Real Environments) in conjunction with AGS and EIC.

The CLEA software 1.06 version was released in October 2009 and is a deterministic exposure model with altered exposure data to the original model. The model allows the creation of a generic assessment criteria database with which to screen laboratory testing results. These GACs are conservative and based upon common assumptions.

Detailed Quantitative Risk Assessment (DQRA)

Should any results exceed the GACs, then a DQRA is undertaken to establish site specific assessment criteria (SSAC). This final stage uses specific information regarding the contamination and its potential receptors and pathways. The CLEA 1.06 software enables this to be achieved and produces less conservative, more accurate SSAC.

Data Sources

Where chemical specific data has been used in the above assessments, data has been sourced from available TOX reports, published by DEFRA, The Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG) literature and toxicological and physical data obtained from Environment Agency Publication, 'Human Health Toxicological Assessment of Contaminants in Soil', August 2008.

RISK ASSESSMENT GUIDELINES – GROUNDWATER

The procedures set out in Environment Agency's Remedial Targets Methodology, 'Hydrogeological Risk Assessment for Contaminated Land,' (2006), have been followed.

RESULTS OF TOTAL SOIL TESTS

Two of the contaminants tested for recorded values higher than their relevant environmental standard value for human health for a residential setting.

Where this has occurred, statistical analyses using the methodology set out in the CL:AIRE Document, 'Guidance on Comparing Soil Contamination Data with a Critical Concentration,' have been undertaken on the laboratory test results in order to establish a 'true mean concentration (μ)' within the planning scenario for each determinant over the whole site area.

These analyses establish whether the data is normally distributed as well as taking into account possible erroneously high values and determine whether contamination 'outliers' features are present on the site. Once this has been established the 'upper confidence limit of 95% on μ' are subsequently compared with the relevant environmental standard value, or 'Critical Concentration (C_c)'.

For the purposes of statistical analysis, where values are recorded at below detectable limits then the limit value is adopted. This can distort the data distribution and erroneously identify outliers. Where outliers fall below C_c, then further assessment is not warranted and such results are considered to pose a low risk to end users.

The results of the statistical analyses are described below and presented in Appendix C of this report.

Lead

Of the twenty-three samples of Made Ground tested, the values obtained ranged from 5mg/kg to 1,940mg/kg. The sample of natural soil tested recorded a concentration of 13.9mg/kg.

The statistical analysis showed that there were two outliers recorded. Outliers of 1,090mg/kg and 1,940mg/kg were identified at 1.5m (WSB2) and 0.15m (WSB3) depth. These two boreholes were located close to each other in the central area of the site. However, the observations made during the site work and the results of the subsequent laboratory work do not indicate the Made Ground in this area of the site is different to the Made Ground across the rest of the site. On this basis, the statistical outliers were not removed from the dataset, and using the chebychev test a site wide upper confidence limit of 799mg/kg has been established for the Made Ground at the site.

The Category 4 Screening Level for a residential site is 200mg/kg. This threshold is the most stringent available and its use allows a conservative approach to risk assessment. However, as the soft landscaped areas of the site will be used for communal recreational purposes rather than private gardens the Public Open Space 1 Category 4 Screening Level for lead is considered more suitable for this site. The Public Open Space 1 Category 4 Screening Level for lead is 630mg/kg.

The upper confidence limit of 799mg/kg for lead established for this site is above the Public Open Space 1 Category 4 Screening level for lead.

Copper

Of the twenty-three samples of Made Ground tested, the values obtained ranged from 5.6mg/kg to 7,550mg/kg. The sample of natural soil tested recorded a concentration of 29mg/kg.

The statistical analysis showed that there was one outlier recorded. The outliers of 7,550mg/kg was identified at 2.1m depth in borehole reference WSB6. However, the observations made during the site

work and the results of the subsequent laboratory work do not indicate the Made Ground in this area of the site is different to the Made Ground across the rest of the site. On this basis, the statistical outliers were not removed from the dataset, and using the chebychev test a site wide upper confidence limit of 1,852mg/kg has been established for the Made Ground at the site.

The relevant screening level for a residential site is 2,330mg/kg.

Asbestos

Of the thirteen samples screened for asbestos three recorded loose chrysotile fibres at concentrations of less than 0.001%. The loose fibres were identified in samples taken from depths of 0.5m and 1.0m at borehole reference WSB5 and at 2.1m depth at borehole reference WSB6.

HUMAN HEALTH RISK ASSESSMENT

The following qualitative risk assessment has been carried out using the source-pathway-receptor principle. As such, potential sources of contamination have been assessed using the CLEA Guidelines. The fact that a pathway must exist between a potential source and potential receptor for there to be a risk, has been taken into account. The potential human receptors evaluated for their individual risk are:-

- End users of the site (residents).
- Surrounding residents.
- Construction workers.

GENERAL

A statistical outlier of copper that exceeded the relevant threshold was recorded from a sample of soil at 2.1m depth from WSB6. However, the observations made during the site work and the results of the subsequent laboratory testing do not indicate the presence of more than one type of Made Ground at the site. Statistical analysis indicates the upper confidence limit for the Made Ground across the site is below the relevant threshold. On this basis, copper is not considered to pose a significant risk to the site.

No visual evidence of PCBs was noted during the site work and laboratory testing indicates soil concentrations were below the limits of detection. On this basis, it is considered PCBs do not pose a significant risk at the site.

Some free fibres of chrysotile type asbestos were recorded in three of the thirteen samples tested for an asbestos screen, however the concentrations were recorded as less than 0.001%. Based on the results of the soil testing carried out as par of Campbell Reith Consulting Engineer's Geoenvironmental Land Quality Statement Report (reference 10907 and dated November 2012) asbestos removal specialists eBrit Services Ltd advises the levels of asbestos recorded poses…"Very low risk and there is no need to notify the HSE." They also advised at these levels there is no need to dispose of the soil as hazardous waste, however should larger amounts of asbestos be encountered during the site works further advice should be sought. On the basis of the results of the soil testing and this advice it is considered soil asbestos does not pose a significant risk to the site.

A site wide upper confidence limit approximately 25% above the relevant threshold has been established for lead within the Made Ground. On this basis, it is considered that lead does pose a significant risk to the site.

END USERS OF THE SITE

The elevated concentrations of lead encountered within the Made Ground across the site have the potential to cause significant harm to the end users of the site. The main pathways of concern for lead are direct soil ingestion, dermal contact and inhalation of dust. For the areas of site within the footprint of the proposed buildings and areas of hardstanding these pathways will be removed and therefore the pollutant linkage broken. However, for the areas underlain by soft landscaping the pathways will exist. Therefore the site is considered to pose a significant risk to the end users.

On the basis of the above, it is considered remedial measures to break the source-pathway-receptor linkage will be required in the areas of the site where soft landscaping is proposed.

SURROUNDING RESIDENTS

The relevant thresholds quoted above have been calculated with the most sensitive receptor in mind, i.e., the end users of the site. As such, remedial measures produced to safeguard the health and reduce the risk to this receptor will also reduce the risk for surrounding residents.

Therefore, the conclusions made for the end users are also relevant to the less sensitive surrounding population.

CONSTRUCTION WORKERS

The exposure route of primary concern for the contamination is 'direct soil ingestion'. For the construction workers there is a direct link to the soil when they undertake the site work and therefore different measures should be taken to manage the short-term exposure risk of coming into contact with contaminated soil.

To reduce the risk to as low as reasonably practicable for the construction workers it is recommended that appropriate health and safety measures be implemented along with the use of Personal Protective Equipment (PPE). All personnel coming into contact with the soil, ground workers in particular, should be instructed to use gloves when on site to avoid dermal contact and restrict inadvertent hand-to-mouth ingestion. Washing facilities should be provided for the site staff to use, and should be used prior to eating or smoking. Reference should be made to the HSE Document, 'Protection of Workers and the General Public during Development of Contaminated Land.'

REMEDIAL MEASURES

Elevated concentrations of lead have been recorded within Made Ground samples collected from the site. It has been established that these pose a significant risk to end users of the site, the surrounding residents and the construction workers involved in the development of the site. The main pathways of

concern for this contaminant have been shown to be ingestion, dermal contact and inhalation of dust. For the areas of the site within building footprints and under areas of hardstanding the pollutant linkage will be broken. However, for areas of soft landscaping remedial measures will be required to break the pollutant linkage.

The following remedial solution is recommended:-

i. **Cover system**: Removal of the pathway between the contaminated soil and end users, by adding a carefully designed cover layer in areas of soft landscaping. This would work by removing the pathways and so breaking the pollutant linkage.

   Using the latest guidance document, BRE 465, 'Cover Thickness Design for Regeneration', produced by ENSR International Ltd, on behalf of the BRE, AGS and DTI, a cover thickness of 300mm should be adopted, assuming the imported material is ***certified clean prior to use***. This cover layer would consist of 150mm of **clean** topsoil and 150mm of **clean** subsoil.

   This may be undertaken by either raising site levels or removing some of the soil to create the depth required. We therefore recommend approval is sought from the Local Authority regarding the minimum cover thicknesses required at this site.

For disposal details of these soils reference should be made to the CLASSIFICATION OF WASTE MATERIAL section at the end of this report.

Due to the presence and continued use of Mawson House and Gooch House and other buildings at the site during the investigations it was not possible to locate any exploratory holes within their respective footprints. Contaminated soils are not anticipated under these buildings, however should any unexpected visual or olfactory evidence of contamination be encountered at the site during the construction phase, work should be suspended and further advice sought.

Regulatory Approval

Any finalised remedial measures concerning human health will need to be approved by the relevant Local Authority Environmental Health Department or the NHBC prior to development. These should be accompanied with a copy of this report and any subsequent investigation reports.

Once remediation methods have been finalised it is recommended that a remediation strategy is written so that all parties involved in the development are clear about the chosen method, implementation programmes and verification testing regimes that are required.

VALIDATION TESTING

In soft landscaped areas validation of the imported topsoil/sub soil thicknesses will be necessary along with testing certificates demonstrating the imported soils are suitable for use as discussed below.

Imported Topsoil and Subsoil Specification

Any new soil imported to the site should have been tested for a range of chemicals or determinants by the supplier. The TPH analysis should ideally have a breakdown of the carbon banding ranges.

The concentrations of determinants required in the topsoil must take into account the thickness of the cover system that is being implemented in the gardens at the site and the concentrations of any elevated levels of contaminants in the soil beneath. To ensure that the requirements of the 300mm cover system are fulfilled, any imported subsoil or topsoil should contain levels of contaminants less than half the current thresholds established for this site.

It should be noted that newly placed topsoil will settle over time and may not then fulfil the full thickness requirement of the cover system.

POST REMEDIATION VERIFICATION

Any remedial measures undertaken at the site will require independent verification once completed to ensure the pollutant linkage to the end users of the site has been removed. This is undertaken to satisfy the relevant regulatory authorities and other interested parties, including future owners of the site, banks, insurers and mortgage companies. This usually involves a small validation investigation to confirm that the remediation has been successful.

Any soil imported to the site should be accompanied by a certificate of chemical analysis. Otherwise, further testing for contaminants must be undertaken to demonstrate that the imported soils are clean. The engineer performing the verification will need to see the soil testing results to validate the imported soil prior to the cover system being constructed to ensure that it is suitable for use.

It should be noted that regulators often wish to see independent testing on the imported soil to confirm its suitability in addition to the original certificate of analysis.

If the imported soil was found to be unsuitable, it would need removal and replacing with new clean soil.

GROUNDWATER RISK ASSESSMENT

The following risk assessment has been carried out using the source-pathway-receptor principle. The procedures set out in the Environment Agency's Remedial Targets Methodology, 'Hydrogeological Risk Assessment for Contaminated Land,' (2006), have been followed.

The potential environmental receptor considered during this risk assessment was:-

- Controlled Waters – The underlying Secondary A Aquifer (River Terrace Deposits)

GENERAL

Elevated concentrations of lead have been identified in the soil. However, no groundwater strikes were recorded in the River Terrace Deposits during the site work and most of the site will be covered with buildings and hard standing. In addition, the site is not within a source protection zone and there are no abstraction licenses within 250m of the site.

On the basis of the above, it is considered the site does not pose a significant risk to the controlled waters receptor at the site, and therefore no remedial measures will be required.

In order to reduce potential delays to the development we recommend that these conclusions are agreed with the relevant Regulatory Authorities at the earliest stage.

GAS PROTECTION

Ground gases associated with deep Made Ground were identified as a potential risk to the site in the conceptual model. Consequently, as part of Campbell Reith Consulting Engineer's investigation five boreholes were installed with gas and groundwater monitoring standpipe. Campbell Reith Consulting Engineer subsequently carried out three monitoring visits and Listers Geotechnical Consultants one monitoring visit. The results of all the gas monitoring carried out at the site as part of Campbell Reith Consulting Engineer's and Listers Geotechnical Consultant's investigations are provided in Appendix B.

The results have been evaluated with reference to Code of Practice for the, 'Characterization and Remediation from Ground Gas in Affected Developments,' BS8485:2007. To allow meaningful results to be obtained a default flow rate of 0.1l/hr has been assumed.

Using the maximum carbon dioxide reading of 0.5% with the default flow rate of 0.1l/hr, the maximum gas screening value (GSV) is 0.0005l/hr. As no methane has been detected the GSV for methane is 0.0l/hr. This classifies the site as NHBC green traffic light.

On the basis of the results of the gas monitoring and the absence of significant quantities of organic material within the Made Ground encountered during the site works, it is considered no special gas protection with regard to methane or carbon dioxide gas will be necessary for this development.

No special radon protection measures are required for this site.

CLASSIFICATION OF WASTE MATERIAL

The excavations on site from foundation and services trenches will produce a considerable amount of surplus soil. Under current waste management legislation if this soil is surplus to requirements it will be classified as waste and needs disposing of at a licensed facility.

If it is decided that the soil should be taken off-site as waste and disposed of, the implementation of the Landfill Directive means that the waste soil requires classification prior to leaving site.

European Waste Catalogue Determination

Using the 'Total' soil contamination test results from Campbell Reith Consulting Engineer's investigation in conjunction with the HazWasteOnline spreadsheets, most of the Made Ground has been initially classified as potentially hazardous waste, and some as hazardous. The table below summarises the initial classifications based on the borehole the sample was taken from, its depth and the contaminant/s triggering the potentially hazardous or hazardous classification.

Borehole Reference	Depth (m bgl)	Initial Classification	Triggering Contaminant/s
BHB2A	1.0	Hazardous	TPH
BHB2A	4.0	Potentially hazardous	TPH
BHB2A	8.25	Potentially hazardous	TPH
WSB1	0.1	Potentially hazardous	TPH
WSB1	0.5	Potentially hazardous	TPH
WSB2	0.1	Potentially hazardous	TPH
WSB2	0.5	Potentially hazardous	TPH
WSB2	1.5	Potentially hazardous	TPH
WSB2	3.0	Potentially hazardous	TPH
WSB5	0.1	Potentially hazardous	TPH
WSB5	0.5	Potentially hazardous	TPH
WSB5	1.0	Potentially hazardous	TPH
WSB6	0.1	Potentially hazardous	TPH
WSB6	0.8	Potentially hazardous	TPH
WSB6	2.1	Hazardous	TPH, Copper
WSB3	0.2	Hazardous	TPH, Lead, Zinc
WSB3	0.9	Potentially hazardous	TPH
WSB3	2.5	Potentially hazardous	TPH
WSB4	0.1	Potentially hazardous	TPH
WSB4	0.5	Potentially hazardous	TPH
WSB4	1.5	Potentially hazardous	TPH
WSB4	2.8	Potentially hazardous	TPH

The reason for the initial classification for most of the Made Ground as potentially hazardous is due to potential flammability. However, the concentrations of hydrocarbons within the soils classified as

potentially hazardous are less than 1,000mg/kg and these concentrations are not high enough for flammability to be relevant. In addition, the initial hazardous classification for the sample from 1.0m depth at BHB2A is due to the TPH concentration being greater than 1,000mg/kg. However, a second TPH test carried out on the same sample recorded a total TPH concentration of 247mg/kg and total TPHs for the other samples from the same borehole were all below 1,000mg/kg. Based on the results of this second test and the concentrations of total TPH from tests carried out on other samples from the same borehole all being below 1,000mg/kg, it is considered flammability due to TPH concentrations within the Made Ground is not a significant risk at this site.

The other initial hazardous classifications were triggered by high copper (WSB6) and lead and zinc (WSB3) concentrations. The high concentrations of copper, lead and zinc at these locations are not representative of site wide concentrations and tests carried out samples from the same boreholes did not reveal high concentrations of copper, lead or zinc. On this basis, it is considered the lateral and vertical extent of the hazardous soil is very limited and overall the Made Ground should not be classified as hazardous.

Some free fibres of chrysotile asbestos were identified in the Made Ground at the site. However, advice from the asbestos removal specialists eBrit Services Ltd indicates the concentrations recorded are not high enough to classify the soil as hazardous.

On the basis of the above it is considered the Made Ground at the site should be classified as **non-hazardous** waste. However, note should be made of the few high concentrations of total TPH, lead, copper and zinc recorded in the soil testing and the presence of some free chrysotile in the Made Ground. If unexpected contamination is encountered further testing should be carried out.

A summary of the results of the assessment is provided in Appendix C. The full details of the assessment are available upon request.

Waste Acceptance Criteria (WAC) Testing Results

To further classify the waste soil for landfill disposal, Waste Acceptance Criteria (WAC) testing has been carried out on four representative samples of the Made Ground collected by Listers Geotechnical Consultants from site. The results show that this soil **fails** the **inert** waste criteria due to the levels of total organic carbon, total PAHs and antimony within the Made Ground.

The laboratory testing results are presented in Appendix C.

Waste Classification

From the results of the HazWasteOnline spreadsheets and the WAC testing, currently, the waste soil on this site is classified as **non-hazardous**.

Analytical results relevant to the materials being disposed of should be provided to the landfill operators or waste management contractors to confirm whether it meets their license agreements and to confirm tipping costs.

The Landfill Regulations dictate that all waste must be treated before going to landfill. This treatment should fulfil all of the following three criteria:

- Physical, thermal, chemical or biological process including sorting.
- Change the characteristics of the waste.
- Reduce the volume, reduce the hazardous nature, facilitate its handling or enhance its recovery.

The most basic method of pre-treatment is sorting of the waste and re-cycling any possible materials, many waste disposals companies will have on-site recycling facilities that will be able to undertake this process at the landfill site. However, if treatment would not reduce its quantity or the hazards it poses to human health or the environment, then all three steps may not be necessary. The exception is inert waste for which treatment is not technically feasible.

The Environment Agency expect all landfill operators to obtain written evidence that the waste they accept has been pre-treated. We recommend that a signed certificate should be obtained describing the treatment to give to the receiving landfill. Further testing may be required after the treatment before the soil is accepted by the relevant landfill.

Site Waste Management Plan

Currently, in England, you must have a site waste management plan (SWMP) for all new construction projects worth more than £300,000.

The level of detail that your SWMP should contain depends on the estimated build cost, excluding VAT.

For projects estimated at between £300,000 and £500,000 (excluding VAT) the SWMP should contain details of the:

- types of waste removed from the site

- identity of the person who removed the waste
- site that the waste is taken to

For projects estimated at over £500,000 (excluding VAT) the SWMP should contain details of the:

- types of waste removed from the site
- identity of the person who removed the waste and their waste carrier registration number
- a description of the waste
- site that the waste was taken to
- environmental permit or exemption held by the site where the material is taken

At the end of the project, you must review the plan and record the reasons for any differences between the plan and what actually happened.

SUBSURFACE CONCRETE

Chemical tests carried out as part of the Campbell Reith Consulting Engineer's Geoenvironmental Land Quality Statement Report (reference 10907 and dated November 2012) on selected samples recovered from this site recorded soluble sulphate concentrations ranging from <0.003g/l to 1.730g/l, and pH values ranging from 4.4 to 11.8. The site is underlain by granular soils, therefore the groundwater conditions are assumed to be mobile.

In accordance with BRE Special Digest 1, 'Concrete in Aggressive Ground,' (2005) the Design Sulphate Class should be assumed as DS-2 and the Aggressive Chemical Environment for Concrete as ACEC AC-3z.

UNDERGROUND SERVICES

Elevated levels of lead were recorded in the made ground at the site. These could potentially affect services pipes. It should be noted that the utility companies often have their own local guidelines and standards on levels of shallow soil contamination in the ground that may or may not be acceptable for the installation of below ground services. These standards may be different to those specified for assessing risks to human health and groundwater.

The local requirements should be obtained from the particular service supply company as soon as possible to avoid unexpected delays or additional development costs.

Guidance can be sought from the UK Water Industry Research (UKWIR), 'Guidance for the selection of water supply pipes to be used in brownfield sites', reference 10/WM/03/21 and 'Pipe materials selection and specification for use in contaminated land', referenced 04/WM/03/0. These documents propose that the assessment of the hazard to potable water supply pipes should be based on the following pathways: contact with migrating groundwater, permeation of vapour, and direct contact with soil.

Approval should be sought for the type of pipes proposed before they are installed.

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18. Wragg J, Cave M, Taylor H, Gowing C and Gregory, 'The Solid Phase Distribution and Bioaccessibility of Arsenic, Chromium and Nickel in Natural Ironstone Soils in the UK', BGS 2012.

19. Assessing Risks Posed by Hazardous Ground Gases to Buildings, CIRIA C665, 2007.

20. UK Water Industry Research (UKWIR), 'Guidance for the Selection of Water Supply Pipes to be Used in Brownfield Sites', 10/WM/03/21.

LISTERS 14.04.022

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Signed.....
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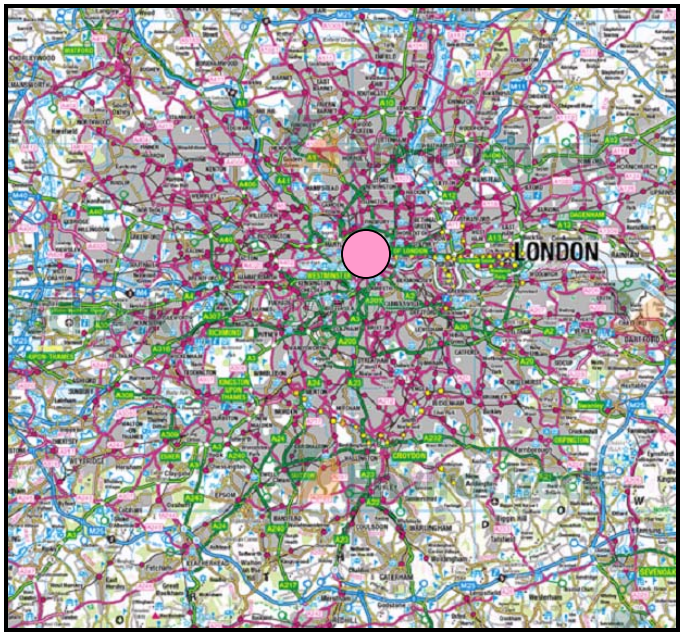
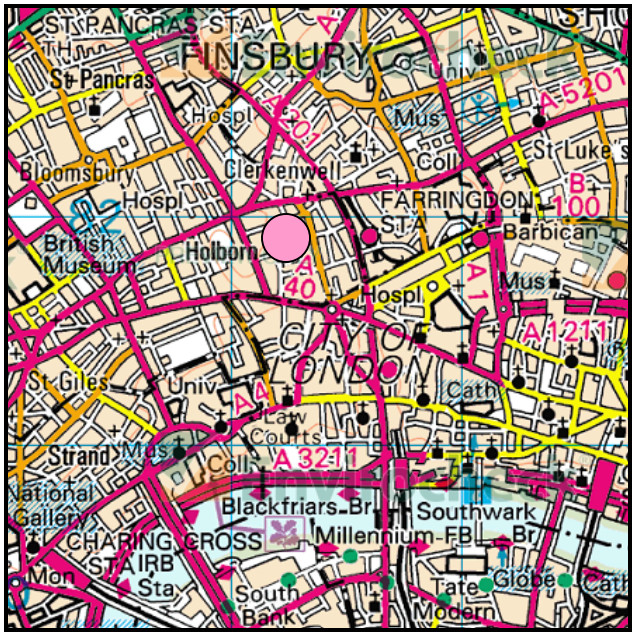
Checked By: -

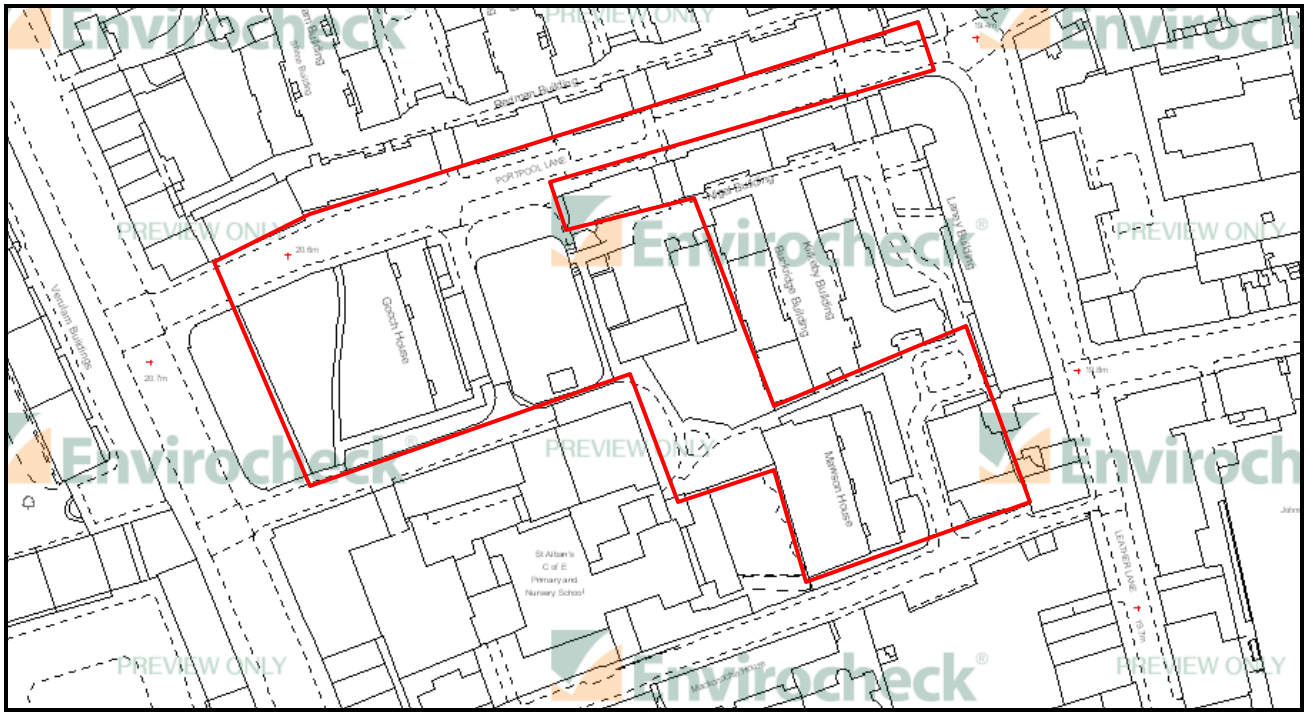
Signed.....
Dr Mark Cowley
BSc, MSc, PhD, MCSM, FGS, CGeol, CSci

For and on behalf of Listers Geotechnical Consultants

APPENDIX A
PLANS AND PLOTS







Project Ref: 14.04.016

Approximate location of the site

Site boundaries

Listers Geotechnical Consultants Ltd.

Slapton Hill Barn,
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Northants,
NN12 8QD
Telephone: (01327) 860060
Email: info@listersgeotechnics.co.uk

Title: **Site Location and Boundaries Plan**

Site: **Bourne Estate, Holborn London, EC1N 7SD**

Scale: NTS	**Drawn by: LC**
Date: 05/14	**Dwg No:** Fig 1

Notes:

1 These proposals are subject to the following surveys which have not been carried out: digital site survey; tube line survey; utilities searches; geotechnical survey; land registry investigation.

2 These proposals are subject to comments from the following parties: the local Planning Authority; Building Control; M&E consultant; Transport consultant; Architectural Liaison Officer (SBD); Daylight / Sunlight consultant.

Date	Rev	By	Comments
Date	Rev	By	Comments

Issued to

Drawing status: PRELIMINARY

MatthewLloydArchitectsLLP

©2011

Project: **Bourne Estate for LB Camden**

Drawing title: Proposed Site Plan

Date	Scale	Drawn by	Checked by
AUG 2012	1:1000@A1	GW	
Drawing no.		200	Revision -

NTS@A3

Camden

Tybalds and Bourne

Client: London Borough of Camden

Figure 3:
Proposed Development Plan

CampbellReith
consulting engineers
LONDON 020 7340 1700 • MANCHESTER 0161 819 3060
REDHILL 01737 784 500 • BIRMINGHAM 01675 467 484
BRISTOL 0117 916 1066 • www.campbellreith.com

	20'0" - 21'6"	Firm Brown Clay
	21'6" - 35'0"	Stiff Blue Clay

S.W.L. 15'0"

W.S. 15'0"
Depth of Borehole 35'0"

Borehole No.3	0 - 10'0"	Made up ground
	10'0"- 11'3"	Brown Clay and Stones
	11'3"- 17'6"	Gravel and Sand Base of Drift at +59 3'0D
	17'6"- 19'0"	Firm Brown Clay
	19'0"- 32'6"	Stiff Blue Clay

S.W.L. 14'6"

W.S. 14'6"
Depth of borehole 32'6 "

TQ 38 SW / 682 3126 8191.

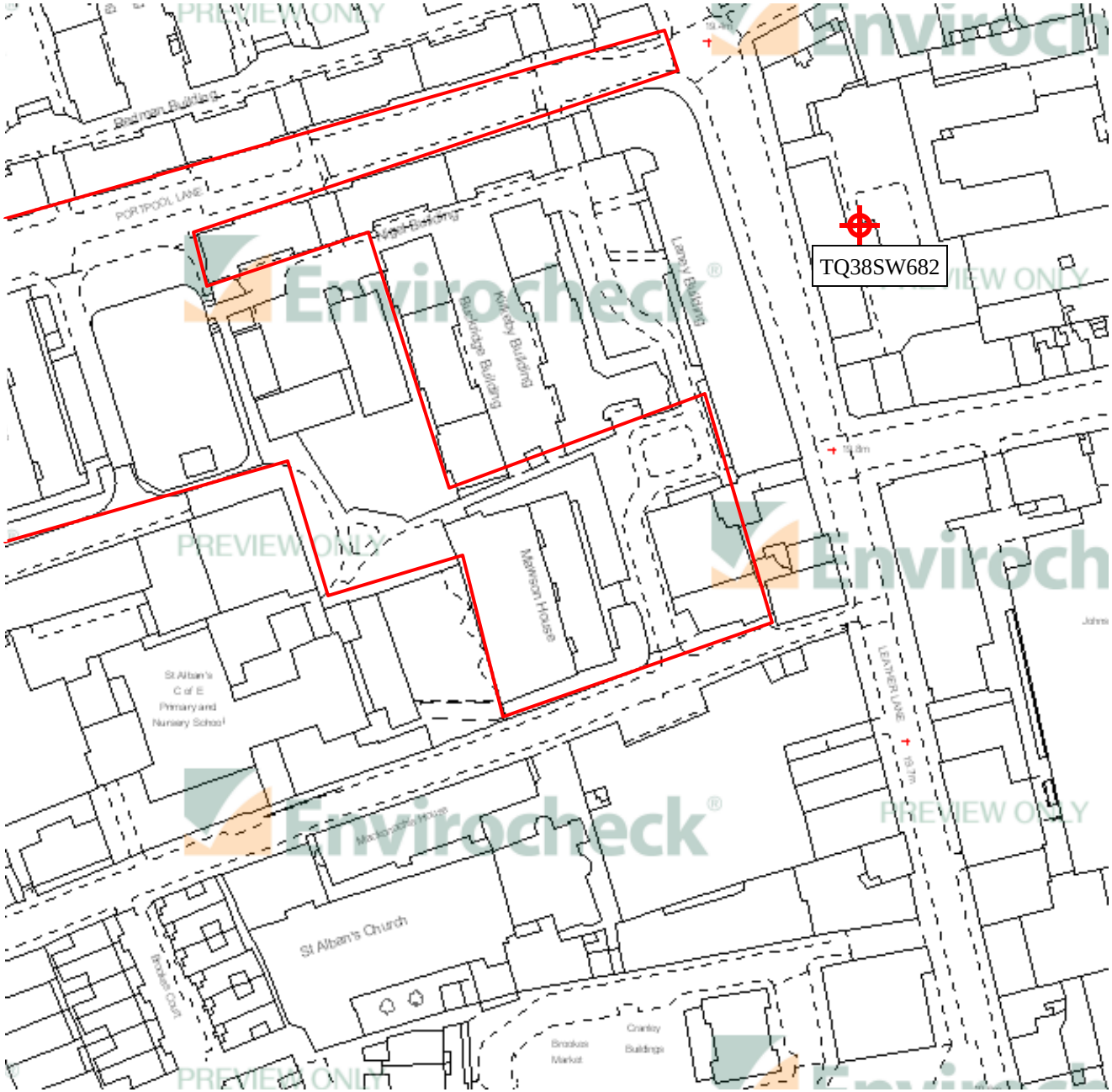
SITE REFERENCE NO.5

Hatton Garden	June 1959	Borehole commenced 9'0" below pavement level
Borehole No.1	0' - 1'3" (0.38)	Made up ground OD ca +56' c+17.07m
	1'3" - 4'0" (1.22)	Moist loamy sand
	4'0" - 8'0" (2.44)	Sandy gravel with some clay
	8'0" - 10'6" (3.20)	Wet coarse brown sand and small gravel
	10'6" - 12'6" (3.81)	Dense, wet brown coarse sand Base of Drift at +36.5'
	12'6" - 13'6"	Soft brown sandy clay
	13'6" - 28'0"	Firm blue laminated clay with fine bands of silty sand
	28'0" - 29'6"	Hard blue laminated clay containing some dark silty sand
	29'6" - 30'6"	Firm blue laminated clay with ¾" thick bands of dark silty sand
	30'6" - 31'6"	Hard grey blue laminated clay containing some lignite and grey sand
	31'6" - 35'0"	Hard blue laminated clay with thin bands of black silty sand
	35'0" - 40'0" (12.19)	Very hard blue laminated clay

Water met at 6'6"

Depth of borehole 40'0"

Borehole No.		Borehole commenced 9'2" below pavement level
	0 - 3'4"	Made up ground
	3'4" - 7'6"	very loose sandy gravel
	7'6" - 12'6"	loose very coarse sand with some small gravel
	12'6" - 13'6"	Soft brown clay +34.5'OD
	13'6" - 30'0"	firm blue laminated clay with thin bands of black and grey sand
	30'0" - 33'0"	hard blue laminated clay with bands of sand



Project Ref: 14.04.016

Approximate location of historic borehole

Site boundaries

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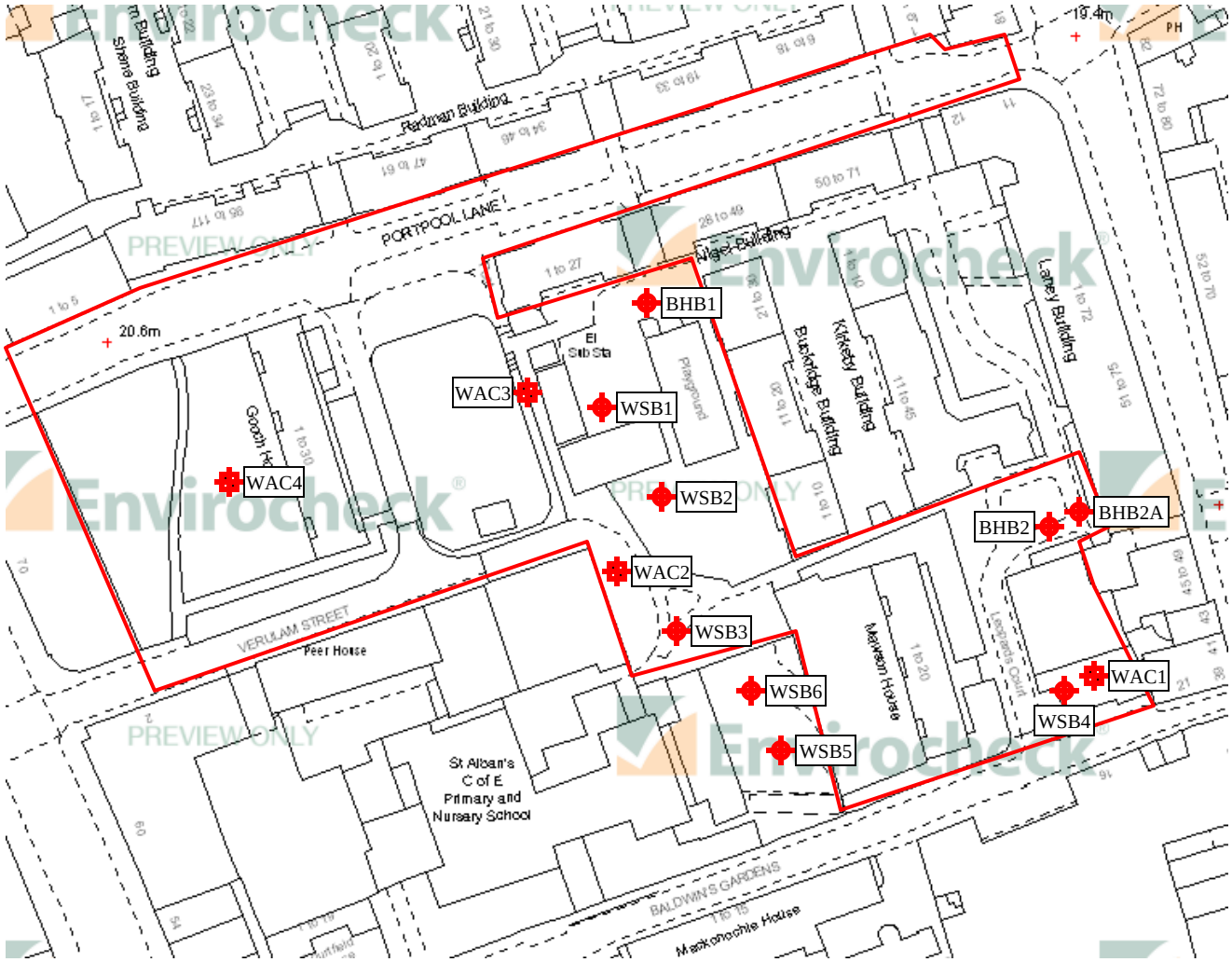
Title: **Historic Borehole Location Plan**

Site: **Bourne Estate, Holborn London, EC1N 7SD**

Scale: NTS	**Drawn by:** LC
Date: 05/14	**Dwg No:** Fig 3



Project Ref: 14.04.016

Approximate locations of Campbell Reith's boreholes

Approximate locations of Listers' hand excavated trial pits

Listers Geotechnical Consultants Ltd.

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Towcester,
Northants,
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Telephone: (01327) 860060
Email: info@listersgeotechnics.co.uk

Title: Exploratory Hole Location Plan

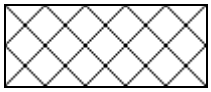
Site: Bourne Estate, Holborn London, EC1N 7SD

Scale: NTS	**Drawn by:** LC
Date: 05/14	**Dwg No:** Fig 2

APPENDIX B
FIELDWORK AND TESTING

1.0 SOIL/ROCK SYMBOLS

1.1 Soils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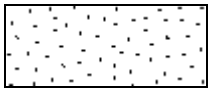
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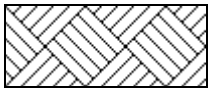
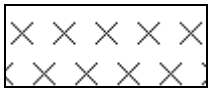
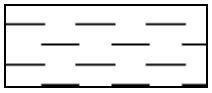
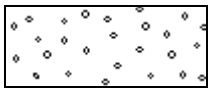
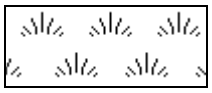

Topsoil


Silt

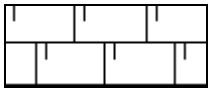

Boulders and Cobbles


Clay


Gravel


Peat

1.2 Rocks, Sedimentary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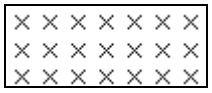
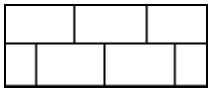
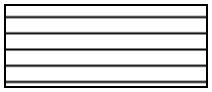
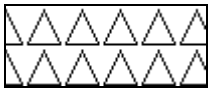

Siltstone

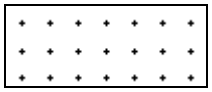

Limestone


Mudstone


Conglomerate


Breccia


Coal


Sandstone

SOIL/ROCK SYMBOLS

LOCATION: Bourne Estate, Holborn

TRIAL PIT: WAC1

Date of Excavation: 17/04/2014

Description of Strata	Strata Change			Samples		Hand Vane (kPa) (Cu)	Water Level -m
	Legend	Depth -m		Depth -m	Type		
		Scale	Strata				
MADE GROUND Dark brown slightly gravelly medium sand. Gravel is fine to coarse sub-rounded to sub-angular chert and brick		0.00	(0.30)				
MADE GROUND Brown very gravelly fine to coarse sand. Gravel is fine to coarse sub-angular brick. Contains occasional cobble sized brick			0.30	0.30-0.70	B		Dry
			(0.50)				
Trial Pit terminated at 0.80 m		1.00	0.80				

Remarks

1. Method of excavation: Hand excavated
2. Trial pit dimensions: 0.5m x 0.5m
3. maximum depth of visible roots: None encountered
4. Groundwater: None encountered
5. Sides stable

▽	Water Strike
▼	Water (Standing Level)
W	Water Sample
B	Bulk Sample
D	Small Disturbed Sample
V	Vane Test
K	Chemical Sample
J	Jar Sample
CBR	CBR Sample
C	Core

Date April 2014	**TRIAL PIT LOG**	**Report No.** 14.04.016 **Client Ref:**

LOCATION: Bourne Estate, Holborn

TRIAL PIT: WAC2

Date of Excavation: 17/04/2014

Description of Strata	Strata Change			Samples		Hand Vane (kPa) (Cu)	Water Level -m
	Legend	Depth -m		Depth -m	Type		
		Scale	Strata				
MADE GROUND Dark brown slightly clayey medium sand.		0.00	(0.40)				
MADE GROUND Brown very gravelly fine to coarse sand. Gravel is fine to coarse sub-angular brick.			0.40	0.40-0.70	B		Dry
			(0.40)				
Trial Pit terminated at 0.80 m			0.80				
		1.00					

Remarks

1. Method of excavation: Hand excavated
2. Trial pit dimensions: 0.5m x 0.5m
3. maximum depth of visible roots: None encountered
4. Groundwater: None encountered
5. Sides stable

▽	Water Strike
▼	Water (Standing Level)
W	Water Sample
B	Bulk Sample
D	Small Disturbed Sample
V	Vane Test
K	Chemical Sample
J	Jar Sample
CBR	CBR Sample
C	Core

Date April 2014	**TRIAL PIT LOG**	**Report No.** 14.04.016 **Client Ref:**

LOCATION: Bourne Estate, Holborn

TRIAL PIT: WAC3

Date of Excavation: 17/04/2014

Description of Strata	Strata Change			Samples		Hand Vane (kPa) (Cu)	Water Level -m
	Legend	Depth -m		Depth -m	Type		
		Scale	Strata				
MADE GROUND Dark brown gravelly medium sand. Gravel is fine to coarse sub-rounded to sub-angular chert and brick		0.00	(0.10) 0.10				
MADE GROUND Dark brown very gravelly fine to coarse sand. Gravel is fine to coarse sub-rounded to sub-angular chert, concrete and brick. Contains some cobble sized brick and concrete			(0.40)	0.20-0.50	B		Dry
Trial Pit terminated at 0.50 m		1.00	0.50				

Remarks

1. Method of excavation: Hand excavated
2. Trial pit dimensions: 0.5m x 0.5m
3. maximum depth of visible roots: None encountered
4. Groundwater: None encountered
5. Sides stable

▽	Water Strike
▼	Water (Standing Level)
W	Water Sample
B	Bulk Sample
D	Small Disturbed Sample
V	Vane Test
K	Chemical Sample
J	Jar Sample
CBR	CBR Sample
C	Core

Date	TRIAL PIT LOG	Report No. 14.04.016
April 2014		Client Ref:

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Percussion Borehole Record

BH B1

Project: Bourne Estate, Camden

Project ID.: GL16482

Coordinates: 531163.3E 181908.3N

Ground Level: 19.53mAOD

Sheet 1 of 1

Description	Depth (m)	O.D. Level (m)	Samples/ Test Type	Samples/ Test Depth (m)	Casing (Water) Depth (m)	Remarks and Test Results
ASPHALT.	0.15	19.38				
MADE GROUND. Medium dense brown, dark brown and grey brown locally slightly clayey silty gravelly fine and medium occasionally coarse SAND. Gravel is angular fine to coarse brick, occasional concrete, rare wood, glass and metal fragments.			ES1	0.25		
			D1	0.50		
			ES2	0.50		
			ES3	1.00		
			C	1.20	1.20	N=13 (2,2,3,3,3,4)
			B1	1.20-1.65		
			ES4	1.50		
			D2	1.80		
			ES5	2.00		
			C	2.50	2.50	N=23 (4,7,9,4,3,7)
			B2	2.50-2.95		
			ES6	2.50		
	2.90	16.63	D3	2.90		
Medium dense to dense yellow brown and brown silty fine to coarse SAND and subrounded to rounded fine to coarse flint GRAVEL. (HACKNEY GRAVEL).			ES7	3.00		
			C	3.50	3.50	N=26 (3,4,4,6,7,9)
			B3	3.50-3.95		
			ES8	3.50		
			D4	4.00		
			ES9	4.00		
			C	4.50	4.50	N=35 (4,6,8,8,9,10)
			B4	4.50-4.95		
			ES10	5.00		
			D5	5.50		
			C	6.00	6.00	N=33 (2,5,7,8,9,9)
			ES11	6.00		
			B5	6.00-6.45		
			ES12	7.00		
			D6	7.00		
			C	7.50	7.50	N=16 (3,3,4,4,4,4)
			B6	7.50-7.95		
Firm to stiff brown silty CLAY. (LONDON CLAY).	7.70	11.83	D7	7.70		
			ES13	7.90		
(Firm to stiff) fissured dark grey silty CLAY. Occasional light grey silt laminae and fissure infill. (LONDON CLAY).	8.00	11.53	D8	8.00		
			ES14	8.25		
			UT1	9.00-9.45		46 blows: 100% recovery
			D9	9.45-9.55		

Installations: 0.20, 1.00, 3.00, 4.00, 8.00

Borehole Complete at 10.00 m

Hole Diameter Details			Chiselling Details		
Diameter (mm)	Depth (m)	Casing Depth (m)	From (m)	To (m)	Time (hhmm)
150	10.00	8.00			

Water Level Observations

Date	Water Strike (m)	Standing Time (mins)	Standing Level (m)	Casing Depth (m)	Depth Sealed (m)

Client: Tibbalds Planning and Urban Design

Engineer: Campbell Reith Hill LLP

Contractor: Harrison Group Environmental Limited

Dates: 12/03/2012

Plant: Dando 2000 Cable Percussive Rig

Drilled By: K. Gorbould

Logged By: G. Dowlen

Checked By: J. Keay

Remarks:

1. Inspection pit excavated from GL to 1.20mbgl.
2. Groundwater was not encountered.
3. Water added to assist drilling from 2.90mbgl to 7.70mbgl (300 litres).
4. Installation details (Dual): 50mm diameter HDPE standpipe (A) installed from 8.00mbgl to GL. Slotted from 8.00mbgl to 4.00mbgl, plain from 4.00mbgl to GL. 50mm diameter HDPE standpipe (B) installed from 3.00mbgl to GL. Slotted from 3.00mbgl to 1.00mbgl, plain from 1.00mbgl to GL. Finished with gas taps, end caps and flush fitting cover. Geowrap and geosock used.
5. Backfill details: Bentonite pellets from 10.00mbgl to 8.00mbgl, gravel filter packs from 8.00mbgl to 4.00mbgl, bentonite pellets from 4.00mbgl to 3.00mbgl, gravel filter packs from 3.00mbgl to 1.00mbgl, bentonite pellets from 1.00mbgl to 0.20mbgl and concrete from 0.20mbgl to GL.
6. Standing Time/ Dayworks: 1.0 hour filling bowser, 0.5 hour movong rig, 1.0 hour bagging spoil and cleaning the site, 0.5 hour collecting installation material on 12/03/2012.

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Percussion Borehole Record

BH B2

Project: Bourne Estate, Camden

Project ID.: GL16482

Coordinates: 531227.2E 181873.0N

Ground Level: 19.75mAOD

Sheet 1 of 1

Description	Legend	Depth (m)	O.D. Level (m)	Samples/ Test Type	Samples/ Test Depth (m)	Casing (Water) Depth (m)	Remarks and Test Results	Installations
ASPHALT.		0.20	19.55					0.40
MADE GROUND. Light yellow brown silty fine to coarse SAND and subangular to subrounded fine to coarse sub base GRAVEL.		0.35	19.40	B1	0.50-0.70			0.70
MADE GROUND. Black, dark grey and red brown silty gravelly fine and medium SAND. Gravel is angular fine to coarse brick. At 0.70m: cast iron pipe.		0.70	19.05					
Borehole Complete at 0.70 m								

Water Level Observations

Hole Diameter Details			Chiselling Details			Date	Water Strike (m)	Standing Time (mins)	Standing Level (m)	Casing Depth (m)	Depth Sealed (m)
Diameter (mm)	Depth (m)	Casing Depth (m)	From (m)	To (m)	Time (hhmm)						

Client: Tibbalds Planning and Urban Design

Engineer: Campbell Reith Hill LLP

Contractor: Harrison Group Environmental Limited

Dates: 07/03/2012

Plant: Dando 2000 Cable Percussive Rig

Drilled By: K. Gorbould

Logged By: G. Dowlen

Checked By: J. Keay

Remarks:

1. Inspection pit excavated from GL to 0.70mbgl.
2. Groundwater was not encountered.
3. Metal pipe encountered at 0.70mbgl. Borehole terminated and moved to position BH B2A.
4. Backfill details: Arisings from 0.70mbgl to 0.40mbgl and concrete from 0.40mbgl to GL.
5. Standing Time/ Dayworks: 1.0 hour awaiting borehole position, 1.0 hour clearing service and 1.5 hour awaiting instruction on pipe on 07/03/2012.

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Percussion Borehole Record

BH B2A

Project: Bourne Estate, Camden

Project ID.: GL16482

Coordinates: 531227.1E 181873.9N

Ground Level: 19.74mAOD

Sheet 1 of 3

Description	Legend	Depth (m)	O.D. Level (m)	Samples/ Test Type	Samples/ Test Depth (m)	Casing (Water) Depth (m)	Remarks and Test Results	Installations
ASPHALT.		0.20	19.54					0.20
MADE GROUND. Light yellow brown silty fine to coarse SAND and subangular to subrounded fine to coarse sub base GRAVEL.		0.35	19.39	ES1	0.30			
				ES2	0.50			
MADE GROUND. Loose becoming medium dense brown, grey brown and dark brown silty gravelly fine to coarse SAND. Gravel is angular fine to coarse brick. Occasional brick cobbles and lenses of grey brown silty sandy gravelly clay.				D1	1.00			1.00
				ES3	1.00			
				C	1.50		N=8 (1,1,1,2,3,2)	
				B1	1.50-1.95			
				ES4	1.50			
				D2	2.00			
				ES5	2.00			
				C	2.50	1.50	N=15 (2,4,4,5,3,3)	
				B2	2.50-2.95			
				ES6	2.50			
				D3	3.00			
				ES7	3.00			
				C	3.50	3.00	N=12 (2,2,2,3,3,4)	
				B3	3.50-3.95			
				ES8	3.50			
				D4	4.00			4.00
				ES9	4.00			
				C	4.50	3.00	N=12 (1,2,2,3,3,4)	
				ES10	4.50			
				B4	4.50-4.95			
				ES11	5.00			
		5.10	14.64	D5	5.00			5.00
Dense yellow brown silty fine to coarse SAND and GRAVEL. Gravel is subrounded to rounded fine to coarse flint. (HACKNEY GRAVEL).				ES12	5.50			
				C	6.00	6.00	N=33 (3,5,7,7,9,10)	
				ES13	6.00			
				B5	6.00-6.45			
				ES14	6.50			
				ES15	7.00			
				C	7.50	6.00	N=17 (2,3,4,4,4,5)	
				ES16	7.50			
		7.70	12.04	B6	7.50-7.95			
(Firm to stiff) brown and grey brown slightlt sandy slightly gravelly silty CLAY. Gravel is rounded fine to coarse flint. (REWORKED LONDON CLAY).				ES17	7.80			
		8.00	11.74	D6	8.00			8.00
				ES18	8.20			
Firm to stiff fissured grey silty CLAY. Occasional light grey silt laminae and fissure infill. (LONDON CLAY).				S	9.00	9.00	N=17 (3,4,4,4,4,5)	
				D7	9.00-9.45			

Continued next sheet

Water Level Observations

Hole Diameter Details			Chiselling Details			Date	Water Strike (m)	Standing Time (mins)	Standing Level (m)	Casing Depth (m)	Depth Sealed (m)
Diameter (mm)	Depth (m)	Casing Depth (m)	From (m)	To (m)	Time (hhmm)						
200	18.00	9.00				08/03/12	22.50	20	20.42	18.50	
150	30.00	30.00									

Client: Tibbalds Planning and Urban Design

Engineer: Campbell Reith Hill LLP

Contractor: Harrison Group Environmental Limited

Dates: 07/03/2012-09/03/2012

Plant: Dando 2000 Cable Percussive Rig

Drilled By: K. Gorbould

Logged By: G. Dowlen

Checked By: J. Keay

Remarks:

1. Inspection pit excavated from GL to 1.20mbgl.
2. Water added to assist drilling from 4.90mbgl to 7.70mbgl (250 litres).
3. Installation details: 50mm diameter HDPE standpipe installed from 8.00mbgl to GL. Slotted from 8.00mbgl to 5.00mbgl, plain from 5.00mbgl to GL. Finished with gas tap, end cap and flush fitting cover. Geowrap and geosock used.
4. Backfill details: Arisings from 30.00mbgl to 10.00mbgl, bentonite pellets from 10.00mbgl to 8.00mbgl, gravel filter packs from 8.00mbgl to 5.00mbgl, bentonite pellets from 5.00mbgl to 4.00mbgl, arisings from 4.00mbgl to 1.00mbgl, bentonite pellets from 1.00mbgl to 0.20mbgl and concrete from 0.20mbgl to GL.
5. Standing Time/ Dayworks: 3.0 hours bagging spoil and cleaning the site, 2.0 hours leaving rig set up to give access to the car park on 09/03/2012.

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Percussion Borehole Record

BH B2A

Project: Bourne Estate, Camden

Project ID.: GL16482

Coordinates: 531227.1E 181873.9N

Ground Level: 19.74mAOD

Description	Legend	Depth (m)	O.D. Level (m)	Samples/ Test Type	Samples/ Test Depth (m)	Casing (Water) Depth (m)	Remarks and Test Results	Installations
Firm to stiff fissured grey silty CLAY. Occasional light grey silt laminae and fissure infill. (LONDON CLAY).				UT1	10.50-10.95		61 blows: 90% recovery	10.00
		11.00	8.74	D8	10.95-11.05			
Stiff closely fissured grey silty CLAY. Occasional light grey silt laminae and fissure infill. Occasional sand size selenite crystals. (LONDON CLAY).								
At 12.00m: becomes stiff.				S D9	12.00 12.00-12.45	9.00	N=24 (3,4,5,6,6,7)	
				UT2	13.50-13.95		77 blows: 100% recovery	
				D10	13.95-14.05			
				S D11	15.00 15.00-15.45	9.00	N=28 (4,4,6,7,7,8)	
				UT3	16.50-16.95		100 blows: 100% recovery	
				D12	16.95-17.05			
				S D13	18.00 18.00-18.95	9.00	N=27 (4,5,5,7,7,8)	
		18.60	1.14	D14	18.60			
Very stiff to hard closely fissured grey blue and brown CLAY. (LAMBETH GROUP).				UT4	19.50-19.95		100 blows: 75% recovery	
				D15	19.95-20.05			

Water Level Observations

Hole Diameter Details			Chiselling Details			Date	Water Strike (m)	Standing Time (mins)	Standing Level (m)	Casing Depth (m)	Depth Sealed (m)
Diameter (mm)	Depth (m)	Casing Depth (m)	From (m)	To (m)	Time (hhmm)						
200 150	18.00 30.00	9.00 30.00				08/03/12	22.50	20	20.42	18.50	

Client: Tibbalds Planning and Urban Design

Engineer: Campbell Reith Hill LLP

Contractor: Harrison Group Environmental Limited

Dates: 07/03/2012-09/03/2012

Plant: Dando 2000 Cable Percussive Rig

Drilled By: K. Gorbould

Logged By: G. Dowlen

Checked By: J. Keay

Remarks:

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Percussion Borehole Record

BH B2A

Project: Bourne Estate, Camden

Project ID.: GL16482

Coordinates: 531227.1E 181873.9N

Ground Level: 19.74mAOD

Sheet 3 of 3

Description	Legend	Depth (m)	O.D. Level (m)	Samples/ Test Type	Samples/ Test Depth (m)	Casing (Water) Depth (m)	Remarks and Test Results	Installations
Very stiff to hard closely fissured grey blue and brown CLAY. (LAMBETH GROUP).				S D16	21.00 21.00-21.45	9.00	50/230mm (8,17,20,14,15,1)	
		22.50	-2.76	W1 UT5	22.50 22.50-22.95		100 blows: 100% recovery	
Blue green clayey fine to coarse SAND. (LAMBETH GROUP).		22.90	-3.16	D17	22.95-23.05			
Very stiff to hard closely fissured variably light blue grey, red brown and light grey slightly silty CLAY. (LAMBETH GROUP).				S D18	24.00 24.00-24.45	(23.10) 24.00	50/200mm (7,12,16,18,16)	
				UT6	25.50-25.95		100 blows: 60% recovery	
				D19	25.95-26.05			
				S D20	27.00 27.00-27.45	(20.20) 26.00	N=48 (3,5,8,12,13,15)	
				S D21	28.50 28.50-28.95	(22.30) 30.00	50/265mm (5,7,10,13,16,11)	

Borehole Complete at 30.00 m

Hole Diameter Details			Chiselling Details		
Diameter (mm)	Depth (m)	Casing Depth (m)	From (m)	To (m)	Time (hhmm)
200 150	18.00 30.00	9.00 30.00			

Water Level Observations

Date	Water Strike (m)	Standing Time (mins)	Standing Level (m)	Casing Depth (m)	Depth Sealed (m)
08/03/12	22.50	20	20.42	18.50	

Client: Tibbalds Planning and Urban Design

Engineer: Campbell Reith Hill LLP

Contractor: Harrison Group Environmental Limited

Dates: 07/03/2012-09/03/2012

Plant: Dando 2000 Cable Percussive Rig

Drilled By: K. Gorbould

Logged By: G. Dowlen

Checked By: J. Keay

Remarks:

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Window Sample Record

WS B1
Sheet 1 of 1

Project: Bourne Estate, Camden

Project ID: GL16482

Coordinates: 531151.0E 181888.5N

Ground Level: 19.55mAOD

Description	Legend	Depth (m)	O.D. Level (m)	Sample Test Type	Sample Test Depth (m)	Remarks and Test Results	Installations
ASPHALT.		0.08	19.47	ES1	0.10		
MADE GROUND. Yellow brown silty gravelly fine and medium occasionally coarse SAND. Gravel is rounded fine and medium flint.		0.20	19.35				
Reinforced CONCRETE.		0.30	19.25	ES2	0.50		
MADE GROUND. Yellow brown silty gravelly fine to coarse SAND. Gravel is angular to rounded fine to coarse flint, brick and rare concrete.				ES3	1.00		
Window Sample Complete at 1.20 m		1.20	18.35				1.20

Drive Records

Diameter (mm)	From (m)	To (m)	Recovery (%)

Water Level Observations

Date	Water Strike (m)	Standing Time (Mins)	Standing Level (m)	Casing Depth (m)	Depth Sealed (m)

Client: Tibbalds Planning and Urban Design
Engineer: Campbell Reith Hill LLP
Contractor: Harrison Group Environmental Limited
Date: 07/03/2012
Plant: Terrier Window Sampling Rig
Drilled By: M. Rose
Logged By: G. Dowlen
Checked By: J. Keay

Remarks:
1. Inspection pit excavated from GL to 1.20mbgl.
2. Groundwater was not encountered.
3. Obstruction encountered at 1.20mbgl. Window sample hole terminated.
4. Backfill details: Arisings from 1.20mbgl to GL.

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Window Sample Record

WS B2
Sheet 1 of 1

Project: Bourne Estate, Camden

Project ID: GL16482

Coordinates: 531161.4E 181877.7N

Ground Level: 19.51mAOD

Description	Legend	Depth (m)	O.D. Level (m)	Sample Test Type	Sample Test Depth (m)	Remarks and Test Results	Installations
MADE GROUND. (Soft) dark brown slightly gravelly silty sandy CLAY. Gravel is angular to rounded fine and medium brick and glass fragments.		0.20	19.31	ES1	0.10		0.20
MADE GROUND. (Soft to firm) dark brown and dark grey brown slightly sandy silty gravelly CLAY. Gravel is angular to rounded fine and medium occasionally coarse flint, brick and concrete. Rare brick cobbles.				ES2	0.50		
				ES3	1.00		1.00
MADE GROUND. very loose red brown brick GRAVEL and COBBLES.		1.10	18.41	S D1 LS1	1.20 1.20-1.65 1.20-2.00	N=3 (2,2,1,1,0,1)	
MADE GROUND. (Soft to firm) black, dark grey and grey brown slightly sandy silty gravelly CLAY. Gravel is angular to rounded fine and medium occasionally coarse flint, occasional brick and charcoal. Occasional oyster shells.		1.30	18.21	ES4	1.50		
				S D2 LS2 ES5	2.00 2.00-2.45 2.00-3.00 2.00	N=3 (1,0,0,1,0,2)	
				ES6	2.50		
				S D3 ES7	3.00 3.00-3.45 3.00	N=10 (1,1,1,1,3,5)	3.00
Window Sample Complete at 3.45 m		3.45	16.06				3.45

Drive Records

Diameter (mm)	From (m)	To (m)	Recovery (%)
115	1.20	2.00	100
115	2.00	3.00	100

Water Level Observations

Date	Water Strike (m)	Standing Time (Mins)	Standing Level (m)	Casing Depth (m)	Depth Sealed (m)

Client: Tibbalds Planning and Urban Design
Engineer: Campbell Reith Hill LLP
Contractor: Harrison Group Environmental Limited
Date: 07/03/2012
Plant: Terrier Window Sampling Rig
Drilled By: M. Rose
Logged By: G. Dowlen
Checked By: J. Keay

Remarks:
1. Inspection pit excavated from GL to 1.20mbgl.
2. Groundwater was not encountered.
3. Installation details: 50mm diameter HDPE standpipe installed from 3.45mbgl to GL. Slotted from 3.45mbgl to 1.00mbgl, plain from 1.00mbgl to GL. Finished with gas tap, end cap and flush fitting cover. Geowrap and geosock used.
4. Backfill details: Arisings from 3.45mbgl to 3.00mbgl. gravel filter packs from 3.00mbgl to 1.00mbgl, bentonite pellets from 1.00mbgl to 0.20mbgl and concrete from 0.20mbgl to GL.

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Window Sample Record

WS B3
Sheet 1 of 1

Project: Bourne Estate, Camden

Project ID: GL16482

Coordinates: 531163.4E 181856.5N

Ground Level: 19.73mAOD

Description	Depth (m)	O.D. Level (m)	Sample Test Type	Sample Test Depth (m)	Remarks and Test Results
Grass over TOPSOIL. Dark brown clayey sandy SILT.			ES1	0.15	
	0.30	19.43			
MADE GROUND. Medium dense becoming loose brown, grey brown and dark brown silty gravelly fine and medium occasionally coarse SAND. Gravel is angular fine and medium occasionally coarse brick and rare concrete. Occasional brick cobbles.			ES2	0.50	
			ES3	0.90	
			ES4	1.10	
			S D1 LS1	1.20 1.20-1.45 1.20-2.00	N=18 (2,3,5,7,3,3)
			ES5	1.50	
			S D2 LS2 ES6	2.00 2.00-2.45 2.00-3.00 2.00	N=6 (1,2,2,2,1,1)
	2.30	17.43			
MADE GROUND. Very loose dark brown and yellow brown silty gravelly fine and medium occasionally coarse SAND. Gravel is angular to rounded fine and medium occasionally coarse flint, occasional brick and charcoal fragments. Occasional oyster shells.			ES7	2.50	
			S D3 ES8	3.00 3.00-3.45 3.00	N=2 (1,0,0,1,0,1)
	3.45	16.28			
Window Sample Complete at 3.45 m					

Installations: 0.20, 1.00, 3.00, 3.45

Water Level Observations

Date	Water Strike (m)	Standing Time (Mins)	Standing Level (m)	Casing Depth (m)	Depth Sealed (m)

Drive Records

Diameter (mm)	From (m)	To (m)	Recovery (%)
115	1.20	2.00	100
115	2.00	3.00	100

Client: Tibbalds Planning and Urban Design
Engineer: Campbell Reith Hill LLP
Contractor: Harrison Group Environmental Limited
Date: 07/03/2012
Plant: Terrier Window Sampling Rig
Drilled By: M. Rose
Logged By: G. Dowlen
Checked By: J. Keay

Remarks:
1. Inspection pit excavated from GL to 1.20mbgl.
2. Groundwater was not encountered.
3. Installation details: 50mm diameter HDPE standpipe installed from 3.45mbgl to GL. Slotted from 3.45mbgl to 1.00mbgl, plain from 1.00mbgl to GL. Finished with gas tap, end cap and flush fitting cover. Geowrap and geosock used.
4. Backfill details: Arisings from 3.45mbgl to 3.00mbgl. gravel filter packs from 3.00mbgl to 1.00mbgl, bentonite pellets from 1.00mbgl to 0.20mbgl and concrete from 0.20mbgl to GL.

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Window Sample Record

WS B4
Sheet 1 of 1

Project: Bourne Estate, Camden

Project ID: GL16482

Coordinates: 531233.2E 181842.9N

Ground Level: 19.95mAOD

Description	Legend	Depth (m)	O.D. Level (m)	Sample Test Type	Sample Test Depth (m)	Remarks and Test Results	Installations
Grass over TOPSOIL. Dark brown organic clayey silty fine SAND.		0.15	19.80	ES1	0.10		0.20
				ES2	0.25		
MADE GROUND. Dark brown silty gravelly fine and medium occasionally coarse SAND. Gravel is subangular fine to coarse brick and concrete. Occasional brick cobbles.				ES3	0.50		
				ES4	1.00		1.00
MADE GROUND. Medium dense off white and light yellow brown silty gravelly fine and medium SAND. Gravel is angular fine to coarse brick and concrete.		1.20	18.75	S D1 LS1	1.20 1.20-1.65 1.20-2.00	N=12 (2,1,2,3,3,4)	
				ES5	1.50		
				S D2 LS2 ES6	2.00 2.00-2.45 2.00-2.80 2.00	N=12 (1,2,2,3,3,4)	
				ES7	2.50		
At 2.80m: becomes very dense.				S D3 ES8	2.80 2.80-2.95 2.80	50/75mm (25,50)	
Window Sample Complete at 2.95 m		2.95	17.00				2.95

Drive Records

Diameter (mm)	From (m)	To (m)	Recovery (%)
115	1.20	2.00	100
115	2.00	2.95	100

Water Level Observations

Date	Water Strike (m)	Standing Time (Mins)	Standing Level (m)	Casing Depth (m)	Depth Sealed (m)

Client: Tibbalds Planning and Urban Design
Engineer: Campbell Reith Hill LLP
Contractor: Harrison Group Environmental Limited
Date: 07/03/2012
Plant: Terrier Window Sampling Rig
Drilled By: M. Rose
Logged By: G. Dowlen
Checked By: J. Keay

Remarks:
1. Inspection pit excavated from GL to 1.20mbgl.
2. Groundwater was not encountered.
3. Installation details: 50mm diameter HDPE standpipe installed from 2.95mbgl to GL. Slotted from 2.95mbgl to 1.00mbgl, plain from 1.00mbgl to GL. Finished with gas tap, end cap and flush fitting cover. Geowrap and geosock used.
4. Backfill details: Gravel filter packs from 2.95mbgl to 1.00mbgl, bentonite pellets from 1.00mbgl to 0.20mbgl and concrete from 0.20mbgl to GL.

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Window Sample Record

WS B5
Sheet 1 of 1

Project: Bourne Estate, Camden

Project ID: GL16482

Coordinates: 531196.5E 181827.8N

Ground Level: 17.76mAOD

Description	Legend	Depth (m)	O.D. Level (m)	Sample Test Type	Sample Test Depth (m)	Remarks and Test Results	Installations
Grass over TOPSOIL. Dark brown organic clayey silty fine and medium SAND.		0.00					
		0.15	17.61	ES1	0.10		
MADE GROUND. Brown, grey brown and grey silty gravelly fine and medium occasionally coarse SAND. Gravel is angular fine to coarse brick, rare concrete, wood and glass fragments.				ES2	0.25		
				ES3	0.50		
				ES4	1.00		
		1.10	16.66				
Yellow brown silty fine and medium occasionally coarse SAND and subrounded to rounded fine and medium occasionally coarse flint GRAVEL. (HACKNEY GRAVEL).				ES5	1.25		
		1.60	16.16	ES6	1.60		1.60
Window Sample Complete at 1.60 m							

Drive Records

Diameter (mm)	From (m)	To (m)	Recovery (%)
115	1.20	1.60	100

Water Level Observations

Date	Water Strike (m)	Standing Time (Mins)	Standing Level (m)	Casing Depth (m)	Depth Sealed (m)

Client: Tibbalds Planning and Urban Design
Engineer: Campbell Reith Hill LLP
Contractor: Harrison Group Environmental Limited
Date: 08/03/0012
Plant: Handheld Window Sampling Rig
Drilled By: M. Rose
Logged By: G. Dowlen
Checked By: J. Keay

Remarks:
1. Inspection pit excavated from GL to 1.20mbgl.
2. Groundwater was not encountered.
3. Obstruction encountered at 1.60mbgl. Window sample hole terminated.
4. Backfill details: Arisings from 1.60mbgl to GL.

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Window Sample Record

WS B6
Sheet 1 of 1

Project: Bourne Estate, Camden

Project ID: GL16482

Coordinates: 531193.5E 181852.5N

Ground Level: 17.91mAOD

Description	Legend	Depth (m)	O.D. Level (m)	Sample Test Type	Sample Test Depth (m)	Remarks and Test Results	Installations
Grass over MADE GROUND. Dark brown slightly gravelly sandy SILT. Gravel is angular fine brick and rare glass fragments.		0.15	17.76	ES1	0.10		
				ES2	0.25		
MADE GROUND. Brown, grey brown and dark brown silty gravelly fine and medium occasionally coarse SAND. Gravel is angular fine and medium occasionally coarse brick, occasional glass and rare concrete fragments.				ES3	0.75		
		1.00	16.91				
MADE GROUND. (Firm) dark grey and dark grey brown slightly sandy slightly gravelly silty CLAY. Gravel is angular to rounded fine to coarse quartz, brick and rare wood fragments. Rare oyster shells.				ES4	1.10		
				ES5	1.50		
				ES6	2.10		
		2.40	15.51				
MADE GROUND. Yellow brown brick GRAVEL and COBBLES.		2.50	15.41				2.50
Window Sample Complete at 2.50 m							

Drive Records

Diameter (mm)	From (m)	To (m)	Recovery (%)
115	1.20	2.00	100
115	2.00	2.50	100

Water Level Observations

Date	Water Strike (m)	Standing Time (Mins)	Standing Level (m)	Casing Depth (m)	Depth Sealed (m)

Client: Tibbalds Planning and Urban Design
Engineer: Campbell Reith Hill LLP
Contractor: Harrison Group Environmental Limited
Date: 08/03/0012-08/03/2012
Plant: Handheld Window Sampling Rig
Drilled By: M. Rose
Logged By: G. Dowlen
Checked By: J. Keay

Remarks:
1. Inspection pit excavated from GL to 1.20mbgl.
2. Groundwater was not encountered.
3. Obstruction encountered at 2.50mbgl. Window sample hole terminated.
4. Backfill details: Arisings from 2.50mbgl to GL.

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Gas Monitoring Field Record

Project Name: Bourne Estate, Camden | **Job No:** GL16482

Client: Tibbalds Planning and Urban Design

Equipment	Model	Serial Number	Manufacturer's Calibration Date
Land Gas Analyser	GA2000	GA05814	19/10/2011
PID	PHOCHECK+	06-01410	10/02/2011

Weather Conditions 24hrs Prior to Monitoring	Broken cloud, 13°C, 1027hPa.
Weather Conditions During Monitoring	Broken cloud, 13°C, 1024hPa.

Location I.D	Date	Time (hhmmss)	Temp (°C)	Atmospheric Pressure 72hrs Prior to Sampling (hPa)	Atmospheric Pressure 48hrs Prior to Sampling (hPa)	Atmospheric Pressure 24hrs Prior to Sampling (hPa)	Atmospheric Pressure When Sampled (hPa)	Relative Pressure (hPa)	PID -Peak (ppm)	PID - Stabilised (ppm)	CH4 (%)	Peak CH4 (%)	LEL (%)	CO2 (%)	O2 (%)	H2S (ppm)	CO (ppm)	Flow Pod (l/Hr)
BH B1 (shallow)	23/03/2012	No access due to car on cover.																
BH B1 (deep)	23/03/2012	No access due to car on cover.																
BH B2A	23/03/2012	13:25:00	13	1032	1033	1027	1025	-3.30	0.0	0.0	0.0	0.0	0.0	0.1	18.9	0	0	0.0
WS B2	23/03/2012	13:55:00	13	1032	1033	1027	1024	-3.16	0.0	0.0	0.0	0.0	0.0	0.4	19.1	0	0	<0.1
WS B3	23/03/2012	14:05:00	13	1032	1033	1027	1024	-3.44	0.0	0.0	0.0	0.0	0.0	0.2	19.4	0	0	<0.1
WS B4	23/03/2012	13:40:00	13	1032	1033	1027	1024	-3.72	0.0	0.0	0.0	0.0	0.0	0.0	20.3	0	0	0.0
Field Engineer:	G. Pursey																	

Pump Running Time (sampling): (Standard 120 sec)
Pump Running Time (purge): (Standard 30 sec)
Flow Details (e.g. 5 sec average for 1 min.):

Other Remarks:

PID : Photo-Ionisation Detector
"<" indicates that reading is **under** the limit range,
">" indicates that reading is **over** the limit range,
"*" Level to be determined

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Gas Monitoring Field Record

Project Name: Bourne Estate, Camden | **Job No:** GL16482

Client: Tibbalds Planning and Urban Design

Equipment	Model	Serial Number	Manufacturer's Calibration Date
Land Gas Analyser	GA2000	GA05814	19/10/2011
PID	PHOCHECK+	06-01410	10/02/2011

Weather Conditions 24hrs Prior to Monitoring	Scattered showers, 10c, 1005mBar
Weather Conditions During Monitoring	Cloudy, 6c, 1019mBar

Location I.D	Date	Time (hhmmss)	Temp (°C)	Atmospheric Pressure 72hrs Prior to Sampling (hPa)	Atmospheric Pressure 48hrs Prior to Sampling (hPa)	Atmospheric Pressure 24hrs Prior to Sampling (hPa)	Atmospheric Pressure When Sampled (hPa)	Relative Pressure (hPa)	PID -Peak (ppm)	PID - Stabilised (ppm)	CH4 (%)	Peak CH4 (%)	LEL (%)	CO2 (%)	O2 (%)	H2S (ppm)	CO (ppm)	Flow Pod (l/Hr)
BH B1 (shallow)	05/04/2012	14:00:00	8	996	1000	1005	1019	-3.30	0.0	0.0	0.0	0.0	0.0	0.0	20.6	0	0	0.0
BH B1 (deep)	05/04/2012	14:05:00	8	996	1000	1005	1019	-3.02	0.0	0.0	0.0	0.0	0.0	0.0	20.6	0	0	0.0
BH B2A	05/04/2012	14:20:00	8	996	1000	1005	1019	-3.02	0.0	0.0	0.0	0.0	0.0	0.2	19.1	0	0	0.0
WS B2	05/04/2012	14:40:00	8	996	1000	1005	1019	-2.64	0.0	0.0	0.0	0.0	0.0	0.3	19.0	0	0	0.0
WS B3	05/04/2012	14:50:00	8	996	1000	1005	1019	-2.57	0.0	0.0	0.0	0.0	0.0	0.5	18.9	0	0	0.0
WS B4	05/04/2012	14:05:00	8	996	1000	1005	1019	-2.88	0.0	0.0	0.0	0.0	0.0	0.1	20.1	0	0	0.0

Field Engineer: G. Pursey

Pump Running Time (sampling): (Standard 120 sec)
Pump Running Time (purge): (Standard 30 sec)
Flow Details (e.g. 5 sec average for 1 min.):

Other Remarks:

PID : Photo-Ionisation Detector
"<" indicates that reading is **under** the limit range,
">" indicates that reading is **over** the limit range,
"*" Level to be determined

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Gas Monitoring Field Record

Project Name: Bourne Estate, Camden | **Job No:** GL16482

Client: Tibbalds Planning and Urban Design

Equipment	Model	Serial Number	Manufacturer's Calibration Date
Land Gas Analyser	GA2000	GA05814	19/10/2011
PID	PHOCHECK+	06-01410	10/02/2011

Weather Conditions 24hrs Prior to Monitoring	Cloudy, 11c, 1023mBar
Weather Conditions During Monitoring	Scattered showers, 12c, 998mBar

Location I.D	Date	Time (hhmmss)	Temp (°C)	Atmospheric Pressure 72hrs Prior to Sampling (hPa)	Atmospheric Pressure 48hrs Prior to Sampling (hPa)	Atmospheric Pressure 24hrs Prior to Sampling (hPa)	Atmospheric Pressure When Sampled (hPa)	Relative Pressure (hPa)	PID -Peak (ppm)	PID - Stabilised (ppm)	CH4 (%)	Peak CH4 (%)	LEL (%)	CO2 (%)	O2 (%)	H2S (ppm)	CO (ppm)	Flow Pod (l/Hr)
BH B1 (shallow)	17/04/2012	14:30:00	12	1020	1019	1023	997	-3.09	0.0	0.0	0.0	0.0	0.0	0.0	20.5	0	0	0.0
BH B1 (deep)	17/04/2012	14:20:00	12	1020	1019	1023	997	-2.98	0.0	0.0	0.0	0.0	0.0	0.0	20.3	0	0	0.0
BH B2A	17/04/2012	14:45:00	12	1020	1019	1023	997	-3.12	0.0	0.0	0.0	0.0	0.0	0.3	19.2	0	0	0.0
WS B2	17/04/2012	14:55:00	12	1020	1019	1023	997	-2.84	0.0	0.0	0.0	0.0	0.0	0.4	19.0	0	0	0.0
WS B3	17/04/2012	15:05:00	12	1020	1019	1023	997	-3.09	0.0	0.0	0.0	0.0	0.0	0.1	19.6	0	0	0.0
WS B4	17/04/2012	15:10:00	12	1020	1019	1023	996	-3.14	0.0	0.0	0.0	0.0	0.0	0.0	20.1	0	0	0.0

Field Engineer: G. Pursey

Pump Running Time (sampling): (Standard 120 sec)
Pump Running Time (purge): (Standard 30 sec)
Flow Details (e.g. 5 sec average for 1 min.):

Other Remarks:

PID : Photo-Ionisation Detector
"<" indicates that reading is **under** the limit range,
">" indicates that reading is **over** the limit range,
"*" Level to be determined

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Geotechnical Consultants

Date of Sampling:	17th April 2014			Weather Conditions:	Dry			
Test Location	Time (hh.mm)	Methane CH4(%)	Carbon Dioxide CO_2(%)	Oxygen O2(%)	LEL (%)	Atmospheric Presure (mBar)	Flow (l/h)	Water Level (m bgl)
BHB1 (Shallow)	NR	0	0	19.9	0	1001	0	Dry
BHB1 (Deep)	NR	0	0	20.1	0	1001	0	Dry
BHB2	NR	0	0.1	19.6	0	1001	0	Dry
WSB2	NR	0	0.2	19.4	0	1001	0	Dry
WSB3	No readings recorded - Could not find monitoring point							
WSB4	NR	0	0	20	0	1001	0	Dry

Date of Sampling:				Weather Conditions:				
Test Location	Time (hh.mm)	Methane CH4(%)	Carbon Dioxide CO_2(%)	Oxygen O2(%)	LEL (%)	Atmospheric Presure (mBar)	Flow (l/h)	Water Level (m bgl)

Gas measurements taken using a portable Gas Data LMS xi gas monitor

Date	**GAS MONITORING RESULTS**	Report No.

APPENDIX C
LABORATORY TEST / MONITORING RESULTS AND TABLES

CERTIFICATE OF ANALYSIS

SDG:	120317-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-5	**Customer:**	Campbell Reith Hill	**Report Number:**	183005
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
§	Deviating sample.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed

Component	LOD/Units	Method	Customer Sample R	BHB2	BHB2	BHB2	WSB1	WSB1	WSB2
			Depth (m)	1.00	4.00	8.25	0.10	0.50	0.10
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
			Date Sampled	08/03/2012	08/03/2012	08/03/2012	08/03/2012	08/03/2012	08/03/2012
			Sample Time	.	.	.	.	.	.
			Date Received	15/03/2012	15/03/2012	15/03/2012	15/03/2012	15/03/2012	15/03/2012
			SDG Ref	120317-4	120317-4	120317-4	120317-4	120317-4	120317-4
			Lab Sample No.(s)	5333442	5333449	5333454	5334285	5334286	5333017
			AGS Reference	ES3	ES9	ES14	ES1	ES2	ES1
Phenol	<0.01 mg/kg	TM062 (S)		<0.01 § M			<0.01 § M	<0.01 § M	<0.01 § M
Soil Organic Matter (SOM)	<0.35 %	TM132		5.02 #			4.97 #	4.34 #	4.1 #
pH	1 pH Units	TM133		10.7 M			11.8 M	11.5 M	7.74 M
Cyanide, Total	<1 mg/kg	TM153		<1 § M			<1 § M	<1 § M	2.38 § M
Cyanide, Free	<1 mg/kg	TM153		<1 § M			<1 § M	<1 § M	<1 § M
TPH >C6-C40	<10 mg/kg	TM154		1140 § #	12.1 § #	50.3 § #	727 § #	349 § #	409 § #
Arsenic	<0.6 mg/kg	TM181		11.7 M	7.91 M	13.8 M	11.6 M	14.4 M	13.6 M
Cadmium	<0.02 mg/kg	TM181		0.173 M	<0.02 M	0.216 M	<0.02 M	0.0558 M	4.66 M
Chromium	<0.9 mg/kg	TM181		15 M	10.3 M	38.9 M	28.5 M	17.1 M	60.8 M
Copper	<1.4 mg/kg	TM181		57 M	5.64 M	29 M	35.8 M	58.2 M	99.8 M
Lead	<0.7 mg/kg	TM181		329 M	5.14 M	13.9 M	215 M	652 M	381 M
Mercury	<0.14 mg/kg	TM181		1.8 M	<0.14 M	<0.14 M	1.01 M	2.6 M	1.23 M
Nickel	<0.2 mg/kg	TM181		15.3 M	12.9 M	39.3 M	11.3 M	13.8 M	28.3 M
Selenium	<1 mg/kg	TM181		<1 #	<1 #	1.75 #	<1 #	<1 #	1.03 #
Zinc	<1.9 mg/kg	TM181		89.7 M	13.1 M	89.3 M	84.5 M	134 M	432 M

CERTIFICATE OF ANALYSIS

SDG:	120317-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-5	**Customer:**	Campbell Reith Hill	**Report Number:**	183005
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
§	Deviating sample.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed

Component	LOD/Units	Method	Customer Sample R	WSB2	WSB2	WSB2	WSB2	WSB5	WSB5
			Depth (m)	0.50	1.50	2.50	3.00	0.10	0.50
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
			Date Sampled	08/03/2012	08/03/2012	08/03/2012	08/03/2012	09/03/2012	09/03/2012
			Sample Time	.	.	.	.	.	.
			Date Received	15/03/2012	15/03/2012	15/03/2012	15/03/2012	15/03/2012	15/03/2012
			SDG Ref	120317-4	120317-4	120317-4	120317-4	120317-4	120317-4
			Lab Sample No.(s)	5333018	5333020	5333022	5333024	5334288	5334290
			AGS Reference	ES2	ES4	ES6	ES7	ES4	ES6
Waste Limit, Gravimetric - %*	<0.001 %	SUB (ASB)							<0.001 (F) #
Waste Limit, PCOM evaluation - %*	<0.001 %	SUB (ASB)							<0.001
Waste Limit, Total - %*	<0.001 %	SUB (ASB)							<0.001 #
Phenol	<0.01 mg/kg	TM062 (S)		<0.01 § M	<0.01 § M		<0.01 § M	<0.01 § M	<0.01 § M
Soil Organic Matter (SOM)	<0.35 %	TM132		2.1 #	9.74 #		0.781 #	2.93 #	
pH	1 pH Units	TM133		8.68 M	8.14 M	8.12 § M	8.04 M	7.76 M	8.41 M
Cyanide, Total	<1 mg/kg	TM153		<1 § M	<1 § M		<1 § M	<1 § M	<1 § M
Cyanide, Free	<1 mg/kg	TM153		<1 § M	<1 § M		<1 § M	<1 § M	<1 § M
TPH >C6-C40	<10 mg/kg	TM154		66.5 § #	94.2 #		<10 § #	147 #	167 #
Arsenic	<0.6 mg/kg	TM181		18.7 M	15 M		9.28 M	10.2 M	16.8 M
Cadmium	<0.02 mg/kg	TM181		0.373 M	<0.02 M		<0.02 M	0.296 M	0.0737 M
Chromium	<0.9 mg/kg	TM181		19.6 M	15.1 M		18.6 M	17.7 M	14.9 M
Copper	<1.4 mg/kg	TM181		88.3 M	184 M		22 M	47.7 M	139 M
Lead	<0.7 mg/kg	TM181		631 M	1090 M		55.3 M	129 M	393 M
Mercury	<0.14 mg/kg	TM181		1.36 M	2.61 M		0.27 M	0.769 M	3.27 M
Nickel	<0.2 mg/kg	TM181		21 M	21.5 M		17.4 M	17 M	16.6 M
Selenium	<1 mg/kg	TM181		<1 #	<1 #		<1 #	<1 #	<1 #
Zinc	<1.9 mg/kg	TM181		89.4 M	113 M		39.8 M	108 M	205 M
Soluble Sulphate 2:1 extract as SO4 BRE	<0.003 g/l	TM243				<0.003 § M			
Chloride 2:1 water/soil extract BRE	<0.001 g/l	TM243				0.0019 § M			
Nitrate as NO3, 2:1 water soluble (BRE)	<0.0003 g/l	TM243				0.012			
Magnesium (BRE)	<0.008 g/l	TM282				<0.008			
Soil Organic Matter (SOM)	<0.1 %	TM321							1.44 #

CERTIFICATE OF ANALYSIS

SDG:	120317-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-5	**Customer:**	Campbell Reith Hill	**Report Number:**	183005
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
§	Deviating sample.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed

Component	LOD/Units	Method	Customer Sample R	WSB5	WSB6	WSB6	WSB6	WSB6
			Depth (m)	1.00	0.10	0.75	1.10	2.10
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
			Date Sampled	09/03/2012	09/03/2012	09/03/2012	09/03/2012	09/03/2012
			Sample Time	.	.	.	.	.
			Date Received	15/03/2012	15/03/2012	15/03/2012	15/03/2012	15/03/2012
			SDG Ref	120317-4	120317-4	120317-4	120317-4	120317-4
			Lab Sample No.(s)	5334291	5334294	5333254	5333255	5333257
			AGS Reference	ES7	ES10	ES8	ES9	ES11
Waste Limit, Gravimetric - %*	<0.001 %	SUB (ASB)		<0.001 (F) #				<0.001 (F) #
Waste Limit, PCOM evaluation - %*	<0.001 %	SUB (ASB)						<0.001
Waste Limit, Total - %*	<0.001 %	SUB (ASB)		<0.001 #				<0.001 #
Phenol	<0.01 mg/kg	TM062 (S)		<0.01 § M	<0.01 § M	<0.01 § M		<0.01 § M
Soil Organic Matter (SOM)	<0.35 %	TM132			4.41 #	2.22 #		
pH	1 pH Units	TM133		8.28 M	7.29 M	8.51 M	8.54 § M	8.62 M
Cyanide, Total	<1 mg/kg	TM153		<1 § M	<1 § M	<1 § M		<1 § M
Cyanide, Free	<1 mg/kg	TM153		<1 § M	<1 § M	<1 § M		<1 § M
TPH >C6-C40	<10 mg/kg	TM154		207 § #	280 § #	70.1 #		<10 #
Arsenic	<0.6 mg/kg	TM181		14.3 M	12.4 M	9.58 M		13.9 M
Cadmium	<0.02 mg/kg	TM181		0.157 M	0.543 M	0.279 M		0.41 M
Chromium	<0.9 mg/kg	TM181		15.5 M	21 M	13.2 M		25.2 M
Copper	<1.4 mg/kg	TM181		150 M	61.5 M	34.4 M		7550 M
Lead	<0.7 mg/kg	TM181		370 M	327 M	95.7 M		327 M
Mercury	<0.14 mg/kg	TM181		2.66 M	0.734 M	0.942 M		2.05 M
Nickel	<0.2 mg/kg	TM181		17.3 M	17.4 M	12.5 M		24.2 M
Selenium	<1 mg/kg	TM181		<1 #	<1 #	<1 #		<1 #
Zinc	<1.9 mg/kg	TM181		219 M	188 M	89.2 M		493 M
Soluble Sulphate 2:1 extract as SO4 BRE	<0.003 g/l	TM243					0.017 § M	
Chloride 2:1 water/soil extract BRE	<0.001 g/l	TM243					0.0021 § M	
Nitrate as NO3, 2:1 water soluble (BRE)	<0.0003 g/l	TM243					0.0139	
Magnesium (BRE)	<0.008 g/l	TM282					<0.008	
Soil Organic Matter (SOM)	<0.1 %	TM321		1.29 #				1.58 #

CERTIFICATE OF ANALYSIS

SDG:	120317-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-5	**Customer:**	Campbell Reith Hill	**Report Number:**	183005
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

PAH by GCMS

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
§	Deviating sample.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed

Component	LOD/Units	Method	Customer Sample R	BHB2	BHB2	BHB2	WSB1	WSB1	WSB2
			Depth (m)	1.00	4.00	8.25	0.10	0.50	0.10
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
			Date Sampled	08/03/2012	08/03/2012	08/03/2012	08/03/2012	08/03/2012	08/03/2012
			Sample Time	.	.	.	.	.	.
			Date Received	15/03/2012	15/03/2012	15/03/2012	15/03/2012	15/03/2012	15/03/2012
			SDG Ref	120317-4	120317-4	120317-4	120317-4	120317-4	120317-4
			Lab Sample No.(s)	5333442	5333449	5333454	5334285	5334286	5333017
			AGS Reference	ES3	ES9	ES14	ES1	ES2	ES1
Naphthalene-d8 % recovery**	%	TM218		99.1	94.2	87	94.9 §	101 §	98.4 §
Acenaphthene-d10 % recovery**	%	TM218		101	93.6	81.6	87.5 §	96 §	99.6 §
Phenanthrene-d10 % recovery**	%	TM218		100	92.5	78.5	86.2 §	95.6 §	96.9 §
Chrysene-d12 % recovery**	%	TM218		91.8	91.3	68.9	83.5 §	99.6 §	96.2 §
Perylene-d12 % recovery**	%	TM218		101	90.3	65	86.3 §	107 §	100 §
Naphthalene	<9 µg/kg	TM218		122 § M	<9 § M	<9 § M	31.5 § M	79 § M	134 § M
Acenaphthylene	<12 µg/kg	TM218		<12 § M	<12 § M	<12 § M	<24 § M	23.1 § M	218 § M
Acenaphthene	<8 µg/kg	TM218		24.8 § M	<8 § M	<8 § M	<16 § M	<8 § M	46.2 § M
Fluorene	<10 µg/kg	TM218		22 § M	<10 § M	<10 § M	<20 § M	<10 § M	52.4 § M
Phenanthrene	<15 µg/kg	TM218		375 § M	<15 § M	<15 § M	126 § M	180 § M	1070 § M
Anthracene	<16 µg/kg	TM218		47 § M	<16 § M	<16 § M	45.7 § M	47.6 § M	298 § M
Fluoranthene	<17 µg/kg	TM218		241 § M	<17 § M	<17 § M	143 § M	132 § M	2730 § M
Pyrene	<15 µg/kg	TM218		218 § M	<15 § M	<15 § M	179 § M	152 § M	2260 § M
Benz(a)anthracene	<14 µg/kg	TM218		147 § M	<14 § M	<14 § M	87.5 § M	121 § M	1500 § M
Chrysene	<10 µg/kg	TM218		141 § M	<10 § M	<10 § M	137 § M	167 § M	1290 § M
Benzo(b)fluoranthene	<15 µg/kg	TM218		199 § M	<15 § M	<15 § M	315 § M	419 § M	2210 § M
Benzo(k)fluoranthene	<14 µg/kg	TM218		61.1 § M	<14 § M	<14 § M	128 § M	139 § M	751 § M
Benzo(a)pyrene	<15 µg/kg	TM218		157 § M	<15 § M	<15 § M	222 § M	304 § M	1750 § M
Indeno(1,2,3-cd)pyrene	<18 µg/kg	TM218		79.5 § M	<18 § M	<18 § M	101 § M	146 § M	1090 § M
Dibenzo(a,h)anthracene	<23 µg/kg	TM218		37.6 § M	<23 § M	<23 § M	<46 § M	55.4 § M	299 § M
Benzo(g,h,i)perylene	<24 µg/kg	TM218		154 § M	<24 § M	<24 § M	141 § M	195 § M	1340 § M
PAH, Total Detected USEPA 16	<118 µg/kg	TM218		2030	<118	<118	1660 §	2160 §	17000 §

CERTIFICATE OF ANALYSIS

SDG:	120317-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-5	**Customer:**	Campbell Reith Hill	**Report Number:**	183005
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

PAH by GCMS

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
§	Deviating sample.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed

Component	LOD/Units	Method	Customer Sample R	WSB2	WSB2	WSB2	WSB5	WSB5	WSB5
			Depth (m)	0.50	1.50	3.00	0.10	0.50	1.00
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
			Date Sampled	08/03/2012	08/03/2012	08/03/2012	09/03/2012	09/03/2012	09/03/2012
			Sample Time	.	.	.	.	.	.
			Date Received	15/03/2012	15/03/2012	15/03/2012	15/03/2012	15/03/2012	15/03/2012
			SDG Ref	120317-4	120317-4	120317-4	120317-4	120317-4	120317-4
			Lab Sample No.(s)	5333018	5333020	5333024	5334288	5334290	5334291
			AGS Reference	ES2	ES4	ES7	ES4	ES6	ES7
Naphthalene-d8 % recovery**	%	TM218		97.9	91.6	89.8 §	93.6	94.9 §	98.9
Acenaphthene-d10 % recovery**	%	TM218		95.7	91.5 §	81.2 §	91.7	92.9 §	97.2
Phenanthrene-d10 % recovery**	%	TM218		92.8	86.6	80 §	89.4	90.9	94.8
Chrysene-d12 % recovery**	%	TM218		83.6	82.1 §	74.3 §	81.2	85.9 §	89.3
Perylene-d12 % recovery**	%	TM218		82.7	81.4	74 §	81.9	85.6 §	89.8
Naphthalene	<9 µg/kg	TM218		13.5 M	64.8 M	12.6 § M	23.6 M	103 § M	75.3 M
Acenaphthylene	<12 µg/kg	TM218		<12 M	<12 § M	<12 § M	<12 M	<12 § M	17.1 M
Acenaphthene	<8 µg/kg	TM218		<8 M	<8 § M	<8 § M	<8 M	<8 § M	14.7 M
Fluorene	<10 µg/kg	TM218		<10 M	<10 § M	<10 § M	<10 M	<10 § M	12.2 M
Phenanthrene	<15 µg/kg	TM218		36.7 M	245 M	<15 § M	109 M	176 M	204 M
Anthracene	<16 µg/kg	TM218		<16 M	<16 § M	<16 § M	23 M	26.5 § M	42.4 M
Fluoranthene	<17 µg/kg	TM218		60.7 M	48.2 § M	<17 § M	208 M	198 § M	297 M
Pyrene	<15 µg/kg	TM218		52.4 M	53.1 M	<15 § M	179 M	211 M	306 M
Benz(a)anthracene	<14 µg/kg	TM218		36.6 M	65.4 § M	<14 § M	119 M	161 § M	231 M
Chrysene	<10 µg/kg	TM218		31.9 M	74.8 § M	<10 § M	108 M	166 § M	209 M
Benzo(b)fluoranthene	<15 µg/kg	TM218		58.2 M	92.5 § M	<15 § M	191 M	269 § M	352 M
Benzo(k)fluoranthene	<14 µg/kg	TM218		22.9 M	22.3 § M	<14 § M	64.2 M	78 § M	115 M
Benzo(a)pyrene	<15 µg/kg	TM218		39.9 M	32.3 § M	<15 § M	123 M	165 § M	229 M
Indeno(1,2,3-cd)pyrene	<18 µg/kg	TM218		25.6 M	26.2 M	<18 § M	84.3 M	111 § M	144 M
Dibenzo(a,h)anthracene	<23 µg/kg	TM218		<23 M	<23 § M	<23 § M	<23 M	36.6 § M	51.8 M
Benzo(g,h,i)perylene	<24 µg/kg	TM218		37.3 M	44.3 § M	<24 § M	91 M	145 § M	183 M
PAH, Total Detected USEPA 16	<118 µg/kg	TM218		416	768	<118 §	1320	1850 §	2480

CERTIFICATE OF ANALYSIS

SDG:	120317-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-5	**Customer:**	Campbell Reith Hill	**Report Number:**	183005
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

PAH by GCMS

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
§	Deviating sample.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed

Component	LOD/Units	Method	Customer Sample R	WSB6	WSB6	WSB6			
			Depth (m)	0.10	0.75	2.10			
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid			
			Date Sampled	09/03/2012	09/03/2012	09/03/2012			
			Sample Time	.	.	.			
			Date Received	15/03/2012	15/03/2012	15/03/2012			
			SDG Ref	120317-4	120317-4	120317-4			
			Lab Sample No.(s)	5334294	5333254	5333257			
			AGS Reference	ES10	ES8	ES11			
Naphthalene-d8 % recovery**	%	TM218		95.7	102	87.3			
Acenaphthene-d10 % recovery**	%	TM218		93.6	104	85.6			
Phenanthrene-d10 % recovery**	%	TM218		91.5	104	82.4			
Chrysene-d12 % recovery**	%	TM218		85.1	93.4	76			
Perylene-d12 % recovery**	%	TM218		88.2	101	69.1			
Naphthalene	<9 µg/kg	TM218		41.7 M	36.3 § M	27.5 M			
Acenaphthylene	<12 µg/kg	TM218		39 M	17.3 § M	<12 M			
Acenaphthene	<8 µg/kg	TM218		12.9 M	<8 § M	<8 M			
Fluorene	<10 µg/kg	TM218		<10 M	<10 § M	<10 M			
Phenanthrene	<15 µg/kg	TM218		210 M	121 § M	59.3 M			
Anthracene	<16 µg/kg	TM218		49.4 M	26.7 § M	<16 M			
Fluoranthene	<17 µg/kg	TM218		563 M	249 § M	52 M			
Pyrene	<15 µg/kg	TM218		467 M	212 § M	46.9 M			
Benz(a)anthracene	<14 µg/kg	TM218		331 M	136 § M	39.6 M			
Chrysene	<10 µg/kg	TM218		323 M	133 § M	38.5 M			
Benzo(b)fluoranthene	<15 µg/kg	TM218		589 M	210 § M	54.9 M			
Benzo(k)fluoranthene	<14 µg/kg	TM218		210 M	67.2 § M	<14 M			
Benzo(a)pyrene	<15 µg/kg	TM218		370 M	145 § M	25.7 M			
Indeno(1,2,3-cd)pyrene	<18 µg/kg	TM218		259 M	94.1 § M	24.6 M			
Dibenzo(a,h)anthracene	<23 µg/kg	TM218		69.8 M	27.4 § M	<23 M			
Benzo(g,h,i)perylene	<24 µg/kg	TM218		319 M	123 § M	36.9 M			
PAH, Total Detected USEPA 16	<118 µg/kg	TM218		3850	1600	406			

CERTIFICATE OF ANALYSIS

SDG:	120317-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-5	**Customer:**	Campbell Reith Hill	**Report Number:**	183005
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

TPH CWG (S)

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
§	Deviating sample.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed

Component	LOD/Units	Method	Customer Sample R	BHB2	WSB1				
			Depth (m)	1.00	0.10				
			Sample Type	Soil/Solid	Soil/Solid				
			Date Sampled	08/03/2012	08/03/2012				
			Sample Time	.	.				
			Date Received	15/03/2012	15/03/2012				
			SDG Ref	120317-4	120317-4				
			Lab Sample No.(s)	5333442	5334285				
			AGS Reference	ES3	ES1				
GRO Surrogate % recovery**	%	TM089		38 §	74				
GRO >C5-C12	<44 µg/kg	TM089		92.3 §	<44				
Methyl tertiary butyl ether (MTBE)	<5 µg/kg	TM089		<5 § #	<5 #				
Benzene	<10 µg/kg	TM089		<10 § M	<10 M				
Toluene	<2 µg/kg	TM089		5.7 § M	<2 M				
Ethylbenzene	<3 µg/kg	TM089		4.56 § M	<3 M				
m,p-Xylene	<6 µg/kg	TM089		12.5 § M	<6 M				
o-Xylene	<3 µg/kg	TM089		6.84 § M	<3 M				
sum of detected mpo xylene by GC	<9 µg/kg	TM089		19.3 §	<9				
sum of detected BTEX by GC	<24 µg/kg	TM089		29.6 §	<24				
Aliphatics >C5-C6	<10 µg/kg	TM089		<10 §	<10				
Aliphatics >C6-C8	<10 µg/kg	TM089		10.3 §	<10				
Aliphatics >C8-C10	<10 µg/kg	TM089		16 §	<10				
Aliphatics >C10-C12	<10 µg/kg	TM089		12.5 §	<10				
Aliphatics >C12-C16	<100 µg/kg	TM173		7040	2760				
Aliphatics >C16-C21	<100 µg/kg	TM173		5070	1220				
Aliphatics >C21-C35	<100 µg/kg	TM173		31800	7480				
Aliphatics >C35-C44	<100 µg/kg	TM173		35600	5340				
Total Aliphatics >C12-C44	<100 µg/kg	TM173		79600	16800				
Aromatics >EC5-EC7	<10 µg/kg	TM089		<10 §	<10				
Aromatics >EC7-EC8	<10 µg/kg	TM089		<10 §	<10				
Aromatics >EC8-EC10	<10 µg/kg	TM089		35.3 §	<10				
Aromatics >EC10-EC12	<10 µg/kg	TM089		<10 §	<10				
Aromatics >EC12-EC16	<100 µg/kg	TM173		4820	5040				
Aromatics >EC16-EC21	<100 µg/kg	TM173		4690	3340				
Aromatics >EC21-EC35	<100 µg/kg	TM173		61500	15900				
Aromatics >EC35-EC44	<100 µg/kg	TM173		96000	23200				
Aromatics >EC40-EC44	<100 µg/kg	TM173		50300	11900				
Total Aromatics >EC12-EC44	<100 µg/kg	TM173		167000	47500				
Total Aliphatics >C5-35	<100 µg/kg	TM173		44000	11500				
Total Aromatics >C5-35	<100 µg/kg	TM173		71100	24300				
Total Aliphatics & Aromatics >C5-35	<100 µg/kg	TM173		115000	35700				
Total Aliphatics & Aromatics >C5-C44	<100 µg/kg	TM173		247000	64300				

CERTIFICATE OF ANALYSIS

SDG:	120317-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-5	**Customer:**	Campbell Reith Hill	**Report Number:**	183005
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

Asbestos Identification - Soil

		Date of Analysis	Analysed By	Comments	Amosite (Brown) Asbestos	Chrysotile (White) Asbestos	Crocidolite (Blue) Asbestos	Fibrous Actinolite	Fibrous Anthophyllite	Fibrous Tremolite	Non-Asbestos Fibre
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BHB2 ES 3 1.00 SOLID 08/03/2012 00:00:00 120317-4 5333442 TM048	05/04/12	Tomasz Pawlikowski	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WSB1 ES 1 0.10 SOLID 08/03/2012 00:00:00 120317-4 5334285 TM048	04/05/12	Tomasz Pawlikowski	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WSB1 ES 2 0.50 SOLID 08/03/2012 00:00:00 120317-4 5334286 TM048	04/05/12	Martin Cotterell	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WSB2 ES 1 0.10 SOLID 08/03/2012 00:00:00 120317-4 5333017 TM048	05/04/12	Paul Poynton	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WSB2 ES 2 0.50 SOLID 08/03/2012 00:00:00 120317-4 5333018 TM048	04/04/12	Martin Cotterell	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Detected

CERTIFICATE OF ANALYSIS

SDG:	120317-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-5	**Customer:**	Campbell Reith Hill	**Report Number:**	183005
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

		Date of Analysis	Analysed By	Comments	Amosite (Brown) Asbestos	Chrysotile (White) Asbestos	Crocidolite (Blue) Asbestos	Fibrous Actinolite	Fibrous Anthophyllite	Fibrous Tremolite	Non-Asbestos Fibre
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WSB2 ES 4 1.50 SOLID 08/03/2012 00:00:00 120317-4 5333020 TM048	05/04/12	Paul Poynton	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WSB2 ES 7 3.00 SOLID 08/03/2012 00:00:00 120317-4 5333024 TM048	04/04/12	Lauren Sargeant	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WSB5 ES 4 0.10 SOLID 09/03/2012 00:00:00 120317-4 5334288 TM048	04/05/12	Tomasz Pawlikowski	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WSB5 ES 6 0.50 SOLID 09/03/2012 00:00:00 120317-4 5334290 TM048	04/05/12	Tomasz Pawlikowski	Loose fibres in soil	Not Detected (#)	Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WSB5 ES 7 1.00 SOLID 09/03/2012 00:00:00 120317-4 5334291 TM048	04/04/12	Lauren Sargeant	Loose fibres in soil.	Not Detected (#)	Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WSB6 ES 10 0.10 SOLID 09/03/2012 00:00:00 120317-4 5334294 TM048	05/04/12	Tomasz Pawlikowski	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Detected

CERTIFICATE OF ANALYSIS

SDG:	120317-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-5	**Customer:**	Campbell Reith Hill	**Report Number:**	183005
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

		Date of Analysis	Analysed By	Comments	Amosite (Brown) Asbestos	Chrysotile (White) Asbestos	Crocidolite (Blue) Asbestos	Fibrous Actinolite	Fibrous Anthophyllite	Fibrous Tremolite	Non-Asbestos Fibre
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WSB6 ES 11 2.10 SOLID 09/03/2012 00:00:00 120317-4 5333257 TM048	05/04/12	Martin Cotterell	Loose fibres in soil.	Not Detected (#)	Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WSB6 ES 8 0.75 SOLID 09/03/2012 00:00:00 120317-4 5333254 TM048	05/04/12	Martin Cotterell	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected

CERTIFICATE OF ANALYSIS

SDG:	120312-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-4	**Customer:**	Campbell Reith Hill	**Report Number:**	181857
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
§	Deviating sample.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed

Component	LOD/Units	Method	Customer Sample R	BHB1	BHB1	BHB1	BHB2A	BHB2A	BHB2A
			Depth (m)	1.80	4.00	9.44 - 9.55	1.00	12.00 - 12.45	16.95 - 17.05
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
			Date Sampled	12/03/2012	12/03/2012	12/03/2012	08/03/2012	08/03/2012	08/03/2012
			Sample Time	.	.	.	.	.	.
			Date Received	10/03/2012	10/03/2012	10/03/2012	10/03/2012	10/03/2012	10/03/2012
			SDG Ref	120312-4	120312-4	120312-4	120312-4	120312-4	120312-4
			Lab Sample No.(s)	5490776	5490783	5490773	5308514	5490789	5490791
			AGS Reference	D2	D4	D9	ES	D9	D12
Phenol	<0.01 mg/kg	TM062 (S)					<0.01 § M		
Soil Organic Matter (SOM)	<0.35 %	TM132					7.53 #		
pH	1 pH Units	TM133	10.8 § M	8.77 § M	4.42 § M	8.22 M	7.15 § M	9.1 § M	
Cyanide, Total	<1 mg/kg	TM153					<1 § M		
Cyanide, Free	<1 mg/kg	TM153					<1 § M		
TPH >C6-C40	<10 mg/kg	TM154					<10 #		
Arsenic	<0.6 mg/kg	TM181					14.5 M		
Cadmium	<0.02 mg/kg	TM181					0.341 M		
Chromium	<0.9 mg/kg	TM181					14.7 M		
Copper	<1.4 mg/kg	TM181					163 M		
Lead	<0.7 mg/kg	TM181					323 M		
Mercury	<0.14 mg/kg	TM181					2.8 M		
Nickel	<0.2 mg/kg	TM181					18.4 M		
Selenium	<1 mg/kg	TM181					<1 #		
Zinc	<1.9 mg/kg	TM181					106 M		
Soluble Sulphate 2:1 extract as SO4 BRE	<0.003 g/l	TM243	0.316 § M	0.009 § M	1.73 § M		0.592 § M	0.307 § M	
Chloride 2:1 water/soil extract BRE	<0.001 g/l	TM243			0.0315 § M				
Nitrate as NO3, 2:1 water soluble (BRE)	<0.0003 g/l	TM243			<0.0003				
Magnesium (BRE)	<0.008 g/l	TM282			0.0441				

CERTIFICATE OF ANALYSIS

SDG:	120312-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-4	**Customer:**	Campbell Reith Hill	**Report Number:**	181857
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
§	Deviating sample.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed

Component	LOD/Units	Method	Customer Sample R	BHB2A	BHB2A	BHB2A	BHB2A	BHB2A	WS B3
			Depth (m)	2.00	21.00 - 21.45	25.95 - 26.05	4.00	8.00	0.15
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
			Date Sampled	07/03/2012	08/03/2012	08/03/2012	08/03/2012	08/03/2012	08/03/2012
			Sample Time	.	.	.	.	.	.
			Date Received	10/03/2012	10/03/2012	10/03/2012	10/03/2012	10/03/2012	10/03/2012
			SDG Ref	120312-4	120312-4	120312-4	120312-4	120312-4	120312-4
			Lab Sample No.(s)	5490779	5490784	5490787	5308521	5490781	5308501
			AGS Reference	D2	D16	D19	ES	D6	ES
Phenol	<0.01 mg/kg	TM062 (S)					<0.01 § M		0.013 § M
Soil Organic Matter (SOM)	<0.35 %	TM132					6.38 #		10.4 #
pH	1 pH Units	TM133	8.34 § M	8.73 § M	9.49 § M	8.52 M	5.44 § M	7.45 M	
Cyanide, Total	<1 mg/kg	TM153					<1 § M		<1 M
Cyanide, Free	<1 mg/kg	TM153					<1 § M		<1 M
TPH >C6-C40	<10 mg/kg	TM154					15.5 #		237 #
Arsenic	<0.6 mg/kg	TM181					16.3 M		27.3 M
Cadmium	<0.02 mg/kg	TM181					0.391 M		7.2 M
Chromium	<0.9 mg/kg	TM181					14.8 M		84.1 M
Copper	<1.4 mg/kg	TM181					151 M		533 M
Lead	<0.7 mg/kg	TM181					471 M		1940 M
Mercury	<0.14 mg/kg	TM181					2.91 M		0.508 M
Nickel	<0.2 mg/kg	TM181					18.7 M		40.6 M
Selenium	<1 mg/kg	TM181					<1 #		1.14 #
Zinc	<1.9 mg/kg	TM181					142 M		834 M
Soluble Sulphate 2:1 extract as SO4 BRE	<0.003 g/l	TM243	0.133 § M	0.293 § M	0.0377 § M		0.797 § M		
Chloride 2:1 water/soil extract BRE	<0.001 g/l	TM243					0.0284 § M		
Nitrate as NO3, 2:1 water soluble (BRE)	<0.0003 g/l	TM243					0.00265		
Magnesium (BRE)	<0.008 g/l	TM282					0.0147		

CERTIFICATE OF ANALYSIS

SDG:	120312-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-4	**Customer:**	Campbell Reith Hill	**Report Number:**	181857
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
§	Deviating sample.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed

Component	LOD/Units	Method	Customer Sample R	WS B3	WS B3	WS B4	WS B4	WS B4	WSB3
			Depth (m)	0.90	2.50	0.10	0.50	1.50	1.20 - 1.65
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
			Date Sampled	08/03/2012	08/03/2012	08/03/2012	08/03/2012	08/03/2012	-
			Sample Time	.	.	.	.	.	.
			Date Received	10/03/2012	10/03/2012	10/03/2012	10/03/2012	10/03/2012	10/03/2012
			SDG Ref	120312-4	120312-4	120312-4	120312-4	120312-4	120312-4
			Lab Sample No.(s)	5308503	5308509	5308486	5308492	5308495	5490793
			AGS Reference	ES	ES	ES1	ES3	ES5	D1
Phenol	<0.01 mg/kg	TM062 (S)		<0.01 § M	<0.01 § M	<0.01 § M	<0.01 § M	<0.01 § M	
Soil Organic Matter (SOM)	<0.35 %	TM132		3.84 #	5.78 #	7.84 #	6.52 #	0.784 #	
pH	1 pH Units	TM133		7.67 M	7.84 M	7.69 M	8.58 M	8.87 M	8.57 § M
Cyanide, Total	<1 mg/kg	TM153		1.22 § M	<1 M	<1 § M	<1 § M	<1 § M	
Cyanide, Free	<1 mg/kg	TM153		<1 § M	<1 M	<1 § M	<1 § M	<1 § M	
TPH >C6-C40	<10 mg/kg	TM154		219 #	23.3 #	318 #	156 #	127 #	
Arsenic	<0.6 mg/kg	TM181		15.5 M	23.1 M	14.7 M	17 M	8.66 M	
Cadmium	<0.02 mg/kg	TM181		4.74 M	0.478 M	2.57 M	0.571 M	0.192 M	
Chromium	<0.9 mg/kg	TM181		57 M	14.8 M	30 M	23.2 M	13.6 M	
Copper	<1.4 mg/kg	TM181		124 M	321 M	61.2 M	144 M	54.5 M	
Lead	<0.7 mg/kg	TM181		595 M	563 M	227 M	297 M	42.3 M	
Mercury	<0.14 mg/kg	TM181		1.14 M	3.14 M	1.27 M	1.32 M	0.191 M	
Nickel	<0.2 mg/kg	TM181		26.6 M	37.7 M	30.5 M	22.5 M	14.5 M	
Selenium	<1 mg/kg	TM181		1.02 #	1.08 #	1.2 #	<1 #	<1 #	
Zinc	<1.9 mg/kg	TM181		417 M	214 M	292 M	254 M	39.8 M	
Soluble Sulphate 2:1 extract as SO4 BRE	<0.003 g/l	TM243							0.0518 § M

CERTIFICATE OF ANALYSIS

SDG:	120312-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-4	**Customer:**	Campbell Reith Hill	**Report Number:**	181857
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
§	Deviating sample.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed

Component	LOD/Units	Method	Customer Sample R	WS B4	WSB4
			Depth (m)	2.80	1.20 - 1.65
			Sample Type	Soil/Solid	Soil/Solid
			Date Sampled	08/03/2012	-
			Sample Time	.	.
			Date Received	10/03/2012	10/03/2012
			SDG Ref	120312-4	120312-4
			Lab Sample No.(s)	5308499	5490792
			AGS Reference	ES8	D1
Phenol	<0.01 mg/kg	TM062 (S)		<0.01 § M	
Soil Organic Matter (SOM)	<0.35 %	TM132		2.12 #	
pH	1 pH Units	TM133		10.6 M	9.21 § M
Cyanide, Total	<1 mg/kg	TM153		<1 § M	
Cyanide, Free	<1 mg/kg	TM153		<1 § M	
TPH >C6-C40	<10 mg/kg	TM154		197 #	
Arsenic	<0.6 mg/kg	TM181		18.3 M	
Cadmium	<0.02 mg/kg	TM181		0.318 M	
Chromium	<0.9 mg/kg	TM181		18.5 M	
Copper	<1.4 mg/kg	TM181		33.9 M	
Lead	<0.7 mg/kg	TM181		373 M	
Mercury	<0.14 mg/kg	TM181		0.531 M	
Nickel	<0.2 mg/kg	TM181		18.5 M	
Selenium	<1 mg/kg	TM181		<1 #	
Zinc	<1.9 mg/kg	TM181		141 M	
Soluble Sulphate 2:1 extract as SO4 BRE	<0.003 g/l	TM243			1.04 § M

CERTIFICATE OF ANALYSIS

SDG:	120312-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-4	**Customer:**	Campbell Reith Hill	**Report Number:**	181857
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

PAH by GCMS

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
§	Deviating sample.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed

Component	LOD/Units	Method	Customer Sample R	BHB2A	BHB2A	WS B3	WS B3	WS B3	WS B4
			Depth (m)	1.00	4.00	0.15	0.90	2.50	0.10
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
			Date Sampled	08/03/2012	08/03/2012	08/03/2012	08/03/2012	08/03/2012	08/03/2012
			Sample Time	.	.	.	.	.	.
			Date Received	10/03/2012	10/03/2012	10/03/2012	10/03/2012	10/03/2012	10/03/2012
			SDG Ref	120312-4	120312-4	120312-4	120312-4	120312-4	120312-4
			Lab Sample No.(s)	5308514	5308521	5308501	5308503	5308509	5308486
			AGS Reference	ES	ES	ES	ES	ES	ES1
Naphthalene-d8 % recovery**	%	TM218		91.4	99	97.3 §	93.8 §	98.4	99.9 §
Acenaphthene-d10 % recovery**	%	TM218		89.1	96.9	96.2 §	94.2 §	94.9	97.4 §
Phenanthrene-d10 % recovery**	%	TM218		85.9	93.7	92.6 §	92.6 §	95.2	94.9 §
Chrysene-d12 % recovery**	%	TM218		83	84.5	91.1 §	90.6 §	89	94.7 §
Perylene-d12 % recovery**	%	TM218		77.4	84.6	92.4 §	97.3 §	90.5	97.9 §
Naphthalene	<9 µg/kg	TM218		45.6 M	230 M	139 § M	95.2 § M	48 § M	104 § M
Acenaphthylene	<12 µg/kg	TM218		<12 M	<12 M	108 § M	105 § M	<12 § M	102 § M
Acenaphthene	<8 µg/kg	TM218		<8 M	<8 M	76.9 § M	43.9 § M	<8 § M	34.2 § M
Fluorene	<10 µg/kg	TM218		<10 M	<10 M	64.7 § M	44.5 § M	<10 § M	35.7 § M
Phenanthrene	<15 µg/kg	TM218		176 M	154 M	1220 § M	802 § M	47.6 § M	759 § M
Anthracene	<16 µg/kg	TM218		<16 M	<16 M	234 § M	188 § M	<16 § M	191 § M
Fluoranthene	<17 µg/kg	TM218		40.1 M	39.7 M	2500 § M	1930 § M	<17 § M	1840 § M
Pyrene	<15 µg/kg	TM218		42.1 M	44.6 M	2030 § M	1600 § M	<15 § M	1610 § M
Benz(a)anthracene	<14 µg/kg	TM218		46 M	48.7 M	1110 § M	938 § M	28.1 § M	934 § M
Chrysene	<10 µg/kg	TM218		63.4 M	44.5 M	1100 § M	910 § M	17.8 § M	915 § M
Benzo(b)fluoranthene	<15 µg/kg	TM218		69.4 M	61.8 M	1760 § M	1570 § M	20.2 § M	1570 § M
Benzo(k)fluoranthene	<14 µg/kg	TM218		<14 M	<14 M	580 § M	538 § M	<14 § M	519 § M
Benzo(a)pyrene	<15 µg/kg	TM218		28.6 M	28.5 M	1240 § M	1220 § M	<15 § M	1090 § M
Indeno(1,2,3-cd)pyrene	<18 µg/kg	TM218		24.1 M	23 M	748 § M	825 § M	<18 § M	680 § M
Dibenzo(a,h)anthracene	<23 µg/kg	TM218		<23 M	<23 M	219 § M	223 § M	<23 § M	199 § M
Benzo(g,h,i)perylene	<24 µg/kg	TM218		41.1 M	45.1 M	887 § M	997 § M	<24 § M	863 § M
PAH, Total Detected USEPA 16	<118 µg/kg	TM218		576	720	14000 §	12000 §	162	11400 §

CERTIFICATE OF ANALYSIS

SDG:	120312-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-4	**Customer:**	Campbell Reith Hill	**Report Number:**	181857
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

PAH by GCMS

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
§	Deviating sample.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed

Component	LOD/Units	Method	Customer Sample R	WS B4	WS B4	WS B4			
			Depth (m)	0.50	1.50	2.80			
			Sample Type	Soil/Solid	Soil/Solid	Soil/Solid			
			Date Sampled	08/03/2012	08/03/2012	08/03/2012			
			Sample Time	.	.	.			
			Date Received	10/03/2012	10/03/2012	10/03/2012			
			SDG Ref	120312-4	120312-4	120312-4			
			Lab Sample No.(s)	5308492	5308495	5308499			
			AGS Reference	ES3	ES5	ES8			
Naphthalene-d8 % recovery**	%	TM218		97.9 §	99.5 §	96.8			
Acenaphthene-d10 % recovery**	%	TM218		96.3 §	99.7 §	95 §			
Phenanthrene-d10 % recovery**	%	TM218		93.7 §	93.9 §	93.1			
Chrysene-d12 % recovery**	%	TM218		93.3 §	93.6 §	92.7 §			
Perylene-d12 % recovery**	%	TM218		95.5 §	97.9 §	96			
Naphthalene	<9 µg/kg	TM218		325 § M	<9 § M	290 M			
Acenaphthylene	<12 µg/kg	TM218		34.1 § M	<12 § M	35.2 § M			
Acenaphthene	<8 µg/kg	TM218		12.5 § M	<8 § M	35.5 § M			
Fluorene	<10 µg/kg	TM218		15.7 § M	<10 § M	49.3 M			
Phenanthrene	<15 µg/kg	TM218		451 § M	<15 § M	852 M			
Anthracene	<16 µg/kg	TM218		75 § M	<16 § M	152 § M			
Fluoranthene	<17 µg/kg	TM218		565 § M	<17 § M	1040 M			
Pyrene	<15 µg/kg	TM218		507 § M	<15 § M	848 M			
Benz(a)anthracene	<14 µg/kg	TM218		369 § M	<14 § M	440 § M			
Chrysene	<10 µg/kg	TM218		352 § M	<10 § M	390 § M			
Benzo(b)fluoranthene	<15 µg/kg	TM218		568 § M	<15 § M	546 § M			
Benzo(k)fluoranthene	<14 µg/kg	TM218		174 § M	<14 § M	181 § M			
Benzo(a)pyrene	<15 µg/kg	TM218		375 § M	<15 § M	421 § M			
Indeno(1,2,3-cd)pyrene	<18 µg/kg	TM218		217 § M	<18 § M	232 M			
Dibenzo(a,h)anthracene	<23 µg/kg	TM218		75.8 § M	<23 § M	65.8 M			
Benzo(g,h,i)perylene	<24 µg/kg	TM218		277 § M	<24 § M	298 § M			
PAH, Total Detected USEPA 16	<118 µg/kg	TM218		4390 §	<118 §	5870			

CERTIFICATE OF ANALYSIS

SDG:	120312-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-4	**Customer:**	Campbell Reith Hill	**Report Number:**	181857
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

Asbestos Identification - Soil

		Date of Analysis	Analysed By	Comments	Amosite (Brown) Asbestos	Chrysotile (White) Asbestos	Crocidolite (Blue) Asbestos	Fibrous Actinolite	Fibrous Anthophyllite	Fibrous Tremolite	Non-Asbestos Fibre
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number		03/04/12	Martin Cotterell	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BHB1 D 2 1.80 SOLID 12/03/2012 00:00:00 120312-4 5490776 TM048	27/04/12	Kevin Bowron	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BHB2A D 2 2.00 SOLID 07/03/2012 00:00:00 120312-4 5490779 TM048	26/04/12	Kevin Bowron	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BHB2A ES 1.00 SOLID 08/03/2012 00:00:00 120312-4 5308514 TM048	03/04/12	Martin Cotterell	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BHB2A ES 4.00 SOLID 08/03/2012 00:00:00 120312-4 5308521 TM048	03/04/12	Martin Cotterell	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected

CERTIFICATE OF ANALYSIS

SDG:	120312-4	**Location:**	Redhill - Bourne Estate	**Order Number:**	
Job:	H_CAMREITH_REH-4	**Customer:**	Campbell Reith Hill	**Report Number:**	181857
Client Reference:		**Attention:**	Rhyadd Watkins	**Superseded Report:**	

		Date of Analysis	Analysed By	Comments	Amosite (Brown) Asbestos	Chrysotile (White) Asbestos	Crocidolite (Blue) Asbestos	Fibrous Actinolite	Fibrous Anthophyllite	Fibrous Tremolite	Non-Asbestos Fibre
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WS B4 ES 1 0.10 SOLID 08/03/2012 00:00:00 120312-4 5308486 TM048	03/04/12	Lauren Sargeant	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WS B4 ES 3 0.50 SOLID 08/03/2012 00:00:00 120312-4 5308492 TM048	03/04/12	Martin Cotterell	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WS B4 ES 5 1.50 SOLID 08/03/2012 00:00:00 120312-4 5308495 TM048	03/04/12	Martin Cotterell	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WS B4 ES 8 2.80 SOLID 08/03/2012 00:00:00 120312-4 5308499 TM048	03/04/12	Lauren Sargeant	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WSB3 D 1 1.20 - 1.65 SOLID 120312-4 5490793 TM048	27/04/12	Kevin Bowron	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Detected
Customer Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	WSB4 D 1 1.20 - 1.65 SOLID 120312-4 5490792 TM048	26/04/12	Kevin Bowron	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected

Client/client ref: Higgins Construction PLC
Project ref: 14.04.016
Site ref: Bourne Estate, Holborn
Data description: Soil
Contaminant(s): Metals
Test scenario: Planning
Date: 19th May 2014
User details: LC

	Arsenic (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Selenium (mg/kg)	Zinc (mg/kg)	
Critical concentration, C_c	**37**	**26**	**627**	**2330**	**200**	**170**	**130**	**350**	**3750**	
Notes										
Sample size, n	23	23	23	23	23	23	23	23	23	0
Sample mean, $\overline{X}$	14.5534783	1.03841304	24.4869565	439.953913	427.453913	1.53282609	20.6304348	1.02043478	205.978261	No Data
Standard deviation, s	4.54893955	1.9023992	18.1743152	1554.17646	409.21298	1.01432923	7.68513528	0.05121064	187.367774	
Number of non-detects	0	0	0	0	0	0	0	0	0	
Set non-detect values to:	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit
Outliers?	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	
Distribution	Normal	Non-normal	Non-normal	Non-normal	Non-normal	Normal	Non-normal	Non-normal	Non-normal	
Statistical approach	Auto: One-sample t-	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto: One-sample t-	Auto: Chebychev	Auto: Chebychev	Auto: Chebychev	Auto

Test scenario:	Planning: is true mean lower than critical concentration (μ < Cc)?				**Evidence level required:**		95%	Use Normal distribution to test for outliers		
t statistic, t_0 (or k_0)	-23.66479824	-62.92662752	-158.9909178	-5.832248043	2.665679484	-796.526571	-68.25097921	-32681.63025	-90.71213701	
Upper confidence limit (on true mean concentration, μ)	16.1822229	2.76749085	41.0054691	1852.53442	799.384832	1.89600597	27.6154024	1.06697979	376.275568	
Evidence level	**100%**	**100%**	**100%**	**97%**	**0%**	**100%**	**100%**	**100%**	**100%**	
Base decision on:	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	
Result	**μ < Cc**	**μ < Cc**	**μ < Cc**	**μ < Cc**	**μ ≥ Cc**	**μ < Cc**	**μ < Cc**	**μ < Cc**	**μ < Cc**	
Select dataset	○ Y	○ Y	○ Y	○ Y	◉ Y	○ Y	○ Y	○ Y	○ Y	○ Y

Back to data | **Go to outlier test** | **Go to normality test** | **Show individual summary**

Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

Final Report

Test Report Number:	14-00309
Issue:	1
Date of Issue:	06/05/2014
Contact:	Lee Chippington
Customer Details:	Listers Geotechnical Consultants Slapton Hill Barn, Blakesley Road Slapton Towcester Northamptonshire
Quotation No:	
Order No:	14.04.016
Customer Reference:	14.04.016 - Bourne Estate, Holborn, EC1N 7SD
Date Received:	24/04/2014
Date Approved:	06/05/2014
Details:	14.04.016 - Bourne Estate, Holborn, EC1N 7SD

Approved by:

Phil Hellier, Project Director

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Results Summary - Soil

Report No.: 14-00309_1

Project: 14.04.016 - Bourne Estate, Holborn, EC1N 7SD

				Customer Sample ID	**WAC1**	**WAC2**	**WAC3**	**WAC4**
				Chemtest Sample ID	1508	1509	1510	1511
				Sample Type	**SOIL**	**SOIL**	**SOIL**	**SOIL**
				Sample Depth (m)	0.30 - 0.50	0.30 - 0.50	0.30 - 0.50	0.30 - 0.50
				Sampling Date	17/04/2014	17/04/2014	17/04/2014	17/04/2014
Determinand	**Accred**	**SOP**	**Units**	**LOD**				
Moisture	N	2030	%	0.02	14	14	11	9.1
pH	M	2010		0	8.3	8.2	8.9	8.6
Acid Neutralisation Capacity	N	2015	mol/kg	0.002	0.18	0.12	0.21	0.16
LOI	M	2610	%	0.1	6.3	8.5	8.4	5.3
Total Organic Carbon	M	2625	%	0.2	3.7	7.7	6.7	5.1
Total TPH >C10-C40	M	2670	mg/kg	10	< 10	48	< 10	130
Total Of 17 PAH's	N	2700	mg/kg	2	13	4.9	32	130
Total BTEX	M	2760	µg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0
PCB 28	M	2810	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010
PCB 52	M	2810	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010
PCB 101	M	2810	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010
PCB 118	M	2810	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010
PCB 153	M	2810	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010
PCB 138	M	2810	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010
PCB 180	M	2810	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010
Total PCBs (7 Congeners)	N	2810	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010

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Results Summary - WAC2s

Report No.: 14-00309_1

Project: 14.04.016 - Bourne Estate, Holborn, EC1N 7SD

WAC Analysis									
LIMS ID: 1511							**Landfill Waste Acceptance Criteria Limits**		
Sample Date: 17/04/2014							**Inert Waste Landfill**	**Stable Non-reactive Hazardous waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Sample ID: WAC4									
Determinand	**SOP**		**Units**						
Total Organic Carbon	2625	M	%			5.1	3	5	6
Loss on Ignition	2610	M	%			5.3	--	--	10
Total BTEX	2761	M	mg/kg			< 1.0	6	--	--
Total PCBs (7 congeners)	2811	M	mg/kg			< 0.010	1	--	--
TPH Total WAC	2670	M	mg/kg			130	500	--	--
Total (of 17) PAHs	2700	N	mg/kg			130	100	--	--
pH	2010	M				8.6	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg			0.16	--	To evaluate	To evaluate
Eluate Analysis			**2:1 mg/l**	**8:1 mg/l**	**2:1 mg/kg**	**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
Arsenic	1450	U	0.016	0.005	< 0.050	0.062	0.5	2	25
Barium	1450	U	0.009	0.003	< 0.50	< 0.50	20	100	300
Cadmium	1450	U	< 0.0008	< 0.0008	< 0.010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70
Copper	1450	U	0.015	< 0.001	< 0.050	< 0.050	2	50	100
Mercury	1450	U	0.0007	< 0.0005	< 0.010	< 0.010	0.01	0.2	2
Molybdenum	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	30
Nickel	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.4	10	40
Lead	1450	U	0.002	0.002	< 0.010	0.019	0.5	10	50
Antimony	1450	U	0.14	0.016	0.28	0.34	0.06	0.7	5
Selenium	1450	U	0.002	< 0.001	< 0.010	< 0.010	0.1	0.5	7
Zinc	1450	U	0.002	< 0.001	< 0.50	< 0.50	4	50	200
Chloride	1220	U	8	< 1.0	16	12	800	15000	25000
Fluoride	1220	U	0.53	0.12	1.1	1.8	10	150	500
Sulphate	1220	U	46	< 1.0	92	66	1000	20000	50000
Total Dissolved Solids	1040	U	150	42	300	580	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-
Dissolved Organic Carbon	1610	U	11	8.5	< 50	89	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.175
Moisture (%)	9.1

Leach Test Information	
Leachant volume 1st extract/l	0.332
Leachant volume 2nd extract/l	1.4
Eluant recovered from 1st extract/l	0.252

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Results Summary - WAC2s

Report No.: 14-00309_1

Project: 14.04.016 - Bourne Estate, Holborn, EC1N 7SD

WAC Analysis

LIMS ID: 1510							Landfill Waste Acceptance Criteria Limits		
Sample Date: 17/04/2014							Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample ID: WAC3									
Determinand	**SOP**		**Units**						
Total Organic Carbon	2625	M	%			6.7	3	5	6
Loss on Ignition	2610	M	%			8.4	--	--	10
Total BTEX	2761	M	mg/kg			< 1.0	6	--	--
Total PCBs (7 congeners)	2811	M	mg/kg			< 0.010	1	--	--
TPH Total WAC	2670	M	mg/kg			< 10	500	--	--
Total (of 17) PAHs	2700	N	mg/kg			32	100	--	--
pH	2010	M				8.9	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg			0.21	--	To evaluate	To evaluate
Eluate Analysis			**2:1 mg/l**	**8:1 mg/l**	**2:1 mg/kg**	**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
Arsenic	1450	U	0.031	0.007	0.062	0.099	0.5	2	25
Barium	1450	U	0.021	0.004	< 0.50	< 0.50	20	100	300
Cadmium	1450	U	< 0.0008	< 0.0008	< 0.010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70
Copper	1450	U	0.01	0.002	< 0.050	< 0.050	2	50	100
Mercury	1450	U	0.0009	0.0006	< 0.010	< 0.010	0.01	0.2	2
Molybdenum	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	30
Nickel	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.4	10	40
Lead	1450	U	0.002	0.003	< 0.010	0.029	0.5	10	50
Antimony	1450	U	0.075	0.011	0.15	0.2	0.06	0.7	5
Selenium	1450	U	0.001	< 0.001	< 0.010	< 0.010	0.1	0.5	7
Zinc	1450	U	0.004	< 0.001	< 0.50	< 0.50	4	50	200
Chloride	1220	U	4.2	< 1.0	< 10	< 10	800	15000	25000
Fluoride	1220	U	0.19	0.12	< 1.0	1.3	10	150	500
Sulphate	1220	U	22	< 1.0	44	30	1000	20000	50000
Total Dissolved Solids	1040	U	220	59	440	810	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-
Dissolved Organic Carbon	1610	U	12	6.5	< 50	72	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.175
Moisture (%)	11

Leach Test Information	
Leachant volume 1st extract/l	0.329
Leachant volume 2nd extract/l	1.4
Eluant recovered from 1st extract/l	0.24

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Results Summary - WAC2s

Report No.: 14-00309_1

Project: 14.04.016 - Bourne Estate, Holborn, EC1N 7SD

WAC Analysis

LIMS ID: 1509						Landfill Waste Acceptance Criteria Limits		
Sample Date: 17/04/2014						Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample ID: WAC2								
Determinand	**SOP**		**Units**					
Total Organic Carbon	2625	M	%		7.7	3	5	6
Loss on Ignition	2610	M	%		8.5	--	--	10
Total BTEX	2761	M	mg/kg		< 1.0	6	--	--
Total PCBs (7 congeners)	2811	M	mg/kg		< 0.010	1	--	--
TPH Total WAC	2670	M	mg/kg		48	500	--	--
Total (of 17) PAHs	2700	N	mg/kg		4.9	100	--	--
pH	2010	M			8.2	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg		0.12	--	To evaluate	To evaluate
Eluate Analysis			**2:1 mg/l**	**8:1 mg/l**	**2:1 mg/kg**	**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**	
Arsenic	1450	U	0.029	0.006	0.057	0.09	0.5	2	25
Barium	1450	U	0.026	0.005	< 0.50	< 0.50	20	100	300
Cadmium	1450	U	< 0.0008	< 0.0008	< 0.010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70
Copper	1450	U	0.032	0.007	0.063	< 0.050	2	50	100
Mercury	1450	U	0.001	0.0007	< 0.010	< 0.010	0.01	0.2	2
Molybdenum	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	30
Nickel	1450	U	0.004	< 0.001	< 0.050	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	0.001	< 0.010	< 0.010	0.5	10	50
Antimony	1450	U	0.029	0.005	0.057	0.076	0.06	0.7	5
Selenium	1450	U	0.002	< 0.001	< 0.010	< 0.010	0.1	0.5	7
Zinc	1450	U	0.007	0.001	< 0.50	< 0.50	4	50	200
Chloride	1220	U	5.5	1.3	11	18	800	15000	25000
Fluoride	1220	U	0.16	0.11	< 1.0	1.2	10	150	500
Sulphate	1220	U	30	< 1.0	59	34	1000	20000	50000
Total Dissolved Solids	1040	U	320	75	630	1000	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-
Dissolved Organic Carbon	1610	U	26	8	51	100	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.175
Moisture (%)	14

Leach Test Information	
Leachant volume 1st extract/l	0.321
Leachant volume 2nd extract/l	1.4
Eluant recovered from 1st extract/l	0.2

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Results Summary - WAC2s

Report No.: 14-00309_1

Project: 14.04.016 - Bourne Estate, Holborn, EC1N 7SD

WAC Analysis

LIMS ID: 1508							Landfill Waste Acceptance Criteria Limits		
Sample Date: 17/04/2014							Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample ID: WAC1									
Determinand	**SOP**		**Units**						
Total Organic Carbon	2625	M	%			3.7	3	5	6
Loss on Ignition	2610	M	%			6.3	--	--	10
Total BTEX	2761	M	mg/kg			< 1.0	6	--	--
Total PCBs (7 congeners)	2811	M	mg/kg			< 0.010	1	--	--
TPH Total WAC	2670	M	mg/kg			< 10	500	--	--
Total (of 17) PAHs	2700	N	mg/kg			13	100	--	--
pH	2010	M				8.3	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg			0.18	--	To evaluate	To evaluate
Eluate Analysis			**2:1 mg/l**	**8:1 mg/l**	**2:1 mg/kg**	**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
Arsenic	1450	U	0.011	0.004	< 0.050	< 0.050	0.5	2	25
Barium	1450	U	0.042	0.004	< 0.50	< 0.50	20	100	300
Cadmium	1450	U	< 0.0008	< 0.0008	< 0.010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70
Copper	1450	U	0.02	< 0.001	< 0.050	< 0.050	2	50	100
Mercury	1450	U	0.0008	0.0005	< 0.010	< 0.010	0.01	0.2	2
Molybdenum	1450	U	0.037	< 0.001	0.073	< 0.050	0.5	10	30
Nickel	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.5	10	50
Antimony	1450	U	0.005	< 0.001	0.011	< 0.010	0.06	0.7	5
Selenium	1450	U	0.003	< 0.001	< 0.010	< 0.010	0.1	0.5	7
Zinc	1450	U	0.015	< 0.001	< 0.50	< 0.50	4	50	200
Chloride	1220	U	45	1.7	89	67	800	15000	25000
Fluoride	1220	U	0.31	0.12	< 1.0	1.4	10	150	500
Sulphate	1220	U	290	15	570	470	1000	20000	50000
Total Dissolved Solids	1040	U	590	71	1200	1300	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-
Dissolved Organic Carbon	1610	U	48	9.9	95	140	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.175
Moisture (%)	14

Leach Test Information	
Leachant volume 1st extract/l	0.32
Leachant volume 2nd extract/l	1.4
Eluant recovered from 1st extract/l	0.204

Report Information

Key

U	hold UKAS accreditation
M	hold MCERTS and UKAS accreditation
N	do not currently hold UKAS accreditation
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SM	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable sample
N/E	not evaluated
<	means "less than"
>	means "greater than"

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected

Sample Deviation Codes

a - No date of sampling supplied
b - Sample age exceeds stability time (sampling to extraction)
c - Sample not received in appropriate containers

Sample Retention and Disposal

All soil samples will be retained for a period of one month
All water samples will be retained for 7 days following the date of the test report
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.co.uk

APPENDIX D
DESK STUDY INFORMATION

CampbellReith
consulting engineers

Confidential

Bourne Estate (South), Regeneration

GEOENVIRONMENTAL LAND QUALITY STATEMENT

For: London Borough of Camden

Camden

Project No:

Project No: 10907

November 2012

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Document History and Status

Revision	Date	Purpose/Status	Author	File Ref	Check	Review
F1	Oct. 2012	Final	R. Watkins	10907	T. Tucker	Detailed
F2	Nov 2012	Final	R. Watkins	10907	D Innes	Detailed

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Author	R. Watkins
Reviewer	T. Tucker / D. Innes
Project Partner	D. Innes
Project Number	10907
Project Name	Bourne Estate (South), Regeneration

CONTENTS

SUMMARY OF ACTIONS

Human Health	Concentrations of contaminants in soil have not been found at levels that may indicate a significant possibility of significant harm (SPOSH) to human health. As such, no specific recommendations for remediation are considered necessary at this stage. However, this should be reviewed upon receipt of any further information relating to ground conditions, which may come to light.
Controlled Waters	No significant volumes of groundwater have been encountered beneath the site, despite the underlying geology being part designated as a Secondary A Aquifer.
Buildings & Structures/ Services	Three rounds of ground gas monitoring have been completed – the results do not indicate a potentially significant ground gas issue at site and therefore specific mitigation is not currently considered necessary. This is subject to confirmation either from the Local Authority that the current level of data is sufficient.
Site Work Controls & Supplementary Site Investigation	Whilst significant levels of contamination have not been identified onsite, there remains the possibility for unforeseen contamination to reside beneath building footprints, particularly in the vicinity of the proposed MUGA. Should programme / phasing permit, it would be beneficial to undertake a supplementary phase of site investigation in order to examine these areas more closely, which could be completed at the same time as the collection of additional geotechnical data that will be required to inform foundation design to the Block 1 extension to Nigel House following demolition of the current MUGA. Regardless of whether supplementary site investigation is undertaken, as a minimum, it is recommended that a *Groundworks Specification* is prepared to manage this risk and to establish protocols for appropriate notification and management should this occur.
Regulatory Approval	This document should be submitted to the Local Authority, via planning, for review by the Environmental Health / Contaminated Land Officer. Approval of this document forms a requirement under the National Planning Policy Framework.
Waste	The LQS does not address the classification of waste soils. The soil results 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 Appraisal	Geotechnical interpretation has not been included within the scope of this report. As such, a *Geotechnical Design Report* should be commissioned in due course in order to provide interpretation on the desktop information and site investigation data in order to inform foundation/ structural design.
Other	An UXO Assessment was completed prior to the mobilisation of site works and is contained within Appendix B. This should be copied to the site Health & Safety File and provided to the Principal Contractor upon appointment to advise on appropriate mitigation measures. Asbestos has been detected within a limited number of soil samples, although at concentrations <0.001% wt/wt. A specialist consultant should be sought to confirm whether there is a significant risk from these soils.
Documentation	This report should be submitted by the Client to the Local Authority for review and approval by the Contaminated Land Officer/ Environmental Health Officer.

EXECUTIVE SUMMARY

Site Location	The Bourne Estate extends over an area of 1.1 ha within the Hatton Garden Conservation Area and is located immediately to the east of Grays Inn, at a National Grid Reference of 531160^{E}, 181890^{N}.
Environmental Setting	The site is set in an area of overall **Medium** environmental sensitivity based upon an underlying **Secondary A Aquifer**. No hydrological or ecological receptors have been identified within 500m of the site.
Current Use and History	The site is currently in use as residential housing estate, and reference to historical mapping indicates that this has been the primary site layout for the past 50 years. Historical mapping from 1851 identified that the site was already developed by this time, predominantly with residential housing that included 'Industrial Dwellings' which may have housed workers from the adjacent brewery or similar industries. During the Second World War, the site is recorded as having sustained significant bomb damage with extensive post-war redevelopment of the site following thereafter. However, it is unclear as to whether this affected the western park area of the site (adjacent to Gooch House).
Geotechnical Hazards & Recommendations	**A 'Geotechnical Design Report' has not been undertaken and should be commissioned in due course in order to provide geotechnical interpretation of the data and inform foundation/ structural design requirements.** There is the potential for significant thicknesses of Made Ground to be present at the site associated with historical development and bombing during WWII, as well as the potential for buried obstructions and relic basements. The London Clay and materials derived from it can be aggressive to buried concrete. Utilities plans indicate that there are other services present on site. The footprint to the Block 1 extension coincides with the current MUGA, and as such, it was not possible to investigate this area within the current phase of site investigation. Noting the relatively variable Lambeth Group strata beneath the site and the length of piles likely to be required, supplementary boreholes within this area may be beneficial in advising appropriate geotechnical design.
Contamination Issues	A Tier 2 (Generic) Environmental Risk Assessment of the data has identified the following risks: • **LOW RISK** in relation to human health of proposed residential end users. • **LOW RISK** in relation to groundworker and maintenance worker human health. This reflects that gross contamination has not been identified and assumes that appropriate Personal Protective Equipment (PPE) will be adopted throughout works. • **LOW RISK** in relation to Controlled Waters (Secondary A Aquifer) due to the absence of a groundwater onsite. • **LOW RISK** in relation to Buildings and Services Infrastructure (excluding future pipework – see below). As such, specific remediation is not considered necessary to deliver the site 'suitable for use'.

Cont.

EXECUTIVE SUMMARY (CONT.)

Geoenvironmental Recommendations	This document should be submitted to the Local Authority for review by the Environmental Health/ Contaminated Land Officer. A supplementary phase of site investigation would significantly reduce latent risk items onsite, particularly with regard to: • the current MUGA area where the Block 1 construction will be located, including basement excavations; and, • the location of the proposed MUGA which is currently occupied by general caretaker stores and TRA offices. It is noted that the historical composite plan (Figure 4, Appendix A) indicates that this area was formerly a residential block, and as such, increased thicknesses of Made Ground may be encountered associated with demolition arisings which may potentially include asbestos. It is recognised that the completed site investigation has been constrained by areas that are inaccessible due to either being in use at the time or occupied by an existing building. Whilst the conclusions of this report do not infer contamination to be present beneath within these areas, it is recommended that a 'watching brief' for unforeseen contamination should be undertaken during any earthworks at the site. A *Groundworks Specification* should be prepared in order to establish the protocols for the notification and management of unforeseen contamination or other significant ground conditions should these be encountered. Aside from the above works which generally fall within the requirements of the *National Planning Policy Framework* and relevant Statutory Guidance, there may be a commercial case in undertaking a *Waste Classification Report*; particularly given the proposed basement excavations associated with Block 1 and the MUGA (which as a minimum is proposed to have a FFL of -1m bgl due to acoustic requirements). This would best be commissioned together with a supplementary phase of site investigation to enable assessment within the area (both laterally and vertically) of proposed excavations.

1.0 INTRODUCTION

1.1 This report has been produced by Campbell Reith Hill LLP (CampbellReith) on behalf of London Borough of Camden (hereafter 'the Client') to summarise geo-environmental information relating to the Bourne Estate, Camden (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.

1.2 The report has been produced in general accordance with the technical procedures for site investigation, interpretation and reporting set out under EA & DEFRA *Contaminated Land Report (CLR) 11*[1] BS 5930[2] (as amended) and BS 10175[3]. The objective of this report is to collate and interpret Phase 1 Desk Study information and Phase 2 exploratory data in order to assess the site and identify whether remedial requirements are necessary to permit the redevelopment of the site for continued residential end use in accordance with the *National Planning Policy Framework*[4]. Details of the proposed scheme are presented under Section 2.0.

1.3 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.

1.4 A geotechnical appraisal has not been carried out at this stage. An interpretative *Ground Investigation Report* and/or *Geotechnical Design Report,* in accordance with Eurocode 7, should be completed in due course as a stand-alone document in order to advise appropriate foundation design amongst other construction matters. These would most appropriately be generated once structural details of the proposed development are confirmed.

1.5 This report is primarily based upon:

- CampbellReith, *Feasibility Stage Geoenvironmental, Drainage & Flood Risk Desktop Study*, Draft 2, Ref: RWeb10907-270112-BourneDTS-D2, March 2012 (Appendix B); and,
- Harrison Group Environmental Ltd, *Bourne Estate, Camden: Ground Investigation Report*, Ref: GL16482, June 2012(Appendix C).

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1 Environment Agency & Department for Environment, Food & Rural Affairs, *Contaminated Land Report 11: Model Procedures for the Management of Land Contamination*, September 2004.

2 British Standards Institute, *BS5930:1999 +A2:2010 – Code of Practice for Site Investigations*, Status: Current (Partially Replaced), October 1999.

3 British Standards Institute, *BS10175:2011 – Investigation of Potentially Contaminated Sites – Code of Practice*, 31st March 2011.

4 Department for Communities & Local Government, *National Planning Policy Framework*, March 2012.

2.0 SITE DESCRIPTION

Site Location

2.1 The Bourne Estate site extends over an area of 1.1 Hectares within the Camden area of London and is located immediately to the east of Grays Inn and to the west of Hatton Garden, at a National Grid Reference of 531160^{E}, 181890^{N}.

Site Layout

2.2 The site includes 6 residential blocks and some 199 residential units of the Bourne Estate contained within:

- Gooch House;
- Nigel Building;
- Buckridge Building;
- Kirkeby Building;
- Mawson House; and,
- Laney Building.

2.3 The site is bounded to the north by Portpool Lane with the southern site boundary formed by Baldwin's Gardens and the St Albans Church of England primary school. The commercial properties that front on to Grays Inn Road form the western boundary of the site with the properties that front on to Heather Lane forming the eastern boundary of the site.

2.4 Within the confines of the site there is approximately 4,094m^2 of open space consisting of a Multi-Use Games Area (MUGA), grassed areas and hard surface court yards. In addition there is also a small resident's community hall and care-takers facilities and substation located within the centre of the site.

Topography

2.5 There site is generally at +26m AOD, however, significant changes in topography were noted during the site walkover.

Access

2.6 Vehicular access is gained from Baldwin's Gardens, Verulam Street and Portpool Lane. These roads also provide the primary pedestrian access to the site. A good pedestrian footway network is provided through the core of the site.

Surrounding Land-Use

2.7 The site is set in an area of mixed use – a description of the main surrounding land uses is summarised under Table 2.1 below.

Table 2.1: Summary of Surrounding Land Uses

Direction	Description
North	The northern portion of the Bourne Estate is situated to the immediate north of the site, adjacent to Portpool Lane.
East	Grade II listed terraces of Laney Building form the eastern site boundary, beyond which runs Leather Lane.
South	St Alban's C.E. Primary School and Nursery is located on the southern site boundary off Baldwin's Gardens.
West	The west of the site is bound by Gray's Inn Road, beyond which lies Gray's Inn Gardens communal open space.

2.8 The site is partly set within and directly adjacent to the Hatton Garden Conservation Area and there are several terraces of Grade II listed buildings which sit to the north and south of the site.

Site After-Use Proposal

2.9 The proposed redevelopment at the site will primarily affect two main areas as shown in Figure 3 (Appendix A) which should be read in conjunction with the following description.

- **Block 1** which is a ground plus 5 Storey extension to the west of Nigel Building, (located in the north of the site) and will replace the current MUGA. Ground floor and basement level for cycle storage, plant, caretaker, sub-station and Tenants Residents Association (TRA). Block 1 will generate a total Gross Internal Area (GIA), excluding ground and basement levels, of 1,987m^2 and 27 residential units. This area will also comprise a new MUGA, Small Ball Court and adjacent Playspace which will be located in the current area of the TRA and caretaker stores in the centre of the site. This will be a replacement for the MUGA and play space that will be lost as part of the construction of Block 1. It is currently proposed to finish the MUGA at 1m+ below surrounding levels for acoustic reasons.

- **Block 2** which is a ground plus 5 Storey new build in the south of the site (to the east of St Alban's school) following the demolition of Mawson House. Leopard's Court will be retained. Block 2 will generate a total of 48 residential units comprising a total GIA of 3,644m^2. An area to the east of Block 2 will also be set aside as Playspace.

3.0 ENVIRONMENTAL SETTING

3.1 The following section has been summarised from CampbellReith's *Feasibility Stage Geoenvironmental, Drainage & Flood Risk Desktop Study* (Appendix B) which should be consulted for further details.

Geology

3.2 The site geology as determined by BGS mapping and historical borehole records is summarised under Table 3.1 below. In summary, a sequence of Lynch Hill Gravel on the western half of the site, and Hackney Gravel on the eastern half of the site, both over London Clay and in turn underlain by Lambeth Group over Thanet Sands with Chalk at depth is anticipated. In addition, historic ground investigation boreholes indicate Made Ground to be present, as expected for a historically developed site.

Table 3.1: Summary of Geology

Type	Base of Stratum (m bgl)	Thickness (m)	Description
Made Ground	3.45 – 4.90	3.45 – 4.90	Topsoil over fill comprising compact bricks and rubble underlain by silty clayey sand.
Hackney Gravel	4.50 – 6.70	0.90 – 2.75	Very dense brown slightly silty sand and gravel.
London Clay	17.35 – 20.70	12.80 – 14.50	Stiff, becoming very stiff with depth, grey fissured silty clay.
Lambeth Group	29.30	11.90	Very stiff multi-coloured mottled fissured clay over pale grey silty fine sand underlain by blue clay to 25.90m bgl (Woolwich and Reading Beds). Pebble beds over blue clay (Upnor Formation).
Thanet Sand	41.45	12.20	Dense green sand.
Chalk	Proven to 68	26.20 proven	White chalk with flints.

Radon

3.3 The site does not fall within an area where radon protection measures are considered necessary for domestic dwellings, nor is it situated in an area requiring a geological assessment for such measures. As such, a **Low** sensitivity is adjudged in relation to radon.

Hydrogeology

3.4 The site is situated in an area of **Medium** sensitivity in relation to hydrogeology primarily due to the presence of a *Secondary A Aquifer* associated with the Lynch Hill Gravels (where present). In

addition, the site is underlain by soils of a 'High (HU)' leaching potential (albeit this is a conservative classification due to the site's urban setting and fewer soil observations). The site is not situated within an Environment Agency *Source Protection Zone* and the nearest potable abstraction is located >1km from the site.

Hydrology

3.5 No surface rivers, lakes or other features have been identified within 500m of the site, and as such, a **Low** sensitivity is considered appropriate in this regard.

Ecological Receptors

3.6 No *Ecological Receptors*, as defined under Table 1 of the Statutory Guidance to the Environmental Protection Act[5] have been identified within 1km of the site, and as such, a **Low** sensitivity is assigned in this regard.

Archaeological and Heritage

3.7 The site is noted to be located within the Hatton Garden Conservation Area. An *Archaeological Desk Based Assessment*[6] has been prepared by CgMs Consulting and should be referred to for further details no this subject.

[5] Department for Environment, Food and Rural Affairs, *Environmental Protection Act 1990: Part 2A – Contaminated Land Statutory Guidance*, April 2012.

[6] CgMs Consulting, *Archaeological Desk Based Assessment: Bourne Estate, Holborn, London*, Report Ref: MC/13803(B), April 2012

4.0 SITE HISTORY AND INDUSTRIAL SETTING

Site History

4.1 Information relating to the site history has been obtained by reference to both Historical Town Plans and Ordnance Survey Mapping of 1: 25,000, 1:10,560, 1:5,280, 1:2,500 and 1: 1,056 dated 1851 – 2011. In addition, Historical Aerial Photography of 1:1,250 and 1; 10,560 dated 1946 – 1949 has been reviewed, together with Historical Building Layout Plans dated 1966. This data is contained within Appendix B.

4.2 A summarised development history for the site and its surroundings is presented below under Tables 4.1 and 4.2, respectively.

Table 4.1: Site History

Date	Development
1851 - 1898	Mapping dated 1851 indicates the site to be already developed, located between Grays Inn Road and Leather Lane. By 1874 – 1875, mapping detail appears to be greatly improved and by the late 1800s, features include 'Industrial Dwellings', 'Laundry', 'Thanksgiving Model Buildings', general 'Courts' and what appears to be terraced housing.
1916 - 1938	At some point between 1898 and 1916, the site appears to have undergone significant redevelopment, with notable differences in building layout. Mapping dated 1937 continues to show the 'Buckridge House' and 'Nigel House' on the eastern site boundary. A building labelled 'Dupcan Buildings' is shown to have been present on the western portion of the site c.1900; although they are only labelled as 'Dupcan Buildings' from c.1937. Aerial photography inferred this building to be a tower-type structure by design.
1946 - 1949	**Historical Aerial Photography** Aerial photography indicates a significant redevelopment of the site, possibly in relation to WWII bomb damage (see Section 4.4). Most notably, the southeast of the site appears to have been cleared of buildings by 1946.
1951 - 1965	By 1951, the west of the site is indicated to have been cleared, and the previous 'Dupcan Buildings' / Tower-like buildings since demolished. Subsequent mapping 1952 – 1953 identifies these buildings as 'ruins'(possibly as a result if WWII bomb damage), together with the southeast portion of the site which is shown as vacant. The existing 'Playground' is shown to have been constructed on the eastern site boundary adjacent to Buckridge House.

Cont.

Table 4.1: Site History (Cont.)

Date	Development
1966	**Historical Building Layout Plan** A brief summary of the main features of interest onsite are summarised below: • Mawson House is shown to have been constructed on the southeast of the site; • The playgrounds on the southeast of the site and adjacent to Buckridge Buildings had been constructed. • The community centre is present with an adjoining 'Builders Workshop and Stores'; • Gooch House had been constructed in the west of the site.
1968 - 2012	Land to the west of Gooch House is indicated to have been landscaped by c. 1968 and by c.1975 the former 'Builders Workshop and Stores' had been redeveloped into an 'Electricity Sub-Station'. The site has remained relatively unchanged to the present day.

Table 4.2: Potentially Contaminative Surrounding Historical Land Uses (≤250M)

Approx. Date	Distance	Development
1874 – 1916	<10m / N	A **Brewery** is indicated to have been present from at least 1874, to the immediate north of Portpool Lane. By 1916, the brewery appears to have been demolished and redeveloped to the present day residential properties (Redman House complex).
1896 - 1952	<10m / S	A **Glass Works** is present to the immediate south of Verulam Street. The works area is labelled 'ruins' by c.1952, suggesting that the glass works were demolished during WWII.
1937 - 1952	<10m / S	**Brook Street Works** is indicated to have been present fromc.1937, located to the immediate south of Baldwins Gardens. From 1952, there still appears to be a building present, however, it is no longer labelled Brook Street Works.
1952 - 1965	50m / NE	A **Tobacco Factory** was present from at least 1952, comprising two factory buildings located adjacent to Clerkenwell Road and Leather Lane. By 1954, one of the buildings is renamed **Factory** (non-descriptive) and by 1965 the second building is also renamed **Factory** (non-descriptive).
1952 - 1958	30m/ E	A **Gold Refinery** is present to the east of the site, adjacent to Leather Lane. Mapping indicates that the refinery comprises an Electricity Sub Station. From 1958 – 1962, the complex is designated a **Works** (non-descriptive) and no particular labelling is attached to the building thereafter.

Unexploded Ordnance (UXO)

4.3 A **Medium – High** risk had been identified in relation to UXO risk under CampbellReith's *Desktop Study* (Appendix B). As such, and prior to mobilisation of the intrusive site investigation works, a

Detailed Unexploded Ordnance (UXO) Risk Assessment was undertaken by 6-Alpha Associates[7] (Appendix B) which concluded that an operational UXO risk management plan, UXO safety and awareness briefings and specialist UXO banksman support were required. These were duly integrated within the site investigation and no UXO were encountered during the course of works.

Current Industrial Setting

4.4 A detailed review of the site's current industrial setting is presented within CampbellReith's *Desktop Study* (Appendix B) and the main findings presented under Table 4.3 below.

Table 4.3: Summary of current Industrial Setting

Type	Distance	Description
Fuel Station Entries	350m / NE	Single entry within 500m of the site, located at 96-100 Clerkenwell Road, Clerkenwell, London, EC1m 5RJ. This entry is recorded as **obsolete**.
Environmental Permits & Prosecutions Relating to Authorise Processes	4 No. ≤250m	Four **Local Authority Pollution Prevention Controls** have been identified within 250m of the site, the nearest of which is approx. 10m to the southeast of the site registered at Baldwins Gardens, Camden, EC1n 7RJ. Authorised under the London Borough of Camden for **PG2/1 Furnaces for the extraction of non-ferrous metal from scrap** and is listed as **revoked**. The remaining three LAPPCs are active and related to Dry Cleaning, Iron, Steel and Non-Ferrous Metal Foundry Processes; and, General Metal Processes.
Water Industry Act	400m / S	**Water Industry Act Referral** registered at 10 Norwich Street, EC4A 1BD. The referral is dated 10th March 2004 for processes requiring permissions or amendments to discharge water under the Water Industry Act 1991. These are processes which result in the discharge of 'Special Category' effluents under The Trade Effluents (Prescribed Processes and Substances) Regulations. The application is recorded as **cancelled**.

4.5 In addition to the above data, research did not establish the presence of any of the following at or within 500m of the site: Pollution Incidents to Controlled Waters; Discharge Consents; Registered Radioactive Substances; Contaminated Land Register Entries and Notices; Discharge Consents; Integrated Pollution Controls (IPC); Integrated Pollution & Prevention Controls (IPPC); Local Authority IPPCs; Local Authority Pollution & Prevention Control Enforcements; Prosecutions relating to Authorised Processes or Controlled Waters; BGS Recorded Landfill Sites; Historical Landfill Sites; Integrated Pollution Control Registered Waste Sites; Licensed Waste Management

[7] 6-Alpha Associates Limited, *Detailed Unexploded Ordnance (UXO) Risk Assessment*, Ref: P2770_V1.0, 22nd February 2012.

Facilities (Landfill Boundaries & Locations); Local Authority Recorded Landfill Sites; Registered Landfill Sites; Registered Waste Transfer Sites; Registered Waste Treatment or Disposal Sites; Control of Major Accident Hazard Sites (COMAH); Explosive Sites; Notification of Instillations Handling Hazardous Substances (NIHHS); Planning Hazardous Substance Consents; or, Planning Hazardous Substance Enforcements.

5.0 PRELIMINARY CONCEPTUAL SITE MODEL

5.1 Current practice for land contamination evaluation involves appraisal of contaminant source-pathway-receptor pollutant linkages. These are summarised below, based upon information presented above, and have been used as a basis for determining the scope of further site investigation.

Conceptual Site Model (CSM)

Potential Sources of Contamination

5.2 Table 5.1 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 CLR11, Department of the Environment (DOD) *Industry Profiles* and anecdotal information. It is noted that additional undocumented sources of contamination/ contaminants may be present.

Table 5.1: Potential Sources of Contamination

Potential Sources of Contamination	Discussion / Potential Contaminant
Onsite	
Made Ground	A significant thickness of Made Ground is anticipated onsite, resulting from bomb damage sustained onsite during WWII and subsequent redevelopment. The site walkover has identified significant changes in level, possibly resulting from areas of localised backfilling. Potential contamination associated with Made Ground can be wide-ranging and may include: • **Asbestos (whether as Asbestos Containing Materials (ACMs)** or as **free fibres** within the soil matrix, both of which may be associated with backfilling of demolition arisings. • Where **deleterious materials** have been backfilled onsite, this may also represent a potential source of **hazardous ground gases**, primarily comprising **Carbon Dioxide** (CO_2) and **Methane** (CH_4). • Depending upon the nature of the backfilled materials, **metals** and **hydrocarbons** (including **Polynuclear Aromatic Hydrocarbons (PAHs)**) may be present.

Cont…\

Table 5.1: Potential Sources of Contamination (Cont.)

Potential Sources of Contamination	Discussion / Potential Contaminant
Onsite (Cont.)	
Potential **Boiler Rooms** which may have been present in historic buildings – as yet unconfirmed.	Given the age of construction of these buildings, it is likely that original boiler systems were **Fuel Oil** based, and as such, fuel storage / tanks are likely to have been present. It is uncertain whether these have been since upgraded to gas fuelled systems.
Builder Workshop adjoining Community Centre between c.1968 – 1975; when it was subsequently used for an Electricity Sub-station to the present day.	It is unclear to the exact nature of the Builder Workshop, however, it is possible that various hydrocarbon contaminants, including **Lubricating oils**, **Fuel oils** and **Polynuclear Aromatic Hydrocarbons** may be present.
Unexploded Ordnance	The site is known to have been heavily bombed during WWII and a preliminary appraisal (presented under Section 4.0) has identified a **Medium - High Risk** in this regard.
Offsite	
Scrap Metal Works Located approximately 10m to the southeast of the site. **[Historic]**	Registered at Baldwins Gardens, Camden, EC1n 7RJ. Authorised under the London Borough of Camden for **PG2/1 Furnaces for the extraction of non-ferrous metal from scrap** and is listed as **revoked**. Potential contaminants include **ash**, **clinker** and **metals**.
Brewery which was present to the immediate north of the site between c. 1874 – 1916. [**Historic**]	Brewing involves the production of beer through the fermentation of grain within water using yeast. . By products from the brewing process typically include spent grains and dregs – the former of which would have been likely re-sold as fodder. In view of this, there is limited potential for contamination as a result of the brewery, which is confined to the creation of of **ash** as a result of fire-heating process water and the potential for **asbestos containing materials** to have been used within building's fabric. In addition, it is likely that the Brewery included groundwater abstraction wells for process water. In view of the importance of high quality process water for the sensitive brewing process, it is unlikely – but possible – that spent process water/ dregs were discharged to groundwater.
A **Glass Works** which was present to the immediate south of the site between c. 1896 and 1952. [**Historic**]	Although it is unclear as to the type of glass produced, the most common type of glass is **soda-lime glass**, composed of approximately 75% silica (SiO_2) plus Na_2O, CaO and several minor additives. Anecdotal information suggests that potential contaminants associated with glass works include: **lead**, **fluorides**, **oil**, **acids**, **arsenic**, **antimony** and **chromium**. Other potential sources of contamination are **coal** and **ash** from the operating of furnaces, firing kilns or similar.

Cont…\

Table 5.1: Potential Sources of Contamination (Cont.)

Potential Sources of Contamination	Discussion / Potential Contaminant
A **Tobacco Factory** which was present from c.1952 to 1965 approximately 50m to the northeast of the site. [**Historic**]	It is likely that the factory was for **cigarette manufacturing** rather than the curing and preparation of tobacco (which is likely to have been undertaken at the point of origin prior to import). The potential contaminants are considered to be similar to other forms of factory production, most notably the potential for **lubrication oil** and **fuel** associated with production plant and potential boiler rooms.
A **Gold Refinery** which was present approximately 30m to the east of the site c.1952 – 1958. [**Historic**]	Gold is usually refined industrially by the 'Wohlwill Process' which is based on electrolysis to produce the highest grade gold (99.999% purity); or, by the 'Miller Process', that is the chlorination in the melt which produces gold of 99.95% purity. It is unclear as to what refining process prevailed at the site; however, in general the potential contaminants may include **acids** and **spent oxides**.

Receptors

5.3 Based upon the site's environmental setting and proposed (generic) development end uses (i.e. Residential), the following receptors have been identified.

Table 5.2: Summary of Identified Receptors

Receptor	Description	Sensitivity
Human Health Residential End Users	Future housing occupants. Sensitivity of residential end users will vary depending upon the precise nature of the redevelopment. For example, developments which provide private gardens and/or allotment areas are of an increased sensitivity relative to flat / apartments. Adjacent land users may also be at risk where mobile contaminants (e.g. solvents or hazardous ground gases) and pathways are present.	High
Human Health Groundworker & Maintenance Workers	Groundworkers and maintenance personnel associated with the development of the site and ongoing / intermittent maintenance following completion.	Medium
Hydrogeology Secondary A Aquifer	Groundwaters contained within the Lynch Hill Gravel superficial aquifer (not within a Source Protection Zone).	Medium
Buildings & Services Infrastructure	Buried concrete, service corridors and other infrastructure (including water supply pipe work) as part of the site development.	Low

5.4 It is noted that no feasible hydrological or ecological receptors have been identified, and therefore, they are excluded from the above table and following Preliminary Risk Assessment.

Pathways

5.5 In the context of the proposed site uses, the potential pathways presented in Table 5.3 are considered applicable and have been considered in the further site investigation.

Table 5.3: Potential Pathways

Potential Pathway	Construction Phase		Occupation Phase	
	Present	Receptors	Present	Receptors
Ingestion of soil and/or dust.	✓	G&M	✓	G&M, HH
Inhalation of soil and/or dust.	✓	G&M	✓	G&M, HH
Inhalation of vapour from soil, dust and/or water.	✓	G&M	✓	G&M, HH
Dermal contact with soil, dust and/or water.	✓	G&M	✓	G&M, HH
Ground gas migration through granular strata.	✓	G&M, HH	✓	G&M, HH
Migration of water bourne contaminants.	✓	E	✓	E
Leaching of contamination through soil and unsaturated zone.	✓	E	✓	E
Surface water run-off.	✓	E	✓	E
Plant uptake and subsequent ingestion of contaminated home grown crops.	×	HH	×	HH

NOTES: G&M Groundworkers & Maintenance Workers. HH Human Health, E Environmental Receptors.

Preliminary [Qualitative] Pollutant Linkage Risk Assessment

5.6 Current 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, Chartered Institute for Environment and Health and CIRIA.

5.7 Tables 5.1 – 5.3 indicate the potential contaminants, receptors and pathways that have been considered at the site. Based upon available desktop information, a preliminary qualitative risk assessment is presented under Tables 6.4 overleaf utilizing the following descriptions of risk that take into account the magnitude of the potential source, likelihood of exposure via a pathway and significance of harm likely to result on the given receptor[8].

[8] CIEH, *Guidelines for Environmental Risk Assessment and Management*; and, CIRIA C552, *Contaminated Land Risk Assessment: Guide to Good Practice*. Section 6 of CIRIA 552 presents matrices for risk assessment – these have been simplified herein.

- **High (H) Risk:** Pollutant linkage is likely to exist with potential to cause significant harm;
- **Medium (M) Risk:** Pollutant linkage is likely to exist but significant harm is unlikely; and,
- **Low (L) Risk:** Pollutant linkage may exist but any harm is likely to be mild.

Table 5.4: Preliminary Conceptual Site Model & Pollutant Linkage Risk Assessment

Potential Sources of Contamination [See Table 5.1 for Details]	**Receptors** [See Table 5.2 for Descriptions]	**General Pathways** [See Table 5.3 for Detailed Breakdown]	**Risk Classification**
Made Ground & Potential Boilers A variable and potentially significant thickness of Made Ground may be present at site, containing: **Asbestos Containing Materials**, **Hazardous Ground Gases**, **Metals** and **Hydrocarbons**. Original boilers are likely to have used **Fuel Oil**.	HH: **Residential Occupants**	Primary risk pathways exist where direct contact is possible with soils. Volatile contaminants and hazardous ground gases present a risk via inhalation pathways.	**Medium**
	HH: **Groundworker & Maintenance Staff**		**Low* – Medium**
	Groundwater: **Secondary A Aquifer**	Risk pathways predominantly via leachate and downward migration of contaminants.	**Low**
Electricity Sub-station An Electricity sub-stations was installed c. 1975 onsite, within the former Building Workshop., This is likely to contain **Polychlorinated Biphenyls (PCBs**). **Mineral oils** are also likely to be present. It is noted that PCBs are highly insoluble.	HH: **Residential Occupants**	Primary risk pathways exist where direct contact is possible with soils. Volatile contaminants and hazardous ground gases present a risk via inhalation pathways.	**Medium**
	HH: **Groundworker & Maintenance Staff**		**Low* - Medium**
	Groundwater: **Secondary A Aquifer**	Risk pathways predominantly via leachate and downward migration of contaminants.	**Medium**
Historical offsite uses including: **Brewery**; **Glass Works**; **Tobacco Factory**; and, **Gold Refinery**.	HH: **Residential Occupants**	Given the fact that all these historical uses are off-site; and, that there is little evidence to suggest that mobile contaminants (e.g. hazardous ground gases or volatile compounds) are migrating onsite – a low level of risk has been identified to Human Health in general.	**Low**
	HH: **Groundworker & Maintenance Staff**		**Low***
	Groundwater: **Secondary A Aquifer**	Whilst these offsite uses may have resulted in impaction of offsite groundwaters, there is considered to be limited risk – particularly given the nature of these industries and the importance of high quality process water. Notwithstanding this, there remains to be a potential (albeit limited) for this to have occurred.	**Low - Medium**

NOTES: HH Human Health. * Lower bound risk classification assumes the use of appropriate Personal Protective Equipment (PPE) and general working Health & Safety provisions.

6.0 SITE INVESTIGATION

Summary of Investigation

Scope of Works

6.1 A ground investigation was undertaken by Harrison Group Environmental Ltd (Harrisons), based upon a specification prepared by CampbellReith, in order to provide environmental data to assess the primary geo-environmental risks previously identified within the Desktop study. The works were procured by CampbellReith and implemented under appointment by London Borough of Camden, with supervision by CampbellReith, between 6th and 12th March 2012. In summary, the works comprised:

- 8 no. Dynamic Sampler (Window Sample) holes (WSB1 – WSB6) to depths between 1.20 and 3.45m bgl;
- 3 no. Cable Percussive Boreholes (BHB1, BHB2 and BHB2A) to depths between 0.70 and 30.00m bgl;
- gas and groundwater monitoring installations within BHB1, BHB2A, WSB2, WSB3 and WSB4;
- 3 no. gas and groundwater monitoring visits;
- geotechnical and environmental sampling; and,
- in-situ geotechnical testing including Standard Penetration Testing (SPTs) and permeability testing.

6.2 Due to the current use of the site at the time of the site investigation works, there remain areas of potential risk which are yet to be investigated. These include:

- beneath the current MUGA, which coincides with the footprint to the proposed Block 1 extension. This area may require investigation at a future date to inform foundation requirements to Block 1 (in light of the likely requirement for piled foundations and the relatively variable nature of the Lambeth Group strata) and advise on the chemical nature (and potential waste classification) of arisings which may require disposal offsite; and,
- beneath the current TRA office and caretaker stores, which is proposed for the new MUGA (also requiring significant excavation) and indicated by the Historical Composite Plan to coincide with a former building which may have resulted in an increased thickness of Made Ground locally.

Pre-commencement Works/ Surveys

6.3 Prior to the commencement of site works, a full services trace was undertaken. A detailed Unexploded Ordnance (UXO) Risk Assessment was undertaken by 6 Alpha Associates, which

concluded a **medium - high** risk of encountering UXO for an intrusive investigation. As such, UXO briefings and supervision were undertaken during the site works. It is recommended that additional advice is undertaken during the proposed development.

Ground Conditions

6.4 The ground conditions encountered were generally as anticipated by the desktop study and are summarised in Table 6.1.

Table 6.1: Summary of Encountered Ground Conditions

Strata	Description	SPT 'N' value	Thickness (m bgl)	Depth to Base (m bgl)
Made Ground	At the surface, asphalt or grass over topsoil, described as dark brown clayey sandy SILT and dark brown organic clayey silty fine and medium SAND. Underlain by Made Ground, generally granular in nature, comprising brown silty gravelly fine to coarse SAND. Locally, cohesive Made Ground was described as soft to firm dark brown and dark grey slightly sandy slightly gravelly CLAY. Gravel is angular fine to coarse brick, occasional concrete, rare wood, glass and metal fragments. Occasional brick cobbles were also encountered.	8 – 23	1.10 – 5.10	1.10 – 5.10
River Terrace Deposits	Medium dense to dense yellow brown and brown silty fine to coarse SAND and GRAVEL. Gravel is sub-rounded to rounded fine to coarse flint.	26 – 35	2.60 – 4.80	7.70
London Clay	Firm to stiff fissured grey silty CLAY.	16 – 28	14.80	22.50
Lambeth Group	Reading Formation (Upper Mottled Beds): 0.40m of blue green clayey fine to coarse SAND over very stiff multi-coloured CLAY.	48 – 75*	7.50 proven	Proven to 30.00
* Extrapolated				

6.5 The Made Ground ranged in thickness between 1.10 and 5.10m, however its full thickness was not revealed in BHB2 and WSB1 to WSB4, which terminated at depths between 0.70 and 3.45m bgl. WSB1 and WSB5 were terminated at 1.20and 1.60m bgl respectively upon encountering obstructions.

Groundwater Observations

6.6 Groundwater was not encountered in any of the window sample boreholes. Groundwater was also not encountered in the River Terrace Deposits in either of the two cable-percussion boreholes, and the third was terminated at 0.70m bgl. However, water was added to assist drilling through the gravel which may have masked any water strikes. A groundwater strike was recorded in BHB2 in the Lambeth Group strata at 22.50m bgl, which rose to 20.42m bgl after 20 minutes.

6.7 One round of gas and groundwater monitoring was undertaken on 23rd March 2012. This data and the installation details are summarised in Table 6.2. Two further rounds of monitoring are due to be undertaken.

Table 6.2: Summary of Installation and Monitoring Data

Exploratory Location	Installation Details		Monitoring Levels (m bgl)
	Depth (m bgl)	Strata	
BHB1	1.00 – 3.00	Made Ground	Not monitored
	4.00 – 8.00	River Terrace Deposits	Not monitored
BHB2A	1.00 – 4.00	Made Ground	N/a
	5.00 – 8.00	River Terrace Deposits	6.22
WSB2	1.00 – 3.00	Made Ground	Dry
WSB3	1.00 – 3.00	Made Ground	Dry
WSB4	1.00 – 3.00	Made Ground	Dry

Geotechnical Testing (In-situ & Laboratory)

6.8 In-situ testing comprised Standard Penetration Tests (SPT) and permeability testing in the cable tool boreholes. In addition, selected samples were submitted to Harrisons for analyses as summarised in Table 6.3. Results should be reviewed and interpreted in the form of a *Geotechnical Design Report* in due course.

Table 6.3: Summary of Scheduled Geotechnical Laboratory Analyses

Test type and reference (BS 1377: 1990 unless stated)	Number
Natural moisture content (Part 2:3.2)	13
Liquid and plastic limits and plasticity index (Part 2:4.3, 5.3 and 5.4)	6
Particle size distribution - wet sieving (Part 2:9.2)	4
Single stage 100mm UU triaxial compression test (Part 7:8)	6
Water soluble sulphate content 2:1 aqueous extract (BRE SD1 2005)	14
Total sulphur content (BRE SD1 2005)	4
Acid soluble sulphate content (BRE SD1 2005)	4
pH of soil (BRE SD1 2005)	14
pH of groundwater (BRE SD1 2005)	1
Sulphate content of groundwater (BRE SD1 2005)	1

Contamination Observations and Testing

6.9 In general, no significant sources of gross contamination have been identified within the exploratory hole records. Relatively benign contaminant bearing Made Ground constituents have been recorded and are summarised in Table 6.4.

Table 6.4: Potential Indications of Contamination and/or Anthropogenic Components

Exploratory Hole	Depth (m bgl)	Description
BHB1	0.15 -2.90	**Made Ground** gravel containing coarse brick, occasional concrete, rare wood, glass and metal fragments.
BHB2	0.35 – 0.70	**Made Ground** gravel containing brick.
BHB2A	0.35 – 5.10	**Made Ground** gravel containing brick. Occasional brick cobbles.
WSB1	0.30 – 1.20	**Made Ground** gravel containing brick and rare concrete.
WSB2	0.00 – 0.20	**Made Ground** gravel containing brick and glass fragments.
WSB2	0.20 – 1.10	**Made Ground** gravel containing brick and concrete. Rare brick cobbles.
WSB2	1.10 – 1.30	**Made Ground** contains brick gravel and cobble.
WSB2	1.30 – 3.45	**Made Ground** gravel contains occasional brick and charcoal.
WSB3	0.30 – 2.30	**Made Ground** gravel contains brick and rare concrete.
WSB3	2.30 – 3.45	**Made Ground** gravel contains brick and charcoal fragments.
WSB4	0.15 – 1.20	**Made Ground** gravel contains brick and concrete. Occasional brick cobbles.
WSB4	1.20 – 2.95	**Made Ground** gravel contains brick and concrete.
WSB5	0.15 – 1.10	**Made Ground** gravel contains brick, rare concrete, wood and glass fragments.
WSB6	0.00 – 0.15	**Made Ground** gravel contains brick and rare glass fragments.
WSB6	0.15 – 1.00	**Made Ground** gravel contains brick, glass and rare concrete.
WSB6	1.00 – 2.40	**Made Ground** gravel contains brick and rare wood fragments.
WSB6	2.40 – 2.50	**Made Ground** comprises yellow brown brick gravel and cobble.

6.10 Selected soil samples were submitted to Envirolab for analyses as summarised in Table 6.5.

Table 6.5: Summary of Scheduled Environmental (Contamination) Analyses

Test type and reference	Number
Metals suite comprising arsenic, cadmium, chromium, lead, mercury, selenium, copper, nickel, and zinc	25
Total Petroleum Hydrocarbons (TPH) Screen C_6-C_{40}	25
Polynuclear Aromatic Hydrocarbons (PAH) Speciated USEPA 16 Priority Compounds	25
Phenols	23
Soil Organic Matter (SOM)	23
Free Cyanide	23
Total Cyanide	23
pH Value	23
Screening method for Asbestos Containing Materials	23

7.0 TIER 2 ENVIRONMENTAL RISK ASSESSMENT & REVISED CONCEPTUAL MODEL

Assessment Framework

7.1 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 the comparison of identified contaminant levels to generic screening values that have been prepared to assess the risk to the receptors identified. The guidance used to provide this initial screening is listed in Table 7.2 in order of application. The assessment is primarily orientated towards identifying land affected by contamination as required under the National Planning Policy Framework.

7.2 With respect to Human Health Risk Assessment, the selection of screening values has been based upon the sensitivity of the proposed residential end-use as a **Residential with Plant Uptake**. It is noted that whilst plans do not currently indicate private gardens to be included, a conservative assumption has been made at this stage.

7.3 The assessment assumes a Soil Organic Matter (SOM) content of 3.0% based on average site derived SOM data from the Made Ground. SOM data is summarised under Table 7.1 below.

Table 7.1: Summary of Soil Organic Matter (SOM) Data

Location	Sample Depth	Strata	SOM (%)
BHB2	1.00m	Made Ground	5.02
BHB2A	1.00m	Made Ground	7.53
BHB2A	4.00m	Made Ground	6.38
WSB1	0.10m	Made Ground	4.97
WSB1	0.50m	Made Ground	4.34
WSB2	0.10m	Made Ground	4.10
WSB2	0.50m	Made Ground	2.10
WSB2	1.50m	Made Ground	9.74
WSB2	3.00m	Made Ground	0.78
WSB3	0.15m	Made Ground	10.40
WSB3	0.90m	Made Ground	3.84
WSB3	2.50m	Made Ground	5.78
WSB4	0.10m	Made Ground	7.84
WSB4	0.50m	Made Ground	6.52
WSB4	1.50m	Made Ground	0.78
WSB4	2.80m	Made Ground	2.12
WSB5	0.10m	Made Ground	2.93
WSB5	0.50m	Made Ground	1.44
WSB5	1.00m	Made Ground	1.29
WSB6	0.10m	Made Ground	4.41
WSB6	0.75m	Made Ground	2.22
WSB6	2.10m	Made Ground	1.58
		Average [Mean] SOM Concentration	**4.37**

7.4 Due to an absence of groundwater at the site, a Tier 2 environmental risk assessment has not been considered necessary in this regard.

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

Table 7.2: Tier 2 (Generic) Screening Values (Soil & Gas)

	Key Guidance
Soil	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.
	Generic Assessment Criteria based upon Environment Agency CLEA UK Beta Version 1.0. Environment Agency Toxicological Reports: 1-25.
Gas	CIRIA Report C665, 'Assessing Risks Posed by Hazardous Ground Gases to Buildings'
	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.

Soil Environmental Risk Assessment

7.6 The statistics associated with soil analysis are summarised in Table 7.2. 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 Tier 2 screen, these results are highlighted and discussed. The remainder are not considered indicative of significant contamination for the proposed end use.

7.7 The statistical assessment has treated the site as a single averaging area and screened in its entirety. Additional tables are presented where appropriate to reflect distinct ground characteristics relevant to the conceptual model.

Table 7.3: Summary of Soil Analysis for Residential with Plant Uptake (3.0% SOM, pH 7)

Contaminant	Units	Exceeding	Max	95th%	Tier 2 Screen
Metals					
Arsenic	mg/kg	0/ 24	27.3	16.08	32[A]
Cadmium	mg/kg	0/ 24	7.2	1.66	10[A]
Chromium	mg/kg	0/ 24	84.1	31.39	627[B]
Copper	mg/kg	1/ 24	**7,550**	154.55*	2,310[B]
Inorganic Mercury(4)	mg/kg	0/ 24	3.27	1.84	170[A]
Nickel	mg/kg	0/ 24	40.6	24.36	127[A]
Lead	mg/kg	7/ 24	**1,940**	378.08	450[C]
Selenium	mg/kg	0/ 24	1.75	1.11	350[A]
Zinc	mg/kg	0/ 24	834	265.76	1,634[B]
Inorganics					
Cyanide	mg/kg	0/ 44	2.38	1.09	18.6[C]
Phenol	mg/kg	NA/ 22	0.013	NC	NT
BTEX Compounds & MTBE					
Benzene	mg/kg	0/ 2	0.01	NC	0.18[B]
Toluene	mg/kg	0/ 2	0.0057	NC	319[B]
Ethylbenzene	mg/kg	0/ 2	0.00456	NC	181[B]
Xylene (Total)	mg/kg	0/ 2	0.0193	NC	117[B]
o - Xylene	mg/kg	0/ 2	0.00684	NC	126[B]
m & p - Xylene	mg/kg	0/ 2	0.0125	NC	123[B]
MTBE	mg/kg	NA/ 2	0.005	NC	NT
Total Petroleum Hydrocarbons (TPH)					
TPH C_6-C_{40}	mg/kg	18/ 24	**1,140**	**300.47**	30[B, Aliphatics>EC8-EC10]
Aliphatics >EC_5-EC_6	mg/kg	0/ 2	0.01	NC	43.8[B]
Aromatics >EC_6-EC_7	mg/kg	0/ 2	0.01	NC	150[B]
Aliphatics>EC_6-EC_8	mg/kg	0/ 2	0.0103	NC	115[B]
Aromatics >EC_7-EC_8	mg/kg	0/ 2	0.01	NC	319[B]
Aliphatics >EC_8-EC_{10}	mg/kg	0/ 2	0.016	NC	30[B]
Aromatics >EC_8-EC_{10}	mg/kg	0/ 2	0.0353	NC	48[B]
Aliphatics >EC_{10}-EC_{12}	mg/kg	0/ 2	0.0125	NC	155[B]
Aromatics >EC_{10}-EC_{12}	mg/kg	0/ 2	0.01	NC	186[B]
Aliphatics >EC_{12}-EC_{16}	mg/kg	0/ 2	7.04	NC	689[B]
Aromatics >EC_{12}-EC_{16}	mg/kg	0/ 2	5.04	NC	398[B]
Aliphatics >EC_{16}-EC_{21}	mg/kg	0/ 2	5.07	NC	37,841[B]
Aromatics >EC_{16}-EC_{21}	mg/kg	0/ 2	4.69	NC	577[B]
Aromatics >EC_{21}-EC_{35}	mg/kg	0/ 2	61.5	NC	1,137[B]
Aliphatics >EC_{21}-EC_{35}	mg/kg	0/ 2	31.8	NC	37,841[B]
Polynuclear Aromaic Hydrocarbons (PAH)					
Naphthalene	mg/kg	0/ 24	0.325	0.12	4.4[B]
Acenaphthylene	mg/kg	0/ 24	0.218	0.05	388[B]
Acenaphthene	mg/kg	0/ 24	0.0769	0.02	402[B]
Fluorene	mg/kg	0/ 24	0.0647	0.03	388[B, X]
Phenanthrene	mg/kg	0/ 24	1.22	0.43	345[B, S]
Anthracene	mg/kg	0/ 24	0.298	0.10	107[B]
Fluoranthene	mg/kg	0/ 24	2.73	0.83	256[B]
Pyrene	mg/kg	0/ 24	2.26	0.70	578[B]

Cont.

Table 7.3: Summary of Soil Analysis for Residential with Plant Uptake (3.0% SOM, pH 7)

Contaminant	Units	Exceeding	Max	95$^{th\%}$	Tier 2 Screen
Chrysene	mg/kg	0/ 24	1.29	0.41	8.4[B]
Benzo(a)anthracene	mg/kg	0/ 24	1.5	0.43	5[B]
Benzo(b)fluoranthene	mg/kg	0/ 24	2.21	0.69	9.4[B]
Benzo(k)fluoranthene	mg/kg	0/ 24	0.751	0.23	9.7[B]
Benzo(a)pyrene	mg/kg	4/ 24	**1.75**	0.50	0.96[B]
Indeno(123-cd)pyrene	mg/kg	0/ 24	1.09	0.32	5.9[B]
Benzo(ghi)perylene	mg/kg	0/ 24	1.34	0.39	10[B]
Dibenzo(ah)anthracene	mg/kg	0/ 24	0.299	0.10	0.87[B]
Total PAH	mg/kg	NA/ 24	17	NC	NT

NT No Tier Screen readily available. **NA** Not Applicable. **NC** Not Calculated – maximum concentration is below the adopted screening threshold. [A] SGV derived using CLEA V1.06 3.0% SOM. [B] GAC derived using CLEA V1.06 3.0% SOM. [C] SGV derived using CLEA UK Beta Version 2.5% SOM. ***X*** Oral GAC used, no inhalation GAC derived (inhalation data not available). ***S*** Soil saturation limit used as cap to GAC due to high value of oral GAC and absence of inhalation GAC (no data available).

Metals

7.8 A statistical outlier (particularly elevated result outside the normal distribution of the wider data) was identified for copper (7,550 mg/kg) at WSB6 at 2.1m bgl. Once removed from the data set, the recalculated 95$^{th\%}$ did not exceed the adopted threshold, and as such, a significant site wide contamination issue has not been determined. With regards to the elevation at WSB6, reference to the exploratory hole records indicates that the sample was collected from Made Ground and it is possible that a fragment of unrecorded metal has inadvertently analysed within the soil matrix. In either case, copper is primarily a phytotoxic contaminant and unlikely to present a significant risk to human health given the chronic nature of occupational exposure.

7.9 All other metals that tested for passed the respective screening thresholds.

Total Petroleum Hydrocarbons (TPH)

7.10 A total of eighteen samples exceeded the most conservative TPH screening threshold for Aliphatic EC_8-EC_{10} compounds; 30 mg/kg. In order to better advise on the potential health risks associated with TPH, the most elevated samples (BHB2 1m bgl 1,140mg/kg & WSB1 0.1m bgl 727mg/kg) were scheduled for additional 'Criteria Working Group' (CWG) analysis. Both samples passed respective CWG band thresholds, and as such, no significant health risk is inferred from this data assessment.

Table 7.4: Summary of TPH Analysis

Headers>	Units	BHB2 1m bgl	WSB1 0.1m bgl	Screening Threshold
Total TPH C_6-C_{40}	mg/kg	1,140	409	30[B, Aliphatics>EC8-EC10]
Aliphatics >EC_5-EC_6	mg/kg	<10	<10	43.8[B]
Aromatics >EC_6-EC_7	mg/kg	<10	<10	150[B]
Aliphatics>EC_6-EC_8	mg/kg	10.30	<10	115[B]
Aromatics >EC_7-EC_8	mg/kg	<10	<10	319[B]
Aliphatics >EC_8-EC_{10}	mg/kg	16	<10	30[B]
Aromatics >EC_8-EC_{10}	mg/kg	35.30	<10	48[B]
Aliphatics >EC_{10}-EC_{12}	mg/kg	12.50	<10	155[B]
Aromatics >EC_{10}-EC_{12}	mg/kg	<10	<10	186[B]
Aliphatics >EC_{12}-EC_{16}	mg/kg	7.04	2.76	689[B]
Aromatics >EC_{12}-EC_{16}	mg/kg	4.82	5.04	398[B]
Aliphatics >EC_{16}-EC_{21}	mg/kg	5.07	1.22	37,841[B]
Aromatics >EC_{16}-EC_{21}	mg/kg	4.69	3.34	577[B]
Aromatics >EC_{21}-EC_{35}	mg/kg	61.50	15.90	1,137[B]
Aliphatics >EC_{21}-EC_{35}	mg/kg	31.80	7.48	37,841[B]
See Table 7.3 for notes.				

Polynuclear Aromatic Hydrocarbons (PAH)

7.11 A total of twenty-four samples were assessed for USEPA Priority 16 PAH Compounds. All calculated 95$^{th\%}$ values passed respective screening thresholds, and as such, no significant health risks have been determined based on the data. It is noted that whilst four samples exceeded the screening threshold for benzo(a)pyrene, in the context of the site-wide condition of soils, these are considered to be acceptable and are not statistically indicative of distinct and localised elevations.

Asbestos

7.12 A total of twenty six samples were analysed for asbestos, of which three samples were reported to contain <0.001% wt/wt asbestos. The human health risks associated with these concentrations should be confirmed with a specialist asbestos consultant; however, they are unlikely to present a significant risk or cause for concern.

Table 7.4: Summary of Asbestos Analysis

Sample	Depth	Comments	Chrysotile	Amosite	Crocidolite	Non Asbestos Fibres
BHB1	1.80m	None	ND	ND	ND	ND
BHB2	1.00m	None	ND	ND	ND	Detected
BHB2A	1.00m	None	ND	ND	ND	Detected
BHB2A	2.00m	None	ND	ND	ND	Detected
BHB2A	4.00m	None	ND	ND	ND	ND
WSB3	0.15m	None	ND	ND	ND	ND

Cont.\

Table 7.4: Summary of Asbestos Analysis (Cont.)

Sample	Depth	Comments	Chrysotile	Amosite	Crocidolite	Non Asbestos Fibres
WSB3	0.90m	None	ND	ND	ND	ND
WSB3	2.50m	None	ND	ND	ND	ND
WSB4	0.10m	None	ND	ND	ND	ND
WSB4	0.50m	None	ND	ND	ND	Detected
WSB4	1.50m	None	ND	ND	ND	ND
WSB4	2.80m	None	ND	ND	ND	ND
WSB1	0.10m	None	ND	ND	ND	ND
WSB1	0.50m	None	ND	ND	ND	ND
WSB2	0.10m	None	ND	ND	ND	ND
WSB2	0.50m	None	ND	ND	ND	Detected
WSB2	1.50m	None	ND	ND	ND	ND
WSB2	3.00m	None	ND	ND	ND	ND
WSB3	1.40m	None	ND	ND	ND	Detected
WSB4	1.40m	None	ND	ND	ND	ND
WSB5	0.10m	None	ND	ND	ND	ND
WSB5	0.50m	Loose Fibres in Soil	<0.001%	ND	ND	ND
WSB5	1.00m	Loose Fibres in Soil	<0.001%	ND	ND	ND
WSB6	0.10m	None	ND	ND	ND	Detected
WSB6	0.75m	None	ND	ND	ND	Detected
WSB6	2.10m	None	<0.001%	ND	ND	ND

7.13 Notwithstanding the above, the potential occurrence of asbestos fibres of asbestos containing materials should be recorded on the Contractor's Health & Safety Risk Assessments and Construction Phase Plans in accordance with CDM Regulations.

Ground Gas Assessment

7.14 A total of three gas monitoring visits were completed on Friday 23rd March, Thursday 5th April and Tuesday 17th April 2012. A summary of the atmospheric conditions and monitored installations is provided under Table 7.5 below. Monitored installation details are summarised under Table 6.2 and each monitoring visit included measurement of: PID (ppm); methane (CH_4); Lower Explosive Limit (LEL) (%); carbon dioxide (CO_2); oxygen (O_2); hydrogen sulphide (H_2S); carbon monoxide (CO); and, flow rate (l Hr^{-1}).

Table 7.5: Summary of Monitoring Visits

Monitoring Date	Atmospheric Pressure				Trend
	72 Hours Prior	48 Hours Prior	24 Hours Prior	Monitoring Date	
Friday 23rd March 2012	1032	1033	1027	1025	Stable
Thursday 5th April 2012	996	1000	1005	1019	Rising
Tuesday 17th April 2012	1020	1019	1023	997	Falling

7.15 No notable results, where carbon dioxide exceeded 1.5%, methane 1.0% and/or oxygen fell below 18.0% have been recorded. Similarly, no measureable concentrations of volatile organic compounds (PID measurements), H_2S, CO or flow rates >0.1l Hr^{-1} were recorded.

7.16 Based upon the guidance presented in Table 7.2, an assessment has been made of the requirements for gas protection that consider sources of gas generation, gas flows and concentrations and potential exposure routes. This is summarised below:

- **Potential On-site Sources of Gas Generation**: Whilst a significant thickness of Made Ground has been encountered onsite, no obvious sources of gas generation have been identified within the exploratory logs. As such, there is considered to be a low potential for gas generation onsite and this is supported by the above data.
- **Potential Off-site Sources of Gas Generation**: Limited potential off-site sources of gas generation have been identified, and in particular, no landfill or similar waste sites have been identified within 250m of the site.
- **Gas Flows**: No significant gas flow rates have been recorded onsite.
- **Exposure Routes**: Gas at the site primarily presents a concern following ingress into confined spaces both during and after construction.

7.17 Initial gas monitoring data indicates a 'CIRIA Characteristic Situation 1', and as such, no particular gas protection measures are considered necessary (by reference to Table 2 of BS8485). However, on the basis of the redevelopment being of a 'Moderate Sensitivity' and - in light of the current gas data – the site being of a 'Low Gas Generation Potential', CIRIA advise a minimum of 6 visits over 2 months. At this stage, it is recommended that provision is made to undertake the additional monitoring, however, it may be able to agree with the Local Authority that the current data is consistent and suitable to inform design requirements.

Revised Conceptual Model

7.18 Based upon the findings of the above Tier 2 Risk Assessment, a revised Conceptual Model is presented below.

Table 7.6: Revised Conceptual Site Model

Sources of Contamination	A statistical interpretation of soil analyses (Table 7.3) has not identified any significantly elevated levels of contaminants. Similarly, a review of ground gas data (Table 7.5) has not identified elevated levels of hazardous gases. Furthermore, a review of exploratory logs (Table 6.4) has not identified gross contamination (such as hydrocarbon free product) to be present onsite.			
Pathway	Potential contaminant pathways for respective receptors are summarised under Table 5.3.			
Receptor (see Table 5.2)	**Human Health** (Residential)	**Human Health** (Groundworkers)	**Hydrogeology** (2º A Aquifer)	**Building** & **Infrastructure**
Risk	Low	Low (Assumes PPE*)	Low	Low
* Assumes that appropriate Personal Protective Equipment (PPE) will be adopted.				

8.0 CONCLUSIONS & RECOMMENDATIONS

8.1 Following a comprehensive desktop study and appropriately designed site investigation, the resultant data has been interpreted in order to provide a Tier 2 Environmental Risk Assessment.

8.2 Based on the Conceptual Site Model presented under Section 5.0, the following risks have been adjudged:

- **LOW RISK** in relation to human health of residential end users. This result primarily reflects the preliminary nature of the site investigation and areas of the site which remain to be inaccessible, primarily the MUGA which was in use at the time of the site investigation and beneath building footprints which are due for demolition. Whilst these areas do not necessarily warrant a post-demolition site investigation specifically, control of groundworks via an appropriate specification to identify and address unforeseen ground conditions may be a sufficiently robust and practicable approach.
- **LOW RISK** in relation to groundworker and maintenance worker human health. This reflects that gross contamination has not been identified and assumes that appropriate Personal Protective Equipment (PPE) will be adopted throughout works.
- **LOW RISK** in relation to Controlled Waters (Secondary A Aquifer) due to the absence of a groundwater onsite.
- **LOW RISK** in relation to Buildings and Services Infrastructure (excluding future pipework – see below).

8.3 A supplementary phase of site investigation (programme/ phasing permitting) may be beneficial in examining ground conditions within the proposed footprint of Block 1 extension (given the likelihood for a piled foundation solution and the relative variability of the underlying Lambeth Group) and proposed MUGA which is anticipated to generate a significant volume of arisings and is known to coincide with a former residential block. Supplementary phases of site investigation will significantly reduce latent project risks associated with ground conditions.

8.4 It is recommended that this report is forwarded to the Local Planning Authority for review by the Environmental Health Officer / Contaminated Land Officer. Approval of this document is required and until which time the findings of this report should be considered 'provisional'.

Additional Matters for Consideration

8.5 This report has been prepared in order to satisfy requirements under the National Planning Policy Framework associated with contamination issues. As such, the following exercises are outwith of the remit of this report:

- **Geotechnical Design Report** which should be completed in due course in accordance with Eurocode 7 as a stand-alone document in order to advise appropriate foundation design amongst other construction matters. These would most appropriately be generated once structural details of the proposed development are confirmed.

- **Waste Classification Report** Given the potential for significant volumes of soil arisings to be generated which will require disposal (e.g. basement level to Block 1) – it may be prudent to commission a preliminary *Waste Classification Report*. This will determine the relative frequency of 'non-hazardous' and 'hazardous' soils within the population of analysed samples collected as part of the site investigation. Given the rising cost of disposal (including landfill tax), this report can be used to inform wider judgements on project costings and may also be provided as part of future contracts for information.

- **Service Pipework Material Selection** Whilst significant levels of contamination with respect to human health and the environment have not been identified, a separate assessment is required to determine the appropriate materials selection for future infrastructure including potable pipework. In the first instance, this report should be provided to an appropriate M&E consultant for review and liaison with the local water authority. Guidance on this subject is primarily provided under UKWIR document Ref: 10/WM/03/21, *Guidance on the Selection of Water Supply Pipes to be used in Brownfield Sites*, 2010.

ENVIRONMENTAL RISK ASSESSMENT SUPPORTING INFORMATION

Soil Screening Values: CLEA 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[9] 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.

The Environment Agency has produced several Soil Guideline Values (SGVs) based upon the revised framework. At the time of writing SGVs exist for the following substances: Benzene; Toluene; Ethylbenzene; Xylenes; Dioxins and dioxin like polychlorinated biphenyls; Arsenic; Cadmium, Mercury; Nickel; Phenol and Selenium. SGV reports are currently being compiled by the Environment Agency for: Chromium; Cyanide; Lead and PAHS.

In the absence of a comprehensive list of SGVs, CampbellReith have generated Generic Assessment Criteria (GAC) utilising CLEA 1.06 and the associated software. This is a rolling review and will continue as further Environment Agency publications become available. 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. In the absence of such a value the withdrawn SGV will be applied for generic assessments. This is considered a suitable course of action until further guidance is published.

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 lead and cyanide. Where referred to, the non compliant standing of these values is considered.

The recently published GACs within 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.

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.

Statistical Analysis of Soil Analytical Results

Statistical analysis of soil based analytical results has been undertaken as detailed in Appendix A of CLEA R&D Publication CLR7, 2002. Although CLR 7 has recently been withdrawn, the use of the Mean Value Test and Maximum Value Test is still considered appropriate for site assessments given current guidance[10]. This guidance advocates use of the one - sample t test, which is a variation of the mean value test and establishes the confidence level at which the assessor can determine whether a particular

[9] 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.

[10] Guidance on Comparing Soil Contamination Data with a Critical Concentration, CL:AIRE, May 2008.

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.

Unless specifically stated within the report text the statistical assessment has treated the site as a single averaging area and screened in its entirety. 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 described in PPS23 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)[11].

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 Site 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 and UK 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).

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.

[11] Refer to Environment Agency Publications for Groundwater Protection Policy and Practice. http://publications.environment-agency.gov.uk/pdf/GEHO0708BOGU-e-e.pdf?lang=_e

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.

APPENDICES

Appendix A: Figures

Figure 1: Site Location
Figure 2: Site Layout Plan
Figure 3: Proposed Development Plan
Figure 4: Historical Composite Plan

Appendix B: Desk Study Information (CD)

CampbellReith, Feasibility Stage Geoenvironmental, Drainage & Flood Risk Desktop Study, Draft 2, Ref: RWeb10907-270112-BourneDTS-D2, March 2012

Alpha Associates Limited, *Detailed Unexploded Ordnance (UXO) Risk Assessment*, Ref: P2770_V1.0, 22nd February 2012.

Appendix C: Site Investigation Information (CD)

Harrison Group Environmental Ltd, *Bourne Estate, Camden: Ground Investigation Report*, Ref: GL16482, June 2012

Appendix D: AGS Data (CD)

Bourne AGS.ags Electronic File

Confidential

Bourne Estate, Holborn, London

FEASIBILITY STAGE GEOENVIRONMENTAL, DRAINAGE & FLOOD RISK DESKTOP STUDY

For: London Borough of Camden

Project No: 10907

March 2012

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Project Partner	D. Innes
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Contents

EXECUTIVE SUMMARY

Site Location	The Bourne Estate extends over an area of 7,719m2 within the Hatton Garden Conservation Area and is located immediately to the east of Grays Inn, at a National Grid Reference of 531160^{E}, 181890^{N}.
Environmental Setting	The site is set in an area of overall **Medium Environmental Sensitivity** based upon the underlying **Secondary A Aquifer**. No hydrological or ecological receptors have been identified within 500m of the site.
Current Use & Development History	The site is currently is use as residential housing, and reference to historical mapping indicates that this has been the primary site use for the past c.50 years. Historical mapping from 1851 identifies that the site was already developed by this time, predominantly with what appear to be residential housing; including 'Industrial Dwellings' which may have housed workers from the adjacent brewery or similar industries. During the Second World War, the site is recorded as having sustained significant bomb damage, and shortly after, with significant site redeveloped following. However, it is unclear as to whether the western park area of the site (adjacent to Gooch House) has ever been constructed upon post-war. Historical Building Layout plans dated1966 indicate *Community Centre* and adjoining ***Builders*** *Workshop* to have been present onsite, the latter of which was redeveloped to house an Electricity Sub Station c.1975. Since this time, the site has remained largely unchanged.
Geotechnical Hazards	There is the potential for significant thicknesses of Made Ground to be present at the site associated with historical development and bombing during WWII, as well as the potential for buried obstructions and relic basements. The London Clay and materials derived from it can be aggressive to buried concrete. Records indicate that a Mail Rail tunnel may run beneath the site. Utilities plans indicate that there are other services present on site.
Contamination Issues	The primary contamination issues at site relate to the potential for significant thicknesses of Made Ground onsite of unknown composition but likely to include demolition materials of a varied nature and ash. The potential inclusion of Asbestos Containing Materials within demolition arisings is of particular concern. No significant industrial use has been identified on site based on current information.
Geotechnical Conclusions	Prior to any development, an intrusive ground investigation should be undertaken at the site with geotechnical testing and groundwater monitoring to confirm the underlying geology, groundwater regime and the engineering properties of the underlying soil. The Made Ground, unless adequately treated, is not considered a suitable founding stratum. Given the considerable thickness of Made Ground at the site, ground improvement could be an option, or foundations could be piled. Piles would require casing through the Made Ground and River Terrace Gravel, and may also require support through the Lambeth Group Strata. Should basements be proposed, a Basement Impact Assessment (DP27) would need to be submitted at planning stage. Full services information should be obtained and consultations with the affected infrastructure companies undertaken with regards to any proposed development at the site. The risk of encountering a UXO at the site is considered to be **Medium-High**. A preliminary UXO risk assessment should be completed as soon as possible to determine the requirement for detailed risk assessment and mitigation measures for site investigation and construction works.
Contamination Conclusions	A preliminary pollutant linkage risk assessment indicates the site to represent an overall **Medium** contamination risk. This primarily relates to the potential for direct contact between end users and potentially contaminated soils.

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EXECUTIVE SUMMARY (CONT.)

Archaeological Baseline Appraisal	Whist there are no Listed Buildings within the site, a total of 61 Listed Buildings are located within the 250m radius of the boundary and 835 within 1km of the site. Part of Hatton Gardens Conservation Area is located within the site boundary and also includes the majority of the Listed Buildings in close proximity to the site. The site is considered to lie within an area of 'high' sensitivity with respect to built heritage. Whilst the site is not known to contain any archaeological deposits, this assessment has identified six findspots located within the 250m radius of the site boundary and 111 findspots within 1km of the site, therefore the site is considered to lie within an area of 'medium-high' potential for archaeology.
Flood Risk Assessment & Recommendations	In order to inform any schematic development proposals it is recommended that a full topographical survey together with intrusive drainage utility and CCTV survey of the private drainage within the site are carried out to fully understand the operation and condition of the existing drainage systems for assessment of future abandonment, diversion or reuse and Flood Risk as part of the development proposals.
Development Constraints / Considerations	**Waste Soils Arising via Redevelopment** Given the potential inclusion of basement levels or other deep excavations, a significant volume of waste soils could arise through redevelopment. Where possible, provision should be made to reuse these either onsite or at an offsite location in accordance with industry guidance (e.g. via a treatment centre of a materials exchange scheme). Where re-use is not possible, disposal at landfill may be necessary and may attract a significant cost (particularly where waste soils are classified as 'Hazardous'). **Potential for Remediation & Validated Cover** The requirement for remediation can only be determined via intrusive investigation and subsequent assessment. However, in general, should groundwater remediation or contaminated soils require treatment – this may attract a significant development cost. In addition, where proposed redevelopment includes soft landscaping, a thickness in the region of 300 – 600mm of validated cover is likely to be required. Given the potential for contamination within Made Ground and the general absence of sub- and top-soil onsite, it is possible that importation of these cover materials may be required.
Recommendations	**Exploratory Intrusive Site Investigation** In order to initially assess the key risks identified within this report, it is recommended that an *Exploratory Intrusive Site Investigation* is undertaken in accordance with BS10175 and BS5930, prior to demolition of existing structures. This should be designed by a land quality specialist to examine: ground conditions across the site; contamination analysis; geotechnical analysis; waste appraisal; and, groundwater and gas monitoring. In due course, following demolition, it will be necessary to complete a 'main' intrusive site investigation to collect full ground investigation data for the site. With regards to site archaeology, incorporation of trial pitting within the preliminary site investigation would present an opportunity to undertake an *archeological watching brief* such that any future requirements and potential delays/ project risk can be identified and allowed for in advance.

Cont…\

EXECUTIVE SUMMARY (CONT.)

Recommendations (Cont.)	**Pre-planning Reporting: Preliminary Land Quality Statement** Following the collection of site investigation data (as outlined above), this will require specialist interpretation to allow preliminary geotechnical and geoenvironmental design. Engineering constraints should be communicated – pre-planning – to ensure that the submitted scheme reflects particular constraints and/or feasible engineering solutions can be incorporated within the architect's proposals. This forms an important project design review to ensure that any significant engineering requirements are considered within the permitted masterplan. **Optional Reporting: Preliminary Waste Classification Report** It is possible to undertake a Waste Classification on the obtained site investigation data to inform potential disposal costs. This may have a significant impact on the feasibility of the scheme, particularly any basement levels, under-croft parking or similar. It is noted that this does not form a planning requirement but may be useful in project planning and feasibility appraisal. **Site Records**: **Asbestos Registers & Surveys** Asbestos surveys have been undertaken. A review should be made of the asbestos survey and registers for the current buildings, in order to determine the extent of Asbestos Containing Materials within the current building fabrics. In addition, it is noted that 'Pre Demolition Surveys' will be required prior to demolition, once the buildings have been vacated and intrusive sampling can be undertaken.

1.0 INTRODUCTION

1.1 This report has been produced by Campbell Reith Hill LLP (CampbellReith) on behalf of London Borough of Camden ('the Client') to summarise geoenvironmental and geotechnical information relating to Bourne Estate, Holborn (hereafter referred to as the site). The references and limitations associated with this report follow the main text. Figures showing the location existing layout of the site are presented in Appendix A.

1.2 This report has been prepared in general accordance with the technical procedures for site investigation, interpretation and reporting set out in DEFRA Contaminated Land Report (CLR) 11, BS10175 and BS 5930 (as amended). The objective of the report is to collate and interpret Phase 1 Desk Study information in order to advise upon potential development constraints and/ or associated potential abnormal development costs.

1.3 The contamination appraisal is intended to identify remedial requirements necessary to permit a general redevelopment of the site on a broadly 'like for like' end use basis in accordance with Policy Planning Statements (PPS) 1 and 23. Similarly, the geotechnical appraisal has been based upon likely construction requirements.

1.4 It should be recognised that both aspects of these appraisals will require updating once a re-development masterplan has been assembled. In addition, it may be prudent to undertake an exploratory intrusive site investigation in advance of fixing the masterplan, such that any significant ground constraints can be considered at the outline design stage.

1.5 The updated report and preliminary site investigation data should be presented as a *Phase 1 Preliminary Land Quality Statement* for submission at planning application in accordance with Planning Policy Statements (PPS) 23, *Planning and Pollution Control*. In addition to planning requirements, the preparation of these reports facilitates an iterative and staged approach to managing land quality matters and project risk.

1.6 The draft National Planning Policy Framework (NPPF) was published on 25th July 2011 for consultation (closed 17th October 2011). Significant revisions to planning process and requirements are likely to follow in March 2012. Notwithstanding the above, subsequent reporting should be cognisant of any amendments to planning requirements as they develop.

1.7 The report is primarily based upon a proprietary data search, site reconnaissance and supplemented with other readily available as referenced. A compendium of information is provided under Appendix C. A list of the technical references used is presented at the end of the report text.

2.0 SITE DESCRIPTION

Site Location

The Bourne Estate site extends over an area of 7,719m^2 within the Hatton garden Conservation area and is located immediately to the east of Grays Inn, at a National Grid Reference of 531160^E, 181890^N.

Site Layout

2.1 The site provides 50 residential units contained within two apartment blocks. The site is bounded to the north by Portpool Lane with the southern site boundary formed by Baldwin's Gardens and the St Albans C of E primary School. The commercial properties that front on to Grays Inn Road form the western boundary of the site with the residential block of Buckridge Building forming the eastern boundary of the site.

2.2 The 50 residential units are contained with Mawson House and Gooch House. Both buildings were built between 1905 and 1909 with Gooch House containing 30 flats and Mawson House the remaining 20 flats. Within the confines of the site there is approximately 4094m^2 of open space consisting of a Multi-use games area (MUGA), grassed areas and hard surface court yards. In addition there is also a small resident's community hall located within the centre of the site.

Topography

2.3 There site is generally at +26m AOD, however, significant changes in topography were noted during the site walkover.

Access

2.4 Vehicular access is gained from Baldwin's Gardens, Verulam Street, Leopards Court and Portpool Lane. These roads also provide the primary pedestrian access to the site. A good pedestrian footway network is provided through the core of the site.

Surrounding Land-Use

2.5 The site is set in an area of mixed use – a description of the main surrounding land uses is summarised under Table 2.1 below.

Table 2.1: Summary of Surrounding Land Uses

Direction	Description
North	Redman House residential complex is situated to the immediate north of the site, adjacent to Portpool Lane.
East	Grade II listed terraces form the eastern site boundary, beyond which runs Leather Lane.
South	St Alban's C.E. Primary School and Nursery is located on the southern site boundary off Baldwin's Gardens.
West	The west of the site is bound by Gray's Inn Road, beyond which lies Gray's Inn Gardens communal open space.

2.6 The site is partly set within and directly adjacent to the Bloomsbury Conservation Area and there are several terraces of Grade II listed buildings which sit to the north and south of the site.

Site After-Use Proposal

2.7 There are a variety of possible interventions on this Estate, with one infill and two redevelopment opportunities shown on the adjacent plan. Any proposals will have to be carefully designed to a high architectural standard to be acceptable in proximity to the surrounding Grade II listed buildings.

Proposal 1: The first proposal looks to replace the two single storey community buildings, set out in an L-shape, with a new larger rectangular building with community facilities at ground floor and four storeys of residential above. This block would rationalise this area and create a clearly defined frontage enclosing open spaces to the front and rear, whilst providing modern accessible community facilities (new community centre and 12 flats).

Proposal 2: The second opportunity could come through the extension from the blank façade of 1 – 27 Portpool Lane or through the creation of a new free standing block, reaching up to 5 storeys fronting Portpool Lane. In order to enable this development the currently substantial sports pitch would have to be remodelled making it a few meters shorter to enable a buffer between the two uses and the loss of a significant tree considered (3 houses or 10 flats).

Proposal 3: The last and most significant intervention option would require the demolition of Mawson House, containing 20 flats (5 studios, 5 1-beds, 5 2-beds and 5 3-beds) and only one leasehold. These could be replaced with up to 3 times the amount of accommodation set out in larger modern flats and maisonettes, most of which would have their own private outdoor spaces running back to back (38 maisonettes and flats).

2.8 The new blocks could be set out in a number of ways, running east-west, north-south or some combination of the two. The adjacent plan makes use of the existing blank facaed and tries to create a variety of private and semi-private spaces whilst creating a strong new identity and street frontage for Baldwin's Gardens. Overlooking of the school is likely to be a consideration at consultation.

3.0 ENVIRONMENTAL SETTING

Geology

3.1 The site geology is summarised in Table 3.1 and the associated references are listed at the rear of the report. The geological sheet for the area [1] indicates that the site is underlain by Lynch Hill Gravel on the western half of the site, and Hackney Gravel on the eastern half of the site, both over London Clay. Approximately 200m north and 300m east of the site are Alluvium and localised outcrops of London Clay. The Alluvium is likely to be associated with the historic River Fleet which flowed approximately 200m north and 300m east of the site. It is likely that the Lynch Hill Gravel was eroded away by the historic River Fleet, giving rise to the outcrops of London Clay.

3.2 The base of the drift deposits is between 5 and 7m bgl and the London Clay around 17 to 21m bgl, indicating that the London Clay is around 13 to 15m in thickness. The London Clay is in turn underlain by the Lambeth Group over Thanet Sand, with Chalk at depth. CIRIA Report C583 Engineering in the Lambeth Group indicates that the Lambeth Group is in the region of 15 to 20m thick and comprises Upper Mottled Clay, Laminated Beds, Lower Mottled Clay and the Upnor Formation.

3.3 A historic ground investigation, comprising one borehole to 6m bgl, located on site in 1973, revealed 3.45m of Made Ground comprising brick rubble, tarmac and concrete fragments over coarse brown sand and gravel.

3.4 Three additional historic borehole records were obtained from the British Geological Survey [2]. One was formed on site to 27m bgl, one was formed 100m north of the site to 68m bgl and the other was formed 100m north west of the site to 18m bgl.

3.5 Groundwater was not recorded in any of the boreholes above. Descriptions of the ground conditions encountered are summarised in Table 3.1.

Table 3.1: Summary of Geology

Type	Base of Stratum (m bgl)	Thickness (m)	Description
Made Ground	3.45 – 4.90	3.45 – 4.90	Topsoil over fill comprising compact bricks and rubble underlain by silty clayey sand.
Hackney Gravel	4.50 – 6.70	0.90 – 2.75	Very dense brown slightly silty sand and gravel.
London Clay	17.35 – 20.70	12.80 – 14.50	Stiff, becoming very stiff with depth, grey fissured silty clay.

Cont.

Table 3.1: Summary of Geology (Cont.)

Type	Base of Stratum (m bgl)	Thickness (m)	Description
Lambeth Group	29.30	11.90	Very stiff multi-coloured mottled fissured clay over pale grey silty fine sand underlain by blue clay to 25.90m bgl (Woolwich and Reading Beds). Pebble beds over blue clay (Upnor Formation).
Thanet Sand	41.45	12.20	Dense green sand.
Chalk	Proven to 68	26.20 proven	White chalk with flints.

Table 3.2: Summary of Geotechnical Hazards

Hazard	Distance	Description	Ref
Former structures	On site	Potential for obstructions, relic basements and increased thickness of Made Ground to be present on site.	-
Buried concrete	On site	The London Clay and materials derived from it can naturally contain elevated concentrations of minerals that can be aggressive to buried concrete.	BRE SD1[1]
Bomb damage	On site	Bomb craters may be filled with rubble or concrete forming soft spots or obstructions. The risk from UXO is considered later.	-
Shrink/Swell Clay	On site	'Moderate' hazard associated with London Clay. Soils are known to have a high volume change potential.	[3]
Lost Rivers	200m N	The historic River Fleet is located approximately 200m north and 300m east of the site.	[4]
Rising Groundwater	On site	The site is located in a critical area for deep foundations and basements.	[5]
Scour Hollows	320m NW	A scour hollow associated with the River Fleet is located approximately 320m north west of the site.	[3

3.6 The Envirocheck Report indicates a '**Low**', '**Very Low**' to '**No hazard**' potential in relation to the following ground stability hazards: collapsible ground, compressible ground, ground dissolution, landslides and running sand. However, a '**Moderate**' compressible ground stability hazard has been assigned 180m north of the site, likely to be associated with the presence of Alluvium.

3.7 Whilst Ref [5] indicates that the site is within a critical area with respect to deep foundations and basements, a consortium, GARDIT, was set up to control rising groundwater in London.

3.8 GARDIT includes the Environment Agency (EA) who report annually on the effectiveness of the control measures that GARDIT have put in place. Their most recent report 'Management of the London Basin Chalk Aquifer', dated 2011, indicates the site is within an area where groundwater levels in the aquifer have fallen by around 10m since 2000 and were static between 2009 and 2010. It is assumed that GARDIT's groundwater control measures will remain in place as they

[1] BRE Special Digest 1: 2005 Concrete in aggressive ground.

protect major parts of London's infrastructure, such as the underground train network. Consequently rising groundwater levels are unlikely to affect the development.

Radon

3.9 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 considered 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.

Hydrogeology

3.10 The site hydrogeology is summarised in Table 3.2 and the associated references listed at the rear of the report.

Table 3.2: Summary of Hydrogeology

Property	Distance	Description	Ref
Superficial Aquifers	Onsite	**Secondary A Aquifer** associated with the Lynch Hill Gravels (where present). These aquifers (formerly classified as 'Minor Aquifers' are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.	[3, 6]
Bedrock Aquifers	>500m	**Unproductive Strata**. No bedrock aquifers have been identified within 500m of the site.	[3, 6]
Soil Leaching Potential	Onsite	Soil Classification: Soils of **High Leaching Potential (U)** – Soil information for restored mineral workings and urban areas are based on fewer observations than elsewhere, and as such, a worst case vulnerability classification is assumed until proven otherwise.	[3]
Source Protection Zone	>500m	The nearest Source Protection Zone (SPZ) is located approximately 700m to the northeast of the site; recorded as a **Zone II (Outer Protection Zone)**: either 25% of the source area or a 400 day travel time, whichever is greater.	[3, 6]
Groundwater Abstractions	>500m	The nearest record of groundwater abstraction is located approximately 400m to the southeast of the site, registered to *Citigen (London Ltd*. The abstraction is via 'Borehole A,Charterhouse Street, London' and is for **Other Industrial/ Commercial/ Public Services: Evaporative Cooling**. The abstraction is recorded as having been authorised to start on 08/11/2010. The nearest **Public Water Supply** abstraction is registered 1km to the northeast of the site (Licence Number: 28/39/39/0201) at *New River Head, Finsbury – Borehole*.	[3] [3]

3.11 The site is considered to have a **Medium Sensitivity** with respect to hydrogeology, primarily based upon the Secondary A Aquifer associated with the Lynch Hill Gravels (where present).

Hydrology

3.12 The sites hydrological setting is summarised under Table 3.3 below.

Table 3.3: Summary of Hydrological Setting

Property	Distance	Description	Ref
Nearest River	>500m	No surface rivers have been identified within 500m of the site.	[3, 6]

Drainage

3.13 The Bourne Estate situated in the Hatton Garden Area of Holborn is served by a combined (foul and surface water) drainage network situated in the surrounding highway network namely Portpool Lane, Leather Lane, Verulam Street, Baldwins Gardens and Leopards Court.

3.14 The local sewerage network is operated by Thames Water and their asset records have been obtained and reviewed. Their records indicate combined sewers varying in size from 229mm to 1245mm diameter up to 4.5 metres deep. They are likely to have been constructed in Victorian times using Clayware or Brick.

3.15 Based upon the Thames Water asset records there is little evidence of any public sewers within the curtilage of the site and it is recommended that a full topographical survey together with intrusive drainage utility and CCTV survey of the private drainage within the site are carried out to fully understand the operation and condition of the existing drainage systems for assessment of future abandonment, diversion or reuse as part of the development proposals.

3.16 On 1 October 2011 Water & Sewerage undertakers in England and Wales became responsible for private sewers under Section 102 & 105 of the Water Industry Act. As a result of this, all previously unrecorded private sewers will now become Thames Waters responsibility where diversion, abandonment or reuse will require their formal approval.

3.17 All new drainage serving the proposed development shall be designed on the basis of a separate system of drainage for foul and surface water in accordance with current design standards. Once the site development proposals have been further developed, an enquiry to Thames Water can be made to obtain details with regards to the existing capacities within the local sewerage network, and any requirement for a drainage impact study.

3.18 The Flood Water Management Act 2011 and more recently Defra have issued consultation proposals in December 2011 on the Implementation of Sustainable Drainage Systems (SDS) relating to future development in England.

3.19 The above legislation together with the introduction of National SuDS Standards and SuDS Approval Body (SAB's) will work alongside other legislation, policy and standards that include Code for Sustainable Homes (CfSH), Building Regs and Water Industry Act will cover the future design, construction, operation and maintenance of SuDS and will be applied to all new development.

3.20 The Act will require that any construction work with drainage implications to have its drainage systems for the management of surface water run-off to be approved before construction may commence.

3.21 The delayed publication of Sewers for Adoption, 7th Edition is likely to refer to or include these National SuDS standards upon which future sites shall require to be designed.

Flood Risk

3.22 The site is shown by the Environment Agency Flood Maps to be located within Flood Zone 1, Low Risk with the River Thames and its associated floodplain situated approximately 1 km to the south.

3.23 The Camden / North London Strategic Flood Risk Assessment (SFRA) has been reviewed which show the site and surrounding areas to be at low risk of fluvial and tidal flooding.

3.24 The SFRA also shows a low risk of groundwater flooding, with no history of groundwater flood events in the area. The geology of the local area is shown to be underlain by London Clays, which are designated as 'Unproductive Strata'.

3.25 A review of Envirocheck Flood Data maps suggest a Moderate to Moderately High Susceptibility to Groundwater Flooding and therefore, will require further intrusive geotechnical investigation covered separately within this report.

3.26 A Flood Risk Assessment will be required, in accordance with Planning Policy Statement 25 (PPS 25) and Environment Agency guidance, to support any Planning Application.

3.27 The Flood Risk Assessment should confirm the risk of flooding at the sites and will focus on the management of surface water.

3.28 It is noted that LBC Development Policy 27[2] will require the assessment of any new basements with respect to impacts to the water table or in relation to flooding.

3.29 The FRA will also require:

- surface water management proposals which, where practicable, reduce the rate and volume of runoff from the site,
- information about the existing surface water disposal system and their state of maintenance,
- an assessment of the proposed volume of surface water runoff likely to be generated from the proposed development and measures to reduce to 'greenfield' run off rates and volumes,
- a design allowance for how the increased frequency and intensity of rainfall predicted as a result of climate change will affect the proposed development.

Ecological Receptors

3.30 *Ecological Receptors* within Part 2A are listed in Table A of the Statutory Guidance (this is revised to 'Table 1' in the revised Guidance and it is noted that the content has been slightly reduced). In summary, these comprise any ecological system, or living organism forming part of such as system, within a location which is:

- a Site of Special Scientific Interest (SSSI) notified under section 28 of the Wildlife and Countryside Act 1981;
- a National Nature Reserve (declared under section 35 of the above act);
- a Marine Nature Reserve (designated under section 36 of the above act);
- an area of special protection for birds (under section 3 of the above act);
- any habitat or site afforded policy protection under paragraph 6 of Planning Policy Statement 9 (PPS 9) on nature conservation;
- any nature reserve established under section 21 of the National Parks and Access to the Countryside Act 1949; or,
- a *European Site* - i.e. a Special Area of Conservation or a Special Protection Area within the meaning of Regulation 10 of the Conservation (Natural Habitats etc.) Regulations 1994; or, any candidate Special areas of Conservation or Special Protection Areas given equivalent protection).

3.31 None of the above designations have been identified within 1km of the site, and as such, a **Low Sensitivity** is assigned in this regard, Ref [3, 9, 10].

[2] London Borough of Camden (LBC) Development Policy 27, *Basements & Lightwells*.

Non Part 2A Ecological Designations

3.32 In addition to the above (but not considered under the Statutory Contaminated Land Appraisal), none of the following designations have been identified within 1km of the site:

- Local Nature Reserves (LNRs); or,
- Sites of Importance to Nature Conservation.

4.0 SITE HISTORY AND INDUSTRIAL SETTING

Site History

4.1 Information relating to the site history has been obtained by reference to both Historical Town Plans and Ordnance Survey Mapping of 1: 25,000, 1:10,560, 1:5,280, 1:2,500 and 1: 1,056 dated 1851 – 2011. In addition, Historical Aerial Photography of 1:1,250 and 1: 10,560 dated 1946 – 1949 has been reviewed, together with Historical Building Layout Plans dated 1966. This data is contained within Ref [3], Appendix B.

4.2 A summarised development history for the site and its surroundings is presented below under Tables 4.1 and 4.2, respectively.

Table 4.1: Site History

Date	Development
1851 - 1898	Mapping dated 1851 indicates the site to be developed, located between Grays Inn Road and Leather Lane. By 1874 – 1875, mapping detail appears to be greatly improved and by the late 1800s, features including a 'Industrial Dwellings', 'Laundry', 'Thanksgiving Model Buildings', general 'Courts' and what appears to be terraced housing can be inferred.
1916 - 1938	At some point between 1898 and 1916, the site appears to have undergone significant redevelopment, with notable differences in building layout. Mapping dated 1937 continues to show the 'Buckridge House' and 'Nigel House' on the eastern site boundary. A tower like building 'Dupcan Buildings' (tower-type description inferred from subsequent aerial photography) – is shown to have been present on the western portion of the site c.1900; although they are only labelled as 'Dupcan Buildings' from c.1937.
1946 - 1949	**Historical Aerial Photography** Aerial photography indicates a significant redevelopment of the site, possibly in relation to WWII bomb damage (see Section 4.4). Most notably, the southeast of the site appears to have been cleared of buildings by 1946.
1951 - 1965	By 1951, the west of the site is indicated to have been cleared, and the previous 'Dupcan Buildings' / Tower like buildings demolished. Subsequent mapping 1952 – 1953 identifies these buildings as 'ruins', together with the southeast portion of the site which is shown as vacant. The existing 'Playground' is shown to have been constructed on the eastern site boundary adjacent to Buckridge House.

Cont…\

Table 4.1: Site History (Cont.)

Date	Development
1966	**Historical Building Layout Plan** A brief summary of the main features on interest onsite are summarised below: • Mawson House is shown to have been constructed on the southeast of the site; • The playgrounds on the southeast of the site and adjacent to Buckridge Buildings are constructed. • The community centre is present with an adjoining 'Builders Workshop and Stores'; • Gooch House has been constructed on the west of the site.
1968 - 2012	Land to the west of Gooch House is indicated to is indicated to have been redeveloped to landscaping by c. 1968 and by c.1975 the former 'Builders Workshop and Stores' has been redeveloped to an 'Electricity Sub-Station' and the site has remained relatively unchanged to the present day.

Table 4.2: Potentially Contaminative Surrounding Historical Land Uses (≤250M)

Approx. Date	Distance	Development
1874 – 1916	<10m / N	A **Brewery** is indicated to have been present from at least 1874, to the immediate north of Portpool Lane. By 1916, the brewery appears to have been demolished and redeveloped to the present day residential properties (Redman House complex).
1896 - 1952	<10m / S	A **Glass Works** is present to the immediate south of Verulam Street. The works area is labelled 'ruins' by c.1952, suggesting that the glass works were demolished during WWII.
1937 - 1952	<10m / S	**Brook Street Works** is indicated to have been present fromc.1937, located to the immediate south of Baldwins Gardens. From 1952, there still appears to be a building present, however, it is no longer labelled Brook Street Works.
1952 - 1965	50m / NE	A **Tobacco Factory** was present from at least 1952, comprising two factory buildings located adjacent to Clerkenwell Road and Leather Lane. By 1954, one of the buildings is renamed **Factory** (non-descriptive) and by 1965 the second building is also renamed **Factory** (non-descriptive).
1952 - 1958	30m/ E	A **Gold Refinery** is present to the east of the site, adjacent to Leather Lane. Mapping indicates that the refinery comprises an Electricity Sub Station. From 1958 – 1962, the complex is designated a **Works** (non-descriptive) and no particular labelling is attached to the building thereafter.

Liaison With Regulatory Authorities

4.3 Consultations with Camden Council Building Control and Planning departments are currently underway.

4.4 Consultation with the Trees and Landscape Officer at Camden Council confirmed that there are no Tree Protection Orders (TPO) on site. However, it was stated that the trees are owned by the council and are likely to meet the TPO criteria.

Unexploded Ordnance (UXO)

4.5 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' [11] and the assessment matrices presented in Tables 5.1 – 5.3 therein.

4.6 A review of the London County Council Bomb Damage Maps 1939-1945 [12] indicates that the site lies in an area that was subject to heavy bombing during the Second World War with an estimated bombing density in excess of 600 bombs per 1,000 acres for the Holborn area.

4.7 The mapping indicates that the vast majority of buildings on site suffered serious damage ranging from 'Seriously damaged, doubtful if repairable' to 'Total destruction'.

4.8 Buildings approximately 150 to 200m east of the site also suffered similar damage, but as a result of a V1 flying bomb. Buildings directly to the west of the site, at Gray's Inn Square also suffered serious damage and total destruction. Elsewhere, to the north and south of the site there was serious damage to individual properties, but the remaining buildings within 250m were generally undamaged.

4.9 Aerial photography from 1948 shows a significant proportion of the site to be vacant, and post-war mapping from 1953 indicates four 'ruins' on the site. 'Ruins' are also indicated 150 to 200m east of the site, where the V1 flying bomb was recorded. Additional 'ruins' are labelled within 100m of the site, generally to the south and east.

4.10 By reference to Table 5.1, given that the site is situated in an area known to have undergone significant bombing during the Second World War, the potential for aerial delivered ordnance to have landed on the site is considered to be high.

4.10 By reference to Tables 5.2 and 5.3, given that the site has undergone some significant post war development in areas, but only soft landscaping in others, the risk of encountering UXOs at the site can be considered moderate where development has occurred, and high elsewhere.

4.11 At this stage, taking into account the high density of bombing in this area and site information, the risk of encountering a UXO at the site is considered to be **'Medium-High'**. A preliminary

UXO risk assessment should be completed as soon as possible to determine the requirement for detailed risk assessment and mitigation measures for site investigation and construction works.

Tunnels

Crossrail

4.11 The site is not situated within the safeguarding zone for either of the proposed Crossrail routes.

London Underground

4.12 Consultation with Transport for London [Appendix D] indicates that the site is remote from any London Underground assets.

Other Tunnels and Services

4.13 However, this should be confirmed through consultation with the asset owners. There are no government communication tunnels, deep cable tunnels, Mail Rail Tunnels or sewer tunnels within the vicinity of the site.

4.14 Detailed site service assessments are being prepare by TGA Consulting Engineers LLP.

Current Industrial Setting

4.15 A review of Contemporary Trade Entries has been completed utilising data within Ref [3] and identified a number of potential sources of contamination within 150m of the site, as summarised under Table 4.3 overleaf.

4.16 A single fuel station entry within 500m of the site, located 350m to the northeast of the site at Clerkenwell Road Service Station, 96 – 100 Clerkenwell Road, Clerkenwell, London, EC1M 5RJ. This entry is registered as obsolete.

Table 4.3: Summary of Potentially Contaminative Trade Entries (≤100m from Site)

Name	Distance	Address	Classification	Significance
Registered as 'Active'				
P T C R Jewellery Polishing	4m / SE	21 Baldwins Gdns, EC1N 7UY	Jewellery Manufacturers & Repairers	Low
Wienerberger Ltd	6m / W	1-5 Portpool La, EC1N 7UU	Brick Manufacturers	Low - Medium
Galaxy Ltd	12m / S	214 Baldwins Gdns, EC1N 7RJ	Jewellery Manufacturers & Repairers	Low
Omni Colour Presentations Ltd	19m / SE	16-16a Baldwins Gdns, EC1N 7RJ	Printers	Low
Jewel Works Repairs Ltd	19m / SE	16-16a Baldwins Gdns, EC1N 7RJ	Jewellery Manufacturers & Repairers	Low
C L P London	19m / SE	16-16a Baldwins Gdns, EC1N 7RJ	Copying & Duplicating Services	Low
The Jewel Studio	20m / SE	Suite 108, 16-16a Baldwins Gdns, EC1N 7RJ	Jewellery Manufacturers & Repairers	Low
Sue Smart	20m / NE	86 Leather Lane, EC1N 7TT	Dry Cleaners	Low
Tassili	22m / S	21 Baldwins Gdns, EC1N 7UY	Jewellery Manufacturers & Repairers	Low
Gala Creations	43m / E	Langdales 5, St. Cross Street, EC1N 8UA	Jewellery Manufacturers & Repairers	Low
DI Graphics	45m/ NE	98 Leather Lane, EC1N 7TX	Printers	Low
Banks Assays	59m / NE	17 – 21 Hatton Wall, EC1N 8JE	Non-Ferrous Metals	Low
Refined Precious Metals Ltd	59m / NE	17 – 21 Hatton Wall, EC1N 8JE	Precious Metal Recovery	Low
Cartouche UK London Ltd	60m / NE	62 Hatton Garden, EC1N 8LR	Digital Printing	Low
Oldacres & Co Ltd	60m / NE	62 Hatton Garden, EC1N 8LR	Printers	Low
Lewis Simon	60m / NE	62 Hatton Garden, EC1N 8LR	Jewellery Manufacturers & Repairers	Low
D H J Lawes	64m / E	24 St. Cross Street, London, EC1N 8UH	Jewellery Manufacturers & Repairers	Low
Oriental Press UK Ltd (*also shown as inactive)	65m / E	New House, 67-68 Hatton Garden, EC1N 8JY	Printers	Low
Herbert Marx Ltd/ Peter Malvermi/ Le Q	65m / E	New House, 67-68 Hatton Garden, EC1N 8JY	Jewellery Manufacturers & Repairers	Low
Unique Rings Ltd/ Justin Wilson/ A R Blake	71m / NE	Colonial Buildings, 59-61 Hatton Garden, EC1N 8LS	Jewellery Manufacturers & Repairers	Low
Electrak	71m / NE	Colonial Buildings, 59-61 Hatton Garden, EC1N 8LS	Power Transmission Equipment	Low
Central Jewellery	77m / N	115 Clerkenwell Road, EC1R 5BY	Jewellery Manufacturers & Repairers	Low
Diana 's	78m / N	103 Clerkenwell Road, London, EC1R 5BX	Dry Cleaners	Low
Registered as 'Inactive'				
Royal Cleaning Services	6m / NW	Flat 47, Redman Building, EC1N 7UB	Commercial Cleaning Services	Low
W G Polishing	8m / SE	21 Baldwins Gardens, EC1N 7UY	Jewellery Manufacturers & Repairers	Low
Calenergy Gas (Holdings) Ltd/ G D F Britain Ltd	16m / SW	60 Gray's Inn Road, WC1X 8LU	Oil & Gas Exploration Supplies & Services	Low

Cont…\

Table 4.3: Summary of Potentially Contaminative Trade Entries (≤100m from Site) (Cont.)

Name	Distance	Address	Classification	Significance
Registered as 'Inactive' (Cont.)				
D J Griffin Ltd/ Loveweds/ J Marling/ P A Specialist Polishers/ Sportgold 90 Ltd	19m / SE	16-16a Baldwins Gdns, EC1N 7RJ	Jewellery Manufacturers & Repairers	Low
Goldies/ / M C P Litho Ltd/ Ginger Printing/ Classic Print & Design Ltd	19m / SE	16-16a Baldwins Gdns, EC1N 7RJ	Printers	Low
Omega Colour Laboratories Ltd/ Snapdragon	19m / SE	16-16a Baldwins Gdns, EC1N 7RJ	Photographic Processors	Low
Cyclops Creative	19m / SE	16-16a Baldwins Gdns, EC1N 7RJ	Photo & Digital Imaging Bureaus	Low
E C 1 Jewels Ltd/ Roth Bros International	20m / SE	Suite 208, 16 Baldwins Gdns, EC1N 7RJ	Jewellery Manufacturers & Repairers	Low
Epic	20m / SE	Suite 10, 16 Baldwins Gdns, EC1N 7RJ	Printers	Low
Apex Creative Services Ltd	22m / W	88-90 Gray's Inn Road, WC1X 8AA	Printers	Low
Momo	29m / NE	80 Leather Lane, EC1N 7TR	Jewellery Manufacturers & Repairers	Low
Toy Castings Ltd/ Fos Jewellery Ltd/ Memis Gold	31m / NE	City House, 72-80 Leather Lane, EC1N 7TR	Jewellery Manufacturers & Repairers	Low
Ironforge	31m / NE	City House, 72-80 Leather Lane, EC1N 7TR	Precious Metal Recovery	Low
Thistle Jewellery	33m / NE	20-28 Hatton Wall, EC1N 8JH	Jewellery Manufacturers & Repairers	Low
Cobiere Setting Co./ Paradise Jewellery/ David Luton	34m / NE	31 Hatton Wall, EC1N 8JJ	Jewellery Manufacturers & Repairers	Low
King Jewellers	34m / NE	Unit 210, 24-28 Hatton Wall, EC1N 8JH	Jewellery Manufacturers & Repairers	Low
Actgold Ltd	35m / NE	Ruby House, 30 Hatton Wall, EC1N 8JH	Jewellery Manufacturers & Repairers	Low
Shaun Leane Ltd/ Oddy	35m / NE	20 – 28 Hatton Wall, EC1N 8JH	Jewellery Manufacturers & Repairers	Low
Group 2 Graphics	60m/ NE	62 Hatton Garden, EC1N 8LR	Printers	Low
Belgique Joaillerie Ltd	64m / NE	83 Clerkenwell Road, EC1R 5AR	Jewellery Manufacturers & Repairers	Low
Scan Mobile	64m / NE	85 Clerkenwell Road, EC1R 5AR	Telecommunications Equipment & Systems	Low
J Designs	65m / E	New House, 67-68 Hatton Garden, EC1N 8JY	Jewellery Manufacturers & Repairers	Low
Fine Firs Ltd	65m / E	New House, 67-68 Hatton Garden, EC1N 8JY	Furriers	Low
Jewel Works/ The Ring Mount & Setting Co./ Gradia	65m / E	New House, 67-68 Hatton Garden, EC1N 8JY	Jewellery Manufacturers & Repairers	Low
Panther Imaging Ltd	66m / N	87 Clerkenwell Road, EC1R 5BX	Photographic Processors	Low
Joseph & Joseph Ltd	68m / NE	14 Hatton Wall, EC1N 8JH	Jewellery Manufacturers & Repairers	Low
Quamina/ P F G Ltd/ Phodi Panayi/ David Simons/ Unique	71m / NE	Colonial Buildings, 59-61 Hatton Garden, EC1N 8LS	Jewellery Manufacturers & Repairers	Low
Desmond Young	72m / NE	Wall House, 12 Hatton Wall, EC1N 8JH	Jewellery Manufacturers & Repairers	Low
City Dry Cleaners	77m / N	121 Clerkenwell Road, EC1R 5BY	Dry Cleaners	Low
G S McSweeney / M Neil & M Monsellato	93m / SE	85 Hatton Garden, EC1N 8JR	Jewellery Manufacturers & Repairers	Low

4.17 Table 4.4 summarises identified industrial features which may present a potential source of contamination to the site.

Table 4.4: Industrial Setting

Type	Distance	Description	Ref
Environmental Permits & Prosecutions Relating to Authorised Processes (≤250m)			
Mastermelt Ltd Permit Ref: Not Given	9m/ SE	**Local Authority Pollution Prevention Control** registered at Baldwins Gardens, Camden, EC1n 7RJ. Authorised under the London Borough of Camden for **PG2/1 Furnaces for the extraction of non-ferrous metal from scrap** and is registered as **revoked**.	[3]
Sue Smart Permit Ref: PPC/DC29	18m / NE	**Local Authority Pollution Prevention Control** registered at 86 Leather Lane, EC1N 7TT. Authorised under the London Borough of Camden for **PG6/46 Dry Cleaning** and is currently active.	[3]
Mastermelt Permit Ref: Not Given	20m / SE	**Local Authority Pollution Prevention Control** registered at Unit 211, 31-37 Leather Lane, NW6 3BB. Authorised under London Borough of Camden for **PG2/4 Iron, Steel and Non-Ferrous Metal Foundry Processes**. The permit is registered as 'permitted' (i.e. active).	[3]
Mastermelts Ltd Permit Ref: PPC11	101m / NE	**Local Authority Pollution Prevention Control** registered at 56 Hatton Garden, EC1N 8HP. Authorised under London Borough of Camden for **Part B – General Metal Processes** (No Specific References).	[3]
Water Industry Act Referrals (≤500m)			
Aeromet International Plc **Permit Ref:** Bz0564	400m / S	**Water Industry Act Referral** registered at 10 Norwich Street, EC4A 1BD. The referral is dated 10th March 2004 for processes requiring permissions or amendments to discharge water under the Water Industry Act 1991. These are processes which result in the discharge of 'Special Category' effluents under The Trade Effluents (Prescribed Processes and Substances) Regulations. The application is recorded as **cancelled**.	[3]

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

- Pollution Incidents to Controlled Waters;
- Discharge Consents;
- Registered Radioactive Substances;
- Contaminated Land Register Entries and Notices;
- Discharge Consents;
- Integrated Pollution Controls (IPC);

- Integrated Pollution & Prevention Controls (IPPC);
- Local Authority IPPCs;
- Local Authority Pollution & Prevention Control Enforcements;
- Prosecutions relating to Authorised Processes or Controlled Waters;
- BGS Recorded Landfill Sites;
- Historical Landfill Sites;
- Integrated Pollution Control Registered Waste Sites;
- Licensed Waste Management Facilities (Landfill Boundaries & Locations);
- Local Authority Recorded Landfill Sites;
- Registered Landfill Sites;
- Registered Waste Transfer Sites;
- Registered Waste Treatment or Disposal Sites;
- Control of Major Accident Hazard Sites (COMAH);
- Explosive Sites;
- Notification of Instillations Handling Hazardous Substances (NIHHS);
- Planning Hazardous Substance Consents; or,
- Planning Hazardous Substance Enforcements.

5.0 ARCHAEOLOGY BASELINE APPRAISAL

Introduction

5.1 This report highlights the archaeological and built heritage sensitivities that should be taken into account when looking at the redevelopment of the Bourne Estate, Camden. Records were obtained for the following within a 1 kilometre (km) radius of the site boundary (see Figure 5):

- Scheduled Ancient Monuments;
- Monuments;
- Registered Parks and Gardens;
- Listed Buildings;
- Conservation Areas; and,
- Archaeological findspots.

5.2 Baseline conditions within the study area have been determined with reference to:

- Greater London Historic Environmental Record (HER) data provided by English Heritage (EH) (contained within Appendix C).

5.3 Due to the significant amount of data that was supplied, records within a 250m radius have been assessed in further detail (see Figure 6).

Archaeological and Historical Baseline conditions

5.4 The principal archaeological periods used within this assessment are listed in Table 5.1 below.

Table 5.1: Archaeological periods used in the assessment

Period	Approximate duration
Prehistoric (500000 BC to 42 AD)	
Palaeolithic	500,000 BC – c. 10,001 BC
Mesolithic	10000 BC to 4001 BC
Neolithic	4000 BC to 2201 BC
Bronze Age	2200 BC to 701 BC
Iron Age	700 BC to 42 AD
Historic	
Roman	43 AD to 409 AD
Anglo-Saxon (Early Medieval / Dark Age	410 AD to 1065 AD
Medieval	1066 AD to 1539 AD
Post Medieval	1540 AD to 1900 AD
19th Century	1801 AD to 1900 AD
Modern	1940 AD to 2050 AD

Scheduled Ancient Monuments

5.5 There are no Scheduled Ancient Monuments (SAMs) within the site boundary or within a 250m radius of the site.

5.6 A total of 8 SAMs have been identified within a 1km radius of the site boundary.

Monuments

5.7 One monument is recorded within the site boundary. The monument has been identified as Furnival Inn and dates back to the Medieval / post medieval period (MLO17840). A total of 51 monuments are present within 250m of the site boundary.

5.8 A total of 1,499 monuments are present within 1km of the site boundary.

Registered Parks and Gardens

5.9 No registered Parks and Gardens are within the site boundary. Gray's Inn Gardens (MLO59307) is located directly west of the site boundary. The gardens were first enclosed in the late 16th Century and have been registered as Grade II*, which means that they are 'more of a special interest' than Grade II listed.

5.10 A total of 16 registered Parks and Gardens are located within 1km from the site.

Listed Buildings

5.11 There are no Listed Buildings within the site; however 61 Listed Buildings are located within 250m of the site. These are listed in full and are contained within Appendix C.

5.12 There are two Listed Buildings bordering the site boundary which are listed in the table below.

Table 5.2: Listed Buildings within 250m of the site

ID	Description	Date
MLO81445	Nos. 83 – 89 (odd) 4 terraced houses at Leather Lane Grade II Listed Building	17th Century to Modern (1700 AD to 1999 AD)
MLO81447	Nos. 67 – 69 Leather Lane Grade II Listed Building	Modern (1905 AD to 1945 AD)

5.13 There are a total of 835 Listed Buildings within 1km of the site.

Conservation Areas

5.14 A part of the site is located in Hatton Gardens Conservation Area as shown on Figures 5 and 6. The Hatton Gardens Conservation Area is located in the southern part of the borough bordering Islington to the east and the City of London to the south. Hatton Gardens has a long history of development dating back to the medieval period.

5.15 Hatton Gardens was first identified as part of the 'Royal Courts of Justice, Inns of Court Area of Special Character' in the Greater London Development Plan in 1976. This indicated that the area was considered to be of 'metropolitan importance' because of its architectural and historic interest. The character and special interest of the Hatton Garden area is defined largely by the quality and variety of the buildings and uses, as well as the unique pattern of streets. Building types which make a particular contribution to the character and appearance of the Conservation Area include Georgian terraced buildings, late 19th Century and early 20th Century residential blocks, warehouse and workshop buildings and neo-classical buildings.

Historic Environmental Record

5.16 No HER records are located within the site boundary, however six findspots are present within a 250m radius of the of site boundary. The findspots locations are shown on Figure 6 and are summarised in Table 5.3 below.

Table 5.3: HER entries within approximately 250m of the site

ID	Description	Date	Distance from site
MLO71747	Coin; Claudius.	Roman (43 AD – 409 AD)	Approx. 125m north west
MLO17782	Two cremations in urns.	Roman (43 AD – 409 AD)	Approx. 125m north west
MLO63079	Re-deposited Roman pottery	Roman (43 AD to 409 AD)	Approx. 225m south
MLO71755	Two ceramic jugs, one Kingston ware and the other London-type ware were recovered near Hatton Gardens	Medieval (1066 AD – 1539 AD)	Approx. 100m east

Cont…\

Table 5.3: HER entries within approximately 250m of the site (Cont.)

ID	Description	Date	Distance from site
MLO1665	Knives, spoons and other domestic implements were found in the River Fleet	Medieval (1066 AD – 1539 AD) 15th Century to 16th Century (1485 AD – 1600 AD)	Approx. 245m east
MLO31834	Pottery associated with Grays Inn	Post Medieval (1540 AD to 1900 AD)	Approx. 200m south

5.17 A total of 111 archaeological findspots are present within 1km of the site.

Summary

5.18 There are no SAMs within the site boundary or within a 250m radius of the site; however a total of 8 SAMs have been identified within a 1km radius of the site boundary.

5.19 One monument is recorded within the site boundary and a total of 51 monuments are present within 250m of the site boundary. A total of 1,499 monuments are present with 1km of the site boundary.

5.20 No registered Parks and Gardens are within the site boundary; however, 1 Garden is present within a 250m radius of the site. A total of 16 registered Parks and Gardens are located within 1km from the site.

5.21 Whist there are no Listed Buildings within the site, a total of 61 Listed Buildings are located within the 250m radius of the boundary and 835 within 1km of the site. Part of Hatton Gardens Conservation Area is located within the site boundary and also includes the majority of the Listed Buildings in close proximity to the site.

5.22 The site is considered to lie within an area of 'high' sensitivity with respect to built heritage.

5.23 Whilst the site is not known to contain any archaeological deposits, this assessment has identified six findspots located within the 250m radius of the site boundary and 111 findspots within 1km of the site, therefore the site is considered to lie within an area of '**Medium-High**' potential for archaeology.

Potential Impacts and Recommendations

Past Impacts

5.24 Potential impacts upon archaeological remains caused by the previous land-use must be considered as previous development can affect the survival of such deposits.

5.25 The site is previously developed land and therefore a variable thickness of Made Ground is anticipated to be present. Past construction has the potential to have destroyed, damaged and / or truncated any hitherto unknown deposits in these areas.

Recommendations

5.26 It is clear that the design of the development will need to consider the character and fabric of built heritage assets in the vicinity of the site.

5.27 It is recommended that a detailed archaeological desk top study is undertaken to further inform the design and construction of the development. The archaeological desk-based assessment is likely to be a requirement for planning.

5.28 It is recommended that the desk-based assessment is undertaken prior to any intrusive investigations on the site. It is likely that intrusive groundwork's will need an archaeological watching brief undertaken by a suitably qualified archaeologist.

5.29 It is likely that a watching brief will also be required during construction works, although it is recommended the approach is discussed and agreed with the Archaeological Officer at Camden Borough Council once the desk-based assessment has been completed. A watching brief can be conditioned by the way of a suitably worded planning condition.

6.0 PRELIMINARY CONCEPTUAL SITE MODEL

6.1 Current practice for land contamination evaluation involves appraisal of contaminant source-pathway-receptor pollutant linkages. These are summarised below, based upon information presented above, and have been used as a basis for determining the scope of further site investigation in advising the proposed redevelopment masterplanning.

Conceptual Site Model (CSM)

Potential Sources of Contamination

6.2 Table 6.1 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, Department of the Environment (DOD) *Industry Profiles* and anecdotal information. It is noted that additional undocumented sources of contamination/ contaminants may be present.

Table 6.1: Potential Sources of Contamination

Potential Sources of Contamination	Discussion / Potential Contaminant
Onsite	
Made Ground	A significant thickness of Made Ground is anticipated onsite, resulting from bomb damage sustained onsite during WWII and subsequent redevelopment. The site walkover has identified significant changes in level, possibly resulting from areas of localised backfilling. Potential contamination associated with Made Ground can be wide-ranging and may include: • **Asbestos Containing Materials** and associated **dispersed fibres** primarily relating to the potential backfilling of demolition arisings onsite. • Where **deleterious materials** have been backfilled onsite, this may represent a potential source of **hazardous ground gases**, primarily comprising **Carbon Dioxide** (CO_2) and **Methane** (CH_4). • Depending upon the nature of the backfilled materials, **metals** and **hydrocarbons** (including **polynuclear aromatic hydrocarbons (PAHs)**) may be present.

Cont…\

Table 6.1: Potential Sources of Contamination (Cont.)

Potential Sources of Contamination	Discussion / Potential Contaminant
Onsite (Cont.)	
Potential **Boiler Rooms** which may have been present in historic buildings – as yet unconfirmed.	Given the age of construction of these buildings, it is likely that original boiler systems were **Fuel Oil** based, and as such, fuel storage / tanks are likely to have been present. It is uncertain whether these have been since upgraded to gas fuelled systems.
Builder Workshop adjoining Community Centre between c.1968 – 1975; when it was subsequently used for an Electricity Sub-station to the present day.	It is unclear to the exact nature of the Builder Workshop, however, it is possible that various hydrocarbon contaminants, including **Lubricating oils**, **Fuel oils** and **Polynuclear Aromatic Hydrocarbons** can
Unexploded Ordnance	The site is known to have been heavily bombed during WWII and a preliminary appraisal (presented under Section 4.0) has identified a **Medium - High Risk** in this regard.
Offsite	
Brewery which was present to the immediate north of the site between c. 1874 – 1916. [**Historic**]	Brewing involves the production of beer through the fermentation of grain within water using yeast. The brewing process can be broken down as: **malting;** milling; mashing; lautering; **boiling; fermenting**; conditioning; filtering; and, packaging. By products typically include spent grains and dregs – the former of which would have been likely re-sold as fodder. In view of the above, only relatively limited potential for contamination is considered likely as a result of the brewery. This includes the presence of **Ash** as a result of fire-heating process water and the potential for **Asbestos Containing Materials** to have been used within plant material. In addition, it is likely that the Brewery included groundwater abstraction wells for process water. In view of the importance of high quality process water for the sensitive brewing process, it is unlikely – but possible – that spent process water/ dregs were discharged to groundwater.
A **Glass Works** which was present to the immediate south of the site between c. 1896 and 1952. [**Historic**]	Although it is unclear as to the type of glass produced, the most common type of glass is **soda-lime glass**, composed of approximately 75% silica (SiO_2) plus Na_2O, CaO and several minor additives. Anecdotal information suggests that potential contaminants associated with glass works include: **lead**, **fluorides**, **oil**, **acids**, **arsenic**, **antimony** and **chromium**. Other potential sources of contamination are **coal** and **ash** from the operating of furnaces, firing kilns or similar.

Cont…\

Table 6.1: Potential Sources of Contamination (Cont.)

Potential Sources of Contamination	Discussion / Potential Contaminant
A **Tobacco Factory** which was present from c.1952 to 1965 approximately 50m to the northeast of the site. [**Historic**]	It is likely that the factory was for **cigarette manufacturing** rather than the curing and preparation of tobacco (which is likely to have been undertaken at the point of origin prior to import). The potential contaminants are considered **to be similar to** other forms of factory production, most notably **the potential** for **lubrication oil** and **fuel** associated **with production plant** and potential boiler rooms.
A **Gold Refinery** which was present approximately 30m to the east of the site c.1952 – 1958. [**Historic**]	Gold is usually refined **industrially by the 'Wohlwill Process'** which is based on electrolysis **to produce the highest** grade gold (99.999% purity); **or, by the 'Miller Process', that is** the chlorination **in the melt which produces gold of 99.95% purity.** It is unclear as **to what refining process prevailed at the site;** however, **in general the potential contaminants may include acids and spent oxides.**

Receptors

6.3 Based upon the site's environmental setting and proposed (generic) development end uses (i.e. Residential with the potential for Plant Uptake, the following receptors have been identified.

Table 6.2: Summary of Identified Receptors

Receptor	Description	Sensitivity
Human Health Residential End Users	Future housing occupants. *Sensitivity of residential end users will vary depending upon the precise nature of the redevelopment. For example, developments which provide private gardens and/or allotment areas are of an increased sensitivity relative to flat / apartments. Adjacent land users may also be at risk where mobile contaminants (e.g. solvents or hazardous ground gases) and pathways are present.	Medium - High
Human Health Groundworker & Maintenance Workers	Groundworkers and maintenance personnel associated with the development of the site and ongoing / intermittent maintenance following completion.	Low - Medium
Hydrogeology Secondary A Aquifer	Groundwaters contained within the Lynch Hill Gravel superficial aquifer (not within a Source Protection Zone).	Medium
Buildings & Services Infrastructure	Buried concrete, service corridors and other infrastructure (including water supply pipe work) as part of the site development.	Low

6.4 It is noted that no feasible hydrological or ecological receptors have been identified, and therefore, they are excluded from the above table and following Preliminary Risk Assessment.

Pathways

6.5 In the context of the proposed site uses, the potential pathways presented in Table 6.3 are considered applicable and have been considered in the further site investigation.

Table 6.3: Potential Pathways

Potential Pathway	Construction Phase		Occupation Phase	
	Present	Receptors	Present	Receptors
Ingestion of soil and/or dust.	✓	G&M	✓	G&M, HH
Inhalation of soil and/or dust.	✓	G&M	✓	G&M, HH
Inhalation of vapour from soil, dust and/or water.	✓	G&M	✓	G&M, HH
Dermal contact with soil, dust and/or water.	✓	G&M	✓	G&M, HH
Ground gas migration through granular strata.	✓	G&M, HH	✓	G&M, HH
Migration of water bourne contaminants.	✓	E	✓	E
Leaching of contamination through soil and unsaturated zone.	✓	E	✓	E
Surface water run-off.	✓	E	✓	E
Plant uptake and subsequent ingestion of contaminated home grown crops.	×	HH	✓	HH

NOTES: G&M Groundworkers & Maintenance Workers. HH Human Health, E Environmental Receptors.

Preliminary [Qualitative] Pollutant Linkage Risk Assessment

6.6 Current 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, Chartered Institute for Environment and Health and CIRIA.

6.7 Tables 6.1 – 6.3 indicate the potential contaminants, receptors and pathways that have been considered at the site. Based upon available desktop information, a preliminary qualitative risk assessment is presented under Tables 6.4 overleaf utilizing the following descriptions of risk that take into account the magnitude of the potential source, likelihood of exposure via a pathway and significance of harm likely to result on the given receptor[3].

[3] CIEH, *Guidelines for Environmental Risk Assessment and Management*; and, CIRIA C552, *Contaminated Land Risk Assessment: Guide to Good Practice*. Section 6 of CIRIA 552 presents matrices for risk assessment – these have been simplified herein.

- **High (H) Risk:** Pollutant linkage is likely to exist with potential to cause significant harm;
- **Medium (M) Risk:** Pollutant linkage is likely to exist but significant harm is unlikely; and,
- **Low (L) Risk:** Pollutant linkage may exist but any harm is likely to be mild.

6.8 Table 6.4. excludes UXO risk, which has been separately assessed under Section 4.0 and a **Medium - High Risk** concluded.

Table 6.4: Preliminary [Qualitative] Pollutant Linkage Risk Assessment

Potential Sources of Contamination [See Table 6.1 for Details]	**Receptors** [See Table 6.2 for Descriptions]	**General Pathways** [See Table 6.3 for Detailed Breakdown]	**Risk Classification**
Made Ground & Potential Boilers A variable and potentially significant thickness of Made Ground may be present at site, containing: **Asbestos Containing Materials**, **Hazardous Ground Gases**, **Metals** and **Hydrocarbons**. Original boilers are likely to have used **Fuel Oil**.	HH: **Residential Occupants**	Primary risk pathways exist where direct contact is possible with soils. Volatile contaminants and hazardous ground gases present a risk via inhalation pathways.	**Medium**
	HH: **Groundworker & Maintenance Staff**		**Low* – Medium**
	Groundwater: **Secondary A Aquifer**	Risk pathways predominantly via leachate and downward migration of contaminants.	**Low**
Electricity Sub-station An Electricity sub-stations was installed c. 1975 onsite, within the former Building Workshop., This is likely to contain **Polychlorinated Biphenyls (PCBs)**. **Mineral oils** are also likely to be present. It is noted that PCBs are highly insoluble.	HH: **Residential Occupants**	Primary risk pathways exist where direct contact is possible with soils. Volatile contaminants and hazardous ground gases present a risk via inhalation pathways.	**Medium**
	HH: **Groundworker & Maintenance Staff**		**Low* - Medium**
	Groundwater: **Secondary A Aquifer**	Risk pathways predominantly via leachate and downward migration of contaminants.	**Medium**
Historical offsite uses including: **Brewery**; **Glass Works**; **Tobacco Factory**; and, **Gold Refinery**.	HH: **Residential Occupants**	Given the fact that all these historical uses are off-site; and, that there is little evidence to suggest that mobile contaminants (e.g. hazardous ground gases or volatile compounds) are migrating onsite – a low level of risk has been identified to Human Health in general.	**Low**
	HH: **Groundworker & Maintenance Staff**		**Low***
	Groundwater: **Secondary A Aquifer**	Whilst these offsite uses may have resulted in impaction of offsite groundwaters, there is considered to be limited risk – particularly given the nature of these industries and the importance of high quality process water. Notwithstanding this, there remains to be a potential (albeit limited) for this to have occurred.	**Low - Medium**
NOTES: HH Human Health. * Lower bound risk classification assumes the use of appropriate Personal Protective Equipment (PPE) and general working Health & Safety provisions.			

7.0 GEOTECHNICAL CONCLUSIONS

7.1 The geological sequence at the site comprises Made Ground, underlain by River Terrace Deposits over the London Clay. Previous borehole data obtained encountered the London Clay at approximately 5 to 7m below ground level. It is relatively thin in this area of London, with the underlying Lambeth Group strata anticipated at 17 to 21m bgl.

7.2 There is the potential for areas of deep fill and/or underground obstruction to exist on site associated with previous buildings which may have had basements and with infilled bomb craters. If obstructions are present, these will require removal within any proposed building footprint so as not to hinder foundation construction.

7.3 The London Clay and materials derived from it may contain elevated concentrations of sulphates and sulphides, which can be aggressive to buried concrete. Consequently, elevated protection from aggressive ground conditions may be required for buried concrete.

7.4 Full services information should be obtained and consultations with the affected infrastructure companies undertaken with regards to any proposed development at the site.

7.5 Prior to any development, it is recommended that an intrusive ground investigation is undertaken at the site with geotechnical testing and groundwater monitoring to confirm the underlying geology, groundwater regime and the engineering properties of the underlying soil.

7.6 The suitability of shallow or piled foundations will be dependent on the sequence of strata and the structural loads of the proposed development. Some general advice is given below.

7.7 Unless adequately treated, Made Ground is not considered a suitable founding stratum due to its inherently variable and generally poor strength and load bearing characteristics. Foundations should be taken though such deposits to a minimum depth of 300mm in to the underlying natural soils or to 1.00m below ground level (bgl), whichever is the deepest.

7.8 A considerable thickness of Made Ground (3.45m) was previously recorded at the site, and as such shallow foundations may not be feasible. Ground improvement could be an option, or foundations could be piled. Given the site's location, CFA and bored piles are considered suitable, although both could be hampered if there are significant underground obstructions. Bored piles would require casing through the Made Ground and River Terrace Gravel, and may also require support through the Lambeth Group Strata.

7.9 The site is in close proximity to existing developments and thus should any basements be proposed, consideration would need to be given to their construction and any resulting ground movements around the excavation. The impact of any ground movements on surrounding structures and infrastructure would have to be assessed. The London Clay has the potential to heave if subject to unloading and basements may therefore have to be designed to accommodate heave pressures as well as hydrostatic pressure. Groundwater levels should be confirmed by intrusive investigation. Any proposed basements will require a Basement Impact Assessment (DP27) to be submitted at planning stage.

7.10 The risk of encountering a UXO at the site is considered to be **'Medium-High'**. A preliminary UXO risk assessment should be completed as soon as possible to determine the requirement for detailed risk assessment and mitigation measures for site investigation and construction works.

8.0 GEOENVIRONMENTAL CONCLUSIONS

Contamination Issues

8.1 The site is considered to lie within an area of overall **Low - Medium Sensitivity**, solely relating to the underlying Secondary A Aquifer (which is considered to be of Medium Sensitivity in particular). With regards to the sensitivity of the proposed redevelopments, whilst proposals are at a preliminary stage, a **Medium – High Sensitivity** should be assumed. Elevated end-use sensitivity is attributed to the inclusion of allotments or private gardens.

8.2 The primary contamination issues at site relate to the potential for significant thicknesses of Made Ground onsite of unknown composition but likely to include demolition materials of a varied nature and ash. The potential inclusion of Asbestos Containing Materials within demolition arisings is of particular concern. No significant industrial use has been identified on site based on current information.

8.3 A preliminary qualitative pollutant linkage risk assessment is presented under Table 6.4 and indicates the site to represent an overall **Medium** contamination risk. This primarily relates to the potential for direct contact between end users and potentially contaminated soils.

Potential Abnormal Project Costs Resulting from Geoenvironmental Issues

Waste Soils Arising via Redevelopment

8.4 Given the potential inclusion of an underground sports facility, a significant volume of waste soils could arise through redevelopment. Where possible, provision should be made to reuse these either onsite or at an offsite location via the CL:AIRE 'Code of Practice'[4]. These options are strictly controlled via material suitability and requires specialist advice, preparation at an early project stage. Where re-use is not an option, or where the materials are found to be unsuitable, they are likely to require disposal to landfill or licensed recycling via a treatment centre. This may represent a significant cost, particularly if the presence of contamination causes soils to be classified as 'Hazardous Waste'.

[4] CLAIRE, *The Definition of Waste: Development Industry Code of Practice,* Version 2, March 2011.

Potential for Remediation & Validated Cover

8.5 The requirement for remediation can only be determined via an iterative process of intrusive investigation and subsequent assessment. However, in general, should groundwater remediation or asbestos contaminated soils require treatment – this may attract a significant development cost. In addition, where proposed redevelopment includes soft landscaping, a thickness in the region of 300 – 600mm of validated cover is likely to be required. Given the potential for contamination within Made Ground and the general absence of sub- and top-soils onsite, it is possible that importation of these cover materials may be required.

9.0 RECOMMENDATIONS

Pre-planning: Exploratory Site Investigation & Reporting

Scope of Site Investigation

9.1 In order to address the main risks identified within this report, it is recommended that an *Exploratory Intrusive Site Investigation* is undertaken in accordance with BS10175 and BS5930 prior to demolition of existing structures. This should be designed by a land quality specialist and include provision to examine:

- **Ground Conditions across the Site**, particularly the thickness and composition of Made Ground and its variability onsite. Particular areas for examination raised via this study include: the vicinity around Windmill and Blemundsbury House which are expected to have been constructed as a result of bomb damage on this area of site; the area to the immediate west of Orde Hall Road and around Chancellors and Babington House where anecdotal information suggests that demolition arisings have been backfilled; and, in the area of the proposed MUGA underground facility in order to advise potential disposal costs and contribute to the feasibility appraisal during masterplanning.
- **Contamination Analysis**, particularly within the Made Ground strata and/or other horizons which are anticipated to either be removed from site or reused as validated cover. The analysis should be cognisant of the potential contaminants identified within Table 5.1 and should permit *Quantitative Risk Assessment* for Human Health, Controlled Waters in accordance with CLR11 and, *Waste Classification* in accordance with Environment Agency Guidance.
- **Geotechnical Analysis** to determine the sequence of strata at the site and the groundwater regime. In situ testing, including Standard Penetration Tests to facilitate foundation design. Laboratory testing, including undrained shear strength, moisture content, Atterberg Limit, particle size distribution and buried concrete to facilitate foundation design.
- **Groundwater and Ground Gas Monitoring** to allow groundwater sampling and analysis and to determine the shallow ground gas regime and subsequent risks and mitigation requirements (if any) – for example, gas protection membranes. This will require construction of 'monitoring installations' within boreholes and subsequent monitoring visits over a 3 – 6 week period.

9.2 It is envisaged that in order to deliver the above, a combination of trial pitting, windowless dynamic sampling ('window sampling') and cable percussive boreholes will be required. Prior to deployment, the Contractor should review the preliminary UXO assessment herein and supplement as necessary.

9.3 With regards to site archaeology, incorporation of trial pitting within the preliminary site investigation would present an opportunity to undertake an *archaeological watching brief* such

that any future requirements and potential delays/ project risks can be identified and allowed for in advance.

9.4 Other matter which would require clarification prior to mobilisation include:

- Full **services details** for the site to be provided to the designer and site investigation contractor;
- **Resident liaison** such that car parking areas, sports areas, communal landscaping etc. can be kept vacant as necessary to permit investigation and allow safe working areas; and,
- **Reinstatement** requirements should also be confirmed – although it is expected that full reinstatement on a 'like-for-like' basis would be required.

9.5 It is advised that the works are competitively tendered on order to achieve best value, and subject to the exact requirements of the above matters (e.g. scope of archaeological watching brief, level of UXO mitigation required etc.), a provisional budget of **£20,000 - £25,000** should be allowed for site investigation works – excluding third party archaeological and/or UXO watching briefs. This also excludes provisions for specialist design, procurement and management.

Pre-planning Reporting: Preliminary Land Quality Statement

9.6 Following the collection of site investigation data as outlined above, this will require specialist interpretation to allow preliminary geotechnical design and a revised Conceptual Site Model and risk assessment for contamination issues (in accordance with CLR11). Engineering constraints should be communicated – pre-planning – to ensure that the submitted scheme reflects these particular constraints and/or feasible engineering solutions can be incorporated within the architects proposals. This forms an important project design review to ensure that any significant engineering requirements are considered within the permitted masterplan.

9.7 These findings would be collated within a *Preliminary Land Quality Statement* and forms the first reporting requirement under Planning. It is noted that Land Quality appraisal is an iterative process and further stages of site investigation, reporting and design are likely to be required in due course, following demolition, it will be necessary to complete a 'main' intrusive site investigation to collect full ground investigation data for the site.

Optional Reporting: Preliminary Waste Classification Report

9.8 It is possible to undertake a preliminary Waste Classification on the obtained site investigation data to inform potential disposal costs. This may have a significant impact on the feasibility of

the scheme, particularly the any basement levels, under-croft parking or similar. It is noted that this does not form a planning requirement but may be useful in project planning and feasibility appraisal.

Technical References

[1] BGS Geological Sheet 256 North London.

[2] BGS Borehole Records, Log References: TQ38SW4911, TQ38SW461, TQ38SW3950

[3] Landmark Information Group, *Envirocheck® Report*, Order Number: 37161780_1_1 dated 6th January 2012. Report includes historical mapping and historical building layout plans.

[4] Barton N. J., *The Lost Rivers of London*,

[5] Construction Industry Research and Information Association (CIRIA) Special Publication (SP)69, *Engineering Implications of Rising Groundwater Levels in the Deep Aquifer beneath London*, 1989.

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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.

APPENDICES

Appendix A: Figures

Figure 1: Site Location
Figure 2: Site Layout
Figure 3: Underground Constraints Plan
Figure 4: Composite Historical Development Plan
Figure 5: Historic Environment Record Data within 1km of the Site
Figure 6: Historic Environment Record Data within 250m of Site

Appendix B: Site Photographs

To be completed in final report.

Appendix C: Desktop Information (CD)

Landmark Information Group, Envirocheck® Report, Order Number: 37161780_1_1 dated 6th January 2012. Report includes historical mapping and historical building layout plans.

English Heritage, Historic Environment Records [HER] Data, January 2012.

Thames Water Drainage Records.

Appendix D: Regulatory Consultations (CD)

To be completed in final report.