LONDON BOROUGH OF CAMDEN

CHESTER BALMORE DEVELOPMENT,
LONDON N19 5BZ

REPORT ON PHASE 2 SITE INVESTIGATION

Contract: 51481A

Date: January 2011

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REPORT ON PHASE 2 SITE INVESTIGATION

carried out at

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Prepared for

LONDON BOROUGH OF CAMDEN
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EXECUTIVE SUMMARY

On the instructions of Engineers Haskins Robinson Waters, on behalf of the London Borough of Camden, a site investigation was undertaken to determine ground conditions to enable foundation and road/hard standing design to be carried out, together with a contamination risk assessment and a review of gas emissions.

The site, which it is understood is proposed for redevelopment for new residential flats, is situated to the north of Chester Road, south of Balmore Street and southeast of Raydon Street in Highgate, London, and may be located by National Grid Reference TQ 288 866. The development is referred to as 'Chester Balmore'.

Published geological and hydrogeological records indicate that the site is located above unproductive strata relating to the negligibly permeable London Clay Formation.

The site work was carried out between the 30 November and 3 December 2010 and comprised six cable percussion boreholes, generally to depths of between 7.45m and 20.45m. Borehole 3 was terminated at 1.40m due to a concrete obstruction and repositioned to borehole 3A. In addition, four trial pits were excavated by hand to expose adjacent foundations along the eastern boundary of the site.

Made Ground was encountered in all of the exploratory locations and extended to depths of between 0.50m and 2.10m. The London Clay was encountered directly beneath the Made Ground, extending to the full depth of the investigation at 20.45m. Groundwater was not encountered, though seepage associated with perched water in the Made Ground should be anticipated.

Consideration may be given to the adoption of shallow spread foundations to support the proposed structures taken through the Made Ground into the natural strata to a minimum depth below ground level of 1.00m with an allowable bearing pressure, at such a depth, of 85kPa. In the location of boreholes 3, 3A and 4, where a greater thickness of Made Ground was encountered, foundations may need to be extended to a depth of up to 2.10m. Where a basement level is proposed, assuming a depth of some 3m below ground level, following removal of up to 3m of material within the basement a gross bearing pressure of 195kPa could be adopted.

In the proximity of trees either existing, recently removed or planned planting, foundations should be extended to depths recommended by the NHBC for soils of high swell potential. This is unlikely to affect below ground basement structures.

However, it may be considered that for foundations over a certain depth it may be more economical to adopt piles. Guidelines for the design of piles are given in Appendix 5, which may be used with the plot of N value and shear strength with depth included in Figure A5.3

For the purposes of the contamination risk assessment, the results of the soil analyses have been compared to the CLEA SGVs published in Environment Agency Science Reports SCR050021 and SC050021/SR3, where available, and Generic Assessment Criteria (GAC), determined by LQM and CIEH, in accordance with current legislation and guidance.

The contamination risk assessment identified elevated concentrations of arsenic and PAH compounds within the Made Ground across the site. In areas that are to be covered by buildings or hard standing, no pathway is likely to exist and therefore no further remedial action is likely to be required. However, in proposed landscaped or garden areas, the contaminated material will need to either be removed, or capped with clean, inert material to ensure that there is no associated significant risk of significant harm to human health for end users / occupants of the final development.

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1.0 INTRODUCTION

1.1 It is understood that the proposed development comprises residential flats.

1.2 On the instructions of Engineers Haskins Robinson Waters, on behalf of the London Borough of Camden, a site investigation was undertaken to determine ground conditions to enable foundation and road/hard standing design to be carried out, together with a contamination risk assessment and a review of gas emissions.

1.3 This report should be read in conjunction with the Phase 1 Desk Study, which was reported under reference 51481 in March 2010.

1.4 It is recommended that a copy of this report be submitted to the relevant authorities to enable them to carry out their own site assessments and provide any comments.

1.5 This report has been prepared for the sole use of the Client for the purpose described and no extended duty of care to any third party is implied or offered. Third parties using any information contained within this report do so at their own risk.

1.6 The comments given in this report and the opinions expressed herein are based on the information received, the conditions encountered during site works, and on the results of tests made in the field and laboratory. However, there may be conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken into account in the report.

1.7 The comments on groundwater conditions are based on observations made at the time the site work was carried out. It should be noted that groundwater levels vary owing to seasonal or other effects.

2.0 SITE SETTING

2.1 Site Location

2.1.1 The site is situated to the north of Chester Road, south of Balmore Street and southeast of Raydon Street in Highgate, London, and may be located by National Grid Reference TQ 288 866.

2.1.2 A site plan is included in Appendix 1, Figure A1.1.

2.2 Geological Setting

2.2.1 Details of the geology underlying the site have been obtained from the British Geological Survey map, Sheet No. 256, 'North London', solid and drift edition, 1:50,000 scale, published 2006.

2.2.2 The geological map indicates the site to be directly underlain by the London Clay Formation, briefly described as clay, silty in part.

2.2.3 The site is within an urban area and, although not indicated as present on the site from the geological maps, the possibility that Made Ground exists on site cannot be discounted.

2.3 Potential Geological Hazards

2.3.1 The following are brief findings relating to factors highlighted in the Phase 1 report that may have a potential impact upon the engineering of the proposed development.

Potential Hazard	Assessed Risk On Site
Ground Conditions	
Swelling clay subsidence	Moderate
Potential for chemical attack on concrete	Moderate
Topography	
Landslip subsidence	Very low
Previous Use	
Potential for chemical attack on concrete from Made Ground	Moderate
Anticipated presence of Made Ground	Moderate

3.0 SITE WORK

3.1 The site work was carried out between the 30 November and 3 December 2010. The locations of exploratory holes were determined by the client and the site work carried out on the basis of the practices set out in BS 10175:2001, ref. 9.2, BS 5930:1999 ref. 9.3 and ISO 1997:2007, ref 9.4.

3.2 Six boreholes, designated 1A, 2, 3, 3A, 4 and 5, were sunk by light cable percussion or percussive sampler method, and four trial pits, designated TP1 to TP4, were dug by hand at the positions shown on the site plan, Appendix 1, Figure A1.1. The depths of boreholes and trial pits, descriptions of strata encountered and comments on groundwater conditions are given in the borehole and trial pit records, Appendix 2, Figures A2.1 to A2.10.

3.3 Representative disturbed and undisturbed samples were taken at the depths shown on the borehole and trial pit records and despatched to the laboratory. Standard (split-barrel and cone) penetration tests, ref. 9.6, were carried out in the light cable percussion boreholes in the various strata to assess the relative density or consistency. The values of penetration resistance are given in the borehole records.

3.4 Samples for environmental purposes were collected in amber glass jars and kept in a cool box.

3.5 Monitoring installations, protected by a stopcock cover were installed in boreholes 1A, 2 and 5, as detailed in the borehole records to record gas and groundwater levels in the shallow soils.

3.6 The ground levels at the borehole and trial pit locations, reported on the records, were interpolated from spot levels on a survey drawing provided by the Client.

3.7 Groundwater and gas monitoring visits were undertaken on the 14 December 2010 and 6 January 2011, as detailed in Figure A2.11. Two further rounds of gas monitoring are to be completed and will be issue in an addendum to this report.

4.0 LABORATORY TESTS

4.1 Geotechnical Testing

4.1.1 Geotechnical laboratory testing was undertaken as follows and the results included in Figure A3.1.

4.1.2 The natural moisture contents, natural wet densities and shear strengths of eighteen undisturbed 100mm samples were determined.

4.1.3 The natural moisture contents were determined of twenty-two samples and liquid and plastic limit tests were carried out on twelve samples and the results included in Appendix 3, Figure A3.1 and the plasticity classification chart, Figure A3.2.

4.1.4 One-dimensional consolidation tests were made on three 100mm diameter undisturbed samples. The voids ratio/effective pressure relationships have been plotted in Figure A3.1 where the values of specific gravity, coefficient of consolidation (cv) and coefficient of volume compressibility (mv) are also given.

4.1.5 Chemical tests were carried out on fifteen soil samples to determine the sulphate concentrations as a 2:1 water/soil extract and the pH values, with eleven of these samples also tested for acid soluble sulphate and total sulphur. The results of these tests are included in Figures A3.1 and A3.3.

4.2 Chemical Testing

4.2.1 The suite of chemical analyses has been based upon the findings of the desk study, along with any on-site observations, to investigate the potential sources of contamination identified in the conceptual model. The chemical analyses were carried out on seven soil samples. The nature of the analyses is detailed below:

4.2.2 **Metals Suite** - arsenic, cadmium, chromium, hexavalent chromium, lead, mercury, selenium, boron (water soluble), copper, nickel and zinc.

4.2.3 **Organic Suite -** petroleum hydrocarbons– TPH CWG speciated analysis with BTEX and basic carbon banded analysis, polycyclic aromatic hydrocarbons (PAH) – USEPA 16 suite, phenols, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs).

4.2.4 **Inorganics Suite** - cyanide (total).

4.2.5 **Others** - pH, organic matter content and asbestos.

4.2.6 The results of these tests are shown in Appendix 4, Figures A4.1 and A4.2.

5.0 GROUND CONDITIONS ENCOUNTERED

5.1 Sequence

5.1.1 The sequence of the strata encountered during the investigation generally confirms the anticipated geology as interpreted from the geological map.

5.1.2 Interpolation of strata depths between locations should be undertaken with caution, particularly for depths of Made Ground where structures are still present at the time of the investigation.

5.1.3 The sequence and indicative thicknesses of strata are provided below:

Strata Encountered	Depth Encountered (m)		Strata Thickness (m)
	From	To	
Made Ground	0.00	0.50 to 2.10	0.50 to 2.10
London Clay Formation	0.50 to 2.10	> 20.45	> 19.95

5.2 Made Ground

5.2.1 Made Ground was encountered in all of the exploratory locations and extended to depths of between 0.50m and 2.10m. The full depth of the Made Ground was unproven in borehole 3, which was terminated due to the presence of concrete at 1.40m, and also in trial pits 1 and 4.

5.2.2 Concrete, between 0.40m and 0.50m thick, was encountered at the surface of boreholes 1, 2 and 5, and 0.05m thick concrete paving slabs were encountered at the surface of all four hand-dug trial pits, overlying between a 0.10m and 0.15m thickness of orange brown fine sand.

5.2.3 The remainder of the Made Ground (Reconstituted Ground) generally comprised brown, orange brown, red brown, clayey sand and gravel or sandy gravelly silty clay/Topsoil with inclusions of concrete, brick and roots.

5.2.4 In the trial pits, black, brown gravelly sand with brick, concrete and clinker was encountered overlying brown sandy gravelly clay with brick, concrete and wood (trial pit 1 only), although the sandy gravelly clay was absent in trial pit 3 and the gravelly sand was overlain by a 0.10m thickness of broken tarmac. The gravelly sand was absent in trial pit 4.

5.3 London Clay Formation

5.3.1 The London Clay Formation was encountered directly beneath the Made Ground in all of the exploratory locations, with the exception of borehole 3 and trial pits 1 and 4, which were terminated within the Made Ground.

5.3.2 The stratum was weathered to a depth of some 7.50m to in excess of 10.45m, generally consisting of stiff to very stiff fissured laminated orange brown silty clay with occasional blue grey staining to depths of some 3.00m to 5.50m. Rare orange silty and sandy pockets and lenses were noted together with rare to occasional selenite. Rootlets were noted to depths of between 1.50m and 5.50m. The stratum became predominantly brown and occasionally orange from 3.00m to 7.00m. Boreholes 3A and 4 were terminated in this material.

5.3.3 Beyond the weathered zone in the remaining boreholes the soil was generally described as very stiff fissured laminated dark grey silty clay with rare orange and grey silty pockets and lenses, shell fragments and iron pyrite.

5.3.4 Claystone beds occasionally with associated groundwater seepage were noted at depths of 8.50m to 9.00m in borehole 1A, 9.00m to 9.50m and 10.50m in borehole 2, 4.00m to 4.66m in borehole 3A and 9.00m to 9.50m in borehole 5.

5.4 Groundwater

5.4.1 Groundwater was encountered in boreholes 1, 2 and 5 at depths of between 8.70m and 9.50m, rising to between 8.40m and 9.30m in 20 minutes. These groundwater strikes were associated with claystone bands within the London Clay Formation.

5.4.2 A shallower groundwater strike was also recorded in borehole 2 at a depth of 1.00m rising to 0.80m in 20 minutes, perched at the top of the London Clay.

5.4.3 No other evidence of groundwater was encountered during the site works.

5.4.4 On a return visit to monitor the standpipes in boreholes 1A, 2 and 5 on the 14 December 2010, groundwater was recorded in borehole 2 only at a depth of 0.75m. A second monitoring visit on the 6 January 2011 found the groundwater level to be at 0.35m in borehole 2, 1.88m in borehole 5 and borehole 1A was dry.

6.0 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS IN RELATION TO THE PROPOSED DEVELOPMENT

6.1 Structural Details

6.1.1 It is understood that the proposed development is to consist of a five storey commercial/residential unit with a single storey basement together with smaller buildings with possible basements.

6.1.2 Finished floor levels for the proposed structure are understood to be approximately 61.0mOD to 62.0mOD for the properties adjacent to Balmore Street, between 60.7mOD and 61.0mOD for properties adjacent to Raydon Street with a lift pit at 59.6mOD, and 63.0mOD at Chester Road.

6.1.3 Precise structural details were not available at the time of preparation of this report.

6.1.4 Details of the foundations to the eastern party wall are given in appendix 2, Figures A2.7 to A2.10 and in photographs, Figures A2.12 and A2.13.

6.2 Assessment of Soil Condition

6.2.1 Removing undisturbed samples of over-consolidated fissured clays from boreholes can result in disturbance of the material that is exacerbated during subsequent preparation for laboratory testing. This can result in misleadingly low shear strengths being obtained in the laboratory.

6.2.2 In accordance with EN ISO22475, ref. 9.33, and BS5930 amendment 2, ref. 9.4, the thick walled U100 sample is considered as a Class B sampling technique and will only produce Class 3 to 5 quality samples in accordance with EN 1997-2:2007, ref. 9.5.

6.2.3 Laboratory strength testing and consolidation tests can only be carried out on Class 1 quality samples, which can be obtained from a Class A sampling technique, ref. 9.4. This is due to possible disturbance during sampling.

6.2.4 Therefore the c_u and mv values derived for use in this report can only be used as guidance.

6.2.5 In some cases, in-situ testing is more advantageous when compared with taking undisturbed samples followed by laboratory tests.

6.2.6 Work undertaken by Stroud, ref. 9.7, determined a relationship between SPT 'N' values and the undrained shear strengths of many over-consolidated clays. Further work by Stroud and Butler, ref. 9.8, in which data was analysed from sites covering a wide range of glacial deposits, confirmed there to be a correlation between the 'N' value and undrained shear strength.

6.2.7 The relationship was of the form:

$$Cu = F_1 \times N$$

and

$$mv = \frac{1}{F_2 \times N}$$

where

Cu	=	Undrained shear strength
mv	=	Coefficient of compressibility
F_1 and F_2	=	Factors

6.2.8 It was determined by Stroud that F_1 varied between 4kPa for material of high plasticity and 6kPa for material of low plasticity. Similarly F_2 varied between 400kPa and 600kPa.

6.2.9 It is considered that for the London Clay encountered on this site a value of F_1 = 5.0kPa for the weathered material and F_1 = 4.5kPa for the unweathered material would be appropriate when taking into account the above relationships.

6.3 Foundation Design

6.3.1 The results of laboratory tests indicate the London Clay Formation is of very high plasticity and of high volume change potential as defined by the National House Building Council, ref 9.9, and other published data, refs 9.10 and 9.11. Changes in moisture content will result in significant changes in volume, seasonal changes being exacerbated by the presence of trees. It is recommended that for design purposes, high volume change potential should be adopted.

6.3.2 On the basis of observations made on site together with results of in-situ and laboratory tests, consideration could be given to the adoption of shallow spread foundations to support the proposed structures.

6.3.3 Outside the zone of influence of existing and proposed trees, it is recommended that conventional shallow spread footings should be taken through any Made Ground and placed in the underlying natural strata at a minimum depth of 1.00m. Due to the depth of Made Ground encountered in the boreholes located adjacent to Chester Road, being borehole 3, 3A and 4, it is likely that foundations would have to be placed at depths up to 2.10m below ground level in this area.

6.3.4 Within the zone of influence of recently removed, existing or proposed trees, foundations for structures without a basement level should be taken through the Made Ground and placed at depths recommended by the NHBC for soils of high volume change potential. The relevant sections of the NHBC Standard are included in Appendix 5, Figures A5.1 and A5.2. Compressible material should be placed on the inside faces of foundations as specified by the NHBC.

6.3.5 Such foundations located at a depth of 1.00m below current ground level may be designed to an allowable bearing pressure of 85kPa, which would provide an adequate factor of safety against shear failure. Where a basement level is proposed, assuming a depth of some 3m below ground level, following removal of up to 3m of material within the basement a gross bearing pressure of 195kPa could be adopted. Settlements for a 1m wide strip foundation are likely to be of the order of 10mm to 15mm, however, these should be checked when the final structural loading is known.

6.3.6 It may be considered however that for foundations over a certain depth it may be more economical to adopt piles. Guidelines for the design of piles are given in Appendix 5, which may be used with the plot of N value and shear strength with depth included in Figure A5.3.

6.3.7 Within the zone of influence of trees the piles should be sleeved to depths equivalent to those specified by the NHBC for a foundation at the same location. Compressible material should be placed below and on the inside faces of pile caps and beams, as specified by the NHBC.

6.3.8 The carrying capacity of piles depends not only on their size and the ground conditions but also on their method of installation. Pile design and installation are continuously evolving processes and state-of-the-art techniques are often employed before they reach the public domain, perhaps several years down the line. Therefore, it is recommended that specialist Piling Contractors be contacted as to the suitability and carrying capacity of their piles in the ground conditions pertaining to the site.

6.3.9 It should be noted that groundwater seepage was present and claystone beds were encountered, which could affect the installation of the piles.

6.4 Ground Floor Slabs

6.4.1 On the basis of observations on site together with the results of laboratory tests, it is recommended that outside the zone of influence of trees consideration is given to constructing ground floor slabs on formation prepared in the London Clay or Made Ground. Any soft or deleterious material should be removed and replaced with properly compacted granular fill.

6.4.2 Within the zone of influence of trees the floor slabs should be suspended over a void, in accordance with NHBC guidelines.

6.4.3 Where the final levels dictate that the depth of sub floor fill exceeds 600mm, ground floor slabs should be suspended in accordance with NHBC requirements.

6.5 Basement Floor Slab

6.5.1 Basement floor slabs at a depth of at least 3m below ground level located within the London Clay may be ground bearing and should be at such a depth so as not to be affected by tree root activity.

6.6 Retaining Wall Design

6.6.1 The long term forces that act on any retaining structure are governed by the effective stress parameters. For a cohesive material, the characteristics change with time from a cohesive material, with very little internal friction, to one with low cohesion and a high angle of internal friction.

6.6.2 To determine the long term clay strength, effective stress analyses should be carried out, either fully drained or undrained with pore water pressure measurements. Such tests must be carried out slowly to ensure equalisation of pore pressures. The soil parameters determined by such tests may also be affected by sample quality and a certain amount of interpretation of the data is required to assess the cohesion and shearing resistance.

6.6.3 Therefore, for design purposes, the conservative critical state angle of shearing resistance given in Figure A5.5 could be used, with an effective cohesion of zero, ref. 9.16. However, should the stratum contain silt or sand partings, or have pre-existing slip planes, this value may have to be amended. On the basis of observations on site and the laboratory classification tests, it is considered that for the weathered London Clay a ϕ' value of 20° could be adopted.

6.6.4 If the undrained strength of stiff clay is to be relied upon during temporary works construction, then care is necessary to ensure that there are no sand or silt partings containing free water which would affect the undrained shear strength.

6.6.5 The most important is that the equilibrium of the wall during service shall be compatible with the serviceability of all the associated structures and with the environmental context of the wall. The movement of the wall during service, in reacting to the loads upon it, must not cause distress or damage to any structure behind or in front of it. The movement of the wall should not lead to the deterioration of the wall nor result in undue maintenance problems. Serviceability is important because the maximum earth pressures occur during working conditions.

6.6.6 The maximum earth pressures due to the retained soil occur where there is, for whatever reason, a minimum movement of the wall. If the design requirements restrict the movement of the wall, the active earth pressures due to the retained soil will be more than the fully active earth pressures. Structural restraints result in the earth pressure increasing from the fully active condition, k_a, through the earth pressure at rest k_o, to the passive condition, k_p.

6.7 Excavations

6.7.1 On the basis of observations on site, together with the results of in-situ and laboratory tests, it is considered that excavations to less than 1.20m should stand unsupported in the short term. Side support for safety purposes should of course be provided to all excavations which appear unstable, and those in excess of 1.20m deep, in accordance with Health and Safety Regulations, ref. 9.13.

6.7.2 Groundwater should not be expected in shallow excavations for foundations or services. However, it is possible that perched groundwater could be present overlying the London Clay, as noted in standpipe installation in borehole 2 at depths of 0.35m to 0.75m. It is considered that this could be dealt with by the use of a small pump.

6.8 Road and Hard Standing Design

6.8.1 The structural design of a road or hard standing is based on the strength of the subgrade, which is assessed on the California Bearing Ratio, CBR, scale. Experience has indicated that the measurement of the in-situ CBR value tends to give unreliable results because of the influence of the moisture content of the materials. In practice, the correlation given by the Highways Agency, ref. 9.14, is usually more appropriate than direct determination of the CBR.

6.8.2 On the basis of laboratory classification tests it is recommended that for formation prepared in the London Clay, a subgrade CBR value of 2% be adopted for design purposes. The assessment assumes there to be a low water table, good construction conditions and a thin pavement construction. Any areas of soft or deleterious material in the Made Ground should be excavated and replaced with a properly compacted granular fill.

6.8.3 For routine cases, all material within 450mm of the road surface should be non frost-susceptible.

6.9 Chemical Attack on Buried Concrete

6.9.1 The site has been classified in accordance with BRE Special Digest 1, ref. 9.15, as Made Ground and as natural ground that contains pyrite and laboratory testing undertaken accordingly. It is recommended that the guidelines given in BRE Special Digest 1, ref. 9.15, be adopted. Relevant details of this digest are included in Appendix 5, Figure A5.4.

6.9.2 The results of chemical tests in the Made Ground indicate a sulphate concentration in the soil of between 60mg/l and 1600mg/l as a 2:1 water/soil extract, with pH values in the range of 7.3 to 10.6.

6.9.3 The results of chemical tests in the pyritic soils, the London Clay, indicate a sulphate concentration in the soil of between 73mg/l and 3300mg/l as a 2:1 water/soil extract, a total sulphate concentration of between 0.07% and 4.80% and total sulphur of between 0.05% and 4.40%, with pH values in the range of 8.4 to 10.0.

6.9.4 It is recommended that for conventional shallow foundations the groundwater should be regarded as mobile in the Made Ground and static in the London Clay. Localised areas of mobile groundwater are associated with the claystone beds.

6.9.5 Static groundwater is defined as ground which is permanently dry, or is relatively impermeable, that is with a coefficient of permeability of generally less than 10^{-7}m/s.

6.9.6 Characteristic values for each strata have been derived from laboratory results for pH, 2:1 water/soil extract (WS), total (acid) soluble sulphate (AS), equivalent Total Potential Sulphate (TPS) and Oxidisable Sulphate (OS), and are presented in the table below, together with Design Sulphate Class and the ACEC Class: -

Stratum	pH	WS (mg/l)	AS (%)	TPS (%)	OS (%)	Groundwater Condition	DS	AC
Made Ground	7.3	1305	N/a	N/a	N/a	Mobile	2	2
Weathered London Clay	8.4	3250	4.00	10.80	7.30	Static	4/5	3s/4s
Unweathered London Clay	8.9	550	0.12	1.20	1.08	Static	2/3	1s/2s

6.9.7 Values for OS greater than 0.30% indicate that pyrite is present and may be oxidised to sulphate where the ground is disturbed.

6.9.8 On the basis of the laboratory test results it is considered that a Design Sulphate Class for concrete located in the Made Ground may be taken as DS-2 with an ACEC class of AC-2.

6.9.9 Where shallow foundations are taken into the pyritic soil, the London Clay, laboratory results suggest that further oxidation of pyrite to sulphate is likely. Therefore, it is recommended that the Design Sulphate Class of DS-5 and ACEC class of AC-4s should be adopted. However where piles are the preferred foundation solution a Design Sulphate Class of DS-4 and ACEC class of AC-3s would be acceptable.

7.0 ENVIRONMENTAL RISK ASSESSMENT IN RELATION TO PROPOSED DEVELOPMENT

7.1 Contaminated Land

7.1.1 The statutory definition of contaminated land is defined in the Environmental Protection Act 1990, ref 9.17, which was introduced by the Environment Act 1995, ref 9.18, as;

- 'Land which appears to the Local Authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that –
- significant harm is being caused or there is a significant possibility of such harm being caused; or
- significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused.'

7.2 Risk Assessment

7.2.1 The definition of contaminated land is based on the principles of risk assessment. Risk is defined as a combination of:

- The probability, or frequency of exposure to a substance with the potential to cause harm, and:
- The seriousness of the consequence.

7.3 Pollutant Linkage

7.3.1 The basis of an environmental risk assessment involves identifying a 'source' of contamination, a 'pathway' along which the contamination may migrate and a 'receptor' at risk from the contamination.

7.3.2 Current legislation defines the various elements of the pollution linkage as:

- A contaminant is a substance, which is in or under the ground and which has the potential to cause harm or to cause pollution of controlled waters.
- A pathway is one or more routes through which a receptor is being exposed to, or affected by, a contaminant, or could be so affected.
- A receptor is either a living organism, an ecological system, a piece of land or property, or controlled water.

7.3.3 A pollutant linkage indicates that all three elements have been identified. The site can only be defined as 'Contaminated Land' if a pollutant linkage exists and the contamination meets the criteria in Section 7.1 above.

7.3.4 The guidance proposes a four-stage approach for the assessment of contamination and the associated risks. The four stages are listed below:

- Hazard Identification
- Hazard Assessment
- Risk Assessment
- Risk Evaluation

7.3.5 The hazard identification and hazard assessment have been based upon the Phase 1 Desk Study and formed the conceptual site model, detailed in our report, reference 51481, dated March 2010.

7.3.6 The risk assessment and evaluation stages are presented in this phase 2 interpretive report, after an intrusive ground investigation has taken place.

7.4 Risk Assessment – Human Health

7.4.1 The proposed development consists of residential flats. The risk assessment has therefore been based on guidelines for a residential end use. Should the proposed development be changed in the future then further risk assessment may be required.

7.4.2 The results of the soil analyses have been compared to the CLEA SGVs published in Environment Agency Science Reports SC050021/SR3, ref 9.19 and SC050021, ref 9.20, where available, and Generic Assessment Criteria (GAC), determined by LQM and CIEH, ref 9.21, in accordance with current legislation and guidance, as detailed in Appendix 6.

7.4.3 The guidance values used within this contamination assessment have been tabulated and are detailed within Appendix 6.

7.4.4 The results of chemical analyses have been processed in accordance with recommendations set out in the CIEH and CL:AIRE document 'Guidance on Comparing Soil Contamination Data with a Critical Concentration', ref 9.23. Where the concentrations determined on site are at or below the respective Guidance Level, they are considered not to pose a risk and are removed from further consideration, unless otherwise stated. Those contaminants with observed concentrations above the Guidance Level are detailed below:

Location	Depth (m)	Contaminant	Concentration (mg/kg)	Guidance Level (mg/kg)
BH3A	0.20	Naphthalene	5.9	3.7
		Benzo(a)anthracene	53	4.7
		Chrysene	53	8
		Benzo(b)fluoranthene	39	6.5
		Benzo(k)fluoranthene	30	9.6
		Benzo(a)pyrene	42	0.94
		Dibenzo(ah)anthracene	7.4	0.86
		Indeno (123-cd)pyrene	31	3.9
BH4	0.20	Benzo(a)anthracene	11	4.7
		Chrysene	10	8
		Benzo(b)fluoranthene	9.7	6.5
		Benzo(a)pyrene	10	0.94
		Dibenzo(ah)anthracene	1.6	0.86
		Indeno (123-cd)pyrene	6.7	3.9
TP1	0.20	Arsenic	62	32
		Lead	1000	450
		Naphthalene	3.8	3.7
		Benzo(a)anthracene	11	4.7
		Chrysene	11	8
		Benzo(b)fluoranthene	7.4	6.5
		Benzo(a)pyrene	11	0.94
		Dibenzo(ah)anthracene	1.4	0.86
		Indeno (123-cd)pyrene	5.9	3.9
TP2	0.20	Naphthalene	16	3.7
		Benzo(a)anthracene	8.3	4.7
		Chrysene	8.2	8
		Benzo(b)fluoranthene	7.6	6.5