ARLINGTON BUSINESS PARKS (G P) LTD

PLOT 5600 SITE B HATFIELD BUSINESS PARK, GYPSY MOTH AVENUE, HATFIELD AL10 9BS

REPORT ON PHASE 2 GROUND INVESTIGATION

Contract: 52050A

Date: June 2013

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carried out at

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GYPSY MOTH AVENUE, HATFIELD AL10 9BS

Prepared for

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Arlington Business Park
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EXECUTIVE SUMMARY

On the instructions of the Baynham Meikle Partnership, on behalf of Arlington Business Parks (GP) Ltd, an investigation was undertaken to determine ground conditions to enable foundation and road/hard standing design to be carried out, together with a contamination risk assessment and a review of gas emissions.

The site, which is proposed for commercial development, is situated approximately 1.6km to the northwest of the town centre of Hatfield and may be located by Grid Reference TL 215 097.

Published geological and hydrogeological records indicate the site to be located above unproductive strata relating to the negligibly permeable superficial deposits of the Lowestoft Formation, which is underlain by a Principal aquifer relating to the highly permeable Nodular Chalk Formation and the Seaford Chalk Formation.

Site works were undertaken between the 2 May and 10 May 2013 and comprised two cable percussion boreholes to a depth of 11m, four window sampler boreholes to 5.45m and four machine-dug trial pits to between 3.00m and 3.10m. The exploratory locations encountered the anticipated geological sequence, though superficial deposits of the Lowestoft Formation were generally found to comprise predominantly outwash sand and gravel with a thin overlying clay bed interpreted as Till. The natural strata were overlain by a thickness of Made/Reworked Ground which extended to a depth of up to 1.30m and to an average depth of 1.0m.

Consideration may be given to the adoption of conventional shallow spread footings to support any proposed structures, taken through any Made/Reworked Ground and placed in the underlying natural strata at a minimum depth of 0.75m. At the average depth for the Made/Reworked Ground of 1.0m foundations may be designed to an allowable bearing pressure of 160kPa.

Within the zone of influence of recently removed, existing or proposed trees, foundations should be taken through the Made/Reworked Ground and placed at depths recommended by the NHBC for soils of low volume change potential. Where shallow spread foundations are to be formed at a depth and of a size so as to be uneconomical or impractical consideration may be given to a deep foundation solution such as piles or ground improvements.

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

The assessment did not identify any contamination within the shallow soils that would represent a significant risk to the proposed commercial development. Very marginally elevated leachate results for petroleum hydrocarbons were identified in one sample, though the concentrations are not considered to represent a significant risk to controlled waters. However, elevated carbon dioxide was identified and therefore, gas protection measures may be required in the new building(s). Further monitoring is recommended to comply more closely with current guidelines prior to final design being undertaken.

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1.0 INTRODUCTION

1.1 It is understood that the site is proposed for commercial development.

1.2 On the instructions of the Baynham Meikle Partnership, on behalf of Arlington Business Parks (GP) Ltd, an investigation was undertaken to determine ground conditions to enable foundation and road/hard standing design to be carried out, together with a contamination risk assessment and a review of gas emissions.

1.3 This report should be read in conjunction with the Phase 1 Desk Study, which was reported under reference 52050 in May 2013.

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

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

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

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

2.0 SITE SETTING

2.1 Site Location

2.1.1 The site is situated approximately 1.6km to the northwest of the town centre of Hatfield and may be located by Grid Reference TL 215 097.

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

2.2 Geological Setting

2.2.1 Details of the geology underlying the site have been obtained from the British Geological Survey map, Sheet No. 239, 'Hertford', drift edition, 1:50,000 scale, published 1978.

2.2.2 The geological map indicates the site to be underlain by superficial deposits of the Lowestoft Formation, comprising chalky till together with outwash sands and gravels, silts and clays.

2.2.3 The superficial deposits are underlain by undifferentiated deposits of the Lewes Nodular Chalk Formation and Seaford Chalk Formation, described as a soft white chalk with many flints.

2.2.4 Although not indicated as present on the site from the geological maps, there is the possibility that Made Ground may exist on the site as a result of its previous use as an aerodrome and surrounding development.

2.2.5 Local existing boreholes close to the site indicate superficial deposits of up to 18.70m thick underlain by chalk. This information is based upon records provided by the British Geological Survey.

3.0 SUMMARY DESK STUDY FINDINGS

3.1 A walkover survey of the site was carried out on the 29 April 2013, at which time the site comprised a vacant plot of land with drainage ditches present along the northern, eastern and western boundaries, which were partly filled with general domestic waste. A bus garage was noted immediately to the southwest of the site.

3.2 Whilst the review of available historical maps revealed that the site was located within an agricultural field from the earliest map, dated 1879, and has since remained undeveloped, though from c.1960 appeared to be located within an airfield, later identified as Hatfield Aerodrome. By c.2006, the site was located within its current setting of a business park. A works was located approximately 210m to the west of the site from c.1960 and was redeveloped, along with the aerodrome as part of the current business park c.2006.

3.3 The assessment identified the following potential sources of contamination which were considered to represent a possible risk to the proposed development and required further investigation:

- Contamination associated with Made Ground due to previous use of the site as an aerodrome and surrounding development, and the potential infilling of the former watercourse in the western part.
- Contamination directly associated with the use of the site as an aerodrome, such as potential storage of fuels and lubricating oils on the land.
- Contamination associated with surrounding commercial sites, particularly the bus depot to the southwest.

3.4 The overall risk to end users and controlled waters, both groundwater and surface water, from potential contamination beneath the site was considered to be low to moderate.

4.0 SITE WORK

4.1 The site work was carried out between 2 May and 10 May 2013. The locations of exploratory holes were as per the clients instructions and planned, where possible, in general accordance with CLR 4, ref. 10.1 and the site work carried out on the basis of the practices set out in BS 10175:2001, ref. 10.2, BS 5930:1999 ref. 10.3 and ISO 1997:2007, ref 10.4.

4.2 Two boreholes, designated 202 and 203, were sunk by light cable percussion method, four boreholes, designated WS201 to WS204, were undertaken by drive-in window sampler technique and four trial pits, designated TP201 to TP204, were dug by mechanical excavator at the positions shown on the site plan, Appendix 1, Figure A1.1. The depths of boreholes and trial pits, descriptions of strata encountered and comments on groundwater conditions are given in the borehole and trial pit records, Appendix 2, Figures A2.1 to A2.10.

4.3 Representative disturbed samples were taken at the depths shown on the borehole and trial pit records and despatched to the laboratory. Standard (split-barrel and cone) penetration tests, refs. 10.6 and 10.5 were carried out in the light cable percussion and window sampler boreholes in the various strata to assess the relative density or consistency. The values of penetration resistance are given in the borehole records.

4.4 In-situ CBR tests were carried out at the locations of trial pits 201 to 204 and the results provided in Figure A2.11.

4.5 A falling head permeability test was carried out in trial pit 201, in line with guidelines given in BRE Digest 365, ref 10.7. The result of which is included in Figure A2.12.

4.6 Monitoring installations protected by a stopcock cover were installed in boreholes 202 to 203 as detailed in the borehole records, and groundwater and gas monitoring visits were undertaken on the 21 May and 7 June 2013 as detailed in Figure A2.13.

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

4.8 The ground levels at the borehole and trial pit locations were not determined.

5.0 LABORATORY TESTS

5.1 Geotechnical Testing

5.1.1 Geotechnical soil analysis was undertaken of samples obtained during the investigation based on the strata encountered as follows:

5.1.2 7 No. Water Content Tests.

5.1.3 7 No. Plasticity Index Tests.

5.1.4 5 No. Particle Size Distribution (by Wet Sieving and Pipette Method).

5.1.5 The laboratory test report is given in Appendix 3, Figure A3.1.

5.2 Chemical Testing

5.2.1 The suite of chemical analyses has been based upon the findings of the desk study, along with any on-site observations, to investigate the potential sources of contamination identified in the conceptual model. The chemical analyses were carried out on six samples of soil. Leachate analysis was also conducted on two of the soil samples, and Waste Acceptance Criteria (WAC) analysis on one sample. The nature of the analyses is detailed below:

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

5.2.3 **Organics Suite -** petroleum hydrocarbons – TPH CWG speciated analysis and EPH basic carbon banded analysis and polycyclic aromatic hydrocarbons (PAH) – USEPA 16 suite.

5.2.4 **Inorganics Suite** - water soluble sulphate.

5.2.5 **Others** - Waste Acceptance Criteria (WAC) full suite.

5.2.6 The results of these tests are shown in Appendix 4, Figure A4.1.

6.0 GROUND CONDITIONS ENCOUNTERED

6.1 Sequence

6.1.1 The sequence of the strata encountered during the investigation generally confirms the anticipated geology as interpreted from the geological map, though the chalk formation was not encountered for the depth of this investigation.

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

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

Strata Encountered	Depth Encountered (m)		Strata Thickness (m)
	From	To	
Made/Reworked Ground	0.00	0.40 to 1.30	0.40 to 1.30
Lowestoft Formation - Till	0.40 to 1.30	1.40 to 4.25	0.70 to 2.95
Lowestoft Formation – Outwash Sand and Gravel	1.05 to 4.25	>11.00	>9.10

6.2 Made/Reworked Ground

6.2.1 Made/Reworked Ground was identified at the majority of locations extending to a depth of between 0.40m and 1.30m and to an average depth of 1.0m.

6.2.2 The material was of variable consistency/strength ranging from soft to very stiff, and generally comprised friable dark brown/orange brown slightly sandy to sandy slightly gravelly to gravelly very silty clay with occasional black flecks and rare pockets of decomposing matter or dark orange brown/brown slightly sandy slightly gravelly clayey silt with rootlets.

6.2.3 Rare to occasional made materials were encountered in borehole WS201 and trial pits 201, 202 and 204 including brick, iron, clinker, ash, wood and concrete fragments.

6.3 Lowestoft Formation - Till

6.3.1 Material interpreted as possible Till was encountered below the Made/Reworked Ground in all the exploratory locations apart from trial pits 203 and 204 to a depth of between 1.40m and 4.25m consisting of firm, occasionally soft towards the top orange brown and dark brown occasionally mottled light bluish grey slightly sandy to very sandy slightly gravelly to very gravelly clay with occasional black flecks and rootlets.

6.4 Lowestoft Formation – Outwash Sand and Gravel

6.4.1 Predominantly granular deposits underlay the Made/Reworked Ground or Till to the full depth of the investigation at 11m.

6.4.2 This material generally comprised interbedded medium dense orange brown occasionally slightly clayey to very clayey sand and gravel, sandy to very sandy gravel, clayey slightly gravelly to very gravelly sand and clayey sand.

6.4.3 A bed of orange brown and light grey slightly sandy silty clay was noted in borehole 202 from 3.60m to 4.40m.

6.5 Groundwater

6.5.1 Groundwater was encountered in boreholes 202 and 203 at depths of between 8.70m and 8.90m rising in a twenty minute period to a depth of between 7.40m and 7.90m, and in borehole WS201 at 4.30m.

6.5.2 On return visits to monitor the standpipes installed in boreholes 202 and 203 to depths of 4.0m and 10.0m respectively, significant groundwater was recorded in borehole 203 only at 6.73m to 6.79m. Groundwater was noted at the full depth of the pipe in borehole 202.

7.0 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS IN RELATION TO THE PROPOSED DEVELOPMENT

7.1 Structural Details

7.1.1 It is understood that the proposed development is to consist of a new commercial development.

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

7.2 Assessment of Soil Condition

7.3 Made/Reworked Ground and Till

7.3.1 Laboratory testing for the clay beds in these materials recorded natural moisture contents of between 14% and 28%, with an average of 21%, liquid limits of between 25% and 43%, with an average of 34%, plastic limits of between 13% and 20%, with an average of 17% and plasticity indices of between 11% and 27%, with an average of 17%. The plastic index test results are presented on the plasticity classification chart, Appendix 3, Figure A3.2.

7.3.2 These results indicate the clay beds are of low to intermediate plasticity and of low to medium volume change potential. Whilst modified plasticity index values indicate the material to be of no to medium volume change potential with the average modified plasticity index value of 13% suggesting low volume change as defined by the National House Building Council, ref 10.10 and other published data, refs 10.11 and 10.12. Changes in moisture content will result in small to moderate changes in volume, seasonal changes being exacerbated by the presence of trees. It is recommended that for design purposes, low volume change potential could be adopted.

7.3.3 SPT's were undertaken and where full penetration was achieved, recorded SPT 'N' values of between 7 and 21, with an average of 16 suggesting the material to be medium to high strength.

7.3.4 In situ CBR tests carried out at each of the trial pit locations at a depth of 0.45m below ground level recorded CBR values of 3.2%, 8.9% and 19% with one test exceeding the maximum limit of the apparatus.

7.4 Outwash Sand and Gravel

7.4.1 SPT's undertaken in this material where full penetration was achieved, recorded 'N' values of between 2 and 22, with an average of 16.

7.4.2 These values indicate the material is generally medium dense occasionally loose, whilst the particle size grading indicates the deposit to be generally well graded sand and gravel, sandy gravel and occasionally gravelly sand with shallower deposits containing a significant silt/clay fraction of some 24%.

7.5 Foundation Design

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

7.5.2 Outside the zone of influence of existing and proposed trees, it is recommended that conventional shallow spread footings should be taken through any Made/Reworked Ground and placed in the underlying natural strata at a minimum depth of 0.75m. Due to the depth of Made/Reworked Ground encountered in the boreholes and trial pits, it is likely that foundations would have to be placed at depths up to 1.30m and to an average depth of 1.0m.

7.5.3 Within the zone of influence of recently removed, existing or proposed trees, foundations should be taken through the Made/Reworked Ground and placed at depths recommended by the NHBC for soils of low volume change potential.

7.5.4 Such foundations at the average depth of 1.0m may be designed to an allowable bearing pressure of 160kPa which would provide an adequate factor of safety against shear failure. Settlements are likely to be of the order of 20mm, however, these should be checked when the final structural loading is known.

7.5.5 Due to the variable nature of the shallow deposits encountered it is possible that shallow spread foundations within the same structure could be supported on beds of variable consistency resulting in possible differential settlements and therefore it is recommended that nominal reinforcement be included within the foundations to minimise differential settlement.

7.5.6 It may be considered that for foundations over a certain depth it may be more economical to adopt a deep foundation solution in the form of piles or ground improvements.

7.5.7 Guidelines for the design of piles are given in Appendix 5, which may be used with the plot of SPT 'N' value with depth included in Figure A5.1. Within the zone of influence of trees the piles should be sleeved to depths equivalent to those specified by the NHBC for a foundation at the same location. Compressible material should be placed below and on the inside faces of pile caps and beams, as specified by the NHBC.

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

7.5.9 It should be noted that groundwater was present which could affect the installation of the piles.

7.5.10 A specialist contractor should be contacted as to the suitability of the ground conditions for ground improvements.

7.6 Ground Floor Slabs

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

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

7.7 Excavations

7.7.1 On the basis of observations on site, together with the results of in-situ and laboratory tests, it is considered that excavations to less than 1.20m would not stand unsupported in the short term. Side support for safety purposes should of course be provided to all excavations which appear unstable, and those in excess of 1.20m deep, in accordance with Health and Safety Regulations, ref. 10.13.

7.7.2 Groundwater should not be expected in shallow excavations for foundations or services. However, it is possible that perched groundwater could be present in the Made Ground overlying the more clay based Till. It is considered that this could be dealt with by the use of a small pump.

7.7.3 Groundwater should be anticipated from depths of 4.3m.

7.8 Road and Hard Standing Design

7.8.1 The structural design of a road or hard standing is based on the strength of the subgrade, which is assessed on the California Bearing Ratio, CBR, scale from which the subgrade surface modulus can be estimated. Experience has indicated that the measurement of the in-situ CBR value tends to give unreliable results because of the influence of the moisture content of the materials. In practice, the correlation given by the Highways Agency, ref. 10.14, is usually more appropriate than direct determination of the CBR.

7.8.2 The process of design given in the guidance notes requires an estimate of CBR and subgrade stiffness modulus to be made at the design stage and in-situ measurement prior to construction.

7.8.3 On the basis of laboratory classification and in-situ CBR tests and taking into account the variable nature of the material encountered, it is recommended that for formation prepared in the Made/Reworked Ground, a subgrade CBR value of 6% be adopted for design purposes. The assessment assumes there to be a low water table, good construction conditions and a thin pavement construction. Any areas of soft or deleterious material in the Made Ground should be excavated and replaced with a properly compacted granular fill.

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

7.9 Soakaways

7.9.1 A soakaway test was undertaken in trial pit 201 in the slightly sandy slightly gravelly clay over clayey very gravelly sand from a depth of 0.80m.

7.9.2 The result of the permeability test gave coefficient of permeability in the Lowestoft Formation of $3x10^{-6}$m/s.

7.10 Chemical Attack on Buried Concrete

7.10.1 The site has been classified in accordance with BRE Special Digest 1, ref. 10.17, as Made Ground and natural ground without the presence of pyrite and laboratory testing undertaken accordingly. It is recommended that the guidelines given in BRE Special Digest 1, ref. 10.17, be adopted.

7.10.2 The results of chemical tests in the non-pyritic soils indicate a sulphate concentration in the soil of between <10mg/l and 25mg/l as a 2:1 water/soil extract, with pH values in the range of 7.4 and 8.2.

7.10.3 It is recommended that for conventional shallow foundations the groundwater should be regarded as mobile. Static groundwater is defined as ground which is permanently dry, or is relatively impermeable, that is with a coefficient of permeability of generally less than 10^{-7}m/s.

7.10.4 On the basis of the laboratory test results it is considered that a Design Sulphate Class for this material may be taken as DS-1. The site conditions would suggest that an ACEC class for the site of AC-1 would be appropriate.

8.0 ENVIRONMENTAL RISK ASSESSMENT IN RELATION TO PROPOSED DEVELOPMENT

8.1 Contaminated Land

8.1.1 The statutory definition of contaminated land is defined in the Environmental Protection Act 1990, ref 10.18, which was introduced by the Environment Act 1995, ref 10.19, as;

8.1.2 'Land which appears to the Local Authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that –

- significant harm is being caused or there is a significant possibility of such harm being caused; or
- significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused.'

8.2 Risk Assessment

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

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

8.3 Pollutant Linkage

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

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

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

8.3.3 A pollutant linkage indicates that all three elements have been identified. The site can only be defined as 'Contaminated Land' if a pollutant linkage exists and the contamination meets the criteria in Section 8.1 above.

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

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

8.3.5 The hazard identification and hazard assessment have been based upon the Phase 1 Desk Study and formed the conceptual site model, detailed in our report, reference 52050, dated May 2012.

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

8.4 Risk Assessment – Human Health

8.4.1 The site is proposed for commercial development. The risk assessment has therefore been based on guidelines for commercial / industrial end use. Should the proposed development be changed in the future then further risk assessment may be required, particularly should a more sensitive end-use be envisaged.

8.4.2 The results of the soil analyses have been compared to CLEA SGVs published in Environment Agency Science Reports SC050021/SR3, ref 10.20 and SC050021, ref 10.21, where available, and Generic Assessment Criteria (GAC), determined by LQM and CIEH, ref 10.22, in accordance with current legislation and guidance, as detailed in Appendix 6.

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

8.4.4 The results of chemical analyses have been processed in accordance with recommendations set out in the CIEH and CL:AIRE document 'Guidance on Comparing Soil Contamination Data with a Critical Concentration', ref 10.24. Where the concentrations determined on site are at or below the respective Guidance Level, they are considered not to pose a risk and are removed from further consideration, unless otherwise stated.

8.4.5 None of the results exceeded the relevant guideline values and therefore, no contamination has been identified that is considered to represent a risk to the proposed commercial development.

8.5 Risk Assessment - Controlled Waters

8.5.1 The site is located above a Principal aquifer, though this may be afforded some protection by the overlying low permeability superficial deposits (unproductive strata), and it is within a zone 3 source protection zone.

8.5.2 The nearest surface water feature is a pond located approximately 15m to the northwest of the site, and a surface water drain is located immediately beyond Hatfield Avenue to the north. During the walkover survey, drainage ditches were noted along the northern, eastern and western boundaries of the site.

8.5.3 An initial assessment of the risk to controlled waters has been carried out on the basis of the results of leachate analysis undertaken on two of the soil samples from borehole WS201 and trial pit 204, both at a depth of 0.30m. The leachate results have been screened against the Water Supply (Water Quality) Regulations 2000, ref. 10.30, and also the freshwater Environmental Quality Standards (EQS), ref. 10.32.

8.5.4 It should be noted that there is no TPH guideline parameter within the Water Supply Regulations 2000. As such, the guidance value of 10µg/l within the Water Supply Regulations 1989, ref. 10.31, has been adopted as a conservative approach.

8.5.5 The majority of the results were below the relevant guidance values with the exception of petroleum hydrocarbons (EPH) in the sample from trial pit 204, which just exceeded the guidance value of 10µg/l within the Water Supply Regulations 1989 with 11µg/l in the carbon range C_{21}-C_{36} and a total concentration (C_{10}-C_{40}) of 16µg/l. These concentrations are not considered to represent a significant risk to controlled waters, particularly given the absence of any other contamination identified in either the soil or leachate analyses.

8.5.6 It is recommended that the Environment Agency be consulted with regard to the significance of these results, particularly in light of the fact that there is no current guideline TPH parameter within the Water Supply Regulations 2000.

8.5.7 Given the ground conditions encountered at the site and the results of this contamination assessment, it is considered unlikely that further assessment of the risks to controlled waters will be required.

8.6 Gas Generation

8.6.1 Gas monitoring visits were undertaken on the 21 May and the 7 June 2013, the results of which are included within Appendix 2, Figure A2.13.

8.6.2 The results of initial gas monitoring determined the presence of methane at a concentration of up to 0.1%v/v and carbon dioxide up to 5.3%v/v, with no detectable air flow recorded. Atmospheric pressure was 1011mb and 1017mb respectively.

8.6.3 On the basis of these results, with carbon dioxide exceeding 5%v/v in borehole 202 on the first visit, the site would be classified under Characteristic Situation 2, Table A7.2 and therefore, remedial measures may be required. For Situation A, being any development other than low rise residential with suspended floor slab and ventilated void, gas protective measures are given in Appendix 7, sections A7.7 and A7.10.

8.6.4 These comments are based on two sets of readings over a period of approximately two weeks, both undertaken with high atmospheric pressure (>1000mb), which does not follow the recommended guidelines given in Appendix 7, Table A7.1. As elevated concentrations were recorded, it is recommended that a continued programme of monitoring be carried out to comply more closely with these guidelines before final design is undertaken.

8.7 Protection Of Services

8.7.1 Due to the increasing number of developments being undertaken on potentially contaminated land, the Water Supply Industry has identified the need to protect newly laid water supply pipes. They are likely to impose constraints on the nature of water supply pipes that are to be laid in contaminated land. Guidance on the selection of materials for water pipes is provided by the Water Regulations Advisory Scheme, ref 10.33.

8.8 Risk Evaluation

8.8.1 The conceptual model formed within the Phase 1 Desk Study has been updated to reflect the findings of the contamination risk assessment and the revised conceptual model, detailing the relevant pollutant linkages, is tabulated below:

Source	Potential Pathways	Receptor Group	Recommendations
Very marginally elevated concentrations of leachable petroleum hydrocarbons	• Infiltration • Migration • Surface run-off	Water Environment • Groundwater • Surface waters	Concentrations identified, not considered to represent a significant risk to controlled waters. Environment Agency should be consulted for confirmation.
Elevated carbon dioxide gas	• Migration • Ingression	Humans and buildings • Gas ingress into building/s • Site occupants	Further monitoring followed by installation of protection measures as appropriate, to be agreed with Local Authority Building Regulations.

8.9 Summary of Risk Evaluation

8.9.1 The above assessment identifies that the 'source – pathway – receptor' linkage potentially occurs with carbon dioxide. Therefore, it would be necessary to manage the risk at this location by either eliminating one of the links or by minimising the potential effects.

8.9.2 Marginally elevated leachable petroleum hydrocarbons were also identified in one sample, though the identified concentrations are not considered to represent a significant risk to controlled waters. It is recommended that the Environment Agency be consulted for confirmation of whether any further assessment will be required.

8.9.3 It is proposed that further gas monitoring be undertaken to comply more closely with the recommended guidelines prior to the final design of gas protection measures for the proposed development.

8.10 Waste

8.10.1 An initial assessment of the likely waste classification for any material to be disposed of has been conducted on the basis of the chemical test results obtained as part of the contamination risk assessment.

8.10.2 This assessment has been conducted using the HazWasteOnline^{tm} tool, ref 10.34, the summary output sheet from which is included within Appendix 4, Figure A4.2, with a full copy of the output included on the accompanying CD.

8.10.3 This initial assessment indicates that none of the samples are likely to be classified as hazardous waste, on the basis of identified contaminant concentrations.

8.10.4 In addition, Waste Acceptance Criteria (WAC) analysis was carried out on one sample from trial pit 201 at a depth of 0.40m, the results of which are included in Figure A4.1 and indicate that the sample would be classified as inert waste.

8.10.5 It should be noted that individual tips might require further analysis prior to the disposal of any material from the site. Any such requirements should be clarified with the tip prior to any further analysis being undertaken.

9.0 MANAGEMENT OF CONTAMINATION

9.1 Remediation and Verification

9.1.1 The risk management framework set out in the Model Procedures for the Management of Land Contamination, CLR 11, ref. 10.35, is applicable to the redevelopment of sites that may be affected by contamination.

9.1.2 The risk management process set out in the Model Procedures has three main components:

- Risk assessment
- Options appraisal
- Implementation

9.1.3 This initial risk assessment has identified the presence of elevated carbon dioxide in one of the standpipes installed on the site, along with very marginally elevated leachate results, though these are not considered to represent a significant risk to controlled waters. Relevant pollutant linkages have been identified, as demonstrated in the updated conceptual model.

9.1.4 The remediation strategy will need to review methods of reducing or controlling the identified unacceptable risks. This could be done by removing or treating the source of contamination, removing or modifying the pathways or removing or modifying the behaviour of the receptors, to ensure there is no significant risk of significant harm to either human health or controlled waters from the identified contamination, in relation to the proposed end use.

9.1.5 An important part of the risk management process is identifying and informing all stakeholders with an interest in the outcome of the risk management project. To this end, if the regulators have not yet been contacted with regard to the redevelopment of this site, it is recommended that they be supplied with a copy of both the Phase 1 Desk Study and this Phase 2 Ground Investigation report in order to enable liaison to be undertaken with them.

9.1.6 Following liaison with the relevant regulatory bodies, a remediation strategy could be formulated, which should incorporate an options appraisal and summarise in detail the chosen remedial approach, along with the verification proposals. The remediation strategy should then be approved by the relevant regulatory authorities prior to implementation.

9.1.7 Where remediation is required, a verification report will need to be formulated following implementation of the remediation strategy, which should provide a complete record of all remedial activities conducted on site and include all the data obtained to support the remedial objectives and demonstrate that the remediation has been effective. Any unexpected conditions encountered during the remedial works should also be detailed within the verification report.

9.1.8 It is recommended that further gas monitoring is carried out following which, the level of protection required for the proposed development can be confirmed and the design submitted to and approved by the Local Authority.

9.2 Management of Unidentified Sources of Contamination

9.2.1 There is the possibility that other sources of contamination may be present on the site, which were not detected during the investigation. Should such contamination be identified or suspected during the site clearance or ground works, these should be dealt with accordingly. A number of options are available for handling this material, which include:

- The removal from site and disposal to a suitably licensed tip of all material suspected of being contaminated. The material would need to be classified prior to disposal.

- Short-term storage of the suspected material while undertaking verification testing for potential contamination. The storage area should be a contained area to ensure that contamination does not migrate and affect other areas of the site. Depending upon the amounts of material under consideration, this could be either a skip or a lined area.

- Having a suitably experienced environmental engineer either on-call or with a watching brief for the visual and olfactory assessment of the material, and sampling for verification purposes.

9.3 Consultation

9.3.1 During the development of a contaminated site, consultation may be required for a number of reasons with a number of regulatory Authorities. The following provides an indication as to the most likely Authorities with which consultation may be required.

- **Local Authority.** There may be a planning condition regarding contamination and consultation will be required with a designated Contaminated Land Officer within the Environmental Health Department. The Local Authority is generally concerned with human health risks. Some Authorities now require 'Completion Certificates' to be signed off following remediation works.

- **Environment Agency.** Where a site is within a groundwater protection zone or has been designated as a special site, the Environment Agency is likely to be involved to ensure that controlled waters are protected.

9.3.2 Based on the results of any consultation, there may be specific remediation requirements imposed by one or more of the Authorities.

9.4 Risk Management During Site Works

9.4.1 During ground works, some simple measures may have to be put in place to mitigate the risk of contamination affecting the site workers and the environs. The majority of the proposed measures represent good practice for the construction industry and include:

- Informing the site workers of the contamination on site and the potential health effects from exposure.
- Where appropriate, the provision of suitable Personal Protective Equipment (PPE) for workers who may be potentially impacted by working in areas of the contamination.
- Ensuring good hygiene is enforced on site and washing facilities are maintained on the site. Workers are discouraged from smoking, eating or drinking without washing their hands first.
- Dust monitoring, and if necessary, suppression measures should be put into practice where contamination is becoming airborne.
- Site drainage should be prevented from entering any adjacent watercourse, ref 10.36.

9.4.2 Where contaminated materials are being removed from the site they should be disposed of at a suitably licensed landfill, with a 'duty of care' system in place and maintained throughout the disposal operations.

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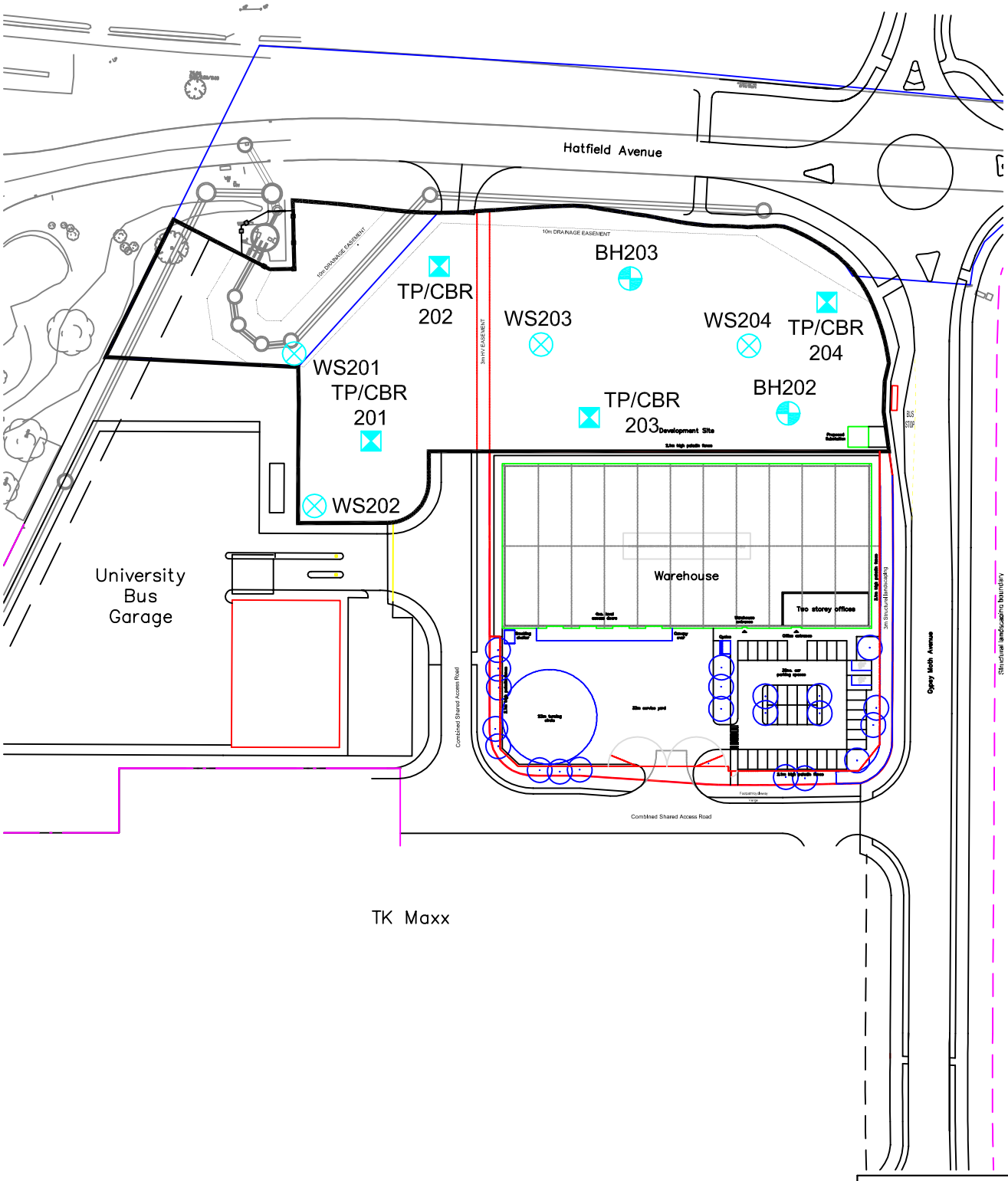
APPENDIX 1

DRAWINGS



Scale :	N.T.S.
Drawn By :	P.L.E.
Job No:	52050
Fig:	A1.1

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

SITE PLAN

Plot 5600, Site B, Hatfield Business Park.

APPENDIX 2

SITE WORK

APPENDIX 2

GENERAL NOTES ON SITE WORKS

A2.1 SITE WORK

A2.1.1 General

Site work is carried out in general accordance with the guidelines given in ISO 1997, 10.4 and BS 5930, ref 10.3.

A2.1.2 Trial Pits

Shallow trial pits are generally dug by mechanical excavator, however, in difficult access locations or adjacent to structures, such pits may be hand dug. Pits are best used where the ground will stand unsupported and generally, the maximum depth of machine dug pits is 4m to 5m. Where personnel are required to enter pits, it is essential that side support is provided. Entry by personnel into unsupported pits deeper than 1.2m is not allowed for health and safety reasons.

Trial pits allow the in-situ condition of the ground to be examined both laterally and vertically and also allow discontinuities to be recorded. The field record should give the orientation of the pit with details of which face was logged, assessment of stability of sides of pit and groundwater as well as the strata encountered. Photographs of the pit should also be taken.

In-situ testing, such as hand penetrometer, hand vane, Macintosh probe, or similar, can be undertaken in the sides or base of pits while both disturbed and undisturbed samples recovered.

It is generally advisable to backfill the pits as soon as possible, open pits should not be left unattended.

A2.1.3 Light Cable Percussion Boring

For routine soil exploration to depths in excess of 3m, the light cable percussion rig is generally employed for boring through soils and weak rocks, refs 10.3, 10.4 and 10.5. It consists of a powered winch and tripod frame, with running wheels that are permanently attached so that the rig may be towed behind a suitable vehicle. The rig is towed into position and set up using its own winching system.

The locations of services are checked to make sure the borehole is not situated unacceptably near any services. Regardless of the proximity of services, a CAT scan is undertaken at the borehole location and a trial hole dug to 1.20m by hand.

Boreholes are advanced in soil by the percussive action of the cable tool. The force of the cylindrical tool as it is dropped a short distance cuts a plug of cohesive soil that is removed by the tool.

In non-cohesive soils, the borehole is advanced by a ‘shell’, otherwise known as a ‘bailer’ or ‘sand pump’, which incorporates a clack valve. Material is transferred into the shell and retained by the clack valve. The water level in a borehole is maintained above that in the surrounding granular soil to allow for temporary reductions in the head of water as the shell is withdrawn from the borehole. Water should flow from the borehole into the surrounding soil at all times to prevent ‘piping’ and loosening the soil at the base of the hole. The casing is always advanced with the borehole in granular soil so that material is drawn from the base rather than the borehole sides.

Obstructions to boring are overcome by fitting a serrated chiselling ring to the base of the percussion tool. For large obstructions, a heavy chisel with a hardened cutting edge may have to be used.

Disturbed samples are taken in polythene bags, jars or tubs that are sealed against air or water loss.

Undisturbed samples are generally taken in cohesive materials at changes in strata and at one metre intervals to 5 metres then at 1.5 metre intervals to the full depths of the borehole. The general purpose open-tube sampler is suitable for firm to stiff clays, but is often used to retrieve disturbed samples of weak rocks, soft or hard clay and also clayey sand or silts. This has been adopted for routine use, and usually consists of a 100mm internal diameter tube (U100), which is capable of taking soil samples up to 450mm in length. The undisturbed samples are sealed at each end using micro-crystalline wax to prevent drying.

Standard penetration tests are generally carried out in non-cohesive soils but also in stiff clays and soft rocks at frequencies similar to that of undisturbed sampling.

A2.1.4 Percussive Window Sampling Rig

The percussive sampler consists of a track mounted window sampler, ref 10.37, with tube sizes varying in diameter from 98mm to 86mm. The sample tube is driven by a drop weight, which can also be used for dynamic probing and standard SPT tests. A cutting shoe is fitted to the bottom of each tube, whilst the sample is collected in a plastic sleeve.

The borehole is extended by using progressively smaller diameter tubes.

A2.2 IN-SITU TESTS

A2.2.1 Standard Penetration Test

The Standard Penetration Test is carried out in accordance with the proposals recommended by ISO 1997, ref 10.4, BS 1377, Part 9, 1990 ref 10.6 and ISO 22476 ref 10.5.

The standard penetration test, **SPT**, covers the determination of the resistance of soils to the penetration of a split barrel sampler. A 50mm diameter split barrel sampler is driven 450mm into the soil using a 63.5kg hammer with a 760mm drop. The penetration resistance is expressed as the number of blows required to obtain 300mm penetration below an initial seating drive of 150mm through any disturbed ground at the bottom of the borehole. The number of blows to achieve the standard penetration of 300mm is reported as the 'N' value.

The 'N' value reported on the borehole logs is as measured but may be corrected for the energy ratio (E_r) of the specific test equipment.

E_r for the drilling apparatus used for this ground investigation is

$E_r = 65.1\%$

The test is generally carried out in fine soils, however, it may also be carried out in coarse granular soils, weak rocks and glacial tills using the same procedure as for the SPT but with a 50mm diameter, 60° apex solid cone replacing the split spoon sampler, **CPT.**

When attempting the standard penetration test in very dense material or weathered rocks it may be necessary to terminate the test before completion to prevent damage to the equipment. In these circumstances it is important to distinguish how the blow count relates to the penetration of the sampler. This may be achieved in the following manner:

- Where the seating drive has been completed, the test drive is terminated if 50 blows are reached before the full penetration of 300mm is achieved. The penetration for 50 blows is recorded and an approximate N value obtained by linear extrapolation of the number of blows for the partial test drive.

- If the seating drive of 150mm is not achieved within the first 25 blows, the penetration after 25 blows is recorded and the test drive then commenced.

- For tests in soft rocks, the test drive should be terminated after 100 blows where the penetration of 300mm has not been achieved.

The N-value obtained from the Standard Penetration Test may be used to assess the relative density of sands and gravels as follows:

Term	SPT N-Value : Blows/300mm Penetration
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Over 50

A2.2.2 California Bearing Ratio, CBR

The California Bearing Ratio test is used to evaluate the strength of subgrade by measuring the load required to cause a plunger of standard size (50mm diameter) into the ground at a standard rate (1.00mm/min) and comparing the result with a standard material, ref 10.6.

The test is arbitrary in that the results cannot be accurately related to any of the fundamental properties governing soil strength. However, in that the deformation is predominantly shear, the CBR can be regarded as an indirect measurement of shear strength and modulus of subgrade reaction.

Alternative methods of determining the equivalent CBR by cone penetrometer can be undertaken. The Mexicone consists of a 30° cone of 129mm² cross-section that is pushed into the ground at a steady rate. The load is determined through a compression spring that deflects under load and is calibrated to give a direct reading of CBR on a dial. The instrument is best suited in cohesive or fine granular soil, but in gravelly soil it should not be used.

A2.3 SAMPLES

A2.3.1 General

Samples have been recovered and stored in accordance with the guidelines given in ISO 22475-1:2006, ref 10.37 and BS 5930, ref 10.3.

The undisturbed samples recovered from the percussive sampler were of varying diameters depending upon the depth taken and the ground conditions encountered.

In accordance with EN ISO 22475, ref. 10.37, and BS 5930, ref. 10.3, the thick walled U100 sample is considered as a Class B sampling technique and will only produce Class 3 to 5 quality samples in accordance with EN 1997-2:2007, ref. 10.4. A similar assumption can be made from samples tested from the percussive window sample probing.

Laboratory strength and consolidation testing can only be carried out on Class 1 quality samples, which can be obtained from a Class A sampling technique, ref. 10.4. This is due to possible disturbance during sampling, giving a weaker strength in testing.

Therefore values for c_u and mv derived for use in this report can only be used as guidance and not used to determine the shear strength properties of the clay and is not used to give a descriptive strength in the borehole records.

U represents undisturbed 100mm diameter sample, the number of blows to obtain the sample also recorded.

U fail indicates undisturbed sample not recovered

J represents sample recovered in an amber jar, generally for environmental analysis

HV represents Hand Vane test with equivalent undrained shear strength in kPa.

PP represents Pocket Penetrometer test with equivalent undrained shear strength in kPa.

CBR represents California Bearing Ratio test

B represents large bulk disturbed samples

D represents small disturbed sample

W represents water sample

$\underline{\nabla}$ represents water strike

$\underline{\blacktriangledown}$ represents level to which water rose

A2.4 DESCRIPTION OF SOILS

A2.4.1 General

The procedures and principles given in ISO 14688 Parts 1 and 2, ref 10.38, supplemented by section 6 of BS 5930, ref. 10.3 have been used in the soil descriptions contained within this report.

IAN FARMER ASSOCIATES

Site	Borehole Number
Plot 5600 - Site B - Hatfield Business Park	BH202

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 11.00m		Arlington Business Parks (GP) Ltd	52050
	Location	**Dates**	**Engineer**	**Sheet**
	TL 214 096	02/05/2013	Baynham Meikle Partnership	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.20 0.30-0.70	E1 B1					(1.20)	*Grass over soft to firm friable becoming firm to very stiff friable darkish brown, orange brown slightly sandy slightly gravelly very silty CLAY with occasional becoming rare rootlets. Sand is fine. Gravel is fine to coarse angular to rounded flint and occasional pebble. (REWORKED)			
0.80 0.80-1.20	E2 B2						From 0.80m; Soft to very stiff orange brown occasionally darkish brown.			
1.20-1.65 1.20-1.65	SPT N=11 D1	1.00	DRY	1,1/2,3,2,4		1.20 (0.70)	Soft to firm orange brown sandy gravelly silty CLAY with occasional black flecks. Sand is fine to coarse. Gravel is fine to medium angular to subrounded flint.			
1.90 2.00-2.45 2.00-2.50	D2 SPT(C) N=29 B3	2.00	DRY	3,3/5,7,7,10		1.90 (0.90)	Medium dense brown, orange brown silty very clayey becoming slightly wet orange brown, light brown slightly clayey to clayey fine to coarse SAND, fine to coarse angular to rounded flint and occasional pebble GRAVEL with occasional clay pockets.			
2.80 3.00-3.45 3.00-3.50	D3 SPT(C) N=10 B4	3.00	2.40	1,2/2,3,3,2		2.80 (0.80)	Wet becoming slightly wet loose to medium dense orange brown, light brown slightly clayey fine to coarse SAND, fine to coarse angular to rounded flint and occasional pebble GRAVEL.			
3.60 4.00-4.45 4.00-4.45	D4 SPT N=8 D5	4.00	3.10	1,2/2,2,2,2		3.60 (0.80)	Very soft orange brown occasionally light grey becoming firm brown, orange brown occasionally dark grey slightly sandy silty CLAY with occasional black flecks to 4.00m. Sand is fine to medium.			
							From 4.00m; Not sandy.			
4.60 5.00-5.45 5.00-5.50	D6 SPT(C) N=20 B5	5.00	2.70	3,4/4,3,5,8		4.40	Slightly wet to wet medium dense orange brown becoming brown, orange brown slightly clayey fine to coarse SAND, fine to coarse angular to rounded flint and some pebble GRAVEL.			
6.00 6.50-6.95 6.50-7.00	D7 SPT(C) N=20 B6	6.50	4.10	2,3/4,5,5,6						
7.40 7.50	W1 D8					(6.60)			▼1	
8.00-8.45 8.00-8.50	SPT(C) N=22 B7	8.00	6.90	2,2/5,5,6,6						
9.00	D9			Fast(1) at 8.70m, rose to 7.40m in 20 mins, not sealed.					▽1	
9.50-9.95 9.50-10.00	SPT(C) N=14 B8	9.50	8.40	1,1/3,4,4,3			From 9.50m to 10.00m; Slightly cobbly. Cobbles are subangular flint.			

Remarks

Plain standpipe installed to 0.50m surrounded with bentonite, slotted standpipe installed to 4.00m surrounded with pea gravel, bentonite seal to 4.50m, fitted with a gas tap and a stop cock cover.
*Drillers description.
Groundwater at 5.10m when casing removed.
Depth to water recorded at 3.00m, 4.00m, 5.00m, 6.50m and 8.00m SPT or CPT tests may possible be due to adding water to assist with drilling the borehole or may possibly be masking a groundwater strike.
Water added from 2.60m to 8.70m. Excavating from 0.00m to 1.20m for 1 hour.

Scale (approx)	Logged By
1:50	EM

Figure No. A2.1

IAN FARMER ASSOCIATES

Site	Borehole Number
Plot 5600 - Site B - Hatfield Business Park	BH202

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 11.00m		Arlington Business Parks (GP) Ltd	52050
	Location	**Dates**	**Engineer**	**Sheet**
	TL 214 096	02/05/2013	Baynham Meikle Partnership	2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.20	D10						... as previous			
10.50-10.95 10.50-11.00	SPT(C) N=21 B9	10.50	9.10	2,3,4,5,6,6 02/05/2013:9.10m		11.00	Complete at 11.00m			

Remarks

Scale (approx)	Logged By
1:50	EM

Figure No. A2.1

IAN FARMER ASSOCIATES

Site	Borehole Number
Plot 5600 - Site B - Hatfield Business Park	BH203

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 11.00m		Arlington Business Parks (GP) Ltd	52050
	Location	**Dates**	**Engineer**	**Sheet**
	TL 214 096	03/05/2013	Baynham Meikle Partnership	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.20 0.30-0.70	E1 B1					(1.20)	Firm to stiff friable darkish brown, orange brown slightly sandy slightly gravelly very silty CLAY with some becoming rare rootlets and occasional black flecks from 0.80m. Sand is fine. Gravel is fine to medium angular to rounded flint and rare pebble. (REWORKED)			
0.80 0.90-1.20	E2 B2						From 0.80m; Soft to firm brown, orange brown occasionally darkish brown. Sand is fine to medium to fine to coarse.			
1.20-1.65 1.20-1.70	SPT(C) N=10 B3	1.00	DRY	1,2/2,3,3,2		1.20	Soft to firm darkish brown, orange brown silty very sandy very gravelly CLAY with rare rootlets to 1.90m. Sand is fine to coarse. Gravel is fine to coarse angular to rounded flint and occasional pebble.			
1.90 2.00-2.45 2.00-2.50	D1 SPT(C) N=13 B4	2.00	DRY	1,2/3,3,4,3		(1.50)	From 1.90m; Brown, orange brown and light brown.			
2.70	D2					2.70	Medium dense orange brown silty very clayey fine to coarse SAND, fine to coarse angular to rounded flint and occasional pebble GRAVEL with frequent pockets of very soft to soft grey occasionally orange brown sandy silty clay from 3.00m to 3.50m and some becoming frequent pockets of soft orange brown, light brown silty very sandy very gravelly clay from 3.80m.			
3.00-3.45 3.00-3.50	SPT(C) N=12 B5	3.00	DRY	1,1/3,3,2,4						
3.80	D3					(2.00)				
4.00-4.45 4.00-4.50	SPT(C) N=13 B6	4.00	DRY	1,2/2,3,3,5			From 3.00m to 3.50m; Slightly gravelly SAND.			
4.70	D4					4.70	Slightly wet medium dense brown, orange brown slightly clayey fine to coarse SAND, fine to coarse angular to rounded flint and some pebble GRAVEL.			
5.00-5.45 5.00-5.50	SPT(C) N=18 B7	5.00	4.10	2,3/4,4,5,5						
6.00	D5									
6.50-6.95 6.50-7.00	SPT(C) N=18 B8	6.50	5.70	3,3/5,4,5,4						
7.50	D6									
7.90 8.00-8.45 8.00-8.50	W1 SPT(C) N=15 B9	8.00	7.40	1,2/4,4,4,3		(6.30)			▼1	
9.00	D7			Fast(1) at 8.90m, rose to 7.90m in 20 mins, not sealed.					▽1	
9.50-10.00	B10									

Remarks
Groundwater at 6.90m prior to installation of standpipe.
*Drillers description.
Depth to water recorded at 5.00m, 6.50m and 8.00m CPT tests may possible be due to adding water to assist with drilling the borehole or may possibly be masking a groundwater strike.
Plain standpipe installed to 1.00m surrounded with bentonite, slotted standpipe installed to 10.00m surrounded with pea gravel, fitted with a gas tap and a stop cock cover.
Water added from 4.50m to 8.90m. Excavating from 0.00m to 1.20m for 1 hour.

Scale (approx)	Logged By
1:50	EM

Figure No. A2.2

IAN FARMER ASSOCIATES

Site	Borehole Number
Plot 5600 - Site B - Hatfield Business Park	BH203

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 11.00m		Arlington Business Parks (GP) Ltd	52050
	Location	**Dates**	**Engineer**	**Sheet**
	TL 214 096	03/05/2013	Baynham Meikle Partnership	2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.20	D8						... as previous			
10.50-10.95 10.50-11.00	SPT(C) N=17 B11	10.50	9.10	2,2/4,5,5,3 03/05/2013:8.70m		11.00	Complete at 11.00m			

Remarks

Scale (approx)	Logged By
1:50	EM

Figure No. A2.2

IAN FARMER ASSOCIATES

Site	Trial Pit Number
Plot 5600 - Site B - Hatfield Business Park	TP201

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator	0.70m x 3.40m x 3.10m.		Arlington Business Parks (GP) Ltd	52050
	Location TL 214 096	**Dates** 08/05/2013	**Engineer** Baynham Meikle Partnership	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.15	E1				(0.80)	MADE GROUND: Dark orange brown slightly sandy slightly gravelly clayey silt with occasional rootlets, rare brick and iron. Gravel is fine to coarse subangular to subrounded flint.		
0.40	E2				0.80			
1.20	B1				(1.30)	Firm orange brown mottled light bluish grey slightly sandy slightly gravelly silty CLAY with rare pockets of sand. Gravel is fine to medium subangular to subrounded flint.		
2.50	B2				2.10			
					(1.00)	Light orange brown clayey silty very gravelly fine to medium SAND with rare pockets of clay and sand. Gravel is fine to coarse angular to subrounded flint.		
					3.10	Complete at 3.10m		

Plan

Remarks

Groundwater not encountered.
Soakaway test undertaken at 0.79m.

Scale (approx)	Logged By	Figure No.
1:50	LH	A2.3

IAN FARMER ASSOCIATES

Site	Trial Pit Number
Plot 5600 - Site B - Hatfield Business Park	TP202

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator			Arlington Business Parks (GP) Ltd	52050
	Location	**Dates**	**Engineer**	**Sheet**
	TL 214 096	08/05/2013	Baynham Meikle Partnership	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.15	E1				(1.00)	MADE GROUND: Dark orange brown slightly sandy slightly gravelly clayey silt with occasional rootlets and rare fragments of brick. Gravel is fine to coarse subangular to subrounded flint.		
0.60	E2				1.00			
					(0.90)	Firm dark orange brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse angular to subrounded flint.		
1.50	B1				1.90			
					(1.20)	Orange brown clayey silty very gravelly fine to medium SAND. Gravel is fine to coarse angular to subrounded flint.		
3.00	B2				3.10	Complete at 3.10m		

Plan

Remarks

Groundwater not encountered.

Scale (approx)	Logged By	Figure No.
1:50	LH	A2.4

IAN FARMER ASSOCIATES

Site	Trial Pit Number
Plot 5600 - Site B - Hatfield Business Park	TP203

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator			Arlington Business Parks (GP) Ltd	52050
	Location	**Dates**	**Engineer**	**Sheet**
	TL 214 096	07/05/2013	Baynham Meikle Partnership	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.15	E1				(1.05)	Soft to firm friable dark orange brown occasionally darkish brown slightly sandy gravelly very silty CLAY with rare decomposing organic matter and rootlets (REWORKED). Sand is fine to coarse. Gravel is fine to medium subangular to subrounded flint.		
0.60	E2							
0.75	B1				1.05			
1.60	B2				(1.95)	Orange brown occasionally light grey mottled clayey silty gravelly fine to medium SAND with rare pockets of sand.		
2.50	B3				3.00			
						Complete at 3.00m		

Plan

Remarks

Groundwater not observed.

Scale (approx)	Logged By	Figure No.
1:50	LH	A2.5

IAN FARMER ASSOCIATES

Site	Trial Pit Number
Plot 5600 - Site B - Hatfield Business Park	TP204

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator			Arlington Business Parks (GP) Ltd	52050
	Location	**Dates**	**Engineer**	**Sheet**
	TL 214 096	07/05/2013	Baynham Meikle Partnership	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.30	E1				(0.35) 0.35	MADE GROUND: Stiff to very stiff friable darkish brown, dark orange brown slightly gravelly sandy very silty clay with occasional ash, clinker, brick, concrete and wood fragments and rare rootlets. Sand is fine to medium. Gravel is fine to coarse angular to subrounded flint.		
0.70 0.75	E2 B1				(0.95) 1.30	Soft to firm friable dark orange brown slightly sandy slightly gravelly very silty CLAY with rare rootlets (REWORKED). Sand is fine. Gravel is fine to medium subangular to subrounded flint.		
1.60	B2				(1.80)	Orange brown clayey silty gravelly fine to medium SAND with rare pockets of sand. Gravel is fine to coarse angular to subrounded flint.		
2.50	B3				3.10	Complete at 3.10m		

Plan

Remarks

Groundwater not observed.

Scale (approx)	Logged By	Figure No.
1:50	LH	A2.6

IAN FARMER ASSOCIATES

Site	Number
Plot 5600 - Site B - Hatfield Business Park	WS201

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Percussive window sampler			Arlington Business Parks (GP) Ltd	52050
	Location TL 214 096	**Dates** 10/05/2013	**Engineer** Baynham Meikle Partnership	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.20	D1				(0.90)	MADE GROUND: Orange brown slightly gravelly sandy silty clay with occasional brick, concrete fragments, rootlets, rare ash and clinker.		
0.20	E1							
0.50	D2							
0.50	E2							
					0.90			
1.00	D3				(1.10)	Orange brown slightly gravelly silty sandy CLAY with rare pockets of decomposing organic matter, black speckling and rootlets. Gravel is fine subangular flint.		
1.50	D4							
					2.00			
2.00-2.45	SPT N=16		7,6/4,4,4,4		(0.40)	Medium dense light orange brown slightly gravelly clayey silty fine to medium SAND. Gravel is fine to medium subangular flint.		
2.00	D5							
2.00-2.45	D6				2.40			
2.20	D7				(0.35)	Light greyish brown clayey silty gravelly fine to medium SAND. Gravel is fine to coarse angular to subrounded flint.		
2.50	D8				2.75			
					(0.25)	Medium dense becoming very loose orange brown clayey silty gravelly fine to medium SAND with occasional black speckling. Gravel is fine to coarse angular to subrounded flint.		
3.00-3.45	SPT N=16		4,4/4,4,4,4		3.00			
3.00	D9							
3.00-3.45	D10							
3.50	D11					Medium dense orange brown occasional red brown mottled slightly gravelly clayey silty fine to medium SAND. Gravel is fine to medium angular to subrounded flint.		
4.00-4.45	SPT N=2		1,0/1,0,1,0					
4.00	D12				(2.45)			
4.00-4.45	D13		Water strike(1) at 4.30m.					▽1
4.50	D14							
5.00-5.45	SPT N=13		1,1/1,2,5,5					
5.00	D15							
5.00-5.45	D16							
					5.45	Complete at 5.45m		

Remarks

Scale (approx)	Logged By
1:50	LH

Figure No. A2.7

IAN FARMER ASSOCIATES

Site	Number
Plot 5600 - Site B - Hatfield Business Park	WS202

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Percussive window sampler			Arlington Business Parks (GP) Ltd	52050
	Location TL 214 096	**Dates** 10/05/2013	**Engineer** Baynham Meikle Partnership	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.20	E1					Dark orange brown slightly sandy slightly gravelly clayey SILT with occasional rootlets and rare pockets of decomposing organic matter (REWORKED). Gravel is fine to medium subangular to subrounded flint.		
0.40	E2							
0.50	D1				(1.30)			
1.00-1.45	SPT N=7		1,1/1,2,2,2					
1.00	D2							
1.00-1.45	D3				1.30			
1.50	D4					Firm orange brown mottled red brown slightly sandy slightly gravelly silty CLAY. Gravel is fine subangular flint.		
					(0.80)	From 1.75m; Gravelly.		
2.00-2.45	SPT N=21		3,3/4,5,6,6		2.10			
2.00	D5					Firm light brownish grey mottled orange brown sandy gravelly silty CLAY. Gravel is fine to coarse angular to subrounded flint.		
2.00-2.45	D6							
2.50	D7				(1.10)			
3.00-3.45	SPT N=18		4,5/5,6,7,0					
3.00	D8				3.20			
3.50	D9					Firm orange brown slightly gravelly sandy silty CLAY with occasional pockets of fine to medium sand. Gravel is fine to medium subangular to subrounded flint.		
					(1.05)			
4.00-4.45	SPT N=14		3,3/3,3,4,4					
4.00	D10				4.25			
4.00-4.45	D11					Medium dense orange brown slightly gravelly clayey silty fine to medium SAND. Gravel is fine to medium subangular flint.		
4.50	D12							
					(1.20)			
5.00-5.45	SPT N=16		4,4/4,4,4,4					
5.00	D13							
5.00-5.45	D14				5.45			
						Complete at 5.45m		

Remarks
Groundwater not encountered.

Scale (approx)	Logged By
1:50	LH

Figure No. A2.8

IAN FARMER ASSOCIATES

Site	Number
Plot 5600 - Site B - Hatfield Business Park	WS203

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Percussive window sampler			Arlington Business Parks (GP) Ltd	52050
	Location TL 214 096	**Dates** 10/05/2013	**Engineer** Baynham Meikle Partnership	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.20	E1				(0.45)	Brown slightly gravelly clayey sandy SILT with occasional rootlets and pockets of decomposing organic matter (REWORKED). Gravel is fine subangular flint.		
0.40	E2				0.45			
0.50	D1					Firm orange brown mottled brown slightly gravelly sandy silty CLAY. Gravel is fine subangular flint.		
1.00-1.45	SPT N=19		1,1/4,5,5,5		(1.45)			
1.00	D2							
1.00-1.45	D3					From 1.30m to 1.35m; Gravelly.		
1.50	D4							
					1.90	From 1.60m; Gravelly.		
2.00-2.45	SPT N=22		1,2/4,5,6,7		(0.20)			
2.00	D5				2.10	Orange brown silty gravelly fine to medium SAND. Gravel is fine to coarse angular to subrounded flint.		
2.00-2.45	D6							
2.50	D7					Medium dense orange brown clayey fine to medium SAND with rare pockets of sand.		
3.00-3.45	SPT N=17		3,3/3,4,5,5					
3.00	D8							
3.00-3.45	D9							
3.50	D10				(3.35)			
4.00-4.45	SPT N=19		3,4/4,5,5,5			From 4.00m; Gravelly.		
4.00	D11							
4.50	D12							
5.00-5.45	SPT N=12		4,3/3,4,3,2					
5.00	D13							
5.00-5.45	D14							
					5.45	Complete at 5.45m		

Remarks
Groundwater not encountered.

Scale (approx)	Logged By
1:50	LH

Figure No. A2.9

IAN FARMER ASSOCIATES

Site	Number
Plot 5600 - Site B - Hatfield Business Park	WS204

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Percussive window sampler			Arlington Business Parks (GP) Ltd	52050
	Location TL 214 096	**Dates** 10/05/2013	**Engineer** Baynham Meikle Partnership	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.15	E1				(0.40)	Greyish brown/brown slightly gravelly clayey sandy SILT with occasional rootlets (REWORKED). Gravel is fine subangular flint.		
					0.40			
0.45	E2					Firm orange brown mottled brown slightly gravelly sandy silty CLAY with rare pockets of decomposing organic matter. Gravel is fine subangular flint.		
0.50	D1							
					(1.00)			
1.00-1.45	SPT N=18		3,4/5,4,5,4					
1.00	D2							
1.00-1.45	D3							
					1.40			
1.50	D4					Medium dense slightly gravelly clayey fine to medium SAND with occasional pockets of clay. Gravel is fine to coarse angular to subrounded flint.		
2.00-2.45	SPT N=15		3,3/3,4,4,4					
2.00	D5							
2.00-2.45	D6							
2.50	D7							
					(3.20)			
3.00-3.45	SPT N=19		2,4/5,4,5,5					
3.00	D8							
3.00-3.45	D9							
3.50	D10							
4.00-4.45	SPT N=15		4,4/4,3,4,4					
4.00	D11							
4.00-4.45	D12							
4.50	D13				4.60			
						Medium dense orange brown silty gravelly fine to medium SAND. Gravel is fine to coarse angular to subrounded flint.		
5.00-5.45	SPT N=19		4,5/5,5,4,5		(0.85)			
5.00	D14							
5.00-5.45	D15							
					5.45			
						Complete at 5.45m		

Remarks
Groundwater not encountered.

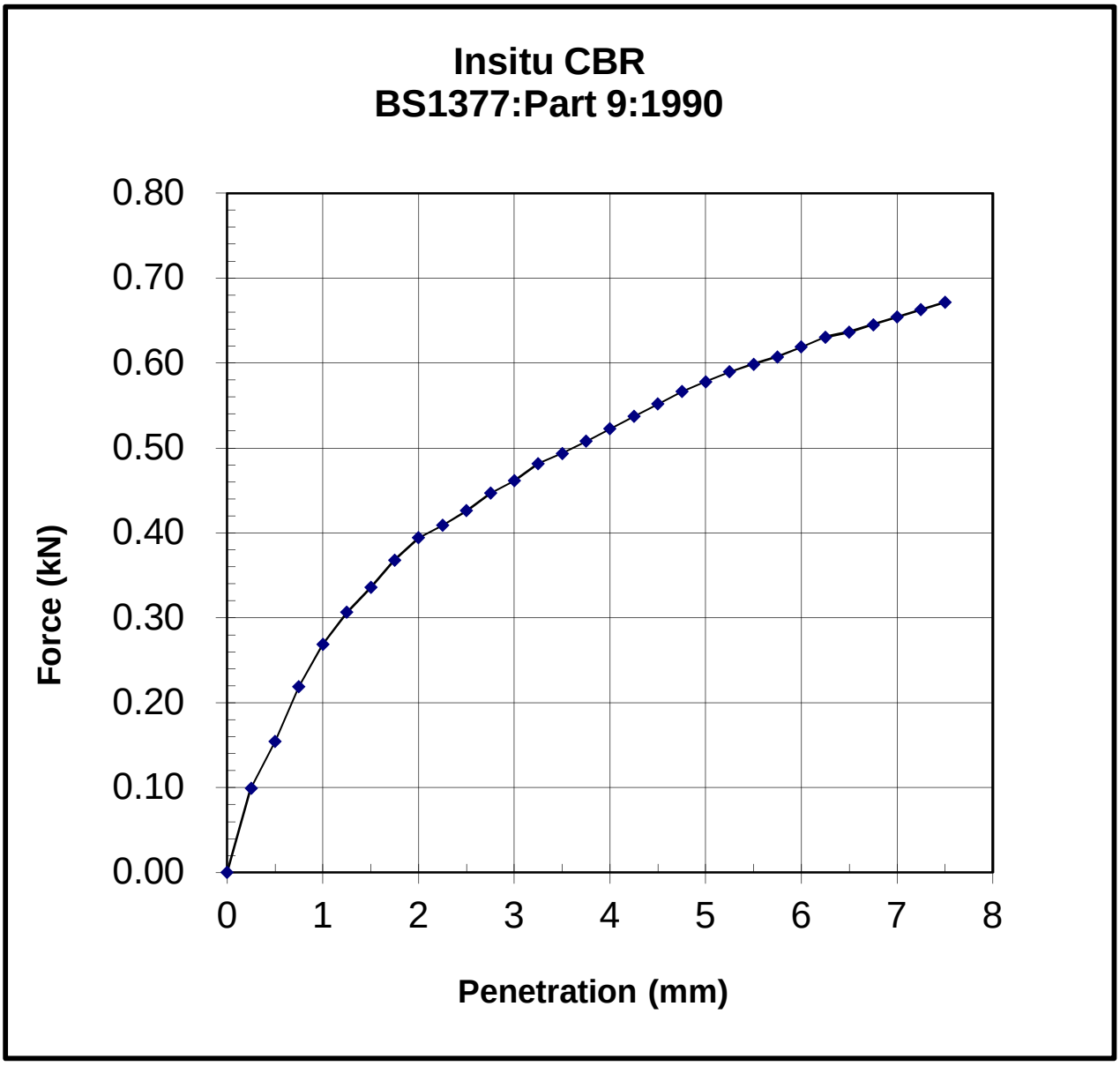
Scale (approx)	Logged By
1:50	LH

Figure No. A2.10

CALIFORNIA BEARING RATIO

In accordance with BS 1377: Part 9: 1990: Clause 4.3

Client:	IFA Harpenden	**Test Location:**	201
Contract:	Hatfield	**Test Depth:**	0.45m
Contract No.	21066A	**Figure No.**	21066A/201
Test Date:	09/05/2013		



Material Description: Brown silty CLAY

Penetration (mm)	2.5	5	Moisture Content (%)	**19**
Force (kN)	0.43	0.58	CBR Value: (%)	**3.2**
Value	3.2	2.9		

Remarks:

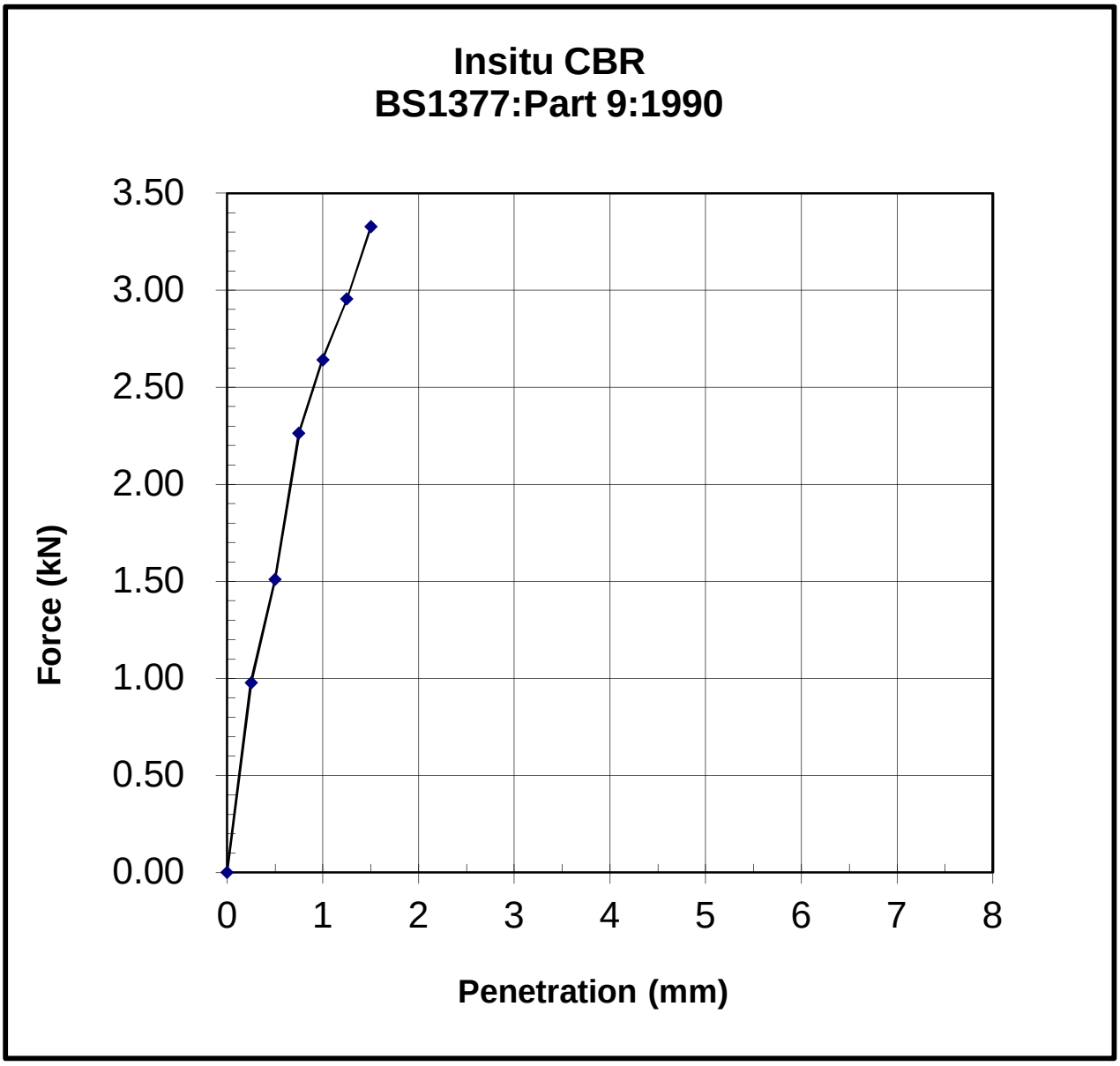
Ian Farmer Associates (1998) Limited
1 Fairfield Court, Seven Stars Ind Est,
Coventry, CV3 4LJ
T: 024 7630 3422

Figure A2.11

CALIFORNIA BEARING RATIO

In accordance with BS 1377: Part 9: 1990: Clause 4.3

Client:	IFA Harpenden	**Test Location:**	202
Contract:	Hatfield	**Test Depth:**	0.45m
Contract No.	21066A	**Figure No.**	21066A/202
Test Date:	09/05/2013		



Material Description: Brown very gravelly CLAY

Penetration (mm)	2.5	5	Moisture Content (%)	**10**
Force (kN)	n/a	n/a	CBR Value: (%)	**n/a**
Value	n/a	n/a		

Remarks: Load ring limit of 1140 divisions reached at 1.50mm. Max. load applied = 3.33kN.

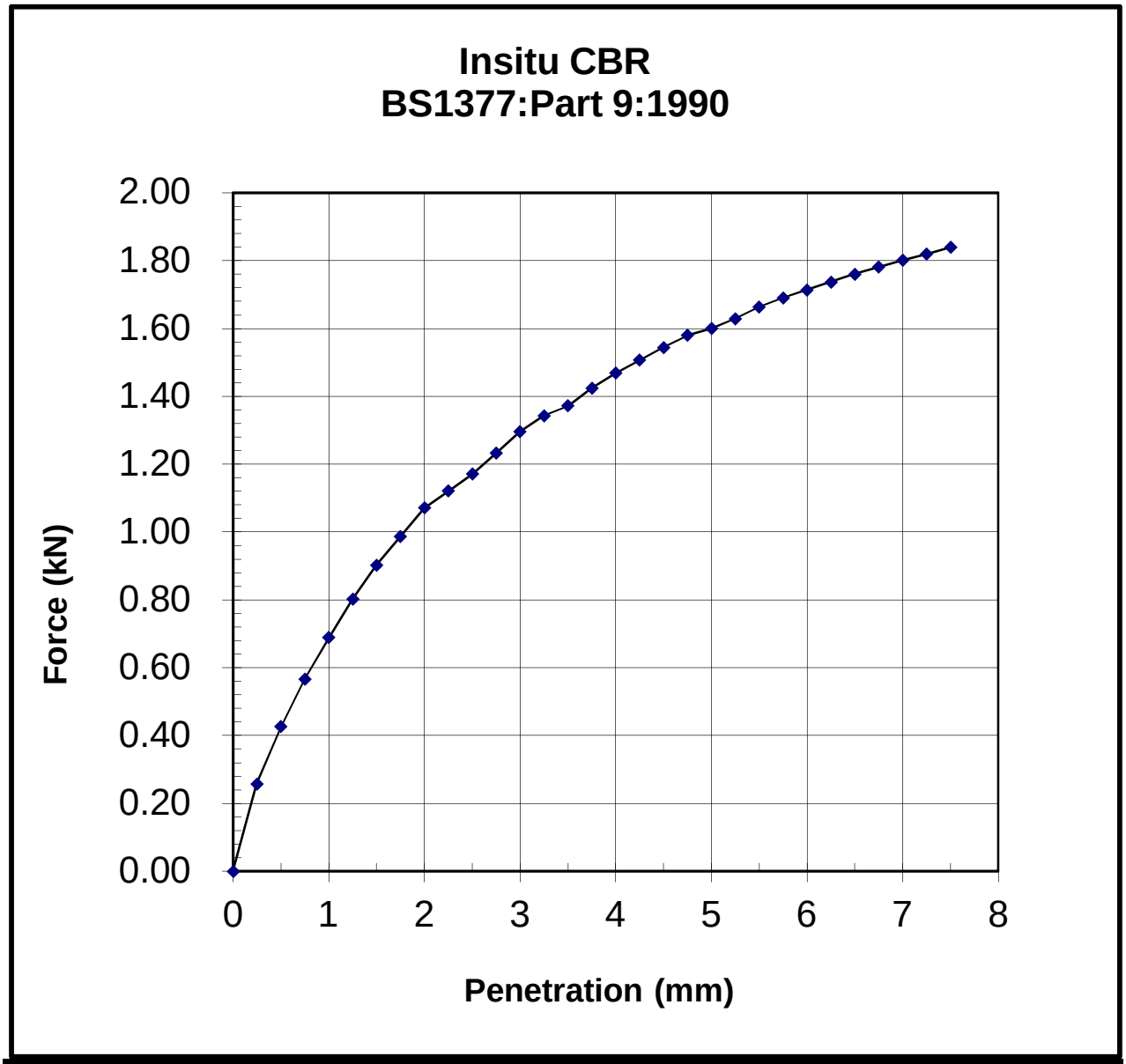
Ian Farmer Associates (1998) Limited
1 Fairfield Court, Seven Stars Ind Est,
Coventry, CV3 4LJ
T: 024 7630 3422

Figure A2.11

CALIFORNIA BEARING RATIO

In accordance with BS 1377: Part 9: 1990: Clause 4.3

Client:	IFA Harpenden	**Test Location:**	203
Contract:	Hatfield	**Test Depth:**	0.45m
Contract No.	21066A	**Figure No.**	21066A/203
Test Date:	09/05/2013		



Material Description: Brown silty CLAY

Penetration (mm)	2.5	5	Moisture Content (%)	**18**
Force (kN)	1.17	1.60	CBR Value: (%)	**8.9**
Value	8.9	8.0		

Remarks:

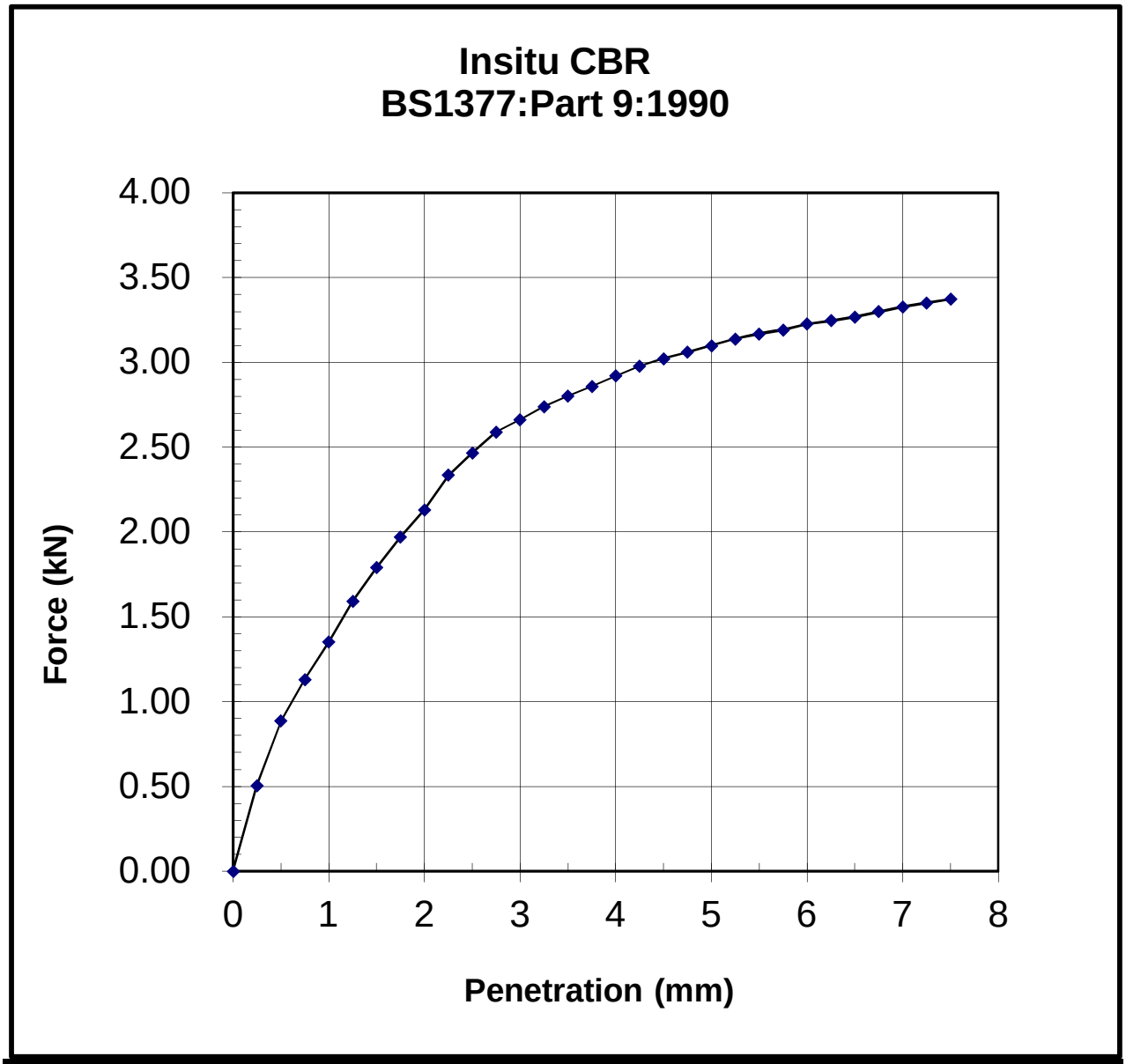
Ian Farmer Associates (1998) Limited
1 Fairfield Court, Seven Stars Ind Est,
Coventry, CV3 4LJ
T: 024 7630 3422

Figure A2.11

CALIFORNIA BEARING RATIO

In accordance with BS 1377: Part 9: 1990: Clause 4.3

Client:	IFA Harpenden	**Test Location:**	204
Contract:	Hatfield	**Test Depth:**	0.45m
Contract No.	21066A	**Figure No.**	21066A/204
Test Date:	09/05/2013		



Material Description: Brown slightly gravelly silty CLAY

Penetration (mm)	2.5	5	Moisture Content (%)	**15**
Force (kN)	2.47	3.10	CBR Value: (%)	**19**
Value	19.0	15.0		

Remarks:

Ian Farmer Associates (1998) Limited
1 Fairfield Court, Seven Stars Ind Est,
Coventry, CV3 4LJ
T: 024 7630 3422

Figure A2.11

SOAKAWAY DESIGN IN ACCORDANCE WITH BRE DIGEST 365: 1991
BRE Digest 365, Figure 2, Page 5

Client:			
Site:	**Hatfield**		
Job No:	**52050**	**Test No:**	**TP201**

CALCULATION OF SOIL INFILTRATION RATE

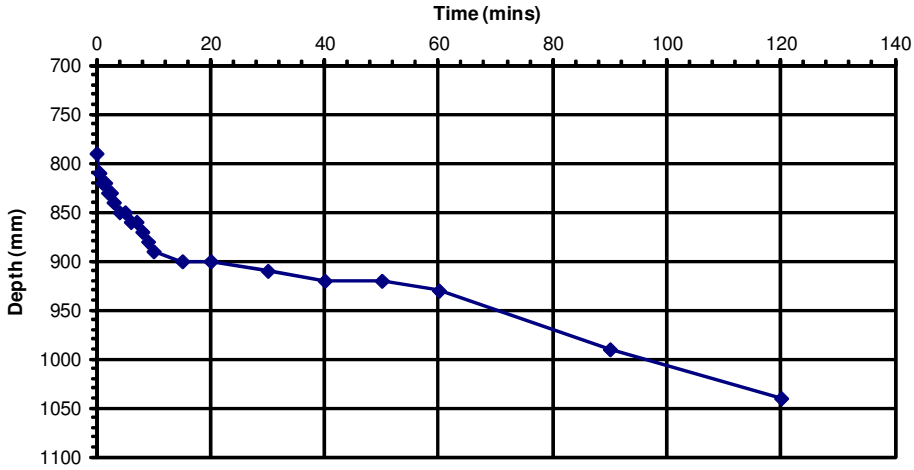
Time (min)	Depth (mm)
0	790
0.5	810
1	820
1.5	820
2	830
2.5	830
3	840
4	850
5	850
6	860
7	860
8	870
9	880
10	890
15	900
20	900
30	910
40	920
50	920
60	930
90	990
120	1040

Size of Soakaway	Length (m) =	3.40
	Width (m) =	0.70
	Depth (m) =	3.10

Depth to water at start of test =	790mm
Depth to water at end of test =	1040mm
Depth to water at 75% level =	853mm
Depth to water at 50% level =	915mm
Depth to water at 25% level =	978mm
Base area of pit (m^2) =	2.380
Eff area of loss 75 - 25% (m^2) =	20.297
Volume outflow 75 - 25% (m^3) =	0.298

From the graph:	
tp 75 (min) =	5.2
tp 25 (min) =	84

Soil infiltration rate, f, (m/s) =		**3.10E-06**	**normal test**
Soil infiltration rate, f, (m/s) =			**pit with stone**
Input by:	**LH**	**Date:**	**09/05/2013**
Checked by:	**DA**	**Date:**	**07/06/2013**



Notes

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

Background Readings:	Date of Visit	21/05/2013				
	CH_4%v/v	CO_2%v/v	O_2%v/v	H_2Sppm	COppm	VOC ppm
	0.1	0.0	20.8	0	0	NR
	Weather Conditions		Overcast			
	Ground Conditions (dry/wet etc.)		Dry			
	Atmospheric Pressure (mb)		1011			

Plot 5600 - Site B - Hatfield Business Park

RESULTS OF GAS AND GROUNDWATER MONITORING

Hole No:	Time (hh:mm)	Atmos. Pressure (mb)	Gas Flow Rate (l/hr)	CH_4% v/v		CO_2% v/v		O_2% v/v		H_2S ppm		CO ppm		VOC ppm		Water Level	Depth of Well	Water Sample Y / N
				Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	mBGL	mBGL	
BH202	16:45	1011	0.0	0.1	0.1	5.3	5.3	12.8	12.8	0	0	0	0	NR	NR	3.99	3.99	N
BH203*	16:50	1011	0.0	0.1	0.1	0.6	0.6	19.7	19.7	0	0	0	0	NR	NR	6.73	9.77	N

BH203* Gas tap open on arrival.

ND = Below detection limit of instrument. NR = Not Read.

Readings Taken By: **BP** Checked By: **VT**

Job No: 52050A

Figure No: A2.13

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

Background Readings:	Date of Visit	07/06/2013				
	CH_4%v/v	CO_2%v/v	O_2%v/v	H_2Sppm	COppm	VOC ppm
	0.0	0.0	20.5	0	0	NR
	Weather Conditions		Sunny			
	Ground Conditions (dry/wet etc.)		Dry			
	Atmospheric Pressure (mb)		1017			

Hole No:	Time (hh:mm)	Atmos. Pressure (mb)	Gas Flow Rate (l/hr)	CH_4% v/v		CO_2% v/v		O_2% v/v		H_2S ppm		CO ppm		VOC ppm		Water Level	Depth of Well	Water Sample Y / N
				Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	mBGL	mBGL	
BH202	12:00	1017	0.0	0.1	0.1	3.3	3.3	16.8	16.8	0	0	0	0	NR	NR	3.98	3.98	N
BH203	12:10	1017	0.0	0.1	0.1	0.8	0.8	19.1	19.1	0	0	0	0	NR	NR	6.79	9.76	N

ND = Below detection limit of instrument. NR = Not Read.

Readings Taken By:	**BP**	Checked By:	**VT**

Plot 5600 - Site B - Hatfield Business Park

RESULTS OF GAS AND GROUNDWATER MONITORING

Job No: 52050A

Figure No: A2.13 cont.

APPENDIX 3

LABORATORY TESTS

APPENDIX 3

GENERAL NOTES ON LABORATORY TESTS ON SOILS

A3.1 GENERAL

A3.1.1 Where applicable all tests are carried out in accordance with the relevant British Standard. The laboratory test procedures are as below:

Test Name	Procedures BS1377:1990 Part:Clause
Moisture Content	2:3
Liquid Limit	2:4
Plastic Limit and Plastic Index	2:5
Particle Size Distribution	9.2
Sedimentation	9.4
Mass Loss on Ignition	3.4
Sulphate content	3:5
pH Value	3:9
Compaction Test	4:3
California Bearing Ratio	4:7
Consolidation	5:3
Bulk Density	7:2
Laboratory Vane Tests	7:3
Triaxial Compression	
Total Stress Single-Stage	7:8
Total Stress Multi-Stage	7:9
Desiccation	Note 1

Note 1 - BRE Information paper IP4/93 issued February 1993

A3.1.2 Where an external laboratory has carried out testing, their report, including test methods is included in this Appendix.

A3.1.3 A summary sheet of laboratory test results undertaken by Ian Farmer Laboratories is included.

A3.1.4 Any discussion in this report is based on the values and results obtained from the appropriate tests. Due allowance should be made, when considering any result in isolation, of the possible inaccuracy of any such individual result. Details of the accuracy of results are included in this section, where applicable.

A3.2 SOIL CLASSIFICATION

A3.2.1 Classification of soils is usually undertaken by means of the Plasticity Classification Chart, sometimes called the A-Line Chart. This is graphical plot of PI against LL with the A-Line defined as PI = 0.73(LL - 20).

A3.2.2 This line is defined from experimental evidence and does not represent a well defined boundary between soil types, but forms a useful reference datum. When the values of LL and PI for inorganic clays are plotted on the chart they generally lie just above the A-Line in a narrow band parallel to it, while silts and organic clays plot below this line.

A3.2.3 Clays and silts are divided into five zones of plasticity:

Low Plasticity (L)	LL less than 35
Intermediate Plasticity (I)	LL between 35 and 50
High Plasticity (H)	LL between 50 and 70
Very High Plasticity (V)	LL between 70 and 90
Extremely High Plasticity (E)	LL greater than 90

A3.2.4 In general, clays of high plasticity are likely to have a lower permeability, are more compressible and consolidate over a longer period of time under load than clays of low plasticity. Clays of high plasticity are more difficult to compact as fill material.

Project Name:	Plot 5600-Site B- Hatfield Business Park			**Samples Received:**	10/05/2013
				Project Started:	10/05/2013
Client:	Ian Farmer Associates			**Testing Started:**	29/05/2013
Project No:	52050	**Our job/report no:**	14560	**Date Reported:**	31/05/2013

K4 SOILS

Borehole No:	Sample No:	Depth (m)	Description	Moisture content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425 mm (%)	Remarks
BH202	T2	0.80	Brown slightly sandy slightly gravelly silty CLAY (gravel is fine and sub-angular)	23	39	20	19	96	
BH202	D1	1.20 - 1.65	Brown slightly silty sandy gravelly CLAY (gravel is fm and sub-angular)	17	33	18	15	35	
BH202	D4	3.60	Yellowish brown slightly gravelly silty CLAY with occasional sand pockets (gravel is fm and sub-angular)	28	43	16	27	91	
BH203	B2	0.80	Brown slightly sandy slightly gravelly silty CLAY (gravel is fm and sub-angular)	21	38	18	20	67	
BH203	B3	1.20	Brown sandy gravelly CLAY (gravel is fmc and sub-angular)	14	25	14	11	38	
BH203	B5	3.00	Pale brown slightly gravelly clayey SAND with occasional clay lumps (gravel is fm and sub-angular)	17	25	13	12	78	
TP203	B1	0.75	Brown slightly gravelly slightly fine sandy silty CLAY (gravel is fmc and sub-angular)	25	37	20	17	80	

UKAS TESTING 2519

Summary of Test Results

BS 1377 : Part 2 : Clause 4.3 : 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: 31/05/2013

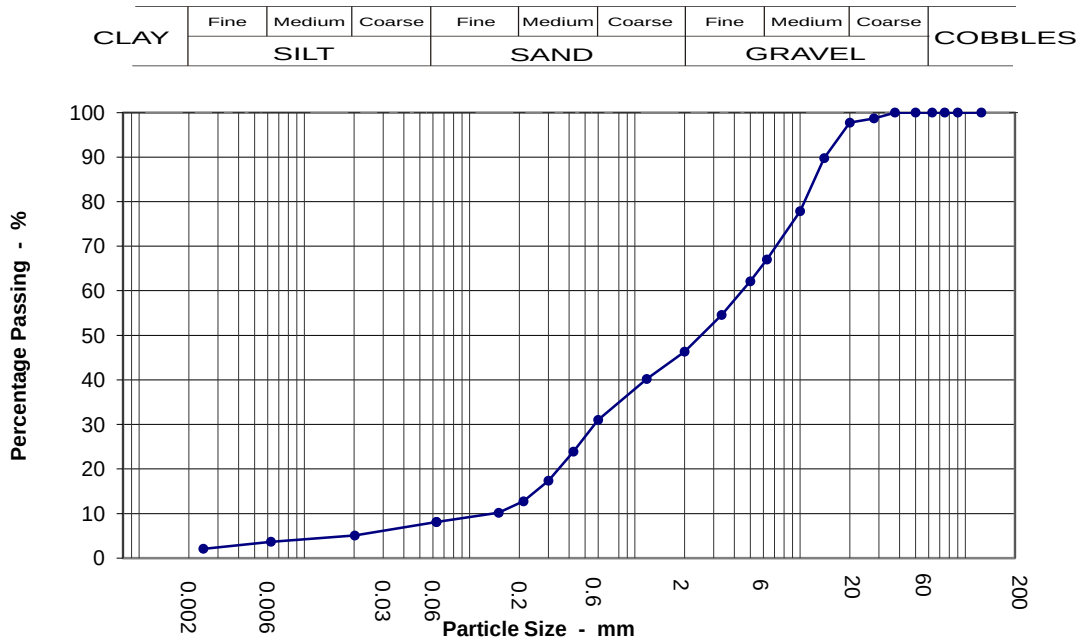
Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU

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

All samples connected with this report ,incl any on 'hold' will be stored and disposed off according to Company policy.Acopy of this policy is available on request. MSF-11/R2

Figure A3.1

K4 SOILS	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	14560
		Project No:	52050
Location	Plot 5600-Site B- Hatfield Business Park	Borehole / Trial Pit No:	BH202
		Depth	2.00 m
Visual Soil Description	Orange brown slightly clayey slightly silty sandy GRAVEL (gravel is fmc and angular to rounded)	Sample Type/No	B - 3



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.020	5
90	100	0.006	4
75	100	0.002	2
63	100		
50	100		
37.5	100		
28	99		
20	98		
14	90		
10	78		
6.3	67		
5	62		
3.35	55		
2	46		
1.18	40		
0.6	31		
0.425	24		
0.3	17		
0.212	13		
0.15	10		
0.063	8		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	Clause 9.4
Suitable Amount Of Sample Received	Yes

Sample Proportions	
Cobbles	0.0
Gravel	53.7
Sand	38.4
Silt & Clay	7.9

Grading Analysis	
D100	125.0
D60	4.5
D10	0.1
Uniformity Coefficient	32

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Test results relate only to the sample numbers shown above

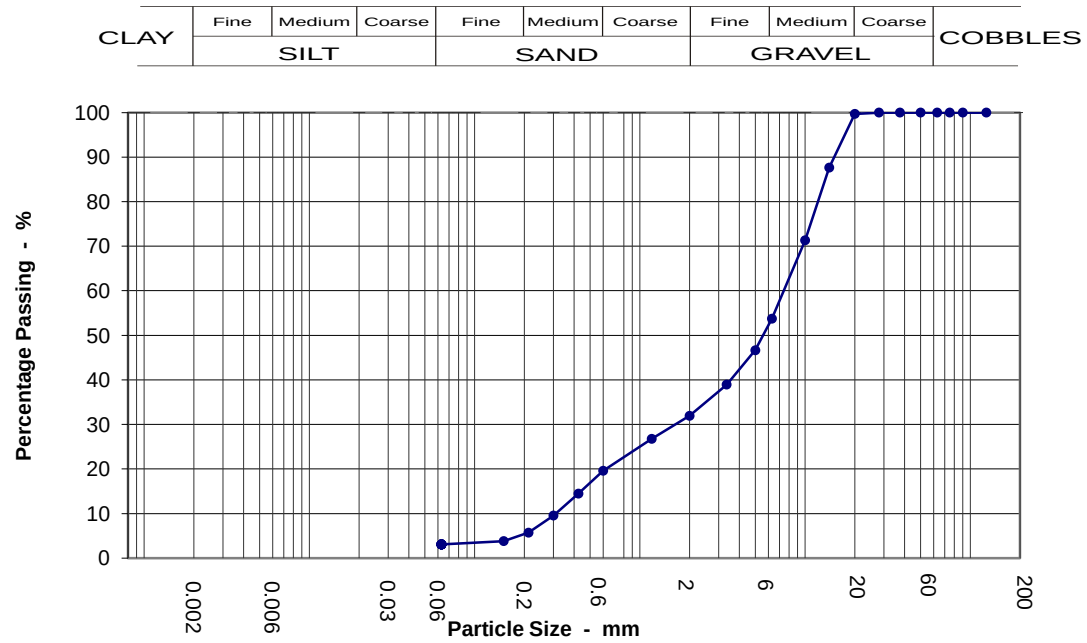
Checked and Approved
Initials: kp
Date: 31/05/2013

UKAS TESTING

2519

Figure A3.1

K4 SOILS	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	14560
		Project No:	52050
Location	Plot 5600-Site B- Hatfield Business Park	Borehole / Trial Pit No:	BH202
		Depth	3.00 m
Visual Soil Description	Brown slightly clayey sandy GRAVEL (gravel is fm and angular to rounded)	Sample Type/No	B - 4



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	88		
10	71		
6.3	54		
5	47		
3.35	39		
2	32		
1.18	27		
0.6	20		
0.425	14		
0.3	10		
0.212	6		
0.15	4		
0.063	3		

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	68.1
Sand	28.9
Silt & Clay	3.1

Grading Analysis	
D100	125.0
D60	7.6
D10	0.3
Uniformity Coefficient	24

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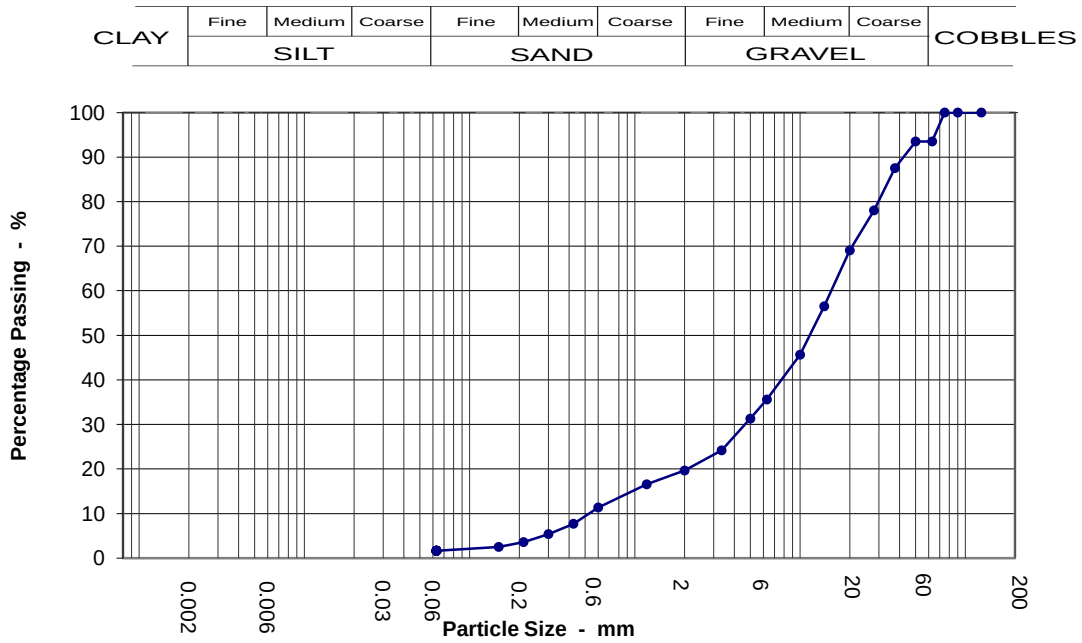
Test results relate only to the sample numbers shown above

Checked and Approved
Initials: kp
Date: 31/05/2013

UKAS TESTING

Figure A3.1

K4 SOILS	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	14560
		Project No:	52050
Location	Plot 5600-Site B- Hatfield Business Park	Borehole / Trial Pit No:	BH202
		Depth	9.50 m
Visual Soil Description	Orange brown slightly clayey slightly sandy GRAVEL (gravel is fmc and cobble sized and angular to rounded)	Sample Type/No	B - 8



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	94		
50	94		
37.5	88		
28	78		
20	69		
14	57		
10	46		
6.3	36		
5	31		
3.35	24		
2	20		
1.18	17		
0.6	11		
0.425	8		
0.3	5		
0.212	4		
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	6.5
Gravel	73.9
Sand	18.0
Silt & Clay	1.6

Grading Analysis	
D100	125.0
D60	15.7
D10	0.5
Uniformity Coefficient	29

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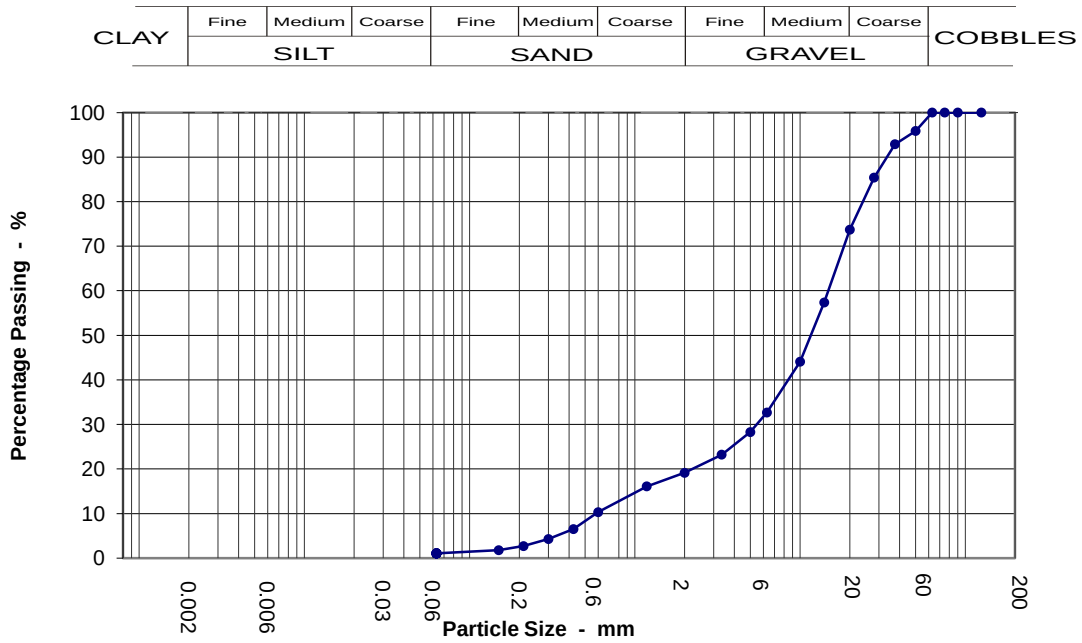
Checked and Approved
Initials: kp
Date: 31/05/2013

UKAS TESTING

Figure A3.1

K4 SOILS	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	14560
		Project No:	52050
Location	Plot 5600-Site B- Hatfield Business Park	Borehole / Trial Pit No:	BH203
		Depth	5.00 m
Visual Soil Description	Brown slightly clayey slightly sandy GRAVEL (gravel is fmc and angular to rounded)	Sample Type/No	B - 7



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	96		
37.5	93		
28	85		
20	74		
14	57		
10	44		
6.3	33		
5	28		
3.35	23		
2	19		
1.18	16		
0.6	10		
0.425	7		
0.3	4		
0.212	3		
0.15	2		
0.063	1		

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	80.9
Sand	18.1
Silt & Clay	1.1

Grading Analysis	
D100	125.0
D60	15.0
D10	0.6
Uniformity Coefficient	26

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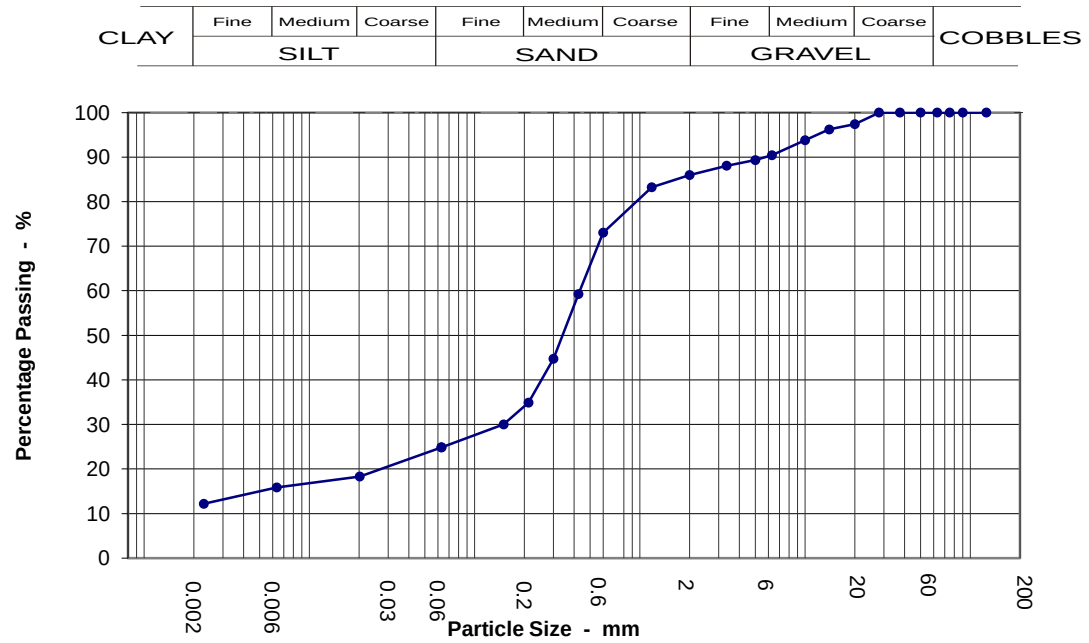
Test results relate only to the sample numbers shown above

Checked and Approved
Initials: kp
Date: 31/05/2013

UKAS TESTING

Figure A3.1

K4 SOILS	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	14560
		Project No:	52050
Location	Plot 5600-Site B- Hatfield Business Park	Borehole / Trial Pit No:	TP203
		Depth	1.60 m
Visual Soil Description	Brown slightly clayey slightly gravelly SAND with occasional lumps of brown blue grey silty clayey sand (gravel is fmc and angular to rounded)	Sample Type/No	B - 2



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.020	18
90	100	0.006	16
75	100	0.002	12
63	100		
50	100		
37.5	100		
28	100		
20	97		
14	96		
10	94		
6.3	90		
5	89		
3.35	88		
2	86		
1.18	83		
0.6	73		
0.425	59		
0.3	45		
0.212	35		
0.15	30		
0.063	25		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	Clause 9.4
Suitable Amount Of Sample Received	Yes

Sample Proportions	
Cobbles	0.0
Gravel	14.0
Sand	61.6
Silt & Clay	24.4

Grading Analysis	
D100	125.0
D60	0.4
D10	
Uniformity Coefficient	N/A

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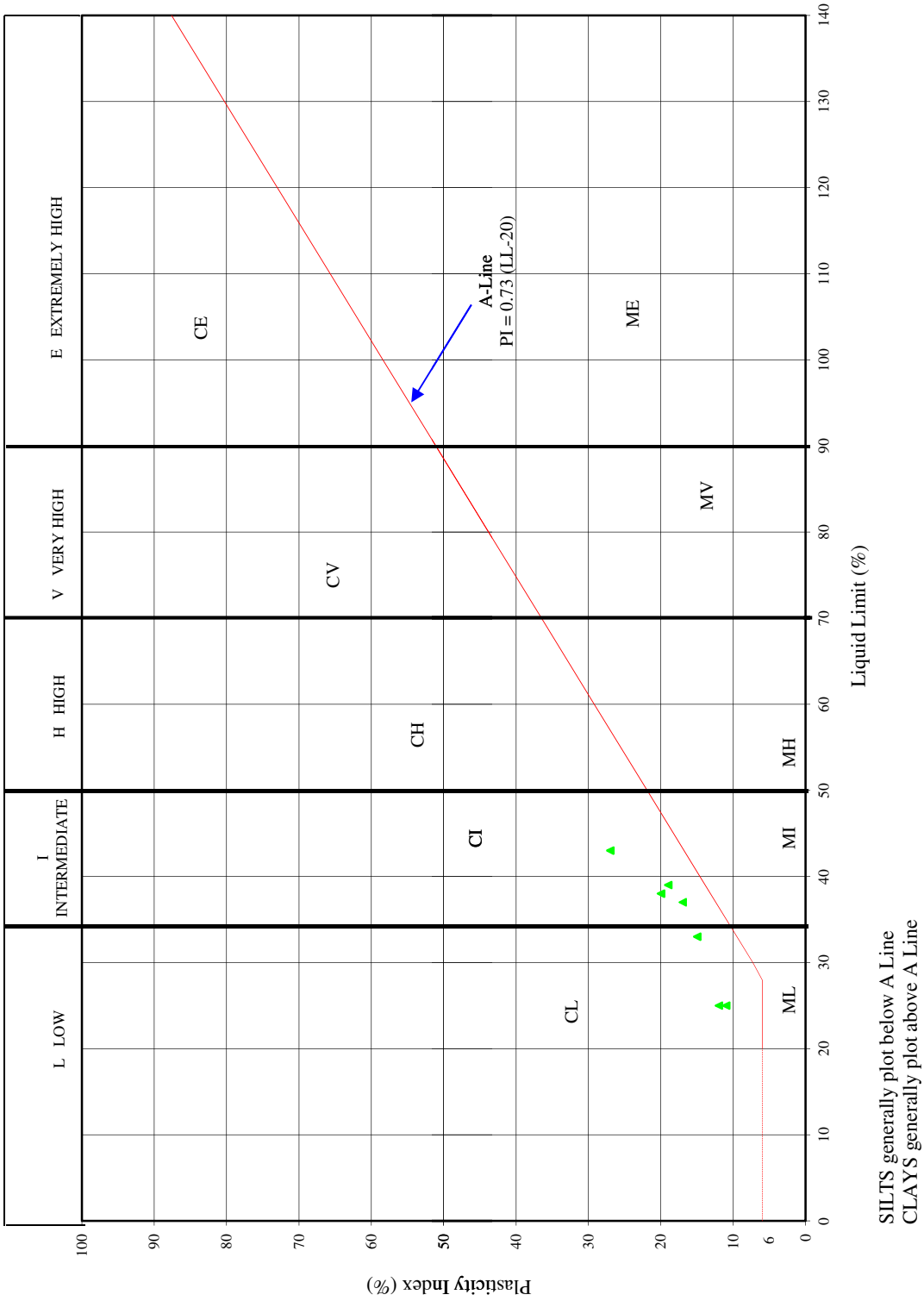
Test results relate only to the sample numbers shown above

Checked and Approved
Initials: kp
Date: 31/05/2013

UKAS TESTING

2519

Figure A3.1



IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**PLASTICITY CLASSIFICATION CHART**	Job no. 52050A
	Plot 5600 Site B Hatfield Business Park, Hatfield	Fig no. A3.2

APPENDIX 4

CHEMICAL TESTS

Certificate of Analysis

2139

Certificate Number: 13-80888

Date: 20/05/2013

Client:	Ian Farmer Associates 1A Batford Mill Lower Luton Road Harpenden Herts AL5 5BZ
Our Reference:	13-80888
Client Reference:	52050A
Contract Title:	Plot 5600 Hatfield Business Park
Description:	1 leachate sample 8 soil samples
Date Received:	10 May 2013
Date Started:	10 May 2013
Date Completed:	20 May 2013
Test Procedures:	Identified by prefix DETSn, details available upon request.
Notes:	Observations and interpretations are outside the scope of UKAS accreditation
Approved By:	

Rob Brown, Business Manager

Derwentside Environmental Testing Services Limited
Unit 2, Park Road Industrial Estate South, Consett, Co Durham, DH8 5PY
Tel: 01207 582333 • Fax 01207 582444 • email: info@dets.co.uk • www.dets.co.uk

Figure A4.1

Information in Support of the Analytical Results

Analysis

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425um 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 28oC +/-2oC.

Key

*	Denotes test not included in laboratory scope of accreditation
#	Denotes test that holds MCERTS accreditation, however, MCERTS accreditation is only implied if the report carries the MCERTS logo
$	Denotes tests completed by an approved subcontractor
I/S	Denotes insufficient sample to carry out test
U/S	Denotes that the sample is not suitable for testing

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

Figure A4.1

Summary of Chemical Analysis
Matrix Descriptions

Our Ref: 13-80888
Client Ref: 52050A
Contract Title: Plot 5600 Hatfield Business Park

Sample ID	Other ID	Depth	Sample No	Completed	Matrix Description
BH202		0.20	511236	20/05/2013	Brown slightly gravelly sandy CLAY with odd rootlets
BH203		0.20	511237	20/05/2013	Brown slightly gravelly sandy CLAY with odd rootlets
TP203		0.15	511238	20/05/2013	Brown slightly gravelly sandy CLAY
TP204		0.30	511239	20/05/2013	Brown slightly gravelly sandy CLAY with odd rootlets
BH202		1.90	511240	20/05/2013	Brown gravelly sandy CLAY
BH202		4.00	511241	20/05/2013	Brown grey slightly gravelly CLAY
BH203		1.90	511242	20/05/2013	Brown gravelly sandy CLAY
TP204		1.60	511243	20/05/2013	Brown gravelly sandy CLAY

Figure A4.1

Summary of Chemical Analysis
Soil Samples

Our Ref: 13-80888
Client Ref: 52050A
Contract Title: Plot 5600 Hatfield Business Park

			Lab No.	511236	511237	511238	511239	511240
			Sample ID	BH202	BH203	TP203	TP204	BH202
			Depth	0.20	0.20	0.15	0.30	1.90
			Sample Ref					
			Sample Type					
			Sampling Date	07/05/2013	07/05/2013	07/05/2013	07/05/2013	07/05/2013
			Sampling Time					
Test	**Units**	**DETSxx**	**LOD**					
Mercury	mg/kg	DETSC 2325#	0.05	0.14	< 0.05	< 0.05	0.10	
Arsenic	mg/kg	DETS 042#	0.2	9.9	11	13	9.2	
Cadmium	mg/kg	DETS 042#	0.1	0.5	0.4	0.4	0.4	
Chromium	mg/kg	DETS 042#	0.15	20	23	24	20	
Copper	mg/kg	DETS 042#	0.2	56	18	16	19	
Nickel	mg/kg	DETS 042#	1	16	22	24	16	
Lead	mg/kg	DETS 042#	0.3	50	25	16	44	
Selenium	mg/kg	DETS 042#	0.5	< 0.5	< 0.5	< 0.5	< 0.5	
Zinc	mg/kg	DETS 042#	1	55	51	46	110	
Boron (water soluble)	mg/kg	DETS 020#	0.2	1.1	1.8	1.7	1.6	
Organic matter	%	DETSC 2002#	0.1	1.4	1.0	0.8	1.4	
Sulphate Aqueous Extract as SO4	mg/l	DETSC 2076#	10	18		< 10	25	< 10
pH		DETSC 2008#		7.4	7.5	7.7	7.9	7.9
Aliphatic C5-C6	mg/kg	DETSC 3321*	0.01				< 0.01	
Aliphatic C6-C8	mg/kg	DETSC 3321*	0.01				< 0.01	
Aliphatic C8-C10	mg/kg	DETSC 3321*	0.01				< 0.01	
Aliphatic C10-C12	mg/kg	DETSC 3072#	1.5				< 1.5	
Aliphatic C12-C16	mg/kg	DETSC 3072#	1.2				< 1.2	
Aliphatic C16-C21	mg/kg	DETSC 3072#	1.5				< 1.5	
Aliphatic C21-C35	mg/kg	DETSC 3072#	3.4				< 3.4	
Aromatic C5-C7	mg/kg	DETSC 3321*	0.01				< 0.01	
Aromatic C7-C8	mg/kg	DETSC 3321*	0.01				< 0.01	
Aromatic C8-C10	mg/kg	DETSC 3321*	0.01				< 0.01	
Aromatic C10-C12	mg/kg	DETSC 3072#	0.9				< 0.9	
Aromatic C12-C16	mg/kg	DETSC 3072#	0.5				< 0.5	
Aromatic C16-C21	mg/kg	DETSC 3072#	0.6				< 0.6	
Aromatic C21-C35	mg/kg	DETSC 3072#	1.4				< 1.4	
Aliphatic C5-C35	mg/kg	DETSC 3072*	10				< 10	
Aromatic C5-C35	mg/kg	DETSC 3072*	10				< 10	
TPH Ali/Aro	mg/kg	DETSC 3072*	10				< 10	
Acenaphthene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1	< 0.1	
Acenaphthylene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1	< 0.1	
Anthracene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1	< 0.1	
Benzo(a)anthracene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1	< 0.1	
Benzo(a)pyrene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1	< 0.1	
Benzo(b)fluoranthene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1	< 0.1	
Benzo(k)fluoranthene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1	< 0.1	
Benzo(g,h,i)perylene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1	< 0.1	
Chrysene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1	< 0.1	
Dibenzo(a,h)anthracene	mg/kg	DESTC 3301	0.1	< 0.1	< 0.1	< 0.1	< 0.1	
Fluoranthene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1	< 0.1	
Fluorene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1	< 0.1	
Indeno(1,2,3-c,d)pyrene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1	< 0.1	

Figure A4.1

Summary of Chemical Analysis
Soil Samples

Our Ref: 13-80888
Client Ref: 52050A
Contract Title: Plot 5600 Hatfield Business Park

			Lab No.	511236	511237	511238	511239	511240
			Sample ID	BH202	BH203	TP203	TP204	BH202
			Depth	0.20	0.20	0.15	0.30	1.90
			Sample Ref					
			Sample Type					
			Sampling Date	07/05/2013	07/05/2013	07/05/2013	07/05/2013	07/05/2013
			Sampling Time					
Test	**Units**	**DETSxx**	**LOD**					
Naphthalene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1	< 0.1	
Phenanthrene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1	< 0.1	
Pyrene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1	< 0.1	
PAH	mg/kg	DETSC 3301	1.6	< 1.6	< 1.6	< 1.6	< 1.6	
EPH (C10-C12)	mg/kg	DETSC 3311	10		< 10			
EPH (C12-C16)	mg/kg	DETSC 3311	10		< 10			
EPH (C16-C21)	mg/kg	DETSC 3311	10		< 10			
EPH (C21-C36)	mg/kg	DETSC 3311	10		47			
EPH (C36-C40)	mg/kg	DETSC 3311	10		19			
EPH (C10-C40)	mg/kg	DETSC 3311#	10		67			
Hexavalent Chromium	mg/kg	DETSC 2204*	1	< 1.0	< 1.0	< 1.0	< 1.0	

Figure A4.1

Summary of Chemical Analysis
Soil Samples

Our Ref: 13-80888
Client Ref: 52050A
Contract Title: Plot 5600 Hatfield Business Park

			Lab No.	511241	511242	511243
			Sample ID	BH202	BH203	TP204
			Depth	4.00	1.90	1.60
			Sample Ref			
			Sample Type			
			Sampling Date	07/05/2013	07/05/2013	07/05/2013
			Sampling Time			
Test	**Units**	**DETSxx**	**LOD**			
Mercury	mg/kg	DETSC 2325#	0.05			
Arsenic	mg/kg	DETS 042#	0.2			
Cadmium	mg/kg	DETS 042#	0.1			
Chromium	mg/kg	DETS 042#	0.15			
Copper	mg/kg	DETS 042#	0.2			
Nickel	mg/kg	DETS 042#	1			
Lead	mg/kg	DETS 042#	0.3			
Selenium	mg/kg	DETS 042#	0.5			
Zinc	mg/kg	DETS 042#	1			
Boron (water soluble)	mg/kg	DETS 020#	0.2			
Organic matter	%	DETSC 2002#	0.1			
Sulphate Aqueous Extract as SO4	mg/l	DETSC 2076#	10	16	11	14
pH		DETSC 2008#		7.9	8.2	8.0
Aliphatic C5-C6	mg/kg	DETSC 3321*	0.01			
Aliphatic C6-C8	mg/kg	DETSC 3321*	0.01			
Aliphatic C8-C10	mg/kg	DETSC 3321*	0.01			
Aliphatic C10-C12	mg/kg	DETSC 3072#	1.5			
Aliphatic C12-C16	mg/kg	DETSC 3072#	1.2			
Aliphatic C16-C21	mg/kg	DETSC 3072#	1.5			
Aliphatic C21-C35	mg/kg	DETSC 3072#	3.4			
Aromatic C5-C7	mg/kg	DETSC 3321*	0.01			
Aromatic C7-C8	mg/kg	DETSC 3321*	0.01			
Aromatic C8-C10	mg/kg	DETSC 3321*	0.01			
Aromatic C10-C12	mg/kg	DETSC 3072#	0.9			
Aromatic C12-C16	mg/kg	DETSC 3072#	0.5			
Aromatic C16-C21	mg/kg	DETSC 3072#	0.6			
Aromatic C21-C35	mg/kg	DETSC 3072#	1.4			
Aliphatic C5-C35	mg/kg	DETSC 3072*	10			
Aromatic C5-C35	mg/kg	DETSC 3072*	10			
TPH Ali/Aro	mg/kg	DETSC 3072*	10			
Acenaphthene	mg/kg	DETSC 3301	0.1			
Acenaphthylene	mg/kg	DETSC 3301	0.1			
Anthracene	mg/kg	DETSC 3301	0.1			
Benzo(a)anthracene	mg/kg	DETSC 3301	0.1			
Benzo(a)pyrene	mg/kg	DETSC 3301	0.1			
Benzo(b)fluoranthene	mg/kg	DETSC 3301	0.1			
Benzo(k)fluoranthene	mg/kg	DETSC 3301	0.1			
Benzo(g,h,i)perylene	mg/kg	DETSC 3301	0.1			
Chrysene	mg/kg	DETSC 3301	0.1			
Dibenzo(a,h)anthracene	mg/kg	DESTC 3301	0.1			
Fluoranthene	mg/kg	DETSC 3301	0.1			
Fluorene	mg/kg	DETSC 3301	0.1			
Indeno(1,2,3-c,d)pyrene	mg/kg	DETSC 3301	0.1			

Figure A4.1

Summary of Chemical Analysis
Soil Samples

Our Ref: 13-80888
Client Ref: 52050A
Contract Title: Plot 5600 Hatfield Business Park

			Lab No.	511241	511242	511243
			Sample ID	BH202	BH203	TP204
			Depth	4.00	1.90	1.60
			Sample Ref			
			Sample Type			
			Sampling Date	07/05/2013	07/05/2013	07/05/2013
			Sampling Time			
Test	**Units**	**DETSxx**	**LOD**			
Naphthalene	mg/kg	DETSC 3301	0.1			
Phenanthrene	mg/kg	DETSC 3301	0.1			
Pyrene	mg/kg	DETSC 3301	0.1			
PAH	mg/kg	DETSC 3301	1.6			
EPH (C10-C12)	mg/kg	DETSC 3311	10			
EPH (C12-C16)	mg/kg	DETSC 3311	10			
EPH (C16-C21)	mg/kg	DETSC 3311	10			
EPH (C21-C36)	mg/kg	DETSC 3311	10			
EPH (C36-C40)	mg/kg	DETSC 3311	10			
EPH (C10-C40)	mg/kg	DETSC 3311#	10			
Hexavalent Chromium	mg/kg	DETSC 2204*	1			

Figure A4.1

Summary of Chemical Analysis
Leachate Samples

Our Ref: 13-80888
Client Ref: 52050A
Contract Title: Plot 5600 Hatfield Business Park

			Lab No.	511244
			Sample ID	TP204
			Depth	0.30
			Sample Ref	
			Sample Type	
			Sampling Date	07/05/2013
			Sampling Time	
Test	**Units**	**DETSxx**	**LOD**	
NRA Leachate Preparation		DETS 036*		Y
Arsenic, Dissolved	ug/l	DETSC 2306	0.16	< 0.16
Beryllium, Dissolved	ug/l	DETSC 2306*	0.1	< 0.10
Cadmium Dissolved	ug/l	DETSC 2302	2	< 2.0
Chromium Dissolved	ug/l	DETSC 2302	5	< 5.0
Copper Dissolved	ug/l	DETSC 2302	2	< 2.0
Lead Dissolved	ug/l	DETSC 2302	4	< 4.0
Mercury, Dissolved	ug/l	DETSC 2306	0.01	< 0.010
Nickel Dissolved	ug/l	DETSC 2302	10	< 10
Selenium Dissolved	ug/l	DETSC 2302	12	< 12
Zinc Dissolved	ug/l	DETSC 2302	1	< 1.0
Boron	ug/l	DETS 020	100	340
Acenaphthene	ug/l	DETS 074*	0.01	0.02
Acenaphthylene	ug/l	DETS 074*	0.01	< 0.01
Anthracene	ug/l	DETS 074*	0.01	< 0.01
Benzo(a)anthracene	ug/l	DETS 074*	0.01	0.01
Benzo(a)pyrene	ug/l	DETS 074*	0.01	< 0.01
Benzo(b)fluoranthene	ug/l	DETS 074*	0.01	< 0.01
Benzo(k)fluoranthene	ug/l	DETS 074*	0.01	< 0.01
Benzo(g,h,i)perylene	ug/l	DETS 074*	0.01	< 0.01
Chrysene	ug/l	DETS 074*	0.01	0.03
Dibenzo(a,h)anthracene	ug/l	DETS 074*	0.01	< 0.01
Fluoranthene	ug/l	DETS 074*	0.01	0.03
Fluorene	ug/l	DETS 074*	0.01	0.03
Indeno(1,2,3-c,d)pyrene	ug/l	DETS 074*	0.01	< 0.01
Naphthalene	ug/l	DETS 074*	0.01	0.03
Phenanthrene	ug/l	DETS 074*	0.01	0.06
Pyrene	ug/l	DETS 074*	0.01	0.03
PAH	ug/l	DETS 074*	0.2	0.26
EPH (C10-C12)	ug/l	DETSC 3311	10	< 10
EPH (C12-C16)	ug/l	DETSC 3311	10	< 10
EPH (C16-C21)	ug/l	DETSC 3311	10	< 10
EPH (C21-C36)	ug/l	DETSC 3311	10	11
EPH (C36-C40)	ug/l	DETSC 3311	10	< 10
EPH (C10-C40)	ug/l	DETSC 3311	10	16

Figure A4.1

Sample Comments

DETS cannot be held responsible for the integrity of sample(s) 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 below. 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.

Lab No.	Sample ID	Date Sampled	Containers Received	Deviating due to holding time being exceeded for test(s)	Deviating due to inappropriate container for test(s)	Deviating due to headspace presence in container for test(s)
511236	BH202 0.20 SOIL	07/05/2013	Glass Jar 250ml or less (250ml), Glass Vial (40ml), Plastic Tub 1 litre (1kg)			
511237	BH203 0.20 SOIL	07/05/2013	Glass Jar 250ml or less (250ml), Glass Vial (40ml), Plastic Tub 1 litre (1kg)			
511238	TP203 0.15 SOIL	07/05/2013	Glass Jar 250ml or less (250ml), Glass Vial (40ml), Plastic Tub 1 litre (1kg)			
511239	TP204 0.30 SOIL	07/05/2013	Glass Jar 250ml or less (250ml), Glass Vial (40ml), Plastic Tub 1 litre (1kg)			
511240	BH202 1.90 SOIL	07/05/2013	Plastic Bag			
511241	BH202 4.00 SOIL	07/05/2013	Plastic Bag			
511242	BH203 1.90 SOIL	07/05/2013	Plastic Bag			
511243	TP204 1.60 SOIL	07/05/2013	Plastic Bag			
511244	TP204 0.30 LEACHATE	07/05/2013	Glass Jar 1 litre (1 litre)			

Figure A4.1

Appendix A - Details of Analysis

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.

Method	Name of Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETSC 2002	Organic Matter	%	0.01	Air Dried	No	Yes	Yes
DETSC 2003	Loss on Ignition	%	0.01	Air Dried	No	Yes	Yes
DETSC 2004	Total Sulphate	%	0.01	Air Dried	No	Yes	Yes
DETSC 2321	Total Sulphate	%	0.01	Air Dried	No	Yes	Yes
DETSC 2004	Water Soluble Sulphate	mg/l	10.00	Air Dried	No	Yes	Yes
DETSC 2076	Water Soluble Sulphate	mg/l	10.00	Air Dried	No	Yes	Yes
DETSC 2006	Chloride	mg/kg	0.01	Air Dried	No	Yes	Yes
DETSC 2008	pH	pH Units	0.10	Air Dried	No	Yes	Yes
DETS 042	Selenium	mg/kg	0.50	Air Dried	No	Yes	Yes
DETSC 2119	Ammonia	mg/kg	0.02	Air Dried	No	Yes	Yes
DETS 020	Boron (Water Soluble)	mg/kg	0.20	Air Dried	No	Yes	Yes
DETSC 2024	Sulphide	mg/kg	10.00	Air Dried	No	Yes	Yes
DETS 042	Antimony	mg/kg	1.00	Air Dried	No	No	No
DETS 042	Arsenic	mg/kg	0.20	Air Dried	No	Yes	Yes
DETS 042	Barium	mg/kg	1.50	Air Dried	No	Yes	Yes
DETS 042	Beryllium	mg/kg	0.20	Air Dried	No	Yes	Yes
DETS 042	Cadmium	mg/kg	0.10	Air Dried	No	Yes	Yes
DETS 042	Cobalt	mg/kg	0.70	Air Dried	No	Yes	Yes
DETS 042	Copper	mg/kg	0.20	Air Dried	No	Yes	Yes
DETS 042	Chromium	mg/kg	0.15	Air Dried	No	Yes	Yes
DETS 042	Iron	mg/kg	1.00	Air Dried	No	Yes	No

Figure A4.1

Appendix A - Details of Analysis

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.

Method	Name of Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETS 042	Lead	mg/kg	0.30	Air Dried	No	Yes	Yes
DETS 042	Manganese	mg/kg	20.00	Air Dried	No	Yes	Yes
DETSC 2325	Mercury	mg/kg	0.05	Air Dried	No	Yes	Yes
DETS 042	Molybdenum	mg/kg	0.40	Air Dried	No	Yes	Yes
DETS 042	Nickel	mg/kg	0.20	Air Dried	No	Yes	Yes
DETS 042	Thallium	mg/kg	1.00	Air Dried	No	No	No
DETS 042	Vanadium	mg/kg	0.80	Air Dried	No	Yes	Yes
DETS 042	Zinc	mg/kg	1.00	Air Dried	No	Yes	Yes
DETSC 3049	Sulphur (Free)	mg/kg	0.50	As Received	No	Yes	Yes
DETSC 3301	PAH by GC-FID	mg/kg	0.10	As Received	No	Yes	No
DETSC 3311	TPH (C10 - C40)	mg/kg	20.00	As Received	No	Yes	Yes
DETSC 3401	PCB	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3321	Benzene	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3321	Toluene	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3321	Ethylbenzne	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3321	Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 2130	Phenol - Monohydric	mg/kg	0.3	Air Dried	No	Yes	Yes
DETSC 2130	Easily Liberatable Cyanide	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC 2130	Complex Cyanide	mg/kg	0.30	Air Dried	No	Yes	No
DETSC 2130	Total Cyanide	mg/kg	0.40	Air Dried	No	Yes	Yes
DETSC 2130	Thiocyanate	mg/kg	0.6	Air Dried	No	Yes	Yes

Figure A4.1

Appendix A - Details of Analysis

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.

Method	Name of Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETSC 3431	VOC	mg/kg	0.01	As Received	No	No	No
DETSC 3303	PAH by GCMS (see list below)						
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)anthracene	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(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 3303	Anthracene	mg/kg	0.03	As Received	No	Yes	No
DETSC 3303	Chrysene	mg/kg	0.03	As Received	No	Yes	No
DETSC 3303	Fluorene	mg/kg	0.03	As Received	No	Yes	No

Figure A4.1

Certificate of Analysis

2139

Certificate Number: 13-81144

Date: 21/05/2013

Client:	Ian Farmer Associates 1A Batford Mill Lower Luton Road Harpenden Herts AL5 5BZ
Our Reference:	13-81144
Client Reference:	52050A
Contract Title:	Plot 5600 Hatfield Business Park
Description:	1 leachate sample 3 soil samples
Date Received:	14 May 2013
Date Started:	15 May 2013
Date Completed:	21 May 2013
Test Procedures:	Identified by prefix DETSn, details available upon request.
Notes:	Observations and interpretations are outside the scope of UKAS accreditation
Approved By:	

Rob Brown, Business Manager

Derwentside Environmental Testing Services Limited
Unit 2, Park Road Industrial Estate South, Consett, Co Durham, DH8 5PY
Tel: 01207 582333 • Fax 01207 582444 • email: info@dets.co.uk • www.dets.co.uk

Figure A4.1

Information in Support of the Analytical Results

Analysis

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425um 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 28oC +/-2oC.

Key

*	Denotes test not included in laboratory scope of accreditation
#	Denotes test that holds MCERTS accreditation, however, MCERTS accreditation is only implied if the report carries the MCERTS logo
$	Denotes tests completed by an approved subcontractor
I/S	Denotes insufficient sample to carry out test
U/S	Denotes that the sample is not suitable for testing

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

Figure A4.1

Summary of Chemical Analysis
Matrix Descriptions

Our Ref: 13-81144
Client Ref: 52050A
Contract Title: Plot 5600 Hatfield Business Park

Sample ID	Other ID	Depth	Sample No	Completed	Matrix Description
TP201		0.40	513037	21/05/2013	Brown gravelly sandy CLAY with odd rootlets
TP202		0.60	513038	21/05/2013	Brown gravelly sandy CLAY
WS201		0.20	513039	21/05/2013	Brown gravelly sandy CLAY (made ground includes brick)

Figure A4.1

Summary of Chemical Analysis
Soil Samples

Our Ref: 13-81144
Client Ref: 52050A
Contract Title: Plot 5600 Hatfield Business Park

			Lab No.	513037	513038	513039
			Sample ID	TP201	TP202	WS201
			Depth	0.40	0.60	0.20
			Sample Ref			
			Sample Type			
			Sampling Date	08/05/2013	08/05/2013	10/05/2013
			Sampling Time			
Test	**Units**	**DETSxx**	**LOD**			
Mercury	mg/kg	DETSC 2325#	0.05	0.16	0.11	0.31
Arsenic	mg/kg	DETS 042#	0.2	9.9	8.3	11
Cadmium	mg/kg	DETS 042#	0.1	0.8	0.6	1.3
Chromium	mg/kg	DETS 042#	0.15	28	22	29
Copper	mg/kg	DETS 042#	0.2	26	15	21
Nickel	mg/kg	DETS 042#	1	20	15	20
Lead	mg/kg	DETS 042#	0.3	49	32	56
Selenium	mg/kg	DETS 042#	0.5	< 0.5	< 0.5	< 0.5
Zinc	mg/kg	DETS 042#	1	62	52	71
Boron (water soluble)	mg/kg	DETS 020#	0.2	1.7	1.8	2.5
Organic matter	%	DETSC 2002#	0.1	0.7	0.8	0.5
pH		DETSC 2008#		7.7	7.9	8.2
Aliphatic C5-C6	mg/kg	DETSC 3321*	0.01			< 0.01
Aliphatic C6-C8	mg/kg	DETSC 3321*	0.01			< 0.01
Aliphatic C8-C10	mg/kg	DETSC 3321*	0.01			< 0.01
Aliphatic C10-C12	mg/kg	DETSC 3072#	1.5			< 1.5
Aliphatic C12-C16	mg/kg	DETSC 3072#	1.2			< 1.2
Aliphatic C16-C21	mg/kg	DETSC 3072#	1.5			< 1.5
Aliphatic C21-C35	mg/kg	DETSC 3072#	3.4			< 3.4
Aromatic C5-C7	mg/kg	DETSC 3321*	0.01			< 0.01
Aromatic C7-C8	mg/kg	DETSC 3321*	0.01			< 0.01
Aromatic C8-C10	mg/kg	DETSC 3321*	0.01			< 0.01
Aromatic C10-C12	mg/kg	DETSC 3072#	0.9			< 0.9
Aromatic C12-C16	mg/kg	DETSC 3072#	0.5			< 0.5
Aromatic C16-C21	mg/kg	DETSC 3072#	0.6			< 0.6
Aromatic C21-C35	mg/kg	DETSC 3072#	1.4			< 1.4
Aliphatic C5-C35	mg/kg	DETSC 3072*	10			< 10
Aromatic C5-C35	mg/kg	DETSC 3072*	10			< 10
TPH Ali/Aro	mg/kg	DETSC 3072*	10			< 10
Acenaphthene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1
Anthracene	mg/kg	DETSC 3301	0.1	< 0.1	0.7	< 0.1
Benzo(a)anthracene	mg/kg	DETSC 3301	0.1	< 0.1	2.7	< 0.1
Benzo(a)pyrene	mg/kg	DETSC 3301	0.1	< 0.1	3.0	0.2
Benzo(b)fluoranthene	mg/kg	DETSC 3301	0.1	< 0.1	3.0	0.2
Benzo(k)fluoranthene	mg/kg	DETSC 3301	0.1	< 0.1	5.2	< 0.1
Benzo(g,h,i)perylene	mg/kg	DETSC 3301	0.1	< 0.1	3.0	0.3
Chrysene	mg/kg	DETSC 3301	0.1	< 0.1	3.9	< 0.1
Dibenzo(a,h)anthracene	mg/kg	DESTC 3301	0.1	< 0.1	2.0	< 0.1
Fluoranthene	mg/kg	DETSC 3301	0.1	< 0.1	8.8	0.3
Fluorene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1
Indeno(1,2,3-c,d)pyrene	mg/kg	DETSC 3301	0.1	< 0.1	3.0	0.1
Naphthalene	mg/kg	DETSC 3301	0.1	< 0.1	< 0.1	< 0.1

Figure A4.1

Summary of Chemical Analysis
Soil Samples

Our Ref: 13-81144
Client Ref: 52050A
Contract Title: Plot 5600 Hatfield Business Park

			Lab No.	513037	513038	513039
			Sample ID	TP201	TP202	WS201
			Depth	0.40	0.60	0.20
			Sample Ref			
			Sample Type			
			Sampling Date	08/05/2013	08/05/2013	10/05/2013
			Sampling Time			
Test	**Units**	**DETSxx**	**LOD**			
Phenanthrene	mg/kg	DETSC 3301	0.1	< 0.1	0.7	< 0.1
Pyrene	mg/kg	DETSC 3301	0.1	< 0.1	3.7	0.2
PAH	mg/kg	DETSC 3301	1.6	< 1.6	40	< 1.6
EPH (C10-C12)	mg/kg	DETSC 3311	10	< 10	< 10	
EPH (C12-C16)	mg/kg	DETSC 3311	10	< 10	< 10	
EPH (C16-C21)	mg/kg	DETSC 3311	10	< 10	< 10	
EPH (C21-C36)	mg/kg	DETSC 3311	10	14	< 10	
EPH (C36-C40)	mg/kg	DETSC 3311	10	< 10	< 10	
EPH (C10-C40)	mg/kg	DETSC 3311#	10	20	< 10	
Hexavalent Chromium	mg/kg	DETSC 2204*	1	< 1.0	< 1.0	< 1.0

Figure A4.1

Summary of Chemical Analysis
Leachate Samples

Our Ref: 13-81144
Client Ref: 52050A
Contract Title: Plot 5600 Hatfield Business Park

			Lab No.	513040
			Sample ID	WS201
			Depth	0.30
			Sample Ref	
			Sample Type	
			Sampling Date	10/05/2013
			Sampling Time	
Test	**Units**	**DETSxx**	**LOD**	
Arsenic, Dissolved	ug/l	DETSC 2306	0.16	0.78
Cadmium, Dissolved	ug/l	DETSC 2306	0.03	< 0.030
Chromium, Dissolved	ug/l	DETSC 2306	0.25	< 0.25
Copper, Dissolved	ug/l	DETSC 2306	0.4	1.3
Lead, Dissolved	ug/l	DETSC 2306	0.09	0.39
Mercury, Dissolved	ug/l	DETSC 2306	0.01	< 0.010
Nickel, Dissolved	ug/l	DETSC 2306	0.5	< 0.50
Selenium, Dissolved	ug/l	DETSC 2306	0.25	< 0.25
Zinc, Dissolved	ug/l	DETSC 2306	1.25	< 1.3
Boron	ug/l	DETS 020	100	110
Acenaphthene	ug/l	DETS 074*	0.01	< 0.01
Acenaphthylene	ug/l	DETS 074*	0.01	< 0.01
Anthracene	ug/l	DETS 074*	0.01	0.01
Benzo(a)anthracene	ug/l	DETS 074*	0.01	0.03
Benzo(a)pyrene	ug/l	DETS 074*	0.01	0.02
Benzo(b)fluoranthene	ug/l	DETS 074*	0.01	0.02
Benzo(k)fluoranthene	ug/l	DETS 074*	0.01	0.01
Benzo(g,h,i)perylene	ug/l	DETS 074*	0.01	< 0.01
Chrysene	ug/l	DETS 074*	0.01	0.06
Dibenzo(a,h)anthracene	ug/l	DETS 074*	0.01	< 0.01
Fluoranthene	ug/l	DETS 074*	0.01	0.05
Fluorene	ug/l	DETS 074*	0.01	< 0.01
Indeno(1,2,3-c,d)pyrene	ug/l	DETS 074*	0.01	0.04
Naphthalene	ug/l	DETS 074*	0.01	< 0.01
Phenanthrene	ug/l	DETS 074*	0.01	0.05
Pyrene	ug/l	DETS 074*	0.01	0.06
PAH	ug/l	DETS 074*	0.2	0.35
EPH (C10-C12)	ug/l	DETSC 3311	10	< 10
EPH (C12-C16)	ug/l	DETSC 3311	10	< 10
EPH (C16-C21)	ug/l	DETSC 3311	10	< 10
EPH (C21-C36)	ug/l	DETSC 3311	10	< 10
EPH (C36-C40)	ug/l	DETSC 3311	10	< 10
EPH (C10-C40)	ug/l	DETSC 3311	10	< 10

Figure A4.1

WASTE ACCEPTANCE CRITERIA TESTING
ANALYTICAL REPORT

Job Title:	Plot 5600 Hatfield Business Park	**Job Number:**	13-81144
Client Reference:	52050A	**Sample Numbe**	513221 513037
Sample ID:	TP201 / 0.40	**Date Analysed:**	21/05/2013

Test Results On Waste			**WAC Limit Values**		
Determinand and Method Reference	**Units**	**Result**	**Inert Waste**	**SNRHW**	**Hazardous Waste**
Total Organic Carbon	%	0.8	3	5	6
DETSC2003# Loss On Ignition	%	3.9	n/a	n/a	10
DETSC3321# BTEX	mg/kg	<0.04	6	n/a	n/a
DETSC3401# PCB's (7 congeners)	mg/kg	<0.01	1	n/a	n/a
DETSC3311# TPH (C10 - C40)	mg/kg	20	500	n/a	n/a
PAHs	mg/kg	<1.6	100	n/a	n/a
DETSC2008# pH	pH Units	7.7	n/a	>6	n/a
DETS073* Acid Neutralisation Capacity (pH4)	mol/kg	<1	n/a	TBE	TBE
DETS073* Acid Neutralisation Capacity (pH7)	mol/kg	<1	n/a	TBE	TBE

Test Results On Leachate					**WAC Limit Values** limit values for LS10 Leachate		
Determinand and Method Reference	**Conc in Eluate ug/l**		**Amount Leached mg/kg**		**Inert Waste**	**SNRHW**	**Hazardous Waste**
	2:1	**8:1**	**LS2**	**LS10**			
DETSC2306 Arsenic as As	0.71	0.26	<0.002	<0.01	0.5	2	25
DETSC2306 Barium as Ba	11	2.4	0.02	<0.1	20	100	300
DETSC2306 Cadmium as Cd	<2.0	<2.0	<0.004	<0.02	0.04	1	5
DETSC2306 Chromium as Cr	2.2	<5.0	<0.02	<0.1	0.5	10	70
DETSC2306 Copper as Cu	3.8	0.86	0.008	<0.02	2	50	100
DETSC2306 Mercury as Hg	<0.05	<0.05	<0.0004	<0.002	0.01	0.2	2
DETSC2306 Molybdenum as Mo	<10	<10	<0.02	<0.1	0.5	10	30
DETSC2306 Nickel as Ni	1.4	<10	<0.02	<0.1	0.4	10	40
DETSC2306 Lead as Pb	2	0.3	<0.01	<0.05	0.5	10	50
DETSC2306 Antimony as Sb	0.3	<1.0	<0.01	<0.05	0.06	0.7	5
DETSC2306 Selenium as Se	<12	<12	<0.006	<0.03	0.1	0.5	7
DETSC2306 Zinc as Zn	5.1	<1.0	0.010	<0.01	4	50	200
DETSC2055 Chloride as Cl	1600	980	<20	<100	800	15,000	25,000
DETSC2055 Fluoride as F	460	160	0.92	2.00	10	150	500
DETSC2055 Sulphate as SO4	3100	1600	<20	<100	1000	20,000	50,000
DETSC2009* Total Dissolved Solids	27000	11000	54	131	4000	60,000	100,000
DETSC2130 Phenol Index	<100	<100	<0.2	<1.0	1	n/a	n/a
DETSC2033* Dissolved Organic Carbon	24000	11000	48	127	500	800	1000

Additional Information		
DETSC2008 pH	5.8	8.1
DETSC2009 Conductivity uS/cm	39.5	16.3
Temperature*	17	17

Mass of Sample Kg	0.140
Mass of dry Sample Kg	0.120
Stage 1	
Volume of Leachant L2	0.220
Volume of Eluate VE1	0.160
Stage 2	
Volume of Leachant L8	0.960
Volume of Eluate VE2	0.880

TBE = To Be Evaluated

SNRHW = Stable Non-Reactive Hazardous Waste

Disclaimer: *The WAC limit values are provided for guidance only. DETS does not accept responsibility for errors or omissions. Values are correct at time of issue.*

DERWENTSIDE ENVIRONMENTAL TESTING SERVICES LIMITED

Figure A4.1

Sample Comments

DETS cannot be held responsible for the integrity of sample(s) 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 below. 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.

Lab No.	Sample ID	Date Sampled	Containers Received	Deviating due to holding time being exceeded for test(s)	Deviating due to inappropriate container for test(s)	Deviating due to headspace presence in container for test(s)
513037	TP201 0.40 SOIL	08/05/2013	Glass Jar 250ml (250ml), Glass Vial (40ml), Plastic Tub 1 litre (1kg)			
513038	TP202 0.60 SOIL	08/05/2013	Glass Jar 250ml (250ml), Glass Vial (40ml), Plastic Tub 1 litre (1kg)			
513039	WS201 0.20 SOIL	10/05/2013	Glass Jar 250ml (250ml), Glass Vial (40ml), Plastic Tub 1 litre (1kg)			
513040	WS201 0.30 LEACHATE	10/05/2013	Glass Jar 1 litre (1 litre)			
513220	TP201 0.40 LEACHATE	08/05/2013	Glass Jar 1 litre (1 litre)			
513221	TP201 0.40 LEACHATE	08/05/2013	Glass Jar 1 litre (1 litre)			

Figure A4.1

Appendix A - Details of Analysis

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.

Method	Name of Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETSC 2002	Organic Matter	%	0.01	Air Dried	No	Yes	Yes
DETSC 2003	Loss on Ignition	%	0.01	Air Dried	No	Yes	Yes
DETSC 2004	Total Sulphate	%	0.01	Air Dried	No	Yes	Yes
DETSC 2321	Total Sulphate	%	0.01	Air Dried	No	Yes	Yes
DETSC 2004	Water Soluble Sulphate	mg/l	10.00	Air Dried	No	Yes	Yes
DETSC 2076	Water Soluble Sulphate	mg/l	10.00	Air Dried	No	Yes	Yes
DETSC 2006	Chloride	mg/kg	0.01	Air Dried	No	Yes	Yes
DETSC 2008	pH	pH Units	0.10	Air Dried	No	Yes	Yes
DETS 042	Selenium	mg/kg	0.50	Air Dried	No	Yes	Yes
DETSC 2119	Ammonia	mg/kg	0.02	Air Dried	No	Yes	Yes
DETS 020	Boron (Water Soluble)	mg/kg	0.20	Air Dried	No	Yes	Yes
DETSC 2024	Sulphide	mg/kg	10.00	Air Dried	No	Yes	Yes
DETS 042	Antimony	mg/kg	1.00	Air Dried	No	No	No
DETS 042	Arsenic	mg/kg	0.20	Air Dried	No	Yes	Yes
DETS 042	Barium	mg/kg	1.50	Air Dried	No	Yes	Yes
DETS 042	Beryllium	mg/kg	0.20	Air Dried	No	Yes	Yes
DETS 042	Cadmium	mg/kg	0.10	Air Dried	No	Yes	Yes
DETS 042	Cobalt	mg/kg	0.70	Air Dried	No	Yes	Yes
DETS 042	Copper	mg/kg	0.20	Air Dried	No	Yes	Yes
DETS 042	Chromium	mg/kg	0.15	Air Dried	No	Yes	Yes
DETS 042	Iron	mg/kg	1.00	Air Dried	No	Yes	No

Figure A4.1

Appendix A - Details of Analysis

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.

Method	Name of Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETS 042	Lead	mg/kg	0.30	Air Dried	No	Yes	Yes
DETS 042	Manganese	mg/kg	20.00	Air Dried	No	Yes	Yes
DETSC 2325	Mercury	mg/kg	0.05	Air Dried	No	Yes	Yes
DETS 042	Molybdenum	mg/kg	0.40	Air Dried	No	Yes	Yes
DETS 042	Nickel	mg/kg	0.20	Air Dried	No	Yes	Yes
DETS 042	Thallium	mg/kg	1.00	Air Dried	No	No	No
DETS 042	Vanadium	mg/kg	0.80	Air Dried	No	Yes	Yes
DETS 042	Zinc	mg/kg	1.00	Air Dried	No	Yes	Yes
DETSC 3049	Sulphur (Free)	mg/kg	0.50	As Received	No	Yes	Yes
DETSC 3301	PAH by GC-FID	mg/kg	0.10	As Received	No	Yes	No
DETSC 3311	TPH (C10 - C40)	mg/kg	20.00	As Received	No	Yes	Yes
DETSC 3401	PCB	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3321	Benzene	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3321	Toluene	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3321	Ethylbenzne	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3321	Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 2130	Phenol - Monohydric	mg/kg	0.3	Air Dried	No	Yes	Yes
DETSC 2130	Easily Liberatable Cyanide	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC 2130	Complex Cyanide	mg/kg	0.30	Air Dried	No	Yes	No
DETSC 2130	Total Cyanide	mg/kg	0.40	Air Dried	No	Yes	Yes
DETSC 2130	Thiocyanate	mg/kg	0.6	Air Dried	No	Yes	Yes

Figure A4.1

Appendix A - Details of Analysis

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.

Method	Name of Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETSC 3431	VOC	mg/kg	0.01	As Received	No	No	No
DETSC 3303	PAH by GCMS (see list below)						
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)anthracene	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(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 3303	Anthracene	mg/kg	0.03	As Received	No	Yes	No
DETSC 3303	Chrysene	mg/kg	0.03	As Received	No	Yes	No
DETSC 3303	Fluorene	mg/kg	0.03	As Received	No	Yes	No

Figure A4.1

Job name

52050A Plot 5600 Hatfield Business Park

Waste stream

Con Land Waste - Tony

Comments

Report

Created by: Tickner, Victoria
Created date: 10/06/2013 14:40

Job summary

#	Sample name	Depth	Classification result	Hazardous properties
1	BH202	0.2	Non Hazardous	
2	BH203	0.2	Non Hazardous	
3	TP203	0.15	Non Hazardous	
4	TP204	0.3	Non Hazardous	
5	TP201	0.4	Non Hazardous	
6	TP202	0.6	Non Hazardous	
7	WS201	0.2	Non Hazardous	

Figure A4.2

APPENDIX 5

DESIGN CONSIDERATIONS

APPENDIX 5

GUIDELINES FOR THE DESIGN OF PILES

FIRST APPROXIMATION OF WORKING LOAD

A5.1 GENERAL

The ultimate carrying capacity, Qu, of a particular pile is taken as the sum of the ultimate shaft friction resistance, Qs, and the ultimate end bearing resistance, Qb. This may be expressed as follows:-

$$Qu = Qs + Qb$$

$$= f.As + q.Ab$$

where f = unit shaft resistance

As = embedded surface area of pile

q = unit end bearing resistance

Ab = effective cross-sectional area of pile base

A5.2 COHESIVE SOILS

A5.2.1 Shaft Resistance

The ultimate shaft resistance, f, for piles in both compression or tension in cohesive soils is determined by applying a factor to the undrained shear strength, Cs, which exists in the soils along the embedded length of the pile, and is given by:-

$$f = \alpha.Cs$$

Where α is an adhesion factor, which for straight-shafted bored piles may be taken as 0.45 to 0.60.

Ultimate unit shaft friction should not exceed 100kPa.

A5.2.2 End Bearing

For piles terminating in cohesive soils, the ultimate unit end bearing resistance q, is given by:-

$$q = Nc.Cb$$

where Cb is the undrained shear strength at the base of the pile

and Nc is a bearing capacity factor

The value of Nc for a cohesive material is variable, depending on the depth of the penetration of the pile into the bearing stratum. Generally, Nc could be taken to have a value of 9, except in the case of large diameter short piles where a lesser value should be used.

A5.3 COHESIONLESS SOILS

A5.3.1 Shaft Resistance

For piles driven in cohesionless soils the ultimate unit shaft resistance, f, may be calculated using the following method, which gives:-

$$f = 0.5\gamma' (D+d) Ks \tan \delta$$

where γ' = average effective unit weight of soil surrounding the pile

D = depth to the pile toe or to the base of the granular stratum whichever is the lesser

d = depth to the top of the granular stratum

δ = angle of friction between pile and soil (see below)

Ks = a coefficient (see below)

VALUES OF Ks AND δ

Pile Type	δ	Ks		
		Relative Density		Tension Piles
		Low	High	
Steel	20°	0.5	1.5	0.5
Concrete	0.75ϕ	1.0	2.0	0.5

The value of ϕ may be interpreted from standard penetration tests, see Figure A5.2.

For bored and cast-in-place piles, δ = 22° and Ks = 1 should be used to allow for loosening of the soil during boring.

It has been found that the ultimate unit shaft resistance does not exceed 100kPa and therefore this value should not be exceeded in design.

A5.3.2 End Bearing

The unit ultimate end bearing resistance (q) of piles in cohesionless soils may be calculated as follows:-

$$q = \gamma'.D.Nq$$

where γ' = average effective unit weight of soil surrounding the pile

D = depth to pile toe

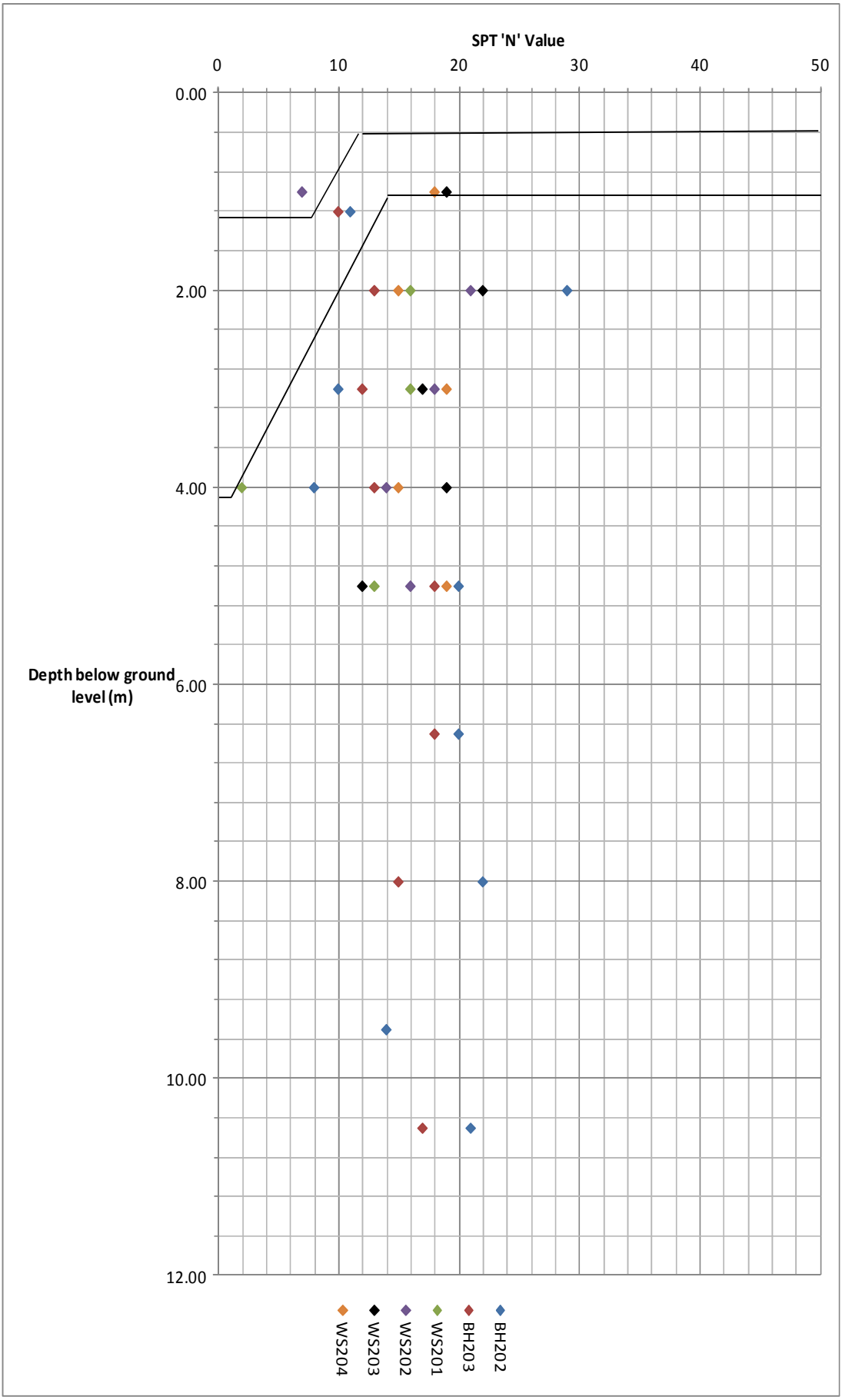
Nq = bearing capacity factor

Values for Nq, where piles penetrate the bearing stratum by more than five diameters, are given in Figure A5.3. In addition, the ultimate unit base resistance should not exceed a value of 11,000kPa. For bored and cast-in-place piles the value of Nq used should correspond to loose soil conditions.

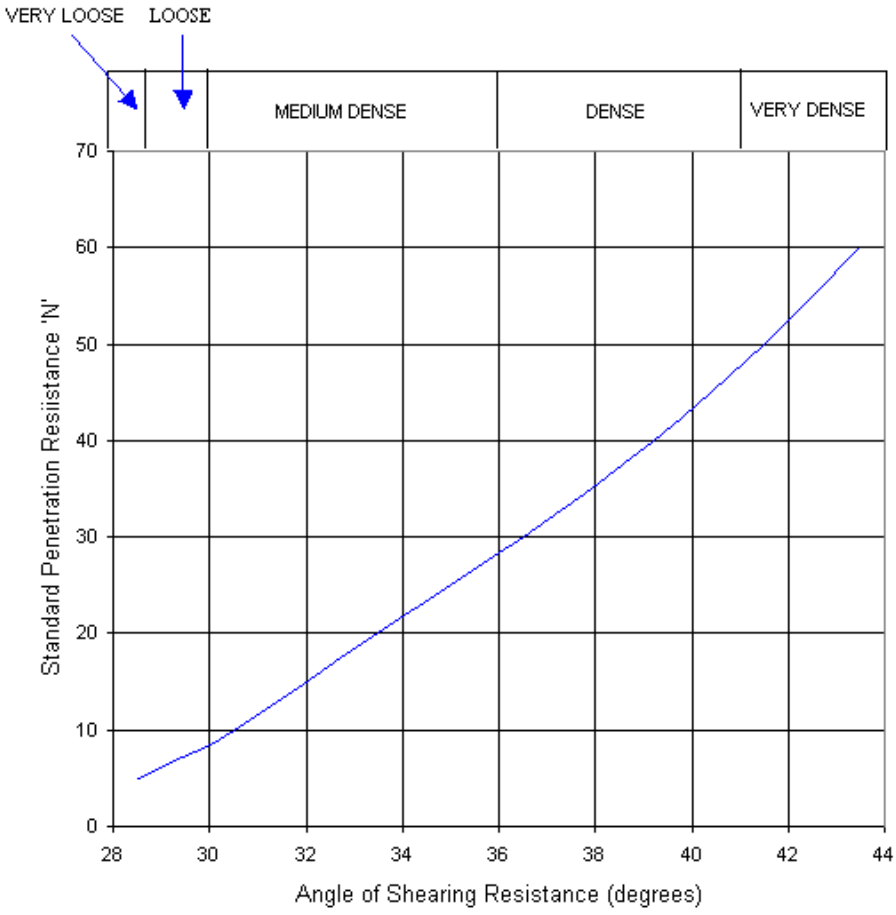
A5.4 FACTORS OF SAFETY

A5.4.1 Cohesive and Non-cohesive Soils

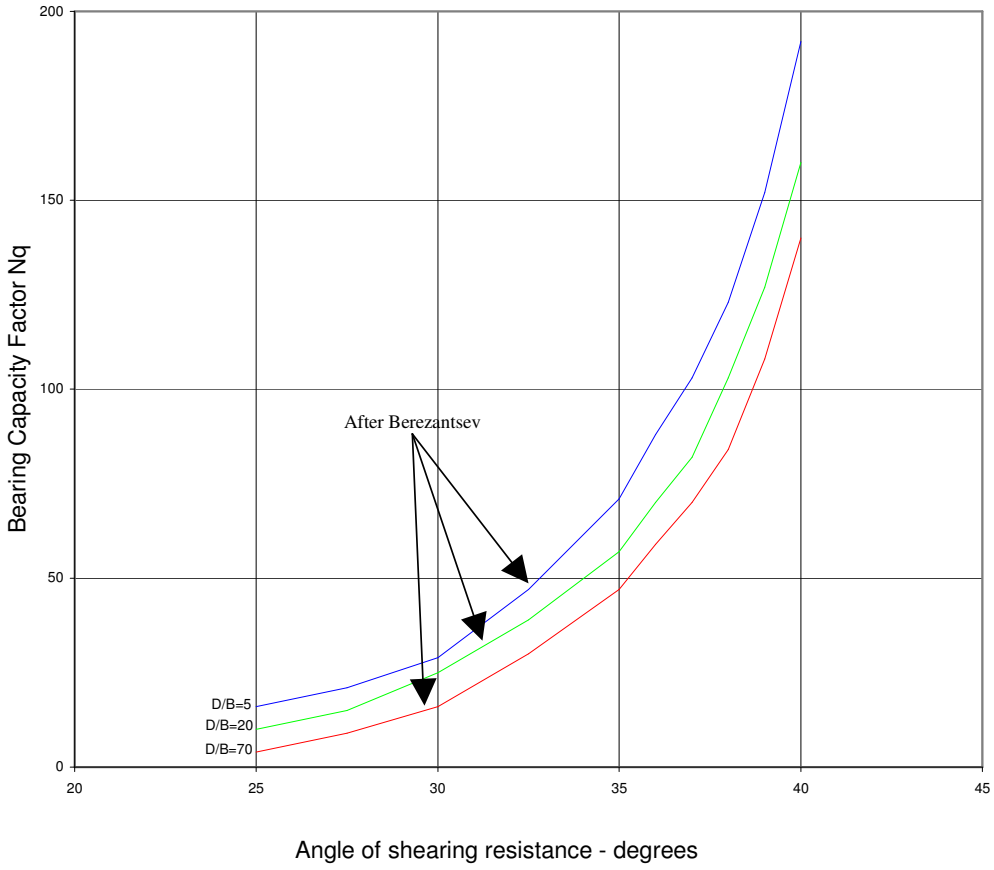
For cohesive and non-cohesive soils a factor of safety of 3 may be used to obtain the allowable or safe carrying capacity of piles from the ultimate carrying capacity.



IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**PLOT OF STRENGTH WITH DEPTH**	Job no. 52050A
	Plot 5600 Site B Hatfield Business Park, Hatfield	Fig No A5.1



IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**RELATIONSHIP BETWEEN SPT AND ANGLE OF INTERNAL RESISTANCE**	Job no. 52050A
	Plot 5600 Site B Hatfield Business Park, Hatfield	Fig. A5.2



D = Penetration of bearing stratum
B = Pile diameter or least width

IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	RELATIONSHIP BETWEEN BEARING CAPACITY FACTOR & ANGLE OF INTERNAL RESISTANCE	Job no. 52050A
	Plot 5600 Site B Hatfield Business Park, Hatfield	Fig. A5.3

APPENDIX 6

CONTAMINATION ASSESSMENT

APPENDIX 6

GENERAL NOTES ON CONTAMINATION ASSESSMENT

A6.1 STATUTORY FRAMEWORK AND DEFINITIONS

A6.1.1 The statutory definition of contaminated land is defined in the Environmental Protection Act 1990, ref 10.18, which was introduced by the Environment Act 1995, ref 10.19;

'Land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that –

(a) significant harm is being caused or there is a significant possibility of such harm being caused; or

(b) pollution of controlled waters is being, or is likely to be, caused.'

A6.1.2 The UK guidance on the assessment of contaminated has developed as a direct result of the introduction of these two Acts. The technical guidance supporting the new legislation has been summarised in a number of key documents collectively known as the Contaminated Land Reports (CLRs), a proposed series of twelve documents. Seven were originally published in March 1994, four more were published in April 2002, while the last remaining guidance document, CLR 11, ref 10.35 was published in 2004. In 2008 CLR reports 7 to 10 were withdrawn by DEFRA and the Environment Agency and updated version of CLR 9 and 10 were produced in the form of Science Reports SR2, ref 10.27 and SR3, ref 10.20.

A6.1.3 In establishing whether a site fulfils the statutory definition of 'contaminated land' it is necessary to identify, whether a pollutant linkage exists in respect of the land in question and whether the pollutant linkage:

- is resulting in significant harm being caused to the receptor in the pollutant linkage,
- presents a significant possibility of significant harm being caused to that receptor,
- is resulting in the pollution of the controlled waters which constitute the receptor, or
- is likely to result in such pollution.

A6.1.4 A *'pollutant linkage'* may be defined as the link between a contaminant *'source'* and a *'receptor'* by means of a *'pathway'*.

A6.2 ASSESSMENT METHODOLOGY

A6.2.1 The guidance proposes a four-stage assessment process for identifying potential pollutant linkages on a site. These stages are set out in the table below:

No.	Process	Description
1	Hazard Identification	Establishing contaminant sources, pathways and receptors (the conceptual model).
2	Hazard Assessment	Analysing the potential for unacceptable risks (what linkages could be present, what could be the effects).
3	Risk Estimation	Trying to establish the magnitude and probability of the possible consequences (what degree of harm might result and to what receptors, and how likely is it).
4	Risk Evaluation	Deciding whether the risk is unacceptable.

A6.2.2 Stages 1 and 2 develop a *'conceptual model'* based upon information collated from desk based studies, and frequently a walkover of the site. The walkover survey should be conducted in general accordance with CLR 2, ref 10.40. The formation of a conceptual model is an iterative process and as such, it should be updated and refined throughout each stage of the project to reflect any additional information obtained.

A6.2.3 The extent of the desk studies and enquiries to be conducted should be in general accordance with CLR 3, ref 10.41. The information from these enquiries is presented in a desk study report with recommendations, if necessary, for further work based upon the conceptual model. CLR 8, ref. 10.42, together with specific DoE 'Industry Profiles' provides guidance on the nature of contaminants relating to specific industrial processes. Although CLR 8 has been withdrawn, no replacement guidance has been published that lists the contaminants likely to be present on contaminated sites and as such the guidance relating to this issue of CLR 8 is considered to still be relevant.

A6.2.4 If potential pollutant linkages are identified within the conceptual model, a Phase 2 site investigation and report will be recommended. The investigation should be planned in general accordance with CLR 4, ref 10.1. The number of exploratory holes and samples collected for analysis should be consistent with the size of the site and the level of risk envisaged. This will enable a contamination risk assessment to be conducted, at which point the conceptual model can be updated and relevant pollutant linkages can be identified.

A6.2.5 A two-stage investigation may be more appropriate where time constraints are less of an issue. The first stage investigation being conducted as an initial assessment for the presence of potential sources, a second being a more refined investigation to delineate wherever possible the extent of the identified contamination.

A6.2.6 All site works should be in general accordance with the British Standards, BS 5930:1999, ref. 10.3, ISO 1997, ref 10.4 and BS 10175:2001, ref 10.2.

A6.2.7 The generic contamination risk assessment screens the results of the chemical analysis against generic guidance values. Soils will be compared to Assessment Criteria (AC) generated using the Contaminated Land Exposure Assessment (CLEA) Software Version 1.06, ref 10.2310.22. Toxicological and physico-chemical/fate and transport data used to generate the AC has been derived from a hierarchy of data sources as follows:

1. Environment Agency or Department of Environment Food and Rural Affairs

   (DEFRA) documents;

2. Other documents produced by UK Government or state organisations;

3. European institution documents;

4. International organisation documents;

5. Foreign government institutions.

A6.2.8 In the case of the majority of contaminants considered, the toxicological data has been drawn from the relevant CLR 9 TOX report, or updated toxicological data published by the Environment Agency (2009), ref. 10.21, where available. Where no TOX report is available reference has been made to the health criteria values, derived for use in Land Quality Press (2006), ref 10.28, as this is considered to represent a peer reviewed data source. Similarly, fate and transport data has been derived in the first instance from Environment Agency (2003), ref 10.43 and for contaminants not considered in this document the fate and transport data used in previous versions of the CLEA model has been used.

A6.2.9 Recommendations for tolerable intakes of lead are based on evaluation of the relationship between exposure and blood lead levels. Consequently the Tox report for lead considers a health criteria value based on an uptake dose, whereas the CLEA model estimates exposure in terms of an intake dose, therefore, the CLEA model is not considered appropriate for determining an assessment criteria for lead. In the absence of a current published assessment criterion, the SGVs for lead reported in R&D Publication CLR 10 ref 10.44 have been used in this assessment.

A6.2.10 Chemical laboratory test results are processed as follows. A statistical analysis of the results is conducted, as detailed in CIEH and CL:AIRE 'Guidance on Comparing Soil Contamination Data with a Critical Concentration', ref 10.22. Individual concentrations are compared to the selected guideline values to identify concentrations of contaminants that are above the selected screening criteria.

A6.2.11 Initially the distribution of the data set is tested using the Shapiro-Wilk normality test, ref 10.26 to determine if the data set is, or is not, normally distributed. Where the distribution of the data is shown to be normal, the mean value test is applied to determine whether the mean characteristics of the selected soil unit present a significant possibility of significant harm to human health. Where the data is not normally distributed a method based on the Chebychev Theorem can be applied to test the same hypothesis. The significance of the data is further tested using the maximum value test. This determines whether the highest recorded contaminant concentrations are from the same statistical distribution or whether they may represent a 'hot spot'.

A6.2.12 Where the risk estimation identifies significant concentrations of one or more contaminants, a further risk evaluation needs to be undertaken.

A6.2.13 The risk evaluation will address the potential pollutant linkages between an identified source of contamination and the likely receptors both on and off site.

A6.2.14 The potential receptors include:

1) Humans – current site occupants, construction workers, future site users and neighbouring site users.

2) Controlled Waters – surface water and groundwater resources

3) Plants – current and future site vegetation

4) Building materials

A6.2.15 The potential hazards to be considered in relation to contamination are:

a) Ingestion and inhalation.

b) Uptake of contaminants via cultivated vegetables.

c) Dermal contact

d) Phytotoxicity (the prevention or inhibition of plant growth)

e) Contamination of water resources

f) Chemical attack on building materials and services

g) Fire and explosion

A6.2.16 Dependent on the outcome of the initial, generic contamination risk assessment, further detailed assessment of the identified risks may be required.

A6.3 Generic Guidance Values Used Within Contamination Risk Assessment

Commercial End Use

	Determinant	Guidance Value (mg/kg)	Primary Data Source
		1% SOM	
PAH	Acenaphthene	85000 (57)	LQM CIEH GAC
	Acenaphthylene	84000 (86)	LQM CIEH GAC
	Anthracene	530000	LQM CIEH GAC
	Benzo(a)anthracene	90	LQM CIEH GAC
	Benzo(a)pyrene	14	LQM CIEH GAC
	Benzo(b)fluoranthene	100	LQM CIEH GAC
	Benzo(ghi)perylene	650	LQM CIEH GAC
	Benzo(k)fluoranthene	140	LQM CIEH GAC
	Chrysene	140	LQM CIEH GAC
	Dibenzo(ah)anthracene	13	LQM CIEH GAC
	Fluoranthene	23000	LQM CIEH GAC
	Fluorene	64000 (31)	LQM CIEH GAC
	Indeno(123-cd)pyrene	60	LQM CIEH GAC
	Naphthalene	200 (76)	LQM CIEH GAC
	Phenanthrene	22000	LQM CIEH GAC
	Pyrene	54000	LQM CIEH GAC
Other Organics	Phenol	1100000 (24200)	LQM CIEH GAC
Metals	Arsenic	640	EA 2009
	Beryllium	420	LQM CIEH GAC
	Boron	192000	LQM CIEH GAC
	Cadmium	230	EA 2009
	Chromium (III)	30400	LQM CIEH GAC
	Chromium (VI)	35	LQM CIEH GAC
	Copper	71700	LQM CIEH GAC
	Lead	750	CLEA SGV 10
	Inorganic Mercury	3640	EA 2009
	Nickel	1800	EA 2009
	Selenium	13000	EA 2009
	Vanadium	3160	LQM CIEH GAC
	Zinc	665000	LQM CIEH GAC

SOM = Soil Organic Matter
Values in brackets indicate the solubility or vapour saturation limit where this is exceeded by the GAC

A6.3.1 Generic Assessment Criteria for Petroleum Hydrocarbons

Commercial	Guidance Value (mg/kg)	Primary Data Source
	1% SOM	
Aliphatic		
EC 5-6	3400 (304)	LQM CIEH GAC
EC >6-8	8300 (144)	LQM CIEH GAC
EC >8-10	2100 (78)	LQM CIEH GAC
EC >10-12	10000 (48)	LQM CIEH GAC
EC >12-16	61000 (24)	LQM CIEH GAC
EC >16-35	1600000	LQM CIEH GAC
EC >35-44	1600000	LQM CIEH GAC
Aromatic		
EC 5-7 (benzene)	28000 (1220)	LQM CIEH GAC
EC >7-8 (toluene)	59000 (869)	LQM CIEH GAC
EC >8-10	3700 (613)	LQM CIEH GAC
EC >10-12	17000 (364)	LQM CIEH GAC
EC >12-16	36000 (169)	LQM CIEH GAC
EC >16-21	28000	LQM CIEH GAC
EC >21-35	28000	LQM CIEH GAC
EC >35-44	28000	LQM CIEH GAC
Aliphatic and Aromatic		
EC >44-70	28000	LQM CIEH GAC
BTEX		
Benzene	28.1	EA 2009
Toluene	59000 (869)	EA 2009
Ethylbenzene	16800 (518)	EA 2009
Xylenes	6940 (478)	EA 2009

SOM = Soil Organic Matter
Values in brackets indicate the vapour saturation limit where this is exceeded by the GAC or SGV

APPENDIX 7

GAS GENERATION

APPENDIX 7

GENERAL NOTES ON GAS GENERATION

A7.1 GENERAL

A7.1.1 In the past, a series of guidance documents were published by CIRIA, ref. 10.44, providing advice on hazards associated with methane. This earlier guidance was consolidated in CIRIA Document C659 to provide a risk based approach to gas contaminated land. This was subsequently re-issued as CIRIA Document C665, ref 10.46. In 2007, British Standard, BS8485, ref 10.47, dealing with ground gas was published. It is recommended that guidance in C665 and BS8485 is adopted to provide a consistent approach in dealing with ground gas contamination, the principal details being as follows.

A7.1.2 This guidance is based on a similar approach to that for dealing with contaminated soil. The presence of hazardous gases could be deemed to be the 'source' in a 'pollutant linkage' that could lead to the conclusion that significant harm is or could be caused to people, buildings or the environment. In such circumstances the land could be deemed 'contaminated', ref. 10.18.

A7.1.3 Should a potential source of gas be identified in the conceptual model, a gas risk assessment should be carried out, sufficient to demonstrate to the local authority that the proposals mitigate any hazards associated with ground gas. The authority enforces compliance with Approved Document Part C of the Building Regulations, ref. 10.48.

A7.2 APPROACH

A7.2.1 A flow chart detailing the approach to assessing a site is given in CIRIA document C665, Figure 1.1. This may be summarised as follows.

- Carry out Phase 1 desk study, including initial conceptual model
- Assess site, potential presence of gas / potential unacceptable risk / identify further action, if necessary
- Monitor gas concentrations
- Assessment of Risk
- Recommendations / remediation
- Validation

A7.3 POLLUTANT LINKAGE ASSESSMENT

A7.3.1 A pollutant linkage assessment is presented in Appendix 3 of the Phase 1 Desk Study Report.

A7.3.2 Using the risk model in the desk study, the pollutant linkage can be identified and a preliminary estimate of risk undertaken. If there is no relevant pollutant linkage identified there is no risk. If there is a very low risk, it is likely that no further assessment is required. If further assessment is necessary, then gas monitoring is required.

A7.4 SITE MONITORING

A7.4.1 For sites with low generation potential, giving consistently low concentrations of soil gas under the worst-case conditions, a limited programme of monitoring would be appropriate. Where high or variable concentrations are anticipated or recorded, an extended programme of monitoring would be appropriate. The following guideline has been proposed, ref. 10.50.

Table A7.1

		Generation potential of source				
Sensitivity of development		**Very low**	**Low**	**Moderate**	**High**	**Very high**
	Low (Commercial)	4/1	6/2	6/3	12/6	12/12
	Moderate (Flats)	6/2	6/3	9/6	12/12	24/24
	High (Residential with gardens)	6/3*	9/6	12/6	24/12	24/24

Notes

1. First number is minimum number of readings and second number is minimum period in months, for example 4/1 – Four sets of readings over 1 month.

2. At least two sets of readings must be at low and falling atmospheric pressure (but not restricted to periods below <1000mb) known as worst case conditions (see Boyle and Witherington, 2006).

3. The frequency and period stated are considered to represent typical minimum requirements. Depending on specific circumstances fewer or additional readings may be required (e.g. any such variation subject to site specific justification). * The NHBC guidance is also recommending these periods/frequency of monitoring (Boyle and Witherington, 2006)

4. Historical data can be used as part of the data set.

5. Not all sites will require gas monitoring however, this would need to be confirmed with demonstrable evidence.

6. Placing high sensitivity end use on a high hazard site is not normally acceptable unless the source is removed or treated to reduce its gassing potential. Under such circumstances long-term monitoring may not be appropriate or required.

A7.4.2 Before taking any readings, zero the instrument, record atmospheric pressure and temperature.

A7.4.3 Gas flow should be recorded, giving the range of pressures, ensuring positive or negative flow is recorded.

A7.4.4 Record gas levels, recording peak and steady. Where steady state not obtained within 3 minutes, record change in concentration, where concentrations are decreasing, always record peak value. For very high concentrations, record for longer period of up to 10 minutes.

A7.5 ASSESSMENT OF RISK AND RECOMMENDATIONS

A7.5.1 The main method of characterising a site is the method described by Wilson and Card, ref. 10.51 and is termed Situation A. This can be used for all types of development except conventional low-rise housing with suspended ground floor and ventilated underfloor void.

A7.5.2 Low rise housing, Situation B, was developed by Boyle and Witherington, ref. 10.52 and was developed for the NHBC for classifying gassing sites for houses with suspended ground floor slab with ventilated void.

A7.5.3 Although the Code of Practice, ref 10.47, assesses the characteristic gas situation as CIRIA recommend for Situation A, see Table A7.2 below, their solution for gas protection systems is different, see section A7.10.

A7.6 SITUATION A - ASSESSMENT

A7.6.1 This system proposed by Wilson and Card, ref. 10.51 was originally developed in CIRIA Report 149, ref. 10.44.

A7.6.2 The method uses both gas concentrations and borehole flow rate for methane and carbon dioxide to define a Characteristic Situation for a site.

A7.6.3 Gas Screening Value (litre/hr) = borehole flow rate (litre/hr) x (gas concentration (%))/100. The GSV is determined for methane and carbon dioxide and the worst case adopted. The Characteristic Situation can then be determined from the table below. The GSV can be exceeded if the conceptual model indicates it is safe to do so, and other factors may lead to a change in the Characteristic Situation.

Table A7.2

Characteristic Situation	Risk Classification	Gas screening value (CH_4 or CO_2(1/hr)[1]	Additional factors	Typical source of generation
1	Very low risk	<0.07	Typically methane ≤1% and/or carbon dioxide ≤5%. Otherwise consider increase to Situation 2	Natural soils with low organic content "Typical" Made Ground
2	Low risk	<0.7	Borehole air flow rate not to exceed 70l/hr. Otherwise consider increase to Characteristic Situation 3	Natural soil, high peat/organic content. "Typical" Made Ground
3	Moderate risk	<3.5		Old landfill, inert waste, mineworking flooded
4	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures	Mineworking – susceptible to flooding, completed landfill (WMP 26B criteria)
5	High risk	<70		Mineworking unflooded inactive with shallow workings near surface
6	Very high risk	>70		Recent landfill site

1. Site characterisation should be based on gas monitoring of concentrations and borehole flow rates for the minimum periods defined in Table A7.1
2. Source of gas and generation potential/performance must be identified.
3. If there is no detectable flow use the limit of detection of the instrument.

A7.7 SITUATION A – SOLUTION

A7.7.1 The Characteristic Situation can be used to define the scope of gas protective measures required.

A7.7.2 The CIRIA approach uses the characteristic situation to define the level of gas protection as follows:

Table A7.3

Characteristic situation	Residential building (Not low-rise traditional housing)		Office/commercial/industrial development	
	Number of levels of protection	Typical scope of protective measures	Number of levels of protection	Typical scope of protective measures
1	None	No special precautions	None	No special precautions
2	2	a) Reinforced concrete cast in situ floor slab (suspended non-suspended or raft) with at least 1200g DPM and underfloor venting b) Beam and block or pre-cast concrete and 2000g DPM / reinforced gas membrane and underfloor venting All joints and penetrations sealed	1 to 2	a) Reinforced concrete cast in-situ floor slab (suspended non-suspended or raft) with at least 1200g DPM b) Beam and block or pre cast concrete slab and minimum 2000g DPM/reinforced gas membrane c) Possibly underfloor venting or pressurisation in combination with a) and b) depending on use All joints and penetrations sealed
3	2	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space	1 to 2	All types of floor slab as above. All joints and penetrations sealed. Minimum 2000g/reinforced gas proof membrane and passively ventilated underfloor sub-space or positively pressurised underfloor sub-space
4	3	All types of floor slab as above.	2 to 3	All types of floor slab as above.

Characteristic situation	Residential building (Not low-rise traditional housing)		Office/commercial/industrial development	
		All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated underfloor subspace or positively pressurised underfloor sub-space, oversite capping or blinding and in ground venting layer		All joints and penetration sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space with monitoring facility
5	4	Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and ventilated or positively pressurised underfloor sub-space, oversite capping and in ground venting wells or barriers	3 to 4	Reinforced concrete cast in-situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space with monitoring facility. In ground venting wells or barriers
6	5	Not suitable unless gas regime is reduced first and quantitative risk assessment carried out to assess design of protection measures in conjunction with foundation design	4 to 5	Reinforced concrete cast in-situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and actively ventilated or positively pressurised underfloor sub-space with monitoring facility, with monitoring. In ground venting wells and reduction of gas regime.

1. Typical scope of protective measures may be rationalised for specific developments on the basis of quantitative risk assessments.

2. Note the type of protection is given for illustration purposes only. Information on the detailing and construction of passive protection measures is given in BR414, ref. 10.49.

3. In all cases there should be minimum penetration of ground slabs by services and minimum number of confined spaces such as cupboards above the ground slab. Any confined spaces should be ventilated.

4. Foundation design must minimise differential settlement particularly between structural elements and ground-bearing slabs.

5. Commercial buildings with basement car parks, provided with ventilation in accordance with the Building Regulations, may not require gas protection for characteristic situations 3 and 4.

6. Floor slabs should provide an acceptable formation on which to lay the gas membrane. If a block and beam floor is used it should be well detailed so it has no voids in it that membranes have to span, and all holes for service penetrations should be filled. The minimum density of the blocks should be 600kg/m^3 and the top surface should have a 4:1 sand cement grout brushed into all joints before placing any membrane (this is also good practice to stabilise the floor and should be carried out regardless of the need for gas membrane).

7. The gas-resistant membrane can also act as the damp-proof membrane.

A7.8 SITUATION B -ASSESSMENT

A7.8.1 The NHBC has developed a characterisation system that is similar to Situation A but is specific to low-rise housing development with a clear ventilated underfloor void. The gas emission rates are compared to generic 'Traffic Lights'.

A7.8.2 The Traffic Lights include a Typical Maximum Concentration that is used for initial screening purposes. Where the Typical Maximum Concentration is exceeded the risk-based Gas Screening Value, GSV, should be adopted. The GSVs are determined for the 'model' low rise development and where they differ from this model, the GSV should be reassessed, ref. 10.46.

A7.8.3 The calculations should be made for both methane and carbon dioxide, and the worst case adopted. The GSV is only a guideline.

Table A7.4

Traffic light	Methane		Carbon dioxide	
	Typical maximum concentration[2] (% v/v)	**Gas screening value (GSV)[3] (litres per hour)**	**Typical maximum concentration[2] (% v/v)**	**Gas screening value (GSV)[1,2] (litres per hour)**
Green				
	1	**0.16**	5	**0.78**
Amber 1				
	5	**0.63**	10	**1.56**
Amber 2				
	20	**1.56**	30	**3.13**
Red				

1. Generic GSVs are based on guidance contained within latest revision of Department of the Environment and the Welsh Office (2004 edition) "The Building Regulations: Approved Document C" and used a sub-floor void of 150mm thickness.

2. The Typical Maximum Concentrations can be exceeded in certain circumstances should the conceptual site model indicate it is safe to do so. This is where professional judgement will be required, based on a thorough understanding of the gas-regime identified at the site where monitoring in the worst temporal conditions has occurred.

3. The GSV thresholds should not generally be exceeded without completion of a detailed gas risk assessment taking into account site-specific conditions.

A7.9 SITUATION B – SOLUTION

A7.9.1 On the basis of this Traffic Light classification the following protection should be applied to low-rise housing.

Table A7.5

Traffic Light Classification	Protection measures required
Green	Negligible gas regime identified and gas protection measures are not considered necessary.
Amber 1	Low to intermediate gas regime identified, which requires low-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours.
Amber 2	Intermediate to high gas regime identified, which requires high-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to prevent the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. A specialist contractor should always fit membranes. As with Amber 1, ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours. Certification that these passive protection measures have been installed correctly should be provided.
Red	High gas regime identified. It is considered that standard residential housing would not normally be acceptable without a further Gas Risk Assessment and/or possible remedial mitigation measures to reduce and/or remove the source of gas.

A7.10 CODE OF PRACTICE – SOLUTIONS

A7.10.1 The Characteristic Gas Situation is determine in a similar manner to that recommended by CIRIA, see Table A7.2 above.

A7.10.2 Having selected the Characteristic Gas Situation, the appropriate gas protection could be selected for the building. The tables below give a guide as to the relative performance of the various designs and systems.

A7.10.3 A guidance value for the required gas protection, in the range 0 to 7 should be obtained from Table A7.6 below. Then, a combination of ventilation and/or barrier system should be chosen from Table A7.7 to meet that requirement.

Table A7.6

Characteristic gas situation, CS	NHBC *traffic light*	Required gas protection			
		Non-managed property, e.g. private housing	**Public building** [A]	**Commercial buildings**	**Industrial buildings** [B]
1	*Green*	0	0	0	0
2	*Amber 1*	3	3	2	1[C]
3	*Amber 2*	4	3	2	2
4	*Red*	6[D]	5[D] 6[E]	4 5 7	3 4 6

NOTE: Traffic light indications are taken from NHBC Report no.: 10627-R01 (04) [3] and are mainly applicable to low-rise residential housing. These are for comparative purposes but the boundaries between the traffic light indications and CS values do not coincide.

A) Public buildings include, for example, managed apartments, schools and hospitals.
B) Industrial buildings are generally open and well ventilated. However, areas such as office pods might require a separate assessment and may be classified as commercial buildings and require a different scope of gas protection to the main building.
C) Maximum methane concentration 20% otherwise consider an increase to CS3.
D) Residential building on higher traffic light/CS sites is not recommended unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g. high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g. in institutional and/or fully serviced contractual situations.
E) Consideration of issues such as ease of evacuation and how false alarms will be handled are needed when completing the design specification of any protection scheme.

A7.10.4 Having determined the appropriate guidance value from Table A7.6, an element or combination of elements from a), b), c) or d) in Table A7.7, should be chosen to achieve the required level of protection .

Table A7.7

PROTECTION ELEMENT/SYSTEM		SCORE	COMMENTS
a) Venting/dilution			
Passive sub floor ventilation (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.)[A]	Very good performance	2.5	*Ventilation performance in accordance with Annex A, ref. 10.47*
	Good performance	1	*If passive ventilation is poor this is generally unacceptable and some form of active system will be required*

PROTECTION ELEMENT/SYSTEM		SCORE	COMMENTS
Subfloor ventilation with active abstraction/pressurization (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.)[A)]		2.5	*There have to be robust management systems in place to ensure the continued maintenance of any ventilation system.* *Active ventilation can always be designed to meet good performance.* *Mechanically assisted systems come in two main forms: extraction and positive pressurization.*
Ventilated car park (basement or undercroft)		4	*Assumes car park is vented to deal with car exhaust fumes, designed to Building Regulations Document F and IstructE guidance*
b) Barriers			
Floor slabs			
Block and beam floor slab		0	*It is good practice to install ventilation in all foundation systems to effect pressure relief as a minimum.* *Breached in floor slabs such as joints have to be effectively sealed against gas ingress in order to maintain these performances*
Reinforced concrete ground bearing floor slab		0.5	
Reinforced concrete ground bearing foundation raft with limited service penetrations that are cast into slab		1.5	
Reinforced concrete cast in situ suspended slab with minimal service penetrations and water bars around all slab penetrations and at joints		1.5	
Fully tanked basement		2	
c) Membranes			
Taped and sealed membrane to reasonable levels of workmanship/in line with current good practice with validation[B), C)]		0.5	*The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation, and the integrity of joints*
Proprietary gas resistant membrane to reasonable levels of workmanship/in line with current good practice under independent inspection (CQA)[B), C)]		1	
Proprietary gas resistant membrane installed to reasonable levels of workmanship/in line with current good practice under CQA with integrity testing and independent validation		2	
d) Monitoring and detection (not applicable to non-managed property, or in isolation)			
Intermittent monitoring using hand held equipment		0.5	
Permanent monitoring and alarm system[A)]	Installed in the underfloor venting/ dilution system	2	*Where fitted, permanent monitoring systems ought to be installed in the underfloor venting/dilution system in the first instance but can also be provided within the occupied space as a fail safe.*
	Installed in the building	1	

PROTECTION ELEMENT/SYSTEM	SCORE	COMMENTS
e) Pathway intervention		
Pathway intervention	-	*This can consist of site protection measures for off-site or on-site sources (see Annex A, ref. 10.47)*
NOTE: In practice the choice of materials might well rely on factors such as construction method and the risk of damage after installation. It is important to ensure that the chosen combination gives an appropriate level of protection		

A) It is possible to test ventilation systems by installing monitoring probes for post installation validation.
B) If a 1200 g DPM material is to function as a gas barrier it should be installed according to BRE 414, ref. 10.49 being taped and sealed to all penetrations.
C) Polymeric Materials >1200g can be used to improve confidence in the barrier. Remember that their gas resistance is little more than the standard 1200g (proportional to thickness) but their physical properties mean that they are more robust and resistant to site damage.