# GROUND INVESTIGATION REPORT

Tybalds Estate
Camden
London WC1

Client: Durkan Limited

Engineer: Mason Navarro Pledge

J15072

May 2015




GEA Geotechnical & Environmental Associates

## Document Control

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# EXECUTIVE SUMMARY

*This executive summary contains an overview of the key findings and conclusions. No reliance should be placed on any part of the executive summary until the whole of the report has been read. Other sections of the report may contain information that puts into context the findings that are summarised in the executive summary.*

## BRIEF

This report describes the findings of a ground investigation carried out by Geotechnical and Environmental Associates Limited (GEA) on the instructions of Mason Navarro Pledge, on behalf of Durkan Ltd, with respect to the redevelopment of the site through the construction of several two-storey to five-storey residential structures. The purpose of the investigation has been to review the previous reports carried out, to further determine the ground conditions and engineering properties of the soils, to investigate the presence of contamination and to provide information to assist with the design of suitable foundations. A desk study has previously been carried out, by Campbell Reith Consulting Engineers (Report ref 10907, dated March 2012) and a ground investigation has been carried out by Harrison Group Environmental Ltd (Report ref GL16481, dated June 2012); these are referred to within this report where appropriate.

## PREVIOUS DESK STUDY FINDINGS

The previous desk study indicated the site to have first been developed at some point before 1851, predominantly with housing and several public houses. The site is recorded as having sustained significant bomb damage during the Second World War. During the late 1940s / early 1950s seven residential blocks of five-storeys to 11-storeys were constructed in the centre and south of the site. During the 1960s, Chancellor and Babington Court, blocks of 14 storeys, were constructed in the north of the site. Historical Building Layout plans from 1958 indicate that printers and photo-printing premises were located on site. Since the redevelopment of the site in the 1960s, it has remained largely unchanged.

The desk study indicated that there are no historical or existing landfill sites, no registered waste management facilities, and no registered waste treatment or disposal sites or groundwater abstractions within 500 m of the subject site. There are no discharge consents recorded within 250 m of the site.

## GROUND CONDITIONS

A significant thickness of made ground was encountered, over Lynch Hill Gravel, which in turn was underlain by London Clay. The made ground was encountered to depths of between 1.15 m and 4.90 m and generally comprised brown or reddish brown silty gravelly sand with fragments of brick. At some locations fragments of metal, glass, ceramic pipe, wood, ash and asphalt were encountered. The underlying Lynch Hill Gravel initially comprised firm sandy slightly gravelly clay, which was found to extend to depths of between 1.55 m and 4.30 m. Brown sandy gravel was then encountered to depths of between 4.0 m and 6.2 m, and was found to be in a dense or very dense condition. This investigation encountered the top of the London Clay at one location, whilst the previous investigation found that the London Clay initially comprised firm brown becoming grey slightly silty clay to a maximum depth of 7.7 m. Thereafter stiff clay was encountered to a maximum depth of 27.70 m, which then became very stiff and was proved to the maximum depth of 35.00 m. Groundwater was encountered within the Lynch Hill Gravel at a depth of 4.50 m during drilling and has been monitored at depths of between 3.42 m and 6.58 m within the standpipes installed.

The results of contamination testing have revealed elevated concentrations of lead and PAH, including benzo(a)pyrene, within the made ground, and minor elevations of hydrocarbons in the groundwater. Asbestos fibres were identified in samples tested from across the site. Gas monitoring has not indicated elevated levels of ground gas.

## RECOMMENDATIONS

Spread foundations are unlikely to be appropriate, due to the significant thickness of made ground. Piled foundations are considered the most appropriate foundation solution, although consideration could also be given to ground improvement techniques.

A cover of imported subsoil and topsoil of 600 mm in thickness should be specified to ensure protection to end users and successful plant growth in private garden areas. Gas protection measures are not considered to be required.

# Part 1: INVESTIGATION REPORT

This section of the report details the objectives of the investigation, the work that has been carried out to meet these objectives and the results of the investigation. Interpretation of the findings is presented in Part 2.

## 1.0 INTRODUCTION

Geotechnical and Environmental Associates Limited (GEA) has been commissioned by Mason Navarro Pledge, on behalf of Durkan Ltd, to carry out a ground investigation at the Tybalds Estate, Camden, London WC1N 3JT.

Campbell Reith Consulting Engineers has previously carried out a Desk Study report (Report ref 10907, dated March 2012) and Harrison Group Environmental Ltd has previously carried out a Ground Investigation (Report ref. GL16481, dated June 2012); these reports are referred to within this report where relevant.

### 1.1 Proposed Development

Consideration is being given to the redevelopment of this site through the construction of around ten new two-storey houses and two new residential blocks of three-storey and five-storeys in areas of the existing open space within the estate. The proposals include the construction of a new access road and new areas of soft landscaping.

This report is specific to the proposed development and the advice herein should be reviewed if the proposals are amended.

### 1.2 Purpose of Work

The principal technical objectives of the work carried out were as follows:

- to review the reports previously carried out at the site and re-interpret the available data with regard to the proposed development;
- to confirm the ground conditions and their engineering properties;
- to provide advice with respect to the design of suitable foundations;
- to provide further information on and assess the degree of contamination of soils and groundwater beneath the site; and
- to assess the risk that any such contamination may pose to the proposed development, its users or the wider environment in conjunction with the previous findings.

### 1.3 Scope of Work

In order to meet the above objectives, an intrusive ground investigation was carried out which comprised, in summary, the following activities:

- a series of four boreholes advanced to a depth of 5.0 m using a tracked opendrive sampler;
- standard penetration tests (SPTs) to provide additional quantitative data on the strength of the soils;
- a series of four foundation inspection pits, manually and machine excavated;
- laboratory testing of selected soil and groundwater samples for geotechnical purposes and for the presence of contamination; and
- provision of a report presenting and interpreting the above data, together with our advice and recommendations with respect to the proposed development.

### 1.4 Limitations

The conclusions and recommendations made in this report are limited to those that can be made on the basis of the investigation. The results of the work should be viewed in the context of the range of data sources consulted, the number of locations where the ground was sampled and the number of soil, gas or groundwater samples tested; no liability can be accepted for information in other data sources or conditions not revealed by the sampling or testing. Any comments made on the basis of information obtained from the client or other third parties are given in good faith on the assumption that the information is accurate; no independent validation of such information has been made by GEA.

## 2.0 THE SITE

### 2.1 Site Description

The site is located approximately 1 km southeast of London Euston Railway Station and approximately 1.1 km west of Farringdon Railway Station. It is bordered to the northeast by houses on Orde Hall Street, to the southwest and southeast by mixed commercial and residential buildings on Old Gloucester Street, Theobald Street and adjoining roads, and to the northeast by Great Ormond Street Hospital. The site may be additionally located by National Grid Reference (NGR) 522550, 178640.

The Tybalds Estate occupies approximately 2.2 hectares of residential land, comprising 360 residential units within nine blocks. The site forms an irregularly shaped parcel of land measuring at maximum approximately 160 m southwest to northeast and approximately 150 m northwest to southeast. The site layout reflects its phased development, with an irregular layout including nine residential blocks surrounded by roads and areas of soft landscaping. It is predominantly level at around 31 m OD, but some changes in level are present which has meant that some of the site is terraced, with a maximum difference in level of around 2 m present. Some blocks have therefore been built with lower ground floor levels.

## 2.2 Previous Desk Study Findings

The previous desk study indicated the site was developed at some time before 1851, predominantly with housing, although a couple of public houses were also present. The site is recorded as having sustained significant bomb damage during the Second World War. During the late 1940s / early 1950s, seven residential blocks of between five-storey to 11-storey were constructed. During the 1960s, Chancellor and Babington Court, 14-storeys residential blocks, were constructed in the north of the site, replacing two residential blocks Historical Building Layout plans from 1958 indicated that a printers and photo-printing premises were located on site, the exact location is however not clear from the desk study report. Since the redevelopment during the 1960s, it has remained largely unchanged.

The desk study indicated that there are no historical or existing landfill sites, no registered waste management facilities, and no registered waste treatment or disposal sites or groundwater abstractions within 500 m of the subject site. There are no discharge consents recorded within 250 m of the site.

The report lists a single fuel station entry located 470 m to the north of the site at Nos 3-16 Woburn Place, Coram Street, St Pancras, with the entry registered as obsolete.

The report indicates a single recorded Pollution Incident to Controlled Waters, at around 73 m south of the site. The incident, in January 1996, involved Fire Water / Foam and is recorded as a Category 3 – Minor Incident, which is unlikely to have materially affected the site.

The report includes reference to records compiled by the Health Protection Agency (formerly the National Radiological Protection Board) which indicates that the site does not fall within an area where full or basic protection measures are considered necessary, nor is it situated in an area requiring a geological assessment of such measures. Therefore radon protective measures should not be necessary.

The risk of encountering a UXO at the site is considered to be Medium.

The preliminary risk appraisal of the site showed that there is a moderate risk of there being a significant contaminant linkage at this site.

The geological map of the area indicates that the site is underlain by Lynch Hill Gravel over the London Clay Formation. The superficial deposits are classified as a Secondary 'A' Aquifer and the underlying London Clay is classified as an Unproductive Stratum.

## 2.3 Summary of Previous Investigation

### 2.3.1 Ground Conditions

Harrison Group Environmental Ltd carried out an intrusive investigation in June 2012 which comprised three cable percussion boreholes advanced to depths of between 10.45 m and 35.00 m, five window sampler boreholes advanced to depths of between 2.2 m and 3.0 m, and a total of seven foundation inspection pits advanced to depths of between 0.75 m and 2.5 m.

The investigation encountered made ground of varying composition, although generally comprising brown or reddish brown silty gravelly sand with fragments of brick. At some locations fragments of metal, glass, ceramic pipe, wood, ash and asphalt were observed. Made ground was found at all locations; the base was proved at depths of between 1.15 m and

3.20 m, although the full thickness of the made ground was not reached in three out of the five window sampling boreholes or in five out of the seven foundation inspection pits, undertaken to depths of between 0.75 m and 3.00 m.

Beneath the made ground, the Lynch Hill Gravel initially comprised firm to stiff brown and yellow brown slightly gravelly silty sandy clay proved at one location to a depth of 4.3 m, in two of the window sampling boreholes and in one of the foundation inspection pits, undertaken of depths of between 1.55 m and 2.30 m, the full depth was not reached. The Lynch Hill Gravel then comprised dense yellow brown silty fine to coarse sand and gravel, which became very dense at depths of 4.5 m and 5.0 m, and was proved within the cable percussion boreholes to depths of between 7.0 m and 7.7 m.

The London Clay initially comprised firm, becoming stiff at 10.45 m, fissured grey silty clay with occasional light grey silt laminae and fissure infill and occasional off-white sand sized selenite crystals. This stratum became very stiff in the deeper borehole at a depth of 19.80 m, and was proved to the full depth of the investigation, of 35.0 m.

Groundwater was not encountered during drilling. Groundwater monitoring undertaken two weeks, four weeks and six weeks after drilling measured groundwater at depths of between 4.04 m and 6.58 m. Groundwater monitoring standpipes installed to shallower depths (between 1.95 m and 3.0 m) remained dry.

Gas monitoring was carried out on three occasions; no methane was detected and carbon dioxide was measured at values between 0.0% and 1.8%.

### 2.3.2 Existing Foundations

The previous investigation included the excavation of a series of seven foundation inspection pits, to depths of between 0.75 m to 2.5 m. The bases of the foundations were not proved at any location.

### 2.3.3 Soil Contamination

The table below sets out the values measured within 34 samples of made ground which were tested for contaminant concentrations during the previous investigation carried out by others; all concentrations are in mg/kg unless otherwise stated.

| Determinant | Maximum concentration (mg/kg) | Minimum concentration (mg/kg) | Number of samples below detection limit | Number of samples exceeding guideline values |
|---|---|---|---|---|
| pH | 10.4 | 6.9 | None | N/A |
| Arsenic | 24.3 | 7.9 | None | None |
| Cadmium | 2.06 | <0.02 | 7 | None |
| Chromium | 41.2 | 6.7 | None | None |
| Copper | 725 | 5.7 | None | None |
| Mercury | 14.5 | <0.14 | 2 | None |
| Nickel | 35.9 | 10.3 | None | None |
| Lead | **11,170** | 6.58 | None | 18 |
| Selenium | 1.43 | <1 | 31 | None |

| Determinant | Maximum concentration (mg/kg) | Minimum concentration (mg/kg) | Number of samples below detection limit | Number of samples exceeding guideline values |
|---|---|---|---|---|
| Zinc | 1,150 | 11.1 | None | None |
| Total Cyanide | <1 | <1 | All | None |
| Total Phenols | 0.03 | <0.01 | 23 | None |
| TPH <C6-C40 | 3,500 | <10 | 7 | N/A |
| Aliphatics >C5-C12 | <10 | <10 | All | None |
| Aliphatics C12-C16 | 16.3 | 0.9 | None | None |
| Aliphatics C16-C21 | 21.0 | 6.7 | None | None |
| Aliphatics C21-C35 | 90 | 14.2 | None | None |
| Aliphatics C35-C44 | 111 | 2.7 | None | None |
| Aromatics>EC5-EC12 | <10 | <10 | All | None |
| Aromatics EC12-EC16 | 85.7 | 13.2 | None | None |
| Aromatics EC16-EC21 | **752** | 12 | None | 1 |
| Aromatics EC21-EC35 | **1,350** | 32.5 | None | 1 |
| Aromatics EC35-EC44 | 655 | 12.8 | None | None |
| Naphthalene | 0.85 | <0.009 | 5 | None |
| Benzo(a)anthracene | **40.2** | <0.014 | 4 | 1 |
| Chrysene | **34.1** | <0.01 | 4 | 1 |
| Benzo(b)fluoranthene | **37.8** | <0.015 | 5 | 1 |
| Benzo(k)fluoranthene | **18.5** | <0.014 | 10 | 1 |
| Benzo(a)pyrene | **32.2** | <0.15 | 8 | 1 |
| Indeno(1, ,3,-cd)pyrene | **15.7** | <0.018 | 9 | 1 |
| Dibenzo(a,h)anthracene | **4.84** | <0.023 | 18 | 1 |
| Benzo(g.h.i)perylene | **17.8** | <0.024 | 10 | 1 |
| Total PAH | **566** | <0.18 | 3 | |
| Soil Organic Matter % | 1.72 | 0.875 | None | N/A |

Figure in bold indicates concentration in excess of risk-based soil guideline values, as discussed in Part 2 of this report

The results indicate extremely high lead concentrations in one sample together with highly elevated PAH concentrations. The borehole record for this sample does not provide any indication that metallic lead fragments were present, but the measured concentration is such that it is unlikely to be accountable from any other source. However, elevated lead concentrations were evident throughout the site in 18 of the 34 samples tested.

In addition, the 34 samples of made ground were screened for the presence of asbestos fibres. Chrysotile fibres were detected in five of the samples and amosite fibres were detected in one of the samples tested. No quantification was carried out.

### 2.3.4 Groundwater Contamination

Two groundwater samples were retrieved in the previous investigation and tested for a range of contaminants. The results can been compared to a number of published datasets that provide screening criteria for a Tier 1 assessment of the water environment. In the first instance the Environmental Quality Standards (EQS)[1] for freshwater water may be used, but screening criteria are not given for all analytes. For these analytes, the more conservative UK Drinking Water Standards (UK DWS)[2] may be referred to, and in the absence of appropriate UK specific criteria, World Health Organisation (WHO) guideline values[3] can be used, such as for banded Total Petroleum Hydrocarbons. The table below shows the concentrations of contaminants measured and their locations. The significance and appropriateness of these guideline criteria values for this site are discussed in Part 2 of this report.

| Contaminant of Concern | Concentration recorded (µg/kg) | Locations where elevated concentrations recorded | Screening criteria value (µg/kg) | Screening criteria value source |
|---|---|---|---|---|
| Benzo(a)pyrene | 0.0254 | BHT2A | 0.01 | UK Drinking Water Standards |
| Sum of Benzo(g,h,i)perylene and Indeno(1,2,3-cd)pyrene | 0.0366 | BHT2A | 0.002 | EQS Screening Criteria (Freshwater) |
| TPH / Oil and greases | 1,650 | BHT1 | Speciated testing needed, value exceeds threshold values for all carbon chain ranges | |

No concentrations of any other contaminants were found to be elevated above their respective selected guideline values.

## 3.0 EXPLORATORY WORK

In order to meet the above objectives, a total of four additional boreholes was advanced to a maximum depth of 5.0 m using a tracked open-drive sampler. Standard penetration tests (SPTs) were carried out to provide additional quantitative data on the strength of the soils and disturbed and undisturbed samples were recovered for subsequent laboratory examination and testing.

In addition, a total of four trial pits was excavated, initially manually and then with the aid of a mechanical excavator and a hand auger, to a maximum depth of 3.2 m, to allow further inspection of the foundations of existing structures in and around the site.

A single gas and groundwater monitoring standpipe was installed, with a response zone from 2.0 m to 4.0 m for potential future use in a detailed quantitative groundwater risk assessment.

All of the field work was carried out under the supervision of a geotechnical engineer from GEA. A selection of the soil samples recovered from the boreholes and the groundwater samples recovered from the standpipes was submitted to a soil mechanics laboratory to undergo a programme of geotechnical testing, and to an analytical laboratory for a programme of contamination testing. Further gas monitoring was not included in the brief for this investigation.

The borehole and trial pit records, and results of the laboratory analyses are appended, together with a site plan indicating the borehole positions.

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2 Water Supply (Water Quality) Regulations 2000 (SI 2000/3184)
3 Petroleum Products in Drinking-water, Background document for development of WHO Guidelines for Drinking-water Quality, WHO (WHO/SDE/WSH/05.08/123);

### 3.1 Sampling Strategy

The boreholes were positioned on site by an engineer from GEA to provide additional coverage of the site. The trial pit locations were specified by the consulting engineers, although the presence of basements or sunken ground floor at many of the proposed locations rendered the use of hand dug trial pits ineffective. The previous investigation included hand dug trial pits which were not able to prove the base of foundations, in light of which a mini-excavator was used to assist the excavation. Access suitable for a small tracked excavator to all but the four trial pit locations undertaken was restricted by the presence of steps or cast iron gates.

Three samples of made ground were recovered and subjected to analysis of a suite of typical industrial contaminants. Groundwater samples were recovered from two of the standpipes previously installed and subjected to a general suite of contamination testing. The contamination analyses were carried out at an MCERTs accredited laboratory with the majority of the testing suite accredited to MCERTS standards. Details of the MCERTs accreditation and test methods are included in the Appendix together with the analytical results.

## 4.0 GROUND CONDITIONS

The additional investigation has confirmed the expected ground conditions in that, below a surface covering of hardstanding and a significant thickness of made ground, Lynch Hill Gravel was encountered and was underlain by London Clay.

### 4.1 Made Ground

Made ground extended to depths between 2.0 m and 4.9 m, althought the base of the made ground was not proved in Borehole No 3, which terminated at a depth of 2.2 m on an obstruction. These soils were variable, and comprised brown, reddish brown and greyish brown very sandy gravelly clay or sandy gravel with brick, concrete, clinker, glass and flint fragments. In Borehole No 3 the made ground comprised black and reddish brown sandy clayey brick gravel with occasional concrete fragments.

Clinker and brick fragments were encountered in the made ground, and black colouration was encountered in Borehole No 1 at a depth of 3.5 m to 4.2 m; no other visual or olfactory evidence of significant contamination was observed within these soils. Three samples of the made ground were analysed for a range of contaminants and the results are summarised in Section 4.5.

### 4.2 Lynch Hill Gravel

The Lynch Hill Gravel initially comprised firm brown slightly sandy gravelly clay in Borehole No 4, Trial Pit No1 and No 4 where it was found to extend to a maximum depth of 3.2 m. Very dense yellowish brown slightly clayey sandy gravel was then encountered, the base of the stratum was only proven Borehole No 4, where the underlying London Clay was encountered at a depth of 4.0 m. The base of these soils were not found in Borehole Nos 1 and 2, undertaken to depths of 5.0 m and 3.7 m.
No visual or olfactory evidence of contamination was observed within these soils.

Laboratory plasticity index tests indicate the clay to be of moderate shrinkability. No visual or olfactory evidence of contamination was observed within these soils.

## 4.3 London Clay

This stratum was encountered in Borehole No 4 only and comprised firm greyish brown silty slightly sandy clay and was proved to the full depth of the borehole, of 5.0 m.

Laboratory plasticity index tests indicate the clay to be of moderate shrinkability, however the geotechnical testing carried out on samples retrieved in the previous investigation indicate the soils to be of high shrinkability which is typical of London Clay. No visual or olfactory evidence of contamination was observed within these soils.

## 4.4 Groundwater

A slow inflow of groundwater was encountered in Borehole No 4 within the Lynch Hill Gravel at a depth of 4.5 m. The standpipes installed during the previous investigation were monitored on three occasions up to two months after installation and, groundwater was measured at a minimum depth of 4.04 m. During the most recent fieldwork two of the standpipes were accessed and groundwater was measured at a minimum depth of 3.42 m. The results are shown in the table below.

| Borehole No | Depth to groundwater (m) | | | |
|---|---|---|---|---|
| | 23/03/12 | 05/04/12 | 17/04/12 | 31/03/15 |
| BHT1 | 4.85 | 4.84 | 4.04 | 3.42 |
| BHT2A | 4.22 | 4.24 | 4.24 | 4.10 |
| BHT4 (shallow) | Dry at 1.95 | Dry at 1.95 | Dry at 1.96 | Not accessible |
| BHT4 (deep) | 6.48 | 6.58 | 6.58 | Not accessible |
| WST1 | Dry at 3.00 | Dry at 3.00 | Dry at 3.00 | Not accessible |
| WST5 | Dry at 2.19 | Dry at 2.18 | Dry at 2.18 | Not accessible |

It is not possible to infer a groundwater direction from the groundwater monitoring results available in the absence of ground level information.

During the recent fieldwork, groundwater samples were recovered from standpipes previously installed in BH1T and BH2T and submitted to an analytical laboratory for a suite of contamination testing, as discussed below in Section 4.6. A standpipe was installed in Borehole No 4 to allow future monitoring.

## 4.5 Soil Contamination

Three samples of made ground that have been analysed for contaminant concentrations; the results are broadly similar to the chemical testing results in the previous ground investigation, in that elevated lead concentrations were encountered. However, no elevated polyaromatic hydrocarbons (PAHs) were found in the recent testing.

The significance of these results is discussed in Part 2 of this report.

### 4.5.1 Generic Quantitative Risk Assessment

The use of a risk-based approach has been adopted to provide an initial screening of the test results to assess the need for subsequent site-specific risk assessments. Contaminants of concern that have values in excess of a generic human health risk based screening values would require further assessment. The values adopted for this initial screening are either that of the CLEA[4] Soil Guideline Value where available, or is a Generic Screening Value calculated using the CLEA UK Version 1.06 software assuming a residential end use, or are based on the Defra Category 4 Screening values[5]. Whilst this site is to be for residential usage with no private gardens, a residential end use without plant uptake has therefore been assumed. The key generic assumptions for this end use are as follows:

- that groundwater will not be a critical risk receptor;
- that the critical receptor for human health will be a young female child aged 0 to 6 years old;
- that the exposure duration will be will be six years;
- that the critical exposure pathways will be direct soil and indoor dust ingestion, skin contact with soils and dust, and inhalation of dust and vapours; and
- that the building type equates to a two-storey small terraced house.

It is considered that these assumptions are appropriate for this generic assessment of this site. The tables of generic screening values derived by GEA and an explanation of how each value has been derived are included in the Appendix.

Where contaminant concentrations are measured at concentrations below the generic screening value it is considered that they pose an acceptable level of risk and thus further consideration of these contaminant concentrations is not required. However where concentrations are measured in excess of these generic screening values there is considered to be a potential that they could pose an unacceptable risk and thus further action will be required which could include:

- additional testing to zone the extent of the contaminated material and thus reduce the uncertainty with regard to its potential risk;
- site specific risk assessment to refine the assessment criteria and allow an assessment to be made as to whether the concentration present would pose an unacceptable risk at this site; or
- soil remediation or risk management to mitigate the risk posed by the contaminant to a degree that it poses an acceptable risk.

4 *Updated Technical Background to the CLEA Model (Science Report SC050021/SR3) Jan 2009 and Soil Guideline Value reports for specific contaminants; all DEFRA and Environment Agency.*

5 *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination - Final Project Report SP100 (CL:AIRE 2013) and Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document SP1010 (DEFRA 2014)*

When comparing the results from the contamination testing to those in the Soil Guideline Values and Generic Guideline Values, the analyses have revealed elevated lead concentrations in 20 of the 37 samples that have been tested as part of this or the previous investigation. In addition, a number of five ring PAHs and aromatic hydrocarbons EC16-EC35 were found to be elevated when compared to guideline values in a single sample of made ground retrieved from WST5 in the previous investigation, at a depth of 0.25 m. It is thought that these elevated concentrations could be caused by extraneous fragments of tar, ash, clinker or tarmac which were encountered in WST5.

No other concentrations in excess of the generic risk-based screening values were encountered.

The significance of these results is considered further in Part 2 of the report.

## 4.6 Groundwater Contamination

Groundwater samples were retrieved from Borehole Nos BH1T and BH2TA previously installed by others. These samples were tested for a range of common contaminants and contamination indicative parameters. The testing revealed no PAHs were present above the detection limit of 0.20 µg/l. Extractable petroleum hydrocarbons were detected at concentrations of 120 µg/l and 59 µg/l.

The significance of these results is considered further in Part 2 of the report.

## 4.7 Existing Foundations

The findings of the trial pits are summarised in the table below. Sketches and photographs of each pit are included in the Appendix.

| Trial Pit No | Structure | Foundation detail | Bearing Stratum |
|---|---|---|---|
| **1** | Wall bounding gardens of Great Ormond Street | Inconclusive. Brick built wall was proven to a depth of 3.2m with possible concrete footing projection at .3.2m | Not determined |
| **2** | Ormond House | Inconclusive. Brick built wall was proven to a depth of 2.7m | Not determined |
| **3** | Wall bounding gardens of Great Ormond Street | Inconclusive. Brick built wall was proven to a depth of 2.4m | Not determined |
| **4** | Richbell Court | Concrete block and beam<br>Top 1.0m<br>Base 2.12m<br>Lateral projection 0.78m | Pale brown SAND and GRAVEL |

## 4.8 California Bearing Ratio Testing

In-situ California Bearing Ratio Tests were carried out in three locations. In one location access for the truck mounted equipment was not possible; here a Dynamic Cone Penetrometer (DCP) test was carried out to provide an equivalent CBR value.

The results are included in the appendix and summarised in the below table.

| Test | In situ CBR value % | Soil description |
|---|---|---|
| **CBR1** | 24 | Grey gravelly SAND with fragments of brick and concrete |
| **CBR2** | 10 | Grey gravelly SAND with fragments of brick and concrete |
| **CBR3** | 4.1 | Brown slightly sandy gravelly CLAY |
| **DCP1** | 4 | Brown slightly sandy gravelly CLAY |

# Part 2: DESIGN BASIS REPORT

This section of the report provides an interpretation of the findings detailed in Part 1, in the form of a ground model, and then provides advice and recommendations with respect to foundation options and contamination issues.

## 5.0 INTRODUCTION

Consideration is being given to the redevelopment of this site through the construction of around ten new two-storey houses and two new residential blocks of three-storeys and six-storey construction. The new blocks are to be constructed in the areas of the existing open space within the estate. The proposals include the construction of a new access road new areas of soft landscaping.

## 6.0 GROUND MODEL

The previous desk study indicated that the site has had a potentially contaminative history as it has historically had printing and photo-printing activities at the site, and that there would likely be significant depths of made ground. On the basis of the fieldwork for this investigation and the previous fieldwork, the ground conditions at this site can be characterised as follows:

- below a significant thickness of made ground, Lynch Hill Gravel was encountered and was underlain by London Clay;
- the made ground is present to depths of between 1.15 m and 4.90 m and generally comprises brown or reddish brown silty gravelly sand with fragments of brick, at some locations fragments of metal, glass, ceramic pipe, wood, ash and asphalt are present;
- the Lynch Hill Gravel initially comprises firm brown and yellowish brown sandy slightly gravelly clay with some flint gravel, proven to a depths of 2.30 m and 4.30 m, thereafter it comprises dense becoming very dense yellow brown sandy gravel, proven to depths of between 4.0 m and 6.2 m. The thickness of the Lynch Hill Gravel was found to vary between 2.0 m and 3.4 m;
- the London Clay initially comprises firm brown becoming grey slightly silty clay to a maximum depth of 7.7 m, stiff clay was then encountered to a maximum depth of 19.80 m, which then became very stiff and was proved to the maximum depth investigated, of 35.00 m;
- groundwater was encountered in the Lynch Hill Gravel at a depth 4.50 m during drilling. Monitoring of the standpipes recorded groundwater at depths of between 3.42 m and 6.58 m; and
- the contamination testing has revealed elevated concentrations of lead and some five ring PAH, including benzo(a)pyrene, and asbestos fibres within the made ground, and minor concentrations of hydrocarbons in the groundwater.

# 7.0 ADVICE AND RECOMMENDATIONS

Due to the significant thickness of made ground, spread foundations are only considered possible if deep excavations are made so that such foundations can found on the dense and very dense sandy gravel of the Lynch Hill Gravel below. It is therefore considered that recourse should be made to a piled foundation solution. Consideration could alternatively be given to the use of a ground improvement technique to allow shallow foundations to be placed within the made ground, although vibration, disturbance and nuisance caused to the existing structures and residents will need to be managed. It is understodd that Column loads are to be between 450kN and 600 kN.

## 7.1 Spread Foundations

Moderate width pad or strip foundations may be placed on the dense and very dense sandy gravel of the Lynch Hill Gravel at a minimum depth of 1.0 m and may be designed to apply a net allowable bearing pressure of 200 kN/m$^2$. This value incorporates an adequate factor of safety against bearing capacity failure and should ensure that settlement remains within normal tolerable limits.

In view of the thickness of the made ground the foundations will in places need to extend to in excess of 3 m to reach natural soils, which is unlikely to represent an economic solution.

## 7.2 Ground Improvement

Consideration could be given to the use of a ground treatment technique, such as vibroflotation, to improve the load-bearing characteristics of the made ground and to allow shallow foundations to be placed on the improved made ground. Such a technique has the potential to induce intolerable vibrations in to neighbouring properties and thus should further consideration be given to this option it is recommended that the advice of a specialist piling contractor be sought.

## 7.3 Piled Foundations

For the ground conditions at this site some form of bored pile is likely to be the most appropriate type as the noise and vibrations associated with driven piles is unlikely to be acceptable. A conventional rotary augered pile may be appropriate, with temporary casing installed through the made ground and Lynch Hill Gravel to maintain stability and prevent groundwater inflows, although bored piles installed using continuous flight auger (cfa) techniques, which would not require the provision of casing, are likely to be the most appropriate type.

The following table of ultimate coefficients may be used for the preliminary design of bored piles, based on the measured SPT and cohesion / depth graph in the appendix. These values are based on the previous borehole data and have not been corroborated.

| Stratum | Depths m | kN / m² |
|---|---|---|
| **Ultimate Skin Friction** | | |
| Made Ground | GL to 4.90 | Ignore |
| Lynch Hill Gravel (gravel ϕ = 38°) | 4.90 to 6.20 | 50 |
| London Clay (α = 0.5) | 6.2 to 13.0 | 50 |
| London Clay (α = 0.5) | 13.0 to 35.0 | Increasing linearly from 50 to 215 |
| **Ultimate End Bearing** | | |
| London Clay | 13.0 to 35.0 | Increasing linearly from 900 to 3900 |

In the absence of pile tests, guidance from the London District Surveyors Association[6] (LDSA) suggests that a factor of safety of 2.6 should be applied to the above coefficients in the computation of safe theoretical working loads. It is also common practice to limit the average ultimate shaft friction to 110 kN/m$^2$. On this basis it has been estimated that a 300 mm diameter pile founding at a depth of 15.0 m below ground level should provide a safe working load of about 220 kN. Alternatively a 450 mm diameter pile founding at depth of 20 m should provide a safe working load of about 600 kN.

The above examples are not intended to constitute any form of recommendation with regard to pile size or type, but merely serve to illustrate the use of the above coefficients. Specialist piling contractors should be consulted with regard to the design of a suitable piling scheme for this site.

## 7.4 Excavations

On the basis of the trial pit findings, it is considered likely that it will be feasible to form relatively shallow, short-term excavations that extend through the made ground without the requirement for lateral support, although localised instabilities may occur. Where personnel are required to enter excavations, a risk assessment should be carried out and temporary lateral support or battering of the excavation sides will be required in order to comply with normal safety requirements. Any seepages from perched water tables should be suitably controlled by sump pumping.

## 7.5 Ground Floor Slabs

In view of the thickness of made ground a suspended floor slab will be required, unless ground improvement techniques are adopted. Gas exclusion measures are not considered necessary at this site.

## 7.6 Pavement Design

Formation level for new roads and pavements are is likely to be in the made ground. California bearing ratio tests have been carried out and suggest that a CBR values of 4% is appropriate where made ground comprising of clay is encountered, where sandy made ground is found a CBR value of 10% could be achieved. It should however be noted that made

6 LDSA (2009) *Foundations No 1 – Guidance notes for the design of straight shafted bored piles in London Clay*. LDSA Publication

ground is inherently variable and as such unless it can be confirmed that it has been placed as an engineered fill under controlled conditions, significant variations in the CBR value could occur over a relatively small distance and it may be prudent to design all paved areas on made ground to a CBR value of 'less than 2%'. Geotechnical testing indicates that these soils are not likely to be frost susceptible.

## 7.7 Effect of Sulphates

Chemical analyses have revealed low to moderate concentrations of soluble sulphate in accordance with Class DS-2 conditions of Table C2 of BRE Special Digest 1:SD Third Edition (2005). The measured pH values of the samples show that the ACEC class of AC-2 would be appropriate for the site, assuming mobile water conditions.

The guidelines contained in the above digest should be followed in the design of foundation concrete.

## 7.8 Site Specific Risk Assessment

The chemical testing has indicated elevated lead and some five ring PAH, including benzo(a)pyrene, within the made ground. In addition asbestos fibres have been detected in six of the 34 samples screened. Some remediation will therefore be required to protect end users at the site. The most likely source of the lead and PAH contamination is fragments of clinker noted in the made ground. Such contaminants associated with ash and clinker are not considered likely to be in a soluble form and as such do not present a significant risk to adjacent sites or the underlying Secondary A Aquifer, as they are likely to be relatively immobile in soils such as this with a relatively high clay and organic content. Fragments of clinker are not considered to present a vapour risk and with no vapours recorded during the site work this pathway is not considered plausible at this site. However, in the proposed garden and landscaped areas a potential risk of direct exposure to the soil and to soil derived dust will exist.

Chemical testing of groundwater samples retrieved during the previous investigation which indicated marginally elevated concentrations of some PAHs, namely benzo(a)pyrene, benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene and a maximum concentration of 1,650 µg/kg total petroleum hydrocarbons (TPH). Groundwater samples retrieved from the same standpipes during the recent fieldwork indicated no detectable PAH concentrations and TPH concentrations of 120 µg/kg and 59 µg/kg.

### 7.8.1 End Users

In private garden areas and areas of communal soft landscaping end users could come into direct contact with the contaminated soils and suitable precautions will need to be taken in these areas to protect end users and to allow successful plant growth. The made ground is unlikely to be a suitable growing medium in any case. At this stage it is recommended that a cover thickness of imported subsoil and topsoil of 600 mm in thickness should be specified to ensure successful plant growth, in accordance with recommendations from BRE[7]. This material should be placed above a geotextile separation and visual marker layer. As potentially soluble contaminants are not anticipated at this site, there should be no need for a capillary break layer below the imported topsoil. It may be possible to reduce the final thickness of cover required, but this will need to be determined once final levels have been established and the concentrations of potential contaminants within the imported material are known. Elsewhere,

[7] BRE (2004) *Cover systems for land regeneration. Thickness of cover systems for contaminated land.* BRE pub 465

end users will be effectively isolated from direct contact with the contaminants identified in the made ground by the extent of buildings and areas of external hardstanding. It is recommended that the imported topsoil be tested to confirm its chemical and physical suitability and that copies of these test certificates be submitted to the Local Authority.

### 7.8.2 Site Workers

Site workers should be made aware of the contamination and a programme of working should be identified to protect workers handling any soil. The method of site working should be in accordance with guidelines set out by HSE and CIRIA and the requirements of the Local Authority Environmental Health Officer. Asbestos fibres have been detected in samples of made ground and precautions should be taken accordingly. Specialist advice should be sought with regard to appropriate precautions, but a damping down method should be used to prevent dusting and consideration should be given to boundary and personnel monitoring.

### 7.8.3 Buried Services

Consideration may need to be given to the protection of buried plastic services within the underlying soils. Details of the proposed protection measures for buried plastic services will in any case need to be approved by the Environmental Health Officer (EHO) and the relevant service authority prior to the adoption of any scheme. It is likely that barrier pipe will be required or that additional testing will need to be carried out.

### 7.8.4 Groundwater

It is likely that the previous groundwater analyses where elevated PAH and TPH concentrations were measured reflected the inclusion of disturbed sediment within the samples tested and did not thus represent a true soluble contaminant content.

The groundwater results have indicated a marginally elevated concentration of TPH in the two sample of groundwater tested. These samples are considered to have been less affected by the presence of sediment in the sample and are considered to be likely to be below the generic threshold screening values. The previous investigation included chemical testing on soils which indicated elevated hydrocarbon, particularly aromatics EC21-EC35. This banding has a maximum solubility of 6.6µg/l, therefore it is thought that the hydrocarbons detected in the groundwater samples are likely adhered to particles of sediment within the samples, rather than in solution, suggesting them to represent a low risk to off-site groundwater quality

## 7.9 Soil Gas

Three gas monitoring visits have been previously carried out at the site. No methane, hydrogen sulphide or carbon monoxide have been detected during the gas monitoring visits. Concentrations of carbon dioxide ranged from a minimum of 0.0% to 1.8%. Flow has been measured at a maximum of 0.1 litres per hour.

The site conceptual model has not indicated any sources of ground gas that could conceivably affect the site, and measured concentrations of total organic content in the made ground do not present a significant risk of gas generations.

The gas monitoring results indicate that a Characteristic Situation 1 exists on the site, therefore no gas protection methods should be required although it could be considered prudent to carry out further monitoring to confirm this.

## 7.10 Waste Disposal

Any spoil arising from excavations or landscaping works, which is not to be re-used in accordance with the CL:AIRE guidance[8], will need to be disposed of to a licensed tip. Under the European Waste Directive, waste is classified as being either Hazardous or Non-Hazardous and landfills receiving waste are classified as accepting hazardous or non-hazardous wastes or the non-hazardous sub-category of inert waste in accordance with the Waste Directive. Waste going to landfill is subject to landfill tax at either the standard rate of £82.60 per tonne (about £150 per $m^3$) or at the lower rate of £2.60 per tonne (roughly £5 per $m^3$).

However, the classifications for tax purposes and disposal purposes differ and currently all made ground and topsoil is taxable at the 'standard' rate and only naturally occurring rocks and soils, which are accurately described as such in terms of the 2011 Order[9], would qualify for the 'lower rate' of landfill tax.

Based on the technical guidance provided by the Environment Agency[10] it is considered likely that the made ground from this site, as represented by the 34 samples chemically analysed, would be classified as HAZARDOUS waste under the waste code 17 05 04 (soils and stones not containing dangerous substances) and would be taxable at the standard rate. It is likely that the natural soils, if separated out, could be classified as an inert waste also under the waste code 17 05 04. This material would be taxable at the lower rate, if accurately described as naturally occurring soil and stones in terms of the 2011 Order on the waste transfer note, although WAC testing is likely to be required for such inert waste going to landfill. This would however need to be confirmed by the receiving landfill site.

Under the requirements of the European Waste Directive all waste needs to be pre-treated prior to disposal. The pre-treatment process must be physical, thermal, chemical or biological, including sorting. It must change the characteristics of the waste in order to reduce its volume, hazardous nature, facilitate handling or enhance recovery. The waste producer can carry out the treatment but they will need to provide documentation to prove that this has been carried out. Alternatively, the treatment can be carried out by an approved contractor. The Environment Agency has issued a position paper[11] which states that in certain circumstances, segregation at source may be considered as pre-treatment and thus excavated material may not have to be treated prior to landfilling if the soils can be "segregated" on site by sufficiently characterising the soils insitu prior to excavation.

The above opinion with regard to the classification of the excavated soils and its likely landfill taxable rate is provided for guidance only and should be confirmed by the receiving landfill once the soils to be discarded have been identified.

The local waste regulation department of the Environment Agency (EA) should be contacted to obtain details of tips that are licensed to accept the soil represented by the test results. The tips will be able to provide costs for disposing of this material but may require further testing.

8 CL:AIRE (2011) *The Definition of Waste: Development Industry Code of Practice* Version 2, March 2011
9 *Landfill Tax (Qualifying Material) Order 2011*
10 Environment Agency (2008) *Hazardous Waste: Interpretation of the definition and classification of hazardous waste. Technical Guidance* WM2 Second Edition Version 2.2, May 2008
11 Regulatory Position Statement (2007) *Treating non-hazardous waste for landfill - Enforcing the new requirement* Environment Agency 23 Oct 2007

If consideration were to be given to the re-use of the soil as a structural fill on this or another site, in accordance with the Code of Practice for the definition of waste, it would be necessary to confirm its suitability for use, its certainty of use and to confirm that only as much material is to be used as is required for the specific purpose for which it was being used. A materials management plan could then be formulated and a tracking system put in place such that once placed the material would no longer be regarded as being a waste and thus waste management licensing and landfill tax would not apply.

## 8.0 OUTSTANDING RISKS AND ISSUES

This section of the report aims to highlight areas where further work is required as a result of limitations on the scope of this investigation, or where issues have been identified by this investigation that warrant further consideration. The scope of risks and issues discussed in this section is by no means exhaustive, but covers the main areas where additional work is considered to be required.

The ground is a heterogeneous natural material and variations will inevitably arise between the locations at which it is investigated. This report has provided an assessment of the ground conditions based on the discrete points at which the ground was sampled, but the ground conditions should be subject to review as the work proceeds to ensure that any variations from the Ground Model are properly assessed by a suitably qualified person.

If during ground works any visual or olfactory evidence of contamination is identified it is recommended that further investigation be carried out and that the risk assessment is reviewed. These areas of doubt should be drawn to the attention of prospective contractors and further investigation will be required or sufficient contingency should be provided to cover the outstanding risk.

This investigation has indicated the presence of contamination and recommendations have been made for the mitigation of this contamination in light of the current development proposals. This report should be viewed as the first stage in a process which culminates in the provision of a Completion Report confirming that the remediation has been carried out satisfactorily. The next stage in this process should be consultation with the Local Environmental Health Officer (EHO) and Environment Agency (EA) and the provision of Remediation Proposals that can be agreed with these parties as a basis for the remediation of the contamination.

Further groundwater testing may need to be carried out to investigate the elevated hydrocarbons found within the groundwater, and a detailed qualitative risk assessment may be required

## APPENDIX

Borehole Records

Trial Pit Records

Laboratory Test Results

SPT & Cohesion / Depth Graph

SPT Results Summary

Chemical Analyses (Soil)

Chemical Analyses (Water)

Generic Risk Guideline Values

Site Plan

| GEA Geotechnical & Environmental Associates | Widbury Barn<br>Widbury Hill<br>Ware,Herts<br>SG12 7QE | **Site**<br>Tybalds Estate, Camden, London WC1N 3JT | **Number**<br>**BH1** |
|---|---|---|---|
| **Excavation Method**<br>Open-drive percussive sampler (Terrier Rig) | **Dimensions** | **Ground Level (mOD)** | **Client**<br>Durkan Ltd | **Job Number**<br>J15072 |
| | **Location** | **Dates**<br>31/03/2015 | **Engineer**<br>Mason Navarro Pledge | **Sheet**<br>1/1 |

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | | (4.90) | Made Ground (brown and reddish brown very sandy clay with fragments of clinker, brick and concrete) | | |
| 3.80 | D1 | | | | | Black colouration from 3.5 m to 4.2 m | | |
| 4.20 | D2 | | | | | | | |
| 4.90-5.10 | SPT(C) 25*/65<br>50/135 | | 25/50 | | 4.90<br>5.00 | Very dense slightly clayey very sandy GRAVEL<br>Complete at 5.00m | | |

**Remarks**
Groundwater was not encountered

| Scale (approx) | Logged By |
|---|---|
| 1:50 | SK |

**Figure No.**
J15072.BH1

| GEA Geotechnical & Environmental Associates | Widbury Barn<br>Widbury Hill<br>Ware,Herts<br>SG12 7QE | **Site**<br>Tybalds Estate, Camden, London WC1N 3JT | **Number**<br>**BH2** |
|---|---|---|---|
| **Excavation Method**<br>Open-drive percussive sampler (Terrier Rig) | **Dimensions** | **Ground Level (mOD)** | **Client**<br>Durkan Ltd | **Job Number**<br>J15072 |
| | **Location** | **Dates**<br>31/03/2015 | **Engineer**<br>Mason Navarro Pledge | **Sheet**<br>1/1 |

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | | (0.30) | Made Ground (brown silty sandy gravelly clay with fragments of brick, concrete and clinker) | | |
| 0.20 | D1 | | | | 0.30<br>(0.20) | | | |
| | | | | | 0.50 | Made Ground (brown sandy gravel) | | |
| | | | | | (0.50) | Made Ground (brown silty sandy gravelly clay with fragments of brick, concrete and clinker) | | |
| | | | | | 1.00 | Made Ground (reddish brown gravelly sand with many fragments of brick) | | |
| 2.00 | D2 | | | | (2.20) | | | |
| | | | | | 3.20 | | | |
| | | | | | (0.40) | Made Ground (brown sandy silty gravelly clay with fragments of glass, clinker and plastic) | | |
| 3.50 | D3 | | | | 3.60 | | | |
| 3.70-3.75 | SPT(C) 25*/20<br>50/30 | | 25/50 | | 3.70 | Very dense orange-brown sandy GRAVEL<br>Complete at 3.70m | | |

**Remarks**
Groundwater was not encountered

| Scale (approx) | Logged By |
|---|---|
| 1:50 | SK |

**Figure No.**
J15072.BH2

| GEA Geotechnical & Environmental Associates | Widbury Barn<br>Widbury Hill<br>Ware,Herts<br>SG12 7QE | **Site**<br>Tybalds Estate, Camden, London WC1N 3JT | **Number**<br>**BH3** |
|---|---|---|---|
| **Excavation Method**<br>Open-drive percussive sampler (Terrier Rig) | **Dimensions** | **Ground Level (mOD)** | **Client**<br>Durkan Ltd | **Job Number**<br>J15072 |
| | **Location** | **Dates**<br>31/03/2015 | **Engineer**<br>Mason Navarro Pledge | **Sheet**<br>1/1 |

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | | (0.40) | Concrete | | |
| | | | | | 0.40 | Made Ground (black and reddish brown sandy clayey brick gravel with occasional concrete fragments) | | |
| 0.90 | D1 | | | | (1.80) | | | |
| | | | | | 2.20 | Terminated at 2.20m | | |

**Remarks**
Borehole terminated at 1.0 m on obstruction
Groundwater was not encountered

| Scale (approx) | Logged By |
|---|---|
| 1:50 | SK |

**Figure No.**
J15072.BH3

| | | | |
|---|---|---|---|
| GEA Geotechnical & Environmental Associates<br>Widbury Barn<br>Widbury Hill<br>Ware,Herts<br>SG12 7QE | **Site**<br>Tybalds Estate, Camden, London WC1N 3JT | | **Number**<br>**BH4** |
| **Excavation Method**<br>Open-drive percussive sampler (Terrier Rig) | **Dimensions** | **Ground Level (mOD)** | **Client**<br>Durkan Ltd | **Job Number**<br>J15072 |
| | **Location** | **Dates**<br>31/03/2015 | **Engineer**<br>Mason Navarro Pledge | **Sheet**<br>1/1 |

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | | (0.70) | Made Ground (brown, white and reddish brown sandy concrete gravel with fragments of brick and tarmac) | | |
| | | | | | 0.70 | Made Ground (black and blackish brown sandy slightly gravelly clay with fragments of brick and concrete) | | |
| 1.50 | D1 | | | | (1.30) | | | |
| | | | | | 2.00 | Firm brown slightly sandy gravelly CLAY | | |
| | | | | | (0.30) | | | |
| 2.20 | D3 | | | | 2.30 | Very dense pale brown sandy GRAVEL | | |
| 3.00-3.45 | SPT(C) N=47 | | 8,10/10,11,12,14 | | (1.70) | | | |
| 4.00-4.45 | SPT N=13 | | 6,6/5,4,2,2 | | 4.00 | Firm greyish brown silty slightly sandy CLAY | | |
| 4.50 | D.2 | | Water strike(1) at 4.50m. | | (1.00) | | | ▽1 |
| | | | | | 5.00 | Complete at 5.00m | | |

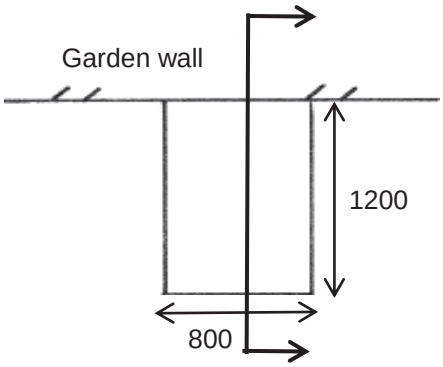
**Remarks**
50 mm gas and groundwater monitoring standpipe installed with response zone from 2 m to 4 m

| Scale (approx) | Logged By |
|---|---|
| 1:50 | SK |

**Figure No.**
J15072.BH4

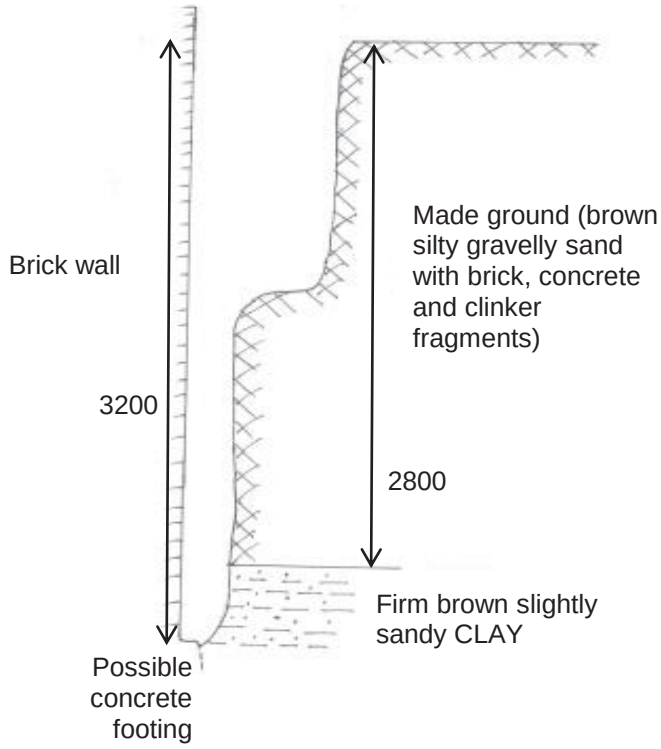
| | | | | |
|---|---|---|---|---|
| GEA Geotechnical & Environmental Associates<br>Widbury Barn<br>Widbury Hill<br>Ware<br>Herts SG12 7QE | | | **Site**<br>Tybalds Estate, Camden, London WC1N 3JT | **Trial Pit Number**<br>**TP1** |
| **Excavation Method**<br>Manual | **Dimensions**<br>1200 x 800 x 3200 | **Ground Level (mOD)** | **Client**<br>Durkan Ltd | **Job Number**<br>J15072 |
| | **Location** | **Dates**<br>02/04/2015 | **Engineer**<br>Mason Navarro Pledge | **Sheet**<br>1/4 |

**Plan: -**





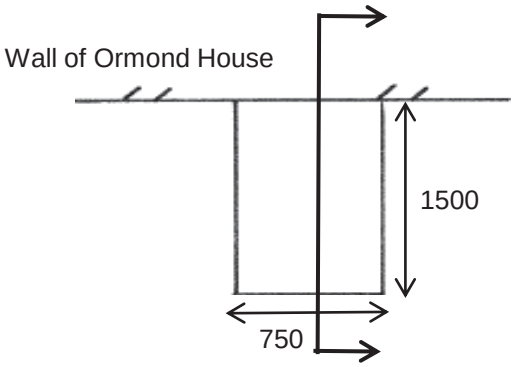
**Section A - A: -**




| | |
|---|---|
| Remarks: Trial pit extended with machine excavator, hand auger and steel bar<br>All dimensions in millimetres<br>Sides of trial pit remained stable during excavation<br>Groundwater was not encountered | Scale: 1 to 10<br>Logged by: SK |

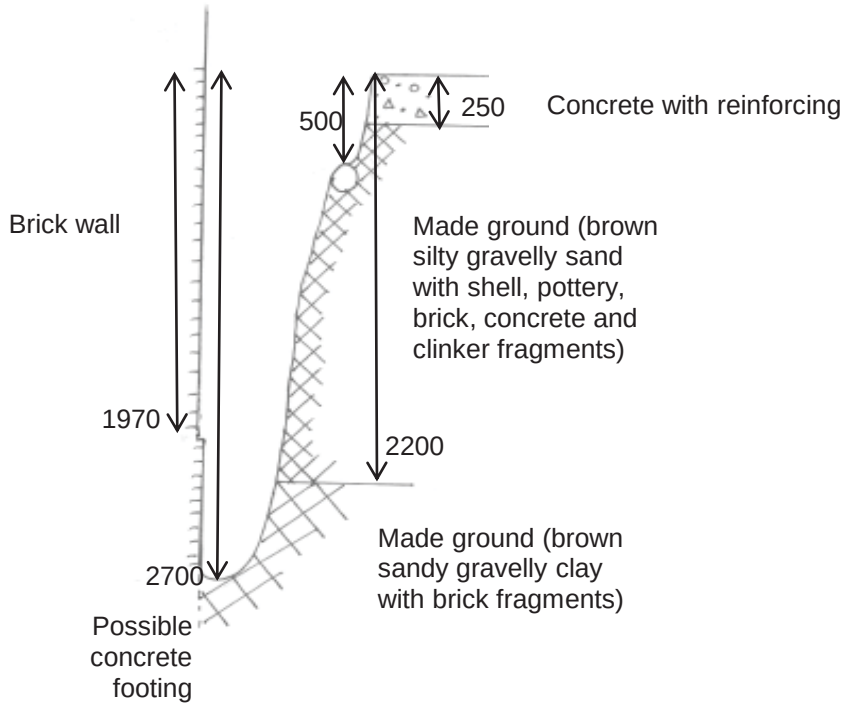
| | | | | |
|---|---|---|---|---|
| GEA Geotechnical & Environmental Associates<br>Widbury Barn<br>Widbury Hill<br>Ware<br>Herts SG12 7QE | | | **Site**<br>Tybalds Estate, Camden, London WC1N 3JT | **Trial Pit Number**<br>**TP2** |
| **Excavation Method**<br>Manual | **Dimensions**<br>1500 x 750 x 2700 | **Ground Level (mOD)** | **Client**<br>Durkan Ltd | **Job Number**<br>J15072 |
| | **Location** | **Dates**<br>02/04/2015 | **Engineer**<br>Mason Navarro Pledge | **Sheet**<br>2/4 |

**Plan: -**





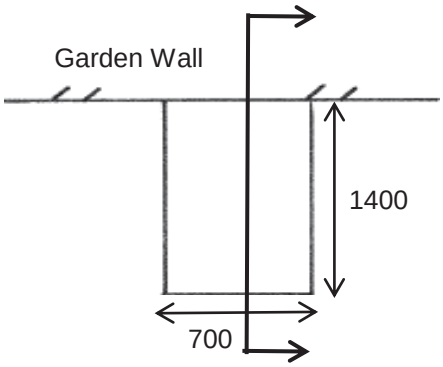
**Section A - A: -**




| | |
|---|---|
| Remarks: Trial pit extended with machine excavator, hand auger and steel bar<br>All dimensions in millimetres<br>Sides of trial pit remained stable during excavation<br>Groundwater was not encountered | Scale: 1 to 10<br>Logged by: SK |

| | | | | |
|---|---|---|---|---|
| GEA Geotechnical & Environmental Associates<br>Widbury Barn<br>Widbury Hill<br>Ware<br>Herts SG12 7QE | | | **Site**<br>Tybalds Estate, Camden, London WC1N 3JT | **Trial Pit Number**<br>**TP3** |
| **Excavation Method**<br>Manual | **Dimensions**<br>1400 x 700 x 2400 | **Ground Level (mOD)** | **Client**<br>Durkan Ltd | **Job Number**<br>J15072 |
| | **Location** | **Dates**<br>02/04/2015 | **Engineer**<br>Mason Navarro Pledge | **Sheet**<br>3/4 |

**Plan: -**





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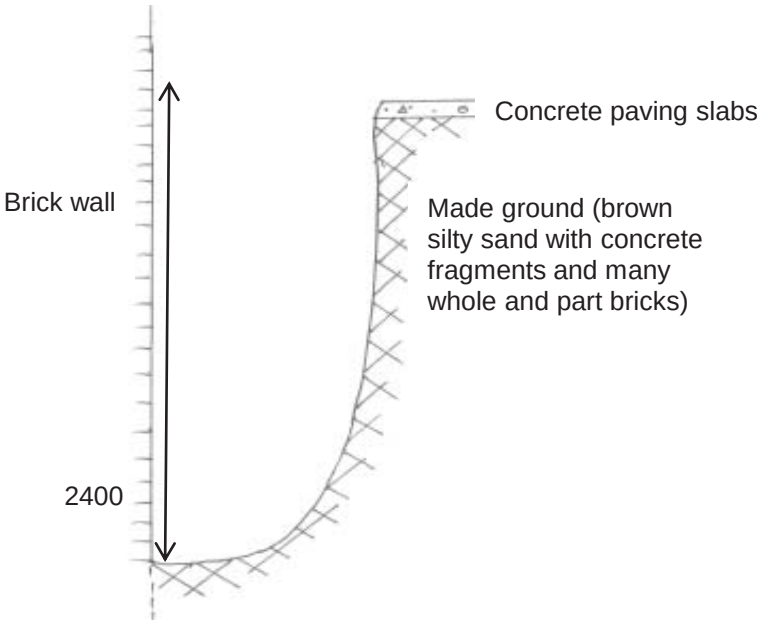
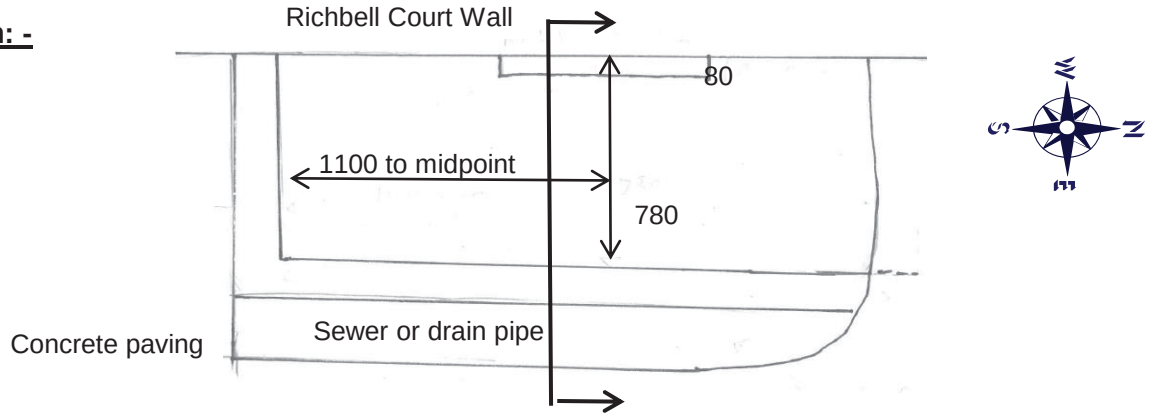


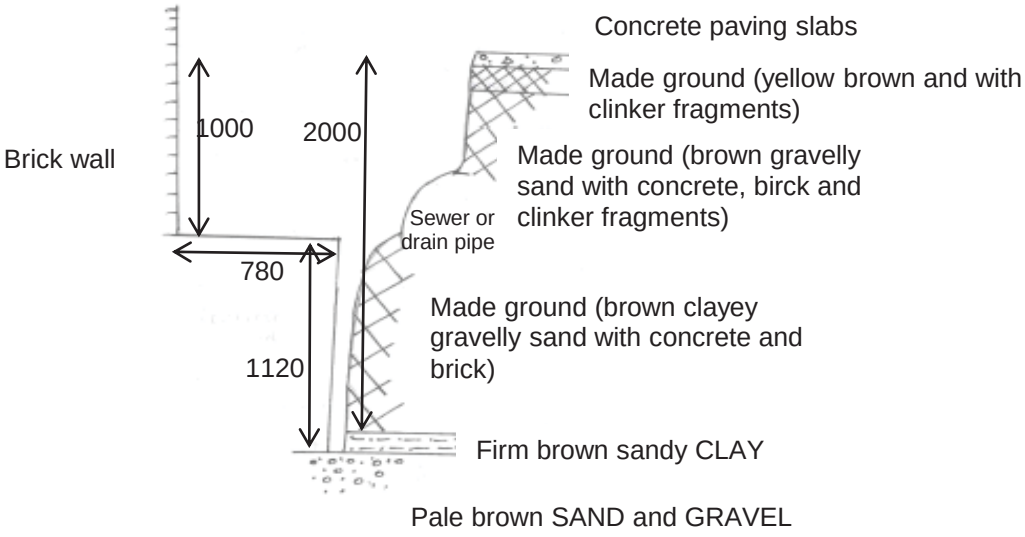

| | | |
|---|---|---|
| Remarks: Trial pit extended with machine excavator, hand auger and steel bar | | Scale: 1 to 10 |
| All dimensions in millimetres | | |
| Some instability was observed during excavation | | Logged by: |
| Groundwater was not encountered | | SK |

| GEA Geotechnical & Environmental Associates | Widbury Barn<br>Widbury Hill<br>Ware<br>Herts SG12 7QE | **Site**<br>Tybalds Estate, Camden, London WC1N 3JT | **Trial Pit Number**<br>**TP3** |
|---|---|---|---|
| **Excavation Method**<br>Manual | **Dimensions**<br>2000 x 1000 x 2120 | **Ground Level (mOD)** | **Client**<br>Durkan Ltd | **Job Number**<br>J15072 |
| | **Location** | **Dates**<br>02/04/2015 | **Engineer**<br>Mason Navarro Pledge | **Sheet**<br>4/4 |

**Plan: -**




**Section A - A: -**




| Remarks: | Trial pit extended with machine excavator, hand auger and steel bar<br>All dimensions in millimetres<br>Sides of trial pit remained stable during excavation<br>Groundwater was not encountered | Scale: 1 to 10<br>Logged by:<br>SK |
|---|---|---|

| | | | |
|---|---|---|---|
| **Project Name:** | Tybalds Estate, London WC1N 3JT | **Samples Received:** | 16/04/2015 |
| | | **Project Started:** | 17/04/2015 |
| **Client:** | GEA | **Testing Started:** | 23/04/2015 |
| **Project No:** | J15072 **Our job/report no:** 18691 | **Date Reported:** | 27/04/2015 |

K4 SOILS

| Borehole No: | Sample No: | Depth (m) | Description | Moisture content (%) | Liquid Limit (%) | Plastic Limit (%) | Plasticity Index (%) | Passing 0.425 mm (%) | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| BH2 | D2 | 0.50 | Brown slightly gravelly sandy silty CLAY (gravel is fm and rounded to sub-angular) | 13 | 30 | 14 | 16 | 96 | |
| BH3 | D1 | 0.90 | Orangeish brown slightly sandy gravelly silty CLAY (gravel is fmc and sub-angular to sub-rounded) | 15 | 52 | 22 | 30 | 38 | |
| BH3 | D3 | 6.00 | Grey silty CLAY | 25 | 58 | 22 | 36 | 100 | |
| BH4 | D2 | 1.50 | Dark brown, orangish brown and bluish grey slightly sandy slightly gravelly silty CLAY (gravel is fmc and sub-rounded to rounded) | 18 | 46 | 19 | 27 | 95 | |
| BH4 | D3 | 2.20 | Brown and bluish grey slightly gravelly slightly sandy silty CLAY (gravel is fm and sub-rounded to rounded) | 18 | 43 | 19 | 24 | 90 | |

UKAS TESTING 2519

## Summary of Test Results

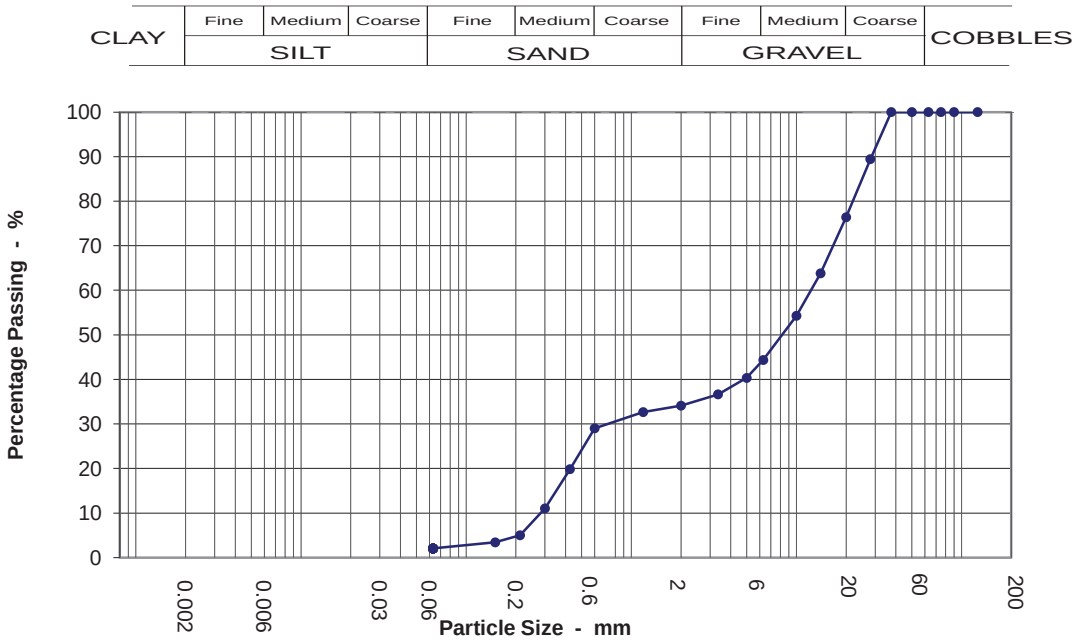
BS 1377 : Part 2 : Clause 4.4 : 1990 Determination of the liquid limit by the cone penetrometer method.
BS 1377 : Part 2 : Clause 5 : 1990 Determination of the plastic limit and plasticity index.
BS 1377 : Part 2 : Clause 3.2 : 1990 Determination of the moisture content by the oven-drying method.

**Checked and Approved**
Initials: K.P
Date: 27/04/2015

Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU

Test Results relate only to the sample numbers shown above. Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

| K4 SOILS | PARTICLE SIZE DISTRIBUTION<br>BS 1377 : Part 2 : 1990 : Clause 9 | Our Report No: | 18691 |
|---|---|---|---|
| | | Project No: | J15072 |
| Location | Tybalds Estate, London WC1N 3JT | Borehole / Trial Pit No: | TP2 |
| | | Depth | 2.30 m |
| Visual Soil Description | Brown slightly clayey very sandy GRAVEL (gravel is fmc and sub-angular to rounded) | Sample Type/No | D - 2 |




| Sieving | | Sedimentation | |
|---|---|---|---|
| Particle Size mm | % Passing | Particle Size mm | % Passing |
| 125 | 100 | | |
| 90 | 100 | | |
| 75 | 100 | | |
| 63 | 100 | | |
| 50 | 100 | | |
| 37.5 | 100 | | |
| 28 | 89 | | |
| 20 | 76 | | |
| 14 | 64 | | |
| 10 | 54 | | |
| 6.3 | 44 | | |
| 5 | 40 | | |
| 3.35 | 37 | | |
| 2 | 34 | | |
| 1.18 | 33 | | |
| 0.6 | 29 | | |
| 0.425 | 20 | | |
| 0.3 | 11 | | |
| 0.212 | 5 | | |
| 0.15 | 3 | | |
| 0.063 | 2 | | |

| Test Method | |
|---|---|
| BS 1377 : Part 2 : 1990 | |
| Sieving | Clause 9.2 |
| Sedimentation | N/A |
| Suitable Amount Of Sample Received | Yes |

| Sample Proportions | |
|---|---|
| Cobbles | 0.0 |
| Gravel | 65.9 |
| Sand | 32.1 |
| Silt & Clay | 2.0 |
| | |

| Grading Analysis | |
|---|---|
| D100 | 125.0 |
| D60 | 12.4 |
| D10 | 0.3 |
| Uniformity Coefficient | 44 |


**K4 SOILS LABORATORY**
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU.
E-mail: k4soils@aol.com


**Approved Signatories:**
K.Phaure(Tech.Mgr) J.Phaure(Lab.Mgr)

Test results relate only to the sample numbers shown above

**Checked and Approved**
Initials: kp
Date: 27/04/2015

UKAS TESTING

| | | | |
|---|---|---|---|
| **Project Name:** | Tybalds Estate, London WC1N3JT | **Project Started:** | 02/03/2015 |
| | | **Testing Started:** | 02/03/2015 |
| **Client Name:** | Geotechnical Environmental Associates | **Date reported:** | 09/04/2015 |
| **Project No:** | J15072 **Our Job / report no:** 18606 | **Sample no/ type:** | - |
| **Sample description:** | Grey gravelly SAND (gravel consist of fm gravel and fmc brick and concrete fragments) | **TP No:** | CBR1 |
| | | **Depth (m):** | 0.35 |
| | | **Test No:** | - |

K4 SOILS

Note: Test applicable only when maximum particle size beneath plunger does not exceed 20mm

Note: Penetration and force readings after seating load zeroed.

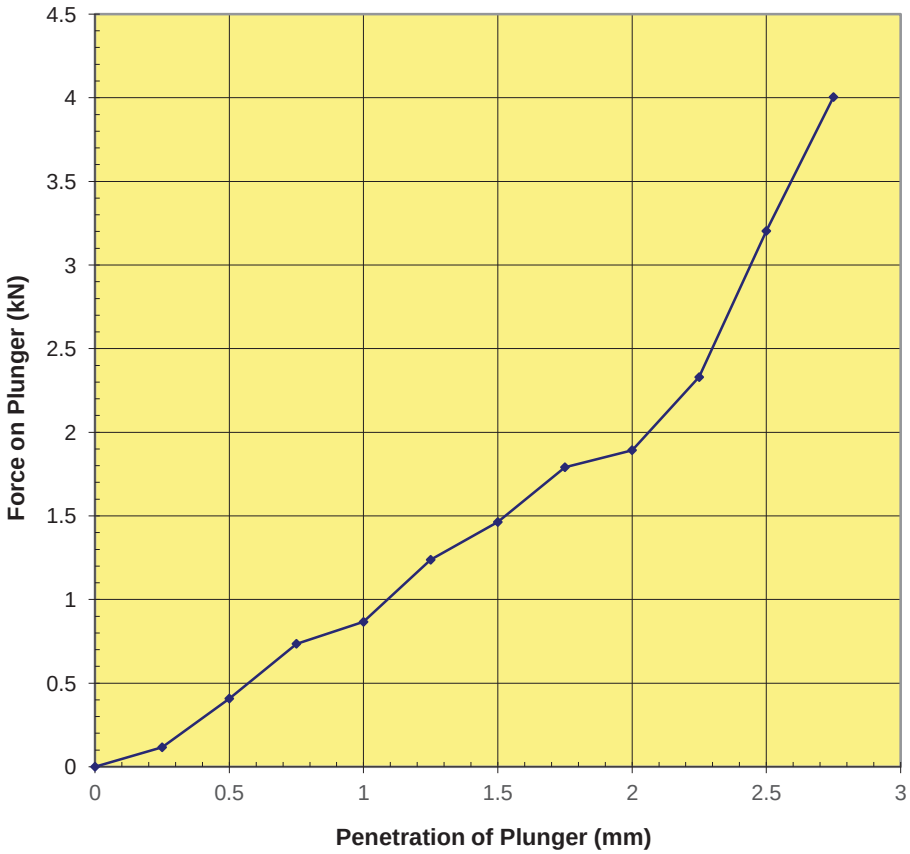
**Rate of Strain :1.00mm/min**

**Mass of Surcharge** **8.5** **kg**

**Proving Ring factor:** **7.28**

**RECORDINGS**

| Penetration of Plunger | Force on Plunger | |
|---|---|---|
| | Dial Reading | Load |
| mm | | kN |
| 0 | 0 | 0 |
| 0.25 | 16 | 0.12 |
| 0.50 | 56 | 0.41 |
| 0.75 | 101 | 0.74 |
| 1.00 | 119 | 0.87 |
| 1.25 | 170 | 1.24 |
| 1.50 | 201 | 1.46 |
| 1.75 | 246 | 1.79 |
| 2.00 | 260 | 1.89 |
| 2.25 | 320 | 2.33 |
| 2.50 | 440 | 3.20 |
| 2.75 | 550 | 4.00 |




**RESULTS:**

Moisture content (%) 12

**In-situ CBR value %** **24**

| Penetration mm | Force kN | Standard Force kN | **CBR %** |
|---|---|---|---|
| 2.5 | 3.20 | 13.2 | 24.27 |
| 5 | - | 20 | - |
| | | | |

# In-situ CBR Test

BS1377 Part 9 : 1990 : 4.3

Determination of In-situ CBR values

**Approved by**

Initials : kp

Date : 09/04/2015

UKAS TESTING 2519

**Remarks:**

Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford WD18 9RU

Test Results relate only to the sample numbers shown above. Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

| | | | |
|---|---|---|---|
| **Project Name:** | Tybalds Estate, London WC1N3JT | **Project Started:** | 02/03/2015 |
| | | **Testing Started:** | 02/03/2015 |
| **Client Name:** | Geotechnical Environmental Associates | **Date reported:** | 09/04/2015 |
| **Project No:** | J15072 **Our Job / report no:** 18606 | **Sample no/ type:** | - |
| **Sample description:** | Brown slightly sandy gravelly CLAY (gravel is fmc and sub-angular to rounded) | **TP No:** | CBR2 |
| | | **Depth (m):** | 0.30 |
| | | **Test No:** | - |

K4 SOILS

Note: Test applicable only when maximum particle size beneath plunger does not exceed 20mm

Note: Penetration and force readings after seating load zeroed.

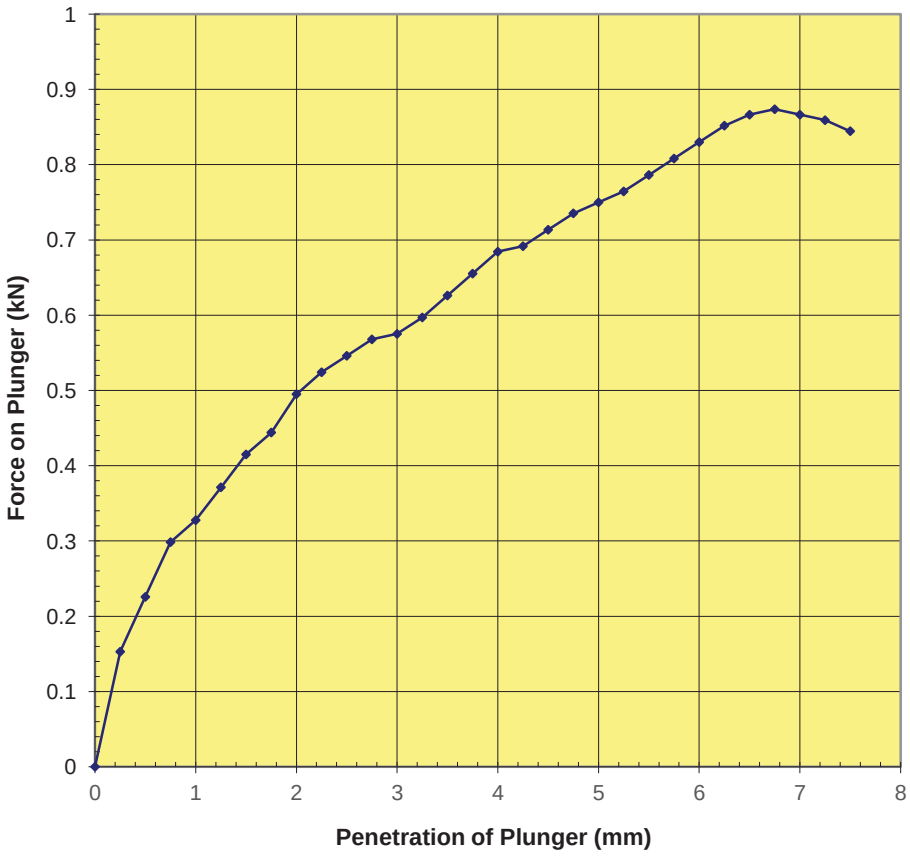
**Rate of Strain :1.00mm/min**

**Mass of Surcharge** **8.5** **kg**

**Proving Ring factor:** **7.28**

**RECORDINGS**

| Penetration of Plunger | Force on Plunger | |
|---|---|---|
| | Dial Reading | Load |
| mm | | kN |
| 0 | 0 | 0 |
| 0.25 | 21 | 0.15 |
| 0.50 | 31 | 0.23 |
| 0.75 | 41 | 0.30 |
| 1.00 | 45 | 0.33 |
| 1.25 | 51 | 0.37 |
| 1.50 | 57 | 0.41 |
| 1.75 | 61 | 0.44 |
| 2.00 | 68 | 0.50 |
| 2.25 | 72 | 0.52 |
| 2.50 | 75 | 0.55 |
| 2.75 | 78 | 0.57 |
| 3.00 | 79 | 0.58 |
| 3.25 | 82 | 0.60 |
| 3.50 | 86 | 0.63 |
| 3.75 | 90 | 0.66 |
| 4.00 | 94 | 0.68 |
| 4.25 | 95 | 0.69 |
| 4.50 | 98 | 0.71 |
| 4.75 | 101 | 0.74 |
| 5.00 | 103 | 0.75 |
| 5.25 | 105 | 0.76 |
| 5.50 | 108 | 0.79 |
| 5.75 | 111 | 0.81 |
| 6.00 | 114 | 0.83 |
| 6.25 | 117 | 0.85 |
| 6.50 | 119 | 0.87 |
| 6.75 | 120 | 0.87 |
| 7.00 | 119 | 0.87 |
| 7.25 | 118 | 0.86 |
| 7.50 | 116 | 0.84 |




**RESULTS:**

Moisture content (%) 15

**In-situ CBR value %** **4.1**

| Penetration mm | Force kN | Standard Force kN | **CBR %** |
|---|---|---|---|
| 2.5 | 0.55 | 13.2 | 4.14 |
| 5 | 0.75 | 20 | 3.75 |
| | | | |

UKAS TESTING 2519

# In-situ CBR Test

BS1377 Part 9 : 1990 : 4.3

Determination of In-situ CBR values

**Approved by**

Initials : kp

Date : 09/04/2015

**Remarks:**

Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford WD18 9RU

Test Results relate only to the sample numbers shown above. Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

| | | | |
|---|---|---|---|
| **Project Name:** | Tybalds Estate, London WC1N3JT | **Project Started:** | 02/03/2015 |
| | | **Testing Started:** | 02/03/2015 |
| **Client Name:** | Geotechnical Environmental Associates | **Date reported:** | 09/04/2015 |
| **Project No:** | J15072 **Our Job / report no:** 18606 | **Sample no/ type:** | - |
| **Sample description:** | Grey gravelly SAND (gravel consist of fm gravel and fmc brick and concrete fragments) | **TP No:** | CBR3 |
| | | **Depth (m):** | 0.40 |
| | | **Test No:** | - |

K4 SOILS

Note: Test applicable only when maximum particle size beneath plunger does not exceed 20mm

Note: Penetration and force readings after seating load zeroed.

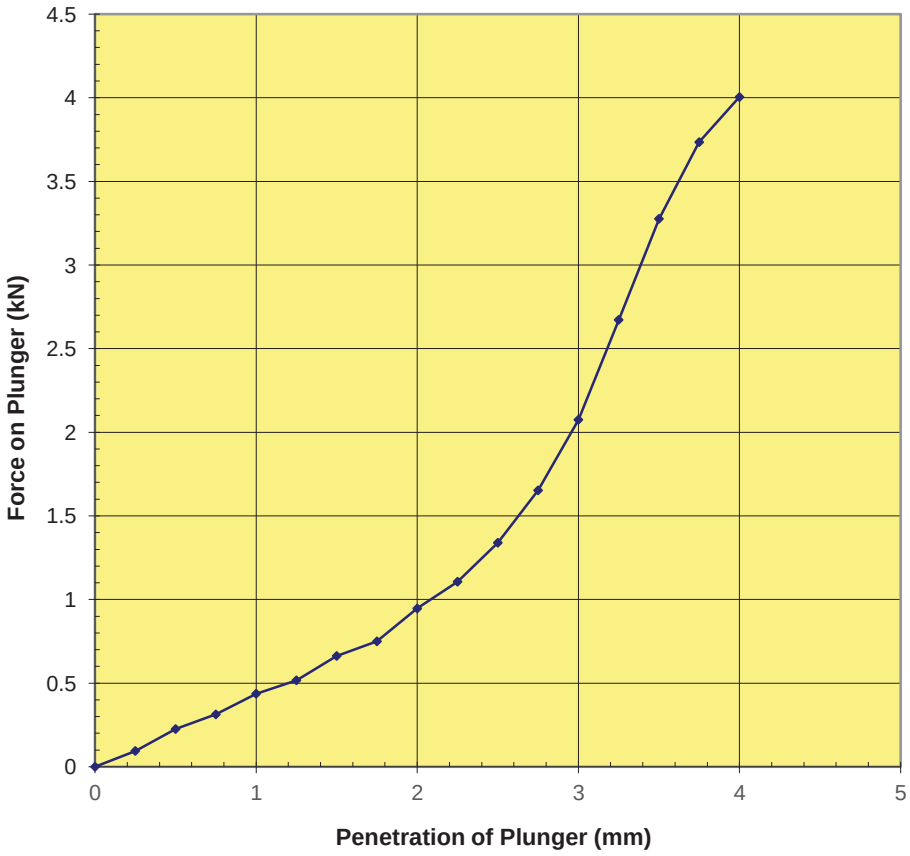
**Rate of Strain :1.00mm/min**

**Mass of Surcharge** **8.5** **kg**

**Proving Ring factor:** **7.28**

**RECORDINGS**

| Penetration of Plunger mm | Force on Plunger Dial Reading | Load kN |
|---|---|---|
| 0 | 0 | 0 |
| 0.25 | 13 | 0.09 |
| 0.50 | 31 | 0.23 |
| 0.75 | 43 | 0.31 |
| 1.00 | 60 | 0.44 |
| 1.25 | 71 | 0.52 |
| 1.50 | 91 | 0.66 |
| 1.75 | 103 | 0.75 |
| 2.00 | 130 | 0.95 |
| 2.25 | 152 | 1.11 |
| 2.50 | 184 | 1.34 |
| 2.75 | 227 | 1.65 |
| 3.00 | 285 | 2.07 |
| 3.25 | 367 | 2.67 |
| 3.50 | 450 | 3.28 |
| 3.75 | 513 | 3.73 |
| 4.00 | 550 | 4.00 |




**RESULTS:**

Moisture content (%) 20

**In-situ CBR value %** **10**

| Penetration mm | Force kN | Standard Force kN | **CBR %** |
|---|---|---|---|
| 2.5 | 1.34 | 13.2 | 10.15 |
| 5 | - | 20 | - |
| | | | |

UKAS TESTING 2519

# In-situ CBR Test

BS1377 Part 9 : 1990 : 4.3

Determination of In-situ CBR values

**Approved by**

Initials : kp

Date : 09/04/2015

**Remarks:**

Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford WD18 9RU

Test Results relate only to the sample numbers shown above. Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

| | | | |
|---|---|---|---|
| Project Name: | Tybalds Estate, London WC1N 3JT | | K4 SOILS |
| Client: | GEA | Project no: J15072 | |
| | | Our job no: 18691 | |

| Borehole No: | Sample No: | Depth m | Description | pH | Sulphate content (g/l) |
|---|---|---|---|---|---|
| BH2 | D2 | 0.50 | Brown slightly gravelly sandy silty CLAY (gravel is fm and rounded to sub-angular) | 7.8 | 0.18 |
| BH4 | D2 | 1.50 | Dark brown, orangish brown and bluish grey slightly sandy slightly gravelly silty CLAY (gravel is fmc and sub-rounded to rounded) | 7.9 | 0.21 |
| BH4 | D3 | 2.20 | Brown and bluish grey slightly gravelly slightly sandy silty CLAY (gravel is fm and sub-rounded to rounded) | 7.9 | 0.13 |

## Summary of Test Results

Date 27/04/2015

BS 1377 : Part 3 :Clause 5 : 1990

Determination of sulphate content of soil and ground water : gravimetric method

Checked and Approved

Initials : kp

Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU

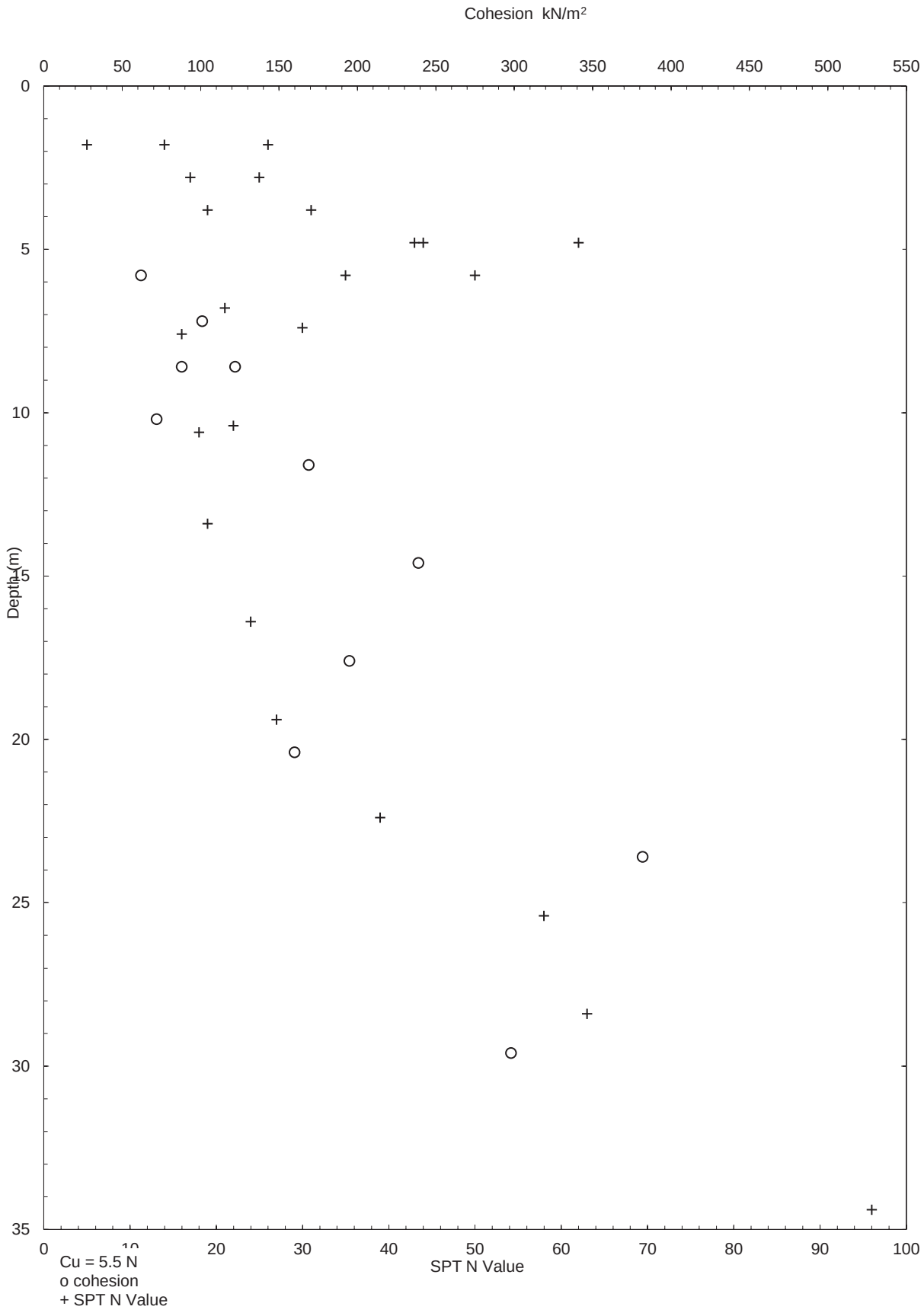
Geotechnical & Environmental Associates
Widbury Barn
Widbury Hill
Ware
Herts SG12 7QE

# SPT & Cohesion / Depth Graph

| | |
|---|---|
| **Site** | Tybalds Estate, Camden, London WC1N 3JT |
| **Client** | Durkan Ltd |
| **Engineer** | Mason Navarro Pledge |

**Job Number** J15072

**Sheet** 1 / 1



GEA Geotechnical & Environmental Associates

Widbury Barn
Widbury Hill
Ware,Herts
SG12 7QE

# Standard Penetration Test Results

**Site** : Tybalds Estate, Camden, London WC1N 3JT

**Client** : Durkan Ltd

**Engineer** : Mason Navarro Pledge

**Job Number** J15072

**Sheet** 1 / 1

| Borehole Number | Base of Borehole (m) | End of Seating Drive (m) | End of Test Drive (m) | Test Type | Seating Blows per 75mm | | Blows for each 75mm penetration | | | | Result | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 1 | 2 | 3 | 4 | | |
| BH1 | 4.90 | 4.97 | 5.10 | CPT | 25 | | 50 | | | | 25*/65mm<br>50/135mm | |
| BH2 | 3.70 | 3.72 | 3.75 | CPT | 25 | | 50 | | | | 25*/20mm<br>50/30mm | |
| BH4 | 3.00 | 3.15 | 3.45 | CPT | 8 | 10 | 10 | 11 | 12 | 14 | N=47 | |
| BH4 | 4.00 | 4.15 | 4.45 | SPT | 6 | 6 | 5 | 4 | 2 | 2 | N=13 | |

# Certificate of Analysis

## Certificate Number 15-32090

20-Apr-15

*Client* Geotechnical & Environmental Associates
Widbury Barn
Widbury Hill
Ware
Hertfordshire
SG12 7QE

*Our Reference* 15-32090

*Client Reference* J15072

*Contract Title* Tybalds Estate, London WC1N 3JT

*Description* One Soil sample.

*Date Received* 10-Apr-15

*Date Started* 10-Apr-15

*Date Completed* 20-Apr-15

*Test Procedures* Identified by prefix DETSn (details on request).

*Notes* Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

*Approved By*

Rob Brown
Business Manager

# Summary of Chemical Analysis
# Matrix Descriptions

*Our Ref* 15-32090
*Client Ref* J15072
*Contract Title* Tybalds Estate, London WC1N 3JT

| Sample ID | Other ID | Depth | Lab No | Completed | Matrix Description |
|---|---|---|---|---|---|
| TP2 | 1 | 1.8 | 795940 | 20/04/2015 | Dark brown, gravelly, sandy CLAY (Made ground - brick) |

# Summary of Chemical Analysis
# Soil Samples

*Our Ref* 15-32090
*Client Ref* J15072
*Contract Title* Tybalds Estate, London WC1N 3JT

| | |
|---|---|
| **Lab No** | 795940 |
| **Sample ID** | TP2 |
| **Depth** | 1.80 |
| **Other ID** | 1 |
| **Sample Type** | D |
| **Sampling Date** | n/s |
| **Sampling Time** | n/s |

| Test | Method | LOD | Units | |
|---|---|---|---|---|
| **Preparation** | | | | |
| Stones Removed | DETSC 1003* | 0 | % | 0.0 |
| Moisture Content 30øC | DETSC 1004* | 0.1 | % | 18 |
| **Metals** | | | | |
| Arsenic | DETSC 2301# | 0.2 | mg/kg | 22 |
| Cadmium | DETSC 2301# | 0.1 | mg/kg | 0.4 |
| Chromium | DETSC 2301# | 0.15 | mg/kg | 17 |
| Copper | DETSC 2301# | 0.2 | mg/kg | 140 |
| Lead | DETSC 2301# | 0.3 | mg/kg | 840 |
| Mercury | DETSC 2325# | 0.05 | mg/kg | 2.0 |
| Nickel | DETSC 2301# | 1 | mg/kg | 17 |
| Selenium | DETSC 2301# | 0.5 | mg/kg | < 0.5 |
| Zinc | DETSC 2301# | 1 | mg/kg | 90 |
| **Inorganics** | | | | |
| pH | DETSC 2008# | | | 8.0 |
| Cyanide total | DETSC 2130# | 0.1 | mg/kg | < 0.1 |
| Total Organic Carbon | DETSC 2002 | 0.1 | % | 4.0 |
| Chloride | DETSC 2055 | 1 | mg/kg | 17.2 |
| Sulphate Aqueous Extract as SO4 | DETSC 2076# | 10 | mg/l | 160 |
| Sulphide | DETSC 2024# | 10 | mg/kg | < 10 |
| Total Sulphate as SO4 | DETSC 2321# | 0.01 | % | 0.16 |
| **Petroleum Hydrocarbons** | | | | |
| EPH (C8-C10) | DETSC 3321* | 10 | mg/kg | < 10 |
| EPH (C10-C12) | DETSC 3311 | 10 | mg/kg | < 10 |
| EPH (C12-C16) | DETSC 3311 | 10 | mg/kg | < 10 |
| EPH (C16-C21) | DETSC 3311 | 10 | mg/kg | < 10 |
| EPH (C21-C35) | DETSC 3311 | 10 | mg/kg | < 10 |
| EPH (C10-C40) | DETSC 3311# | 10 | mg/kg | < 10 |
| **PAHs** | | | | |
| Naphthalene | DETSC 3301 | 0.1 | mg/kg | < 0.1 |
| Acenaphthylene | DETSC 3301 | 0.1 | mg/kg | < 0.1 |
| Acenaphthene | DETSC 3301 | 0.1 | mg/kg | < 0.1 |
| Fluorene | DETSC 3301 | 0.1 | mg/kg | < 0.1 |
| Phenanthrene | DETSC 3301 | 0.1 | mg/kg | < 0.1 |
| Anthracene | DETSC 3301 | 0.1 | mg/kg | < 0.1 |
| Fluoranthene | DETSC 3301 | 0.1 | mg/kg | < 0.1 |
| Pyrene | DETSC 3301 | 0.1 | mg/kg | < 0.1 |
| Benzo(a)anthracene | DETSC 3301 | 0.1 | mg/kg | < 0.1 |
| Chrysene | DETSC 3301 | 0.1 | mg/kg | < 0.1 |
| Benzo(b)fluoranthene | DETSC 3301 | 0.1 | mg/kg | < 0.1 |
| Benzo(k)fluoranthene | DETSC 3301 | 0.1 | mg/kg | < 0.1 |
| Benzo(a)pyrene | DETSC 3301 | 0.1 | mg/kg | < 0.1 |

Key: * -not accredited. # -MCERTS (accreditation only implied if report carries the MCERTS logo). n/s -not supplied.

# Summary of Chemical Analysis
# Soil Samples

*Our Ref* 15-32090
*Client Ref* J15072
*Contract Title* Tybalds Estate, London WC1N 3JT

| | |
|---|---|
| **Lab No** | 795940 |
| **Sample ID** | TP2 |
| **Depth** | 1.80 |
| **Other ID** | 1 |
| **Sample Type** | D |
| **Sampling Date** | n/s |
| **Sampling Time** | n/s |

| Test | Method | LOD | Units | |
|---|---|---|---|---|
| Indeno(1,2,3-c,d)pyrene | DETSC 3301 | 0.1 | mg/kg | < 0.1 |
| Dibenzo(a,h)anthracene | DETSC 3301 | 0.1 | mg/kg | < 0.1 |
| Benzo(g,h,i)perylene | DETSC 3301 | 0.1 | mg/kg | < 0.1 |
| PAH | DETSC 3301 | 1.6 | mg/kg | < 1.6 |
| **Phenols** | | | | |
| Phenol - Monohydric | DETSC 2130# | 0.3 | mg/kg | < 0.3 |

# Information in Support of the Analytical Results

*Our Ref* 15-32090
*Client Ref* J15072
*Contract* Tybalds Estate, London WC1N 3JT

## Containers Received & Deviating Samples

| Lab No | Sample ID | Date Sampled | Containers Received | Holding time exceeded for tests | Inappropriate container for tests |
|---|---|---|---|---|---|
| 795940 | TP2 1.80 SOIL | | GJ 250ml, GJ 60ml x2, PT 500ml | Sample date not supplied | |

Key: G-Glass P-Plastic J-Jar T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time and/or inappropriate containers are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

## Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

## Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

# Appendix A - Details of Analysis

| Method | Parameter | Units | Limit of Detection | Sample Preparation | Sub-Contracted | UKAS | MCERTS |
|---|---|---|---|---|---|---|---|
| DETSC 2002 | Organic matter | % | 0.1 | Air Dried | No | Yes | Yes |
| DETSC 2003 | Loss on ignition | % | 0.01 | Air Dried | No | Yes | Yes |
| DETSC 2008 | pH | pH Units | 1 | Air Dried | No | Yes | Yes |
| DETSC 2024 | Sulphide | mg/kg | 10 | Air Dried | No | Yes | Yes |
| DETSC 2076 | Sulphate Aqueous Extract as SO4 | mg/l | 10 | Air Dried | No | Yes | Yes |
| DETSC 2084 | Total Carbon | % | 0.5 | Air Dried | No | Yes | Yes |
| DETSC 2084 | Total Organic Carbon | % | 0.5 | Air Dried | No | Yes | Yes |
| DETSC 2119 | Ammoniacal Nitrogen as N | mg/kg | 0.5 | Air Dried | No | Yes | Yes |
| DETSC 2130 | Cyanide free | mg/kg | 0.1 | Air Dried | No | Yes | Yes |
| DETSC 2130 | Cyanide total | mg/kg | 0.1 | Air Dried | No | Yes | Yes |
| DETSC 2130 | Phenol - Monohydric | mg/kg | 0.3 | Air Dried | No | Yes | Yes |
| DETSC 2130 | Thiocyanate | mg/kg | 0.6 | Air Dried | No | Yes | Yes |
| DETSC 2321 | Total Sulphate as SO4 | % | 0.01 | Air Dried | No | Yes | Yes |
| DETSC 2325 | Mercury | mg/kg | 0.05 | Air Dried | No | Yes | Yes |
| DETSC 3049 | Sulphur (free) | mg/kg | 0.75 | Air Dried | No | Yes | Yes |
| DETSC2123 | Boron (water soluble) | mg/kg | 0.2 | Air Dried | No | Yes | Yes |
| DETSC2301 | Arsenic | mg/kg | 0.2 | Air Dried | No | Yes | Yes |
| DETSC2301 | Barium | mg/kg | 1.5 | Air Dried | No | Yes | Yes |
| DETSC2301 | Beryllium | mg/kg | 0.2 | Air Dried | No | Yes | Yes |
| DETSC2301 | Cadmium Available | mg/kg | 0.1 | Air Dried | No | Yes | Yes |
| DETSC2301 | Cadmium | mg/kg | 0.1 | Air Dried | No | Yes | Yes |
| DETSC2301 | Cobalt | mg/kg | 0.7 | Air Dried | No | Yes | Yes |
| DETSC2301 | Chromium | mg/kg | 0.15 | Air Dried | No | Yes | Yes |
| DETSC2301 | Copper | mg/kg | 0.2 | Air Dried | No | Yes | Yes |
| DETSC2301 | Manganese | mg/kg | 20 | Air Dried | No | Yes | Yes |
| DETSC2301 | Molybdenum | mg/kg | 0.4 | Air Dried | No | Yes | Yes |
| DETSC2301 | Nickel | mg/kg | 1 | Air Dried | No | Yes | Yes |
| DETSC2301 | Lead | mg/kg | 0.3 | Air Dried | No | Yes | Yes |
| DETSC2301 | Selenium | mg/kg | 0.5 | Air Dried | No | Yes | Yes |
| DETSC2301 | Zinc | mg/kg | 1 | Air Dried | No | Yes | Yes |
| DETSC 3072 | Ali/Aro C10-C35 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C10-C12 | mg/kg | 1.5 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C10-C12 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C10-C35 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C12-C16 | mg/kg | 1.2 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C12-C16 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C16-C21 | mg/kg | 1.5 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C16-C21 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C21-C35 | mg/kg | 3.4 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C21-C35 | mg/kg | 3.4 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C10-C12 | mg/kg | 0.9 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C10-C12 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C10-C35 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C12-C16 | mg/kg | 0.5 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C12-C16 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C16-C21 | mg/kg | 0.6 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C16-C21 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C21-C35 | mg/kg | 1.4 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C21-C35 | mg/kg | 1.4 | As Received | No | Yes | Yes |
| DETS 062 | Benzene | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETS 062 | Ethylbenzene | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETS 062 | Toluene | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETS 062 | Xylene | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETS 062 | m+p Xylene | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETS 062 | o Xylene | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETSC 3311 | C10-C24 Diesel Range Organics (DRO) | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3311 | C24-C40 Lube Oil Range Organics (LORO) | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3311 | EPH (C10-C40) | mg/kg | 10 | As Received | No | Yes | Yes |

# Appendix A - Details of Analysis

| Method | Parameter | Units | Limit of Detection | Sample Preparation | Sub-Contracted | UKAS | MCERTS |
|---|---|---|---|---|---|---|---|
| DETSC 3303 | Acenaphthene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Acenaphthylene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Benzo(a)pyrene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Benzo(a)anthracene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Benzo(b)fluoranthene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Benzo(k)fluoranthene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Benzo(g,h,i)perylene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Dibenzo(a,h)anthracene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Fluoranthene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Indeno(1,2,3-c,d)pyrene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Naphthalene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Phenanthrene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Pyrene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3401 | PCB 28 + PCB 31 | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETSC 3401 | PCB 52 | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETSC 3401 | PCB 101 | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETSC 3401 | PCB 118 | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETSC 3401 | PCB 153 | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETSC 3401 | PCB 138 | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETSC 3401 | PCB 180 | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETSC 3401 | PCB Total | mg/kg | 0.01 | As Received | No | Yes | Yes |

Method details are shown only for those determinands listed in Annex A of the MCERTS standard. Anything not included on this list falls outside the scope of MCERTS. No Recovery Factors are used in the determination of results. Results reported assume 100% recovery. Full method statements are available on request.

# Certificate of Analysis

## Certificate Number 15-32294

21-Apr-15

*Client* Geotechnical & Environmental Associates
Widbury Barn
Widbury Hill
Ware
Hertfordshire
SG12 7QE

*Our Reference* 15-32294

*Client Reference* J15072

*Contract Title* Tybalds Estate

*Description* 2 Soil samples.

*Date Received* 14-Apr-15

*Date Started* 14-Apr-15

*Date Completed* 21-Apr-15

*Test Procedures* Identified by prefix DETSn (details on request).

*Notes* Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

*Approved By*

Rob Brown
Business Manager

# Summary of Chemical Analysis
# Matrix Descriptions

*Our Ref* 15-32294
*Client Ref* J15072
*Contract Title* Tybalds Estate

| Sample ID | Depth | Lab No | Completed | Matrix Description |
|---|---|---|---|---|
| BH2 | 3.5 | 797064 | 21/04/2015 | Brown, gravelly, sandy CLAY |
| BH4 | 1.5 | 797065 | 21/04/2015 | Dark brown, gravelly, sandy CLAY including odd rootlets (Made ground - brick) |

# Summary of Chemical Analysis
# Soil Samples

*Our Ref* 15-32294
*Client Ref* J15072
*Contract Title* Tybalds Estate

| | | | | | |
|---|---|---|---|---|---|
| | | | **Lab No** | 797064 | 797065 |
| | | | **Sample ID** | BH2 | BH4 |
| | | | **Depth** | 3.50 | 1.50 |
| | | | **Other ID** | | |
| | | | **Sample Type** | SOIL | SOIL |
| | | | **Sampling Date** | 31/03/15 | 31/03/15 |
| | | | **Sampling Time** | n/s | n/s |
| **Test** | **Method** | **LOD** | **Units** | | |
| **Preparation** | | | | | |
| Stones Removed | DETSC 1003* | 0 | % | 0.0 | 0.0 |
| Moisture Content 30øC | DETSC 1004* | 0.1 | % | 32 | 21 |
| **Metals** | | | | | |
| Arsenic | DETSC 2301# | 0.2 | mg/kg | 17 | 24 |
| Cadmium | DETSC 2301# | 0.1 | mg/kg | 0.5 | 0.9 |
| Chromium | DETSC 2301# | 0.15 | mg/kg | 15 | 12 |
| Copper | DETSC 2301# | 0.2 | mg/kg | 94 | 1100 |
| Lead | DETSC 2301# | 0.3 | mg/kg | 230 | 470 |
| Mercury | DETSC 2325# | 0.05 | mg/kg | 35 | 1.9 |
| Nickel | DETSC 2301# | 1 | mg/kg | 15 | 18 |
| Selenium | DETSC 2301# | 0.5 | mg/kg | < 0.5 | < 0.5 |
| Zinc | DETSC 2301# | 1 | mg/kg | 280 | 180 |
| **Inorganics** | | | | | |
| pH | DETSC 2008# | | | 7.3 | 7.5 |
| Cyanide Total | DETSC 2130# | 0.1 | mg/kg | 0.4 | 0.1 |
| Total Organic Carbon | DETSC 2002 | 0.1 | % | 2.8 | 4.5 |
| Chloride | DETSC 2055 | 1 | mg/kg | 24.3 | 47.9 |
| Sulphate Aqueous Extract as SO4 | DETSC 2076# | 10 | mg/l | 610 | 1200 |
| Sulphide | DETSC 2024# | 10 | mg/kg | 44 | 48 |
| Total Sulphate as SO4 | DETSC 2321# | 0.01 | % | 0.24 | 0.30 |
| **Petroleum Hydrocarbons** | | | | | |
| EPH (C8-C10) | DETSC 3321* | 10 | mg/kg | < 10 | < 10 |
| EPH (C10-C12) | DETSC 3311 | 10 | mg/kg | < 10 | < 10 |
| EPH (C12-C16) | DETSC 3311 | 10 | mg/kg | < 10 | < 10 |
| EPH (C16-C21) | DETSC 3311 | 10 | mg/kg | 40 | 13 |
| EPH (C21-C35) | DETSC 3311 | 10 | mg/kg | 370 | 38 |
| EPH (C10-C40) | DETSC 3311# | 10 | mg/kg | 430 | 64 |

Key: * -not accredited. # -MCERTS (accreditation only implied if report carries the MCERTS logo). n/s -not supplied.

# Summary of Chemical Analysis
# Soil Samples

*Our Ref* 15-32294
*Client Ref* J15072
*Contract Title* Tybalds Estate

| | | | | | |
|---|---|---|---|---|---|
| | | | **Lab No** | 797064 | 797065 |
| | | | **Sample ID** | BH2 | BH4 |
| | | | **Depth** | 3.50 | 1.50 |
| | | | **Other ID** | | |
| | | | **Sample Type** | SOIL | SOIL |
| | | | **Sampling Date** | 31/03/15 | 31/03/15 |
| | | | **Sampling Time** | n/s | n/s |
| **Test** | **Method** | **LOD** | **Units** | | |
| **PAHs** | | | | | |
| Naphthalene | DETSC 3301 | 0.1 | mg/kg | < 0.1 | < 0.1 |
| Acenaphthylene | DETSC 3301 | 0.1 | mg/kg | < 0.1 | < 0.1 |
| Acenaphthene | DETSC 3301 | 0.1 | mg/kg | < 0.1 | < 0.1 |
| Fluorene | DETSC 3301 | 0.1 | mg/kg | < 0.1 | < 0.1 |
| Phenanthrene | DETSC 3301 | 0.1 | mg/kg | < 0.1 | < 0.1 |
| Anthracene | DETSC 3301 | 0.1 | mg/kg | < 0.1 | < 0.1 |
| Fluoranthene | DETSC 3301 | 0.1 | mg/kg | < 0.1 | < 0.1 |
| Pyrene | DETSC 3301 | 0.1 | mg/kg | < 0.1 | < 0.1 |
| Benzo(a)anthracene | DETSC 3301 | 0.1 | mg/kg | < 0.1 | < 0.1 |
| Chrysene | DETSC 3301 | 0.1 | mg/kg | < 0.1 | < 0.1 |
| Benzo(b)fluoranthene | DETSC 3301 | 0.1 | mg/kg | < 0.1 | < 0.1 |
| Benzo(k)fluoranthene | DETSC 3301 | 0.1 | mg/kg | < 0.1 | < 0.1 |
| Benzo(a)pyrene | DETSC 3301 | 0.1 | mg/kg | < 0.1 | < 0.1 |
| Indeno(1,2,3-c,d)pyrene | DETSC 3301 | 0.1 | mg/kg | < 0.1 | < 0.1 |
| Dibenzo(a,h)anthracene | DETSC 3301 | 0.1 | mg/kg | < 0.1 | < 0.1 |
| Benzo(g,h,i)perylene | DETSC 3301 | 0.1 | mg/kg | < 0.1 | < 0.1 |
| PAH | DETSC 3301 | 1.6 | mg/kg | < 1.6 | < 1.6 |
| **Phenols** | | | | | |
| Phenol - Monohydric | DETSC 2130# | 0.3 | mg/kg | < 0.3 | 0.4 |

Key: * -not accredited. # -MCERTS (accreditation only implied if report carries the MCERTS logo). n/s -not supplied.

# Information in Support of the Analytical Results

*Our Ref* 15-32294
*Client Ref* J15072
*Contract* Tybalds Estate

## Containers Received & Deviating Samples

| Lab No | Sample ID | Date Sampled | Containers Received | Holding time exceeded for tests | Inappropriate container for tests |
|---|---|---|---|---|---|
| 797064 | BH2 3.50 SOIL | 31/03/15 | GJ 250ml, PT 500ml | pH (7 days) | |
| 797065 | BH4 1.50 SOIL | 31/03/15 | GJ 60ml x2, PT 500ml x2 | pH (7 days) | |

Key: G-Glass P-Plastic J-Jar T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time and/or inappropriate containers are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

## Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

## Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

# Appendix A - Details of Analysis

| Method | Parameter | Units | Limit of Detection | Sample Preparation | Sub-Contracted | UKAS | MCERTS |
|---|---|---|---|---|---|---|---|
| DETSC 2002 | Organic matter | % | 0.1 | Air Dried | No | Yes | Yes |
| DETSC 2003 | Loss on ignition | % | 0.01 | Air Dried | No | Yes | Yes |
| DETSC 2008 | pH | pH Units | 1 | Air Dried | No | Yes | Yes |
| DETSC 2024 | Sulphide | mg/kg | 10 | Air Dried | No | Yes | Yes |
| DETSC 2076 | Sulphate Aqueous Extract as SO4 | mg/l | 10 | Air Dried | No | Yes | Yes |
| DETSC 2084 | Total Carbon | % | 0.5 | Air Dried | No | Yes | Yes |
| DETSC 2084 | Total Organic Carbon | % | 0.5 | Air Dried | No | Yes | Yes |
| DETSC 2119 | Ammoniacal Nitrogen as N | mg/kg | 0.5 | Air Dried | No | Yes | Yes |
| DETSC 2130 | Cyanide free | mg/kg | 0.1 | Air Dried | No | Yes | Yes |
| DETSC 2130 | Cyanide total | mg/kg | 0.1 | Air Dried | No | Yes | Yes |
| DETSC 2130 | Phenol - Monohydric | mg/kg | 0.3 | Air Dried | No | Yes | Yes |
| DETSC 2130 | Thiocyanate | mg/kg | 0.6 | Air Dried | No | Yes | Yes |
| DETSC 2321 | Total Sulphate as SO4 | % | 0.01 | Air Dried | No | Yes | Yes |
| DETSC 2325 | Mercury | mg/kg | 0.05 | Air Dried | No | Yes | Yes |
| DETSC 3049 | Sulphur (free) | mg/kg | 0.75 | Air Dried | No | Yes | Yes |
| DETSC2123 | Boron (water soluble) | mg/kg | 0.2 | Air Dried | No | Yes | Yes |
| DETSC2301 | Arsenic | mg/kg | 0.2 | Air Dried | No | Yes | Yes |
| DETSC2301 | Barium | mg/kg | 1.5 | Air Dried | No | Yes | Yes |
| DETSC2301 | Beryllium | mg/kg | 0.2 | Air Dried | No | Yes | Yes |
| DETSC2301 | Cadmium Available | mg/kg | 0.1 | Air Dried | No | Yes | Yes |
| DETSC2301 | Cadmium | mg/kg | 0.1 | Air Dried | No | Yes | Yes |
| DETSC2301 | Cobalt | mg/kg | 0.7 | Air Dried | No | Yes | Yes |
| DETSC2301 | Chromium | mg/kg | 0.15 | Air Dried | No | Yes | Yes |
| DETSC2301 | Copper | mg/kg | 0.2 | Air Dried | No | Yes | Yes |
| DETSC2301 | Manganese | mg/kg | 20 | Air Dried | No | Yes | Yes |
| DETSC2301 | Molybdenum | mg/kg | 0.4 | Air Dried | No | Yes | Yes |
| DETSC2301 | Nickel | mg/kg | 1 | Air Dried | No | Yes | Yes |
| DETSC2301 | Lead | mg/kg | 0.3 | Air Dried | No | Yes | Yes |
| DETSC2301 | Selenium | mg/kg | 0.5 | Air Dried | No | Yes | Yes |
| DETSC2301 | Zinc | mg/kg | 1 | Air Dried | No | Yes | Yes |
| DETSC 3072 | Ali/Aro C10-C35 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C10-C12 | mg/kg | 1.5 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C10-C12 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C10-C35 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C12-C16 | mg/kg | 1.2 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C12-C16 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C16-C21 | mg/kg | 1.5 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C16-C21 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C21-C35 | mg/kg | 3.4 | As Received | No | Yes | Yes |
| DETSC 3072 | Aliphatic C21-C35 | mg/kg | 3.4 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C10-C12 | mg/kg | 0.9 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C10-C12 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C10-C35 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C12-C16 | mg/kg | 0.5 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C12-C16 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C16-C21 | mg/kg | 0.6 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C16-C21 | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C21-C35 | mg/kg | 1.4 | As Received | No | Yes | Yes |
| DETSC 3072 | Aromatic C21-C35 | mg/kg | 1.4 | As Received | No | Yes | Yes |
| DETS 062 | Benzene | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETS 062 | Ethylbenzene | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETS 062 | Toluene | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETS 062 | Xylene | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETS 062 | m+p Xylene | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETS 062 | o Xylene | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETSC 3311 | C10-C24 Diesel Range Organics (DRO) | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3311 | C24-C40 Lube Oil Range Organics (LORO) | mg/kg | 10 | As Received | No | Yes | Yes |
| DETSC 3311 | EPH (C10-C40) | mg/kg | 10 | As Received | No | Yes | Yes |

# Appendix A - Details of Analysis

| Method | Parameter | Units | Limit of Detection | Sample Preparation | Sub-Contracted | UKAS | MCERTS |
|---|---|---|---|---|---|---|---|
| DETSC 3303 | Acenaphthene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Acenaphthylene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Benzo(a)pyrene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Benzo(a)anthracene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Benzo(b)fluoranthene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Benzo(k)fluoranthene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Benzo(g,h,i)perylene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Dibenzo(a,h)anthracene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Fluoranthene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Indeno(1,2,3-c,d)pyrene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Naphthalene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Phenanthrene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3303 | Pyrene | mg/kg | 0.03 | As Received | No | Yes | Yes |
| DETSC 3401 | PCB 28 + PCB 31 | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETSC 3401 | PCB 52 | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETSC 3401 | PCB 101 | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETSC 3401 | PCB 118 | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETSC 3401 | PCB 153 | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETSC 3401 | PCB 138 | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETSC 3401 | PCB 180 | mg/kg | 0.01 | As Received | No | Yes | Yes |
| DETSC 3401 | PCB Total | mg/kg | 0.01 | As Received | No | Yes | Yes |

Method details are shown only for those determinands listed in Annex A of the MCERTS standard. Anything not included on this list falls outside the scope of MCERTS. No Recovery Factors are used in the determination of results. Results reported assume 100% recovery. Full method statements are available on request.

Derwentside Environmental Testing Services

# Certificate of Analysis

## Certificate Number 15-31818

15-Apr-15

*Client* Geotechnical & Environmental Associates
Widbury Barn
Widbury Hill
Ware
Hertfordshire
SG12 7QE

*Our Reference* 15-31818

*Client Reference* J15072

*Contract Title* Tybalds Estate, London WC1N 3JT

*Description* 2 Water samples.

*Date Received* 08-Apr-15

*Date Started* 08-Apr-15

*Date Completed* 15-Apr-15

*Test Procedures* Identified by prefix DETSn (details on request).

*Notes* Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

*Approved By*

Rob Brown
Business Manager

UKAS TESTING
2139

# Summary of Chemical Analysis
# Water Samples

*Our Ref* 15-31818
*Client Ref* J15072
*Contract Title* Tybalds Estate, London WC1N 3JT

| | | | | | |
|---|---|---|---|---|---|
| | | | **Lab No** | 794683 | 794684 |
| | | | **Sample ID** | BH1T | BH2TA |
| | | | **Depth** | 4.00 | 4.00 |
| | | | **Other ID** | W1 | W1 |
| | | | **Sample Type** | WATER | WATER |
| | | | **Sampling Date** | 03/03/15 | 03/03/15 |
| | | | **Sampling Time** | n/s | n/s |
| **Test** | **Method** | **LOD** | **Units** | | |
| **Metals** | | | | | |
| Arsenic, Dissolved | DETSC 2306 | 0.16 | ug/l | 0.67 | 1.3 |
| Cadmium, Dissolved | DETSC 2306 | 0.03 | ug/l | < 0.03 | < 0.03 |
| Chromium, Dissolved | DETSC 2306 | 0.25 | ug/l | 6.0 | 6.1 |
| Lead, Dissolved | DETSC 2306 | 0.09 | ug/l | < 0.09 | < 0.09 |
| Mercury, Dissolved | DETSC 2306 | 0.01 | ug/l | < 0.01 | < 0.01 |
| Nickel, Dissolved | DETSC 2306 | 0.5 | ug/l | 1.2 | 2.4 |
| **Inorganics** | | | | | |
| Conductivity | DETSC 2009 | 1 | uS/cm | 1280 | 758 |
| pH | DETSC 2008 | | | 7.6 | 8.2 |
| Ammoniacal Nitrogen as N | DETSC 2207 | 0.015 | mg/l | 0.090 | < 0.015 |
| Chloride | DETSC 2055 | 0.1 | mg/l | 61 | 46 |
| Nitrate as NO3 | DETSC 2055 | 0.1 | mg/l | 140 | 34 |
| Sulphate as SO4 | DETSC 2055 | 0.1 | mg/l | 160 | 71 |
| Sulphide | DETSC 2208 | 10 | ug/l | < 10 | < 10 |
| Total Organic Carbon | DETSC 2033 | 2 | mg/l | 59 | 36 |
| **Petroleum Hydrocarbons** | | | | | |
| EPH (C10-C40) | DETSC 3311 | 10 | ug/l | 120 | 59 |
| **PAHs** | | | | | |
| Chrysene | DETS 074* | 0.01 | ug/l | < 0.01 | < 0.01 |
| PAH | DETS 074* | 0.2 | ug/l | < 0.20 | < 0.20 |
| **Phenols** | | | | | |
| Phenol | * | 0.5 | ug/l | < 0.50 | < 0.50 |

Key: * -not accredited. n/s -not supplied.

# Information in Support of the Analytical Results

*Our Ref* 15-31818
*Client Ref* J15072
*Contract* Tybalds Estate, London WC1N 3JT

## Containers Received & Deviating Samples

| Lab No | Sample ID | Date Sampled | Containers Received | Holding time exceeded for tests | Inappropriate container for tests |
|---|---|---|---|---|---|
| 794683 | BH1T 4.00 WATER | 03/03/15 | GB 1L, GV | Conductivity (28 days), Conductivity (non reportable) (28 days), Anions (30 days), Kone (30 days), Kone (Sulphide) (30 days), pH/Cond/TDS (7 days), Metals (Soluble) ICPMS (30 days), Naphthalene (14 days), Ammoniacal Nitrogen as N (10 days), Nitrate as NO3 (2 days), PAH LC (14 days), Phenols MS (21 days), TOC (7 days), EPH (14 days) | |
| 794684 | BH2TA 4.00 WATER | 03/03/15 | GB 1L, GV | Conductivity (28 days), Conductivity (non reportable) (28 days), Anions (30 days), Kone (30 days), Kone (Sulphide) (30 days), pH/Cond/TDS (7 days), Metals (Soluble) ICPMS (30 days), Naphthalene (14 days), Ammoniacal Nitrogen as N (10 days), Nitrate as NO3 (2 days), PAH LC (14 days), Phenols MS (21 days), TOC (7 days), EPH (14 days) | |

Key: G-Glass B-Bottle V-Vial

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time and/or inappropriate containers are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

## Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

GEA Geotechnical & Environmental Associates

Widbury Barn
Widbury Hill
Ware
Herts SG12 7QE

# Generic Risk-Based Soil Screening Values

| | | |
|---|---|---|
| **Site** | Tybalds Estate, Camden, London WC1N 3JT | **Job Number** J15072 |
| **Client** | Durkan Ltd | **Sheet** 1 / 1 |
| **Agent** | Mason Navarro Pledge | |

**Proposed End Use** Residential without plant uptake

**Soil pH** 8

**Soil Organic Matter content %** 1.0

| Contaminant | Screening Value mg/kg | Data Source |
|---|---|---|
| ***Metals*** | | |
| Arsenic | 40 | C4SL |
| Cadmium | 149 | C4SL |
| Chromium (III) | 3000 | LQM/CIEH |
| Chromium (VI) | 21 | C4SL |
| Copper | 2,330 | LQM/CIEH |
| Lead | 310 | C4SL |
| Elemental Mercury | 1.02 | SGV |
| Inorganic Mercury | 235 | SGV |
| Nickel | 130 | LQM/CIEH |
| Selenium | 595 | SGV |
| Zinc | 3,750 | LQM/CIEH |
| ***Hydrocarbons*** | | |
| Benzene | 0.89 | C4SL |
| Toluene | 120 | SGV |
| Ethyl Benzene | 65 | SGV |
| Xylene | 42 | SGV |
| Aliphatic C5-C6 | 30 | LQM/CIEH |
| Aliphatic C6-C8 | 73 | LQM/CIEH |
| Aliphatic C8-C10 | 19 | LQM/CIEH |
| Aliphatic C10-C12 | 93 | LQM/CIEH |
| Aliphatic C12-C16 | 740 | LQM/CIEH |
| Aliphatic C16-C35 | 45,000 | LQM/CIEH |
| Aromatic C6-C7 | See Benzene | LQM/CIEH |
| Aromatic C7-C8 | See Toluene | LQM/CIEH |
| Aromatic C8-C10 | 27 | LQM/CIEH |
| Aromatic C10-C12 | 69 | LQM/CIEH |
| Aromatic C12-C16 | 140 | LQM/CIEH |
| Aromatic C16-C21 | 250 | LQM/CIEH |
| Aromatic C21-C35 | 890 | LQM/CIEH |
| PRO ($C_5$ –$C_{10}$) | 270 | Calc |
| DRO ($C_{12}$ –$C_{28}$) | 46,130 | Calc |
| Lube Oil ($C_{28}$ –$C_{44}$) | 45,890 | Calc |
| **TPH** | **1000** | Trigger for speciated testing |

| Contaminant | Screening Value mg/kg | Data Source |
|---|---|---|
| ***Anions*** | | |
| Soluble Sulphate | 0.5 g/l | Structures |
| Sulphide | 50 | Structures |
| Chloride | 400 | Structures |
| ***Others*** | | |
| Organic Carbon (%) | 6 | Methanogenic potential |
| Total Cyanide | 140 | WRAS |
| Total Mono Phenols | 310 | SGV |
| ***PAH*** | | |
| Naphthalene | 2.33 | Rev. LQM/CIEH |
| Acenaphthylene | 1,950 | LQM/CIEH |
| Acenaphthene | 2,020 | LQM/CIEH |
| Fluorene | 1,850 | LQM/CIEH |
| Phenanthrene | 837 | LQM/CIEH |
| Anthracene | 19,800 | LQM/CIEH |
| Fluoranthene | 972 | LQM/CIEH |
| Pyrene | 2,330 | LQM/CIEH |
| Benzo(a) Anthracene | 5.5 | Rev. LQM/CIEH |
| Chrysene | 13 | Rev. LQM/CIEH |
| Benzo(b) Fluoranthene | 10.6 | Rev. LQM/CIEH |
| Benzo(k) Fluoranthene | 15.2 | Rev. LQM/CIEH |
| Benzo(a) pyrene | 4.65 | C4SL |
| Indeno(1 2 3 cd) Pyrene | 6.3 | Rev. LQM/CIEH |
| Dibenzo(a h) Anthracene | 1.31 | Rev. LQM/CIEH |
| Benzo (g h i) Perylene | 71 | Rev. LQM/CIEH |
| **Screening value for PAH** | **66.4** | B(a)P / 0.15 |
| ***Chlorinated Solvents*** | | |
| 1,1,1 trichloroethane (TCA) | 6.33 | LQM/CIEH |
| tetrachloroethane (PCA) | 1.08 | LQM/CIEH |
| tetrachloroethene (PCE) | 1.03 | LQM/CIEH |
| trichloroethene (TCE) | 0.11 | LQM/CIEH |
| 1,2-dichloroethane (DCA) | 0.00646 | LQM/CIEH |
| vinyl chloride (Chloroethene) | 0.000543 | LQM/CIEH |
| tetrachloromethane (Carbon tetra | 0.0362 | LQM/CIEH |
| trichloromethane (Chloroform) | 0.917 | LQM/CIEH |

*Notes*

Concentrations measured below the above values may be considered to represent 'uncontaminated conditions' which pose 'LOW' risk to human health. Concentrations measured in excess of these valuesindicate a potential risk which require further, site specific risk assessment.

SGV - Soil Guideline Value, derived from the CLEA model and published by Environment Agency 2009

LQM/CIEH - Generic Assessment Criteria for Human Health Risk Assessment 2nd edition (2009)derived using CLEA 1.04 model 2009

C4SL - Defra Category 4 Screening value based on Low Level of Toxicological Risk

Rev LQM/CIEH calculated using C4SL revisions to exposure assessment but LQM/CIEH health criteria values

Calc - sum of nearest available carbon range specified including BTEX for PRO fraction

B(a)P / 0.15 - GEA experience indicates that Benzo(a) pyrene (one of the most common and most carcenogenic of the PAHs) rarely exceeds 15% of the total PAH concentration, hence this Total PAH threshold is regarded as being conservative

| | | |
|---|---|---|
| GEA Geotechnical & Environmental Associates<br>Widbury Barn<br>Widbury Hill<br>Ware<br>Herts SG12 7QE | | **Site Plan** |
| **Site** | Tybalds Estate, Camden, London WC1N 3JT | **Job Number** J15072 |
| **Client** | Durkan Ltd | **Sheet** 1 / 1 |
| **Engineer** | Mason Navarro Pledge | |


Exploratory positions undertaken by Harrison Group

**Exploratory positions undertaken by GEA**

Approximate scale in metres

0 60 120 180

Geotechnical & Environmental Associates (GEA)
is an engineer-led and client-focused independent specialist providing a complete range of geotechnical and contaminated land investigation, analytical and consultancy services to the property and construction industries.

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GEA Geotechnical & Environmental Associates