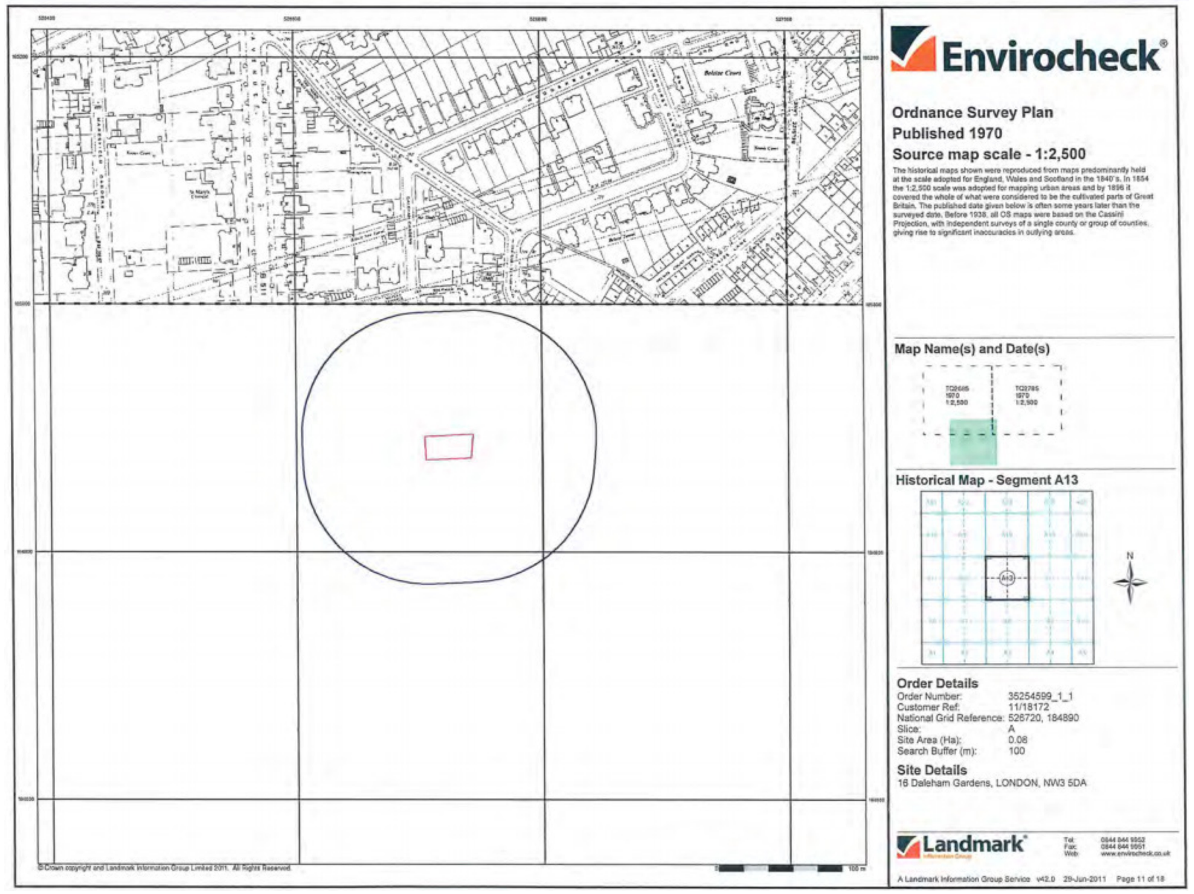
Envirocheck®
Ordnance Survey Plan
Published 1970
Source map scale - 1:2,500
The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.
Map Name(s) and Date(s)
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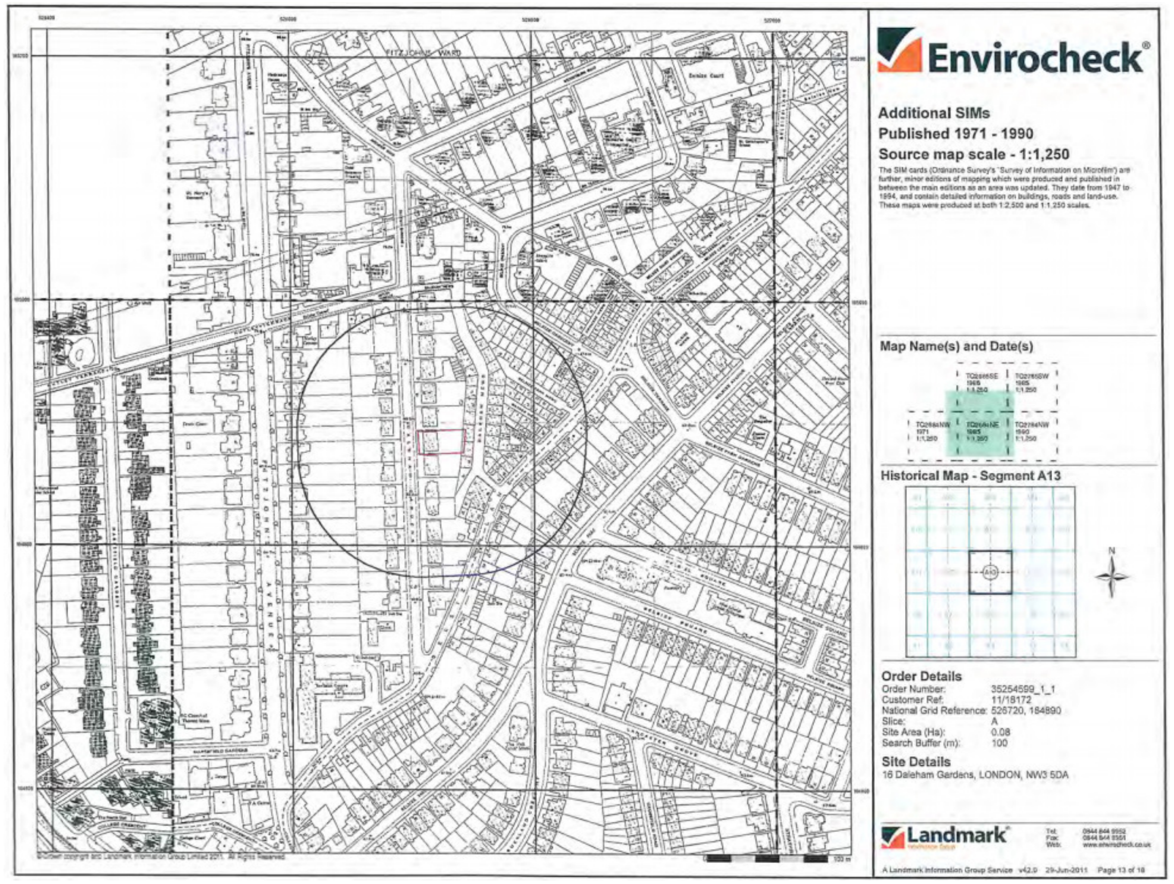
16 Daleham Gardens, LONDON, NW3 5DA
Landmark
A Landmark Information Group Service v42.0 29-Jun-2011 Page 11 of 18


Envirocheck®
Additional SIMs
Published 1971 - 1990
Source map scale - 1:1,250
The SIM cards (Ordnance Survey's "Survey of Information on Microfilm") are further, minor editions of mapping which were produced and published in between the main editions as an area was updated. They date from 1947 to 1994, and contain detailed information on buildings, roads and land-use. These maps were produced at both 1:2,500 and 1:1,250 scales.
Map Name(s) and Date(s)
Historical Map - Segment A13
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Landmark
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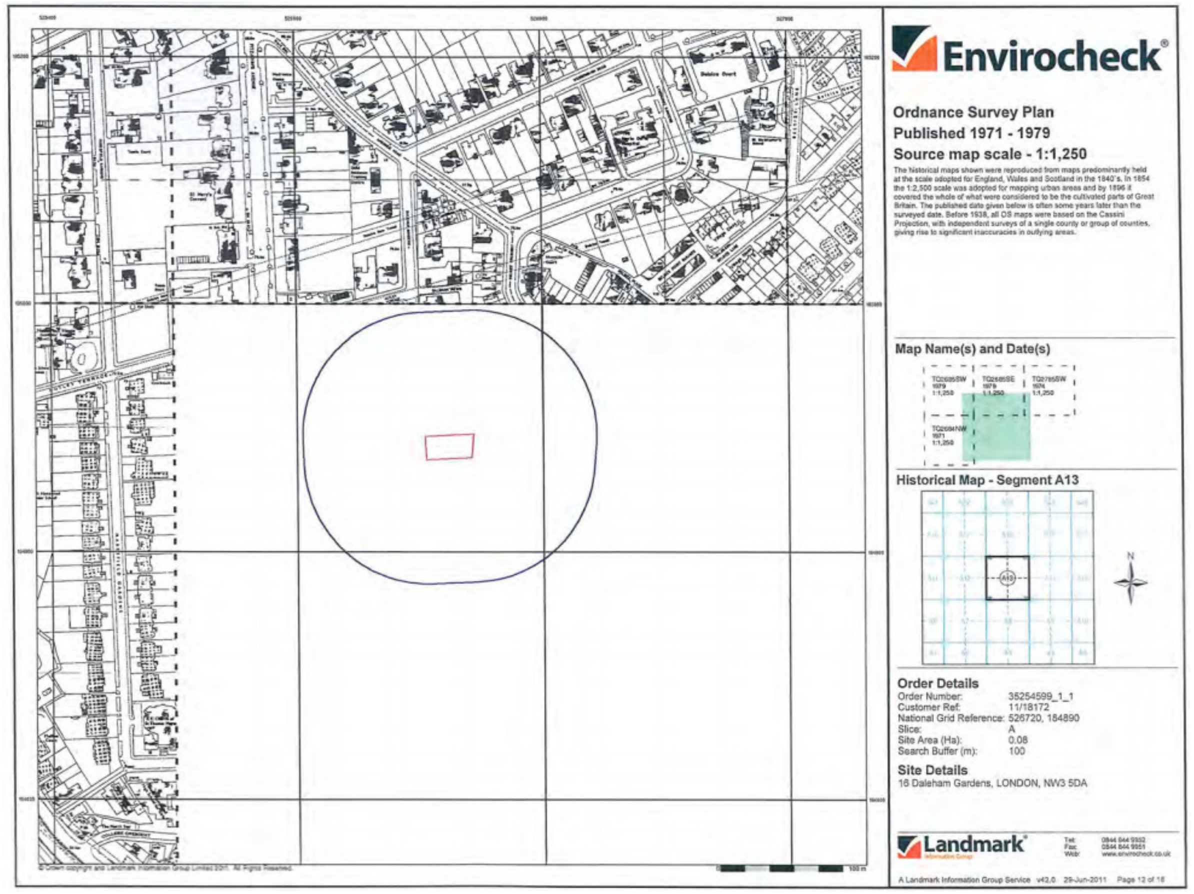
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Ordnance Survey Plan
Published 1971 - 1979
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Site Details
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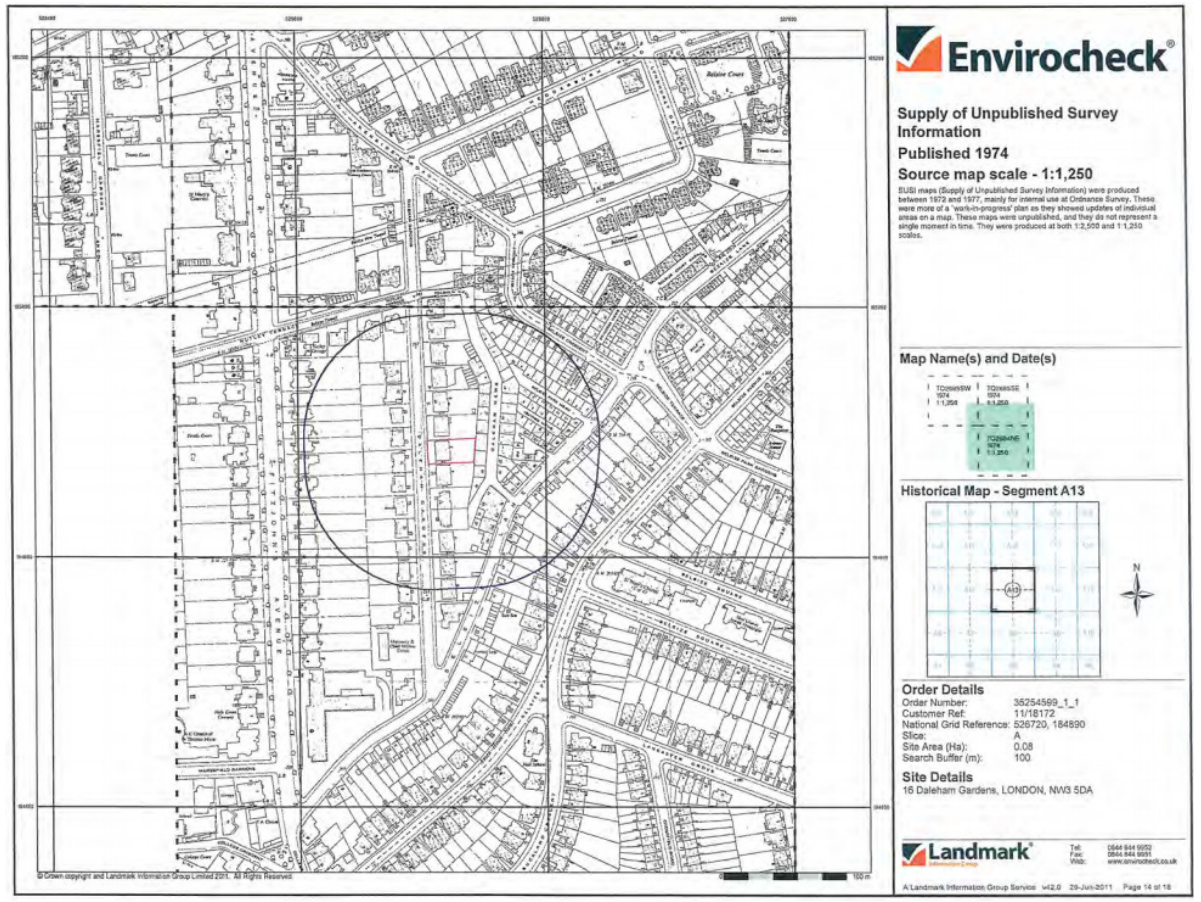
Landmark
A Landmark Information Group Service v42.0 29-Jun-2011 Page 12 of 18


Envirocheck®
Supply of Unpublished Survey Information
Published 1974
Source map scale - 1:1,250
SUSI maps (Supply of Unpublished Survey Information) were produced between 1972 and 1977, mainly for internal use at Ordnance Survey. These were more of a 'work-in-progress' plan as they showed updates of individual areas on a map. These maps were unpublished, and they do not represent a single moment in time. They were produced at both 1:2,500 and 1:1,250 scales.
Map Name(s) and Date(s)
Historical Map - Segment A13
Order Details
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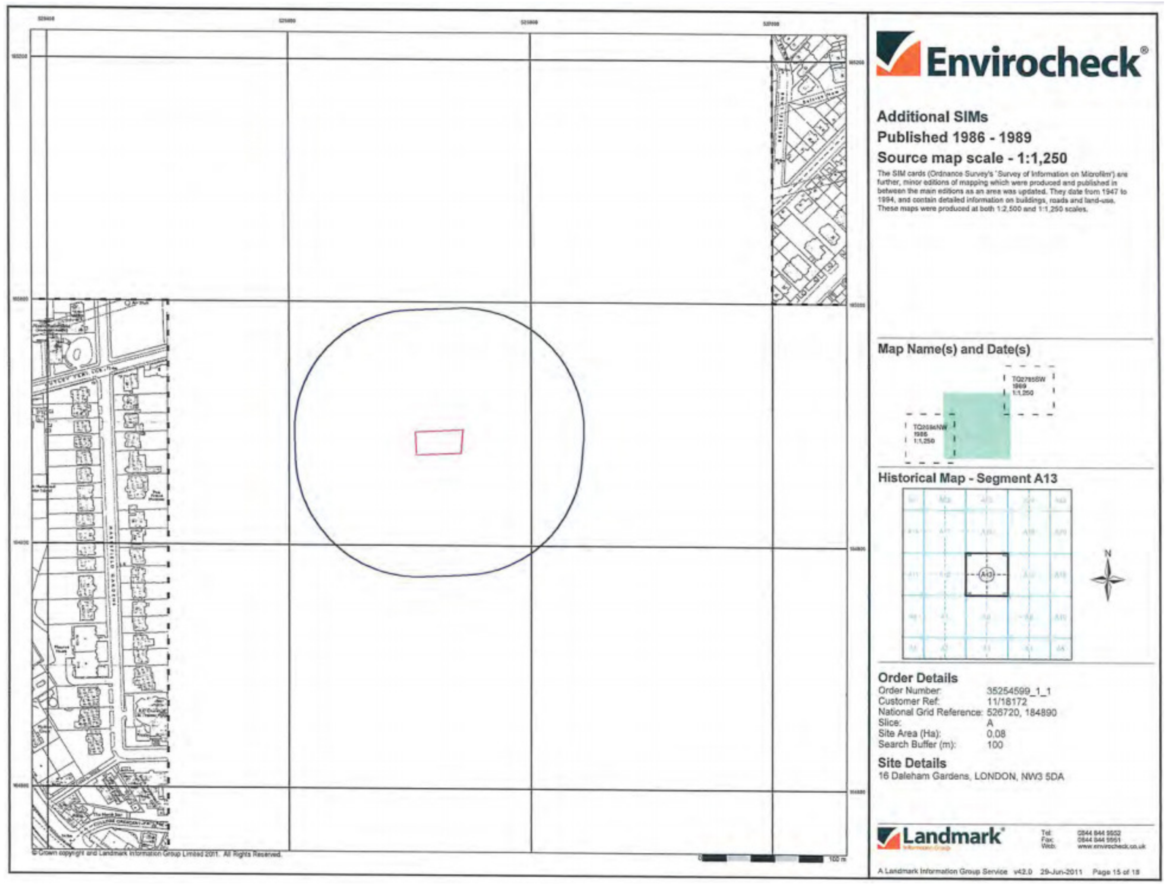
Envirocheck®
Additional SIMs
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Map Name(s) and Date(s)
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TQ2684NW 1986 1:1,250
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A13
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Order Details
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Customer Ref: 11/18172
National Grid Reference: 526720, 184890
Slice: A
Site Area (Ha): 0.08
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Site Details
16 Daleham Gardens, LONDON, NW3 5DA
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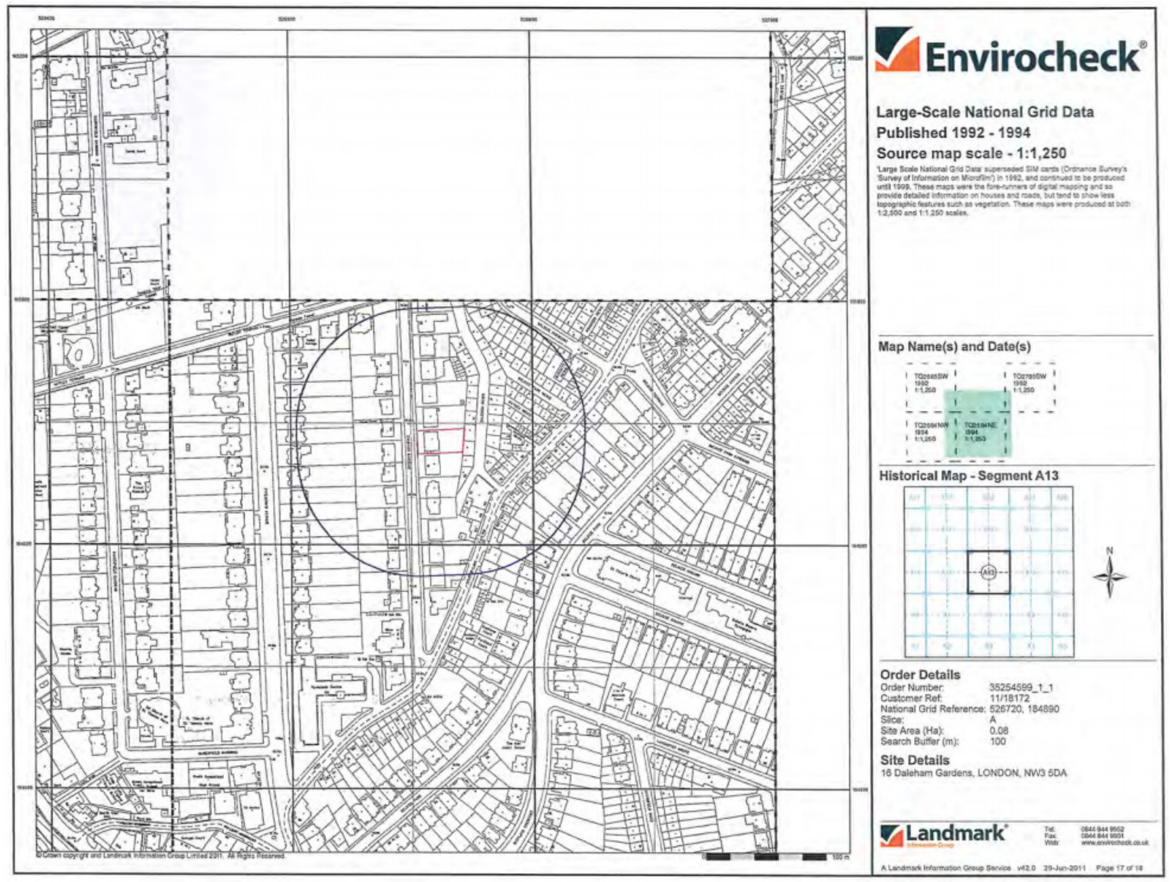
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk
A Landmark Information Group Service v42.0 29-Jun-2011 Page 15 of 18


Envirocheck®
Large-Scale National Grid Data
Published 1992 - 1994
Source map scale - 1:1,250
'Large Scale National Grid Data' superseded SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') in 1992, and continued to be produced until 1999. These maps were the fore-runners of digital mapping and so provide detailed information on houses and roads, but tend to show less topographic features such as vegetation. These maps were produced at both 1:2,500 and 1:1,250 scales.
Map Name(s) and Date(s)
TQ2685SW 1992 1:1,250
TQ2785SW 1992 1:1,250
TQ2684NW 1994 1:1,250
TQ2684NE 1994 1:1,250
Historical Map - Segment A13
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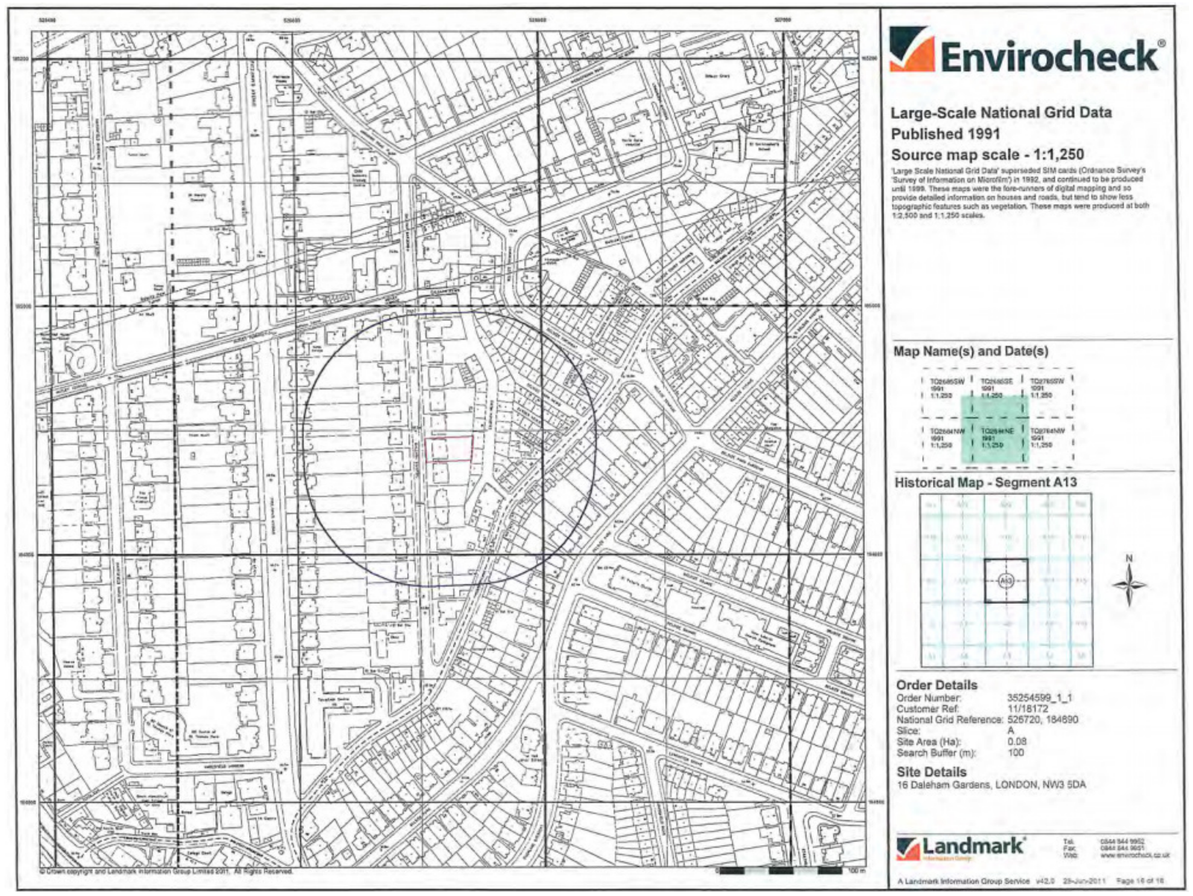
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Large-Scale National Grid Data
Published 1991
Source map scale - 1:1,250
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Map Name(s) and Date(s)
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TQ2684NW 1991 1:1,250
TQ2684NE 1991 1:1,250
TQ2784NW 1991 1:1,250
Historical Map - Segment A13
A13
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Order Details
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Customer Ref: 11/18172
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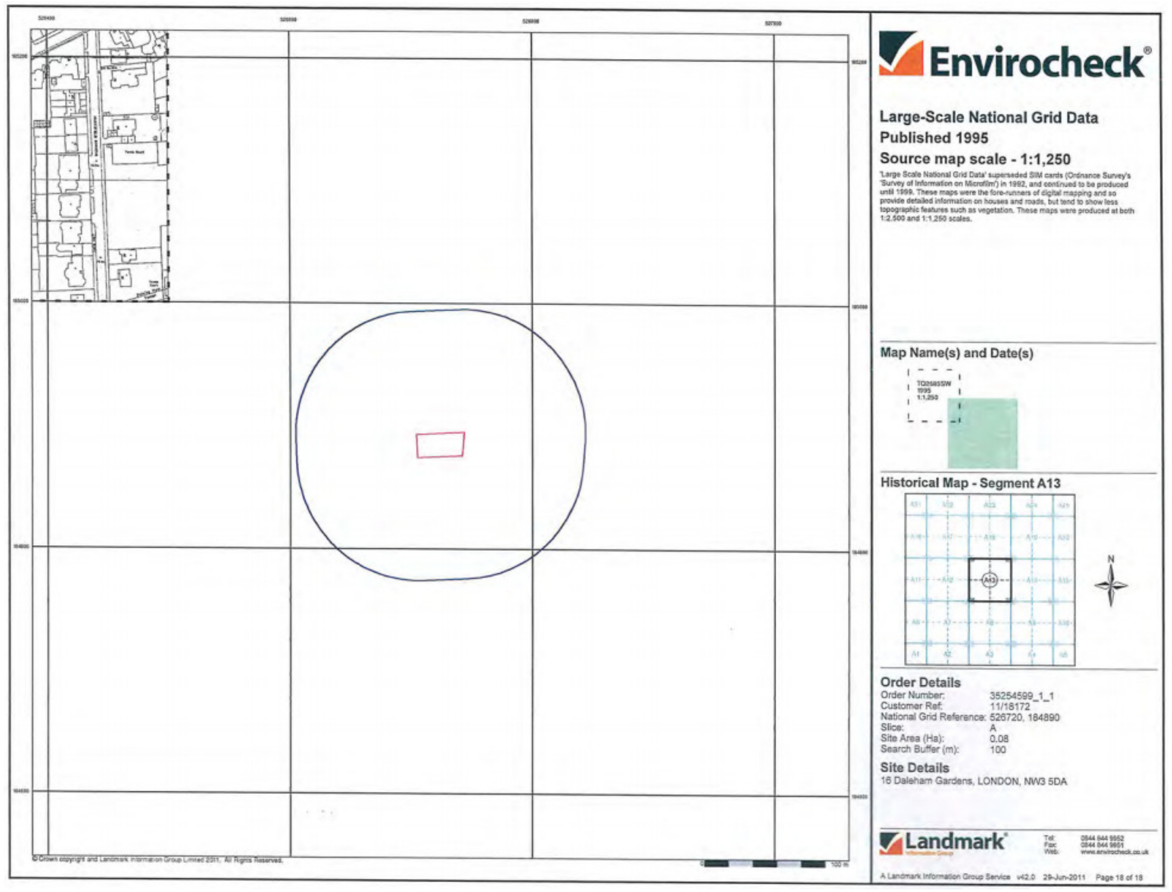
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Large-Scale National Grid Data
Published 1995
Source map scale - 1:1,250
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2.0 Ground Investigation Report

Site Analytical Services Ltd.

Site Investigations, Analytical & Environmental Chemists, Laboratory Testing Services.

Units 14 + 15, River Road Business Park,
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Your Ref:

Our Ref: **11/18172**
August 2011

16 DALEHAM GARDENS

LONDON, NW3 5DA

REPORT ON A GROUND INVESTIGATION

Prepared for

Elliott Wood Partnership LLP Consulting Engineers

Acting on behalf of

Mr Chris Holm

Reg Office: Units 14 + 15, River Road Business Park,
33 River Road, Barking, Essex IG11 0EA
Business Reg. No. 2255616

Site Analytical Services Ltd.

Ref: 10/18172
August 2011

Report on a Ground Investigation

At

16 Daleham Gardens, Belsize Park, London, NW3 5DA

For

Elliott Wood Partnership

1.0 INTRODUCTION

At the request of the Elliott Wood Partnership, Consulting Engineers, acting on behalf of the house owner Mr Chris Holm, a ground investigation was carried out in connection with a proposed basement development at the above site. A Phase 1 Preliminary Risk Assessment was presented under separate cover in a Site Analytical Services Limited report (Project No. 11/18172-1) dated August 2011.

The information was required for the design and construction of foundations and infrastructure for a refurbishment of the upper floors and lowering the existing part basement of the property. It is envisaged that the excavation for the new basement will be a mixture of secant piled retaining walls and underpinning to the existing walls. Information was also required to assess whether any remediation was required for the protection of the end-user from the presence of potential contamination within the soils encountered.

The recommendations and comments given in this report are based on the ground conditions encountered in the exploratory holes made during the investigation and the results of the tests made in the field and the laboratory. It must be noted that there may be special conditions prevailing at the site remote from the exploratory hole locations which have not been disclosed by the investigation and which have not been taken into account in the report. No liability can be accepted for any such conditions.

This report does not constitute a full environmental audit of either the site or its immediate environs.

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2.0 THE SITE AND LOCAL GEOLOGY

(National Grid Reference: TQ 267 848)

2.1 Site Description

The site is situated on the east side of Daleham Gardens in the Belsize Park area of London, NW3 5DA. The site is currently occupied by a large four-storey unoccupied residential property with a rear garden at a lower level.

The site is surrounded by large detached residential houses along both sides of Daleham Gardens and the general area is mainly residential in nature, although there is a health clinic and the Tavistock Centre approximately 120m south of the site.

The site comprises of a large unoccupied four-storey detached house with three-stories evident at the front and a part basement or lower ground floor at the rear. There is a small overgrown front garden with access paths to the front door and side access to the rear at the north end, as well as a limited drive leading to a single-storey side garage at the south end. The rear garden is relatively large and comprises of an overgrown lawn with a gazebo in the north-east corner and shrubbery adjacent to the house.

The garden is bounded on the east side by a high brick wall and by close board fencing to the north and south.

The site lies on ground sloping down to the south and east towards Swiss Cottage and has considerable amounts of vegetation. The rear garden is surrounded by mature trees with a large tree close to the house and overgrown bushes along the rear of the house where a narrow path is present. A row of small trees is present along the western boundary behind a low brick wall adjacent to Daleham Gardens.

2.2 Geology

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area (Sheet 256, 'North London', Solid and Drift Edition) indicates the site to be underlain by Superficial Head deposits overlying the London Clay Formation.

3.0 SCOPE OF WORK

3.1 General

The scope of the investigation was agreed by the Consulting Engineers and comprised:

- The drilling of three cable percussive boreholes to a depth of 20m below ground level, using a specialist demountable cut down drilling rig.

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- The placement of a gas and groundwater monitoring standpipe to a depth of 5m below ground level in each of the boreholes (Boreholes 1, 2 and 3).
- The drilling of six continuous flight auger boreholes to a depth of 5m below ground level (CFA 1 to CFA 6 inclusive).
- The excavation by hand of three trial pits to depths of up to 1.20m below ground level, two to expose the existing foundations of the building, confirm the near surface soil conditions and obtain further samples for laboratory testing together with a further trial pit to attempt to locate an underground sewer (Trial Pit 3).
- Sampling and in-situ testing as appropriate to the ground conditions encountered in the boreholes and trial pits.
- Interpretative reporting on foundation options for the proposed building works and infrastructure.
- A study into the possibility of the presence of toxic substances in the soil, together with limited comment on any remediation required and Waste Acceptance Criteria (WAC) analysis in order to classify soils for disposal purposes.

3.2 Ground Conditions

The locations of the boreholes and trial pits are shown on the site sketch plan (Figure 1).

The exploratory holes revealed ground conditions that were generally consistent with the geological records and known history of the area and comprised between 0.25m and 1.60m thickness of made ground locally overlying a thin layer of Superficial Head Deposits followed by materials typical of the London Clay Formation.

For detailed information on the ground conditions encountered in the borehole and trial pits, reference should be made to the exploratory hole records presented in Appendix A.

The made ground extended down to respective depths of 0.80m, 0.45m, 1.60m, 0.60m, 0.50m, 0.50m, 0.50m, 0.50m and 1.50m below ground level in Boreholes 1, 2 and 3 and CFA 1 to CFA 6 inclusive and to respective depths of 0.28m, 0.25m and 1.50m below ground level in Trial Pits 1 and 2 and 3. The thickest development of made ground was at the front of the house where the ground had been built up to form a level access from Daleham Gardens.

The made ground generally consisted of a surface layer of grass covered topsoil or, in the case of Trial Pits 1, 2 and 3, concrete set on compacted brick rubble generally underlain by a heterogeneous mixture of silty sand, stiff sandy clay, occasional fine to medium flint gravel, ashes, brick rubble and concrete fragments. Roots up to 10mm in diameter were noted within the made ground in CFA 1, 4, 5 and 6.

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The underlying natural material in CFA 1, CFA 2, CFA 3, CFA 4 and CFA 5 consisted of firm mottled sandy silty clay with occasional fine to medium flint gravel up to 0.30m in thickness, although this stratum was absent in the remaining exploratory holes. These materials are typical of Superficial Head Deposits and extended down to a maximum depth of 0.90m below existing ground level. Roots up to 3mm in diameter were noted within these deposits.

The head deposits, where present, were underlain by firm becoming stiff and then very stiff mottled silty clay with occasional partings of silty fine sand and occasional small gypsum crystals. These deposits represent weathered London Clay and extended to respective depths of 8.50m, 7.70m and 9.50m below ground level in Boreholes 1, 2 and 3 and to the full depths of investigation of 5.00m below ground level in CFA 1 to CFA 6 inclusive.

The underlying material comprised of very stiff fissured silty clay with occasional partings of silty fine sand, occasional weak claystone nodules and scattered small gypsum crystals. These materials are typical of the more competent unweathered London Clay Formation and extended down to the full depths of investigation of 20.0m below ground level in Boreholes 1, 2 and 3.

3.3 Groundwater

Groundwater was not encountered in any of the exploratory holes during boring and excavation and the material remained essentially dry throughout.

It must be noted that the speed of excavation and boring is such that there may well be insufficient time for light seepages of groundwater to enter the boreholes and trial pits and hence be detected, particularly within more cohesive soils of low permeability.

Groundwater was subsequently recorded at respective depths of 4.96m, 4.92m and 4.95m below ground level in the monitoring standpipes installed in Boreholes 1, 2 and 3 after a period of approximately three weeks but was not encountered in the final monitoring visit, approximately four weeks post site works, above a depth of 5m below ground level.

Isolated pockets of groundwater may be present perched within any less permeable material found at shallower depth on other parts of the site especially within any made ground.

It should be noted that the comments on groundwater conditions are based on observations made at the time of the investigation (June, July and August 2011) and that changes in the groundwater level could occur due to seasonal effects and also changes in drainage conditions.

3.4 Existing Foundations and services

Trial Pits 1 and 2 were excavated internally adjacent to the flank walls of the property in order to expose the existing foundations and founding stratum.

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Trial Pit 3 was excavated along the access road in order to determine the depth of an existing drain which runs along this area of the site. Whilst the pit was excavated to 1.50m below ground level, six hand augers were made along the course of the pit to depths of 2.60m to determine the depth of the drain. However, the drain was not encountered during the works and further testing in the form of ground penetration radar and CCTV survey work is recommended.

The locations of the trial pits are shown on the site sketch plan (Figure 1) and sketches of the foundations exposed in the trial pits and other pertinent details are presented on Figures 2, 3 and 4.

4.0 IN-SITU AND LABORATORY TESTS

4.1 Standard Penetration Tests

The results of the Standard Penetration Tests carried out in the natural soils (London Clay) are shown on the exploratory hole records in Appendix A. SPT 'N' values range between 8 and 40 with a gradual increase in 'N' value with depth being apparent. Based on the methods outlined by Stroud and Butler (1975) the results indicate the London Clay to be of a firm becoming stiff consistency to depths of between 3.00m and 4.00m and then of a stiff consistency to a depth of about 17.0m below ground level and then very stiff material was encountered.

The correlation between SPT 'N' value and measured cohesion is generally taken as a multiplier of between 4.5 and 5 on the SPT 'N' value according to Stroud and Butler (1975) and has generally proved to be reliable.

The results of the tests are shown on the appropriate borehole records and summary sheet presented in Appendix A.

4.2 Undrained Triaxial Test Results

Quick Undrained Triaxial Tests were made on twenty selected undisturbed 100mm diameter samples taken from the natural cohesive materials encountered in Boreholes 1, 2 and 3. The results show the samples tested to be of a stiff becoming very stiff consistency with increasing depth below ground level.

The results of the tests are presented on Tables 1 and 1a, contained in Appendix B.

4.3 In-Situ Mackintosh Probe and Shear Vane Tests

In the natural cohesive soils encountered in CFA 1 to CFA 6 inclusive at the site, in-situ shear vane tests were made at regular depth intervals in order to assess the undrained shear strength of the material and indicated that it was of a firm becoming stiff and then stiff to very stiff consistency with increasing depth below ground level.

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In the made ground encountered in CFA 6, a Mackintosh Probe test was made in order to assess the relative density or undrained shear strength of the material based on the normally accepted correlation as follows:

Mackintosh N75 X 0.38 = SPT 'N' Value

or

Mackintosh N300 X 0.1 = SPT 'N' Value

The results of the in-situ tests are shown on the appropriate exploratory hole records contained in Appendix A.

4.4 Classification Tests

Atterberg Limit tests were conducted on twelve selected samples taken from the cohesive natural soils encountered at shallow depth in the boreholes and showed the samples tested to fall into Classes CH and CV according to the British Soil Classification System.

These are fine grained sometimes sandy silty clay soils of high and very high plasticity and as such generally have moderate bearing and settlement characteristics, have a low permeability and a generally high susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2. The results indicated Plasticity Index values between 35% and 55%, with ten of the samples being at or above the 40% boundary between soils assessed as medium swelling and shrinkage potential and those assessed as high swelling and shrinkage potential and the other two samples falling just below this boundary and being assessed as being of medium swelling and shrinkage potential (20-40%).

The test results are given in Table 2, contained in Appendix B.

4.5 Sulphate and pH Analyses

The results of the sulphate and pH analyses made on five natural soil samples selected to be close to anticipated foundation level and to give a range of depth are presented on Table 3, whilst further results are contained within the contamination analyses, both contained in Appendix B. The results show the natural soil samples to have water soluble sulphate contents of up to 2.28g/litre associated with near neutral pH values and the samples of made ground to have water soluble sulphate contents of up to 0.52g/litre, associated with near neutral to slightly alkaline pH values.

4.6 In-situ Falling Head Permeability or Soakage Tests

In order to assess the soil infiltration characteristics of the natural superficial soils at the site, in-situ falling head permeability tests were carried out in Boreholes CFA 3 and CFA 4 using a combination of the methods detailed in Building Research Establishment Digest 365:1991 and British Standard 5930:1981. The results of the tests are given on Tables 5 and 5a contained in Appendix B.

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4.7 California Bearing Ratio Tests

Two California Bearing Ratio tests (CBR) were conducted in the laboratory on samples taken at depths of 0.50m below ground level from Boreholes BH3 and CFA 6 using the methods outlined in British Standard BS 1377 : Part 4 : 1990, Clause 7. The CBR method is essentially an empirical method of flexible pavement design in which a design curve is used to estimate pavement thickness appropriate to the CBR value of the soil.

The results of the tests are contained in Appendix B and indicate CBR values ranging from 8.3% to 35%.

5.0 CONTAMINATION TESTING

5.1 General

Samples were obtained from 0.25m below ground level in Boreholes CFA 2, CFA 3 and CFA 5, from 0.50m depth below ground level in Boreholes 1, CFA 1, CFA 4 and CFA 6 and from 1.20m depth below ground level in Borehole 3. The locations of the exploratory holes are detailed on the site sketch plan (Figure 1). Samples were analysed from this depth below ground level as it is felt that these soils will be representative of those of highest end-user exposure through the dermal contact, dust inhalation and soil ingestion pathways. Samples for Waste Acceptance Criteria testing were analysed from 1.00m depth in Borehole 1 and from 0.50m depth in Borehole 2 on-site.

5.2 Interpretation of Findings

The hazard caused by the presence of a substance or element is not absolute but depends on the proposed end use of the site.

It is understood that the site is to be developed for residential purposes and as such the Soil Guideline Values for residential use have been used in the following soil assessment.

Site data has been assessed against current generic assessment criteria (GAC) / guideline values in accordance with current industry practice and statutory guidance; chemical toxicology (TOX), Soil Guideline Value (SGV) reports developed using the new Contaminated Land Exposure Assessment (CLEAv1.06) framework and CLR 11 (Environment Agency, 2009).

However, it must be remembered that GAC are not binding standards but can be useful in forming judgements regarding the level of risk i.e. unacceptable or acceptable. Exceedance of GAC does not automatically result in the requirement for remedial / risk management work but would warrant further assessment.

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5.3 Soil Guideline Values, CLR Documents & Chartered Institute of Environmental Health Values

From January 2009 revised Soil Guidance Values for certain contaminants were issued in the Contaminated Land Reports (CLR) by the Environment Agency in conjunction with Department of the Environment, Food, Agriculture and Rural Affairs. These values and the CLEA methodology used to derive them have superseded CLEA and TOX reports for soil contaminants.

The CLR Documents are a series of contaminated land guidance documents developed by various past and present government agencies involved with protection of the environment.

These documents aim to provide a set of generic Soil Guideline Values and a site specific modelling programme based upon tolerable predicted uptakes from experimental data for a variety of common industrial toxic contaminants. In instances of carcinogenic and mutanagenic substances the guideline values are set on the basis of "As Low As Reasonably Practicable" (ALARP), as theoretically mutation can occur on exposure to a single particle of the contaminant.

At the time of writing this report generic soil guideline values are only in place for Selenium (350mg/kg), Nickel (130mg/kg), Mercury (1-170mg/kg), Inorganic Arsenic (32mg/kg), Benzene (0.33mg/kg), Ethylbenzene (350mg/kg), Xylenes (230-250mg/kg), Toluene (610mg/kg), Cadmium (10mg/kg) and Phenols (420mg/kg) - for a residential scenario.

The Environment Agency has also released a new version of the CLEA software and its handbook to help assessors estimate risks. The Chartered Institute of Environmental Health Generic Assessment Criteria for Human Health Risk Assessment adopt the Environment Agency's CLEA UK (Beta) Model and as such have derived guideline values that are compatible with current English legislation, policy and technical guidance.

Generic Assessment Criteria for Human Health Risk Assessment for Chromium compounds have been produced by Chartered Institute of Environmental Health. These are Trivalent Chromium (Chromium III) at 627mg/kg and Hexavalent Chromium (Chromium VI) at 4.3mg/kg for a residential scenario.

Assessment criteria for selected individual Polycyclic Aromatic Hydrocarbons have been produced by Chartered Institute of Environmental Health; however no values have been attached to Total Polycyclic Aromatic Hydrocarbons. Sixteen individual Polycyclic Aromatic Hydrocarbons with attached screening values include Benzo(a)pyrene (0.83-1.0mg/kg), Dibenzo(a,h)anthracene (0.76-0.90mg/kg), Fluorene (160-780mg/kg) and Naphthalene (1.5-8.7mg/kg) for a residential scenario.

The concentrations of the phytotoxic substances Total Copper, Total Zinc and Boron have been assessed against the Chartered Institute of Environmental Health Generic Assessment Criteria for Human Health Risk Assessment of 2330mg/kg, 3750mg/kg and 291mg/kg respectively which assumes a residential scenario.

The concentrations of Total Petroleum Hydrocarbons have been assessed against assessment criteria for individual Aromatic and Aliphatic carbon band ranges produced by Chartered Institute of Environmental Health for a residential scenario.

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As no generic UK derived guidance is currently available for acceptable concentrations of Total Cyanide a screening value of 20mg/kg (Thiocyanate) has been used as a preliminary screening tool to identify where potential risks may exist.

As no generic UK derived guidance is currently available for acceptable concentrations of Total Lead a previous Soil Guideline Value of 450mg/kg for residential land use has been used to identify where potential risks may exist.

As described in Using Soil Guideline Values – Environment Agency 2009, chemical data from the analysis of samples generated during the intrusive investigation have been used to create a data set for the site. The entire data set, as opposed to individual results has been analysed on the assumption that the samples from the site investigation are to some degree representative of the contaminant concentration throughout the area or volume of soil investigated. The most appropriate method for assessing a given dataset is dependent upon a range of specific factors together with the quantity and quality of the data generated.

In accordance with the recommendations provided within Guidance on comparing soil contamination data with a critical concentration – CIEH/CL:AIRE, 2008, we have selected the one sample t-test at a 95% confidence level as the most appropriate statistical tool for generating site representative soil concentration values and have assumed that the data is normally distributed. We have assumed that this statistical test is required to draw conclusions about the condition of the land under scrutiny as part of a planning scenario as opposed to the Part 2A scenario. Under a planning scenario, comparison is made between a value larger than the sample mean, in this case the Upper Confidence Limit and the critical concentration.

In instances where the Upper Confidence Limit exceeded the given critical value, then the Grubbs Test has been used to identify upper outliers to assess whether the highest vale belongs to the general population of the dataset or is representative of an outlier.

5.4 Assessment of Soil Analyses

It is understood that the site is to be developed for residential purposes and as such the Soil Guideline Values for residential use have been used in the following soil assessment. The samples selected for contamination assessment were sub-contracted to i2 Analytical Limited and QTS Environmental Limited (both UKAS and MCERTS accredited laboratories) and their reports are contained in Appendix B.

5.5 Discussion

Generally, the concentrations of zootoxic heavy metals (Total Arsenic, Total Cadmium, Total Selenium and Total Nickel) encountered did not exceed the Soil Guideline Values for residential use in the samples analysed. As such there is not considered to be any potentially significant level of end-user risk associated with the concentrations of these contaminants encountered.

A marginal concentration of Total Mercury was encountered in the sample from 0.25m depth in CFA 5 at 1.6mg/kg, compared to CIEH Generic screening value of 170mg/kg for Inorganic Mercury and 1mg/kg for Elemental Mercury. It is considered that in excess of 99% of mercury encountered within soils would be within the inorganic form and as such it is not believed that the concentrations encountered would be sufficient to pose a significant risk to end-users of the site in a residential scenario.

Elevated concentrations of Total Lead were encountered in the samples from 0.25m depth in CFA 2 and from 0.25m depth in CF A5 at 840mg/kg and 460mg/kg respectively, in excess of the Soil Guideline Value for residential use of 450mg/kg. It was therefore decided to undertake statistical analysis of the data set, using the arithmetic mean and standard deviation for Lead. A particularly elevated concentration of Lead was encountered in the sample obtained from CFA 2 and an outlier test identified this as not representative of the rest of the sample population. This is indicative of a locally affected area or "hot-spot" of contamination and the soil should be treated accordingly. Following a test scenario from a planning perspective and using samples from the remainder of the site, it was concluded that the true mean of the sample population did not exceed of the CIEH Generic screening values for residential use and as such there is not anticipated to be potential risk to the end-users of the site from the concentrations encountered across the remainder of the site after the removal of the CFA 2 "hot-spot".

The concentrations of Trivalent Chromium and Hexavalent Chromium encountered did not exceed CIEH Generic screening values for residential use.

The concentrations of Total Cyanide were below the screening value of 20mg/kg and the concentrations of Total Phenol were below the Soil Guideline Value for residential use and as such there are not considered to be any significant risks to end-users of the site from these contaminants.

Elevated concentrations of Benzo(a)pyrene were encountered in the samples from 0.50m depth in CFA 1 at 1.2mg/kg and 0.25m depth in CFA 5 at 1.3mg/kg, in excess of the CIEH Generic screening value for residential use of 0.94mg/kg at 2.5% SOM. It was therefore decided to undertake statistical analysis of the data set, using the arithmetic mean and standard deviation for Benzo(a)pyrene. Following a test scenario from a planning perspective, it was concluded that the true mean of the sample population did not exceed of the CIEH Generic screening values for residential use and as such there is not anticipated to be potential risk to the end-users of the site from the concentrations encountered.

The concentrations of Petroleum Hydrocarbons encountered within individual Aromatic and Aliphatic carbon band ranges in the samples analysed did not exceed the generic screening values produced by Chartered Institute of Environmental Health for a residential scenario.

The concentrations of BTEX substances (Benzene, Toluene, Ethylbenzene and Xylenes) encountered did not exceed the Soil Guideline Values for residential use in the samples analysed. As such there is not considered to be any potentially significant level of end-user risk associated with the concentrations of these contaminants encountered.

There was no MTBE detected within the samples analysed.

The concentrations of the phytotoxic substances Total Copper, Total Zinc and Boron encountered in the samples obtained were below the CIEH Generic screening values for residential use and are not considered to be a significant risk to end-users of the site, or sufficient to impair the successful growth of plant species on site.

Concentrations of Total Sulphide did not exceed 3.3mg/kg in the samples obtained from the site. It is therefore not anticipated that sulphides will present any human health risk at the site and are not considered sufficient to affect construction or service materials.

The concentrations of Total Sulphate did not exceed the BRE guidance level of 2400mg/kg in the samples analysed. From the water soluble sulphate concentrations BRE Special Digest 1 : 2005, Tables C1 and C2 would classify the samples analysed as up to Class DS-2. As such reference should be made to the appropriate BRE Guidance documents when selecting construction materials on-site.

All samples were analysed using the 'Catwastesoil' assessment tool, which concluded that all of the samples from the site were non-hazardous in nature.

Two samples of soil (BH1 @ 1.00m and BH2 @ 0.50m) were analysed for Waste Acceptance Criteria Testing in order to classify soils for disposal purposes.

For the purpose of waste disposal, the soil samples would be classified as follows:

Borehole 1 @ 1.00m	*Inert Waste*
Borehole 2 @ 0.50m	*Inert Waste*

5.6 Conclusions

Overall the contaminant of concern with respect to end-user protection which was encountered at the site was a "hot-spot" of elevated Lead encountered in the sample from 0.25m depth in CFA 2 on-site. There remains the potential for some level of end-user risk posed by the concentrations of contaminants encountered.

Remedial measures to protect human health are considered necessary as part of the development at the site to break exposure pathways. After removal of the "hot-spot" of elevated lead in the CFA 2 location, the average site soil concentration of Total Lead will be reduced to a level below the SGV of 450mg/kg and thereby mitigating the potential end-user risk from the concentrations of contaminants encountered.

The soils which are represented by the "hot-spot" of lead contamination including CFA 2 have been delineated on the appended "Remediation Site Sketch Plan" (Figure 1a). It is considered that the remedial measures are necessary within the areas marked on the sketch plan as remediation areas.

It is anticipated that the protection of the end-user may be achieved by the following:

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Areas of proposed hardstanding within the remediation area (e.g. building footprint, roadways etc.)

In areas of permanent hardstanding such as the building footprint and roadways etc., the development itself would adequately break exposure pathways to human health and therefore further remedial measures may not be required in these areas.

Sensitive end use areas within the remediation area (garden areas, patio's etc.)

In areas of sensitive end use such as gardens, patio's etc. the materials represented by the marked remediation areas should be removed from the site to mitigate the risks to end-users and break exposure pathways. It would be recommended that the soils be excavated down to natural soils or at least 600mm and replaced with a clean cohesive fill material of at least 600mm thickness.

Any materials brought onto the site (soils and / or clay) should be validated either at source or once laid at site. Given the nature of the ground conditions, appropriate health and safety practices should be adhered to in order to protect site workers. Any waste material leaving site for off-site disposal (soil and / or water) should be handled in accordance with the current Waste Management and Duty of Care Regulations.

The above conclusions have been drawn on the results of the tests carried out on the soil samples analysed and address remediation issues for the protection of the end-user only. It is recommended that any remedial measures suggested in this report should be subject to formal approval by local Environmental Health and/or Planning Departments and approval should be obtained prior to any works being undertaken. The comments made in this report do not address any third party liability.

5.7 Gas and Groundwater Monitoring Results

The standpipes installed in Boreholes 1, 2 and 3 were monitored for gas and groundwater levels on 28th July and 2nd August 2011 and the results are presented on Table 4 and 4a, contained in Appendix B.

Groundwater was recorded at respective depths of 4.96m, 4.92m and 5.95m below ground level in the monitoring standpipes installed in Boreholes 1, 2 and 3 after a period of approximately three weeks but was not encountered in the final monitoring visit, approximately four weeks post site works.

5.7.1 Methane

Methane is a flammable asphyxiating gas, the flammable range being 5 to 15% by volume in air. If such a methane-air mixture is confined in some way and ignited it will explode. The 5% by volume concentration is termed the lower explosive limit (LEL). Methane is a buoyant gas having a density about two-thirds that of air. Carbon Dioxide is a non-flammable toxic gas, which is about 1.5 times as heavy as air.

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Various guidelines have been published to help determine mitigation measures for landfill gas. `Landfill Gas' includes gas which may be generated in natural soils such as organic alluvium peat. Methane presents an explosion and asphyxiant hazard and Carbon Dioxide an asphyxiant hazard.

Building Research Establishment Report BR212 `Construction of New Buildings on Gas-Contaminated Land', states that if Methane concentrations in the ground are unlikely to exceed 1% by volume and a house or small building is constructed in accordance with its recommendations, then no further protection is required. The recommendations include installing granular under slab venting and sealing floor slabs.

CIRIA Report C665 (2007) "Assessing risks posed by hazardous ground gases to buildings" provides guidance on the monitoring and control of landfill gas. The report suggests a classification system which is summarised in Table 8.5 in the document and employs a method which uses both gas concentrations and borehole flow rates to define a characteristic situation for a site based on the Gas Screening Value (also named the limiting borehole gas volume flow) for methane and carbon dioxide.

5.7.2 Carbon Dioxide

Building Research Establishment Report BR212 `Construction of New Buildings on Gas-Contaminated Land', 1991 states that if carbon dioxide concentrations are above 1.5% by volume then protection should be considered to prevent gas ingress. If concentrations exceed 5% by volume, such protective measures are required. This has been superseded by CIRIA Report C665 (2007), states that if carbon dioxide concentrations are above 5% by volume then protection should be considered to prevent gas ingress.

5.7.3 Carbon Monoxide

The occupational exposure standards for carbon monoxide are 30 ppm for long term exposure (8 hours calculated from the HSE Guidance Note EH40, 1991) and 200 ppm for short term exposure (15 minutes calculated from the HSE Guidance Note EH40, 1991) (CIRIA Report C665).

5.7.4 Hydrogen Sulphide

Hydrogen sulphide is toxic at low concentrations. The occupational exposure standard for hydrogen sulphide is 10 ppm for 8-hour time weighted average reference period and 15 ppm for short-term exposure (10 minutes reference period) (HSE Guidance Note EH40, 1991).

5.7.5 Results

The Gas Screening Value is calculated as follows:

The Gas Screening Value (litres of gas per hour) = maximum borehole flow rate (l/h) x maximum gas concentration (%)

On-site monitoring has shown emissions of methane in air of 0.0% and carbon dioxide in air of up to 6.7% recorded during the initial monitoring visits. The maximum borehole flow rate was 0.0 l/h.

As such the Gas Screening Value for methane at site is 0.0 l/h and the Gas Screening Value for carbon dioxide at site is also 0.0 l/h. As such the worst case value for the site would be less than 0.01 litres of gas per hour.

Carbon monoxide and Hydrogen Sulphide were not detected above the detection limits of the gas monitoring instrument in the boreholes monitored during the monitoring programme.

As such the Gas Screening Value for methane at site is 0.0 l/h and the Gas Screening Value for carbon dioxide at site is also 0.0 l/h. As such the worst case value for the site would be less than 0.01 litres of gas per hour. This typically equates to a Characteristic Situation 1; however, due to the concentration of Carbon Dioxide being in excess of 5%, it is recommended that the site be classified as Characteristic Situation 2 which requires the following precautions:

a) Reinforced concrete cast in-situ floor slab (suspended, non-suspended or raft) with at least 1200g DPM and underfloor venting

b) Beam and block or pre-cast concrete and 2000 g DPM / reinforced gas membrane and underfloor venting

All joints and penetrations sealed.

Employing the NHBC 'traffic light' characterisation system, the site would be classified as Amber 1 in accordance with CIRIA Report C665. Table 8.7 using the maximum gas concentration for carbon dioxide and which require the following precautions:

> Low to intermediate gas regime identified, which requires low-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414 (Johnson, 2001). Ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours.

For further information on design and construction details, discussions should be sought with a specialist contractor. Guidance may also be obtained from the BRE Report BR212 'Construction of New Buildings on Gas-Contaminated Land' and CIRIA Report C665 (2007). It may also be prudent to contact the local Environmental Health Officer in order to comply with the Local Authority requirements.

It is recommended that further gas monitoring is undertaken at the site in accordance with CIRIA report C665 which recommends a minimum of 6 visits for residential developments.

6.0 FOUNDATION DESIGN

6.1 General

It is proposed to carry out a refurbishment of the upper floors of the property and lower the existing part basement of the property. It is envisaged that the excavation for the new basement will be a mixture of secant piled retaining walls and underpinning to the existing walls. Exact details of the finalised structures, layout and loadings were not available at the time of preparation of this report although foundation loads for the proposed building are expected to be moderate and of the order of 100-150kN/m^2. Ground slab loadings are expected to be of the order of 10-15kN/m^2.

6.2 Conventional Spread Foundations

A result of the inherent variability of uncontrolled fill, (Made Ground) is that it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should therefore, be taken through any made ground and either into, or onto a suitable underlying natural strata of adequate bearing characteristics.

Based on the ground and groundwater conditions encountered in the boreholes, it could in theory be possible to support the proposed new development on conventional spread foundations taken down below the made ground and any weak superficial soils and placed in the stiff weathered London Clay deposits encountered at a depth of 1.30m to 3.00m below existing ground level in the boreholes.

Such foundations placed within natural soils could be designed to allowable net bearing pressures of the order of 200kN/m^2 at 2.00m depth increasing to approximately 270kN/m^2 at 3.00m depth in order to allow for a factor of safety of about three against general shear failure. The actual allowable bearing pressure applicable would depend on the form of foundation used, its geometry and depth in accordance with classical analytical methods, details of which can be obtained from "Foundation Design and Construction", Seventh Edition, 2001 by M J Tomlinson (see references) or similar texts.

In addition, foundations would need to be taken deeper where they are within the zones of influence of both the existing trees and any proposed tree planting. The depth of foundation required to avoid the zone likely to be affected by the root systems of trees is shown in the recommendations given in NHBC Standards, Chapter 4.2, April 2003, "Building near Trees" and it is considered that this document is relevant in this situation.

6.3 Piled Foundations

In the event that the use of conventional spread foundations proves either impracticable or uneconomical due to the size and depth of foundation required, a piled foundation will be required. In these ground conditions, it is considered that some form of bored and in-situ cast concrete piled foundation with reinforced concrete ground beams should prove satisfactory.

The construction of a piled foundation is a specialist activity and the advice of a reputable contractor, familiar with the type of soil and groundwater conditions encountered at this site elliottwood

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should be sought prior to finalising the foundation design. The actual pile working load will depend on the particular type of pile chosen and method of installation adopted.

To achieve the full bearing value a pile should penetrate the bearing stratum by at least five times the pile diameter.

Where piles are to be constructed in groups the bearing value of each individual pile should be reduced by a factor of about 0.8 and a calculation made to check the factor of safety against block failure.

Driven piles could also be used and would develop much higher working loads approximately 2.5 to 3 times higher than bored piles of a similar diameter at the same depth. However, the close proximity of adjacent buildings will in all probability preclude their use due to noise and vibration.

6.4 Retaining Walls

It is proposed to lower the existing basement by approximately 1m depth in the main area and 3m depth in the swimming pool area. Exact details of the structure, layout and loadings were not available at the time of preparation of this report.

The results of the investigation indicated that made ground extended to depths of 0.25m and 1.60m locally overlying a thin layer of Superficial Head Deposits followed by materials typical of the London Clay Formation.

Retaining walls should generally be designed as self-supporting cantilevered retaining walls. The excavations for a basement must not affect the integrity of adjacent structures and therefore will need to be supported. Two forms of support could be considered, these being temporary works i.e. sheet piling which could be removed after the earth retaining walls have been constructed or as permanent works incorporated into the final design.

Generally, cantilevered piled walls have an open face to embedded ratio of about one to two, i.e. a supported face three metres in height would require a penetration into the ground of about six metres below the base of the excavation. Should the piled retaining wall be purely an unsupported cantilever, then it is likely that quite deep section sheet piles or large diameter bored piles would be required.

The section of the sheet or the diameter of the piles could be reduced by installing a braced waling to the wall. Piles placed as part of the permanent works would be propped by the roof to the basement and would not be acting purely as a cantilevered support in the long term.

To reduce the likelihood of loss of ground if a sheet piled wall was adopted when removing the sheets, it is considered that the sheet piles should be incorporated into the final wall design. Assuming that the earth retaining wall will be propped, i.e. have its base slab and first floor slab cast in place soon after excavation, it is unlikely that full if any earth pressures will act on the wall while it is not propped. The greatest force acting on the wall, in the short term, is likely to be from the hydrostatic head should water percolate and be retained to the rear of the earth retaining structure.

The design parameters for each element of soil recorded in the relevant exploratory holes are provided in Table A below. The depth of pile penetration can be calculated once structural details of the proposed basement are known.

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Founding Material	Depth to top (m)	Description	Angle of Shearing Resistance (degrees) (Φ)[1]	Coefficient active pressure (Ka)	Coefficient passive resistance (Kp)	Presumed Safe Bearing Capacity qS (kPa)[2]
Head Deposits	0.50 to 0.60	Firm sandy silty CLAY with gravel and roots	23	0.4	2.2	100-150kPa
Weathered London Clay	0.25 to 1.60	Firm becoming stiff and then very stiff silty CLAY	22	0.5	2.1	200-250kPa
London Clay	7.70 to 9.50	Very stiff silty CLAY	21	0.45	2.2	250-300kPa

Table A. Summary of design parameters for proposed basement foundation

Notes:

1. Calculated using guidance from BS8002
2. As the depth and structural details of the proposed basement are unknown these values should be used as guidance only.

The main phase of uplift or heave will come immediately following the excavation of the basement when the greatest elastic rebound of the soil (caused by the loss of the overburden pressure) will occur. Heave can be reduced by proceeding with the excavation in stages and observing and recording any movement that occurs over a set period of time. It may therefore be advantageous to delay the construction until an adequate proportion of the uplift has occurred. Once this monitoring period has elapsed and a suitably qualified engineer is confident that the majority of uplift has occurred, basement construction can commence.

Should a basement raft foundation be adopted, then there is also a potential for some total and differential settlement and consequently the foundation should be constructed on a 300mm thick proof rolled layer of gap graded granular fill and be of a sufficient stiffness to be capable of allowing for a minimum of two linear metres loss of support. Any service entry and exit points should be designed to accommodate settlement by the use of sealed flexible joints.

These processes and other ways of dealing with ground movements are described at length in BS8004 (British Standard Code of Practice for Foundations).

6.5 Basement Floor Slab

Due to the potential for swelling within the natural cohesive soils it is recommended that the ground slabs should be designed as being fully suspended.

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6.6 Excavations

Shallow excavations for foundations and services are likely to require nominal side support in the short term and groundwater is unlikely to be encountered in significant quantities once any accumulated surface water within the made ground has been removed. Deeper and longer excavations below approximately 1.0m below existing ground level will require close side support and some inflows of groundwater are likely to be encountered.

No particular difficulties are envisaged in removing such water by conventional internal pumping methods from open sumps.

Normal safety precautions should be taken if excavations are to be entered.

6.7 Pavement Design

The results of the laboratory California Bearing Ratio tests made on samples taken at a depth of about 0.50m indicate CBR values of between 8.3% and 35%. A study of the borehole records indicates that essentially cohesive soil is likely to be encountered at formation level.

According to the Transport and Road Research Laboratory Road Note 29, the estimated laboratory CBR value for a heavy clay with a Plasticity Index of 40% and a groundwater level greater than 600mm below formation level is 3%. The estimated CBR Equilibrium Suction Index, from Table C1 of the TRRL Laboratory Report 1132, for similar material is also given as 3% for the average construction conditions indicated by the exploratory hole records.

Although an overall design CBR value of more than 8% is indicated by the laboratory test results, the CBR value does not predict the long-term differential settlements that may occur in the made ground and it is therefore recommended that a lower value of 3% be adopted at the site as given in the standard tables detailed above.

Any soft or loose layers encountered in otherwise competent formations should be removed and replaced with well compacted imported granular fill.

The engineering characteristics of any clayey and silty soils at shallow depth are particularly sensitive to changes in soil moisture content and will soften considerably when exposed to free water. It should therefore be prudent to programme pavement construction for the dry summer months.

6.8 Soakaway Design

The results of the in-situ permeability or soakage tests indicate an average soil infiltration rate of about 3 x 10^{-8}m/sec.

The soil infiltration rate given above lies within the range of published data for weathered and fissured clays and is classed as very low permeability material and of poor drainage characteristics.

The results of the test indicated that the soil infiltration rate was low and near surface conventional soakaways will not prove entirely satisfactory at the site. Should they be

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adopted then they should be designed in accordance with the recommendations of Building Research Establishment Digest 365:1991.

6.9 Chemical Attack on Buried Concrete

The results of the chemical analyses show the natural soil samples to have water soluble sulphate contents of up to 2.28g/litre associated with near neutral pH values and the samples of made ground to have water soluble sulphate contents of up to 0.52g/litre associated with near neutral to slightly alkaline pH values.

In these conditions, it is considered that deterioration of buried concrete due to sulphate or acid attack is likely to occur unless precautions are taken. The final design of buried concrete according to Tables C1 and C2 of BRE Special Digest 1:2005 should be in accordance with Class DS-3 conditions.

In addition, segregations of gypsum were noted within the London Clay and scattered small gypsum crystals were also noted at depth. Consequently, it is considered that any buried concrete at depth may be attacked by such sulphates in solution and that it would be prudent to design any such deep buried concrete in accordance with full Class DS-3 conditions.

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REFERENCES

1. Beckett M.J. and Sims D.L. (1984). "The Development of Contaminated Land", Symposium on Hazardous Waste Disposal and the Re-use of Contaminated Land. Society of Chemical Industry.
2. British Standards Institution, 2001. Investigation of Potentially Contaminated Sites - Code of Practice, BS 10175, BSI, London
3. British Standards Institution, 1986. Code of practice for foundations, BS 8004, BSI, London.
4. British Standards Institution, 1990. Methods for test for soils for civil engineering purposes, BS1377, BSI, London
5. British Standards Institution, 1994. Code of practice for earth retaining structures, BS8002, BSI, London
6. British Standards Institution, 2007. Code of Practice for Site Investigations, BS5930, BSI, London
7. Building Research Establishment Special Digest 1, 2005, "Concrete in Aggressive Ground – Third Edition."
8. CIEH/CL:AIRE, 2008. Guidance on comparing soil contamination data with a critical concentration. London: Chartered Institute of Environmental Health.
9. DEFRA and Environment Agency, 2004. Model procedures for the management of land contamination. Contaminated Land Report 11. Bristol: Environment Agency.
10. DEFRA, 2006b. Environmental Protection Act 1990: Part 2A. Contaminated Land. Defra Circular 01/2006. London: Department for Environment, Food and Rural Affairs.
11. DEFRA, 2008a. Improvements to contaminated land guidance. Outcome of the "Way Forward" exercise on soil guideline values. Defra: Department for Environment, Food and Rural Affairs.
12. DEFRA, 2008b. Guidance on the legal definition of contaminated land. London: Department for Environment, Food and Rural Affairs.
13. Driscoll, R (1983) "The influence of vegetation on the shrinking and swelling of clay soils in Great Britain", Geo-technique 33, 93-107

Site Analytical Services Ltd.

14. Environment Agency, 2000a. Secondary model procedure for the development of appropriate soil sampling strategies for land contamination. R&D Technical Report P5-066/TR. Bristol: Environment Agency.
15. Environment Agency, 2000b. Technical aspects of site investigation, Volumes 1 and 2. R&D Technical Report P5-065/TR. Bristol: Environment Agency.
16. Environment Agency, 2005. Sampling and testing of wastes to meet landfill Waste Acceptance Criteria. Bristol: Environment Agency
17. Environment Agency, 2009a. Updated technical background to the CLEA model. Science Report SC050021/SR3. Bristol: Environment Agency.
18. Environment Agency, 2009b. Human health toxicological assessment of contaminants in soil. Science Report Final SC050021/SR2. Bristol: Environment
19. Environment Agency, 2009c. CLEA software version 1.06. Bristol: Environment Agency.
20. Environment Agency, 2009d. CLEA software (version 1.06) handbook. Science Report SC050021/SR4. Bristol: Environment Agency.
21. Eurocode 1: Actions on structures – BS EN 1991-1-1:2002: General actions – Densities, self weight and imposed loads, BSI, London
22. Nathanail C.P., McCaffrey, C., Ashmore, M.H., Cheng, Y.Y., Gillet, A., Ogden, R. & Scott, D., 2009. The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd edition). Land Quality Press, Nottingham.
23. NHBC Standards, Chapter 4.1, "Land Quality - managing ground conditions", September 1999.
24. NHBC Standards, Chapter 4.2, "Building near Trees", April 2003.
25. Stroud M.A. and Butler F.G. (1975) Symposium on the Engineering Behaviour of Glacial Materials; the Midland Soil Mechanics and Foundation Engineering Society; pgs 124 et seq.
26. Tomlinson, M J, 2001. "Foundation Design and Construction", Seventh Edition, Prentice Hall (ISBN 0-13-031180-4).