BRD

Report Title: **Phase 2 – Geo-Environmental Site Investigation**

Project Name: **Harvester Way, Crowland**



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REPORT CONTROL SHEET

REPORT TITLE	**PHASE 2 GEO-ENVIRONMENTAL SITE INVESTIGATION**
PROJECT	**HARVESTER WAY, CROWLAND**
CLIENT	**WHEATLEY HOMES**

REPORT REFERENCE	ISSUE DETAIL	DATE	PREPARED BY	CHECKED BY
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REPORT LAYOUT

This report is divided into the following four sections: Summary Report, Technical Report, Supporting Information and Appendices.

SUMMARY REPORT

This expanded executive summary provides the main findings of the work undertaken in brief non-technical language. This section provides an overview of the key outcomes for the benefit of non-specialists and concludes with the main recommendations. This section should only be relied upon in the context of the whole report and the Technical Report should be referred to support any design decisions.

TECHNICAL REPORT

The main report section is intended to provide the technical detail of the investigation and is intended to provide the level of information required by current guidance documents and practice. The Technical Report is written in a language that, in part, assumes knowledge of subject matter so that it can be written in as concise a form as possible. Its intended audience is peers, regulators and other professionals in related disciplines.

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SUPPORTING INFORMATION

This section of the report provides background details of a generic nature together with specific technical approaches adopted by BRD and details of the guidance documents that are commonly referenced in the report. The section also includes explanations of technical terms to assist non-specialist readers in understanding the Technical Report. It should be noted that not all the information within this section is necessarily applicable to this specific report.

APPENDICES

The final section of the report presents the factual data collected and employed as part of the investigation.

APPENDIX 1	**SITE PLANS & PHOTOGRAPHS**	
	Site Location Plan	Ref. BRD2186-OP1-A
	Revised Conceptual Site Model	Ref. BRD2186-OP6-A
	Exploratory Hole Location Plan	Ref. BRD2185-OP5-A
APPENDIX 2	**EXPLORATORY HOLE & MONITORING RECORDS**	
	Logs of boreholes.	WS01-WS09
	Logs of hand dug pits.	HD01 – HD02
	Dynamic Probing records.	DP01
	TRL Dynamic Cone Penetrometer.	TRL01-TRL04
	Gas monitoring records.	3 x A4 pages
	Groundwater monitoring records.	1 x A4 pages
APPENDIX 3	**LABORATORY TEST RESULTS**	
	QTS reports 14-22952, 14-23126 and 14-23254	15 x A4 pages
	SPT report S27905	13 x A4 pages

SUMMARY REPORT - GENERAL INFORMATION

SUBJECT	COMMENTS
CURRENT SITE USE	The site currently comprises two arable fields used for farming of sugar beet. The fields are separated by Harvester Way.
PROPOSED USE	It is proposed that the site will be developed as a residential estate. Although no actual layout plans have yet been formalised.
HISTORICAL SUMMARY	The site has remained as fields since the first available map edition from 1886. By 1996, the map edition shows a drainage ditch located along the eastern boundary to have been culverted as part of the construction of the adjacent residential estate. Harvester Way was also constructed by this time.
PUBLISHED GEOLOGY	The site is shown to be underlain by Peat overlying the Oxford Clay Formation. Superficial Tidal Flats Deposits are identified to the east of the site and the Abbey Sand and Gravel Formation to the north of the site. Radon protection measures are not required.
ACTUAL GROUND CONDITIONS	Instead of the anticipated Peat Deposits, the investigation encountered superficial deposits across the site, considered to be representative of the Tidal Flat Deposits which consisted of soft organic clays and silty sands, but also included locally present thin peat layers. Towards the western site boundary these deposits were proven to depths of approximately 3.00m bgl. However, to the east, the deposits extended to depths of >7.00m bgl. Underlying the superficial deposits the bedrock geology of the Oxford Clay Formation was only encountered beneath the western third of the site and proven to 5.45m bgl.
HYDROGEOLOGY	Both the superficial deposits and Oxford Clay Formations are shown as Unproductive Strata. However, shallow perched groundwater was encountered within the superficial deposits. Groundwater levels were proven to be shallow along the western boundary at depths of less than 1.00m bgl. The site is not located within a groundwater Source Protection Zone.
HYDROLOGY	The closest water features to the site are drainage ditches along the southern and eastern boundaries. The site is in an area indicated to be at risk of flooding. A Flood Risk Assessment will be required.

SUMMARY REPORT- CONTAMINATION ISSUES

SUBJECT	COMMENTS
RISKS TO HUMAN HEALTH	The investigation has shown that the soils across the site are uncontaminated. The gas monitoring to date has not identified any elevated concentrations, however, in line with current guidance further gas monitoring will be required to confirm this.
RISKS TO THE WATER ENVIRONMENT	No risks to the water environment have been identified from the site.
RISKS TO BUILDING MATERIALS AND SERVICES	No risks to building materials and services have been identified.
WASTE SOIL DISPOSAL	Any sub-soils for off-site disposal should be classified as inert waste.

SUMMARY REPORT- GEOTECHNICAL

SUBJECT	COMMENTS
EXCAVATIONS	It should be possible to forward excavations employing normal equipment, however, it is likely that deeper excavations (beyond 1m depth) will be prone to collapse and groundwater ingress. Specialist groundwater control, such as well pointing, is likely to be required at this site.
SLOPE STABILITY	It is considered that slope stability is unlikely to be a concern at this site.
SUB-SURFACE CONCRETE	Design Sulphate Class of DS-3 and Aggressive Chemical Environment for Concrete class of AC-3 applies to the Tidal Flats Deposits. Further testing may indicate a lower concrete classification may be used.
SOAKAWAYS	Site is not suitable for surface water disposal to soakaways or other forms of infiltration device due to the presence of the shallow water table.
PAVEMENT DESIGN	There is a thin crust of higher strength soils from current ground level to approximately 0.50m depth. Road formations constructed within the slightly higher strength crust may be designed to an equilibrium CBR design value of 3%. As the site is identified to be within a flood risk area the site may need to be infilled to raise ground levels. Roads constructed on any imported fill should be designed to a CBR value of less than 2% unless appropriate testing identifies that a higher CBR value can be adopted.
FOUNDATIONS	
LIKELY FOUNDATION TYPE	Piled foundations. Further investigation and assessment may indicate raft foundations could be considered.
VOLUME CHANGE POTENTIAL	The clay soils within the Tidal Flats Deposits vary from low to high volume change potential deposits.
ESTIMATED FOUNDATION DEPTHS	To be confirmed by further investigation.
HEAVE PROTECTION	Will not be required.

SUMMARY REPORT - KEY RECOMMENDATIONS

RECOMMENDATIONS
It is recommended that this report is submitted to the planning department of the Local Authority, the organisation undertaking the Building Control function and warranty providers to confirm that the investigation completed to date is satisfactory. A total of three further gas monitoring visits will be required including two during a period of falling pressure to more fully evaluate the gas regime at the site. In order to confirm deeper ground conditions for raft or pile design, further ground investigation comprising a combination of deep cable percussive boreholes, Cone Penetration Testing (CPT) or dynamic probing, and trial pits is recommended.

1. INTRODUCTION TO TECHNICAL REPORT

1.1. CONTRACT DETAILS

CLIENT	Wheatley Homes Ltd trading as Wheatley Homes.
SITE	Land situated at either side of Harvester Way in the town of Crowland, Peterborough.
CLIENT'S ADVISORS	BRD Environmental Limited (BRD) has been commissioned by Woods Hardwick Planning Ltd on behalf of the Client.
REPORT CONTEXT	It is understood that the Client intends to develop the site for residential use.
REPORT TYPE	Geo-environmental site investigation (i.e. combined geotechnical ground investigation and Phase 2 contamination assessment)
REPORT OBJECTIVES	The site has been the subject of a desk study referenced as follows: • 'Phase 1 Environmental Desk Study – Harvester Way, Crowland', report ref. BRD2096-OR1, July 2014. The purpose of this current report is to undertake a preliminary combined geotechnical and contamination assessment in respect of the proposed residential development at the site.

1.2. SCOPE OF WORKS

Following discussion with the tenant farmer and the requirement to limit the amount of crop damage the agreed scope of works was:

- Two day of windowless sampling using a percussive drilling rig that will yield approximately 12No. boreholes to a nominal depth of 4m-5m, ground conditions permitting. Undertake Standard Penetration Tests (SPT) at 1m intervals.
- Installation of a 5m depth combined gas and groundwater monitoring well (nominal 50mm diameter) into 4No. boreholes. Installations will be finished with a flush fitting metal stopcock cover.
- Undertake 4No. dynamic penetrometer tests using a TRL probe to determine the CBR design values. The tests will be undertaken to a maximum depth of 1.0m.
- All exploratory points will be logged and sampled in general accordance with BS5930:1999+A2:2010 by a supervising Geo-Environmental Consultant.
- In-situ geotechnical testing of fine soils using a Hand Shear Vane and/or Pocket Penetrometer.
- Determination of the location of exploratory points by hand held tape measurements.
- Environmental Technician to undertake a total of 3No. combined gas and groundwater monitoring visits. For gas, the determination of concentrations of oxygen, carbon dioxide, methane, hydrogen sulphide, carbon monoxide, and recording atmospheric pressure and flow rates using portable equipment. For groundwater, the determination

of groundwater levels. Collection of groundwater samples for testing from the 4No. installations during the first visit only.

- Chemical testing as appropriate to the nature of the soil conditions encountered, but the budget is based on the following testing schedule:
    - 8No. Metals Suite - As, Cd, Cr, CrVI, Hg, Pb, Se, Cu, Ni and Zn.
    - 8No. Inorganics Suite - water soluble sulphate, pH, organic matter.
    - 8No. Speciated Polycyclic Aromatic Hydrocarbons (PAH).
    - 3No. Banded aliphatic/aromatic Total Petroleum Hydrocarbons (TPH).
    - 3No. Benzene, Toluene, Ethylbenzene, Xylene (BTEX) and Methyl Tertiary Butyl Ether (MTBE) compounds.
    - 3No. Semi-Volatile Organic Compounds (SVOC) suite.
    - 2No. Pesticide Screen.
- Chemical testing of 1No. soil sample for Waste Acceptance Criteria (WAC) to assist in establishing the waste classification of the soil for muck away purposes.
- Geotechnical testing as appropriate to the nature of the soil conditions encountered, but the budget is based on the following testing schedule:
    - 6No. Moisture content.
    - 6No. Plasticity indices.
    - 3No. Loss on Ignition
    - 3No. Particle size distribution by wet sieve method, with 1No. by hydrometer.
    - 6No. pH and water soluble sulphate analysis - soil.
    - 4No. pH and sulphate analysis - water.
    - 4No. Total sulphate and sulphur analysis - soil.
- Provision of a combined factual and interpretative investigation report. Factual findings to include a summary of the previously issued desk study information, exploratory point records and test results. Interpretative reporting to include a Generic Quantitative Contamination Risk Assessment (GQRA) and a Geotechnical Assessment providing comments on pavement design, soakaway feasibility and foundation design recommendations.

1.3. REPORT LIMITATIONS

Any site boundary lines depicted on plans included within this report are approximate only and do not imply legal ownership of land. Any observations of tree species, asbestos containing materials within structures or invasive weeds, such as Japanese Knotweed, does not constitute a formal survey of such features. The identification of such features is therefore tentative only. The report does not consider whether sensitive ecology or archaeology is present as these require consideration by professionals specialising in these matters. It should be recognised that the collection of desk study information may not be exhaustive and that other information pertinent to the site may be available.

The recommendations, interpretations and conclusions of this report are based solely on the ground conditions found at the exploratory holes. Due to the variability in the nature of ground, conditions between exploratory holes can only be interpreted and not defined. The description of the site and the ground conditions is accurate only for the dates of the field works. In particular, groundwater levels can vary due to seasonal and other effects.

The assessment and interpretation of contamination risks is based on the scope of works agreed with the Client together with the budgetary and programme constraints imposed. Further investigation, analysis and assessment of contamination may be required by

regulators or other third parties with an interest in the site. An ecological risk assessment of contaminated soils is beyond the scope of this report. This report is concerned with assessing those contamination risks which apply to the future use of the site through the proposed development as part of the planning regime. The assessment does not consider the risk to current site users or continued future use of the site in its current state. If development of the site should occur that differs from that proposed, then the findings of the contamination assessment would need to be re-evaluated.

At the time of writing, detailed information on the proposed structure, such as detailed layout, loadings and serviceability limits, was not available. Accordingly, where geotechnical design advice is provided it is on the prescriptive basis allowed for by Eurocode 7: employing conventional and conservative design rules.

2. SITE CHARACTERISTICS

2.1. SITE SETTING

SITE ADDRESS AND POST CODE	The site is situated either side of the western end of Harvester Way, Crowland, Peterborough. The nearest postcode is PE6 0DG.
NATIONAL GRID REFERENCE	523670E, 309320N.

2.2. SITE SUMMARY

SUBJECT	COMMENTS
Current Site Condition	The site is approximately rectangular in shape and 3.5 hectares in size. An overgrown drainage ditch defines the southern site boundary and a farm/field track on the northern site boundary. To the east is a residential estate and to the west is Crease Drove, a road constructed on a low height embankment. The currently comprises two arable fields used for cultivation of sugar beet. The fields are separated by Harvester Way aligned east/west through the approximate centre of the site. This road is also constructed on a low embankment. Apart from the low embankments supporting Crease Drove and Harvester Way, the site is essentially level.
Proposed Development	It is proposed that the site will be developed as a residential estate, although no layout plans have yet been formalised.
Historical Summary	The site has remained as fields since the first available map edition from 1886. A large drainage ditch was located on the eastern site boundary. By 1996, the map editions show the drainage ditch located along the eastern boundary to have been partially culverted as part of the construction of the adjacent residential estate. Harvester Way had also been constructed.
Published Geology	The site is shown to be underlain by Peat overlying the Oxford Clay Formation. Superficial Tidal Flats Deposits are identified to the east of the site and the Abbey Sand and Gravel Formation north of the site.
Radon	Radon protection measures are not required.
Hydrogeology	Both the superficial deposits and Oxford Clay Formations are shown as Unproductive Strata. However, it is considered that shallow groundwater will likely be encountered within the superficial soils. The site is not located within a groundwater Source Protection

	Zone.
Hydrology	The closest water features to the site are drainage ditches along the southern and eastern boundaries. The site is in an area indicated to be at risk of flooding. A Flood Risk Assessment is therefore required.

2.3. PREVIOUS INVESTIGATIONS

BRD is not aware of any previous ground investigations that have been undertaken on site.

2.4. PRELIMINARY ASSESSMENTS

PRELIMINARY CONTAMINATION RISK ASSESSMENT
Due to the likely organic rich Peat soils indicated to be present beneath the site, the most significant contamination source is the potential generation of carbon dioxide and methane from decomposing plant material. In respect of the on-site soils, the vast majority are unlikely to be significantly contaminated, however, there is the potential for residual pesticides to be present in the near surface soils as well as marginally elevated concentrations of contaminants as a result of the infilling of a culverted ditch with unknown soils along the eastern boundary. The potential migration of hydrocarbon fuel contamination from the adjacent depot may offer some risks. However, given the distance from the site it is considered unlikely that the depot would be of significant concern.

PRELIMINARY GEOTECHNICAL ASSESSMENT
The anticipated soils underlying the site can be highly compressible as well as having shallow groundwater levels, which may affect potential foundation solutions. Deeper foundations may also be required due to the presence of an infilled drainage ditch along the eastern site boundary if plots are constructed in close proximity. The published geology suggests that the ground conditions are unlikely to be suitable for the disposal of surface water to conventional soakaways.

3. GROUND INVESTIGATION

3.1. INVESTIGATION DESIGN

METHODOLOGY	Windowless sample boreholes were selected in order to limit the amount of damage to the existing crop as well as the requirement for gas and groundwater monitoring pipes to be installed. In addition to this, due to the anticipated presence of compressible Peat soils, in-situ density tests (Standard Penetration Tests) were also required. Two hand dug pits were undertaken in the near surface soils in the location of the infilled ditch to target this potential contamination source. Four dynamic penetrometer tests using a TRL probe to determine the CBR design values.	
DATES OF INTRUSIVE GROUND INVESTIGATION	The main field works were undertaken on 8th and 9th July 2014. Monitoring visits were undertaken on 15th, 22nd and 28th July 2014.	
CONSTRAINTS TO EXPLORATORY HOLE LAYOUT	The exploratory hole layout was constrained by the requirement to limit the amount of crop damage. Therefore exploratory holes were undertaken along crop spraying tracks and tracks around the outside of the fields.	
EXPLORATORY HOLE SPACING	Approximate 100m grid.	
LAYOUT RATIONALE	**SOURCE / FEATURE**	**EXPLORATORY HOLE**
CONTAMINATION SOURCES TARGETED	Gas generation from organic rich Peat soils.	WS01 to WS09 (inclusive).
	Pesticide contamination.	WS03, WS09.
	Migration of contamination from off-site crane depot.	WS09.
	Infilled drainage ditch.	HD01 and HD02.
GROUND FEATURES TARGETED	Compressible Peat soils.	WS01 to WS09 (inclusive).
	General site coverage.	WS01 to WS09 (inclusive).
CONTAMINATION SAMPLING PLAN	Based on the proposed end use, the sampling and analysis plan is more positively biased towards near surface samples as these represent the soils most likely to be available to future site users as well as any Made Ground samples as this stratum represents the soils most likely to be contaminated.	

ANALYSIS PLAN	Soils from WS09 were analysed for TPH due to its proximity to the nearby crane depot. The near surface sample from WS03 was analysed for pesticide residues as it was located within the middle of the crop field. An additional sample of analysis for presence of pesticide residues was also tested from WS09, located in the north-west corner of the site, as this was an area of uncultivated ground and seemed the most likely location for the sprayers to empty their tanks. The testing from HD01 and HD02, targeted the potential infilled drainage ditch soils.

3.2. BRD FIELDWORK

HAND DUG INSPECTION PITS	
REFERENCES	HD01 to HD02.
DEPTH RANGE	From 0.42m to 0.60m bgl.
BACKFILL	The inspection pits were backfilled with arisings upon completion.

WINDOWLESS SAMPLING BOREHOLES	
REFERENCES	WS01 to WS09.
DEPTH RANGE	From 4.45m to 7.00m bgl.
RIG TYPE	Premier Drilling Rig.
INSTALLATION / BACKFILL	Boreholes WS01, WS03, WS04, WS06 and WS08 were backfilled with arisings only. Boreholes WS02, WS05, WS07 and WS09 had monitoring wells installed. These comprised 50mm nominal diameter standpipes fitted with a gas tap finished with a flush metal cover. The slotted response length of the well is shown on the individual logs. Bentonite seals are also indicated on the logs. The filter medium used was pea gravel.

DYNAMIC PROBING	
REFERENCES	DP01.
DEPTH RANGE	8.0m bgl.
RIG TYPE	DPSH-A (Super Heavy): 63.5kg mass, 750mm fall.
CONE TYPE	Sacrificial cone.

TRL DYNAMIC CONE PENETROMETER	
REFERENCES	TRL01 to TRL04 (inclusive).
DEPTH RANGE	From 0.41m to 0.99m.
METHODOLOGY	TRL DCP.

MONITORING	
TYPE	Combined gas and groundwater monitoring on the initial visit followed by two further gas monitoring visits only.
DATES	15th, 22nd and 28th July 2014.
GROUNDWATER SAMPLING METHOD	Samples were retrieved using a sampling bailer dedicated to each well.

3.3. LABORATORY TESTING

GEOTECHNICAL TESTING	
The soil samples for geotechnical testing were forwarded to the laboratory of Soil Property Testing Ltd with pH and sulphate analysis undertaken at the laboratory of QTS Environmental Ltd. The geotechnical testing suite is detailed below. The UKAS accreditation of the individual test methods is shown on the laboratory test report included in the Appendices.	
TEST	**NUMBER OF SAMPLES TESTED**
Moisture content	6
Liquid and plastic limits	6
Particle size distribution by wet sieve and hydrometer	2
Organic content by mass loss on ignition	3
pH and Water soluble Sulphate	13
Total Sulphur and Sulphate	4

SOIL CHEMICAL TESTING	
The soil samples for contamination and/or chemical geotechnical testing were forwarded to the laboratory of QTS Environmental Ltd and the testing suite is detailed below. The UKAS or MCERTS accreditation of the individual test methods is shown on the laboratory test report included in the Appendices. The number of samples tested was increased from the scope to allow for the testing of the two samples from the infilled drainage ditch.	
SOIL TESTS	**NUMBER OF SAMPLES TESTED**
Arsenic, Cadmium, Chromium, Chromium VI, Copper, Lead, Mercury, Nickel, Selenium, Zinc	10
Speciated Polycyclic Aromatic Hydrocarbons (PAH)	10
Total Petroleum Hydrocarbons (TPH) with full carbon banding and aliphatic/aromatic split	3
Benzene, Toluene, Ethylbenzene and Xylenes (BTEX) and MTBE	3
Organic Matter	10
Semi-Volatile Organic Compounds (SVOCs)	3
Waste Acceptance Criteria (WAC) testing	1

GROUNDWATER CHEMICAL TESTING	
The water samples for contamination and/or chemical geotechnical testing were forwarded to the laboratory of QTS Environmental Ltd and the testing suite is detailed below. The UKAS or MCERTS accreditation of the individual test methods is shown on the laboratory test report included in the Appendices.	
WATER TESTS	**NUMBER OF SAMPLES TESTED**
pH	4
Sulphate	4

4. GROUND CONDITIONS

4.1. OVERVIEW

The ground conditions differed from the published geology of Peat overlying the Oxford Clay Formation, in that the superficial deposits encountered were considered to be more typical of Tidal Flat Deposits with varying layers of soft organic clays, silts and sands, with occasional thin peat layers/lenses.

The Made Ground soils were generally limited to the near surface with the exception of WS01, located in the south-west of the site adjacent to Crease Drove the road on the low embankment, where reworked soils were encountered to 0.90m bgl.

Towards the eastern boundary of the site, the full depth of the superficial Tidal Flats Deposits were not proved, with borehole WS07 terminating in the deposits at 7.00m bgl. Where these soils were encountered at depth, the drilling process became increasingly more difficult due to "blowing sands" resulting from groundwater pressure.

Underlying the superficial deposits the Oxford Clay was encountered towards the western end of the site in WS01, WS02, WS08 and WS09 at depths ranging from 3.00m to 3.40m bgl.

The soils were generally observed to be saturated from 1.00m bgl and standing groundwater levels ranged from 0.66m bgl to 1.94m bgl as recorded in the standpipes during the subsequent monitoring.

4.2. ARTIFICIAL GROUND

SURFACE HARDSTANDING	Not encountered in exploratory points.
BURIED STRUCTURES	Not encountered in exploratory points.
BURIED SERVICES	Not encountered in exploratory points.

MADE GROUND – ROAD EMBANKMENT			
LOCATION	WS01 only, positioned in the south-west corner of the site, adjacent to the road embankment.		
DEPTH TO BASE	0.90m bgl.	**THICKNESS**	0.70m.
DESCRIPTION			
The Made Ground from WS01 was described as firm, dark brown/ black, silty, slightly sandy peat with occasional shell fragments. Slight organic odour and rare ceramic fragments. The soils located in WS01 contained fragments of pottery and as a result were classified as Made Ground. No further man made components were observed, indicating mainly reworked natural soils.			

OBSERVATIONS	
GEOTECHNICAL	Nothing significant noted.
CONTAMINATION	No visual or olfactory evidence of contamination.
GROUNDWATER	Groundwater was not observed in this stratum.

MADE GROUND - MATERIAL LAID TO FORM TRACK ON NORTHERN BOUNDARY			
LOCATION	Located in WS07 and WS08.		
DEPTH TO BASE	0.30m bgl.	**THICKNESS**	0.30m.
DESCRIPTION			
Boreholes WS07 and WS08 were drilled through a farm track which passes around the outside of the arable field. At the surface of the track aggregate materials included concrete and brick gravel, which had been rolled into the topsoil to form a more stable driving surface.			
OBSERVATIONS			
GEOTECHNICAL	Nothing significant noted.		
CONTAMINATION	No visual or olfactory evidence of contamination.		
GROUNDWATER	Groundwater was not observed in this stratum.		

MADE GROUND- INFILLED DRAINAGE			
LOCATION	HD01 and HD02.		
DEPTH TO BASE	>0.60m bgl.	**THICKNESS**	>0.60m.
DESCRIPTION			
The soils encountered in HD01 consisted of Made Ground topsoil overlying soft slightly gravelly very sandy clay. At 0.40m bgl a concrete obstruction was encountered that prevented further excavation. The concrete obstruction may be the top of the culvert. Within HD02 very sandy slightly gravelly clay was encountered to 0.60m (base of pit). Whilst there was no evidence of man-made objects confirming the soils to be Made Ground, the location of the pit over/in close proximity to the culverted ditch suggests the deposits are Made Ground consisting of reworked natural deposits.			
OBSERVATIONS			
GEOTECHNICAL	Nothing significant noted.		
CONTAMINATION	No visual or olfactory evidence of contamination.		
GROUNDWATER	Groundwater was not observed in this stratum.		

4.3. SUPERFICIAL DEPOSITS

TOPSOIL	Topsoil or Made Ground Topsoil was encountered in all boreholes except WS07 and WS08 and typically to a depth of 0.30m bgl. Generally the Topsoil was described as soft dark brown/ black, very organic, sandy peat or dark brown, sandy, silty, gravelly clay with some rare plant remains, gravel of fine subrounded flint.

TIDAL FLAT DEPOSITS			
LOCATION	WS01 to WS09 (inclusive)		
DEPTH TO BASE	3.00m to >7.00m bgl.	**THICKNESS**	2.10m to >6.80m
DESCRIPTION			
The superficial deposits were encountered to depths ranging from 3.00m to 3.40m bgl beneath the western third of the site, but the base was not encountered beneath the eastern two-thirds of the site where boreholes terminated at depths of between 4.45m and 7.00m bgl within the Tidal Flats Deposits. The near surface soils to approximately 1.00m consisted of firm clays in WS02 to WS05 and WS09, however, in the remainder of the holes the near surface soils were observed to be generally soft clays with some organic content. At depths greater than 1.00m bgl in WS03 to WS07 (inclusive) the soils were described as brown to mottled orange, very sandy silt / silty sand overlying a dark brown, silty, fine sand/ very sandy silt with occasional black organic lenses, shell fragments and organic odour. In WS04 these soils were observed to extend to 7.00m bgl before drilling had to be terminated due to blowing sand conditions. In WS02 from 1.40m to 1.60m bgl, WS08 from 2.20 to 2.40m bgl and WS09 from 1.40m to 1.50m bgl distinctive layers of Peat were encountered. All three boreholes were located in the north-west quarter of the site. Reference to the ground conditions encountered within the boreholes indicated that there was no obvious pattern to the lateral or vertical distribution of the various deposits.			
OBSERVATIONS			
GEOTECHNICAL	Very low SPT readings were recorded within the deposits. The readings may reflect very low strength/low density deposits. However, the SPT results may have been affected by liquefaction of the saturated soils during the drilling process. Liquefaction can commonly occur in saturated fine grained soils. Such silty fine sands are present within the Tidal Flats Deposits and have been proved to be present by the particle size distribution tests undertaken from soil samples recovered during the investigation which have identified approximately 90% fine sand size particles to be present. Therefore the density of the deposits may in practice be lighter than the SPT results suggest.		
CONTAMINATION	Some organic material as well as Peat was encountered within these soils which could result in the generation of soil gases.		

GROUNDWATER	The soils were generally saturated below 1.00m bgl.

4.4. BEDROCK

OXFORD CLAY FORMATION			
LOCATION	WS01, WS02, WS08 and WS09 located within the western third of the site boundary. Not encountered along the eastern boundary of the site.		
DEPTH TO BASE	>5.45m bgl.	**THICKNESS**	>2.45m bgl.
DESCRIPTION			
These soils were typically described as firm to stiff grey, mottled brown in part, clay with relict rootlets and occasional calcareous aggregations.			
OBSERVATIONS			
GEOTECHNICAL	Nothing significant noted.		
CONTAMINATION	No visual or olfactory evidence of contamination.		
GROUNDWATER	Groundwater was not observed in this stratum.		

4.5. GROUNDWATER MONITORING

VISIT DATE	RESTING GROUNDWATER RANGE	COMMENTS
15/07/14	From 0.90m to 1.94m bgl.	The shallowest groundwater was encountered within WS02 and WS09 located on the western boundary of the site. In general groundwater levels recorded a slight rise (became shallower) in water level during the monitoring period.
22/07/14	From 0.67m to 1.74m bgl.	
28/07/14	From 0.66m to 1.81m bgl.	

5. GEOTECHNICAL PROPERTIES

5.1. DYNAMIC PROBING

The single dynamic probe (DP01) undertaken indicates soft/loose ground to a depth of around 6.2m bgl indicative of the presence of the Tidal Flat Deposits. At this depth, more competent ground is present indicative of the Oxford Clay Formation. The probe was undertaken adjacent to boreholes WS04/WS05 so the soil profile within the borehole could be compared with the dynamic probe results.

5.2. DYNAMIC CONE PENETROMETER

The four dynamic cone penetrometer tests undertaken (TRL01-TRL04) reveal a higher strength upper soil most likely associated with a soil desiccation, and then a decline in the CBR values with depth. At 0.50m the CBR values ranged from 3% to 6%, with a gradual reduction in CBR to 1% to 2% below 0.90m bgl.

5.3. COARSE SOIL PARAMETERS

5.3.1. Standard Penetration Tests

Bands of very silty sand were encountered within the Tidal Flat Deposits, however, for the purpose of this assessment, all of the SPT results have been discussed within the fine soils section.

5.3.2. Particle Size Distribution

The grading curves of the two samples of sandy Tidal Flat Deposits confirmed that this soil is borderline between sand and silt with one sample recorded as slightly clayey silty sand and one sample recorded as sandy silt. Both samples were poorly graded with 90%-95% of the particles falling within the fine sand and coarse silt category.

The presence of a high fine sand content makes these soils prone to liquefaction under dynamic loading conditions.

5.4. FINE SOIL PARAMETERS

5.4.1. Index Property Testing

SOIL TYPE	Tidal Flat Deposits - Variable Clays.
PLASTICITY INDEX (PI)	16% to 62% (5No. samples).
MODIFIED PI	Not applicable – no oversize particles.
NHBC CLASS	Low to high volume change potential (one sample low, two samples medium and two samples high).

SOIL TYPE	Tidal Flat Deposits - Silts/sands.
PLASTICITY INDEX (PI)	6.0% (single sample).
MODIFIED PI	Not applicable - no oversize particles.
NHBC CLASS	Non shrinkable soil type.

5.4.2. Undrained Shear Strength

This section discusses all of the laboratory and in-situ tests that produce either direct or indirect measures of undrained shear strength.

5.4.2.1. Standard Penetration Test Correlations

The value for the windowless sampler rig, of 85%, has been assumed on the basis of the type of equipment used and knowledge of calibrated energy ratios for similar equipment.

For fissured, over-consolidated fine-grained soils, the SPT N-values can be converted, using Stroud's method, to equivalent undrained shear strengths of a 100mm-diameter triaxial compression test. This conversion has been conducted on the N_{60}-values using values for Stroud's conversion factor, f1, selected on the basis of the average measured plasticity index.

In the varying clays, silts and sands of the Tidal Flat Deposits, the twenty seven SPTs ranged from 0N to 23N but were generally less than 5N and values of 0N were commonly recorded. The highest value was from 6m bgl in WS4 where a substantial amount of soil had collapsed at this time and therefore the value is unlikely to be representative. Increased SPTs of up to 8N were recorded at 1m depth indicating the presence of a higher strength surface crust in some locations.

It should be noted that the Tidal Flats Deposits include slightly silty and silty fine sands, where up to 85% of the samples being fine sand grading and 10% in the silt grading range. Where such soils are saturated, as is the case at the site, such soils can be susceptible to liquefaction. The dynamic percussion drilling and penetration testing can supply repeated cycles of energy input which can result in liquefaction, which would result in apparent low SPT results.

In the Oxford Clay Formation the ten SPTs ranged from 8N to 22N, with a general increase in N value with depth. Based on the correlation guidelines the N values indicate soils initially of low to medium strength, increasing to soils of high strength with depth.

5.4.3. Organic Content

SOIL TYPE	Organic Tidal Flat Deposits
MASS LOSS ON IGNITION	0.8% to 7.5% (3 samples)
ORGANIC CONTENT	Low to Medium.

5.5. WATER SOLUBLE SULPHATE AND PH

	MADE GROUND			
	Sulphate		pH	
Characteristic Value	100 mg/l		6.7 units	
Justification	Highest measured concentration rounded to nearest 100mg/l.		Lowest measured value.	
	No. of tests	Results Range	No. of tests	Results Range
Soil	4	70 to 140 mg/l	4	6.7 to 8.0 units
Groundwater	0	Not tested	0	Not tested
Total Potential Sulphate	0	Not applicable - Pyrite unlikely		

	TIDAL FLAT DEPOSITS			
	Sulphate		pH	
Characteristic Value	1500 mg/l		6.3 units	
Justification	Highest groundwater result or Total Potential Sulphate.		Lowest groundwater result.	
	No. of tests	Results Range	No. of tests	Results Range
Soil	6	30 to 1170 mg/l	6	7.2 to 7.7 units
Groundwater	4	669 to 1530 mg/l	4	6.3 to 7.0 units
Total Potential Sulphate	4	0.06% to 0.76%		

6. GEOTECHNICAL ASSESSMENT

6.1. INTRODUCTION

The following advice and recommendations are based on the construction of two-storey houses.

The site is identified as being located within a flood risk area (as is all the surrounding land). It will be a requirement that a flood risk assessment will need to be undertaken. As the site is shown to be at risk from flooding it is possible that ground levels will need to be raised. This may be the reason for Harvester Way and Crease Drove roads being on low embankments.

From assessment of the nature of the ground conditions and the type of proposed structures, it is considered that the situation falls within EC7 Geotechnical Category 2.

Should the nature of the development be changed then the results of this investigation would need to be reviewed and reassessed.

6.2. EXCAVATIONS

STABILITY	No trial pits were undertaken as part of the intrusive investigation to assess excavation stability. However based on the presence of deep very low strength soils and shallow water table, collapse of even relatively shallow excavations should be anticipated. On the basis of the above, any excavation requiring man entry should be battered back to a safe angle, supported by an appropriate proprietary trench support system or adequately shored. Shoring to any excavation requiring man entry must be designed by a suitably qualified and experienced engineer. Any support system will require regular inspection as detailed in published guidelines to ensure the excavation support is adequate and appropriate for the ground conditions present.
EQUIPMENT	It should be possible to progress excavations with conventional equipment.
GROUNDWATER CONTROL	It is considered that construction without adequate groundwater control will be problematical and pumping from sumps alone may not be sufficient as the water table is at shallow depth and the fine grained soils would be expected to flow ("running sands") in association with groundwater inflows. Consultation with groundwater control contractors is recommended as specialist measures such as 'well pointing' may be required. Any groundwater control system should be designed and operated to minimise the loss of fines from the soil matrix as this could adversely affect settlement. Groundwater levels at the time of construction will have a critical impact on the ease of which the structure can be built. It is therefore recommended that groundwater monitoring is undertaken to assess the variation in the water table with seasonal or short term weather effects.

PARTY WALL ISSUES	Currently no provisional layout has been provided. However, it is considered unlikely that proposed structures will be located in close proximity to existing structures and consequently the Party Wall Act is unlikely to apply to site development.

6.3. SLOPE STABILITY

The scope of this investigation excludes a formal slope stability study and the following observations are made for information only.

The site is relatively flat and no significant changes in level as part of the development are anticipated. It is therefore considered that slope stability is unlikely to be a concern at this site.

6.4. SUBSURFACE CONCRETE

The Made Ground is thin and localised and therefore the concrete classification is based on the results for the Tidal Flats Deposits.

TIDAL FLATS DEPOSITS	
SITE / SOIL CATEGORY	Natural ground.
DESIGN SULPHATE CLASS	DS-3.
GROUNDWATER REGIME	Mobile.
AGGRESSIVE CHEMICAL ENVIRONMENT FOR CONCRETE (ACEC) CLASS	AC-3.
COMMENTS	The DS-3/AC-3 classification is based on limited testing (six soil and four groundwater results) with one high groundwater and one high soil sulphate concentration defining the classification. Further testing may indicate a lower concrete classification could be adopted.

6.5. SOAKAWAYS

The presence of a shallow water table precludes the use of soakaways.

6.6. PAVEMENT CONSTRUCTION

Reference to the exploratory hole logs and the in-situ TRL DCP tests indicates there is a thin crust of higher strength soils from current ground level to approximately 0.50m depth. Where the site is not required to be infilled due to flood risk and the proposed road is constructed from current site levels, it is considered that road formations constructed within the slightly higher strength crust may be designed to an equilibrium CBR design value of 3%.

The cohesive deposits will be prone to rapid degradation during wet weather working and this should be avoided where possible. In addition excavation through the crust is anticipated to result in disruption of the crust in which case a lower CBR design value would need to be

adopted. Consideration should be given to incorporation of geo-grid on the exposed formation and within the lower part of the road makeup to strengthen the road.

All unsuitable soils, such as Topsoil or desiccated soil, should be removed from beneath proposed paved areas. The exposed sub-grade formation should then be proof rolled to reveal any excessively soft or compressible zones and any such features identified also removed by excavation. Where unsuitable materials are removed, the resultant voids should be filled in layers with appropriately compacted suitable granular fill. To reduce the loss of granular construction materials into the sub-grade, consideration should be given to utilising a geotextile starter layer across the formation level.

As the site is identified to be within a flood risk area it is possible that the site may need to be infilled to raise ground levels. Roads constructed on any imported fill should be designed to a CBR value of less than 2% unless appropriate testing identifies that a higher CBR value can be adopted. Due consideration will also need to be given to the potential for instigation of settlement as a result of the load applied by raising ground levels. Any imported materials should also be confirmed to be uncontaminated.

6.7. PRELIMINARY FOUNDATION RECOMMENDATIONS

6.7.1. Introduction

The intrusive investigation has identified the presence of very low strength Tidal Flats Deposits to between 3.00m and >7.00m bgl depth. The deposits include locally present peat, more widespread very soft to soft silty sandy clays, but with the dominant soil being silty fine sands. Very low SPT N values were recorded within the deposits, however the results obtained within the silty fine sands may be unrepresentative as the dynamic sampling and testing can induce liquefaction in such saturated deposits.

Contact was made with the local Authority Building Control. Whilst they were aware of the site they had no knowledge of the foundation design solution adopted for the adjacent residential development.

Various foundation design options are considered in the following sections.

6.7.2. Floor Slabs

As a consequence of the variability of the Tidal Flats Deposits and the potential requirement for infilling the site it is recommended that suspended floor slabs are utilised for all plots.

6.7.3. Traditional Footings

As a consequence of the depth and very low strengths recorded within the Tidal Flats Deposits it is considered that the site is not suitable for the adoption of conventional shallow strip/trench fill footings.

6.7.4. Raft Foundations

Dependant on the individual layout of the proposed plots and subject to extensive further investigation to assess likely total and differential settlements, it may be possible to adopt raft foundations. To determine whether or not rafts would provide a suitable foundation design solution the soil strength profile within the Tidal Flats Deposits would need to be confirmed. This would require Cone Penetration testing (fully instrumented push in probes) to prevent liquefaction during investigation. The testing would provide information to assess potential settlements.

6.7.5. Ground Improvement

Ground improvement techniques such as dynamic compaction, excavation and replacement with suitable engineered fill, and surcharging to allow the use of shallow spread foundations are not generally accepted by construction warranty providers, e.g. NHBC, and are therefore not discussed.

With respect to the potential for the bearing capacity of the Tidal Flats Deposits to be improved by the use of vibro-replacement stone or concrete columns the following observations are made:

- It is considered that the very low strengths of the peat and sandy clays will provide insufficient lateral restraint to stone or concrete columns to prevent the treatment points barrelling out. This could result in settlement of any structures constructed over the treatment points.

- The high frequency vibrations of the vibratory poker could lead to liquefaction of the saturated silty fine sands.

On the basis of the above it is considered unlikely that ground improvement would be a viable solution, however, advice should be sought from specialist ground treatment contractors to confirm whether or not ground treatment could provide a suitable foundation design solution.

6.7.6. Piling

As a consequence of the above, at this stage following the preliminary intrusive investigation, it is recommended that a piled foundation solution is adopted.

Due to the predominantly granular nature and low strengths of the Tidal Flats Deposits and the position of the groundwater, traditional bored piles may be difficult to construct unless they are cased through to the underlying Oxford Clay.

The need for casing may be avoided through the use of Continuous Flight Auger (CFA) piling techniques and this may be the best method to construct cast insitu piles. However advice would need to be sought from specialist CFA contractors to assess the ground conditions in particular the low strengths recorded and whether or not the deposits provided sufficient lateral restraint to prevent the concrete slumping into the deposits, resulting in "necking" or "waisting" of the piles. Consideration would need to be given to testing piles to confirm integrity. Additional piles would need to be installed where integrity of individual piles was not confirmed.

Driven pre-cast concrete piles have been considered. However the dynamic energy applied may induce liquefaction. Specialist advice would need to be sought from driven pile contractors to determine whether or not liquefaction was likely to occur. If liquefaction is a concern, then use of driven piles near existing structures in the adjacent residential estate and the potential impact on Harvester Way road construction through the centre of the site would need to be considered as liquefaction could result in settlement of these third party structures.

For the purposes of pile design it is recommended that skin friction from the Made Ground and Tidal Flats deposits is ignored, and that the working load is calculated from a combination of skin friction and end bearing within the underlying Oxford Clay.

Where a piled design is adopted it will be necessary to provide a working platform design to support the rig to prevent overturning. Some additional shallow investigation of the soil strength profile would be required to provide platform design parameters.

It is recommended that consultation with a specialist piling contractor is undertaken in order to evaluate likely pile loads, diameter and depths based upon the ground conditions revealed within the context of the specified technical requirements of the chosen piling method. In any event, positive contractual assurances should be sought from the piling contractor in respect of the performance of their proprietary system.

6.8. RECOMMENDATIONS FOR FURTHER GEOTECHNICAL WORK

In order to confirm the deeper ground conditions for raft or pile design further ground investigation comprising a combination of deep cable percussive boreholes, Cone Penetration Testing (CPT) or dynamic probing, and trial pits is recommended.

In order to delineate the depth and strength profile and assess settlement parameters of the Tidal Flats Deposits it is recommended that a grid of CPT probe positions is undertaken across the site to assess potential total and differential settlement for raft designs. This will also determine the depth to the Tidal Flats Deposits/Oxford Clay interface, which appears to vary significantly beneath the site

If a pile design is assumed, it is suggested that at least two, and preferably four, boreholes are drilled to depths of 15-18m. Monitoring wells should be included in the boreholes and at least one post work monitoring visit should be undertaken to record groundwater levels. In-situ Standard Penetration Tests should be conducted during forwarding of the boreholes and collected soil samples submitted for appropriate geotechnical laboratory testing.

Where a piled design is adopted it will be necessary to provide a working platform design to support the rig to prevent overturning. Some additional shallow investigation of the soil strength profile would be required to provide platform design parameters.

Consideration should be given to carrying out some trial pits across the site to assess excavation stability, depth and inflow rate of groundwater ingresses and further information on the shallower soils and strength profile.

Further testing may indicate a lower concrete classification may be used.

7. RISK ESTIMATION - SOILS

7.1. HUMAN HEALTH

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
Arsenic	mg/kg	10	11	32	0
Cadmium	mg/kg	10	<0.5	10	0
Chromium (hexavalent)	mg/kg	10	<2	4.3	0
Chromium (total)	mg/kg	10	32	3000	0
Copper	mg/kg	10	26	2,330	0
Lead	mg/kg	10	82	450	0
Mercury	mg/kg	10	<1	7.4	0
Nickel	mg/kg	10	30	130	0
Selenium	mg/kg	10	<3	350	0
Zinc	mg/kg	10	84	3,750	0
pH	Units	10	6.7-7.7	<5-10>	0
Naphthalene	mg/kg	10	<0.1	1.5	0
Acenaphthylene	mg/kg	10	<0.1	170	0
Acenaphthene	mg/kg	10	<0.1	210	0
Fluorene	mg/kg	10	<0.1	160	0
Phenanthrene	mg/kg	10	0.27	92	0
Anthracene	mg/kg	10	<0.1	2,300	0
Fluoranthene	mg/kg	10	0.67	260	0
Pyrene	mg/kg	10	0.54	560	0
Benzo(a)anthracene	mg/kg	10	0.25	3.1	0
Chrysene	mg/kg	10	0.30	6.0	0
Benzo(b)fluoranthene	mg/kg	10	0.36	5.6	0
Benzo(k)fluoranthene	mg/kg	10	0.13	8.5	0
Benzo(a)pyrene	mg/kg	10	0.26	0.83	0
Indeno(1,2,3-cd)pyrene	mg/kg	10	0.18	3.2	0
Dibenzo(a,h)anthracene	mg/kg	10	<0.1	0.76	0
Benzo(ghi)perylene	mg/kg	10	0.15	44	0
TPH Aliphatic C5-C6	mg/kg	3	<0.01	30	0
TPH Aliphatic C6-C8	mg/kg	3	<0.05	73	0
TPH Aliphatic C8-C10	mg/kg	3	<1	19	0
TPH Aliphatic C10-C12	mg/kg	3	<1	93	0
TPH Aliphatic C12-C16	mg/kg	3	<1	740	0
TPH Aliphatic C16-C21	mg/kg	3	<1	45,000	0
TPH Aliphatic C21-C35	mg/kg	3	<6	45,000	0
TPH Aromatic C5-C7	mg/kg	3	<0.01	65	0
TPH Aromatic C7-C8	mg/kg	3	<0.05	120	0

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
TPH Aromatic C8-C10	mg/kg	3	<1	27	0
TPH Aromatic C10-C12	mg/kg	3	<1	69	0
TPH Aromatic C12-C16	mg/kg	3	<1	140	0
TPH Aromatic C16-C21	mg/kg	3	<1	250	0
TPH Aromatic C21-C35	mg/kg	3	<6	890	0
Benzene	mg/kg	3	<0.002	0.079	0
Toluene	mg/kg	3	<0.005	119	0
Ethylbenzene	mg/kg	3	<0.010	65	0
Xylene (total of all types)	mg/kg	3	<0.020	42	0
Methyl Tert Butyl Ether (MTBE)	mg/kg	3	<0.005	49	0
Semi-Volatile Organic Compounds (SVOCs)	mg/kg	3	LOD*	LOD*	0
Pesticide Residues	mg/kg	2	LOD*	LOD*	0
Notes: *Limit of detection: Given a general lack of assessment criteria for these compounds, any concentrations above the detection limit will be discussed below.					

RESULTS EXCEEDING HUMAN HEALTH ASSESSMENT CRITERIA
None of the samples record any contaminants at concentrations exceeding their respective assessment criteria.

7.2. WATER ENVIRONMENT

None of the soils samples record any contaminants at concentrations considered to be of significant concern in respect of the groundwater or surface water environment.

7.3. BUILDING MATERIALS

Contaminant	Units	Number of tests	Maximum Concentration	GAC	Number exceeding GAC
pH	units	13	6.7 (minimum)	<5.5	0
Sulphate (w/s)	mg/l	13	1330	500	3
Sum of any VOC above detection limits	mg/kg	0	Not tested	0.5	Not tested
Sum of SVOC + Aliphatic TPH >C5-C10 + Aromatic TPH >C5-C10 above detection limits	mg/kg	3	0	2	0
Sum of Aliphatic TPH >C10-C21 + Aromatic TPH >C10-C21 above detection limits	mg/kg	3	0	10	0
Sum of Aliphatic TPH >C21-C34 + Aromatic TPH >C10-C35 above detection limits	mg/kg	3	0	500	0
Sum of BTEX + MTBE above detection limits	mg/kg	3	0	0.1	0
Phenols	mg/kg	3	0	2	0
Cresols and chlorinated phenols	mg/kg	3	0	2	0
Naphthalene	mg/kg	5	0	0.5	0
Benzo(a)pyrene	mg/kg	5	0.21	0.5	0

RESULTS EXCEEDING BUILDING MATERIALS ASSESSMENT CRITERIA	
WATER SOLUBLE SULPHATE	Concentrations of water soluble sulphate are such that they could detrimentally impact sub-surface concrete. The impact on concrete mix design is a geotechnical issue that is considered separately and so no further comment is made on these results within this contamination assessment.

8. RISK ESTIMATION – GROUND GAS

RESULTS SUMMARY			
Parameter	**Minimum**	**Maximum**	**Comments**
Methane	0.0%	0.0%	Not detected.
Carbon Dioxide	1.5%	6.1%	Only recorded in excess of 5% in WS09 on the third visit.
Oxygen	16.5%	19.9%	The oxygen levels were typically depleted as the carbon dioxide concentrations increased.
Hydrogen Sulphide	0ppm	2ppm	Trace background levels.
Carbon Monoxide	0ppm	>500ppm	An unusually high concentration was recorded during the first monitoring visit. It is considered that this was as a result of the drilling process as subsequent visits have recorded no significant concentrations. Therefore, the carbon monoxide is not considered to present any cause for concern.
PID	0.0ppm	0.2ppm	No sources of hydrocarbon vapours encountered during the investigation.
Atmospheric pressure	1016mB	1026mB	Monitoring undertaken in summer months with relatively high atmospheric pressure.
Groundwater levels	0.66m	1.94m	The shallowest groundwater was encountered along in WS02 and WS09 along the western boundary of the site.
Flow rate	-3.8 l/hr	0.0 l/hr	Negative flows are indicative of 'draw down' in the boreholes. These can be a factor of the effect of drilling on the immediate ground conditions, the creation of a partial vacuum as a result of monitoring, groundwater behaviour or due to certain geologic conditions. In terms of the contamination risk assessment, this does not present a cause for concern as the net effect is to reduce the emission of gas at surface.

GAS GENERATION POTENTIAL OF SOURCE		
GAS SOURCE	**GENERATION POTENTIAL**	**COMMENTS**
Natural soils with low organic content	Low	Organic lenses, decaying plant remains and Peat were encountered during the investigation. However, these were not encountered in significant quantities.
Made Ground in infilled drainage ditch with low organic content	Low	An infilled drainage ditch is located along the eastern boundary. It is likely that this was infilled with similar soils to the natural encountered on site. Therefore the gas risk is likely to be no greater than for the naturally occurring organic soils on site.

Sensitivity of development	High (Residential with gardens)	
	Idealised	**Actual**
Monitoring period	6 months	1 months
Total number of visits	9 visits	3 visits
Number of visits during falling pressure trends	At least two visits	None
Comment	Due to prolonged hot weather currently being experienced, the atmospheric pressure conditions have remained steady for a long period of time. Therefore no monitoring visits have been undertaken during periods of falling pressure. Although three gas visits have been completed which is sufficient for a preliminary characterisation of the gas regime at the site, a further three monitoring visits are recommended. This should include two visits during periods of falling pressure. Although this does not strictly comply with CIRIA C665, given the generally low concentrations being recorded it is considered that this should enable a full assessment of the gas regime to be undertaken. Should concentrations increase during falling pressure periods, the number of visits may have to be reconsidered.	

GAS REGIME CHARACTERISATION			
Radon protection measures required?	No.	**Vapour protection measures required?**	No.
	Characteristic Gas Concentration (fraction)	Characteristic Gas Flow Rate (l/hr)	Gas Screening Value (l/hr)
Methane	0.00	0.0	0.0
Carbon Dioxide	0.062	0.0	0.0
Methodology	Situation B – Low rise housing with gardens – NHBC 'Traffic Lights'.		
Gas Regime	In consideration of the GSV, the gas regime is considered to be Green subject to the further monitoring confirming the findings to date. The maximum recorded carbon dioxide concentration of 6.2% marginally exceeds the 'Green' threshold of 5% and this only occurred in one borehole on one occasion. In combination with the low GSV this is not considered to present a cause for concern, however, the further monitoring will be required to confirm the situation.		
Gas Protection Measures	Negligible gas regime identified and gas protection measures are not considered necessary (subject to further monitoring).		

9. RISK EVALUATION

9.1. REVISED CONCEPTUAL MODEL

The revised conceptual site model plan is presented in the Appendices.

ADDITIONAL POLLUTANT LINKAGES	During the ground investigation, no additional sources of contamination were identified.
INVALID POLLUTANT LINKAGES	The investigation has shown that the soils beneath the site are uncontaminated and as such do not offer any contamination source to the identified receptors. No evidence of the migration of contamination from the Crane Depot to the north was identified.
LIMITATIONS AND UNCERTAINTIES	In an attempt to minimise crop damage, only limited investigation was undertaken within the central field areas. However, all of the potential contamination sources have been targeted by the exploratory holes. Although further geotechnical investigation has been recommended it is considered that a sufficient number of exploratory points have been completed for contamination assessment purposes. The current level of gas monitoring is sufficient to make an initial assessment of the risk, however, further monitoring will be required to meet current guidance and complete the gas risk assessment.

9.2. UPDATED RISK ASSESSMENT

The pollutant linkages identified in the revised conceptual site model will now be evaluated as to their severity.

SOURCES AND CONTAMINANTS	PATHWAYS (REFERENCE FROM MODEL)	RECEPTORS	RISK
On site Agricultural use of the site. -Pesticides	Ingestion Inhalation of dusts Consumption of home grown produce	Future site users	Negligible risk
	Migration through permeable strata	Groundwater	Negligible risk
	Surface water run off Migration through permeable soils	Surface drains	Negligible risk
On site Infilled ditch with unknown soils	Ingestion Inhalation of dusts Consumption of home grown produce	Future residents	Negligible risk
	Direct contact	Building materials	Negligible risk
On site -Organic rich soils. -Infilled ditch.	Generation of soil gases (7)	Future site users	*Negligible risk
Off site Crowland Cranes Depot -Hydrocarbons	Migration via contaminated groundwater resulting in the inhalation of hydrocarbon vapours	Buildings Future residents Building materials	Negligible risk
	Direct contact		

*Negligible risk - The associated risk is subject to completion of additional gas monitoring.

The contamination risks that are presented to the various receptor groups are discussed further in the following sections:

RISK TO HUMAN HEALTH
The chemical testing has confirmed that the soils on the site are uncontaminated. The gas monitoring has not identified any significant concentrations of gas. However, further monitoring is required to confirm the gas regime.

RISK TO WATER ENVIRONMENT
There are no identified risks to the water environment.

RISK TO BUILDING MATERIALS AND SERVICES
There are no identified risks to building materials or services.

9.3. RISK MANAGEMENT

GENERAL	The investigation has not identified any contamination sources to date and therefore the site is considered suitable for the proposed residential use. It is recommended that this report is submitted to the planning department of the Local Authority, the organisation undertaking the Building Control function and warranty providers to confirm that the investigation completed to date is satisfactory.
FURTHER INVESTIGATION	It is recommended that the following additional investigation elements are completed in order to confirm the findings of the contamination assessment: • It is considered that three further monitoring visits including two during a period of falling pressure will be required to fully evaluate the gas regime.
OUTLINE REMEDIATION SOLUTION	Due to the absence of contamination, no remediation is considered necessary.
CONSTRUCTION CONSIDERATIONS	Although no contamination has been identified, as with any construction site, if any anomalous material is encountered during the redevelopment then expert environmental advice should be sought.
WASTE SOILS CLASSIFICATION	Topsoil should be viewed as a resource rather than a waste and as it is suitable for residential garden use, the topsoil at the site should be stripped and the surplus reused on other developments. It should be noted that topsoil, even if uncontaminated, is unlikely to constitute 'inert waste' due to its high organic matter content. It is considered that the any natural or reworked sub-soils disposed of from the site would be classified as 'inert waste'. However, the chemical results should be forwarded to the proposed landfill site and the waste classification confirmed prior to disposing of any surplus soils. Waste Acceptance Criteria (WAC) testing of the soils has been completed and the results are in the Appendices which confirm the soil tested complies with the inert waste limits. The waste code from the European Waste Catalogue (EWC) 2002 for the soils would be 17 05 04 'Soil and Stones, not containing dangerous substances'.

REPORT SPECIFIC REFERENCES

- 'Phase 1 Environmental Desk Study – Harvester Way, Crowland', report ref. BRD2096-OR1-A, July 2014.
- 'British Geological Survey sheet 158 "Peterborough" Solid and Drift edition (1:50,000) published 1978.

SUPPORTING INFORMATION

GROUND INVESTIGATION

Exploratory holes are logged by an experienced Geo-Environmental Consultant in general accordance with 'Code of practice for site investigations' BS5930:1999 +A2:2010, BSi, August 2010. Soil samples for chemical and geotechnical analysis are taken from the exploratory holes at intervals dictated by the nature of the soils and the objectives of the investigation.

Where stated on the logs of inspection pits, trial pits or boreholes (where insitu testing has not been undertaken), the relative density of coarse (sand and gravel) soils is tentative only. Such assessments of density are on the basis of visual inspection only taking into consideration such factors as drilling rates, stability of pit side walls, appearance and behaviour under excavation.

Where Chalk strata is encountered it is logged and graded in general accordance with CIRIA guidance 'C574 – Engineering in Chalk'. It should be recognised that where percussive drilling methods are employed, the structure of the Chalk is destroyed and therefore the grading stated on such logs is either tentative or absent where it is not possible to assess the grade.

Hand Dug Inspection Pits

Hand tools are used to forward shallow inspection pits as a cost effective method of describing and sampling near surface soils. The technique is also used where exposure of existing footings is required. The depth reached by such techniques is a function of the nature of the ground and generally does not exceed 1.5m

Trial Pits

Mechanically excavated trial pits allow detailed inspection of near surface ground due to the large volume of soil exposed. A wheeled backhoe loader is the usual machine for digging trial pits that are typically 3 to 4.5m deep, 0.5m wide and 3m long.

Windowless Sampling Boreholes

This type of borehole is formed by a small tracked dynamic percussion drilling rig with samples retrieved in thin plastic liners within the narrow diameter steel sampling tubes. Borehole depths of up to 6m is typically, but in exceptional circumstances up to 15m depth can be achieved. This is the smallest type of rig that is capable of undertaking Standard Penetration Tests (SPTs).

Hand Held Window Sampling

Hand held window sampling is a useful method of drilling narrow diameter boreholes particularly where access is difficult. Hand held mechanical percussive hammers are used to drive the sampling tube into the ground. The soil samples are collected within the hollow metal sampling tubes and inspected via the open window along one side. Window sampling boreholes can be forwarded to depths of 3m to 6m depending upon ground conditions.

Cable Percussive Boreholes

This form of drilling involves repetitive dropping of a tube into the soil under its own weight from a tripod support. The sample is obtained from the clay cutter head in fine soils or a bailer for wet granular soils. As the borehole progresses SPTs can be undertaken and relatively undisturbed samples can be obtained. Typically these boreholes are 15 to 25m

deep, but depths of double that can be achieved in soils, but only thin weak rock layers can be penetrated.

Rotary Boreholes

Where competent rock is required to be drilled then rotary drilling techniques are required. The drilling rigs can vary in size from small tracked units to larger units mounted on four wheel drive trucks. Rotary open hole drilling techniques break the rock into small fragments and so recovery of any samples is limited. In contrast, rotary coring retrieves excellent samples. Some rigs also allow windowless sampling to be undertaken through soil layers. There are no practical limits to the depths that this drilling method can achieve.

Dynamic Probing

Dynamic probing comprises a sectional rod with a sacrificial cone at the base of slightly larger diameter than the rod. The rod is driven into the ground by a constant mass falling through a set distance. The number of blows required to forward the rod per 100mm is then recorded and presented in a graph of N_{10} values. The standard applicable to dynamic probing is "BS EN ISO 22476-2:2005 Incorporating corrigendum no. 1, Geotechnical investigation and testing — Field testing — Part 2: Dynamic probing" BSi, February 2007.

Dynamic Penetrometer

The Transport Research Laboratory Dynamic Cone Penetrometer (TRL DCP) uses an 8 kg hammer dropping through a height of 575mm to drive a 60° cone of 20mm maximum diameter into the ground. The depth driven either per blow or per several blows is recorded. The strength of each of the soil layer encountered is then calculated by converting the penetration rate (mm per blow) into an approximate California Bearing Ratio (CBR) value employing the correlation proposed by TRL.

Gas Monitoring

Gas monitoring is undertaken with a portable gas monitor for oxygen, Methane, Carbon Dioxide, Hydrogen Sulphide and Carbon Monoxide together with recording of atmospheric pressure and any flow rate.

Vapour Monitoring

Headspace tests and monitoring for Volatile Organic Compounds (VOC) or Semi Volatile Organic Compounds (SVOC) is undertaken using a Photo Ionisation Detector (PID). The MiniRAE models used have a 10.6 eV lamp calibrated for isobutylene. The PID is useful tool to indicate the presence of a wide range of volatile compounds, but only provides semi-quantitative data as different compounds provide a different response and thus the reading is not a true reflection of the actual concentration present.

Low PID readings can be recorded in natural uncontaminated organic soils or even as a result of atmospheric pollution. It is generally accepted by consultants and regulators that recorded values in excess 50 parts per million (ppm) represents the presence of organic compound pollutants and in excess of 100 ppm such contamination may be significant.

The headspace test procedure involves the collection of a sample of suspected contaminated soils and placing within a sample bag. A tight seal to the bag is formed with a similar volume of air trapped to that of the soil and the sample is left for fifteen minutes to allow volatilisation of any contaminants. The bag is then pierced by, and sealed around, the sample probe of the PID and a reading taken.

Borehole well monitoring is undertaken by connecting the PID directly to the gas tap on the monitoring well installation.

Groundwater Level Monitoring

Groundwater levels are recorded with an electronic dip meter that has a detector end that is lowered into the borehole well. An audible signal is made when water is reached and the depth recorded from the graduated tape used to lower the detector. Where there is potential for a separate Light Non Aqueous Phase Liquid (LNAPL) to be present floating on the groundwater an oil/water interface meter is used in preference to a conventional dip meter so that any such floating product can be detected.

Geotechnical Sampling

BRD schedule a range of geotechnical testing as appropriate to the identified ground conditions, available budget and the proposed development. Different types of soil samples are obtained as appropriate to the ground conditions and planned testing.

SAMPLE TYPE	***SYMBOL USED ON LOGS***	***DESCRIPTION***
Disturbed	*D*	*Small disturbed soil samples of about 1 to 2 kg are collected in plastic bags.*
Bulk	*B*	*Large disturbed bulk samples up to about 30 kg are collected in plastic bags*
Undisturbed	*U*	*'Undisturbed' samples generally collected in plastic or metal tubes within cable percussive boreholes of 100mm diameter for samples of fine soils of firm to stiff consistency. Can also be representative of samples taken by cutting plastic sample liners from windowless sampling drilling methods. It is recognised that such samples do not generally meet Eurocode sample quality requirements for the tests commonly employed. However, given the wealth of experience with these sampling methods this continues to be common in United Kingdom practice particularly for less sensitive developments where more expensive sampling techniques are not economically justifiable.*
Undisturbed	*UT*	*A thin walled steel sampler developed by Archway Engineering called a UT100 in an attempt to gain better quality samples of soft to firm fine soils when using cable percussive drilling methods.*

Contamination Sampling

BRD schedule contamination testing as appropriate to the ground conditions, available budget, potential contaminants and the proposed development. Samples are collected in single use laboratory supplied containers.

Soil samples are retrieved in plastic containers and/or amber glass jars with a lined plastic cap. Contamination samples are indicated by a 'J' on exploratory hole logs.

Water samples are collected in plastic bottles and/or amber glass jars with a lined plastic cap then placed in cool boxes together with freezer packs. Water samples are indicated by a 'W' on exploratory hole records, but generally such samples are not tested as testing from dedicated monitoring wells is preferred for sample quality reasons.

Samples retrieved from the exploratory holes are dispatched to the laboratory by overnight courier. Where samples cannot be transported directly from site they are temporarily stored in the BRD dedicated sample storage facility which includes refrigeration where necessary. The individual accreditation of the test methods is detailed in the laboratory test report.

GEOTECHNICAL PARAMETERS

Soakage Tests

Soakage tests comprise the filling of a test pit with water and recording the time taken for the water to drain away. The test are undertaken in general accordance with 'BRE Digest 365: Soakaway design', Building Research Establishment, 1991. Water is generally supplied by a tanker to allow fast filling of the pits with water. Repeat tests are undertaken where possible within the time available on site with the investigation budget.

Standard Penetration Tests

The standard penetration test (SPT) determines the resistance of soils at the base of a borehole to the dynamic penetration of a split barrel sampler and the recovering of disturbed samples for identification purposes. In gravelly soils and some soft rocks a solid cone is used in preference to the sampler.

The basis of the test consists in driving a sampler by dropping a hammer of 63.5 kg mass on from a height of 760 mm. The number of blows (N value) necessary to achieve a penetration of the sampler of 300 mm is recorded. The test is described in 'Geotechnical investigation and testing — Field testing — Part 3: Standard penetration test - BS EN ISO 22476-3:2005 Incorporating corrigendum no. 1', BSi, 2007.

The uncorrected N values of the SPT tests are recorded upon the borehole logs together with a record of blows for each 75mm test portion including the seating blows. Where the full test depth cannot be achieved due to refusal on hard stratum, the number of blows and the distance achieved is recorded and the N value given as >50. The abbreviation SPT(c) is used upon the logs indicates that the test was performed with a solid cone rather than a split spoon sampler.

It is necessary to apply a correction to the N values to account for the effects of energy delivery using the equation: $N_{60} = \frac{E_r}{60} N$ *where* E_r *is the energy ratio of the specific test equipment.*

In the case of tests in sand, for the effects of overburden and rod length the equation is modified to $N_{60} = \frac{E_r}{60} \; x \; \lambda \; x \; C_N \; x \; N$ *where* λ *is the correction factor for energy losses due*

to the rod length and C_N is the correction factor for vertical stress due to overburden of the soil.

Sulphate

In order to compare the laboratory soil test results with 'Concrete in aggressive ground. BRE Special Digest 1: 2005' (BRE, 2005) laboratory results are converted to SO_4 mg/l. QTS Environmental Ltd results are expressed as SO_4 g/l and so are multiplied by a factor of 1000 to convert to mg/l. Soil Property Testing Ltd laboratory results are expressed as SO_3 g/l and are multiplied by a factor of 1200 to express the results as SO_4 mg/l.

Index Property Tests

In accordance with National House Building Council (NHBC) Standards Chapter 4.2 – Building near trees, the laboratory plasticity indexes are assessed against their volume change potential. The Modified Plasticity Index is defined as the Plasticity Index of the soil multiplied by the percentage of particles with a nominal diameter of less than 425µm. Whilst the NHBC Standards were developed for residential buildings, the advice is equally applicable to a large number of other types of low rise structures.

Hand Shear Vane

The undrained shear strength of the fine (i.e. clay) soils at the site can be established using hand shear vane apparatus. Usually three readings are taken at every depth tested and the uncorrected results recorded on the exploratory point log. Shear vane readings from depths below 1.2m depth in trial pits are from tests performed on excavated soil. In accordance with Eurocode 7 — Geotechnical design — Part 2: Ground investigation and testing EN 1997-2:2007 the results should be corrected. BRD employ only simple correction methods as the more complex correction methodologies implies undue accuracy to a test that has distinct disadvantages and limitations.

Pocket Penetrometers

The Pocket Penetrometer is a lightweight instrument for use by field personnel to check visual classification of soils. It is a simple test and there is inherent uncertainty related to the small volume of soil being tested and so the results should be used with appropriate caution. Pocket penetrometers are calibrated in terms of unconfined compressive strength and once converted to undrained shear strength (divide by two) the results are further reduced by a factor of 1.5 - 2.0 as the device tends to overestimate strengths.

Instrument Reading (uncompressive strength in kg/cm²)	*Indicative Undrained Shear Strength (kN/m²)*	*Indicative Consistency*	*Indicative strength*
1.0	*25 - 33*	*Soft*	*Low*
1.5	*38 - 50*	*Soft to firm*	*Low to medium*
2.0	*50 - 67*	*Firm*	*Medium*
2.5	*63 - 83*	*Firm to stiff*	*Medium to high*
3.5	*88 - 116*	*Stiff*	*High*
4.5	*113 - 150*	*Stiff to very stiff*	*High to very high*

GEOTECHNICAL ASSESSMENT

Under Eurocode 7 (EC7) the following risk ranking is applied to geotechnical projects:

GEOTECHNICAL CATEGORY	*DESCRIPTION*
1	*Small and relatively simple structures for which it is possible to ensure that the fundamental requirements will be satisfied on the basis of experience and qualitative geotechnical investigations with negligible risk. For example, straightforward ground conditions, local experience, no excavation below the water table unless this will be straight forward.*
2	*Conventional types of structures and foundations. No difficult soil or loading conditions. Quantitative geotechnical data and laboratory testing. Routine procedures for field and laboratory testing. Conventional structures and no exceptional geotechnical risk. For example, spread, raft and piled foundations, retaining walls, bridge piers and abutments, embankments, ground anchors, tunnels and excavations.*
3	*Those structures not in Categories 1 and 2 such as very large or unusual structures, structures involving abnormal risks, or unusual or exceptionally difficult ground or loading conditions. Structures in highly seismic areas. Structures in areas of probable site instability or persistent ground movements that require separate investigation or special measures.*

CONTAMINATION ASSESSMENT METHODOLOGY

UK Policy

The UK Government's policy in relation to land affected by historic contamination is based on a 'suitable for use' approach. The approach recognises that the risks presented by any given level of contamination will vary greatly according to the use of the land and a wide range of other factors, such as the underlying geology of the site. Contamination risks therefore need to be assessed on a site-by-site basis. The 'suitable for use' approach limits requirements for remediation to the work necessary to prevent unacceptable risks to human health or the environment in relation to either the current use or future use of the land.

The three main drivers for contamination assessment and remediation are:

- *Voluntary action.*
- *Development as part of the planning regime.*
- *Regulatory action to mitigate unacceptable risks e.g. Part 2A of the Environmental Protection Act 1990.*

Pollutant Linkages

For a contamination risk to exist there must be a 'pollutant linkage' from the contaminant (source) via a pathway (the route from contaminant to receptor) to a receptor (the entity that could be harmed). The absence of a contaminant, pathway or receptor breaks the pollutant linkage and therefore no contamination risk exists.

Contamination is typically present at a site (in the ground and/or in the underlying groundwater) as a result of a historic or current industrial use, usually as a result of leaks, spills or disposal of residues, wastes and excess raw materials from the industrial processes. Contamination may also be present due to:

- *The deliberate application of chemicals e.g. the spraying of herbicide/pesticide.*
- *Migration of pollutants from adjacent land.*

Naturally occurring processes e.g. elevated concentrations of particular heavy metals associated with specific geological strata.

Conceptual Site Model

The conceptual site model can be defined as a textual or graphical representation of the identified pollutant linkages for a given site. The model forms the basis for designing the investigation as the aim will be to target all of the potential pollutant linkages to determine, through the subsequent phases of risk assessment, whether or not they pose an actual risk.

It is important that the conceptual site model is updated with new information as the various investigations, risk assessment and remediation works are completed.

Technical Guidance

The technical and legal framework for contamination assessment is complex. The process adopted through this report for assessing contamination risks is in general accordance with the following guidance, as listed below:

- *'Investigation of Potentially Contaminated Sites - Code of Practice - BS 10175: 2011', BSi, 2011.*
- *'Model Procedures for the management of Land Contamination - CLR Document No. 11', Environment Agency, 2004.*
- *'Guidance for the safe development of housing on land affected by contamination - R&D66: 2008', NHBC/Environment Agency, 2008.*

Risk Assessment Methodology

In line with the technical guidance, the contamination risk assessment follows a series of phased stages for each particular site:

PHASE	***DESCRIPTION***	***RISK ASSESSMENT STAGE***
PHASE1	*Generally limited to desk based research and a site walkover survey to develop an initial conceptual site model and identify what risks, if any, are likely to be presented by the site.*	***Hazard Identification and Assessment*** *A preliminary stage of risk assessment concerned with identifying and characterising the hazards that may be associated with a particular site and identifying potential pollutant linkages.*
PHASE 2	*This phase is concerned with establishing whether contamination is present, usually through intrusive ground investigation, and then evaluating the degree and magnitude of the associated risks.*	***Risk Estimation*** *A stage concerned with estimating the likelihood that receptors will suffer adverse effects if they come into contact with, or are otherwise affected by, a hazardous substance or agent under defined conditions.* ***Risk Evaluation*** *A stage of risk assessment concerned with evaluating the acceptability of estimated risks, taking into account the nature and scale of the risk estimates, any uncertainties associated with the assessment and the broad costs and benefits of taking action to mitigate risks.*
PHASE 3	*The appraisal and selection of remediation techniques, their implementation and verification.*	***Risk Management*** *The process whereby decisions are made to accept a known or assessed risk and/or the implementation of action to reduce the consequences or probabilities of occurrence.*

Risk Classification

The objective of risk assessment is to identify the nature and magnitude of the potential risks and should be based on a consideration of both:

- *The likelihood/probability of an event [taking into account both the presence of the hazard and receptor and the integrity of the pathway].*
- *The severity of the potential consequence [taking into account both the potential severity of the hazard and the sensitivity of the receptor].*

There is a need for a logical, transparent and repeatable system in defining the categories of severity of consequence and likelihood as well as for the risk itself and therefore the following risk rating matrix is employed:

		SEVERITY OF CONSEQUENCE			
		SEVERE	***MEDIUM***	***MILD***	***MINOR***
PROBABILITY	***HIGH LIKELIHOOD***			*Moderate Risk*	*Moderate/Low Risk*
	LIKELY		*Moderate Risk*	*Moderate/Low Risk*	*Low Risk*
	LOW LIKELIHOOD	*Moderate Risk*	*Moderate/Low Risk*	*Low Risk*	
	UNLIKELY	*Moderate/Low Risk*	*Low Risk*		

These risk classifications are defined as follows:

- *Very High Risk - There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without appropriate remediation action.*
- *High Risk - Harm is likely to arise to a designated receptor from an identified hazard at the site without appropriate remediation action.*
- *Moderate Risk - It is possible that without appropriate remediation action harm could arise to a designated receptor. It is relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely that such harm would be relatively mild.*
- *Low Risk - It is possible that harm could arise to a designated receptor from an identified hazard. It is likely that, at worst if any harm was realised any effects would be mild.*
- *Negligible Risk - The presence of an identified hazard does not give rise to the potential to cause harm to a designated receptor.*

This risk assessment matrix and classification system is based on guidance produced by Department for Environment, Food and Rural Affairs (Defra) and the Environment Agency in connection with contaminated land assessment.

RISK ESTIMATION – SOILS

Introduction to Soil Human Health Generic Assessment Criteria (GAC)

At the time of writing, the Environment Agency (EA) and Department of Environment Food and Rural Affairs (DEFRA) had previously issued revised guidance following the consultation about the DEFRA publication "Assessing risks from land contamination – a proportionate approach. Soil Guideline Values: the Way Forward". This resulted in a revised version of the Contaminated Land Exposure Model (CLEA) model and therefore the previously published Soil Guideline Values (SGV) were in the process of being revised.

Currently there is insufficient published EA data to use the revised CLEA model with confidence for any contaminants except those for which a revised SGV has been published. BRD has therefore employed older guidance for existing SGV compounds within this assessment as it is recognised that these generic criteria remain representative of screening levels below which there is no appreciable contamination risk to human health. At the time of writing, BRD is aware of a large number of other consultants and Local Authorities that have adopted the same practice of retaining the older guidance as an interim measure. However, it should be noted that the results of this investigation may need to be reinterpreted as new and revised SGVs become available.

Due to the delays in the production of a complete set of SGVs, the Chartered Institute of Environmental health (CIEH) contracted Land Quality Management Ltd (LQM) to produce Generic Assessment Criteria (GAC) for use in contaminated land human health risk assessment. These LQM CIEH GAC (2nd edition) have been derived using the current CLEA model and are therefore consistent with current guidance. The LQM CIEH GAC tends to be for substances for which no SGV has been published or proposed. In addition, in December 2009, further GAC were produced by the Environmental Industries Commission (EIC), The Association of Geotechnical and Geoenvironmental Specialists (AGS) and Contaminated Land: Applications in Real Environments (CL:AIRE) using the CLEA model. These are referred to as the EIC/AGS/CLAIRE GAC.

In summary, revised assessment criteria have been used for those substances where a new SGV has been published using the current CLEA model. For those substances where revised SGVs have yet to be issued then the old SGVs have been used in this assessment. For those substances for which no SGVs had previously been produced, then the LQM CIEH GAC or EIC/AGS/CLAIRE GAC will be adopted.

It should be noted that unless otherwise stated all the assessment criteria adopted within this report have been derived based on a sandy loam soil at pH 7 and the values quoted are for a conservative soil organic matter content of 1%.

Human Health – Soil Generic Assessment Criteria

The results of the soils analysis have been compared to generic assessment criteria for the default exposure scenarios comprising either residential land with plant uptake, residential land without plant uptake, or commercial/industrial land use. The criteria values selected are listed in the table below and full details on the source are referred to above. The results have also been assessed, where applicable, with reference to the required statistical tests presented within CLAIRE document "Guidance on comparing soil contamination data with a critical concentration".

ANALYSIS	GENERIC ASSESSMENT CRITERIA (mg/kg unless stated)			SOURCE
	RESIDENTIAL WITH PLANT UPTAKE	RESIDENTIAL WITHOUT PLANT UPTAKE	COMMERCIAL / INDUSTRIAL	
Arsenic	32	35	640	Derived using current CLEA model
Cadmium	10	84	230	
Chromium (total)$	3,000	3010	30,400	LQM CIEH GAC
Chromium VI	4.3	4.3	35	
Lead	450	450	750	Former SGV
Mercury*	7.4	8.4	370	Derived using current CLEA model
Selenium	350	600	13,000	
Nickel	130	130	1,800	
Copper	2,330	6,200	71,700	LQM CIEH GAC
Zinc	3,750	40,400	665,000	
pH	<5 - 10> units			Professional judgement
Naphthalene	1.5	1.64	200	LQM CIEH GAC (or derived from data contained therein using CLEA model)
Acenaphthylene	170	1,950	84,000	
Acenaphthene	210	2,020	85,000	
Fluorene	160	1,850	64,000	
Phenanthrene	92	837	22,000	
Anthracene	2,300	19,800	530,000	
Fluoranthene	260	972	23,000	
Pyrene	560	2,330	54,000	
Benzo(a)anthracene	3.1	3.71	90	
Chrysene	6.0	8.84	140	
Benzo(b)fluoranthene	5.6	6.99	100	
Benzo(k)fluoranthene	8.5	10.1	140	
Benzo(a)pyrene	0.83	1.0	14	
Indeno(1,2,3-cd)pyrene	3.2	4.17	60	
Dibenzo(a,h)anthracene	0.76	0.87	13	
Benzo(ghi)perylene	44	46.8	650	
TPH Aliphatic C5-C6	30	29.8	3,400	
TPH Aliphatic C6-C8	73	72.7	8,300	
TPH Aliphatic C8-C10	19	18.8	2,100	
TPH Aliphatic C10-C12	93	92.9	10,000	
TPH Aliphatic C12-C16	740	745	61,000	
TPH Aliphatic C16-C21	45,000	45,300	1,600,000	
TPH Aliphatic C21-C35	45,000	45,300	1,600,000	
TPH Aromatic C5-C7	65	263	28,000	
TPH Aromatic C7-C8	120	607	59,000	
TPH Aromatic C8-C10	27	33.2	3,700	
TPH Aromatic C10-C12	69	177	17,000	
TPH Aromatic C12-C16	140	1,250	36,000	
TPH Aromatic C16-C21	250	1,290	28,000	
TPH Aromatic C21-C35	890	1,330	28,000	
Benzene	0.079	0.27	28.1	Derived using current CLEA model
Toluene	119	607	59,000	
Ethylbenzene	65	167	16,800	
Xylene^	42	53	6,220	
MTBE	49	73	7,900	EIC/AGS/CL:AIRE GAC

Notes:
** The SGV for methyl mercury has been adopted as the worst case mercury compound as generally there is no desk study evidence to suggest the potential for elemental mercury on the majority of sites.*
^ The SGV for p-xylene has been adopted as this has the lowest SGV and therefore is most conservative.
$ GAC for Chromium III adopted, as in the absence of Chromium VI it is likely that all of the chromium will be in this form as these are the two most common and stable forms of chromium in the soil environment.

Where no GAC is available, any concentrations exceeding the laboratory limit of detection are identified and discussed in more detail.

Water Environment - Soil Generic Assessment Criteria

There are no UK published Generic Assessment Criteria for soil test results in respect of the risk to the water environment and therefore risk estimation is on the basis of the professional judgement and experience of BRD to employ values that are a reasonable concentration above which concern for water resources is valid.

The Total PAH GAC employed is the sum of the 16No. priority PAH compounds regularly tested for in contaminated land analysis (i.e. US EPA 16PAHs). BRD employ a soil screening based upon the total PAH limit for 'inert waste' of 100mg/kg. The rationale is based on PAHs are recognised to be generally of low solubility and the risk to the water environment is correspondingly low.

In respect of Total Petroleum Hydrocarbons, BRD employ a value of 500 mg/kg as a screening value in comparison to the sum of the component aliphatic and aromatic TPH carbon bands. The employed soil screening value is based upon:

- *In common with some other consultants, the professional judgement and experience of BRD suggests that this value is a reasonable concentration above which concern for water resources is valid. The rationale is based on the fact that lower concentrations of fuel based contaminants are more likely to naturally degrade than migrate any great distance.*

- *BRD is aware of regional Environment Agency groundwater and contaminated land teams that employ 500 mg/kg as a screening value for considering whether or not TPH could represent a risk to water resources.*

- *The value mirrors the mineral oil Waste Acceptance Criteria limit for what is considered 'inert waste'.*

Should elevated contaminants that pose a potential risk to the water environment be identified then site specific assessment criteria should be developed.

Building Materials and Services - Soil Generic Assessment Criteria

Some hydrocarbon compounds are known to both attack and permeate through certain plastic pipe materials, with the primary concern being the degradation and tainting of water supplies. The UK Water Industry Research (UKWIR) has therefore produced a document 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' (ref. 10/WM/03/21) that specifies threshold criteria for the adoption of 'standard' polythene (PE) or PVC pipes, protective barrier pipe and ductile iron/steel/copper pipes.

The UKWIR threshold assessment criteria from Table 3.1 of this document for standard PE pipes have been employed. It should be noted that the approach taken by UKWIR is very conservative, and both the document and research are flawed. However, it is these values that are being using to specify water pipe materials and therefore it is appropriate to consider them.

The UKWIR is particularly flawed in respect of the chemical analysis it expects as it seeks a limit of detection that is generally below limits that are reasonable or commonly employed in contaminated land assessment. The UKWIR seeks that where a substance is below the limit of detection it should be taken as being present at half this concentration. For the larger suite of chemicals where the limit is against a sum of compounds, this approach would mean that a sample of virgin sub-soil from a greenfield site with absolutely no contamination would actually fail the criteria for using standard PE pipes. To avoid this situation, BRD have adopted the approach of summing only those compounds detected above their respective limits of detection.

In terms of building materials, the primary concern is in respect of concrete as certain commonly occurring natural ground conditions can adversely impact on buried concrete as discussed in 'Special digest 1:2005 Concrete in aggressive ground', BRE, 2005.

ANALYSIS	GENERIC ASSESSMENT CRITERIA	SOURCE
pH	<5.5	BRE Special Digest 1:2005
Sulphate (w/s)	500 mg/l	BRE Special Digest 1:2005
Sum of any VOC above detection limits	0.5 mg/kg	Relevant compounds adapted from UKWIR Table 3.1
Sum of SVOC + Aliphatic TPH >C5-C10 + Aromatic TPH >C5-C10 above detection limits	2 mg/kg	
Sum of Aliphatic TPH >C10-C21 + Aromatic TPH >C10-C21 above detection limits	10 mg/kg	
Sum of Aliphatic TPH >C21-C34 + Aromatic TPH >C10-C35 above detection limits	500 mg/kg	
Sum of BTEX + MTBE above detection limits	0.1 mg/kg	
Phenols	2 mg/kg	
Cresols and chlorinated phenols	2 mg/kg	
Naphthalene	0.5 mg/kg	
Benzo(a)pyrene	0.5 mg/kg	

RISK ESTIMATION – GROUNDWATER

The initial assessment of the contamination risk to groundwater is by comparing dissolved groundwater concentrations with screening values that are protective of groundwater resources.

The reference source for the target concentrations is generally the EA's Environmental Quality Standards (EQS), the Water Supply (Water Quality) Regulations (WSR) 1989 / 2000 and the DW1/DW2 criteria from the Surface Water (Abstraction for drinking water)(classification) Regulations 1996. The target concentrations are outlined in the table overleaf.

ANALYSIS	*GENERIC ASSESSMENT CRITERIA*	*SOURCE*
Arsenic	*50 µg/l*	*EQS*
Cadmium	*5 µg/l*	*EQS*
Chromium (total)	*50 µg/l*	*DW2*
Copper	*50 µg/l*	*DW2*
Nickel	*20 µg/l*	*WSR*
Lead	*50 µg/l*	*DW2*
Mercury	*1 µg/l*	*EQS*
Selenium	*10 µg/l*	*WSR*
Zinc	*5 mg/l*	*DW2*
Cyanide	*50 µg/l*	*WSR*
pH	*6 to 9 units*	*EQS*
Benzene	*30 µg/l*	*EQS*
Toluene	*50 µg/l*	*EQS*
Ethylbenzene	*30 µg/l*	*EQS for benzene as a guide*
Xylene	*30 µg/l*	*EQS for benzene as a guide*
Naphthalene	*2.4 µg/l*	*EQS*
Benzo(a)pyrene	*0.05 µg/l*	*EQS*
Total PAH	*0.2 µg/l*	*DW1*
TPH (dissolved or emulsified hydrocarbons)	*50 µg/l*	*DW1*

There are no available generic assessment criteria for some of the analytical parameters which have been scheduled, for example hexavalent chromium, and individual TPH and PAH and some VOC compounds. These parameters will be assessed based on professional judgement should they exceed the limit of detection.

RISK ESTIMATION – GROUND GAS

Introduction

A variety of potentially hazardous gases occur in naturally in the ground environment. Microbial decay of organic matter under anaerobic conditions and geological processes can lead to the generation of Methane and Carbon Dioxide, but can also include traces gases such as Hydrogen sulphide and Carbon monoxide.

Methane is a colourless and odourless gas that has the hazardous properties of being flammable and, at certain air/Methane mixtures, explosive. Methane has a low toxicity, but can be a simple asphyxiant due to the displacement of oxygen.

Carbon Dioxide is a colourless, odourless and non-combustible gas that has the hazardous property of being a highly toxic chemical. At concentrations of 3% by volume, shortness of breath and headaches will occur becoming acute by 6%. At levels of above 10% by volume headache, visual distortion, tremors and rapid loss of consciousness occur. Concentrations of Carbon Dioxide above 22% by volume are likely to be fatal. The effects of Carbon Dioxide poisoning are made more severe if there is accompanying reduction in oxygen concentrations.

Hydrogen sulphide is a colourless and flammable gas that has an odour of rotten eggs. It is important to that the sense of smell is over powered at higher concentrations. The gas is toxic and can be an asphyxiant.

Carbon monoxide is a colourless, odourless and explosive gas in air mixtures that has the hazardous property of being a highly toxic chemical.

Radon is a naturally occurring colourless and odourless gas that is radioactive. It is formed by the radioactive decay of radium which in turn is derived from the radioactive decay of uranium, both of which are minerals that can be found in many soil types. Whilst it is recognised that the air inside every house contains radon, some houses built in certain defined areas of the country might have unacceptably high concentrations and require special precautions to be taken. The maps contained within BRE211:2007 'Radon: guidance on protective measures for new buildings' identify areas where no radon protection measures are necessary or where higher concentrations are present that either basic or full radon protection measures are required to be fitted to all new dwellings.

Basis of Gas Assessment

In order to classify the level of risk and need, if any, for gas protection measures at a site with the potential for a gas problem, consideration of each of the following is necessary:

- *The source of the gas.*
- *The generation potential of the gas.*
- *The location of the source and the geological setting.*
- *Boreholes flow rate and estimated surface emission rate.*
- *The nature of the proposed development.*
- *Confidence in the knowledge of the gas regime.*

The gas assessment is made with reference to 'C665 - Assessing risks posed by hazardous ground gases to buildings', Construction Industry Research and Information Association (CIRIA), 2007.

Gas Screening Value

The method within CIRIA C665 uses both the gas concentrations and borehole flow rates to define a characteristic situation for a site based on the limiting borehole gas volume flow for Methane and Carbon Dioxide. This limiting borehole gas volume flow is called the Gas Screening Value (GSV) and is expressed below:

Gas Screening Value (l /hr) = borehole flow rate (l/hr) x gas concentration (fraction)

The calculation of GSV is completed for both Methane and Carbon Dioxide and then the 'worse case' maximum values are used in the assessment. The assessment is to determine the gas regime at the site is dependent upon the nature of the development.

Situation A – All development types except low rise housing with gardens.

The characteristic situation for many sites is determined from evaluation of the Gas Screening Value derived against the criteria in the following table.

Characteristic situation	Risk classification	Gas Screening Value (CH4 or CO2 l/hr)	Additional factors	Typical sources of generation
1	Very low risk	<0.07	Typically Methane ≤1% and/or Carbon Dioxide ≤5%. Otherwise consider an increase to characteristic situation 2.	Natural soils with low organic matter content and 'typical' made ground.
2	Low risk	<0.7	Borehole air flow rate not to exceed 70 l/hr. Otherwise consider an increase to characteristic situation 3.	Natural soil with high organic peat/organic content and 'typical' made ground.
3	Moderate risk	<3.5		Old landfill, inert waste and flooded mine working.
4	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protection measures.	Mine working susceptible to flooding and landfill completed to WMP 26B criteria.
5	High risk	<70		Mine working unflooded inactive with shallow workings near surface.
6	Very high risk	>70		Recent landfill site.

Situation B - Low rise housing with gardens - NHBC 'Traffic Lights'

The NHBC model for low rise housing development considered a typical residential house with a ground floor area of 64m^2, suspended floor and ventilated sub-floor void of height 150mm. Where the proposed development of a site is consistent with this model, the NHBC traffic light situation of the site is determined from evaluation of the Gas Screening Value against the criteria in the following table.

Traffic Lights	Methane		Carbon Dioxide	
	Typical maximum concentrations (%)	Gas Screening Value (l/hr)	Typical maximum concentrations (%)	Gas Screening Value (l/hr)
Green	≤1	≤0.16	≤5	≤0.78
Amber 1	1> to ≤5	>0.16 to ≤0.63	>5 to ≤10	>0.78 to ≤1.56
Amber 2	5> to ≤20	>0.63 to ≤1.56	>10 to ≤30	>1.56 to ≤3.13
Red	>20	>1.56	>30	>3.13

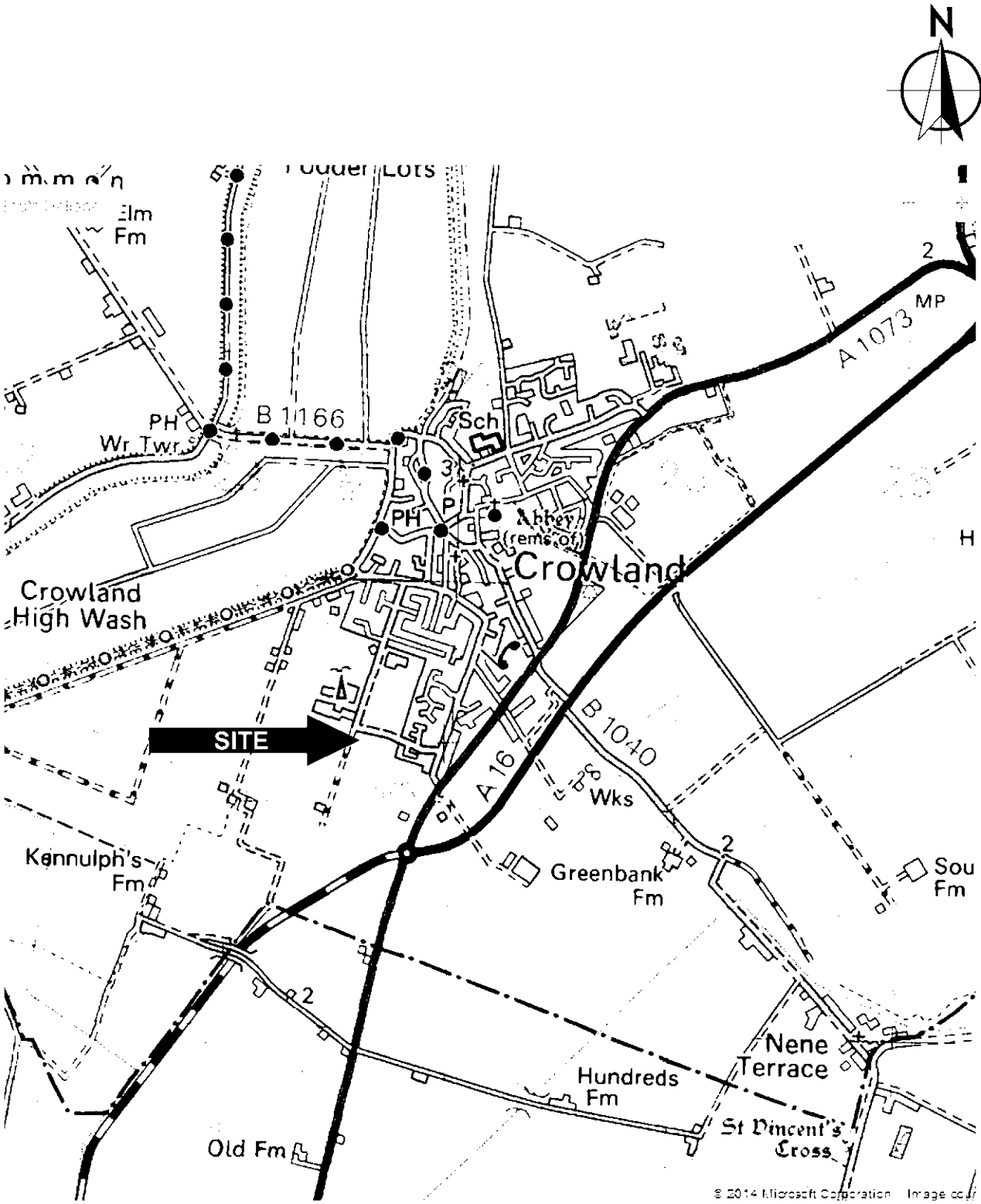
Situation B - Low rise housing with gardens - NHBC 'Traffic Lights'

The NHBC model for low rise housing development considered a typical residential house with a ground floor area of 64m^2, suspended floor and ventilated sub-floor void of height 150mm. Where the proposed development of a site is consistent with this model, the NHBC traffic light situation of the site is determined from evaluation of the Gas Screening Value against the criteria in the following table.

Traffic Lights	Methane		Carbon Dioxide	
	Typical maximum concentrations (%)	Gas Screening Value (l/hr)	Typical maximum concentrations (%)	Gas Screening Value (l/hr)
Green	≤1	≤0.16	≤5	≤0.78
Amber 1	1> to ≤5	>0.16 to ≤0.63	>5 to ≤10	>0.78 to ≤1.56
Amber 2	5> to ≤20	>0.63 to ≤1.56	>10 to ≤30	>1.56 to ≤3.13
Red	>20	>1.56	>30	>3.13

APPENDIX 1

Site Location Plan



Not to scale.

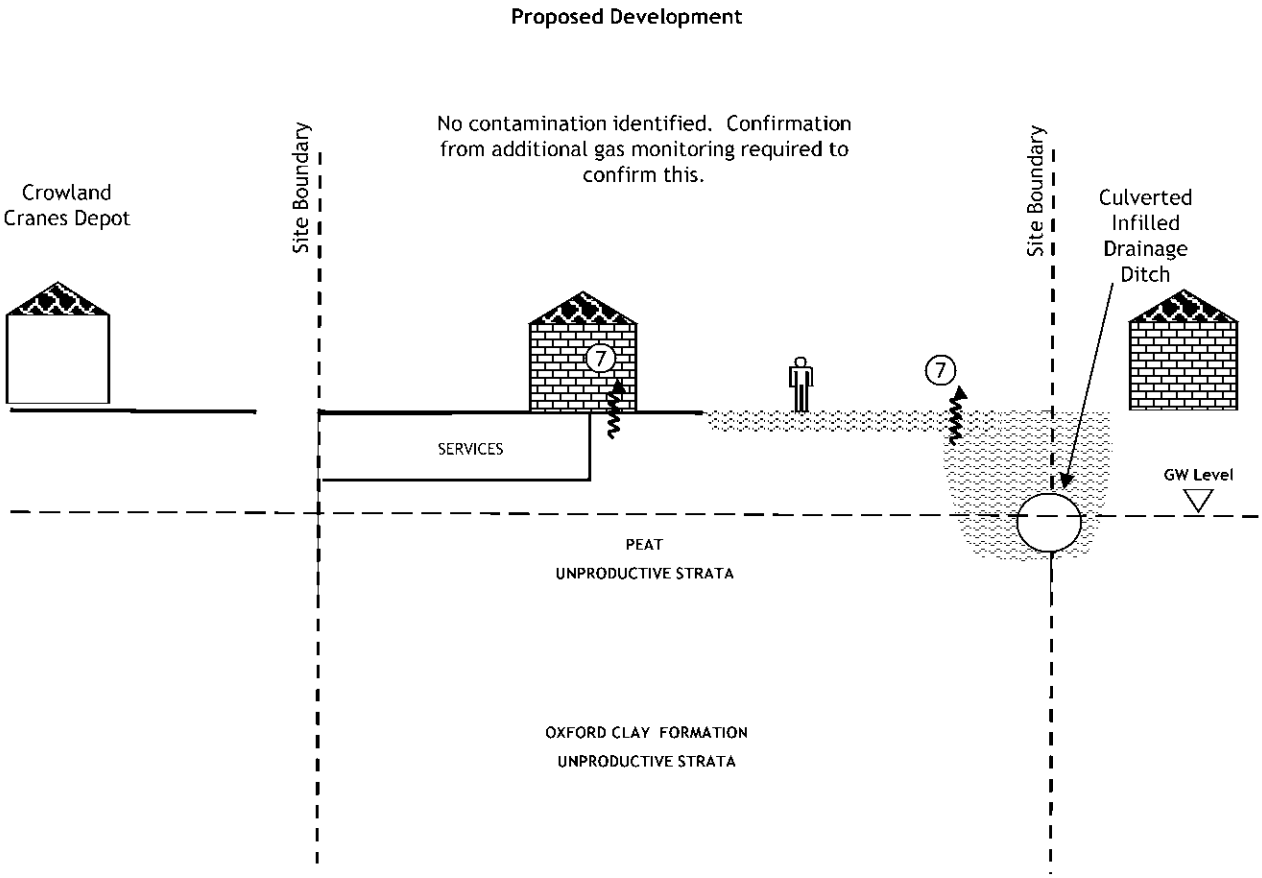
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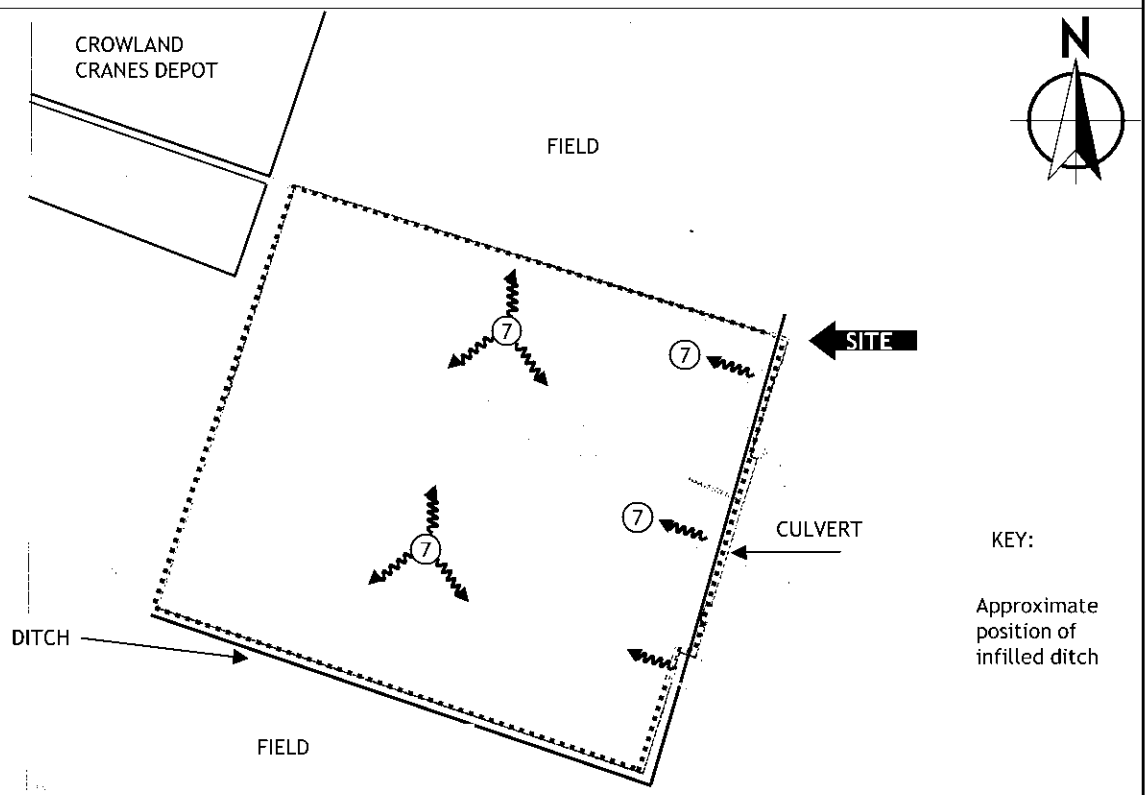
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Project Title:	Harvester Way, Crowland
Client:	Wheatley Homes
BRD Reference:	BRD2186-OP1-A
Date Issued:	July 2014

BRD
01295 272244
info@brduk.com

Revised Conceptual Model

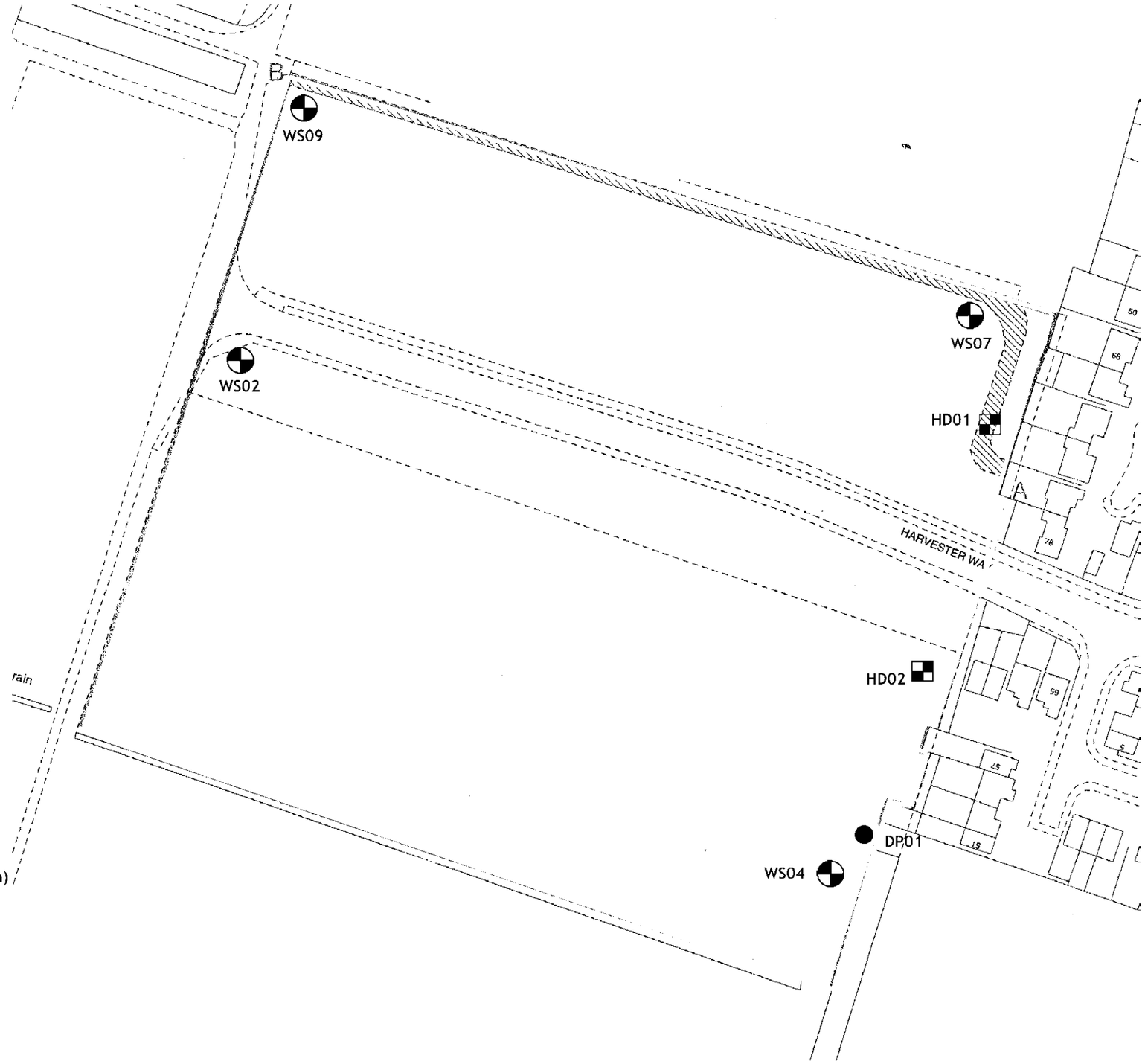




Project Title:	Harvester Way, Crowland
Client:	Wheatley Homes
BRD Reference:	BRD2186-OP6-A
Date Issued:	July 2014

BRD
01295 272244
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Exploratory Point Plan



Key:

HD Hand Dug Pit

WS Window Sample Borehole (With monitoring installtion)

DP Dynamic Probe

Reproduced from Lincolnshire: South Holland Drawing ref. LL20091 Dated 13TH Oct 2005

Not to scale.

All positions illustrative only.

Project Title:	Harvester Way, Crowland
Client:	Wheatley Homes
BRD Reference:	BRD2186-OP5-A
Date Issued:	July 2014

BRD
01295 272244
info@brduk.com

APPENDIX 2

PROBEHOLE RECORD

Client: Wheatley Homes
Project Title: Harvester Way, Crowlands
Project No: BRD2186
Logged By: I Hibberd
Date Commenced: 08/07/2014
Date Completed: 08/07/2014
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS01

Sheet 1 of 2

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.10	J1			MADE GROUND: Hard, dessicated, dark brown, sandy, silty, gravelly clay topsoil with some rare plant remains. gravel is fine subrounded flint.	0.20		MG	
				MADE GROUND: Firm, dark brown/ black, silty, slightly sandy peat with occasional shell fragments. Slight organic odour - possible. Rare ceramic fragments.			MADE GROUND	
0.60	J2							
0.70	D1				0.90			
1.00	SPT	1 N		Very loose, light brown with some grey, silty, clayey SAND. 1.00 m: SPT: 1,0/0,1,0,0	1.0		TIDAL FLAT DEPOSITS	
					1.30			
1.50	D2			Very soft, saturated, mottled, grey-brown slightly sandy CLAY.				
2.00	SPT	0 N			2.0 2.00			
				Very soft, saturated, dark grey orange CLAY. Gravel is fine to medium subrounded flint. Organic odour. 2.00 m: SPT: 1,0/0,0,0,0				
2.50	D3							
					2.70			
				Orange brown, silty, slightly gravelly SAND. gravel is fine to medium subrounded flint.	3.0 3.00			
3.00	SPT	8 N		Firm becoming stiff grey, mottled brown in places, CLAY with relict rootlets and occasional calcareous aggregations. 3.00 m: SPT: 1,2/2,2,2,2			OXFORD CLAY FORMATION	
3.60	D4							
4.00	SPT J3	14 N		4.00 m: SPT: 3,3/3,3,4,4	4.0			
					4.50			

General Remarks:
Terminated at 5.45m bgl.
Backfilled with arisings. Casing to 3.00m bgl.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:25

BRD
Telephone: 01295 272244
Fax: 01295 270098

PROBEHOLE RECORD

Client: Wheatley Homes
Project Title: Harvester Way, Crowlands
Project No: BRD2186
Logged By: I Hibberd
Date Commenced: 08/07/2014
Date Completed: 08/07/2014
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS01

Sheet 2 of 2

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
5.00	SPT	17 N		Continued from 3.00m: Firm becoming stiff grey, mottled brown in places, CLAY with relict rootlets and occasional calcareous aggregations. 5.00 m: SPT: 3,3/4,4,4,5	5.0 5.45 6.0 7.0 8.0 9.0		OXFORD CLAY FORMATION	

General Remarks:
Terminated at 5.45m bgl.
Backfilled with arisings. Casing to 3.00m bgl.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:25

BRD
Telephone: 01295 272244
Fax: 01295 270098

PROBEHOLE RECORD

Client: Wheatley Homes
Project Title: Harvester Way, Crowlands
Project No: BRD2186
Logged By: I Hibberd
Date Commenced: 08/07/2014
Date Completed: 08/07/2014
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS02

Sheet 1 of 2

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.20	J1			TOPSOIL: Soft, dark brown, friable, sandy, slightly gravelly clay. Gravel is fine, subrounded with plant roots.	0.30		TS	
0.70	J2			Firm, brown with some orange and grey mottling, CLAY.				
0.80	D1							
1.00	SPT	1 N		1.00 m: SPT: 1,0/0,1,0,0 1.00 m: Becoming very soft and silty.	1.0			
				Very soft, black, sandy, silty PEAT with some decomposing plant remains. Slight organic odour.	1.40 1.60		TIDAL FLAT DEPOSITS	
1.80	D2			Very soft to soft, saturated, grey-brown with occasional black specks. Slightly organic, slightly gravelly, sandy CLAY. Gravel is fine to medium subangular to subrounded flint.				
2.00	SPT	4 N		2.00 m: SPT: 1,1/1,1,1,1	2.0			
				Firm to stiff, brown to grey mottled, sandy, slightly gravelly CLAY with occasional sandy lenses. Gravel is fine to medium, subangular to subrounded flint.	2.30			
2.60	D3							
3.00	SPT	14 N		3.00 m: SPT: 2,2/3,3,4,4	3.0			
				3.20 - 3.30 m: Lens of yellow sandy gravel of fine to medium, subangular to subrounded flint.	3.30			
				Firm to stiff, grey with some light brown mottling, CLAY with occasional relict root remains.			OXFORD CLAY FORMATION	
4.00	SPT	17 N		4.00 m: SPT: 3,4/4,4,4,5 4.00 m: Becoming slightly grey clay. 4.20 m: Fossil fragments.	4.0			
					4.50			

General Remarks:
Terminated at 5.45m bgl.
Fitted with gas and groundwater monitoring pipe and flush metal cover. Casing to 3.00m bgl.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:25

BRD
Telephone: 01295 272244
Fax: 01295 270098

PROBEHOLE RECORD

Client: Wheatley Homes
Project Title: Harvester Way, Crowlands
Project No: BRD2186
Logged By: I Hibberd
Date Commenced: 08/07/2014
Date Completed: 08/07/2014
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS02

Sheet 2 of 2

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
4.60	D4			Continued from 4.00m: Firm to stiff, slightly grey with some light brown mottling, CLAY with occasional relict root remains.	5.0		OXFORD CLAY FORMATION	
5.00	SPT	20 N		5.00 m: SPT: 4,4/5,5,5,5	5.45			
					6.0			
					7.0			
					8.0			
					9.0			

General Remarks:
Terminated at 5.45m bgl.
Fitted with gas and groundwater monitoring pipe and flush metal cover. Casing to 3.00m bgl.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:25

BRD
Telephone: 01295 272244
Fax: 01295 270098

PROBEHOLE RECORD

Client: Wheatley Homes
Project Title: Harvester Way, Crowlands
Project No: BRD2186
Logged By: I Hibberd
Date Commenced: 08/07/2014
Date Completed: 08/07/2014
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS03

Sheet 1 of 1

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.20	J1			TOPSOIL: Hard, dessicated, dark brown/black, very sandy, slightly silty clay. Gravel is fine, subangular to subrounded flint.	0.30		TS	
				Firm, grey brown with orange, very sandy, slightly silty CLAY. Gravel is fine, subangular to subrounded flint.	0.50		TIDAL FLAT DEPOSITS	
0.70	D1			Light brown with some orange mottling, clayey, very silty SAND/ sandy SILT.	1.0 1.00			
1.00	SPT	8 N		Loose, saturated, light brown with grey orange mottling. Sandy SILT. 1.00 m: SPT: 1,2/2,2,2,2				
1.60	D2							
2.00	SPT	1 N		2.00 m: SPT: 1,0/0,1,0,0 2.00 m: Becoming very loose.	2.0			
					2.50			
2.60	D3			Very loose saturated, dark grey, organic, sandy SILT/ very silty fine SAND with occasional black orange lenses and shell fragments and organic odour.				
2.80	J2							
3.00	SPT	0 N		3.00 m: SPT: 1,0/0,0,0,0	3.0			
					3.50			
				Medium dense, light grey, silty SAND.				
4.00	SPT	16 N		4.00 m: SPT: 2,2/3,4,4,5	4.0			
					4.45			

General Remarks:
Terminated at 4.45m bgl due to blowing sand.
Backfilled with arisings. Casing to 4.00m bgl.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:25

BRD
Telephone: 01295 272244
Fax: 01295 270098

PROBEHOLE RECORD

Client: Wheatley Homes
Project Title: Harvester Way, Crowlands
Project No: BRD2186
Logged By: I Hibberd
Date Commenced: 08/07/2014
Date Completed: 08/07/2014
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS04

Sheet 1 of 2

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.10	J1			TOPSOIL: soft dark brown/ black, very organic, sandy peat.	0.20		TS	
				Firm, light grey with some orange brown, very sandy CLAY.			TIDAL FLAT DEPOSITS	
0.60	J2				0.70			
				Light brown with some orange mottling, clayey, very silty SAND/ sandy SILT.	1.0 1.00			
1.00	SPT	4 N		Very loose to loose, light brown with grey orange mottling, sandy SILT. 1.00 m: SPT: 1,1/1,1,1,1 1.20 m: Saturated.				
1.50	D1							
2.00	SPT	3 N		2.00 m: SPT: 1,1/2,1,0,0 2.00 m: Becoming very loose.	2.0			
2.20	B1			Very loose to loose, saturated, dark grey, organic, slightly silty fine SAND with occasional black orange lenses and shell fragments and organic odour.	2.20			
3.00	SPT	0 N		3.00 m: SPT: 1,0/0,0,0,0	3.0			
4.00	SPT	6 N		4.00 m: SPT: 1,2/1,2,1,2	4.0			
					4.50			

General Remarks:
Terminated at 7.00m bgl. Unable to drill further due to slow progress and blowing sands. Casing to 7.00m bgl. Borehole collpased so unable to install.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:25

BRD
Telephone: 01295 272244
Fax: 01295 270098

PROBEHOLE RECORD

Client: Wheatley Homes
Project Title: Harvester Way, Crowlands
Project No: BRD2186
Logged By: I Hibberd
Date Commenced: 08/07/2014
Date Completed: 08/07/2014
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS04

Sheet 2 of 2

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
				Continued from 2.20m: Dark grey, organic, sandy SILT/ very silty fine SAND with occasional black orange lenses and shell fragments and organic odour.	5.0			
5.00	SPT	2 N		5.00 m: SPT: 1,1/0,1,1,0				
5.50	D2			Medium dense, saturated, dark grey organic sandy SILT / very silty fine SAND with occasional black / orange lenses, sheel fragments and organic odour.	5.50		TIDAL FLAT DEPOSITS	
6.00	SPT	23 N		6.00 m: SPT: 3,3/4,5,7,7	6.0			
					7.0			
					7.00			
					8.0			
					9.0			

General Remarks:
Terminated at 7.00m bgl. Unable to drill further due to slow progress and blowing sands. Casing to 7.00m bgl. Borehole collpased so unable to install.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:25

BRD
Telephone: 01295 272244
Fax: 01295 270098

PROBEHOLE RECORD

Client: Wheatley Homes
Project Title: Harvester Way, Crowlands
Project No: BRD2186
Logged By: I Hibberd
Date Commenced: 08/07/2014
Date Completed: 08/07/2014
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS05

Sheet 1 of 1

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
				TOPSOIL: Soft dark brown/ black, very organic, sandy peat.	0.20		TS	
				Firm, light grey with some orange brown, very sandy CLAY.	0.80		TIDAL FLAT DEPOSITS	
				Light brown with grey orange mottling, sandy SILT / fine SAND.	1.0 2.0			
				Dark grey, organic, sandy SILT/ very silty fine SAND with occasional black orange lenses, shell fragments and organic odour.	2.40 3.0 4.0			
					4.00			

General Remarks:
Terminated at 4.00m bgl.
Borehole drilled adjacent to WS04 to install gas and groundwater monitoring pipe and flush metal cover.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:25

BRD
Telephone: 01295 272244
Fax: 01295 270098

PROBEHOLE RECORD

Client: Wheatley Homes
Project Title: Harvester Way, Crowlands
Project No: BRD2186
Logged By: I Hibberd
Date Commenced: 08/07/2014
Date Completed: 08/07/2014
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS06

Sheet 1 of 1

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.10	J1			TOPSOIL: Soft dark brown/ black, very organic, sandy peat.	0.20		TS	
0.50	J2			Soft, laminated, grey brown with some orange, very sandy CLAY with occasional organic odour.			TIDAL FLAT DEPOSITS	
0.70	D1							
1.00	SPT B1	4 N			1.0 1.00			
				Very loose to loose, brown to mottled orange, very sandy SILT / silty SAND. 1.00 m: Saturated from 1.00m bgl. 1.00 m: SPT: 1,1/1,1,1,1				
2.00	SPT	5 N		2.00 m: SPT: 1,1/1,1,1,2	2.0			
					2.50			
2.60	D2			Very loose, dark brown, silty, fine SAND/ very sandy SILT with occasional black organic lenses, shell fragments and organic odour.				
3.00	SPT	3 N		3.00 m: SPT: 1,0/0,1,1,1	3.0			
3.50	J3							
4.00	SPT	0 N		4.00 m: SPT: 1,0/0,0,0,0	4.0			
					4.45			

General Remarks:
Terminated at 4.45m bgl.
Backfilled with arisings.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:25

BRD
Telephone: 01295 272244
Fax: 01295 270098

PROBEHOLE RECORD

Client: Wheatley Homes
Project Title: Harvester Way, Crowlands
Project No: BRD2186
Logged By: I Hibberd
Date Commenced: 08/07/2014
Date Completed: 08/07/2014
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS07

Sheet 1 of 1

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.20	J1			MADE GROUND: Soft brown/black, sandy, gravelly peat topsoil. Gravel is fine to coarse subangular to angular brick and concrete.	0.30		MG	
0.80	J2			Soft, laminated, grey brown with some orange, very sandy CLAY with occasional organic odours.	0.90			
1.00	SPT	4 N		Very loose to loose, brown to mottled orange, very sandy SILT / silty SAND. 1.00 m: SPT: 1,0/1,1,1,1 1.10 m: Wet from 1.10m bgl.	1.0			
1.50	J3							
1.70	D1							
2.00	SPT	4 N		2.00 m: SPT: 1,1/1,1,1,1	2.0		TIDAL FLAT DEPOSITS	
2.50	D2			Very soft, saturated, grey with some black organic lenses, very sandy SILT / very loose silty SAND.	2.30			
3.00	SPT	0 N		3.00 m: SPT: 1,0/0,0,0,0	3.0			
				Very loose, saturated, grey with some black organic lenses, very silty SAND / very sandy SILT (Wet soils).	3.10			
4.00	SPT	0 N		4.00 m: SPT: 1,0/0,0,0,0	4.0			
					4.45			

General Remarks:
Terminated at 4.45m bgl.
Borehole fitted with gas and groundwater monitoring pipe and flush metal cover.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:25

BRD
Telephone: 01295 272244
Fax: 01295 270098

PROBEHOLE RECORD

Client: Wheatley Homes
Project Title: Harvester Way, Crowlands
Project No: BRD2186
Logged By: I Hibberd
Date Commenced: 08/07/2014
Date Completed: 08/07/2014
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS08

Sheet 1 of 1

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.10	J1			MADE GROUND: Grass over brown, very gravelly, sandy topsoil. gravel is fine to coarse, subangular to angular brick, concrete and flint.	0.30		MG	
				Inferred as very soft CLAY. 0.30 - 1.00 m: 0% recovery due to concrete obstruction from surface.	1.0 1.00		TIDAL FLAT DEPOSITS	
1.00	SPT	0 N		Very soft, brown, with mottled dark grey, CLAY with occasional relict roots and organic plant remains. 1.00 m: SPT: 1,0/0,0,0,0				
1.50	D1							
2.00	SPT	0 N		2.00 m: SPT: 1,0/0,0,0,0	2.0			
				Very soft, black, sandy PEAT.	2.20			
				Very soft, dark grey, very organic, slightly gravelly CLAY with some relict plant remains with some organic odour. Gravel is fine to medium, subangular flint.	2.40			
2.60	D2				2.90			
3.00	SPT D3	5 N		Loose, grey, coarse SAND and fine subrounded flint gravel. 3.00 m: SPT: 1,2/1,2,1,1	3.0			
				Firm, mottled, grey brown, slightly gravelly CLAY. Gravel is fine to medium, subangular to subrounded flint.	3.10			
					3.40			
3.50	J2			Stiff, grey with some brown, mottled CLAY with relict rootlets.			OXFORD CLAY FORMATION	
4.00	SPT	10 N		4.00 m: SPT: 2,2/2,2,3,3	4.0			
					4.45			

General Remarks:
Terminated at 4.45m bgl.
Backfilled with arisings.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:25

BRD
Telephone: 01295 272244
Fax: 01295 270098

PROBEHOLE RECORD

Client: Wheatley Homes
Project Title: Harvester Way, Crowlands
Project No: BRD2186
Logged By: I Hibberd
Date Commenced: 08/07/2014
Date Completed: 08/07/2014
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS09

Sheet 1 of 2

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.20	J1			TOPSOIL: Grass over hard, dessicated, brown, very sandy, slightly gravelly clay. Gravel is fine to medium, subangular flint.	0.30		TS	
0.50	J2			Firm, grey with some brown and yellow mottling, slightly sandy, organic CLAY with organic plant remains.			TIDAL FLAT DEPOSITS	
0.80	D1			0.60 m: Becoming soft.				
1.00	SPT	0 N		0.80 m: Becoming very soft.	1.0			
				1.00 m: SPT: 1,0/0,0,0,0	1.40			
				Soft, black, sandy PEAT.	1.50			
				Very soft, light brown and grey, very sandy, very gravelly CLAY. gravel is fine to medium, subangular to subrounded flint.				
2.00	SPT	8 N		2.00 m: SPT: 1,2/2,2,2,2	2.0			
				2.10 m: becoming stiff.				
2.60	D2							
3.00	SPT	9 N		3.00 m: SPT: 2,2/2,2,2,3	3.0			
				Firm to stiff, grey with some brown, mottled CLAY with relict rootlets.	3.10		OXFORD CLAY FORMATION	
3.80	D3			3.80 m: Occasional fragments of medium siltstone gravel.				
4.00	SPT	14 N		4.00 m: SPT: 2,3/3,3,4,4	4.0			
4.20	J3			4.10 m: Becoming stiff, light grey CLAY with occasional silty partings.				

General Remarks:
Terminated at 5.54m bgl.
Borehole fitted with gas and groundwater monitoring pipe and flush metal cover.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:25

BRD
Telephone: 01295 272244
Fax: 01295 270098

PROBEHOLE RECORD

Client: Wheatley Homes
Project Title: Harvester Way, Crowlands
Project No: BRD2186
Logged By: I Hibberd
Date Commenced: 08/07/2014
Date Completed: 08/07/2014
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS09

Sheet 2 of 2

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
5.00	SPT	22 N		Continued from 3.10m: Firm to stiff, grey with some brown, mottled CLAY with relict rootlets. 5.00 m: SPT: 3,4/5,5,6,6	5.0 5.45 6.0 7.0 8.0 9.0		OXFORD CLAY FORMATION	

General Remarks:
Terminated at 5.54m bgl.
Borehole fitted with gas and groundwater monitoring pipe and flush metal cover.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:25

BRD
Telephone: 01295 272244
Fax: 01295 270098

INSPECTION PIT RECORD

Client:	Wheatley Homes
Project Title:	Harvester Way, Crowland
Project No:	BRD 2186
Logged By:	D Brown
Date Completed:	22/07/2014
Method Used:	Hand Dug

Pit No.

HD01

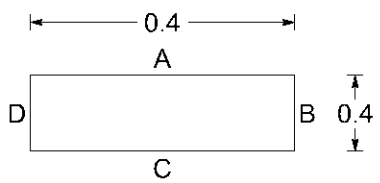
Sheet 1 of 1

Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
			MADE GROUND: Grass over, dark brown, clayey, very sandy topsoil. Gravel of fine to coarse, subrounded flint with occasional rootlets.			
0.20	J1		MADE GROUND: Soft, dark brown, very sandy, slightly gravelly clay. Gravel of fine to medium subrounded flint.	0.20 ()	MG	
			MADE GROUND: Concrete.	0.40 () 0.42 ()		

Pit Stability: Generally stable throughout
Groundwater: Not encountered

Surface Elevation Level:

Plan of Inspection Pit:



General Remarks:
Hand dug pit terminated at 0.40m bgl due to being unable penetrate through concrete obstruction.
Excavated to obtain additional surface samples.

All dimensions in metres
Log Scale 1:10

BRD
Telephone: 01295 272244
Fax: 01295 270098

INSPECTION PIT RECORD

Client:	Wheatley Homes
Project Title:	Harvester Way, Crowland
Project No:	BRD 2186
Logged By:	D Brown
Date Completed:	22/07/2014
Method Used:	Hand Dug

Pit No.

HD02

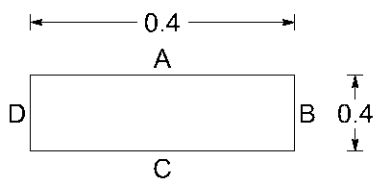
Sheet 1 of 1

Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.20	J1		POSSIBLE MADE GROUND: Grass over, dark brown, very sandy, slightly gravelly, clay. Gravel of fine to coarse subrounded flint with occasional rootlets.	0.40 ()	MADE GROUND	
0.50	J2		POSSIBLE MADE GROUND: Soft, light brown, very sandy, slightly gravelly clay. Gravel of fine to medium subrounded flint.	0.60 ()		
				1		

Pit Stability: Generally stable throughout
Groundwater: Not encountered

Surface Elevation Level:

Plan of Inspection Pit:



General Remarks:
Hand dug pit excavated to obtain additional surface samples.

All dimensions in metres
Log Scale 1:10

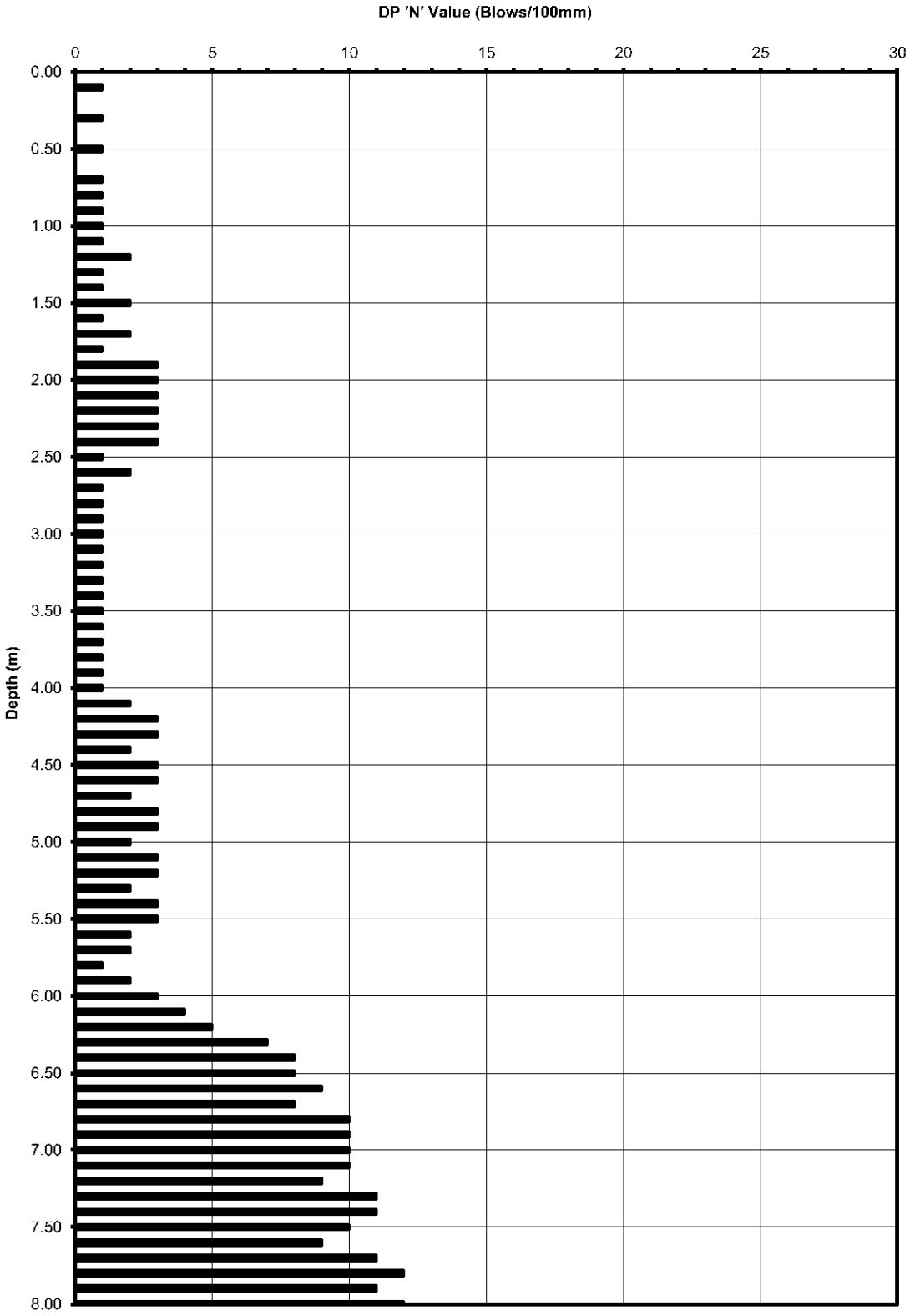
BRD
Telephone: 01295 272244
Fax: 01295 270098

DYNAMIC PROBE TEST RESULTS

Client Name: Wheatley Homes
Project Name: Harvester Way, Crowland
Project Number: BRD2186
Date: 09/07/2014

DP01
Sheet 1 of 1

Torque (Nm)	Depth (m)	Blows/ 100mm
	0.00	
	0.10	1
	0.20	0
	0.30	1
	0.40	0
	0.50	1
	0.60	0
	0.70	1
	0.80	1
	0.90	1
	1.00	1
	1.10	1
	1.20	2
	1.30	1
	1.40	1
	1.50	2
	1.60	1
	1.70	2
	1.80	1
	1.90	3
	2.00	3
	2.10	3
	2.20	3
	2.30	3
	2.40	3
	2.50	1
	2.60	2
	2.70	1
	2.80	1
	2.90	1
	3.00	1
	3.10	1
	3.20	1
	3.30	1
	3.40	1
	3.50	1
	3.60	1
	3.70	1
	3.80	1
	3.90	1
	4.00	1
	4.10	2
	4.20	3
	4.30	3
	4.40	2
	4.50	3
	4.60	3
	4.70	2
	4.80	3
	4.90	3
	5.00	2
	5.10	3
	5.20	3
	5.30	2
	5.40	3
	5.50	3
	5.60	2
	5.70	2
	5.80	1
	5.90	2
	6.00	3
	6.10	4
	6.20	5
	6.30	7
	6.40	8
	6.50	8
	6.60	9
	6.70	8
	6.80	10
	6.90	10
	7.00	10
	7.10	10
	7.20	9
	7.30	11
	7.40	11
	7.50	10
	7.60	9
	7.70	11
	7.80	12
	7.90	11
	8.00	12



Comments:

1. Supervised by: Ian Hibberd
2. Ground Level: Not surveyed
3. Equipment type: Super Heavy (full) - DPSH-B
4. Hammer Weight (kg): 63.5
5. Drop Height (mm): 750
6. Type of cone Sacrificial

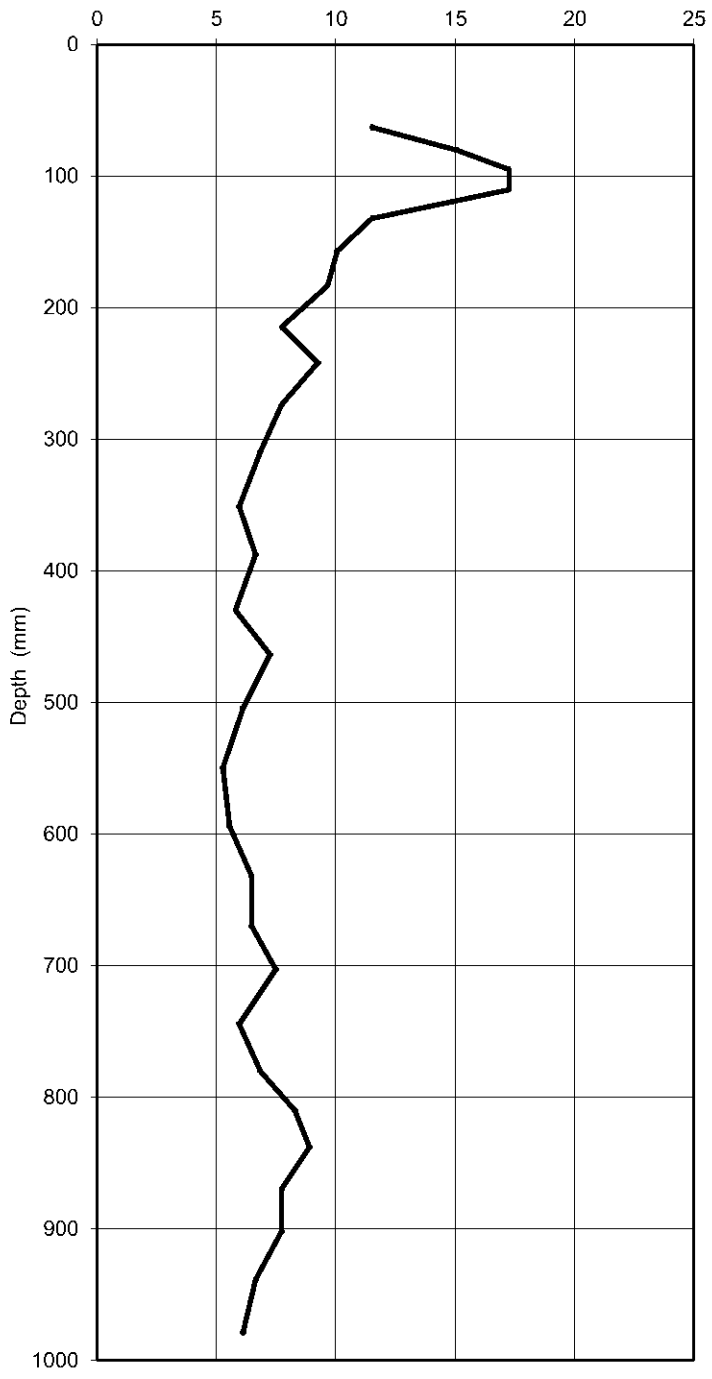
BRD
01295 272244
info@brduk.com

TRL DYNAMIC CONE PENETROMETER TEST

Client Name:	Wheatley Homes Ltd	**Test No:**
Project Name:	Harvester Way, Crowland	**TRL01**
Project No:	BRD2186	
Tested By:	I Hibberd	
Date:	08/07/2014	

Blow Count	Depth (mm)	mm per blow	CBR %
0	41	0	-
1	63	22	12
2	80	17	15
3	95	15	17
4	110	15	17
5	132	22	12
6	157	25	10
7	183	26	9.6
8	215	32	7.7
9	242	27	9.3
10	274	32	7.7
11	310	36	6.8
12	351	41	6.0
13	388	37	6.6
14	430	42	5.8
15	464	34	7.3
16	504	40	6.1
17	550	46	5.3
18	594	44	5.5
19	632	38	6.5
20	670	38	6.5
21	703	33	7.5
22	744	41	6.0
23	780	36	6.8
24	810	30	8.3
25	838	28	8.9
26	870	32	7.7
27	902	32	7.7
28	939	37	6.6
29	979	40	6.1

Plot of CBR (%) against Depth (mm)



Notes:

California Bearing Ratio (CBR) values calculated on the basis of *Operating instructions for the TRL dynamic cone penetrometer (2nd ed)*. Transport Research Laboratory, 1991, wherein:

$\text{Log}_{10}(\text{CBR}) = 2.48 - 1.057 \log_{10}(\text{penetration rate})$

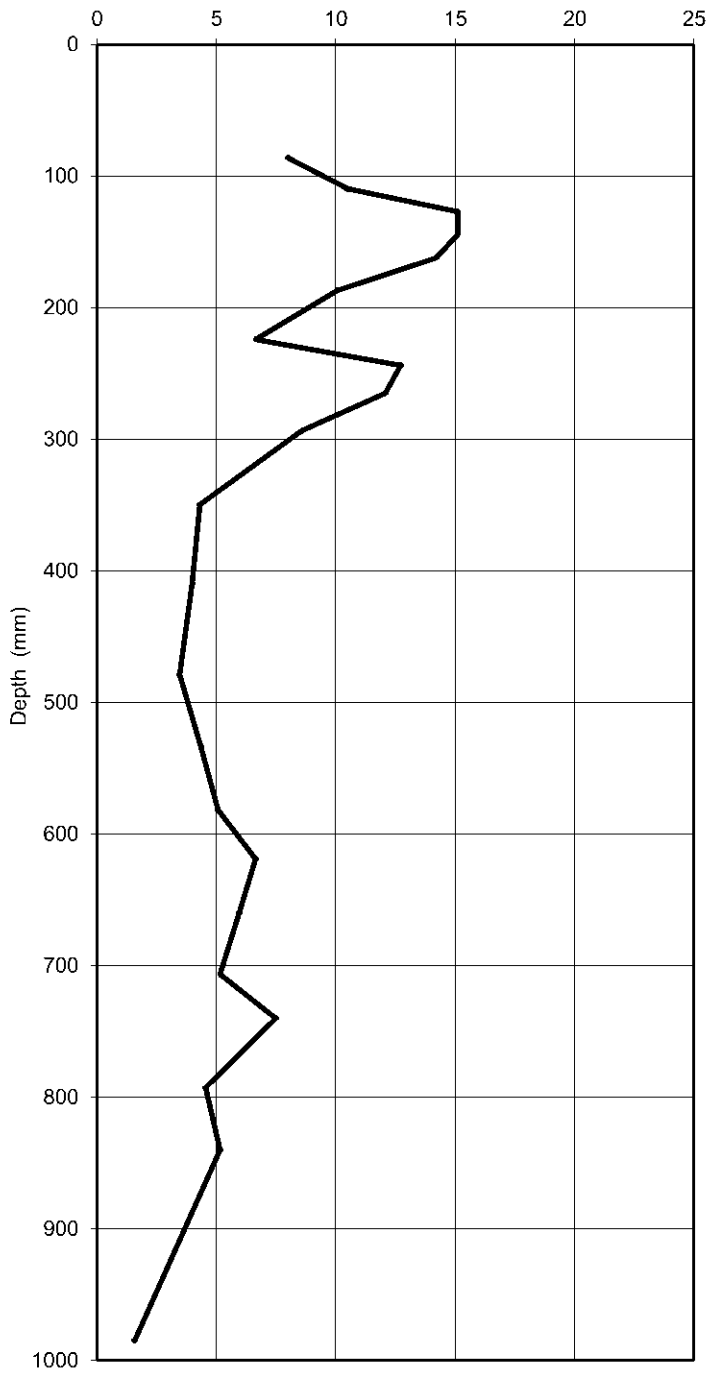
Values more than 25% CBR are plotted as 25% CBR.

TRL DYNAMIC CONE PENETROMETER TEST

Client Name:	Wheatley Homes Ltd	**Test No:**
Project Name:	Harvester Way, Crowland	**TRL02**
Project No:	BRD2186	
Tested By:	I Hibberd	
Date:	08/07/2014	

Blow Count	Depth (mm)	mm per blow	CBR %
0	55	0	-
1	86	31	8.0
2	110	24	10
3	127	17	15
4	144	17	15
5	162	18	14
6	187	25	10
7	224	37	6.6
8	244	20	13
9	265	21	12
10	294	29	8.6
11	350	56	4.3
12	410	60	4.0
13	479	69	3.4
14	534	55	4.4
15	582	48	5.0
16	619	37	6.6
17	660	41	6.0
18	707	47	5.2
19	740	33	7.5
20	793	53	4.5
21	840	47	5.2
22	985	145	1.6

Plot of CBR (%) against Depth (mm)



Notes:

California Bearing Ratio (CBR) values calculated on the basis of *Operating instructions for the TRL dynamic cone penetrometer (2nd ed)*. Transport Research Laboratory, 1991, wherein:

$\text{Log}_{10}(\text{CBR}) = 2.48 - 1.057 \log_{10}(\text{penetration rate})$

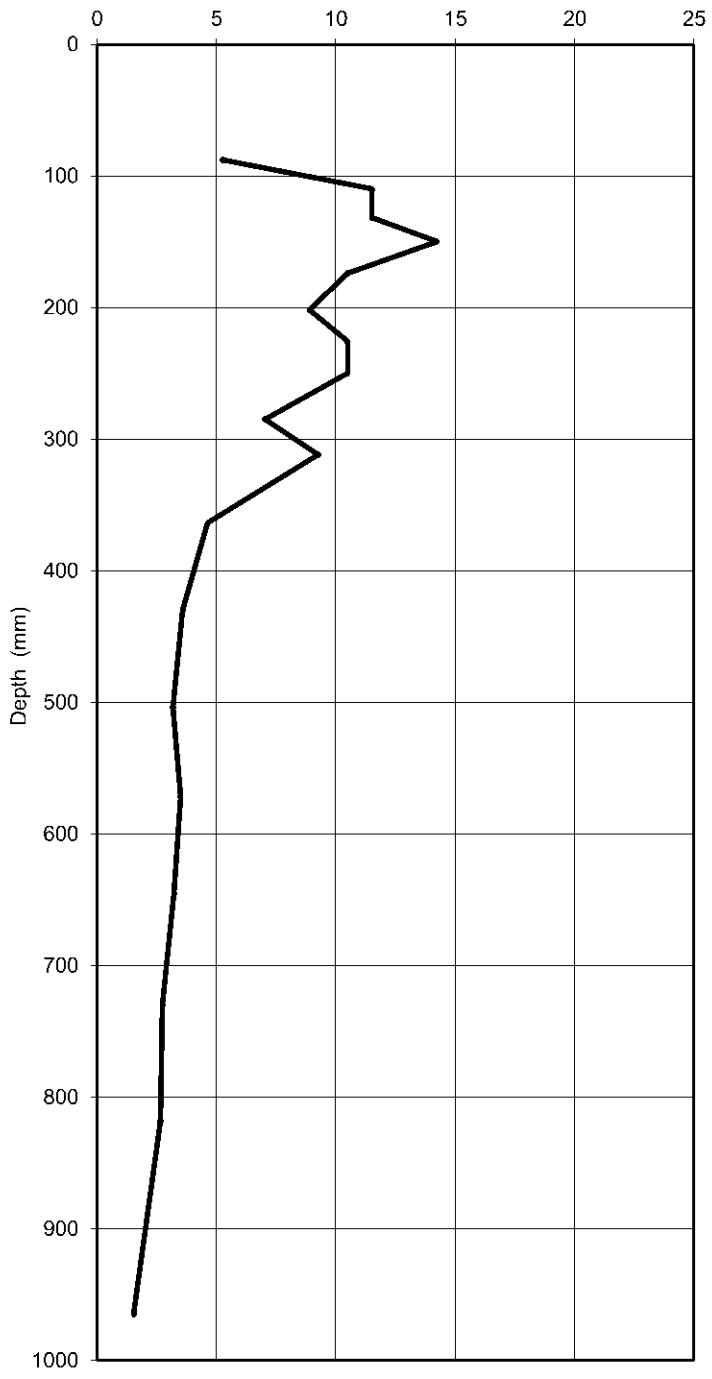
Values more than 25% CBR are plotted as 25% CBR.

TRL DYNAMIC CONE PENETROMETER TEST

Client Name:	Wheatley Homes Ltd	**Test No:**
Project Name:	Harvester Way, Crowland	**TRL03**
Project No:	BRD2186	
Tested By:	I Hibberd	
Date:	09/07/2014	

Blow Count	Depth (mm)	mm per blow	CBR %
0	42	0	-
1	88	46	5.3
2	110	22	12
3	132	22	12
4	150	18	14
5	174	24	10
6	202	28	8.9
7	226	24	10
8	250	24	10
9	285	35	7.0
10	312	27	9.3
11	364	52	4.6
12	430	66	3.6
13	504	74	3.2
14	572	68	3.5
15	645	73	3.2
16	730	85	2.8
17	818	88	2.7
18	965	147	1.5

Plot of CBR (%) against Depth (mm)



Notes:

California Bearing Ratio (CBR) values calculated on the basis of *Operating instructions for the TRL dynamic cone penetrometer (2nd ed)*. Transport Research Laboratory, 1991, wherein:

$\text{Log}_{10}(\text{CBR}) = 2.48 - 1.057 \log_{10}(\text{penetration rate})$

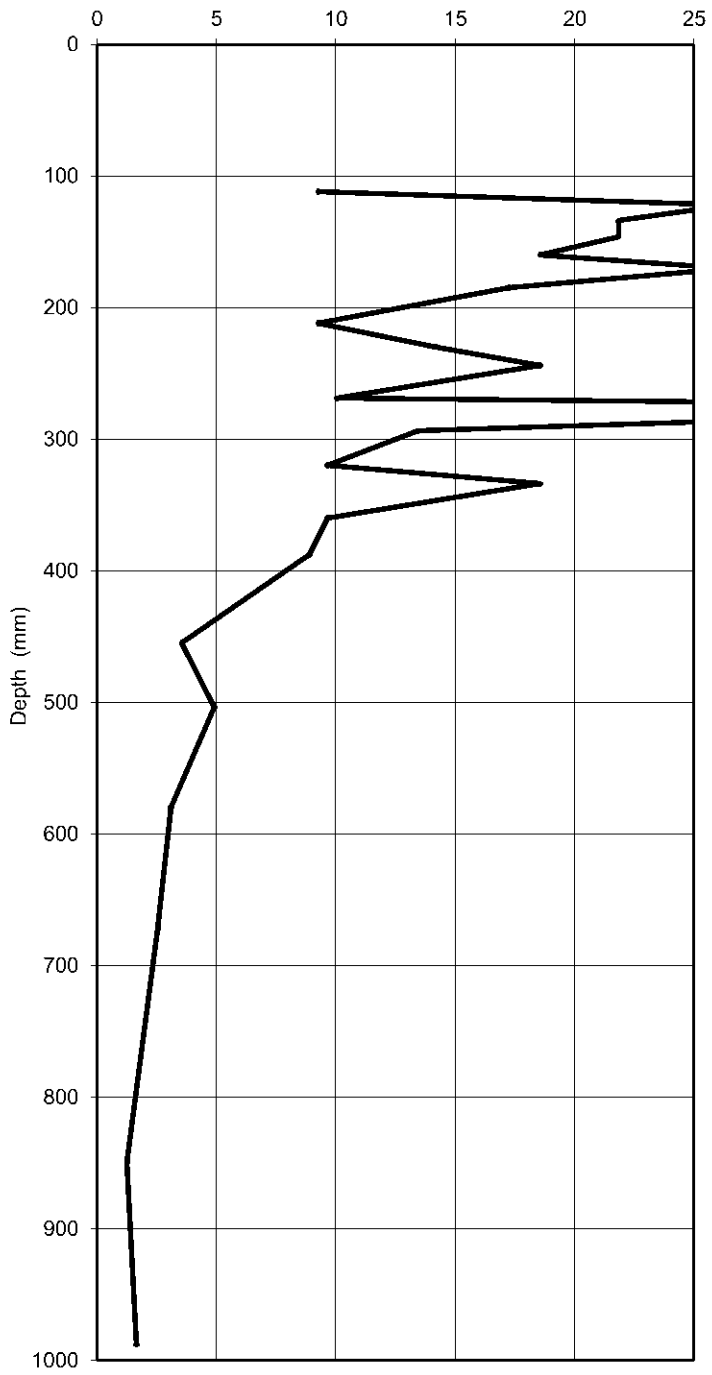
Values more than 25% CBR are plotted as 25% CBR.

TRL DYNAMIC CONE PENETROMETER TEST

Client Name:	Wheatley Homes Ltd	**Test No:**
Project Name:	Harvester Way, Crowland	**TRL04**
Project No:	BRD2186	
Tested By:	I Hibberd	
Date:	09/07/2014	

Blow Count	Depth (mm)	mm per blow	CBR %
0	85	0	-
1	112	27	9.3
2	122	10	26
3	134	12	22
4	146	12	22
5	160	14	19
6	170	10	26
7	185	15	17
8	212	27	9.3
9	230	18	14
10	244	14	19
11	269	25	10
12	275	6	45
13	294	19	13
14	320	26	9.6
15	334	14	19
16	360	26	9.6
17	388	28	8.9
18	455	67	3.5
19	504	49	4.9
20	580	76	3.1
21	672	92	2.5
22	850	178	1.3
23	988	138	1.7

Plot of CBR (%) against Depth (mm)



Notes:

California Bearing Ratio (CBR) values calculated on the basis of *Operating instructions for the TRL dynamic cone penetrometer (2nd ed)*. Transport Research Laboratory, 1991, wherein:

$\text{Log}_{10}(\text{CBR}) = 2.48 - 1.057 \log_{10}(\text{penetration rate})$

Values more than 25% CBR are plotted as 25% CBR.

Gas Monitoring Record

Project Name: Harvester Way, Crowland
Client: Wheatley Homes
Project No: BRD2186

Date:	15/07/2014	Ground conditions:	Damp on grassy areas. Dry on hardstanding.	Recorded by:	Dan Brown
Time at start:	11:00 AM	Weather conditions:	Clear and warm.	Pressure trend:	Rising
Time at finish:	12:00 PM	Air Temperature (^{o}C):	22	Monitor serial no:	G501315

The gas monitoring equipment is a Geotech GA5000 portable analyser. As per manufacturers recommendations this is factory calibrated every six months and in addition BRD undertake calibration checks against bottled standard gases on at least a monthly basis. Gas monitor pump is run for three minutes unless otherwise stated and the steady readings are an average reading taken over this pump run time. Vapour monitoring equipment is either aminiRAE 2000 PGM-7600 or miniRAE lite PGM-7350 Photo Ionisation Detector (PID) with 10.6 eV lamp calibrated for isobutylene. PID calibration check is performed on site against ambient air and also against a 100ppm isobutylene standard gas. Barometric pressure trend and ambient air temperature is recorded from weather websites at the nearest reported weather station.

CH_4 = Methane CO_2 = Carbon Dioxide O_2 = Oxygen H_2S = Hydrogen Sulphide CO = Carbon Monoxide NR = Not Recorded PID = Photo Ionisation Detector

GWL = Groundwater level measured from ground surface and top of standpipe. Base = Base of standpipe measured from ground surface.

Monitoring point				Gas Concentration								Pressure	Flow rate	Vapour	Comments
				Steady			Peak		Minimum	Peak					
Borehole	GWL Ground (m)	GWL Pipe (m)	Base Ground (m)	CH_4 (%)	CO_2 (%)	O_2 (%)	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)	Baro - metric (mb)	Steady (l/hr)	PID (ppm)	
WS02	0.90	0.78	4.92	0.0	2.9	19.7	0.0	2.9	19.7	180	0	1020	0.0	0.0	
WS05	1.90	1.80	2.72	0.0	2.7	17.9	0.0	2.7	17.9	0	0	1021	0.0	0.0	
WS07	1.94	1.84	2.50	0.0	2.7	16.8	0.0	2.7	16.8	1	0	1020	0.0	0.0	
WS09	1.10	0.99	4.94	0.0	1.9	19.9	0.0	1.9	19.9	>500	2	1020	0.0	0.0	Greater then 500ppm on CO

Gas Monitoring Record

Project Name: Harvester Way, Crowland
Client: Wheatley Homes
Project No: BRD2186

Date:	22/07/2014	Ground conditions:	Damp on grassy areas. Dry on hardstanding.	Recorded by:	Dan Brown
Time at start:	10:30 AM	Weather conditions:	Clear and warm.	Pressure trend:	Steady
Time at finish:	11:30 AM	Air Temperature (^{o}C):	20	Monitor serial no:	G501315

The gas monitoring equipment is a Geotech GA5000 portable analyser. As per manufacturers recommendations this is factory calibrated every six months and in addition BRD undertake calibration checks against bottled standard gases on at least a monthly basis. Gas monitor pump is run for three minutes unless otherwise stated and the steady readings are an average reading taken over this pump run time. Vapour monitoring equipment is either aminiRAE 2000 PGM-7600 or miniRAE lite PGM-7350 Photo Ionisation Detector (PID) with 10.6 eV lamp calibrated for isobutylene. PID calibration check is performed on site against ambient air and also against a 100ppm isobutylene standard gas. Barometric pressure trend and ambient air temperature is recorded from weather websites at the nearest reported weather station.

CH_4 = Methane CO_2 = Carbon Dioxide O_2 = Oxygen H_2S = Hydrogen Sulphide CO = Carbon Monoxide NR = Not Recorded PID = Photo Ionisation Detector

GWL = Groundwater level measured from ground surface and top of standpipe. Base = Base of standpipe measured from ground surface.

Monitoring point				Gas Concentration								Pressure	Flow rate	Vapour	Comments
				Steady			Peak		Minimum	Peak					
Borehole	GWL Ground (m)	GWL Pipe (m)	Base Ground (m)	CH_4 (%)	CO_2 (%)	O_2 (%)	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)	Baro - metric (mb)	Steady (l/hr)	PID (ppm)	
WS02	0.95	0.83	4.93	0.0	1.7	19.6	0.0	1.7	19.5	8	0	1026	-0.4	0.1	
WS05	1.74	1.64	2.30	0.0	2.3	17.5	0.0	2.3	17.5	0	0	1026	-0.3	0.0	
WS07	1.68	1.58	2.50	0.0	3.3	16.5	0.0	3.3	16.5	0	0	1026	-0.2	0.2	
WS09	0.67	0.56	4.92	0.0	1.5	18.9	0.0	1.6	18.8	2	0	1025	-0.1	0.1	

Gas Monitoring Record

Project Name: Harvester Way, Crowland
Client: Wheatley Homes
Project No: BRD2186

Date:	28/07/2014	Ground conditions:	Slightly damp	Recorded by:	HKA & JN
Time at start:	11:25 AM	Weather conditions:	Clear and warm.	Pressure trend:	Falling
Time at finish:	12:18 PM	Air Temperature (^{o}C):	20	Monitor serial no:	G501315

The gas monitoring equipment is a Geotech GA5000 portable analyser. As per manufacturers recommendations this is factory calibrated every six months and in addition BRD undertake calibration checks against bottled standard gases on at least a monthly basis. Gas monitor pump is run for three minutes unless otherwise stated and the steady readings are an average reading taken over this pump run time. Vapour monitoring equipment is either aminiRAE 2000 PGM-7600 or miniRAE lite PGM-7350 Photo Ionisation Detector (PID) with 10.6 eV lamp calibrated for isobutylene. PID calibration check is performed on site against ambient air and also against a 100ppm isobutylene standard gas. Barometric pressure trend and ambient air temperature is recorded from weather websites at the nearest reported weather station.

CH_4 = Methane CO_2 = Carbon Dioxide O_2 = Oxygen H_2S = Hydrogen Sulphide CO = Carbon Monoxide NR = Not Recorded PID = Photo Ionisation Detector

GWL = Groundwater level measured from ground surface and top of standpipe. Base = Base of standpipe measured from ground surface.

Monitoring point				Gas Concentration								Pressure	Flow rate	Vapour	Comments
				Steady			Peak		Minimum	Peak					
Borehole	GWL Ground (m)	GWL Pipe (m)	Base Ground (m)	CH_4 (%)	CO_2 (%)	O_2 (%)	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)	Baro - metric (mb)	Steady (l/hr)	PID (ppm)	
WS02	0.89	0.83	4.90	0.0	2.2	18.6	0.0	2.2	18.6	10	1	1019	-1.4	0.0	
WS05	1.81	1.73	2.25	0.0	2.6	17.4	0.0	2.6	17.4	1	1	1018	-0.3	0.0	
WS07	1.79	1.70	2.42	0.0	3.6	16.6	0.0	3.6	16.6	1	1	1018	-0.2	0.0	
WS09	0.66	0.55	4.88	0.0	6.1	17.5	0.0	6.2	17.5	1	1	1016	-3.8	0.0	

Groundwater Monitoring Record

Project: Harvester Way, Crowland
Client: Wheatley Homes
Project No: BRD2186

Borehole name	Date	Monitored by (initials)	Borehole depth (m)	Qty free product detected (mm)	Groundwater level below ground surface (m)	Groundwater level below top of standpipe (m)	Amount purged (l)	Post purge groundwater level below top of standpipe (m)	Comments
WS02	16/07/2014	DB	4.94	0.00	0.99	1.10	2.00	1.75	Yellowish brown water with no sheen or odour, with frequent black specks
WS05	16/07/2014	DB	2.50	0.00	1.84	1.94	0.00	2.45	Dark brown, silty, sediment load with black specks
WS07	16/07/2014	DB	2.72	0.00	1.80	1.90	0.00	2.50	Dark brown, silty, sediment load with black specks
WS09	16/07/2014	DB	4.92	0.00	0.90	0.72	3.00	0.95	Yellowish brown water with no sheen or odour, with frequent black specks

APPENDIX 3

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Banbury
Oxfordshire
OX16 5HT

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t: 01622 850410
russell.jarvis@qtsenvironmental.com

QTS Environmental Report No: 14-22952

Site Reference:	Harvester Way, Crowland
Project / Job Ref:	BRD2186
Order No:	None Supplied
Sample Receipt Date:	11/07/2014
Sample Scheduled Date:	11/07/2014
Report Issue Number:	1
Reporting Date:	17/07/2014

Authorised by:

Russell Jarvis
Director
On behalf of QTS Environmental Ltd

Authorised by:

Kevin Old
Director
On behalf of QTS Environmental Ltd

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Soil Analysis Certificate						
QTS Environmental Report No: 14-22952	**Date Sampled**	08/07/14	08/07/14	08/07/14	09/07/14	09/07/14
BRD Environmental Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Harvester Way, Crowland	**TP / BH No**	WS01	WS01	WS03	WS06	WS06
Project / Job Ref: BRD2186	**Additional Refs**	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	**Depth (m)**	0.10	0.60	0.20	0.10	0.50
Reporting Date: 17/07/2014	**QTSE Sample No**	110628	110629	110630	110631	110632

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	**MCERTS**	7.6	6.7	6.7	7.1	7.6
Total Sulphate as SO_4	mg/kg	< 200	NONE					578
W/S Sulphate as SO4 (2:1)	g/l	< 0.01	**MCERTS**	0.11	0.07	0.04	0.04	0.03
Total Sulphur	mg/kg	< 200	NONE					< 200
Organic Matter	%	< 0.1	NONE	11.3	11.8	18.5	13.8	0.5
Arsenic (As)	mg/kg	< 2	**MCERTS**	10	9	10	10	7
Cadmium (Cd)	mg/kg	< 0.5	**MCERTS**	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Chromium (Cr)	mg/kg	< 2	**MCERTS**	32	27	25	24	19
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Copper (Cu)	mg/kg	< 4	**MCERTS**	26	17	14	20	8
Lead (Pb)	mg/kg	< 3	**MCERTS**	82	45	42	34	10
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1	< 1	< 1	< 1
Nickel (Ni)	mg/kg	< 3	**MCERTS**	30	22	20	20	15
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3	< 3	< 3
Zinc (Zn)	mg/kg	< 3	**MCERTS**	84	75	51	69	39

Analytical results are expressed on a dry weight basis where samples are dried at less than $30^{o}C$
Analysis carried out on the dried sample is corrected for the stone content
Subcontracted analysis [S]

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Soil Analysis Certificate						
QTS Environmental Report No: 14-22952	**Date Sampled**	09/07/14	09/07/14	09/07/14	09/07/14	09/07/14
BRD Environmental Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Harvester Way, Crowland	**TP / BH No**	WS07	WS09	WS09	WS07	WS07
Project / Job Ref: BRD2186	**Additional Refs**	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	**Depth (m)**	0.20	0.20	0.50	0.80	1.50
Reporting Date: 17/07/2014	**QTSE Sample No**	110633	110634	110635	110636	110637

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	**MCERTS**	7.3	7.4	7.2	7.5	7.7
Total Sulphate as SO_4	mg/kg	< 200	NONE			7473	828	534
W/S Sulphate as SO4 (2:1)	g/l	< 0.01	**MCERTS**	0.09	1.33	0.64	0.16	0.06
Total Sulphur	mg/kg	< 200	NONE			2527	1243	< 200
Organic Matter	%	< 0.1	NONE	10.2	12.1	10.7		
Arsenic (As)	mg/kg	< 2	**MCERTS**	8	10	11		
Cadmium (Cd)	mg/kg	< 0.5	**MCERTS**	< 0.5	< 0.5	< 0.5		
Chromium (Cr)	mg/kg	< 2	**MCERTS**	30	26	32		
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2		
Copper (Cu)	mg/kg	< 4	**MCERTS**	21	20	14		
Lead (Pb)	mg/kg	< 3	**MCERTS**	28	29	17		
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1	< 1		
Nickel (Ni)	mg/kg	< 3	**MCERTS**	26	22	18		
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3		
Zinc (Zn)	mg/kg	< 3	**MCERTS**	68	68	48		

Analytical results are expressed on a dry weight basis where samples are dried at less than 30°C
Analysis carried out on the dried sample is corrected for the stone content
Subcontracted analysis [S]

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Soil Analysis Certificate						
QTS Environmental Report No: 14-22952	**Date Sampled**	08/07/14				
BRD Environmental Ltd	**Time Sampled**	None Supplied				
Site Reference: Harvester Way, Crowland	**TP / BH No**	WS02				
Project / Job Ref: BRD2186	**Additional Refs**	None Supplied				
Order No: None Supplied	**Depth (m)**	0.70				
Reporting Date: 17/07/2014	**QTSE Sample No**	110638				

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	**MCERTS**	7.4				
Total Sulphate as SO_4	mg/kg	< 200	NONE					
W/S Sulphate as SO4 (2:1)	g/l	< 0.01	**MCERTS**	1.17				
Total Sulphur	mg/kg	< 200	NONE					
Organic Matter	%	< 0.1	NONE					
Arsenic (As)	mg/kg	< 2	**MCERTS**					
Cadmium (Cd)	mg/kg	< 0.5	**MCERTS**					
Chromium (Cr)	mg/kg	< 2	**MCERTS**					
Chromium (hexavalent)	mg/kg	< 2	NONE					
Copper (Cu)	mg/kg	< 4	**MCERTS**					
Lead (Pb)	mg/kg	< 3	**MCERTS**					
Mercury (Hg)	mg/kg	< 1	NONE					
Nickel (Ni)	mg/kg	< 3	**MCERTS**					
Selenium (Se)	mg/kg	< 3	NONE					
Zinc (Zn)	mg/kg	< 3	**MCERTS**					

Analytical results are expressed on a dry weight basis where samples are dried at less than 30°C
Analysis carried out on the dried sample is corrected for the stone content
Subcontracted analysis [S]

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Soil Analysis Certificate - Speciated PAHs							
QTS Environmental Report No: 14-22952	**Date Sampled**	08/07/14	08/07/14	08/07/14	09/07/14	09/07/14
BRD Environmental Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Harvester Way, Crowland	**TP / BH No**	WS01	WS01	WS03	WS06	WS06
Project / Job Ref: BRD2186	**Additional Refs**	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	**Depth (m)**	0.10	0.60	0.20	0.10	0.50
Reporting Date: 17/07/2014	**QTSE Sample No**	110628	110629	110630	110631	110632

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenanthrene	mg/kg	< 0.1	MCERTS	0.27	0.21	< 0.1	< 0.1	< 0.1
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluoranthene	mg/kg	< 0.1	MCERTS	0.67	0.51	< 0.1	< 0.1	< 0.1
Pyrene	mg/kg	< 0.1	MCERTS	0.54	0.42	< 0.1	< 0.1	< 0.1
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	0.28	0.20	< 0.1	< 0.1	< 0.1
Chrysene	mg/kg	< 0.1	MCERTS	0.30	0.21	< 0.1	< 0.1	< 0.1
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	0.30	0.23	< 0.1	< 0.1	< 0.1
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	0.21	0.17	< 0.1	< 0.1	< 0.1
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	2.6	2	< 1.6	< 1.6	< 1.6

Analytical results are expressed on a dry weight basis where samples are dried at less than 30°C

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Soil Analysis Certificate - Speciated PAHs						
QTS Environmental Report No: 14-22952	**Date Sampled**	09/07/14	09/07/14	09/07/14		
BRD Environmental Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied		
Site Reference: Harvester Way, Crowland	**TP / BH No**	WS07	WS09	WS09		
Project / Job Ref: BRD2186	**Additional Refs**	None Supplied	None Supplied	None Supplied		
Order No: None Supplied	**Depth (m)**	0.20	0.20	0.50		
Reporting Date: 17/07/2014	**QTSE Sample No**	110633	110634	110635		

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	0.18	< 0.1		
Pyrene	mg/kg	< 0.1	MCERTS	< 0.1	0.15	< 0.1		
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Chrysene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6	< 1.6	< 1.6		

Analytical results are expressed on a dry weight basis where samples are dried at less than 30°C

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Soil Analysis Certificate - TPH CWG Banded						
QTS Environmental Report No: 14-22952	**Date Sampled**	08/07/14	09/07/14	09/07/14		
BRD Environmental Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied		
Site Reference: Harvester Way, Crowland	**TP / BH No**	WS01	WS06	WS09		
Project / Job Ref: BRD2186	**Additional Refs**	None Supplied	None Supplied	None Supplied		
Order No: None Supplied	**Depth (m)**	0.60	0.50	0.50		
Reporting Date: 17/07/2014	**QTSE Sample No**	110629	110632	110635		

Determinand	Unit	RL	Accreditation					
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01		
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05		
Aliphatic >C8 - C10	mg/kg	< 1	NONE	< 1	< 1	< 1		
Aliphatic >C10 - C12	mg/kg	< 1	NONE	< 1	< 1	< 1		
Aliphatic >C12 - C16	mg/kg	< 1	NONE	< 1	< 1	< 1		
Aliphatic >C16 - C21	mg/kg	< 1	NONE	< 1	< 1	< 1		
Aliphatic >C21 - C34	mg/kg	< 6	NONE	< 6	< 6	< 6		
Aliphatic (C5 - C34)	mg/kg	< 12	NONE	< 12	< 12	< 12		
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01		
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05		
Aromatic >C8 - C10	mg/kg	< 1	NONE	< 1	< 1	< 1		
Aromatic >C10 - C12	mg/kg	< 1	NONE	< 1	< 1	< 1		
Aromatic >C12 - C16	mg/kg	< 1	NONE	< 1	< 1	< 1		
Aromatic >C16 - C21	mg/kg	< 1	NONE	< 1	< 1	< 1		
Aromatic >C21 - C35	mg/kg	< 6	NONE	< 6	< 6	< 6		
Aromatic (C5 - C35)	mg/kg	< 12	NONE	< 12	< 12	< 12		
Total >C5 - C35	mg/kg	< 24	NONE	< 24	< 24	< 24		

Analytical results are expressed on a dry weight basis where samples are dried at less than 30^{o}C

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Soil Analysis Certificate - BTEX / MTBE						
QTS Environmental Report No: 14-22952	**Date Sampled**	08/07/14	09/07/14	09/07/14		
BRD Environmental Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied		
Site Reference: Harvester Way, Crowland	**TP / BH No**	WS01	WS06	WS09		
Project / Job Ref: BRD2186	**Additional Refs**	None Supplied	None Supplied	None Supplied		
Order No: None Supplied	**Depth (m)**	0.60	0.50	0.50		
Reporting Date: 17/07/2014	**QTSE Sample No**	110629	110632	110635		

Determinand	Unit	RL	Accreditation					
Benzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
Toluene	ug/kg	< 5	MCERTS	< 5	< 5	< 5		
Ethylbenzene	ug/kg	< 10	MCERTS	< 10	< 10	< 10		
p & m-xylene	ug/kg	< 10	MCERTS	< 10	< 10	< 10		
o-xylene	ug/kg	< 10	MCERTS	< 10	< 10	< 10		
MTBE	ug/kg	< 5	MCERTS	< 5	< 5	< 5		

Analytical results are expressed on a dry weight basis where samples are dried at less than 30^{0}C

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Soil Analysis Certificate - Semi Volatile Organic Compounds (SVOC)						
QTS Environmental Report No: 14-22952	**Date Sampled**	08/07/14	09/07/14	09/07/14		
BRD Environmental Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied		
Site Reference: Harvester Way, Crowland	**TP / BH No**	WS01	WS06	WS09		
Project / Job Ref: BRD2186	**Additional Refs**	None Supplied	None Supplied	None Supplied		
Order No: None Supplied	**Depth (m)**	0.60	0.50	0.50		
Reporting Date: 17/07/2014	**QTSE Sample No**	110629	110632	110635		

Determinand	Unit	RL	Accreditation					
Phenol	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1		
1,2,4-Trichlorobenzene	mg/kg	< 0.1	**ISO17025**	< 0.1	< 0.1	< 0.1		
2-Nitrophenol	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1		
Nitrobenzene	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
0-Cresol	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1		
bis(2-chloroethoxy)methane	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
bis(2-chloroethyl)ether	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
2,4-Dichlorophenol	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
2-Chlorophenol	mg/kg	< 0.1	**ISO17025**	< 0.1	< 0.1	< 0.1		
1,3-Dichlorobenzene	mg/kg	< 0.1	**ISO17025**	< 0.1	< 0.1	< 0.1		
1,4-Dichlorobenzene	mg/kg	< 0.1	**ISO17025**	< 0.1	< 0.1	< 0.1		
1,2-Dichlorobenzene	mg/kg	< 0.1	**ISO17025**	< 0.1	< 0.1	< 0.1		
2,4-Dimethylphenol	mg/kg	< 0.15	**ISO17025**	< 0.15	< 0.15	< 0.15		
Isophorone	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1		
Hexachloroethane	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
p-Cresol	mg/kg	< 0.15	**MCERTS**	< 0.15	< 0.15	< 0.15		
2,4,6-Trichlorophenol	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
2,4,5-Trichlorophenol	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
2-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1		
4-Chloro-3-methylphenol	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1		
2-Methylnaphthalene	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
Hexachlorocyclopentadiene	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1		
Hexachlorobutadiene	mg/kg	< 0.1	**ISO17025**	< 0.1	< 0.1	< 0.1		
2,6-Dinitrotoluene	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
Dimethyl phthalate	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1		
2-Chloronaphthalene	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
4-Chloroanaline	mg/kg	< 0.2	NONE	< 0.2	< 0.2	< 0.2		
4-Nitrophenol	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1		
4-Chlorophenyl phenyl ether	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
3-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1		
4-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1		
4-Bromophenyl phenyl ether	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
Hexachlorobenzene	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
2,4-Dinitrotoluene	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
Diethyl phthalate	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
Dibenzofuran	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
Azobenzene	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1		
Dibutyl phthalate	mg/kg	< 0.15	**ISO17025**	< 0.15	< 0.15	< 0.15		
Carbazole	mg/kg	< 0.1	**ISO17025**	< 0.1	< 0.1	< 0.1		
bis(2-ethylhexyl)phthalate	mg/kg	< 0.2	**MCERTS**	< 0.2	< 0.2	< 0.2		
Benzyl butyl phthalate	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
Di-n-octyl phthalate	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		

Analytical results are expressed on a dry weight basis where samples are dried at less than 30°C

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Soil Analysis Certificate - Organochlorine Pesticides						
QTS Environmental Report No: 14-22952	**Date Sampled**	08/07/14	09/07/14			
BRD Environmental Ltd	**Time Sampled**	None Supplied	None Supplied			
Site Reference: Harvester Way, Crowland	**TP / BH No**	WS03	WS09			
Project / Job Ref: BRD2186	**Additional Refs**	None Supplied	None Supplied			
Order No: None Supplied	**Depth (m)**	0.20	0.20			
Reporting Date: 17/07/2014	**QTSE Sample No**	110630	110634			

Determinand	Unit	RL	Accreditation					
Aldrin	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
alpha-HCH	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
beta-HCH	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
cis-chlordane	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
delta-HCH	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
Dieldrin	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
Endosulfan A	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
Endosulfan B	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
Endrin	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
gamma-HCH (Lindane)	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
Heptachlor	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
Heptachlor epoxide	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
Hexachlorobenzene (HCB)	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
Isodrin	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
Methoxychlor	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
o,p' - DDD	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
o,p' - DDE	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
o,p' - DDT	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
p,p' - DDD	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
p,p' - DDE	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
p,p' - DDT	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
trans-chlordane	mg/kg	< 0.02	NONE	< 0.02	< 0.02			
Trifluralin	mg/kg	< 0.02	NONE	< 0.02	< 0.02			

Analytical results are expressed on a dry weight basis where samples are dried at less than 30°C

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Soil Analysis Certificate - Sample Descriptions
QTS Environmental Report No: 14-22952
BRD Environmental Ltd
Site Reference: Harvester Way, Crowland
Project / Job Ref: BRD2186
Order No: None Supplied
Reporting Date: 17/07/2014

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
110628	WS01	None Supplied	0.10	26.4	Brown clayey loam
110629	WS01	None Supplied	0.60	18.9	Brown clayey loam
110630	WS03	None Supplied	0.20	22.3	Brown clayey loam
110631	WS06	None Supplied	0.10	26.5	Brown clayey loam
110632	WS06	None Supplied	0.50	18.3	Light grey sandy clay
110633	WS07	None Supplied	0.20	21.1	Brown clayey loam with vegetation
110634	WS09	None Supplied	0.20	22.9	Brown clayey loam with vegetation
110635	WS09	None Supplied	0.50	38.8	Brown clay
110636	WS07	None Supplied	0.80	21.8	Light grey sandy clay
110637	WS07	None Supplied	1.50	22.9	Red sandy clay
110638	WS02	None Supplied	0.70	19.5	Light grey sandy clay

Moisture content is part of procedure E003 & is not an accredited test
Insufficient Sample I/S
Unsuitable Sample U/S

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Soil Analysis Certificate - Methodology & Miscellaneous Information
QTS Environmental Report No: 14-22952
BRD Environmental Ltd
Site Reference: Harvester Way, Crowland
Project / Job Ref: BRD2186
Order No: None Supplied
Reporting Date: 17/07/2014

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	TPH LQM	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6 - C10)	Determination of hydrocarbons C6-C10 by headspace GC-MS	E001

D Dried
AR As Received

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QTS Environmental Report No: 14-23126

Site Reference:	Harvester Way, Crowland
Project / Job Ref:	BRD2186
Order No:	None Supplied
Sample Receipt Date:	17/07/2014
Sample Scheduled Date:	17/07/2014
Report Issue Number:	1
Reporting Date:	22/07/2014

Authorised by:
Russell Jarvis
Director
On behalf of QTS Environmental Ltd

Authorised by:
Kevin Old
Director
On behalf of QTS Environmental Ltd

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Water Analysis Certificate						
QTS Environmental Report No: 14-23126	**Date Sampled**	15/07/14	15/07/14	15/07/14	15/07/14	
BRD Environmental Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	
Site Reference: Harvester Way, Crowland	**TP / BH No**	WS02	WS05	WS07	WS09	
Project / Job Ref: BRD2186	**Additional Refs**	None Supplied	None Supplied	None Supplied	None Supplied	
Order No: None Supplied	**Depth (m)**	None Supplied	None Supplied	None Supplied	None Supplied	
Reporting Date: 22/07/2014	**QTSE Sample No**	111373	111374	111375	111376	

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	**ISO17025**	6.3	6.8	7.0	6.8	
Sulphate as SO_4	mg/l	< 1	**ISO17025**	1530	993	669	784	

Subcontracted analysis [S]
Insufficient sample [I/S]
Unsuitable Sample [I/S]

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Soil Analysis Certificate - Methodology & Miscellaneous Information
QTS Environmental Report No: 14-23126
BRD Environmental Ltd
Site Reference: Harvester Way, Crowland
Project / Job Ref: BRD2186
Order No: None Supplied
Reporting Date: 22/07/2014

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Water	UF	Alkalinity	Determination of alkalinity by titration against hydrochloric acid using bromocresol green as the end point	E103
Water	UF	BTEX	Determination of BTEX by headspace GC-MS	E101
Water	F	Cations	Determination of cations by filtration followed by ICP-MS	E102
Water	UF	Chemical Oxygen Demand (COD)	Determination using a COD reactor followed by colorimetry	E112
Water	F	Chloride	Determination of chloride by filtration & analysed by ion chromatography	E109
Water	F	Chromium - Hexavalent	Determination of hexavalent chromium by acidification, addition of 1,5 diphenylcarbazide followed by c	E116
Water	UF	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E115
Water	UF	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E115
Water	UF	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E115
Water	UF	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through liquid:liquid extraction with cyclohexane	E111
Water	F	Diesel Range Organics (C10 - C24)	Determination of liquid:liquid extraction with hexane followed by GI-FID	E104
Water	F	Dissolved Organic Content (DOC)	Determination of DOC by filtration followed by low heat with persulphate addition followed by IR detec	E110
Water	UF	Electrical Conductivity	Determination of electrical conductivity by electrometric measurement	E123
Water	F	EPH (C10 – C40)	Determination of liquid:liquid extraction with hexane followed by GI-FID	E104
Water	F	EPH TEXAS	Determination of liquid:liquid extraction with hexane followed by GI-FID	E104
Water	F	Fluoride	Determination of Fluoride by filtration & analysed by ion chromatography	E109
Water	F	Hardness	Determination of Ca and Mg by ICP-MS followed by calculation	E102
Leachate	F	Leachate Preparation - NRA	Based on National Rivers Authority leaching test 1994	E301
Leachate	F	Leachate Preparation - WAC	Based on BS EN 12457 Pt1, 2, 3	E302
Water	F	Metals	Determination of metals by filtration followed by ICP-MS	E102
Water	F	Mineral Oil (C10 - C40)	Determination of liquid:liquid extraction with hexane followed by GI-FID	E104
Water	F	Nitrate	Determination of nitrate by filtration & analysed by ion chromatography	E109
Water	UF	Monohydric Phenol	Determination of phenols by distillation followed by colorimetry	E121
Water	F	PAH - Speciated (EPA 16)	Determination of PAH compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E105
Water	F	PCB - 7 Congeners	Determination of PCB compounds by concentration through SPE cartridge, collection in dichloromethan	E108
Water	UF	Petroleum Ether Extract (PEE)	Gravimetrically determined through liquid:liquid extraction with petroleum ether	E111
Water	UF	pH	Determination of pH by electrometric measurement	E107
Water	F	Phosphate	Determination of phosphate by filtration & analysed by ion chromatography	E109
Water	UF	Redox Potential	Determination of redox potential by electrometric measurement	E113
Water	F	Sulphate (as SO4)	Determination of sulphate by filtration & analysed by ion chromatography	E109
Water	UF	Sulphide	Determination of sulphide by distillation followed by colorimetry	E118
Water	F	SVOC	Determination of semi-volatile organic compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E106
Water	UF	Toluene Extractable Matter (TEM)	Gravimetrically determined through liquid:liquid extraction with toluene	E111
Water	UF	Total Organic Carbon (TOC)	Low heat with persulphate addition followed by IR detection	E110
Water	F	TPH CWG	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID	E104
Water	F	TPH LQM	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID	E104
Water	UF	VOCs	Determination of volatile organic compounds by headspace GC-MS	E101
Water	UF	VPH (C6 - C10)	Determination of hydrocarbons C6-C10 by headspace GC-MS	E101

Key

F Filtered
UF Unfiltered

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QTS Environmental Report No: 14-23254

Site Reference:	Harvester Way, Crowland
Project / Job Ref:	BRD2186
Order No:	None Supplied
Sample Receipt Date:	23/07/2014
Sample Scheduled Date:	23/07/2014
Report Issue Number:	1
Reporting Date:	29/07/2014

Authorised by:

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Authorised by:

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Soil Analysis Certificate						
QTS Environmental Report No: 14-23254	**Date Sampled**	22/07/14	22/07/14			
BRD Environmental Ltd	**Time Sampled**	None Supplied	None Supplied			
Site Reference: Harvester Way, Crowland	**TP / BH No**	HD01	HD02			
Project / Job Ref: BRD2186	**Additional Refs**	None Supplied	None Supplied			
Order No: None Supplied	**Depth (m)**	0.20	0.50			
Reporting Date: 29/07/2014	**QTSE Sample No**	111990	111991			

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	**MCERTS**	8.0	7.7			
W/S Sulphate as SO4 (2:1)	g/l	< 0.01	**MCERTS**	0.14	0.04			
Organic Matter	%	< 0.1	NONE	5.7	5.7			
Arsenic (As)	mg/kg	< 2	**MCERTS**	9	6			
Cadmium (Cd)	mg/kg	< 0.5	**MCERTS**	< 0.5	< 0.5			
Chromium (Cr)	mg/kg	< 2	**MCERTS**	22	17			
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2			
Copper (Cu)	mg/kg	< 4	**MCERTS**	13	11			
Lead (Pb)	mg/kg	< 3	**MCERTS**	18	14			
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1			
Nickel (Ni)	mg/kg	< 3	**MCERTS**	20	15			
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3			
Zinc (Zn)	mg/kg	< 3	**MCERTS**	52	46			

Analytical results are expressed on a dry weight basis where samples are dried at less than 30^{0}C
Analysis carried out on the dried sample is corrected for the stone content
Subcontracted analysis [S]

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Soil Analysis Certificate - Speciated PAHs						
QTS Environmental Report No: 14-23254	**Date Sampled**	22/07/14	22/07/14			
BRD Environmental Ltd	**Time Sampled**	None Supplied	None Supplied			
Site Reference: Harvester Way, Crowland	**TP / BH No**	HD01	HD02			
Project / Job Ref: BRD2186	**Additional Refs**	None Supplied	None Supplied			
Order No: None Supplied	**Depth (m)**	0.20	0.50			
Reporting Date: 29/07/2014	**QTSE Sample No**	111990	111991			

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
Phenanthrene	mg/kg	< 0.1	MCERTS	0.13	< 0.1			
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
Fluoranthene	mg/kg	< 0.1	MCERTS	0.49	< 0.1			
Pyrene	mg/kg	< 0.1	MCERTS	0.44	< 0.1			
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	0.25	< 0.1			
Chrysene	mg/kg	< 0.1	MCERTS	0.26	< 0.1			
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	0.36	< 0.1			
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	0.13	< 0.1			
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	0.26	< 0.1			
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	0.18	< 0.1			
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	0.15	< 0.1			
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	2.6	< 1.6			

Analytical results are expressed on a dry weight basis where samples are dried at less than 30°C

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Waste Acceptance Criteria Analytical Certificate - BS EN 12457/3

QTS Environmental Report No: 14-23254		**Date Sampled**	09/07/14				**Landfill Waste Acceptance Criteria Limits**		
BRD Environmental Ltd		**Time Sampled**	None Supplied				**Inert Waste Landfill**	**Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Site Reference: Harvester Way, Crowland		**TP / BH No**	WS07						
Project / Job Ref: BRD2186		**Additional Refs**	None Supplied						
Order No: None Supplied		**Depth (m)**	0.80						
Reporting Date: 29/07/2014		**QTSE Sample No**	111992						
Determinand	**Unit**	**MDL**							
TOC	%	< 0.1	0.9				3%	5%	6%
Loss on Ignition	%	< 0.01	2.20				--	--	10%
BTEX[MU]	mg/kg	< 0.05	< 0.05				6	--	--
Sum of PCBs	mg/kg	< 0.7	< 0.7				1	--	--
Mineral Oil	mg/kg	< 6	< 6				500	--	--
Total PAH[MU]	mg/kg	< 1.7	< 1.7				100	--	--
pH[MU]	pH Units	N/a	7.6				--	>6	--
Acid Neutralisation Capacity	mol/kg (+/-)	< 1	1.7				--	To be evaluated	To be evaluated

Eluate Analysis	**2:1 mg/l**	**8:1 mg/l**		**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)**		
Arsenic	< 0.01	< 0.01		< 0.2	0.5	2	25
Barium	0.04	< 0.02		0.2	20	100	300
Cadmium	< 0.0005	< 0.0005		< 0.02	0.04	1	5
Chromium	< 0.005	< 0.005		< 0.20	0.5	10	70
Copper	< 0.01	< 0.01		< 0.5	2	50	100
Mercury	< 0.005	< 0.005		< 0.01	0.01	0.2	2
Molybdenum	0.002	0.002		< 0.1	0.5	10	30
Nickel	< 0.007	< 0.007		< 0.2	0.4	10	40
Lead	< 0.005	< 0.005		< 0.2	0.5	10	50
Antimony	< 0.005	< 0.005		< 0.06	0.06	0.7	5
Selenium	< 0.005	< 0.005		< 0.1	0.1	0.5	7
Zinc	0.010	0.010		< 0.2	4	50	200
Chloride[U]	29	4		63	800	15000	25000
Fluoride[U]	0.7	< 0.5		< 1	10	150	500
Sulphate[U]	40	14		168	1000	20000	50000
TDS	176	81		915	4000	60000	100000
Phenol Index	< 0.01	< 0.01		< 0.5	1	-	-
DOC	10.7	6.6		70.2	500	800	1000
Leach Test Information							
Sample Mass (kg)	0.22						
Dry Matter (%)	78.2						
Moisture (%)	28						
Stage 1							
Volume Eluate L2 (litres)	0.30						
Filtered Eluate VE1 (litres)	0.19						

Results are expressed on a dry weight basis, after correction for moisture content where applicable
Stated limits are for guidance only and QTS Environmental cannot be held responsible for any discrepencies with current legislation
M Denotes MCERTS accredited test
U Denotes ISO17025 accredited test

QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

4480

Soil Analysis Certificate - Sample Descriptions	
QTS Environmental Report No: 14-23254	
BRD Environmental Ltd	
Site Reference: Harvester Way, Crowland	
Project / Job Ref: BRD2186	
Order No: None Supplied	
Reporting Date: 29/07/2014	

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
111990	HD01	None Supplied	0.20	14.6	Brown clayey loam with vegetation and rubble
111991	HD02	None Supplied	0.50	15.5	Brown clayey loam with vegetation
$ 111992	WS07	None Supplied	0.80	21.8	Light grey sandy clay

Moisture content is part of procedure E003 & is not an accredited test
Insufficient Sample I/S
Unsuitable Sample U/S

$ samples exceeded recommended holding times

QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
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4480

Soil Analysis Certificate - Methodology & Miscellaneous Information
QTS Environmental Report No: 14-23254
BRD Environmental Ltd
Site Reference: Harvester Way, Crowland
Project / Job Ref: BRD2186
Order No: None Supplied
Reporting Date: 29/07/2014

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	TPH LQM	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6 - C10)	Determination of hydrocarbons C6-C10 by headspace GC-MS	E001

D Dried
AR As Received

TEST REPORT.

ISSUED BY : **SOIL PROPERTY TESTING LTD.**

DATE OF ISSUE : 28/07/14 **PAGE 1 of 13 Pages**

Contract Harvester Way, Crowland.

Serial No. S27905

UKAS TESTING 0998

CLIENT:

BRD Environmental Ltd
Hawthorne Villa
1 Old Parr Road
Banbury
Oxfordshire
OX16 5HT

Soil Property Testing

18 Halcyon Court, St Margarets Way,
Stukeley Meadows, Huntingdon,
Cambs. PE29 6DG.

Telephone (01480) 455579 Fax (01480) 453619
Email enquiries@soilpropertytesting.com

SAMPLES SUBMITTED BY:

BRD Environmental Ltd

APPROVED SIGNATORIES:

☑ **J.C.GARNER B.Eng (Hons.) FGS**
Technical Director

☐ **S.P.TOWNEND FGS**
Quality Manager

☐ **T.FOORD BSc (Hons.) FGS**
Site Services Manager

SAMPLES LABELLED:

Harvester Way, Crowland.

DATE RECEIVED: 10/07/14

SAMPLES TESTED BETWEEN 10/07/14 **and** 28/07/14

REMARKS: For the attention of Mr I Hibberd
Your Ref: BRD2186

NOTES:

1. All remaining samples or remnants from this contract will be disposed of after 21 days from today, unless we are notified to the contrary.
2. (a) UKAS - United Kingdom Accreditation Service.
   (b) Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.
3. Tests marked "NOT UKAS ACCREDITED" in this test report are not included in the UKAS Accreditation Schedule for this testing laboratory.
4. This test report may not be reproduced other than in full except with the prior written approval of the issuing laboratory.

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 **PAGE** 2 **of** 13

Contract Harvester Way, Crowland.

Serial No. S27905

SCHEDULE OF LABORATORY TESTS

Bh./ Tp No.	Sample Ref	Depth (from)	1:Moisture Content Determination	4:Liquid/Plastic limit 1 point	703:Mass Loss on Ignition	10:PSD by Hydr.inc pre-sieve	Remarks
WS01	D2	1.50	*	*	*		
WS02	D1	0.80	*	*			
WS03	D1	0.70	*	*			
WS04	B1	2.20			*	*	
WS06	D1	0.70	*	*			
	B1	1.00				*	
WS08	D1	1.50	*	*			
WS09	D1	0.80	*	*	*		
-	-	-	6	6	3	2	<— Total Number of Tests —

Scheduled by: BRD Environmental Ltd

Target Date: 28/07/14

TEST REPORT.

ISSUED BY : **SOIL PROPERTY TESTING LTD.**

DATE OF ISSUE : As page 1 **PAGE** 3 of (3

Contract Harvester Way, Crowland.

Serial No. S27905

UKAS TESTING 0998

SUMMARY OF MOISTURE CONTENT, LIQUID LIMIT, PLASTIC LIMIT, PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)	SAMPLE PREPARATION				Description	CLASS
								Method S/N	Ret'd 0.425mm (%)	Corr'd M/C <0.425mm	Curing Time (hrs.)		
WS01	1.50	D2	48	60	27	33	0.64	N	0(A)		26	Very soft brown slightly organic CLAY	CHO
WS02	0.80	D1	33	58	23	35	0.29	N	0(A)		26	Firm light olive brown CLAY with occasional grey and orange mottling, rare recently active and decayed roots and selenite crystals	CH
WS03	0.70	D1	27	32	26	6.0	0.17	N	0(A)		26	Brown sandy SILT	ML
WS06	0.70	D1	27	40	24	16	0.19	N	0(A)		26	Firm greyish brown sandy silty CLAY with rare decayed roots	CI
WS08	1.50	D1	64	84	30	54	0.63	N	0(A)		26	Very soft brown CLAY with occasional orange mottling, recently active and decayed roots and rare selenite crystals	CV
WS09	0.90	D1	71	99	37	62	0.55	N	0(A)		27	Very soft dark grey organic CLAY with occasional black and orange staining and decayed roots	CEO

METHOD OF PREPARATION : BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2 S = Wet Sieved Specimen
N = prepared from Natural

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter. A = Assumed, M = Measured

COMMENTS :

REMARKS TO INCLUDE : Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample. Oven drying temperature if not 105-110 deg C.

TEST REPORT.

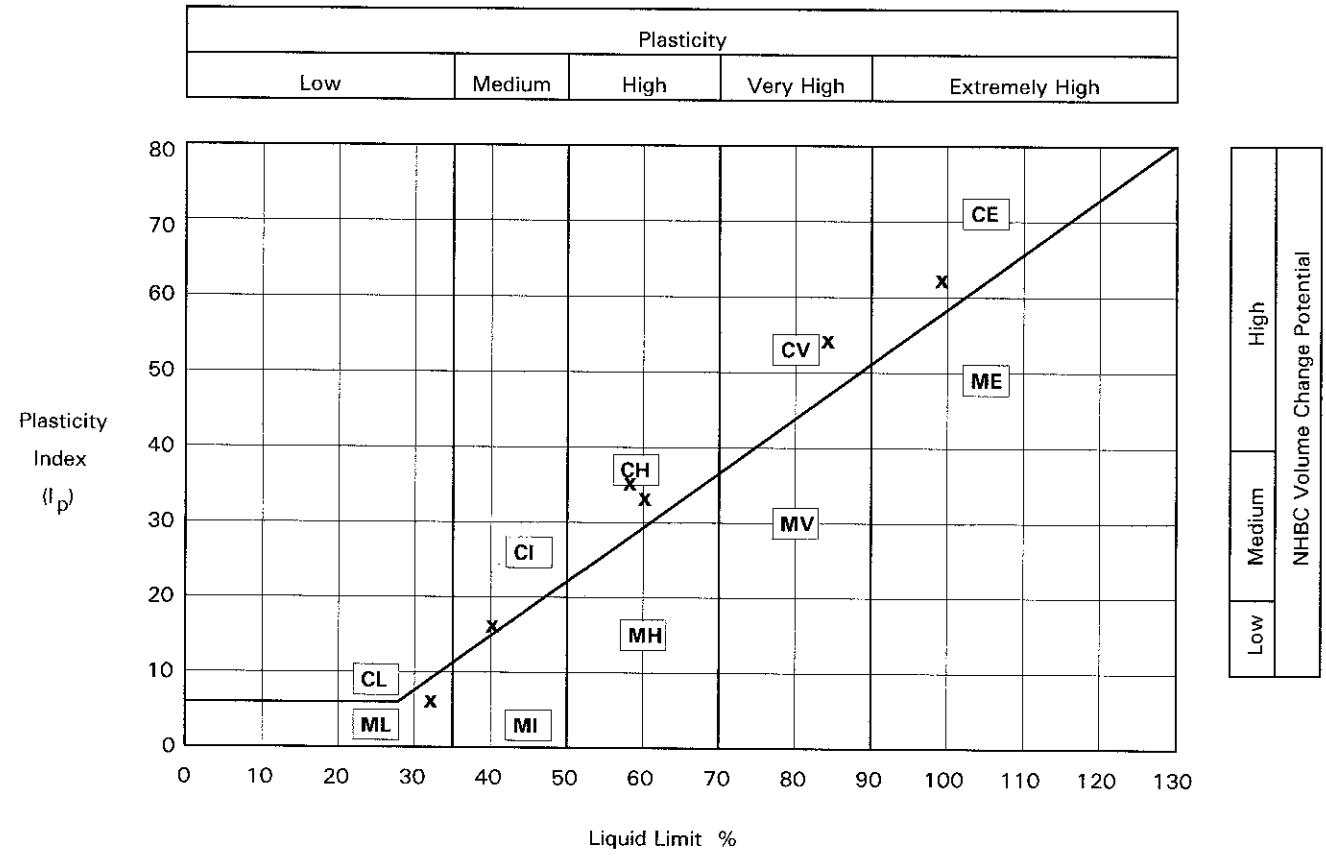
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DATE OF ISSUE : As page 1 **PAGE** 4 of 13

Contract Harvester Way, Crowland.

Serial No. S27905

PLOT OF PLASTICITY INDEX AGAINST LIQUID LIMIT USING CASAGRANDE CLASSIFICATION CHART



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index PLASTICITY CHART BS5930:1999:Figure 18

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 PAGE 5 of 13

Contract: Harvester Way, Crowland.

Serial No. S27905

UKAS TESTING 0998

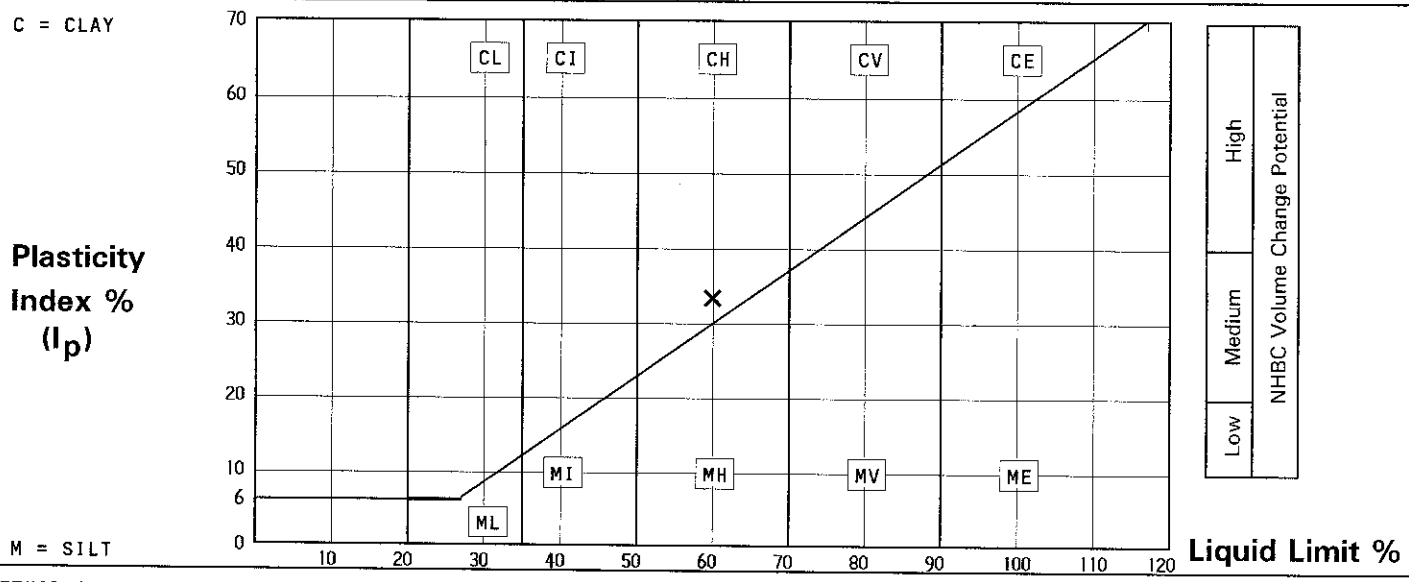
DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
WS01	1.50	D2	48	Very soft brown slightly organic CLAY	

PREPARATION

Method of Preparation	Specimen from Natural Soil
Sample retained 0.425 sieve (Assumed)	0 %
Corrected moisture content for material passing 0.425mm	%
Curing Time	26 Hours

Liquid Limit	60 %
Plastic Limit	27 %
Plasticity Index	33 %
Liquidity Index	0.64
Clay Content	Not analysed. %
Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4 , 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 **PAGE** 6 of 13

Contract Harvester Way, Crowland.

Serial No. S27905

UKAS TESTING 0998

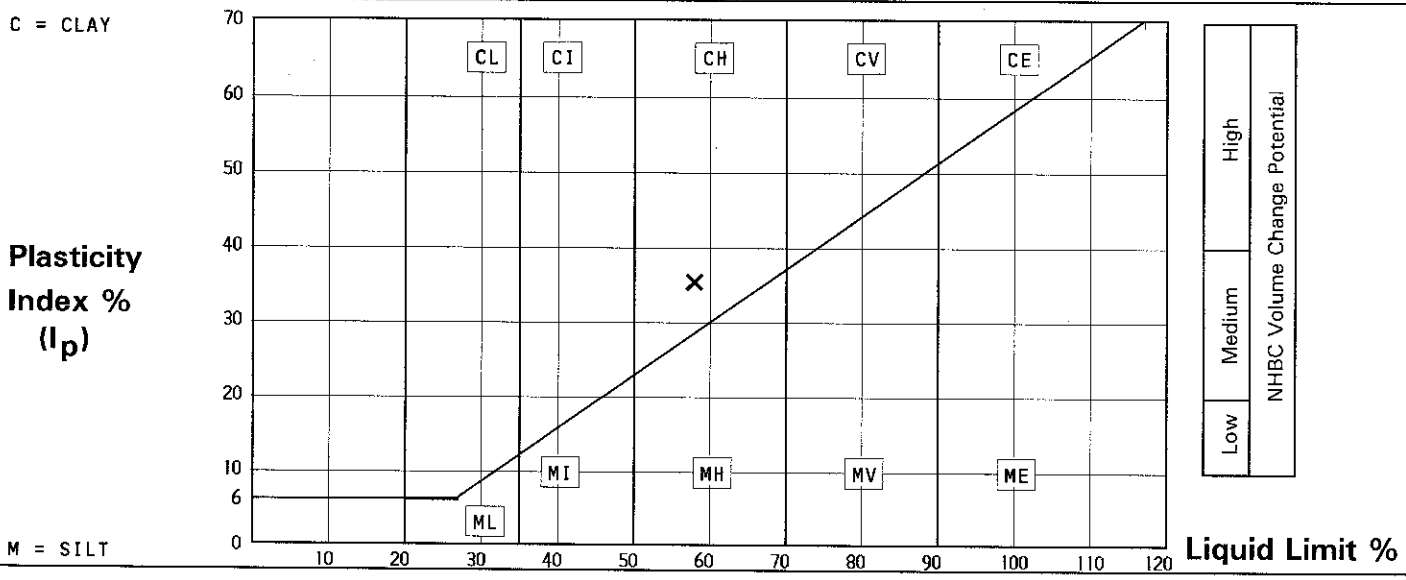
DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
WS02	0.80	D1	33	Firm light olive brown CLAY with occasional grey and orange mottling, rare recently active and decayed roots and selenite crystals	Oven dried at a maximum of 80°C due to the presence of selenite

PREPARATION

Method of Preparation	Specimen from Natural Soil
Sample retained 0.425 sieve (Assumed)	0 %
Corrected moisture content for material passing 0.425mm	%
Curing Time	26 Hours

Liquid Limit	58 %
Plastic Limit	23 %
Plasticity Index	35 %
Liquidity Index	0.29
Clay Content	Not analysed. %
Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4 , 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : **SOIL PROPERTY TESTING LTD.**

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Contract Harvester Way, Crowland.

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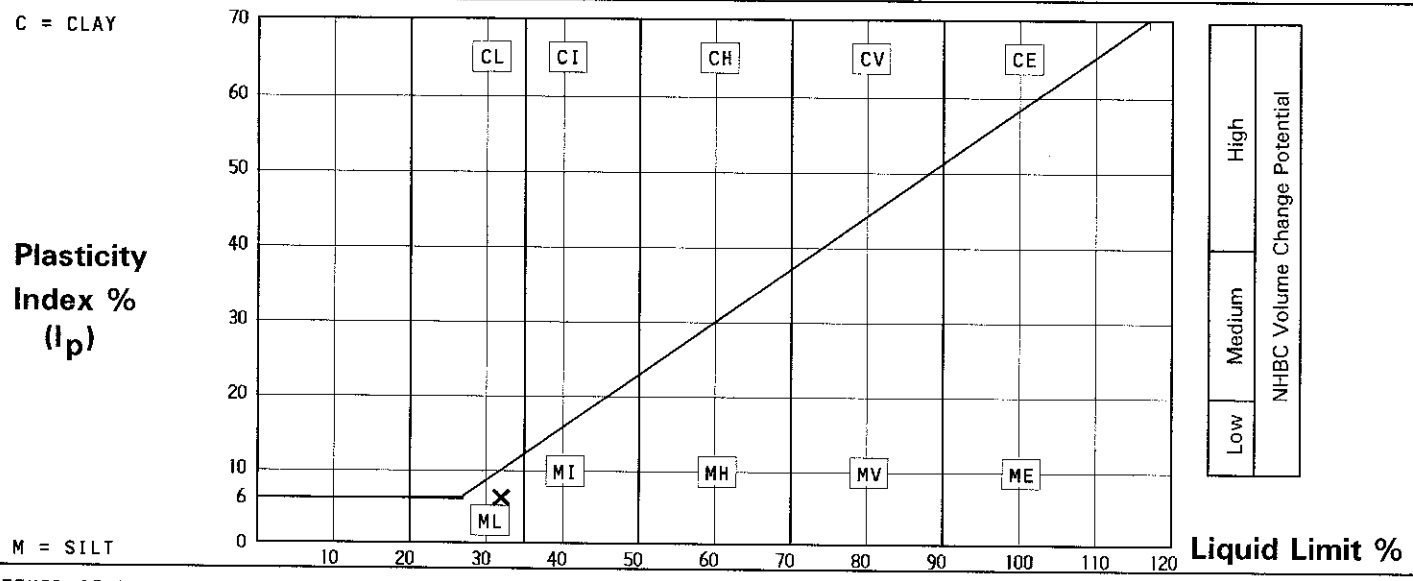
DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
WS03	0.70	D1	27	Brown sandy SILT	

PREPARATION

Method of Preparation	Specimen from Natural Soil
Sample retained 0.425 sieve (Assumed)	0 %
Corrected moisture content for material passing 0.425mm	%
Curing Time	26 Hours

Liquid Limit	32 %
Plastic Limit	26 %
Plasticity Index	6.0 %
Liquidity Index	0.17
Clay Content	Not analysed. %
Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4 , 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 **PAGE** 8 of 13

Contract Harvester Way, Crowland.

Serial No. S27905

UKAS TESTING 0998

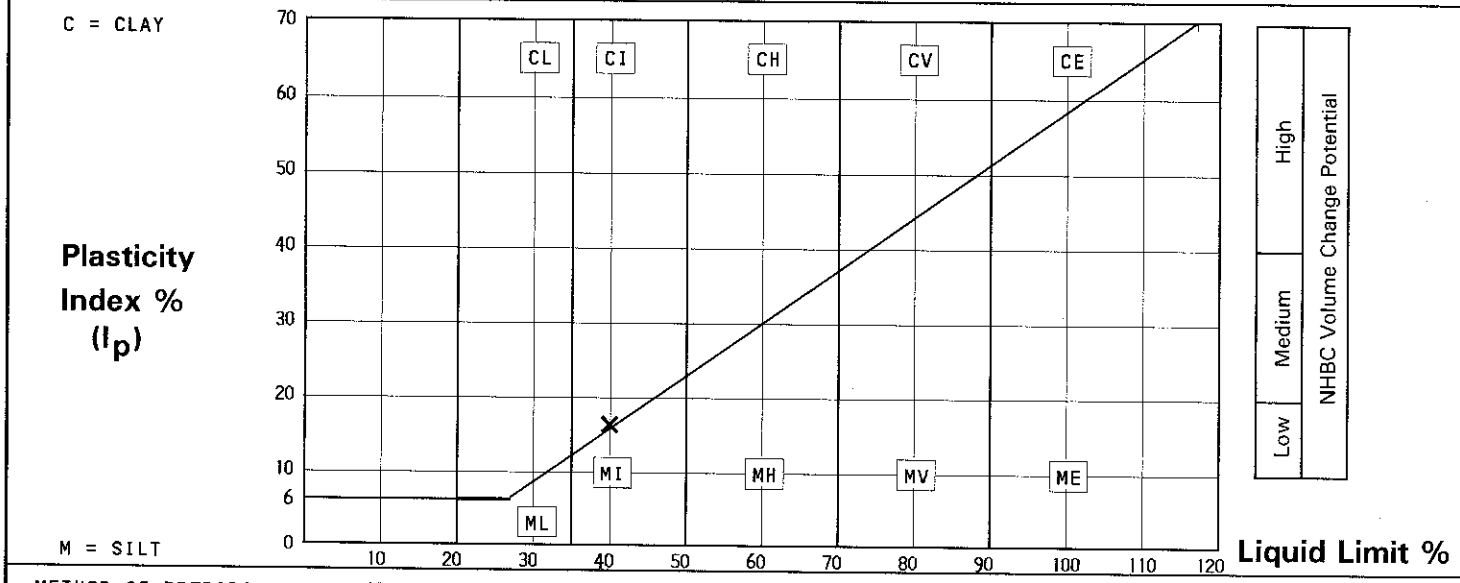
DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
WS06	0.70	D1	27	Firm greyish brown sandy silty CLAY with rare decayed roots	

PREPARATION

Method of Preparation	Specimen from Natural Soil
Sample retained 0.425 sieve (Assumed)	0 %
Corrected moisture content for material passing 0.425mm	%
Curing Time	26 Hours

Liquid Limit	40 %
Plastic Limit	24 %
Plasticity Index	16 %
Liquidity Index	0.19
Clay Content	Not analysed. %
Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4 , 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

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Contract Harvester Way, Crowland.

Serial No. S27905

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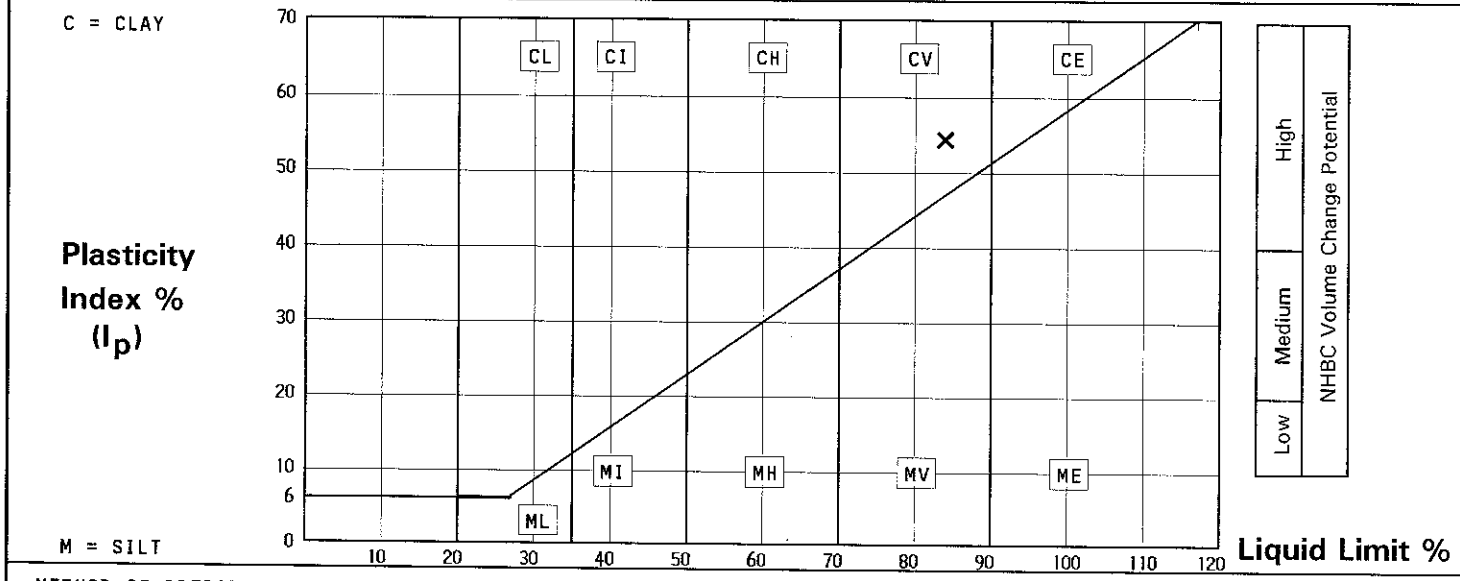
DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
WS08	1.50	D1	64	Very soft brown CLAY with occasional orange mottling, recently active and decayed roots and rare selenite crystals	

PREPARATION

Method of Preparation	Specimen from Natural Soil
Sample retained 0.425 sieve (Assumed)	0 %
Corrected moisture content for material passing 0.425mm	%
Curing Time	26 Hours

Liquid Limit	84 %
Plastic Limit	30 %
Plasticity Index	54 %
Liquidity Index	0.63
Clay Content	Not analysed. %
Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4 , 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : **SOIL PROPERTY TESTING LTD.**

DATE OF ISSUE : As page 1 **PAGE** 10 **of** 13

Contract Harvester Way, Crowland.

Serial No. S27905

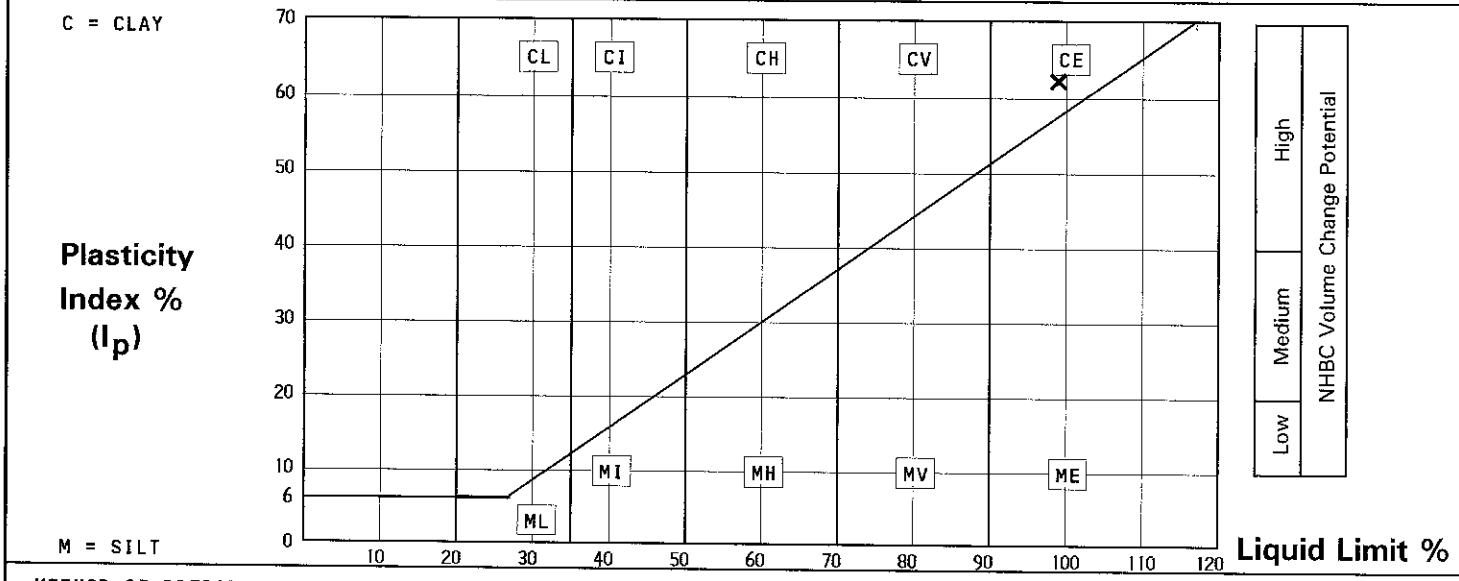
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DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
WS09	0.90	D1	71	Very soft dark grey organic CLAY with occasional black and orange staining and decayed roots	

PREPARATION

Method of Preparation	Specimen from Natural Soil	Liquid Limit	99 %
Sample retained 0.425 sieve	(Assumed) 0 %	Plastic Limit	37 %
Corrected moisture content for material passing 0.425mm	%	Plasticity Index	62 %
Curing Time	27 Hours	Liquidity Index	0.55
		Clay Content	Not analysed. %
		Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4 , 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : **SOIL PROPERTY TESTING LTD.**

DATE OF ISSUE : As page 1 **PAGE** 11 **of** 13

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Serial No. S27905

UKAS TESTING 0998

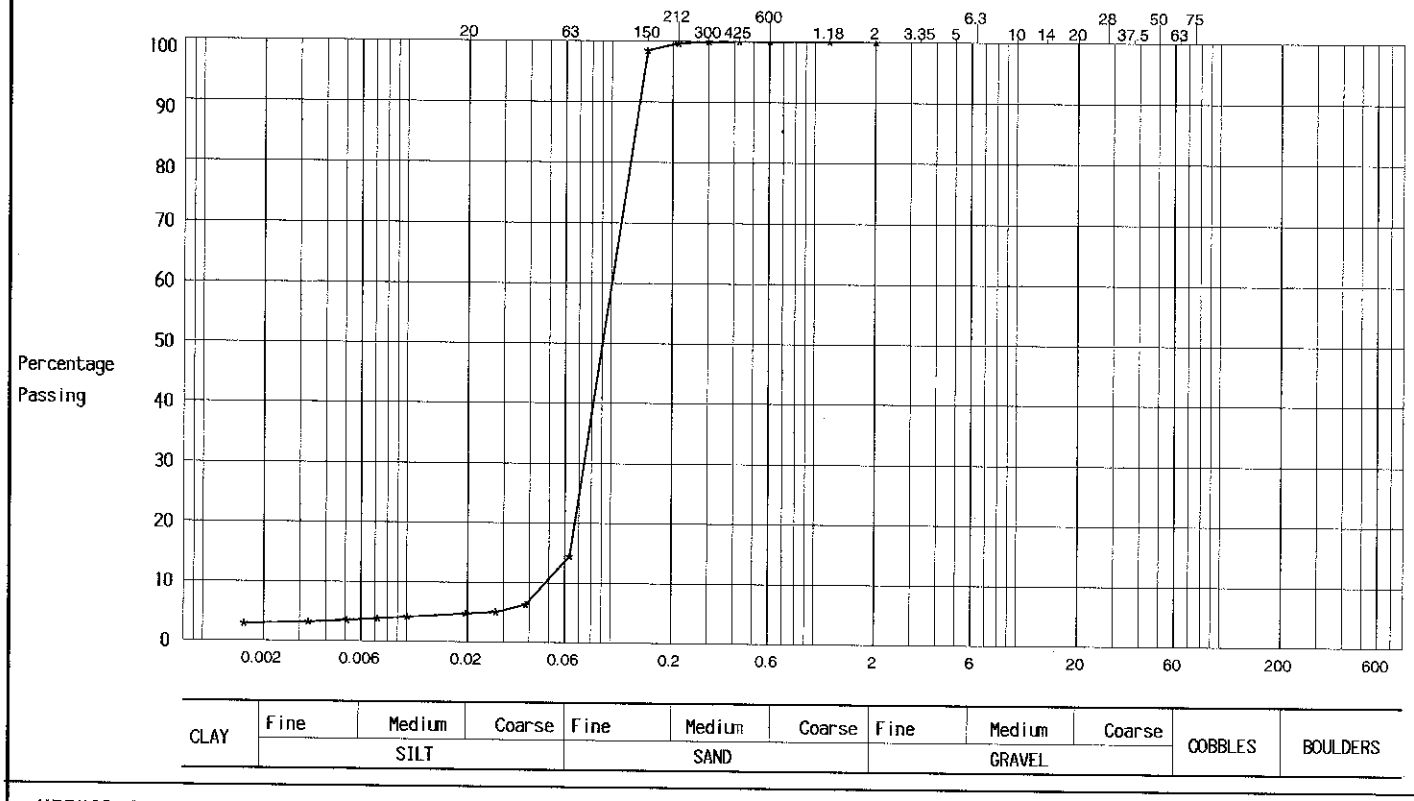
DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole/ Pit No.	Depth m.	Sample	Description	Remarks
WS04	2.20	B1	Dark greyish brown slightly clayey silty SAND	

Method of Test: Wet Sieve + Hydrometer

Method of pre-treatment: Not required

	Size (microns)																Size (mm)										
Sieve Size	1.6	3.3	5.1	7.2	10.1	19.5	27.5	38.5	63	150	212	300	425	600	1.18	2	5	6.3	10	14	20	28	37.5	50	75
Percentage by Mass passing Sieve	3	3	3	4	4	5	5	6	14	98	100	100	100	100	100	100	-	-	-	-	-	-	-	-	-	-



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES	BOULDERS
	SILT			SAND			GRAVEL				

METHOD OF PREPARATION: BS 1377:PART 1:1990:7.3 & 7.4.5

METHOD OF TEST : BS 1377:PART 2:1990:9.2 + 9.5

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS :

REMARKS TO INCLUDE : Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample. Oven drying temperature if not 105-110 deg C.

TEST REPORT.

ISSUED BY : **SOIL PROPERTY TESTING LTD.**

DATE OF ISSUE : As page 1 **PAGE** 12 of 13

Contract Harvester Way, Crowland.

Serial No. S27905

UKAS TESTING 0998

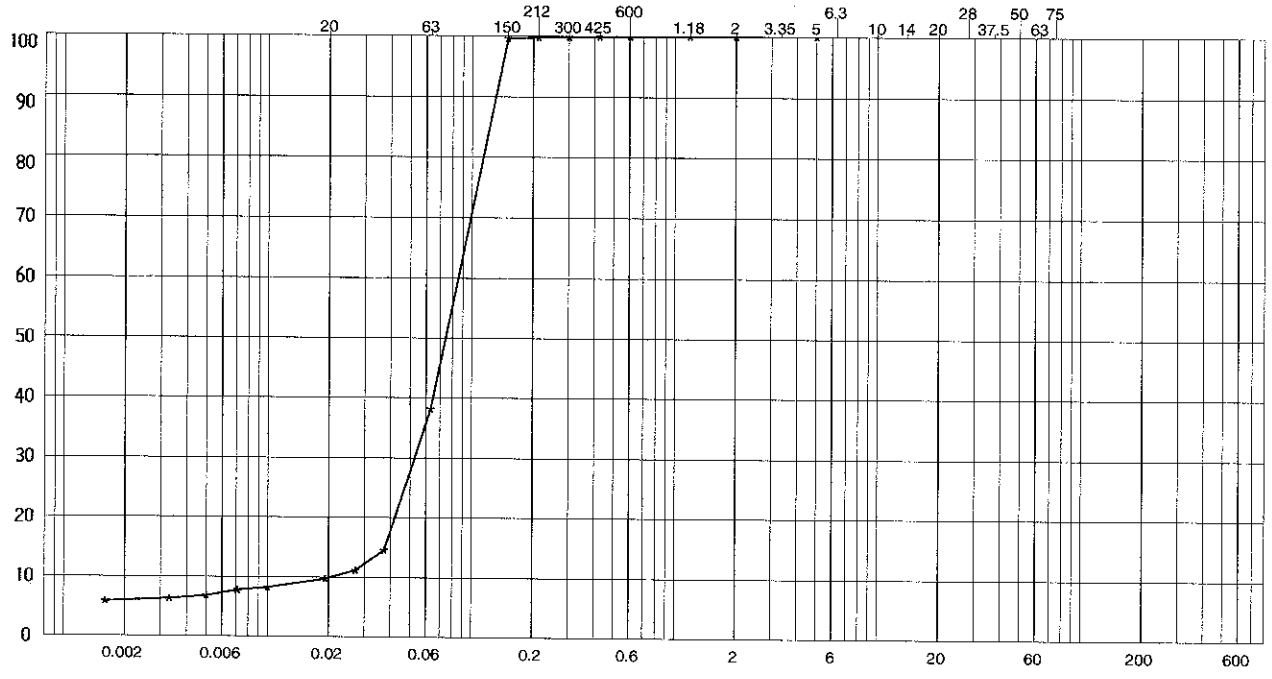
DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole/ Pit No.	Depth m.	Sample	Description	Remarks
WS06	1.00	B1	Yellowish brown and light orangey brown sandy SILT	

Method of Test: Wet Sieve + Hydrometer

Method of pre-treatment: Not required

	Size (microns)																Size (mm)											
Sieve Size	1.6	3.3	5	7.1	10	19.2	27	37.4	63	150	212	300	425	600	1.18	2	5	6.3	10	14	20	28	37.5	50	75
Percentage by Mass passing Sieve	6	6	7	8	8	10	11	14	38	100	100	100	100	100	100	100	100	–	–	–	–	–	–	–	–



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES	BOULDERS
	SILT			SAND			GRAVEL				

METHOD OF PREPARATION: BS 1377:PART 1:1990:7.3 & 7.4.5

METHOD OF TEST : BS 1377:PART 2:1990:9.2 + 9.5

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS :

REMARKS TO INCLUDE : Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample. Oven drying temperature if not 105-110 deg C.

TEST REPORT.

ISSUED BY : **SOIL PROPERTY TESTING LTD.**

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Contract Harvester Way, Crowland.

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DETERMINATION OF THE MASS LOSS ON IGNITION

Borehole/ Pit No.	Depth m.	Sample	% loss of original mass passing 2mm sieve	% of sample passing 2mm sieve	Description	Remarks
WS01	1.50	D2	3.3	100	Very soft brown slightly organic CLAY	
WS04	2.20	B1	0.8	100	Dark greyish brown slightly clayey silty SAND	
WS09	0.90	D1	7.5	100	Very soft dark grey organic CLAY with occasional black and orange staining and decayed roots	

METHOD OF PREPARATION: BS 1377:PART 3:1990:4.3.2

METHOD OF TEST : BS 1377:PART 3:1990:4.3.3

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : NOTE:- DUE TO THE TEMPERATURE INVOLVED (440°C) SOME HELD WATER AND CLAY MINERAL MAY BE BURNT OFF Test not UKAS accredited.

REMARKS TO INCLUDE : Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample. Oven drying temperature if not 105-110 deg C.