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PHASE 2 GROUND INVESTIGATION REPORT

HILLCREST ESTATE

HILLCREST

LONDON N6

Report Reference No. C13269A

On behalf of:-

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N19 5NA

August 2014

HARINGEY COUNCIL

ELLIS & MOORE

CONSULTING ENGINEERS

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INTRODUCTION

Haringey Council, the client, have engaged Consulting Engineers, Ellis & Moore to assess the redevelopment potential of the Hillcrest Estate, Hillcrest, London N6 for residential purposes.

Ground Engineering Limited was instructed to carry out a phase 1 desk study (Report Reference C13269) and phase 2 ground investigation under the direction of Consulting Engineers, Ellis & Moore. This report summarises the findings of the ground investigation in relation to foundation design and construction, and a preliminary contamination assessment based on exploratory hole positions located to minimise tenant disruption rather than target potential sources of contamination, and an updated conceptual model.

LOCATION, TOPOGRAPHY, GEOLOGY AND HYDROGEOLOGY OF THE SITE

Location/Description

The Hillcrest Estate is between the north-eastern side of North Hill and western side of Southwood Lane, some 400m north Highgate High Street, within the Highgate district of the London Borough of Haringey, London N6. The Estate is centred at National Grid Reference TQ 28357 87952.

The approximately pentagonal Estate has a 125m wide frontage on the north-eastern side of North Hill from which it extends east for 115m (south) to 200m (north) through to Southwood Lane. The Estate is bounded to the north by Park House Passage, a footpath, and The Park; and to the south by another footpath, Park Walk.

At the time of this study the Estate was served by a single access road, called Hillcrest, which enters the site from near the centre of the North Hill frontage and runs north-eastwards through the centre of the site to a loop at its north-eastern end. The Estate comprised seven, four to seven-storey residential blocks either side of the central Hillcrest roadway, surrounded by grass communal open spaces, linked by asphalt-surfaced footpaths and with some areas of associated asphalt-surfaced car parking and short rows of residents' garages.

Two electricity sub-stations were present within the Estate; one in the south-eastern corner of the site, and the other to the rear of Alexander House in the western part of the Estate.

Trees were present within and around the site, notably within a conservation area (tree belt) that wrapped around the northern, north-eastern, eastern and southern sides of the Estate. These trees included mature London Plane, Maple, Oak, Pine, Holly, Sycamore, Lime, Hawthorn and Silver Birch.

The area surrounding the site largely comprised semi-detached and detached housing, and residential blocks, with occasional public houses and schools.

Topography

The Estate stands on a hill at the northern end of the Highgate 'high ground'. The elevation around the site falls from south to north, from about 126mOD at the southern end of the Estate, down to 119mOD at the northern end of the site frontage on North Hill, and to 113mOD outside the north-eastern corner of the site on Southwood Lane. The ground levels within the Estate follow a similar trend but also fall towards the eastern boundary.

Geology

The 1934 geological map for this part of London (Sheet II.SW) at 6 inches to 1 mile scale (1:10,560) shows the site at the northern end of the Highgate 'high ground' underlain by the solid geology of the Bagshot Sand. This map indicates the slightly lower ground to the west, north and east to be directly underlain by the underlying Claygate Beds.

This map also depicts the rising of two headwater streams 300m to the north-east and 550m to the east, flowing and converging east-north-eastwards to become the Moselle River, a tributary of the River Lea. The eastern or Highgate source of the River Fleet rises in the grounds of Kenwood House, 800m to the west, and flows south into Highgate Ponds.

The 2006 geological map for the area at 1:50,000 scale, Sheet 256, shows the site to be underlain by the solid geology Bagshot Formation, and then the Claygate Member (formerly Beds), the uppermost unit of the London Clay Formation. The lower slopes of Highgate Hill to the north, west and east are shown to be underlain by the underlying London Clay.

Hydrogeology

The site is designated by the Environment Agency (EA) as being underlain by Secondary (A) Aquifers, the Bagshot Formation and Claygate Member, which overlie the Unproductive stratum of the London Clay. Based on the topography of the site area the direction of near surface groundwater and surface water flow would locally be from south to north.

HISTORY OF THE SITE - SUMMARY

The site was developed at the beginning of the Nineteenth Century when Park House was built, although the hill may have been the site of the former Highgate Brewery. The Park House mansion was an asylum and then a refuge run by nuns until 1940. The site was redeveloped shortly after the Second World War with the seven extant residential blocks, surrounding open space, associated car parking areas and residents' garages.

The surrounding area has had a largely residential use and was developed primarily during the Nineteenth Century, with piecemeal redevelopment of large houses with residential blocks throughout the Twentieth Century.

ENVIRONMENTAL SEARCHES - SUMMARY

A detailed search of Environmental Databases for a radius of 250m from the site indicated the following:

Environmental Permits, Incidents & Registers

There are no environmental permits, incidents or register entries listed for the site apart from four recorded List 1 Dangerous Inventory Sites and three Part B Authorised Activities, within 250m of the site.

Landfill & Waste Sites

There are no (0) recorded current or former landfills, operational or non-operational landfills, waste transfer or scrapyard sites, or Environment Agency licensed waste sites, within 250m of the site.

Potentially Contaminative Uses

Current Industrial Sites: There are three recorded potentially contaminative uses listed for the site address; two electricity sub-stations and the 'office' of a signs producer in one of the flats of Mountbatten House. Those between 50m and 250m of the site include further electricity sub-stations, a drinks supplier, a metalworker, a cleaning equipment supplier, two tanks, an underground railway station, vehicle repairers, publishers, two entries for petrol filling stations on North Road, construction services and a second hand car dealer. There is only one recorded fuel station entry within 250m of the site.

Geology & Hydrogeology – Pathways & Receptors

The site is recorded as not being covered by artificial soils or made ground, or superficial deposits. The site is underlain by the solid geology of the Bagshot Formation and the Claygate Member of the London Clay Formation.

The site is designated as being underlain by a Secondary (A) Aquifers of the solid geology Bagshot Formation and underlying Claygate Member. The latter is underlain, at depth, by Unproductive strata of the London Clay. There are no groundwater abstraction licences held

within 250m of the site. The site does not lie within 250m of a Source Protection Zone. There are no river network/surface water features listed within 250m of the site. The site is not within a Zone 2 or Zone 3 flood plain.

Environmentally Sensitive Receptors

There are no environmentally sensitive areas, reserves, National Parks or other protected areas or parks recorded as being either on or within 250m of the site apart from Queens Wood (formerly Brewhouse Wood), an ancient and semi-natural woodland some 211m north of the site.

Natural Hazards & Mining

According to the British Geological Survey there is a 'Moderate' hazard for Shrinking and Swelling Clays; a 'Low' hazard from Running Sand; a 'Very Low' hazard from Landslides and Collapsible Rocks; and a 'Negligible' hazard for Compressible Ground, Soluble Rocks and Shallow Mining. The site lies within an area where no radon protection measures are necessary for new dwellings or extensions in accordance with Building Research Establishment report BR211 (1999).

PRELIMINARY CONTAMINATION RISK ASSESSMENT

In order to assess the risks associated with the presence of ground contamination the linkages between the sources and potential receptors to contamination need to be established and evaluated. This is in accordance with the Environmental Protection Act 1990, which provides a statutory definition of Contaminated Land. To fall within this definition it is necessary that, as a result of the condition of the land, substances may be present on or under the land such that

- *Significant harm is being caused or there is a significant possibility of such harm being caused; or*
- *Pollution of controlled waters is being, or is likely to be, caused*

There are three principal factors that are assessed whilst undertaking a qualitative risk assessment for any site. These are the presence of a contamination source, the existence of migration pathways and the presence of a sensitive target(s). It should be noted that it is necessary for each element of source, pathway and target to be present in order for exposure of a human or environmental receptor to occur.

UK Government guidance on the assessment of contaminated land, requires risk to human health and the environment to be reviewed using source – pathway – target relationships. If each of these elements is present, the linkage provides a potential risk to the identified targets. ***Contaminants or potential pollutants*** identified as ***sources*** in relation to the identified previous uses are listed overleaf in Table 1.

Table 1: Identified Potential Contaminant Sources

Contaminant Source	*Comments*
Drainage/Buildings	Effluent from leaking drains would provide a contaminant source. The existing buildings may contain asbestos containing materials (ACMs).
Soil Beneath Site	Contamination may be present within any made ground materials beneath the site.
Historical Uses	Former residential uses of the site, as a dwelling, penitentiary and convent.
Current Uses	Electricity sub-stations and car parking spaces. Leakage of oils potentially containing PCBs from the transformers. Spills and leakage from parked vehicles.
Soil Gas	Potential soil gas generated from made ground or natural organic soils. Hydrocarbon vapours from hydrocarbon-impacted soils.
Ground Contamination Outside Site Boundary	Ground contamination migrating from adjoining sites.

A ***Pathway*** is defined as one or more routes through which a receptor is being, or could be, exposed to, or affected by, a given contaminant.

Potential ***Target or Receptors*** fall within the categories of Human Health, Water Environment, Flora and Fauna, and Building Materials.

There are a number of possible pathways for the contaminants identified on the site to impact human and/or environmental receptors and these are summarised in Tables 2 and 3.

Table 2: Human Receptors and Pathways

Human Receptor-Mechanism	*Typical Exposure Pathway*
Human Inhalation	Breathing Dust and Fumes Breathing Gas emissions
Human Ingestion	Eating -contaminated soil, for example by small children -plants grown on contaminated soil Ingesting dust or soil on fruit or vegetables Drinking contaminated water
Human Contact	Direct skin contact with contamination Direct skin contact with contaminated liquids

Table 3: Water Receptors and Pathways

Receptor-Water Environment	*Typical Exposure Pathway*
Groundwater The site is underlain by a Secondary (A) Aquifer, the solid geology of the Bagshot Formation.	Surface infiltration of atmospheric waters into the soils beneath the site could wash or dissolve potential contaminants and migrate to underlying groundwater. Contamination leads to restriction/prevention of use as a resource, for example, drinking water, and can have secondary impacts on other resources, which depend on it.
Surface Water There are no surface water features or watercourses within 250m of the site.	Surface infiltration of atmospheric waters into the soils beneath the site could wash or dissolve potential contaminants and laterally migrate. Contamination leads to a restriction/prevention of use: -as drinking water resource -for amenity use Effects on aquatic life

Preliminary Conceptual Model

Assessment of the potential linkage between ground contamination sources, human and environmental receptors have been assessed based on the desk study research documented in the preceding sections of this report.

A generalised preliminary conceptual model relative to the construction phase and completed development is presented overleaf in Table 4.

Table 4: Preliminary Conceptual Model Relative to Construction/Future Use of Site

Receptors	Pathway	Estimated Potential for Linkage with Contaminant Sources					
		Drainage/ Buildings	Soil Beneath Site	Historical Uses	Current Uses	Soil Gas	Ground Contamination Outside Site Boundary
Human Health – ground workers	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Likely	Likely	Low likelihood	Low likelihood	Low likelihood	Low likelihood
Human Health – users of completed development	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Unlikely	Low likelihood	Low likelihood	Low likelihood	Low likelihood	Low likelihood
Water Environment	Migration through ground into surface water or groundwater	Low likelihood	Low likelihood	Likely	Low likelihood	Unlikely	Unlikely
Flora	Vegetation on site growing on contaminated soil.	Low likelihood	Low likelihood	Low likelihood	Low likelihood	Unlikely	Low likelihood
Building Materials	Contact with contaminated soil	Low likelihood	Low likelihood	Low likelihood	Low likelihood	Unlikely	Low likelihood

Key to Table 4

Estimated Potential for Linkage with Contaminant Source	Definition
High likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such an event would take place, and is less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.
N/A	Not Applicable

SITE WORK

Two deep boreholes, three shallow boreholes and two foundation inspection pits were undertaken at positions previously agreed on site with the Engineer and Client, one of which was subsequently amended following further instruction, and are depicted on the site plan at the rear of this report.

The investigation was undertaken following the protocols detailed in British Standards (BS) 'Code of Practice for Site Investigations' (BS5930:1999) and 'Methods of test for soils for engineering purposes' (BS1377:1990).

Services information was obtained in relation to the exploratory hole positions prior to boring/excavation. The elevation at the hole positions have been interpolated using the spot heights detailed on a site survey drawing provided by the Engineer.

Boreholes

Two boreholes (BH 1 and BH 2) were originally intended to be undertaken by a standard cable percussive boring rig to 25.00m depth. However, in light of tenant's concerns, BH 2 was replaced with a shallow borehole (WS 4) at a nearby location. Borehole BH 1 was completed between 2nd and 5th June 2014 at the position denoted on the site plan. The borehole position was scanned using a cable avoidance tool (CAT) and a starter pit was then dug to 1.20m depth using hand tools, in order to ensure the absence of buried services and tree roots. The borehole was then advanced using weighted shell and claycutter tools, initially working within 150mm diameter casing. The borehole was completed at 25.45m below ground level.

Undisturbed samples (U) of 100mm in diameter were taken at regular intervals in clay soils. The ends of each sample were capped to maintain it in as representative condition as possible during transit to the laboratory.

Standard penetration tests were undertaken in order to give an indication of the in-situ relative density/shear strength of the soils encountered in BH 1, and following failed attempts

to recover undisturbed samples. The test was made by driving a 50mm diameter solid cone point (C) or open shoe and split spoon sampler (S) into the soil at the base of the borehole by means of an automatic trip hammer weighing 63.50kg falling freely through 760mm. The penetration resistance was determined as the number of blows (N) required to drive the tool the final 300mm of a total penetration of 450mm into the soil ahead of the borehole. The results have been tabulated and plotted against depth in Figure 1.

Representative small (D) and bulk (B) disturbed samples of soil were taken from the boring tools at regular intervals throughout the depth of the borehole. A sample of water (W) was recovered from the borehole once sufficient water had accumulated for collection.

On completion of boring, a 50mm diameter standpipe was installed to 10.00m depth in BH 1. The annulus around the standpipe was backfilled with pea gravel with a bentonite seal placed around the top of the installation within 1.00m of ground level. A gas tap was installed in the top of the standpipe. A protective steel stopcock cover was concreted into the ground flush with the surface over the installation. Below the installation the borehole was infilled with clean arisings.

The borehole record gives the descriptions and depths of the various strata encountered, results of the in-situ tests, details of all samples taken and the groundwater conditions observed during boring, on completion and within the BH 1 standpipe.

Window Sample Boreholes

Three 6.45m deep window sample boreholes (WS 1 to WS 3) were undertaken on 2nd June 2014, under the supervision of a Geoenvironmental Engineer, and the replacement borehole (WS 4) was subsequently taken to 10.45m below ground level on 5th June 2014. The final borehole positions were chosen following a scan using a cable avoidance tool (CAT). Prior to boring at each position a starter pit was hand dug to 1.20m depth in order to confirm the absence of buried services. Small disturbed samples (D) of soil were recovered at regular intervals within these starter pits and the boreholes.

The window sampling equipment consisted of 1.00m long drive-in samplers of specially constructed and strengthened 87mm to 57mm diameter steel sample tubes with a plastic core-liner. The samplers were driven into the ground from the base of the hole by an automatic trip hammer weighing 63.50kg falling freely through 750mm. Upon extraction a continuous profile of the soil was obtained in the plastic liners (U) inserted in the samplers. The liners were split, sub-sampled and described by the supervising Geoenvironmental Engineer.

Standard penetration tests were undertaken in the window sample boreholes at regular intervals in order to give an indication of the in-situ relative density/shear strength of the material. The test was made by driving a 50mm diameter split spoon and open shoe sampler (S) into the soil at the base of the borehole by means of an automatic trip hammer weighing 63.50kg falling freely through 750mm. The penetration resistance was determined as the number of blows required to drive the tool the final 300mm of a total penetration of 450mm into the soil ahead of the borehole. The results have been tabulated to the rear of the window sample borehole records and have been plotted against depth in Figure 1.

On completion of boring WS 4, a 38mm diameter standpipe was installed to 10.00m depth. The annulus around the standpipe was backfilled with pea gravel with a bentonite seal placed around the top of the installation within 1.00m of ground level. A gas tap was installed in the top of the standpipe. A protective steel stopcock cover was concreted into the ground flush with the surface over the installation. The three other boreholes were backfilled with arisings and the surface layers reinstated.

The borehole records give the descriptions and depths of the various strata encountered, results of the in-situ tests, details of all samples taken and the groundwater conditions observed during boring, on completion and in the WS 4 standpipe.

Trial Pits

Two foundation inspection pits (TPs 1 and 2) were undertaken using hand tools and a small hydraulic breaker on 2nd June 2014. The exposed strata and foundations were

logged and the soils sampled by the supervising Geoenvironmental Engineer. The hand dug pits were 1.65m and 1.70m deep.

An immediate assessment of the apparent soil cohesion was made using a Pilcon hand shear vane (V) in clay soils of TP 1. The average of three readings was recorded at each position.

A Mackintosh Probe was used to ascertain the in-situ relative density of coarse grained soils in the base of TP 2. The 25mm diameter solid cone point of the probe was screwed onto the rods and driven into the ground by repeated blows of a 4.5kg slide hammer with a fall of 0.3m. The depth driven for 100 blows was recorded.

Disturbed samples of soil were taken at regular intervals throughout these pits and placed in polycarbonate pots (D samples). Samples of water (W) were recovered from the pits once sufficient water had accumulated for collection.

The trial pit records give descriptions and depths of the various strata encountered, the details of all samples, the results of the in-situ tests and the groundwater conditions observed during excavation. Sketch sections, plans and photographs of the exposed footings in the foundation inspection pits are presented on the pages following the record for the relevant excavation.

On completion of each excavation, the spoil was returned to the pit and placed in layers, which were recompacted and the surface layers reinstated.

Gas and Groundwater Monitoring

Six return visits were made on 12th, 19th and 24th June, 16th and 22nd July, and 6th August 2014 in order to monitor methane, carbon dioxide and oxygen gas levels in the BH 1 and WS 4 standpipes. Ambient pressures and flow rates were recorded together with the depth to groundwater. The water levels have been added to the borehole records and the gas/groundwater results are presented following the exploratory hole records.

LABORATORY TESTING

The samples were inspected in the laboratory and assessments of the soil characteristics have been taken into account during preparation of the exploratory hole records. The soil sample descriptions are in accordance with BS5930:1999.

The chemical testing schedule was devised by Ground Engineering Limited for a broad suite of potential contaminants, outlined by the Environment Agency (EA) and National House Building Council (NHBC) document R&D 66; 2008 'Guidance for the Safe Development of Housing on Land Affected by Contamination'.

The geotechnical tests were conducted to BS1377:1990 and other industry standards, and the results are presented following the exploratory hole records, whilst the results of the chemical tests are presented in Appendix 1.

Geotechnical Testing

The index properties of selected soil samples were determined as a guide to soil classification and behaviour. The liquid limit was determined by the cone penetrometer method.

The particle size distribution of selected samples was obtained by sieve analysis. Results of these tests are given as particle size distribution curves at the end of this report.

Test specimens were prepared at full diameter from the undisturbed samples recovered from borehole BH 1 and the sub-sampled liners of window sample borehole WS 4. Immediate undrained triaxial compression tests were made on the samples at full diameter using the multi-stage technique or at a single pressure equivalent to the overburden pressure at that sample's depth. The results of these tests have been plotted against depth in Figure 2. The moisture content and bulk densities of each specimen were also determined.

An indication of the settlement characteristics of selected samples were obtained from tests in the consolidation apparatus or oedometer. Each test was performed on a 75mm diameter sample, about 19mm thick, contained in a steel ring. The sample was saturated and the

swelling pressure balanced prior to applying a constant load with drainage at both ends. When primary compression was complete, the load was increased and this repeated for three increments of load. The sample was then unloaded in a single stage. The rate and total amount of consolidation were continually monitored using a computer controlled E.L.E. Datasystem 7 Unit. The results were plotted and analysed by the computer for each increment of load to obtain the coefficients of compressibility (m_v), and of consolidation (c_v), which govern the amount and rate of settlement, respectively.

California Bearing Ratio (CBR) tests were performed on a selected recompacted sample of near surface soils from BH 1, which were compacted using a 2.5kg rammer. The test consisted of jacking into the remoulded soil a cylindrical plunger with a cross sectional area of 1935mm^2. A force of 50N was applied initially to seat the plunger on the soil surface and then the plunger was made to penetrate the soil at a uniform rate of 1mm/min. Readings of force were taken at intervals of penetration of 0.25mm to a penetration not exceeding 7.50mm. The CBR value is the ratio of the force required to achieve 2.50mm or 5.00mm penetration to standard forces expressed as a percentage.

Selected samples of soil and water were analysed to determine the concentration of soluble sulphates. The pH values were also determined using an electrometric method.

Chemical Testing

Eight soil samples recovered from the exploratory holes were tested for total concentrations of arsenic, cadmium, chromium, lead, mercury, selenium, nickel and benzo[a]pyrene, together with speciated polyaromatic hydrocarbons (PAH), boron, copper and zinc, phenols, total and free cyanide, hexavalent chromium, sulphate, sulphide and pH. The soil samples were also tested for organic content. Five soil samples were also screened for total petroleum hydrocarbons (TPH).

Two samples of made ground from WS 1 at 0.60m depth and WS 2 at 1.10m depth were scheduled for a full Waste Acceptance Criteria (WAC) CEN Leachate Suite at 2l/kg and 10l/kg.

GROUND CONDITIONS

The ground conditions encountered were broadly as expected from the geological records with a variable thickness of made ground covering remnants of the expected solid geology Bagshot Formation sand, then the silty clays and clayey sands of the Claygate Member, and the underlying London Clay. A longitudinal section depicting the soil sequence encountered by the exploratory holes is presented as Figure 3 at the rear of this report.

Made Ground

The surface layer of made ground penetrated at TP 1 comprised 0.30m of asphalt. Elsewhere the exploratory holes were through 'soft ground' and began either within a firm, friable, dark brown, slightly gravelly, sandy clay/silt, clay or loose, dark brown silty sand and gravel with clay pockets, all with a gravel fraction of flint, brick, mortar, glass, ash, pottery, quartz, quartzite, slate and clinker. The clay fill was locally soft in the trial pits, or very stiff in WS 3 where apparently desiccated.

The base of the made ground was proved at depths between 0.90m (TP 2 and WS 4) and 1.30m (WS 3) within the central eastern part of the site, and 1.00m (TP 1), 1.70m (WS 1), 1.90m (BH 1) and 3.00m (WS 2) in the north-western part of the estate.

Bagshot Formation

In three of the exploratory holes, WS 1, WS 4 and TP 2 the made ground covered a medium dense, light brown, silty fine sand. This typical Bagshot Formation sand was met at 0.90m to 1.70m depth; was found to at least 1.65m below ground level in TP 2; and proved to 1.20m and 2.50m depth in WS 4 and WS 1, respectively.

The elevation of the base of this 0.30m to 0.80m thick stratum was proved at 121.33mOD (WS 1) and 124.98mOD (WS 4).

Claygate Member

The firm, becoming stiff, light brown, orange brown and light grey mottled, slightly sandy to sandy, silty clays of the Claygate Member contained occasional sand laminae and rare gravel size ferruginous concretions, and was found beneath the made ground or Bagshot Formation sand at depths between 1.00m and 3.00m. The three 6.45m deep window sample boreholes were completed within this stratum whilst the two deeper boreholes continued within it. With increasing depth the Claygate Member contained subordinate layers of medium dense, light brown and orange brown silty fine sand with laminae or thin bands of firm clay, whilst the clay layers had occasional bands of silty fine sand within them. Borehole WS 4 was completed in a layer of dense sand at 10.45m depth.

Below 14.00m depth in borehole BH 1 the Claygate Member strata graded down into a medium dense, dark grey, silty fine sand with many bands of stiff, dark grey clay, and this was proved to 17.60m depth (104.95mOD), a thickness of 15.70m.

London Clay

The underlying stiff, dark grey and dark brown mottled, slightly sandy, silty clay with occasional gravel size pyrite nodules, has been ascribed here to the London Clay rather than the Claygate Member. Below 20.00m depth the London Clay became a very stiff, fissured, grey brown and dark brown mottled, silty clay with occasional partings of light brown silt and fine sand.

Borehole BH 1 was completed within this stratum at 25.45m below ground level.

Groundwater

Water was met in both of the shallow trial pits at 1.30m (TP 2) and 1.60m (TP 1). The water levels rose within the excavations to stand at 1.10m and 1.55m, respectively.

The four window sample boreholes were dry during boring and on completion.

The deepest borehole, BH 1, encountered water within the Claygate Member at 13.30m depth, which rose to 11.40m before drilling resumed fifteen minutes later, and then again shortly after it had been sealed out by the casing. The second ingress was at 14.20m depth and this strike rose to 12.40m before boring recommenced. Water was sealed out of the hole by the casing in the London Clay at 19.00m depth, and the hole was dry on completion. Removal of the casing resulted in a water level of 8.80m below ground level.

The 10.00m deep standpipe in borehole WS 4, which was located within the higher ground within the central, eastern part of the site, was dry on the six occasions that it was monitored. Water levels in the BH 1 standpipe was recorded at 8.07m to 8.21m below ground level, about 114.5mOD, during the monitoring period in June, July and August 2014.

Observations

Live roots were generally recorded to depths between 0.60m and 4.00m below ground level, with the deepest recorded in BH 1, WS 1 and WS 2 close to the tree belt around the northern side of the site.

The sides of the trial pits were stable until water was met, after which the sides were unstable.

Evidence of Contamination

The made ground contained occasional pieces of ash, brick, clinker, concrete, pottery, glass, asphalt, plastic and mortar. There was no olfactory or visual evidence of hydrocarbon contamination. No visual evidence of asbestos containing material was observed within the exploratory holes.

Existing Foundations

Trial pit TP 1 found the north-western corner of the seven-storey Mountbatten House to be based on a 0.84m thick and 1.63m deep concrete foundation, which projected about 0.50m from the building.

Trial pit TP 2 found the south-eastern corner of the seven-storey Dowding House to be based on a 0.70m thick concrete foundation based at 1.44m below ground level that projected 0.64m from the building.

COMMENTS ON THE GROUND CONDITIONS IN RELATION TO FOUNDATION DESIGN AND CONSTRUCTION

The investigation found a variable cover of made ground, underlain by local remnants of the expected solid geology of the Bagshot Formation sand, and then the underlying Claygate Member and London Clay. Foundations for new buildings on this site will need to penetrate the made ground and will either need to be supported on deepened foundations within the underlying naturally deposited soils, due to the presence of trees within and around this site, or alternatively supported on piles taken down into the Claygate Member and London Clay at depth.

Foundation Depths

The exploratory holes encountered made ground to depths between 0.90m and 3.00m associated with the historical residential uses of the site. Large scale processes of natural sedimentation allow a certain degree of confidence to be placed in the absence of important variation of the engineering properties of natural soils across sites. By contrast, made ground, whose history is not completely known, must, despite any amount of investigation, inevitably present the possibility of conditions existing which could not be accepted when considering the material as a bearing stratum.

The medium dense Bagshot Formation sand may be regarded as non-shrinkable but is of limited thickness and apparently limited to parts of the southern half of the site, and so is unlikely to be suitable as a bearing stratum. The results of the in-situ SPTs in the Bagshot Formation sand indicate an allowable bearing pressure of 100kN/m^2 could be applied on a footing up to 1.20m wide, for up to 25mm of immediate settlement, for small-scale structures founded within it.

The near surface Claygate Member clay was found to have modified plasticity indices of 33% and 35% and so a medium volume change potential. A minimum foundation

depth of 0.90m below existing or finished ground level, whichever is deepest, could be adopted on this site, where natural ground is present at such a depth. The presence of trees within and around the site will locally have increased the depth affected by seasonal changes in moisture content of the clay soils. Reference to the National House Building Council (NHBC) Standards Chapter 4.2 "Building near trees" (2010) indicates increased footing depths in the order of 1.95m where mature moderate water demand London Plane, Sycamore, Horse Chestnut and Maple trees are 1.00m from the proposed foundations, in these medium volume change potential clays, but at least 2.50m within 6.00m of a mature Oak. The presence of live roots to depths of 3.00m and 4.00m below ground level is considered to reflect the sloping nature of the site periphery and hence the potential for trees to be at lower elevations than the site.

The proposed building levels will need to be taken into account when determining the minimum foundation depth requirements in respect of trees, and their relative elevations, on and around this site once building positions have been confirmed. It should be noted that where footings are deepened in this regard they will need to be at least 0.50m below the deepest live root.

Foundations within the range of influence of trees, whether they are removed or retained, will have to be separated from the soil by a suitable void former. The required gap dimensions for footings in the medium volume change potential clay soils are detailed in the previously cited NHBC document.

In summary, foundations for new buildings will need to be a minimum of 0.90m deep and may need to be taken to at least 4.50m below ground level or greater, in order to penetrate the depth of potential tree root-induced desiccation around the edge of this site.

Bearing Capacity

The Claygate Member strata below 0.90m depth was generally of a firm consistency and the design of footings placed upon it should use a conservative net safe bearing capacity of 100kN/m^2, for a 1.00m wide strip footing, with a factor of safety of 3.0 against

general shear failure, whilst a 1.00m wide square pad at the same depth could be designed using a maximum safe bearing capacity value of 120kN/m^2, with the same factor of safety.

Deepened foundations taken down to 2.00m and 3.00m depth, would be based on clay with a similar shear strength, which would have net safe bearing capacities of 115kN/m^2 (2.00m deep) and 125kN/m^2 (3.00m deep) for a 1.00m wide strip footing, with a factor of safety of 3.0 against general shear failure, whilst a 1.00m wide square pad at the same depths could be designed using maximum safe bearing capacity values of 140kN/m^2 (2.00m deep) and 150kN/m^2 (2.00m deep) with the same factor of safety. These values may not be sufficient to support the proposed structures on practical width foundations.

The results of the oedometer tests indicate that consolidation settlement within the Claygate Member would be in the order of 10mm to 20mm for the foundations and bearing pressures detailed above, and so within tolerable limits for load bearing brickwork. The settlement could take three to nine months to be complete, depending on the presence of sand layers, and would be differential to existing buildings.

Excavations/Groundwater

Foundation excavations on this site may well encounter water 'perched' within the made ground and soils at shallow depth, as was recorded in the two trial pits adjacent the existing buildings. This will depend on the time of the year when construction takes place. Groundwater levels within the solid geology strata at depth were recorded at about 8.1m below ground level in BH1, some 114.5mOD. The variation in groundwater level could be monitored in the borehole BH 1 and WS 4 installations.

In the event that foundation excavations encountered 'perched' water they will need to be dewatered by screened sump pump techniques. The clay of the Claygate Member may be regarded as highly susceptible to 'loss of strength' if inundated, and so the control of groundwater and surface water run-off is important if the modest bearing properties of these strata are not to be compromised.

The base of foundation excavations should be inspected on completion to ensure that the condition of the soil complies with that assumed in design. Should pockets of inferior material be present, they should be removed and replaced with well graded hardcore or lean mix concrete. The excavated surface should be protected from deterioration and a blinding layer of concrete used where foundations are not completed without delay.

Safety precautions should not be neglected especially where personnel are to enter excavations, when close side support will be required in order to maintain excavation stability. All excavations should be undertaken in accordance with CIRIA Report 97 '*Trenching Practice*'. This is especially important on this site as foundation excavations are unlikely to stand unsupported even in the short term where 'perched' water is present.

Piled Foundations

Piled foundations may well prove most suitable for the proposed structures on this tree-affected site. The ground conditions are considered suitable for bored or CFA, but not driven piles as the vibrations during installation of driven piles could damage nearby buildings in this residential area. The advice of specialist piling contractors should be sought as to their preferred method of pile installation in these conditions.

In order to avoid piles being subjected to the effect of future seasonal and tree root-induced moisture content and volume changes, predominantly heave, it will be necessary to either sleeve the piles to a minimum depth in excess of the maximum potential root depth, or ensure that the piles are reinforced sufficiently to withstand any uplift forces due to such changes. Similarly compressible material would need to be placed around pile caps and ground beams. These measures will be particularly relevant following the removal of trees from this site.

Bored piles will require the use of casing to maintain hole side stability and exclude groundwater.

Preliminary working loads for a single bored pile may be estimated for design and cost purposes using pile bearing coefficients, which are based on the following assumptions.

1) The ultimate load on a pile would be the sum of the side friction/adhesion acting on the pile shaft together with the end bearing load.

2) The pile bearing properties within potentially desiccated soils to 3.00m or 4.00m below ground level will need to be ignored within the range of influence of trees in and around this site, notably those at lower elevations.

3) In sand, shaft friction and end bearing would be a function of the in-situ standard penetration test results (Figure 1) and effective overburden pressure.

4) In clay, the shaft adhesion and end bearing would be a function of apparent cohesion values determined by the in-situ hand vane tests and the laboratory triaxial compression strength tests (Figure 2).

5) A factor of safety of at least 2.0 would be used to assess pile working loads. If test loading of selected piles were not practical the factor of safety would be increased to at least 2.5.

Item	**Ultimate Pile Bearing Value kN/m^2**
Shaft adhesion in potentially desiccated clay to 119mOD	Ignored
Average shaft adhesion in firm Claygate Member, 119mOD to 118mOD	25
Average shaft friction in Claygate Member sand, 118mOD to 117mOD	15
Average shaft adhesion in Claygate Member clay, 117mOD to 115mOD	60
Average shaft friction in Claygate Member sand, 115mOD to 105mOD	35
Average shaft adhesion in London Clay below 105mOD	60
End bearing in stiff Claygate Member clay, 117mOD to 115mOD	1080
End bearing in medium dense Claygate Member sand at 108mOD	5600
End bearing in London Clay	1080

Using these coefficients it is estimated that a single, 450mm diameter bored pile installed to about 14.5m below existing ground level at BH 1, 108mOD, would have an

anticipated working load of 585kN, with a factor of safety of 2.5, whilst a 600mm diameter pile taken to the same depth would have an increased working load of 940kN. Different pile lengths, or diameters, from those detailed above would give different available working loads, which could be tailored to suit the working loads required.

However, in light of the variable succession of interbedded sandy clays and clayey sands of the Claygate Member across this large site, it may be considered prudent to extend piled foundations down into the underlying London Clay, which was met below 105mOD, as this stiff becoming very stiff clay has relatively uniform bearing properties. For example, 450mm and 600mm diameter piles taken to 24m depth at BH 1 would have pile working loads of 600kN and 825kN, both with a factor of safety of 2.5. Alternatively an increased number of boreholes should be undertaken to confirm the pile bearing properties of the Claygate Member strata, once the building positions have been confirmed.

A piling specialist should undertake final design of piles.

Floor Slab

On this site where the floor slabs of the proposed buildings are likely to lie within the range of influence of the trees they will need to be suspended on the foundations and have a sub-floor gap to accommodate potential heave. The required sub-floor gap dimension for medium volume potential clays are detailed in the previously cited NHBC document.

Buried Concrete

Sulphate analysis of the soil and water samples tested gave results in Design Sulphate Classes DS-1 and DS-2 of the BRE Special Digest 1, Table C2 (2005) presented in Appendix 2. The single DS-2 result was obtained from the London Clay at depth. The pH results were between 5.0 and 7.8, and so acidic to mildly alkaline.

The London Clay Formation, including the Claygate Member, is listed in this publication as being a stratum that may contain sulphides, such as pyrite, hence oxidation due to

disturbance during the excavation of foundations may increase the total potential sulphate content. Visual evidence of pyrite beneath this site was occasionally recorded at depth. It should be noted that the use of piled foundations would minimise disturbance of the ground and consequently reduce the potential for the oxidation of any pyritic clay.

Using the sulphate and pH results an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-3z would be considered appropriate for buried concrete beneath this site as detailed in the above cited BRE document.

Pavement Design

The results of the laboratory CBR tests ranged between 21% and 22% from the single sample of made ground tested.

Table 5.1 of Interim Advice Note (IAN) 73/06, Revision 1 (2009), indicates a design CBR value of 2.5% and 3.0% for thin roads, on a site underlain by clay with a plasticity index of 30% and 40%, respectively, such as the near surface Claygate Member clay found across parts of the site at likely sub-grade level.

Provided that the sub-grade is compacted using a vibratory roller and any particularly soft pockets are removed and replaced, a design CBR value of 2.5% could be adopted for hardstanding and road design on the clay soils at shallow depth beneath this site.

Where the sub-grade is the frost-susceptible silty fine sand of the Bagshot Formation a minimum construction thickness of 450mm will be required to avoid the potential damaging effects of frost action.

COMMENTS ON THE CHEMICAL TEST RESULTS

The results of the laboratory chemical testing on soil samples have been compared to CLEA Soil Screening Values (SSVs) and Category 4 Screening Levels (C4SLs), which have been used as screening tools for use in the assessment of land affected by contamination.

Atkins Limited has derived ATRISKsoil SSVs based on the default assumptions provided in SR3, which have been used in the development of the Soil Guideline Values (SGVs) published by the Environment Agency in 2009. Atkins SSVs have been derived in line with the Environment Agency 2009 guidance (SR2, SR3, SR4, SR7) using the CLEA v1.04 and CLEA v1.06 software. These are provided under licence to Ground Engineering Limited, and respective toxicology reports and technical details on the derivation of the SSVs can be provided on request.

Following revised statutory guidance to support Part 2A of the Environment Protection Act (April 2012), Final Category 4 Screening Levels have recently been published (for arsenic, benzene, benzo(a)pyrene, cadmium, chromium VI and lead) by the Department for Environment Food and Rural Affairs in their document SP1010: March 2014. With the exception of lead the C4SLs are higher than the SSVs.

The following standard land uses form the basis of the assessment in relation to soils:

- Residential use with home grown produce
- Residential use without home grown produce
- Commercial and industrial usage

The intended purpose of the SSVs are as "intervention values" in the regulatory framework for assessment of human health risks in relation to land use. These values are not binding standards, but are intended to inform judgements about the need for action to ensure that a new use of land does not pose any unacceptable risks to the health of the intended users.

Table 5 compares the test results for the made ground with the SSVs, and C4SLs for lead, in relation to the specified uses. The numbers of test results, which exceed these values, are also provided.

Table 5: Comparison of Chemical Test Results with Soil Screening Criteria (SSCs)

Determinand	Number of Samples	Min Value (mg/kg)	Max Value (mg/kg)	Number of Samples Exceeding SSC for:			Measured 95th Percentile (mg/kg)	Soil Screening Criteria (1% SOM)			
				Residential with home grown produce	Residential without home grown produce	Commercial/ Industrial		Assessment Method	Residential with home grown produce (mg/kg)	Residential without home grown produce (mg/kg)	Commercial/ Industrial (mg/kg)
Organic matter	8	0.95%	10%	-	-	-	-	-	-	-	-
Arsenic	8	9.3	28	0	0	0	18.51	SSV	32	35	640
Cadmium	8	<0.10	0.81	0	0	0	0.39	SSV	10	83	230
Trivalent* Chromium	8	19	26	0	0	0	24.29	SSV	12,800	15,500	21,300
Hexavalent Chromium	8	<0.50	<0.50	0	0	0	<0.50	SSV	14	38	330
Lead	8	57	950	5	3	0	421.91	C4SL	200#	310#	2330#
Mercury	8	0.24	9.2	1	1	0	3.70	SSV	6	7	66
Selenium	8	0.50	1.1	0	0	0	0.81	SSV	350	595	13,000
Nickel	8	5.4	21	0	0	0	15.27	SSV	130	130	1800
Phenols	8	<0.30	<0.30	0	0	0	<0.30	SSV	162	262	686
Benzo[a]pyrene	8	<0.1	1.6	1	1	0	0.64	SSV	0.8	0.9	14
Copper	8	14	88	0	0	0	59.80	SSV	3970	8370	109,000
Zinc	8	30	400	0	0	0	193.57	SSV	16,900	46,800	917,000
Free Cyanide	8	<0.50	<0.50	0	0	0	<0.50	SSV	34	34	34

Notes

*The concentration of Trivalent Chromium is assumed to be equivalent to the Total Chromium concentration. This is because most naturally occurring chromium is in the trivalent (chromic) state.

Category 4 Screening Levels for lead are based on 6% SOM.

Discussion of Results and Statistics

The results of the laboratory analysis (Table 5) indicate the made ground beneath the site contains a single elevated concentration of lead, mercury and benzo[a]pyrene, which exceeded residential soil screening criteria. The elevated lead, mercury and benzo[a]pyrene concentrations did not exceed the screening values for a commercial/industrial end use. None of the other contaminants tested for exceeded their respective screening values for a residential or commercial/industrial land use.

Statistical analysis, based on the mean value test, indicates that the US95 value for lead exceeded its screening value for a residential with home grown produce end use and residential without home grown produce end use. The maximum value test for the lead data indicates that the highest value obtained is not a statistical outlier, and so is representative of the sample population. However, the highest mercury (9.2mg/kg) and benzo[a]pyrene (1.6mg/kg) results were found to be statistical outliers and so are respective 'hotspots' of mercury and benzo[a]pyrene contamination. Both of these 'hotspot' results were obtained from the ashy clay fill of WS 2 at 0.90m below ground level.

An exceedance of soil screening criteria (SSC) can indicate a potentially significant risk to human health. However, this does not necessarily imply that there is an actual risk to health, and site specific circumstances should be taken into account. In this case, a well-maintained vegetative cover would significantly reduce the actual risk to health by minimising the potential for the ingestion of soil dust.

The results indicate that the made ground beneath the site would be unsuitable for retention at the surface in a residential with home grown produce setting due to the presence of lead within the made ground. The soils tested would be considered suitable within a commercial/industrial setting or in a communal gardens or open space setting where the soil was covered with a well maintained vegetative cover, such as grass.

Hydrocarbon Pollution/Asbestos

Visual and olfactory evidence of hydrocarbon impacted soils was not detected within the soils beneath this site during the investigation. The five results of the TPH screening were between <10mg/kg, the very low detection limit of the analysing laboratory, and 270mg/kg, a low result. The two TPH results determined during the two WAC tests of samples tested from WS 1 and WS 2 also gave results of <10mg/kg. These results are considered likely to reflect the presence of ash and asphalt fragments within the made ground rather than hydrocarbon fuels.

No asbestos containing material (ACM) was found during sample preparation prior to chemical analysis. Visual evidence of ACM was not recorded during this investigation.

SOIL GAS MONITORING RESULTS

Six return visits to monitor gas levels at this site were made in June, July and August 2014 to record the concentrations of landfill type gases (methane, carbon dioxide and oxygen) in the BH 1 and WS 4 standpipes. The results are presented to the rear of the exploratory hole records. The recorded concentrations of methane were all less than 0.1%, whilst the carbon dioxide levels recorded ranged between 0.2% and 3.2%. The recorded oxygen concentrations within the standpipes were generally slightly depleted when compared with atmospheric conditions. The in-situ measurement confirmed a negligible gas emission rate with a recorded flow rate of <0.1l/hr.

Assuming a positive flow rate of 0.1l/hr, the results give a Gas Screening Value (GSV) of 0.0032l/hr. This GSV falls within the modified Wilson and Card Characteristic Situation 1 or 'Green' classification of the NHBC traffic light system (for low rise housing), as defined by the Construction Industry Research and Information Association, CIRIA Report C665, 'Assessing risks posed by hazardous ground gasses to buildings'.

UPDATED CONCEPTUAL MODEL

Assessment of the potential linkage between ground contamination sources, human and environmental receptors have been assessed based on the desk study research and the intrusive ground investigation documented in the preceding sections of this report.

A generalised conceptual model, updated following the intrusive works, monitoring and testing, and targeted to provide coverage across the site, relative to the construction phase and completed development, is presented below in Table 6.

Table 6: Updated Conceptual Model Relative to Construction and Future Development

Receptors	Pathway	Estimated Potential for Linkage with Contaminant Sources					
		Drainage/ Buildings	Soil Beneath Site	Historical Uses	Current Uses	Soil Gas	Ground Contamination Outside Site Boundary
Human Health – ground workers	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Moderate	Moderate	Very Low	Low	Very Low	Very Low
Human Health – users of completed development	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	N/A	Moderate	Very Low	Low	Very Low	Very Low
Water Environment	Migration through ground into surface water or groundwater	N/A	Very Low	Very Low	Low	Very Low	Very Low
Flora	Vegetation on site growing on contaminated soil.	N/A	Very Low	Very Low	Low	Very Low	Very Low
Building Materials	Contact with contaminated soil	N/A	Very Low	Very Low	Low	Very Low	Very Low

Key to Table 6

RISK	Definition
Very High	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, or, there is evidence that severe harm to a designated receptor is currently happening. The risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) and remedial works may be necessary in the short term and likely over the long term.
Moderate	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild.
Low	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.
N/A	Not Applicable because the proposed development will remove the source.

COMMENTS ON GROUND CONTAMINATION IN RELATION TO PROPOSED DEVELOPMENT

Anticipated exposure scenarios relating to the site and future redevelopment works including remedial options as applicable, are discussed as follows.

This investigation may not have revealed the full extent of contamination on the site and appropriate professional advice should be sought if subsequent site works reveal materials that may appear to be contaminated. This is particularly the case on this site where it was not possible to target potential sources of contamination during this phase of investigation.

Contaminated Soil

The site is underlain by between 0.90m and 3.00m of made ground. The made ground beneath the site was found to contain statistically elevated concentrations of lead that exceeded residential with home grown produce soil screening criteria and a residential without home grown produce use. None of the other contaminants tested for exceeded their respective screening values for residential or commercial/industrial land use.

The contamination encountered would not be considered unusual for a site such as this in London, which has been developed and redeveloped (reference desk study report, C13269, August 2014), and may have included historical earthworks. Typically elevated metal concentrations may occur where ash from fireplaces and boilers has been disposed of by being spread over gardens, for example, in order to 'improve' poorly draining clay soil.

Existing Drainage and Buildings

Redundant foul or surface water drain runs, should be removed from beneath the site and precautions should ensure that any remaining effluent is directly disposed off-site. The integrity of existing drainage should be checked, and where they are to be retained, any damaged

sections should be replaced prior to development. The latter measures should remove any future likelihood of risk to human health and to the water environment.

The buildings within the site may have had asbestos containing materials within them. Suitable precautions, in line with current best practice, should be put in place to protect workers from the effects of asbestos material, during the demolition/refurbishment/construction phase.

Human Health - Construction Workers

The presence of lead contamination within the tested made ground, and localised hotspots of mercury and benzo[a]pyrene contamination, indicates that there is a moderate risk that a pathway could develop affecting groundworkers during the construction phase of development.

No special precautions would be required during the development of the site by workers who may come into contact with the soil during groundworks, providing standard precautions are adopted which should generally include the procedures given by the Health and Safety Executive (The Blue Book) HS(G)66.

For the protection of workers during groundworks the following is recommended:

a) Limit repeated or prolonged skin contact with soils by wearing gloves with sleeves rolled down.

b) Washing facilities should be made available to groundworkers, so as to minimise the potential for inadvertent ingestion of soil.

c) If any soils are revealed which are different to those encountered by this ground investigation, the advice of a specialist should be sought in view of classifying the material and ascertaining its risk to groundworkers.

Human Health - Users of Completed Development

The likelihood of any ground contamination affecting the site users when present beneath buildings and permanent areas of hardstanding would be considered to be very low. This is because it would be highly unlikely that the general site users would normally be able to penetrate the building floors and hardstanding, which would be necessary for them to uncover any contaminated soils beneath the site.

Based on the results obtained, the made ground should not be retained at the surface within new gardens and landscaping (flowerbeds or borders), if envisaged within the proposed redevelopment. However, it may be retained beneath a well maintained vegetative cover, such as grass.

Soil Gas

According to database information, there are no active landfills within influencing distance of the site and although up to 3.00m of made ground was encountered it was not found to include a significant amount of organic material.

The gas monitoring has determined that a Wilson and Card Characteristic Situation 1 would apply and that no special precautions are required to protect the proposed development from ingress of soil gases.

The site lies within an area where radon protection measures are not required for new dwellings in accordance with BR211.

Water Environment

Significant soil contamination was not identified by the investigative works; the groundwater table was found to lie at about 8.10m below ground level within the Claygate Member; and the site is underlain at depth by the aquiclude of the relatively impermeable London Clay. The likelihood of impact to groundwater or the water environment from the identified contamination within the made ground is considered to be very low.

Effects on Services

Consideration should be given to upgrading service materials, particularly for water supply pipes, where they will be in contact with made ground containing elevated concentrations of lead, mercury and benzo[a]pyrene, or ensure that the made ground is not used as a backfill around such water supply pipes. Further guidance on the selection of materials for use as water supply pipes should be sought from the local water supplier.

Off-Site Disposal of Soil Arisings

The results of chemical analysis are provided in Appendix 1 and can be used for the basic characterisation of the soil destined for landfill. The Environment Agency publication Hazardous Waste, Technical Guidance WM2 outlines the methodology for classifying wastes and should be referenced for guidance. The test results (total metals, hydrocarbons and cyanide) should be compared to the relevant thresholds to determine whether they fall into the primary categories of non-hazardous waste or hazardous waste and will help indicate the likely European Waste Catalogue (EWC) code, which is determined by the waste type. The results of Waste Acceptance Criteria (WAC) leachate testing should be used to check whether if categorised as non-hazardous waste it could be disposed of at an inert waste landfill; or if categorised as hazardous whether it could qualify as stable non-reactive hazardous waste for disposal in non-hazardous landfill.

Excavated material and excess spoil should always be classified prior to removal from site as required by 'Duty of Care' (Environmental Protection Act, 1990) legislation. This means that material has to be given a proper description and waste classification prior to removal. Basic characterisation is the responsibility of the waste producer and compliance checking and on-site verification are generally the responsibility of the landfill operator. The landfill operator will need to liaise with the waste producer as the approach relies on the information from basic characterisation.

It is expected that clean arisings from foundation excavations into the natural soils across this site would also fall into the inert category under the European Waste Catalogue description 'Soil and Stones', EWC code 17 05 04 with restrictions excluding topsoil and peat.

CONCLUSIONS

Details of the proposed redevelopment are unknown but it is understood that it will include residential buildings with landscaping/communal gardens. The existing site is detailed on the site plan at the rear of this report. The proposed site layout will need to be provided by the client in due course. This plan will need to clearly identify new areas of gardens and soft landscaping (flowerbeds and borders), if any are envisaged. Areas of new and existing well maintained vegetative cover, lawns and open space, should also be identified on the plan.

Remediation

Remediation of the soils beneath the site, in respect of the redevelopment, is only considered necessary in relation to the creation of proposed new areas of gardens and landscaping (flowerbeds and borders), as any new hardstanding and building floors, and a well maintained vegetative cover of grass to lawns and open space, will prevent contact between any contaminated ground and the site end users.

The removal of the surface layers and their replacement within new flowerbeds and borders will provide a cover layer that will prevent contact between any site end users and any underlying contaminant source. It would be considered prudent to place a geotextile membrane between the cover layer and the underlying made ground, in this instance, in order to prevent mixing of these layers.

In order to create private rear gardens on this site, as a minimum, it will be necessary to either remove a sufficient thickness of the surface layers and replace them with imported topsoil material or isolate the contaminated made ground with a sufficient thickness of cover. The removal of 1.00m of made ground or a cover thickness of the same magnitude would be considered prudent for soft landscaping.

In order to create communal gardens and soft landscaping (flowerbeds and borders) on this site, as a minimum, it will be necessary to either remove a sufficient thickness of

the surface layers and replace them with imported topsoil material or isolate the contaminated made ground with a sufficient thickness of cover. The removal of 0.60m of made ground or a cover thickness of the same magnitude would be considered prudent for communal gardens and soft landscaping. Where the made ground is less than 1.00m or 0.60m thick, as may locally be the case, only the full thickness of made ground would need to be removed.

Topsoil

Imported topsoil should have appropriate certificates confirming its suitability prior to placement.

Remediation Plan

This remediation scheme should be used with the proposed development plan to derive a remediation plan, labelled to show the different land uses (for example - hardstanding, buildings, gardens and flowerbeds/borders), which should be submitted to satisfy planning conditions.

Validation

The implementation of the remediation strategy should be checked during construction and on completion, and appropriate records kept so that a Validation Report can be compiled and subsequently submitted to the local authority.

GROUND ENGINEERING LIMITED

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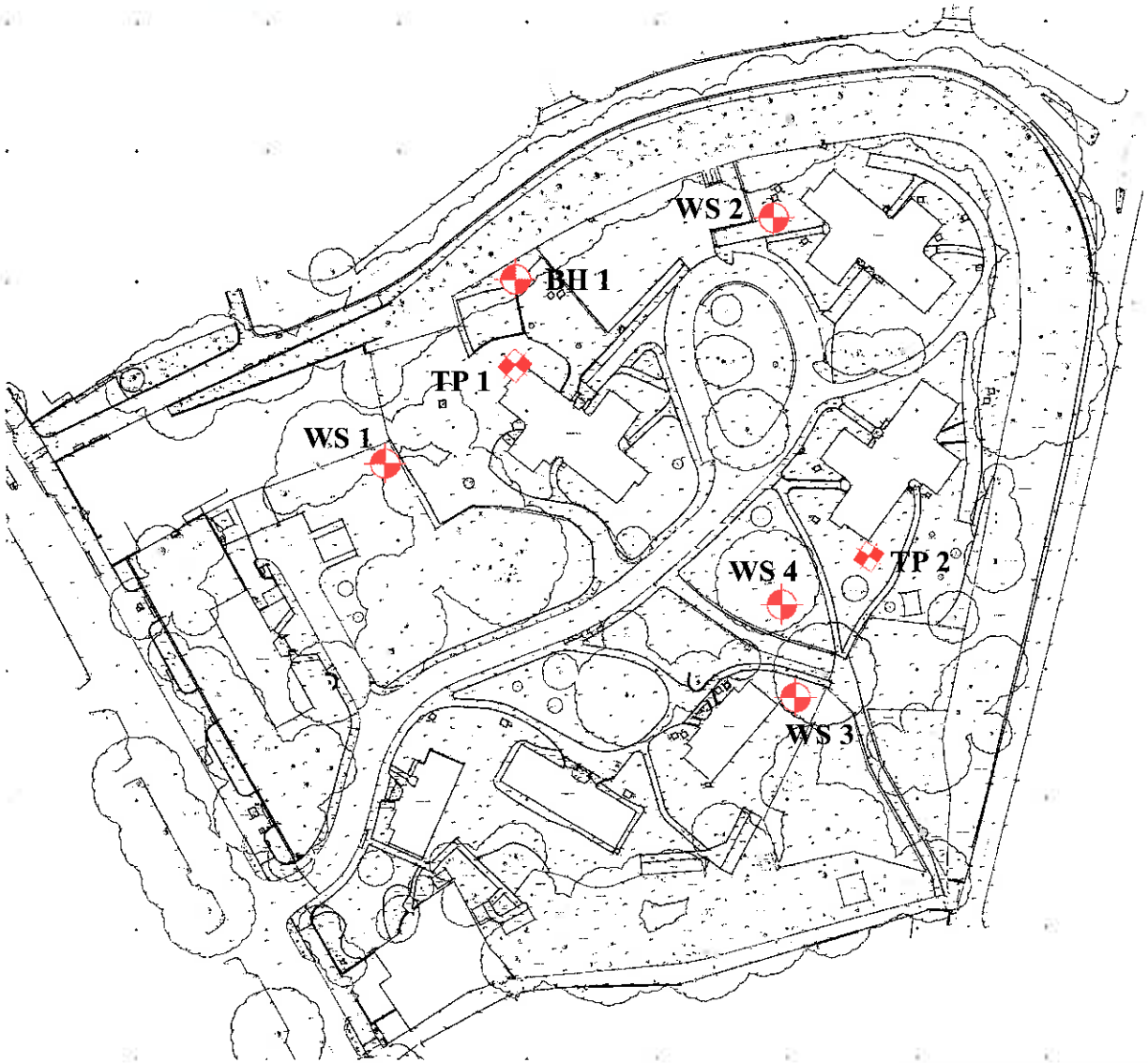
Exploratory Hole Plan

Not to Scale



Key –

Borehole position BH/WS

Trial Pit position TP

Project	Hillcrest Estate, Hillcrest, London N6	GROUND ENGINEERING LIMITED Peterborough Tel : 01733 566566	Project No.
Client	Haringey Council		C13269

GROUND ENGINEERING LIMITED

Tel: 01733-566566
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Site: HILLCREST ESTATE, HILLCREST, LONDON N6

BOREHOLE
BH1

Date: 02/06/14 to 05/06/14

Hole Size: 150mm dia to 25.45m

Ground Level: 122.55m. O.D.

Samples and in-situ Tests			(Date) Casing	Inst.	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Blows						
0.10	D1				MADE GROUND - Firm, friable, dark brown, slightly gravelly, sandy CLAY/SILT. Gravel of flint, brick, mortar, glass, ash, pottery and clinker.			
0.50	D2							
0.60-1.10	B1							
1.20-1.70	B2						1.20	121.35
1.35-1.65	C	N27	1.20		MADE GROUND - Stiff, dark brown and grey mottled, slightly gravelly, silty CLAY with pockets of sand and gravel. Gravel of brick, flint, ash and mortar.		1.90	120.65
1.90	D3		2.00		Firm, becoming stiff, light brown, orange brown and light grey mottled, slightly sandy, silty CLAY with occasional sand laminae.			
2.00-2.40	U1	35						
2.50	D4							
3.00-3.40	U2	40	3.00		(CLAYGATE MEMBER)			
3.50	D5							
4.00-4.40	U3	40	3.00					
4.50-5.00	B3						4.50	118.05
4.50	D6				Medium dense, light brown, silty fine SAND with laminae of firm, brown and orange brown mottled clay.			
4.65-4.95	S	N17	4.50					
4.95	D7							
5.10	D8							
5.20-5.60	U4	40	4.50		(CLAYGATE MEMBER)			
5.70	D9						5.70	116.85
					Very stiff, light brown and orange brown mottled, sandy, silty CLAY with occasional bands of silty fine sand.			
6.20	D10							
6.70-7.10	U5	40	6.00		(CLAYGATE MEMBER)			
7.20	D11							
7.70	D12							
8.00	D13						8.00	114.55
8.10-8.60	B4				Medium dense, orange brown and light brown, silty fine SAND.			
8.25-8.55	S	N13	7.50					
8.55	D14							
			c▼w		(CLAYGATE MEMBER)			
9.10	D15							
9.60-10.10	B5							
9.75-10.00	S	N13	9.00				10.00	112.55

REMARKS
1. Excavating a pit from 0.00m to 1.20m for 1 hour
2. Live roots observed to 3.00m depth
3. Water added from 9.00m to 12.20m
4. Borehole cased to 19.00m depth
5. Gas monitoring standpipe installed to 10.00m depth

Project No 13269

Scale 1:50

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KEY
D - Disturbed Sample
B - Bulk Sample
U - Undisturbed Sample
W - Water Sample
S/C - SPT Spoon/Cone
▼ Water Strike
▼ Water Rise
N - SPT Blows for 0.3m
* - Blows for quoted penetration
V - Vane Shear Test Cohesion ( ) kPa
▼c Level on completion
c▼w Level casing withdrawn
▼s Standpipe Level

Groundwater Strikes

No	Struck (Depth m)	Rose to (Depth m)	Rate	Cased (Depth m)	Sealed (Depth m)
1	13.30	11.40	medium	13.30	14.00
2	14.20	12.40	medium	14.10	19.00

Groundwater Observations

Date	Hole (Depth m)	Casing (Depth m)	Water (Depth m)
02/06/14	12.20	12.00	12.00
03/06/14	12.20	12.00	10.30
03/06/14	15.05	15.00	12.40
04/06/14	15.05	15.00	8.80
04/06/14	25.45	19.00	dry

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Site: HILLCREST ESTATE, HILLCREST, LONDON N6

BOREHOLE BH1

Date: 02/06/14 to 05/06/14

Hole Size: 150mm dia to 25.45m

Ground Level: 122.55m. O.D.

Samples and in-situ Tests			(Date) Casing	Inst.	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Blows						
10.05	D16			BENEATH INSTALLATION	Medium dense, orange brown and light brown, silty fine SAND.		10.00	112.55
10.60	D17			BENEATH INSTALLATION				
11.10-11.60	B6			BENEATH INSTALLATION				
11.25-11.55	S	N15	11.10 1 ▼	BENEATH INSTALLATION				
11.55	D18			BENEATH INSTALLATION				
12.10	D19		2 ▼	BENEATH INSTALLATION	(CLAYGATE MEMBER)			
12.60-13.10	B7			BENEATH INSTALLATION				
12.75-13.00	S	N14	12.60	BENEATH INSTALLATION				
13.05	D20		1 ▽	BENEATH INSTALLATION			13.30	109.25
13.30	D21				Firm, becoming stiff, orange brown and grey mottled, silty CLAY with bands of very silty fine sand, and rare gravel size ferruginous concretions. (CLAYGATE MEMBER)			
13.30	W1							
13.40-13.90	B8		13.40	BENEATH INSTALLATION				
13.55-13.85	S	N14						
13.85	D22							
14.00	D23			BENEATH INSTALLATION			14.00	108.55
14.10-14.60	B9		14.10 2 ▽		Medium dense, dark grey, silty fine SAND with many bands of stiff dark grey clay.			
14.10-14.10	U6	FAIL						
14.20	W2			BENEATH INSTALLATION				
14.60-15.10	B10							
14.75-15.00	S	N12	14.60	BENEATH INSTALLATION				
15.05	D24			BENEATH INSTALLATION				
15.60	D25			BENEATH INSTALLATION				
16.10-16.60	B11			BENEATH INSTALLATION	(CLAYGATE MEMBER)			
16.25-16.55	S	N15	16.10					
16.55	D26			BENEATH INSTALLATION				
17.10	D27			BENEATH INSTALLATION				
17.60-18.10	B12			BENEATH INSTALLATION			17.60	104.95
17.75-18.00	S	N20	17.60	BENEATH INSTALLATION	Stiff, dark grey and dark brown mottled, slightly sandy, silty CLAY with occasional gravel size pyrite nodules.			
18.05	D28			BENEATH INSTALLATION				
18.50	D29							
18.60-19.10	B13			BENEATH INSTALLATION				
18.75-20.00	S	N22	18.60					
19.05	D30			BENEATH INSTALLATION	(LONDON CLAY)			
19.60	D31			BENEATH INSTALLATION				
				BENEATH INSTALLATION			20.00	102.55

REMARKS

Project No 13269

Scale 1:50

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KEY
D - Disturbed Sample
B - Bulk Sample
U - Undisturbed Sample
W - Water Sample
S/C - SPT Spoon/Cone
▽ Water Strike
▼ Water Rise
N - SPT Blows for 0.3m
* - Blows for quoted penetration
V - Vane Shear Test Cohesion ( ) kPa
▼c Level on completion
c▼w Level casing withdrawn
▼s Standpipe Level

Groundwater Strikes

No	Struck	Rose to	Depth m Rate	Cased	Sealed

Groundwater Observations

Date	Depth m Hole	Depth m Casing	Depth m Water
05/06/14	25.45	0.00	8.80
12/06/14	10.00		8.10
19/06/14	10.00		8.12
24/06/14	10.00		8.07
16/07/14	10.00		8.17

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Site: HILLCREST ESTATE, HILLCREST, LONDON N6

BOREHOLE BH1

Date: 02/06/14 to 05/06/14

Hole Size: 150mm dia to 25.45m

Ground Level: 122.55m. O.D.

Samples and in-situ Tests			(Date) Casing	Inst.	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Blows						
20.10-20.50	U7	45	19.00	BENEATH INSTALLATION	Very stiff, fissured, grey brown and dark brown mottled, silty CLAY with occasional partings of light brown silt and fine sand.		20.00	102.55
20.60	D32			BENEATH INSTALLATION				
21.10	D33			BENEATH INSTALLATION				
21.60-22.00	U8	50	19.00	BENEATH INSTALLATION				
22.10	D34			BENEATH INSTALLATION				
22.60	D35			BENEATH INSTALLATION				
23.10-23.50	U9	35	19.00	BENEATH INSTALLATION	(LONDON CLAY)			
23.60	D36			BENEATH INSTALLATION				
24.10	D37			BENEATH INSTALLATION				
24.50-25.00	B14		19.00	BENEATH INSTALLATION				
24.50-24.50	U10	FAIL						
25.15-25.45	S	N32	19.00	BENEATH INSTALLATION				
25.45	D38				Borehole completed at 25.45m depth		25.45	97.10

REMARKS

Project No 13269

Scale 1:50

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KEY
D - Disturbed Sample
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S/C - SPT Spoon/Cone
Water Strike
Water Rise
N - SPT Blows for 0.3m
* - Blows for quoted penetration
V - Vane Shear Test Cohesion ( ) kPa
c Level on completion
c w Level casing withdrawn
s Standpipe Level

Groundwater Strikes						Groundwater Observations			
		Depth m					Depth m		
No	Struck	Rose to	Rate	Cased	Sealed	Date	Hole	Casing	Water
						22/07/14	10.00		8.21

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Site: HILLCREST ESTATE, HILLCREST, LONDON N6

Date: 02/06/14

Hole Size: 87mm dia to 2.00m
77mm dia to 3.00m
50mm dia to 6.45m

WINDOW SAMPLE
WS1

Ground Level: 123.83m. O.D.

Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Result					
0.30	D1			MADE GROUND - Firm, friable, dark brown, slightly gravelly, sandy CLAY/SILT. Gravel of flint, brick and ash.		0.40	123.43
0.60	D2			MADE GROUND - Soft, dark brown and orange brown mottled, sandy CLAY with occasional brick fragments.		0.70	123.13
0.90	D3			MADE GROUND - Loose, dark brown and brown, silty, gravelly SAND with pockets of sandy clay. Gravel of flint, brick and ash.			
1.10	D4						
1.20	D5						
1.20-2.00	U1						
1.35-1.65	S	N6				1.70	122.13
2.00	D6			Medium dense, light brown and orange brown, silty fine SAND. (BAGSHOT FORMATION)			
2.00-3.00	U2						
2.15-2.45	S	N10				2.50	121.33
3.00	D7			Firm, becoming stiff below 5.00m, orange brown, light grey and light brown mottled, slightly sandy, silty CLAY with occasional fine sand laminae below 3.00m depth.			
3.00-4.00	U3						
3.15-3.45	S	N7					
4.00	D8						
4.00-5.00	U4						
4.15-4.45	S	N8					
5.00	D9			(CLAYGATE MEMBER)			
5.00-6.00	U5						
5.15-5.45	S	N12					
6.00	D10						
6.15-6.45	S	N19				6.45	117.38
				Hole completed at 6.45m depth			

REMARKS
1. Starter pit excavated from GL to 1.20m depth
2. Live roots observed to 4.00m depth

Project No 13269

Scale 1:50

Page 1/1

KEY
D - Disturbed Sample
B - Bulk Sample
U - Undisturbed Sample
W - Water Sample
▽ Water Strike
▼ Depth to Water on completion
J - Jar Sample
M - Mackintosh Probe
V - Vane Shear Test Cohesion ( ) kPa
P( ) - Hand Penetrometer Cohesion ( ) kPa
▼s Standpipe Level

Groundwater Strikes						Groundwater Observations			
Depth m							Depth m		
No	Struck	Rose to	Rate	Cased	Sealed	Date	Hole	Casing	Water
						02/06/14	6.45		dry

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Site: HILLCREST ESTATE, HILLCREST, LONDON N6

WINDOW SAMPLE WS2

Date: 02/06/14

Hole Size: 87mm dia to 2.00m
77mm dia to 3.00m
50mm dia to 6.45m

Ground Level: 122.28m. O.D.

Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Result					
0.30	D1			MADE GROUND - Brown, silty SAND AND GRAVEL with pockets of firm, orange brown and dark brown mottled, gravelly clay. Gravel of concrete, ash, brick, clinker and quartz.			
0.60	D2					0.70	121.58
0.90	D3			MADE GROUND - Firm, friable, dark brown and black mottled, slightly sandy, slightly gravelly, silty CLAY. Gravel of ash, brick and flint.			
1.10	D4					1.20	121.08
1.20	D5			MADE GROUND - Firm, dark brown, brown and orange brown mottled, slightly sandy, slightly gravelly CLAY. Gravel of brick and ash.			
1.20-2.00	U1						
1.35-1.65	S	N6					
2.00	D6						
2.00-3.00	U2						
2.15-2.45	S	N6					
3.00	D7					3.00	119.28
3.00-4.00	U3			Firm, locally stiff, orange brown, light brown and light grey mottled, slightly sandy, silty CLAY with occasional fine sand laminae below 5.00m depth.			
3.15-3.45	S	N10					
4.00	D8						
4.00-5.00	U4						
4.15-4.45	S	N18					
5.00	D9			(CLAYGATE MEMBER)			
5.00-6.00	U5						
5.15-5.45	S	N10					
6.00	D10						
6.15-6.45	S	N10				6.45	115.83
				Hole completed at 6.45m depth			

REMARKS
1. Starter pit excavated from GL to 1.20m depth
2. Live roots observed to 3.00m depth

Project No 13269

Scale 1:50

Page 1/1

KEY
D - Disturbed Sample
B - Bulk Sample
U - Undisturbed Sample
W - Water Sample
▽ Water Strike
▼ Depth to Water on completion
J - Jar Sample
M - Mackintosh Probe
V - Vane Shear Test Cohesion ( ) kPa
P( ) - Hand Penetrometer Cohesion ( ) kPa
▼s Standpipe Level

Groundwater Strikes						Groundwater Observations			
		Depth m					Depth m		
No	Struck	Rose to	Rate	Cased	Sealed	Date	Hole	Casing	Water
						02/06/14	6.45		dry

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Site: HILLCREST ESTATE, HILLCREST, LONDON N6
Client: .

Date: 02/06/14
Hole Size: 87mm dia to 2.00m
77mm dia to 3.00m
50mm dia to 6.45m

WINDOW SAMPLE
WS3

Ground Level: 125.97m. O.D.

Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Result					
0.30	D1			MADE GROUND - Dark brown, silty SAND and GRAVEL. Gravel of flint, quartzite, brick, mortar, ash and slate.			
0.60	D2					0.60	125.37
0.90	D3			MADE GROUND - Very stiff, orange brown, brown, dark brown and dark grey mottled, silty CLAY.			
1.10	D4						
1.20	D5					1.30	124.67
1.20-2.00	U1			Stiff, becoming firm, orange brown, light brown and light grey mottled, slightly sandy, silty CLAY with occasional fine sand laminae below 3.00m depth.			
1.35-1.65	S	N13					
2.00	D6						
2.00-3.00	U2						
2.15-2.45	S	N9					
3.00	D7						
3.00-4.00	U3						
3.15-3.45	S	N10					
4.00	D8						
4.00-5.00	U4						
4.15-4.45	S	N12					
				...Becoming stiff below 4.80m depth.			
5.00	D9						
5.00-6.00	U5						
5.15-5.45	S	N19		(CLAYGATE MEMBER)			
6.00	D10						
6.15-6.45	S	N15				6.45	119.52
				Hole completed at 6.45m depth			

REMARKS
1. Starter pit excavated from GL to 1.20m depth
2. Live roots observed to 1.10m depth

Project No 13269
Scale 1:50
Page 1/1

KEY
D - Disturbed Sample
B - Bulk Sample
U - Undisturbed Sample
W - Water Sample
▽ Water Strike
▼ Depth to Water on completion
J - Jar Sample
M - Mackintosh Probe
V - Vane Shear Test Cohesion ( ) kPa
P( ) - Hand Penetrometer Cohesion ( ) kPa
▼s Standpipe Level

Groundwater Strikes						Groundwater Observations			
		Depth m					Depth m		
No	Struck	Rose to	Rate	Cased	Sealed	Date	Hole	Casing	Water
						02/06/14	6.45		dry

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Site: HILLCREST ESTATE, HILLCREST, LONDON N6

WINDOW SAMPLE
WS4

Date: 05/06/14

Hole Size: 87mm dia to 2.00m
77mm dia to 6.00m
50mm dia to 10.45m

Ground Level: 126.18m. O.D.

Samples and in-situ Tests			(Date) Water	Inst.	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Result						
					MADE GROUND - Dark brown, silty SAND AND GRAVEL. Gravel of brick, flint, clinker, ash, slate and quartzite.		0.90	125.28
					Light brown, silty fine SAND. (BAGSHOT FORMATION)		1.20	124.98
0.30	D1				Stiff, becoming firm, orange brown, light brown and light grey mottled, sandy, silty CLAY with occasional fine sand laminae below 4.00m depth and rare gravel size ferruginous concretions at 5.00m depth.			
0.60	D2							
0.90	D3							
1.10	D4							
1.20	D5							
1.20-2.00	U1							
1.35-1.65	S	N16						
2.00	D6							
2.00-3.00	U2							
2.15-2.45	S	N9						
3.00	D7							
3.00-4.00	U3							
3.15-3.45	S	N10						
4.00	D8							
4.00-5.00	U4							
4.15-4.45	S	N9						
5.00	D9							
5.00-6.00	U5							
5.15-5.45	S	N10						
6.00	D10				...Becoming stiff below 6.00m depth.			
6.00-7.00	U6							
6.15-6.45	S	N15						
7.00	D11							
7.00-8.00	U7							
7.15-7.45	S	N13						
					(CLAYGATE MEMBER)			
8.00	D12							
8.00-9.00	U8							
8.15-8.45	S	N10						
9.00	D13							
9.00-10.00	U9							
9.15-9.45	S	N20					9.30	116.88
					Stiff, brown, orange brown and light grey mottled, sandy, silty CLAY with occasional bands of fine sand. (CLAYGATE MEMBER)			
10.00	D14						10.00	116.18

REMARKS
1. Starter pit excavated from GL to 1.20m depth
2. Live roots observed to 0.90m depth
3. Gas monitoring standpipe installed to 10.00m depth

Project No 13269

Scale 1:50

Page 1/2

KEY
D - Disturbed Sample
B - Bulk Sample
U - Undisturbed Sample
W - Water Sample
▽ Water Strike
▼ Depth to Water on completion
J - Jar Sample
M - Mackintosh Probe
V - Vane Shear Test Cohesion ( ) kPa
P( ) - Hand Penetrometer Cohesion ( ) kPa
▼s Standpipe Level

Groundwater Strikes

No	Struck	Rose to	Depth m Rate	Cased	Sealed

Groundwater Observations

Date	Depth m Hole	Casing	Water
05/06/14	10.45		dry
12/06/14	10.00		dry
19/06/14	10.00		dry
24/06/14	10.00		dry
16/07/14	10.00		dry

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Site: HILLCREST ESTATE, HILLCREST, LONDON N6

WINDOW SAMPLE
WS4

Date: 05/06/14

Hole Size: 87mm dia to 2.00m
77mm dia to 6.00m
50mm dia to 10.45m

Ground Level: 126.18m. O.D.

Samples and in-situ Tests			(Date) Water	Inst.	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Result						
10.15-10.45	S	N37			Dense, light brown, silty fine SAND with occasional bands of clay. (CLAYGATE MEMBER)		10.00	116.18
							10.45	115.73
					Hole completed at 10.45m depth			

REMARKS

Project No 13269

Scale 1:50

Page 2/2

KEY
D - Disturbed Sample
B - Bulk Sample
U - Undisturbed Sample
W - Water Sample
▽ Water Strike
▼ Depth to Water on completion
J - Jar Sample
M - Mackintosh Probe
V - Vane Shear Test Cohesion ( ) kPa
P( ) - Hand Penetrometer Cohesion ( ) kPa
▼s Standpipe Level

Groundwater Strikes						Groundwater Observations			
Depth m							Depth m		
No	Struck	Rose to	Rate	Cased	Sealed	Date	Hole	Casing	Water
						22/07/14	10.00		dry

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Site: HILLCREST ESTATE, HILLCREST, LONDON N6

TRIAL PIT TP1

Date: 02/06/14

Pit Size: 0.90m L x 0.65m W x 1.70m D.

Ground Level: 122.20m. O.D.

Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Result					
				MADE GROUND - ASPHALT.		0.25	121.95
0.30	D1			MADE GROUND - Soft, friable, dark grey, slightly gravelly, sandy, silty CLAY with occasional brick cobbles. Gravel of flint, brick, concrete, ceramic, plastic, asphalt and clinker.		0.65	121.55
0.50	D2						
0.80	D3			MADE GROUND - Firm, brown, orange brown, grey and dark brown mottled, slightly gravelly, sandy CLAY. Gravel of brick, concrete, asphalt and flint.		1.00	121.20
1.10	D4			Firm becoming stiff, brown, orange brown and light grey mottled, sandy, silty CLAY.			
1.30	V1	(55)					
1.40	D5						
			1	(CLAYGATE MEMBER)			
1.60	W1						
1.70	D6					1.70	120.50
1.70	V2	(114)		Pit completed at 1.70m depth			

KEY
- D - Disturbed Sample
- B - Bulk Sample
- U - Undisturbed Sample
- **R - Root Sample**
- W - Water Sample
- J - Jar Sample
- ▽ Water Strike
- ▼ Water Rise
- ▼c Level on completion
- MP - Mackintosh Probe
- P( ) - Hand Penetrometer Cohesion ( ) kPa
- V - Vane Shear Test Cohesion ( ) kPa

REMARKS
1. No live roots observed
2. Pit sides stable
3. Groundwater met at 1.60m depth, after 5 mins rose to 1.55m depth

Project No	
13269	
Scale	Page
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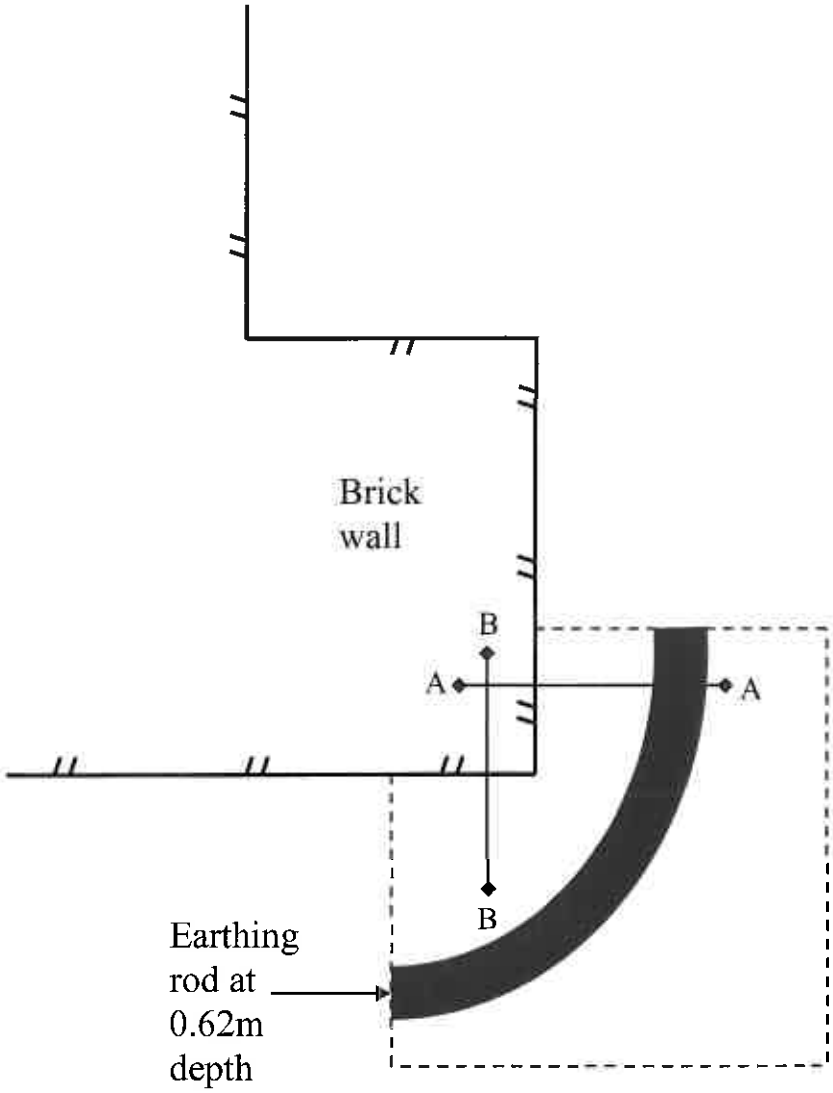
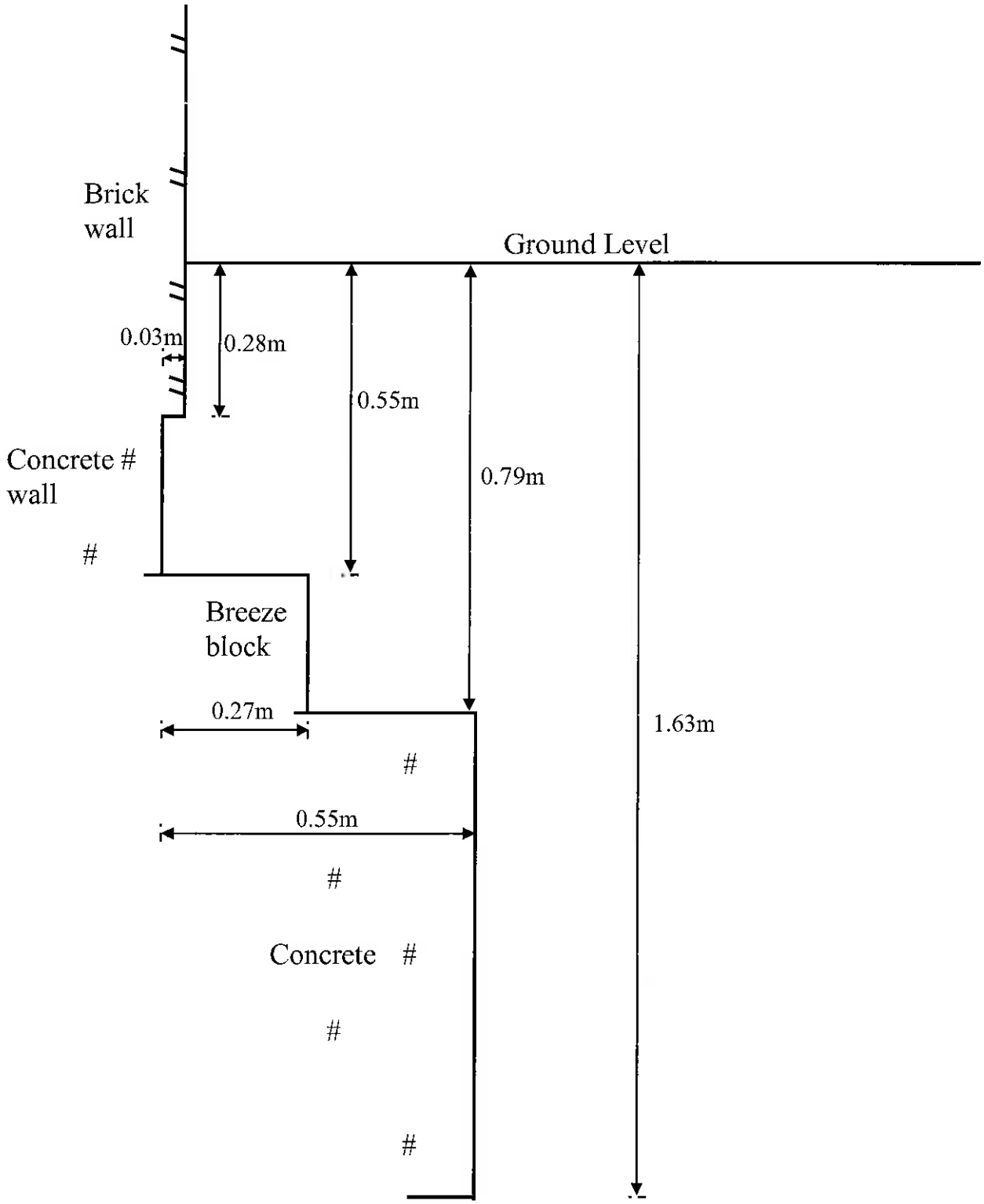
Trial Pit TP1
Plan



Not To Scale

Project : Hillcrest Estate, Hillcrest, London N6 Client : Haringey Council	GROUND ENGINEERING LIMITED Peterborough Tel : 01733 566566	Project No. C13269

Trial Pit TP1
Cross Section A-A



Not To Scale

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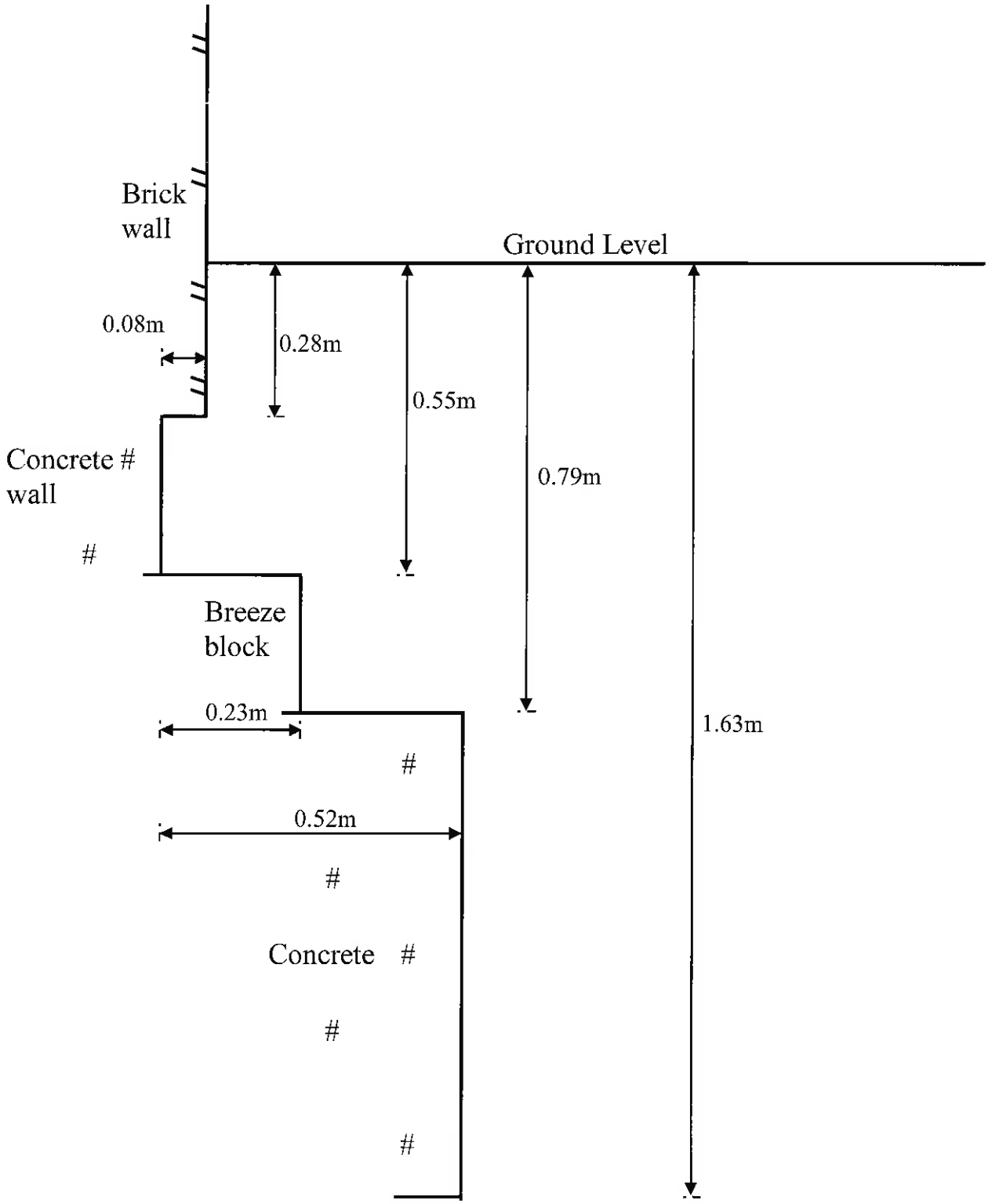
Trial Pit TP1
Cross Section B-B



Not To Scale

Project : Hillcrest Estate, Hillcrest, London N6 **Client : Haringey Council**	**GROUND ENGINEERING LIMITED** Peterborough Tel : 01733 566566	**Project No. C13269**

Trial Pit TP1
Photographs

Project : Hillcrest Estate, Hillcrest, London N6 **Client : Haringey Council**	**GROUND ENGINEERING LIMITED** Peterborough Tel : 01733 566566	**Project No. C13269**

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Site: HILLCREST ESTATE, HILLCREST, LONDON N6

TRIAL PIT TP2

Date: 02/06/14

Pit Size: 0.90m L x 0.60m W x 1.30m D.
Hole Size: 70mm dia to 1.65m

Ground Level: 125.02m. O.D.

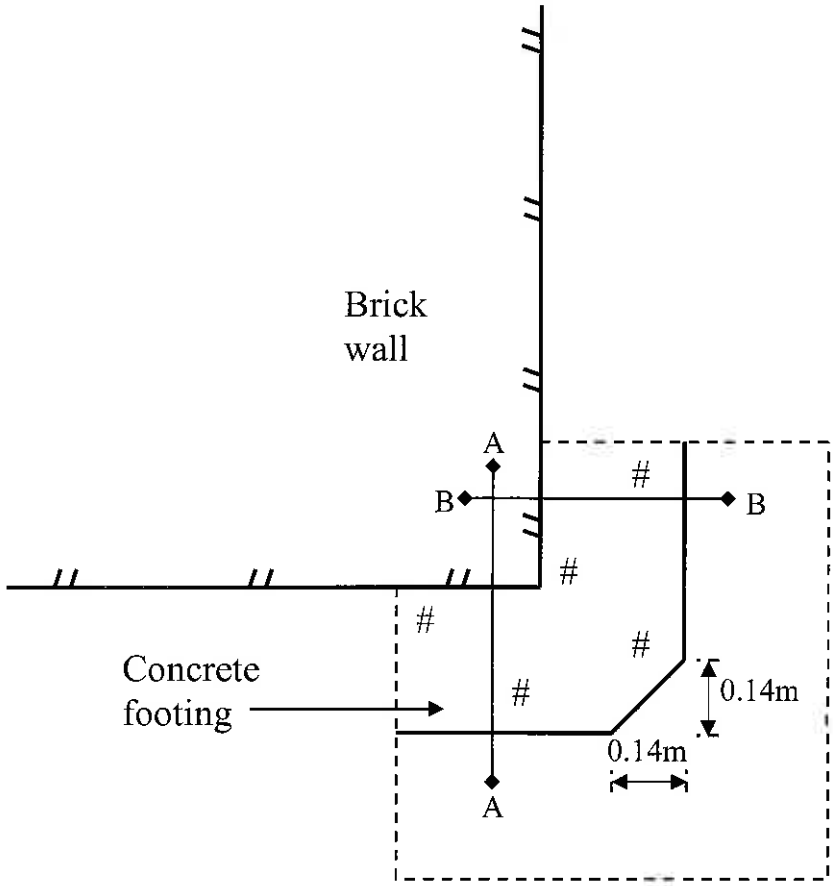
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Result					
0.30	D1			MADE GROUND - Soft, friable, slightly sandy, slightly gravelly, silty CLAY. Gravel of brick, concrete, clinker, ash, breeze block and flint.		0.50	124.52
0.60	D2			MADE GROUND - Soft, locally firm, brown, dark brown, orange brown and grey mottled, slightly gravelly, sandy CLAY. Gravel of flint, brick and concrete.		0.90	124.12
0.80	D3						
1.10	D4		1 ▼	Medium dense, light brown and light grey, silty fine SAND.			
1.20-1.40	B1						
1.30	W1		1 ▽				
1.40	D5			(BAGSHOT FORMATION)			
1.65	D6					1.65	123.37
1.65-1.77	MP1	100					
				Pit completed at 1.65m depth			

KEY
- D - Disturbed Sample
- B - Bulk Sample
- U - Undisturbed Sample
- R - Root Sample
- W - Water Sample
- J - Jar Sample
- ▽ Water Strike
- ▼ Water Rise
- ▼c Level on completion
- MP - Mackintosh Probe
- P( ) - Hand Penetrometer Cohesion ( ) kPa
- V - Vane Shear Test Cohesion ( ) kPa

REMARKS
1. Live roots observed to 0.60m depth
2. Groundwater met at 1.30m depth, rose to 1.10m depth after 2 mins
3. Extended pit sides unstable below 1.50m depth due to groundwater

Project No	
13269	
Scale	Page
1:25	1/1

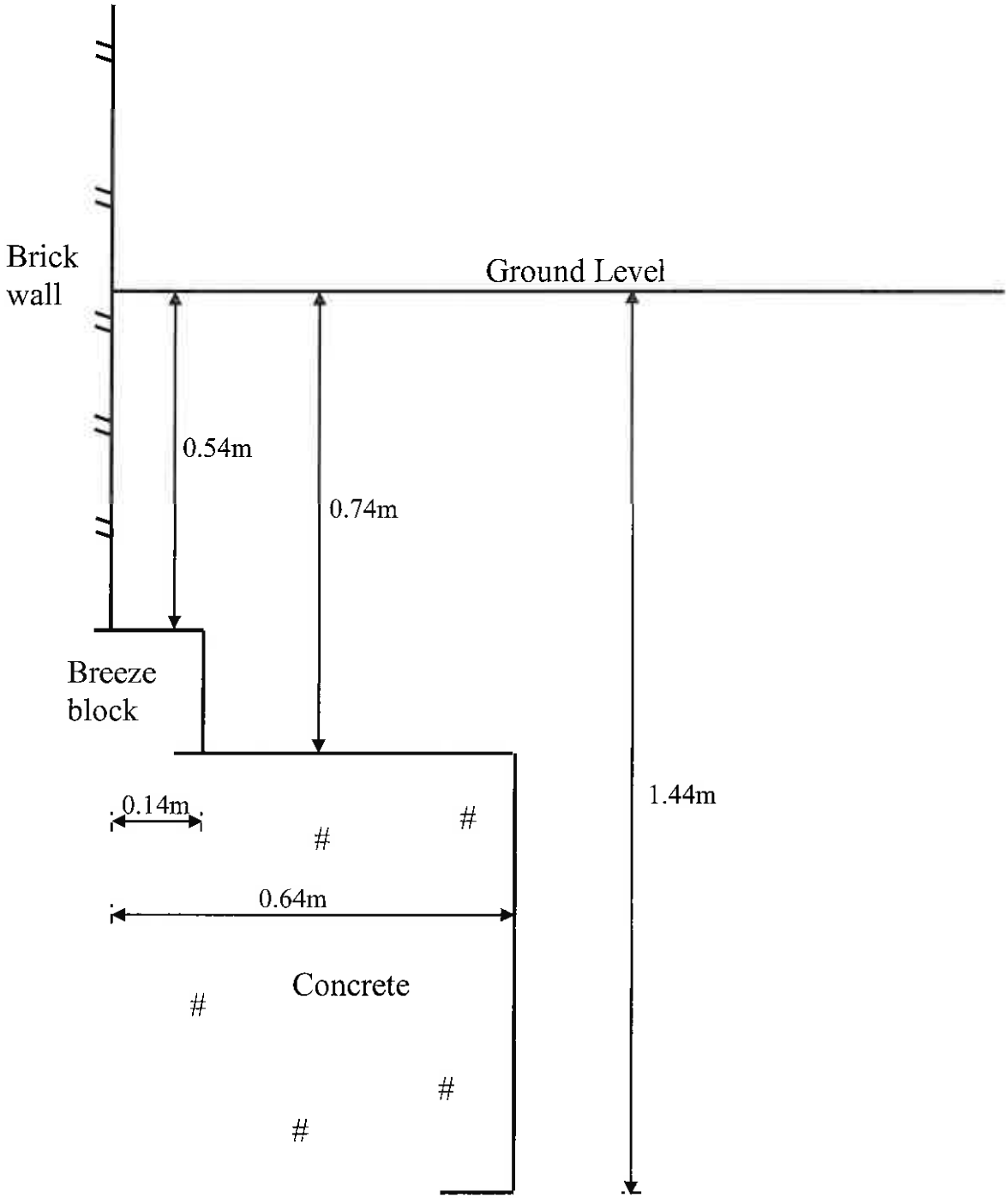
Trial Pit TP2
Plan



Not To Scale

Project : Hillcrest Estate, Hillcrest, London N6 **Client : Haringey Council**	**GROUND ENGINEERING LIMITED** Peterborough Tel : 01733 566566	**Project No. C13269**

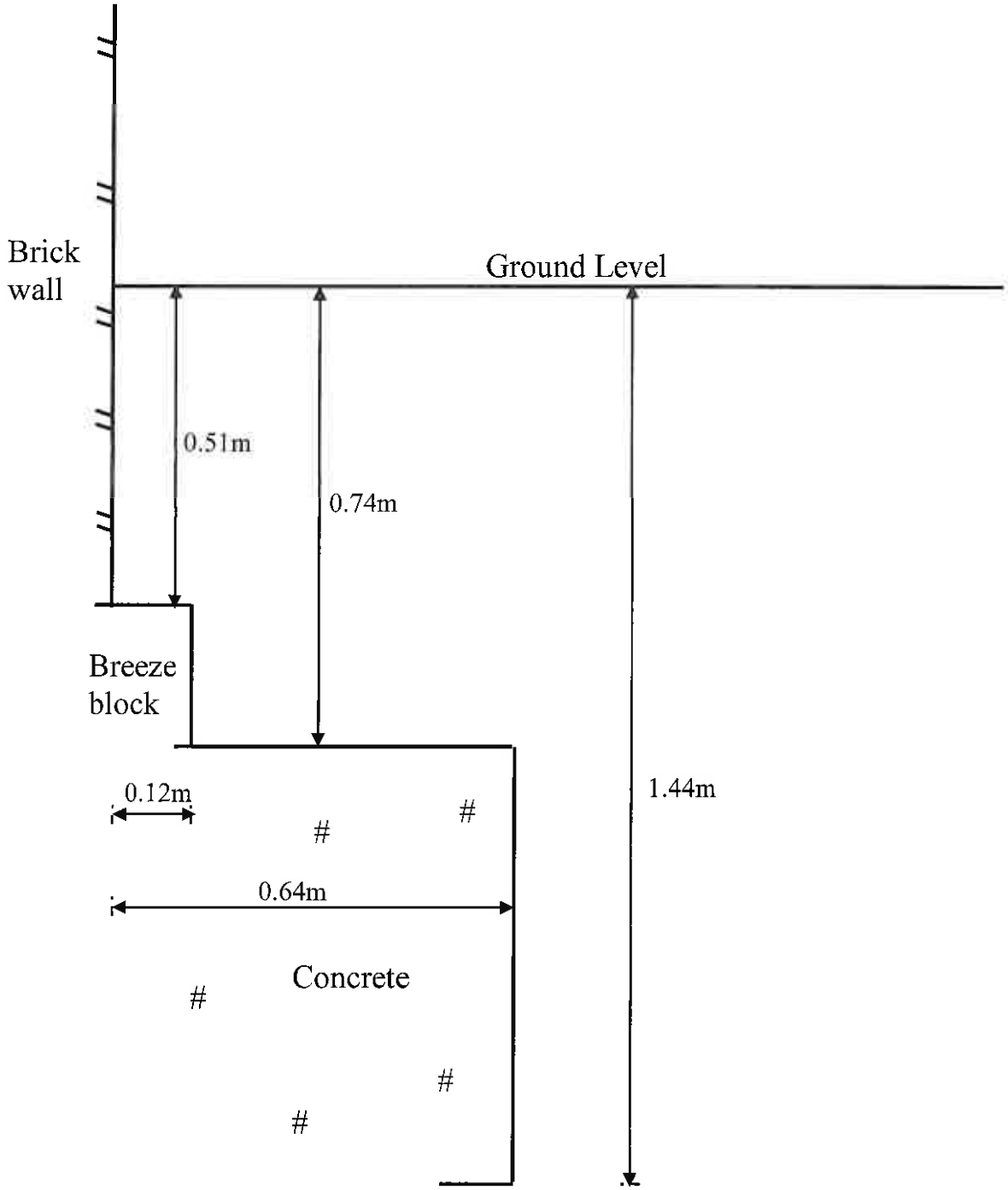
Trial Pit TP2
Cross Section A-A



Not To Scale

Project : Hillcrest Estate, Hillcrest, London N6 **Client : Haringey Council**	**GROUND ENGINEERING LIMITED** Peterborough Tel : 01733 566566	**Project No. C13269**

Trial Pit TP2
Cross Section B-B



Not To Scale

Project : Hillcrest Estate, Hillcrest, London N6 **Client : Haringey Council**	**GROUND ENGINEERING LIMITED** Peterborough Tel : 01733 566566	**Project No. C13269**

Trial Pit TP2
Photograph

Project : Hillcrest Estate, Hillcrest, London N6 **Client : Haringey Council**	**GROUND ENGINEERING LIMITED** Peterborough Tel : 01733 566566	**Project No. C13269**

Borehole Number	Depth (m)	Casing Depth (m)	Depth to Water (m)	Type of Test *	Seating Drive: Blows/Penetration (mm)	Test Drive: 300mm Blows for each successive 75 mm Penetration				N Value	Extrapolated Value
BH1	1.20 - 1.65	1.20		C	10/150	8	6	6	7	27	
	4.50 - 4.95	4.50		S	6/150	4	4	4	5	17	
	8.10 - 8.55	7.50		S	3/150	3	3	3	4	13	
	9.60 - 10.00	9.00	9.20	S	3/150	3	3	3	4	13	
	11.10 - 11.55	11.10	10.70	S	3/150	3	3	4	5	15	
	12.60 - 13.00	12.60	12.00	S	3/150	3	3	4	4	14	
	13.40 - 13.85	13.40	11.40	S	4/150	3	3	4	4	14	
	14.60 - 15.00	14.60	12.40	S	3/150	3	3	3	3	12	
	16.10 - 16.55	16.10	9.30	S	4/150	3	4	4	4	15	
	17.60 - 18.00	17.60	11.00	S	6/150	4	4	6	6	20	
	18.60 - 20.00	18.60	12.30	S	6/150	4	5	6	7	22	
	25.00 - 25.45	19.00		S	11/150	7	7	8	10	32	

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* C denotes test using a solid cone
S denotes test using a split barrel sampler

Results of Standard/Cone Penetration Tests

13269

HILLCREST ESTATE, HILLCREST, LONDON N6

Table No
.

Borehole Number	Depth (m)	Casing Depth (m)	Depth to Water (m)	Type of Test *	Seating Drive: Blows/Penetration (mm)	Test Drive: 300mm Blows for each successive 75 mm Penetration				N Value	Extrapolated Value
WS1	1.20 - 1.65			S	2/150	2	1	2	1	6	
	2.00 - 2.45			S	3/150	2	2	3	3	10	
	3.00 - 3.45			S	2/150	1	2	2	2	7	
	4.00 - 4.45			S	2/150	2	2	2	2	8	
	5.00 - 5.45			S	5/150	3	2	3	4	12	
	6.00 - 6.45			S	5/150	4	5	5	5	19	
WS2	1.20 - 1.65			S	3/150	1	2	1	2	6	
	2.00 - 2.45			S	3/150	1	2	2	1	6	
	3.00 - 3.45			S	2/150	2	2	3	3	10	
	4.00 - 4.45			S	5/150	3	5	5	5	18	
	5.00 - 5.45			S	3/150	2	3	2	3	10	
	6.00 - 6.45			S	3/150	2	2	3	3	10	
WS3	1.20 - 1.65			S	4/150	3	3	3	4	13	
	2.00 - 2.45			S	4/150	3	2	2	2	9	
	3.00 - 3.45			S	2/150	2	3	2	3	10	
	4.00 - 4.45			S	3/150	2	3	3	4	12	
	5.00 - 5.45			S	4/150	4	5	5	5	19	
	6.00 - 6.45			S	6/150	4	4	3	4	15	
WS4	1.20 - 1.65			S	3/150	2	4	5	5	16	
	2.00 - 2.45			S	4/150	2	3	2	2	9	
	3.00 - 3.45			S	2/150	3	2	2	3	10	
	4.00 - 4.45			S	3/150	2	2	2	3	9	
	5.00 - 5.45			S	4/150	2	2	3	3	10	
	6.00 - 6.45			S	4/150	2	4	4	5	15	
	7.00 - 7.45			S	4/150	3	3	3	4	13	
	8.00 - 8.45			S	4/150	2	3	2	3	10	
	9.00 - 9.45			S	2/150	3	5	6	6	20	
	10.00 - 10.45			S	9/150	7	8	11	11	37	

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* C denotes test using a solid cone
S denotes test using a split barrel sampler

Results of Standard/Cone Penetration Tests

13269

Table No .

HILLCREST ESTATE, HILLCREST, LONDON N6

LABORATORY TEST RESULTS

CONTRACT HILLCREST ESTATE, HILLCREST, LONDON N6

Bore-hole	Sample	Depth m	Classification: Liquid Limit %	Classification: Plastic Limit %	Classification: Plasticity Index %	Classification: Moisture Content %	Density: Bulk Mg/m^3	Density: Dry Mg/m^3	Triaxial Compression: Type	Triaxial Compression: Principal Stress Difference kPa	Triaxial Compression: Cell Pressure kPa	Triaxial Compression: Shear Strength kPa	Triaxial Compression: Angle of Shear Resistance degrees	Sulphates (SO_4): Soil Total % Dry Wt.	Sulphates (SO_4): Soil Aqueous Extract mg/l	Sulphates (SO_4): Water mg/l	pH	C.B.R. Top %	C.B.R. Base %	Remarks
BH1	B1	0.60 - 1.10				14	1.78	1.56										22	21	6% retained on 20mm sieve
	B2	1.20 - 1.70													82		7.1			
	U1	2.00 - 2.40	53	18	35	22	2.07	1.69	QM	127 144 164	50 100 200	72	0							SOIL CLASSIFICATION = CH 0% retained on 425μm sieve
	U2	3.00 - 3.40	50	17	33	22	1.92	1.57	QM	142 180 229	50 100 200	74	0		304		6.6			SOIL CLASSIFICATION = CI/CH 0% retained on 425μm sieve
	U3	4.00 - 4.40				25	1.93	1.55	QM	89 163 288	50 100 200	90	0							
	U4	5.20 - 5.60				16	1.77	1.53	QM	239 412 703	100 200 400	25	24		198		6.2			
	U5	6.70 - 7.10				25	2.04	1.63	QM	193 291 416	100 200 400	150	0							
	W1	13.30														265	7.6			
	W2	14.20														494	5.8			

U - UNDISTURBED SAMPLE
D - DISTURBED SAMPLE
B - BULK SAMPLE
W - WATER SAMPLE

C.U. - CONSOLIDATED UNDRAINED
C.D. - CONSOLIDATED DRAINED
Q. - IMMEDIATE UNDRAINED
Q.M. - IMMEDIATE UNDRAINED MULTISTAGE

Aqueous Extract 2:1 Water:Soil

C.B.R. - CALIFORNIA BEARING RATIO

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LABORATORY TEST RESULTS

CONTRACT HILLCREST ESTATE, HILLCREST, LONDON N6

Bore-hole	Sample	Depth m	Classification				Density		Triaxial Compression					Sulphates (SO_4)				C.B.R.		Remarks
			Liquid Limit %	Plastic Limit %	Plasticity Index %	Moisture Content %	Bulk Mg/m^3	Dry Mg/m^3	Type	Principal Stress Difference kPa	Cell Pressure kPa	Shear Strength kPa	Angle of Shear Resistance degrees	Soil Total % Dry Wt.	Soil Aqueous Extract mg/l	Water mg/l	pH	Top %	Base %	
BH1	U7	20.10 - 20.50				25	2.05	1.64	Q	252	360	126	0							
	U8	21.60 - 22.00				25	2.01	1.61	QM	237 263 289	100 200 400	131	0		1103		6.7			
	U9	23.10 - 23.50				25	2.08	1.66	QM	189 212 231	100 200 400	105	0							
	B14	24.50 - 25.00	40	20	20															SOIL CLASSIFICATION = CI 0% retained on 425μm sieve

U - UNDISTURBED SAMPLE
D - DISTURBED SAMPLE
B - BULK SAMPLE
W - WATER SAMPLE

C.U. - CONSOLIDATED UNDRAINED
C.D. - CONSOLIDATED DRAINED
Q. - IMMEDIATE UNDRAINED
Q.M. - IMMEDIATE UNDRAINED MULTISTAGE

Aqueous Extract 2:1 Water:Soil

C.B.R. - CALIFORNIA BEARING RATIO

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LABORATORY TEST RESULTS

CONTRACT HILLCREST ESTATE, HILLCREST, LONDON N6

Bore-hole	Sample	Depth m	Classification: Liquid Limit %	Classification: Plastic Limit %	Classification: Plasticity Index %	Classification: Moisture Content %	Density: Bulk Mg/m^3	Density: Dry Mg/m^3	Triaxial Compression: Type	Triaxial Compression: Principal Stress Difference kPa	Triaxial Compression: Cell Pressure kPa	Triaxial Compression: Shear Strength kPa	Triaxial Compression: Angle of Shear Resistance degrees	Sulphates (SO_4): Soil Total % Dry Wt.	Sulphates (SO_4): Soil Aqueous Extract mg/l	Sulphates (SO_4): Water mg/l	pH	Remarks
WS4	D4	1.10													49		7.2	
	D5	1.20	28	19	9													SOIL CLASSIFCIATION = CL 5% retained on 425μm sieve
	D6	2.00	30	24	6										82		5.0	SOIL CLASSIFICATION = ML 0% retained on 425μm sieve
	U2	2.70 - 3.00				25	2.03	1.62	QM	54 59 144	50 100 200	43	0					
	U3	3.70 - 4.00				22	2.02	1.66	QM	148 159 172	50 100 200	80	0					
	U4	4.70 - 5.00				26	2.02	1.61	QM	54 80 106	50 100 200	40	0					
	U5	5.70 - 6.00				24	1.79	1.44	QM	95 107 116	100 200 400	53	0					
	U6	6.70 - 7.00				25	1.90	1.52	QM	66 81 103	100 200 400	42	0					

U - UNDISTURBED SAMPLE
D - DISTURBED SAMPLE
B - BULK SAMPLE
W - WATER SAMPLE

C.U. - CONSOLIDATED UNDRAINED
C.D. - CONSOLIDATED DRAINED
Q. - IMMEDIATE UNDRAINED
Q.M. - IMMEDIATE UNDRAINED MULTISTAGE

Aqueous Extract 2:1 Water:Soil

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LABORATORY TEST RESULTS

CONTRACT HILLCREST ESTATE, HILLCREST, LONDON N6

Bore-hole	Sample	Depth m	Classification				Density		Triaxial Compression					Sulphates (SO_4)				Remarks
			Liquid Limit %	Plastic Limit %	Plasticity Index %	Moisture Content %	Bulk Mg/m^3	Dry Mg/m^3	Type	Principal Stress Difference kPa	Cell Pressure kPa	Shear Strength kPa	Angle of Shear Resistance degrees	Soil Total % Dry Wt.	Soil Aqueous Extract mg/l	Water mg/l	pH	
WS4	U7	7.70 - 8.00				20	1.85	1.54	QM	94	100	52	0					
										103	200							
										117	400							
	U8	8.70 - 9.00				23	1.91	1.55	QM	91	100	52	0					
										99	200							
										121	400							

U - UNDISTURBED SAMPLE
D - DISTURBED SAMPLE
B - BULK SAMPLE
W - WATER SAMPLE

C.U. - CONSOLIDATED UNDRAINED
C.D. - CONSOLIDATED DRAINED
Q. - IMMEDIATE UNDRAINED
Q.M. - IMMEDIATE UNDRAINED MULTISTAGE

Aqueous Extract 2:1 Water:Soil

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GROUND ENGINEERING

Newark Road Peterborough

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TEST CERTIFICATE

One-Dimensional Consolidation Properties

(Tested in accordance with BS1377 : Part 5 1990)

Client:	Ground Engineering Ltd	Certificate Number:	PL4654-1-3/731
Client Address:	Newark Road	Client Reference Number:	C13269
	Peterborough	Date Sampled:	Unknown
	Cambridgeshire	Date Received:	27.06.2014
Postcode:	PE1 5UA	Date Tested:	02.07.2014
Contact:	Steve Fleming	Sampling Certificate No:	N/A
Site Name:	Hillcrest Estate	Certificate of Sampling:	N/A
Site Address:	London N6	Sampled By:	Client

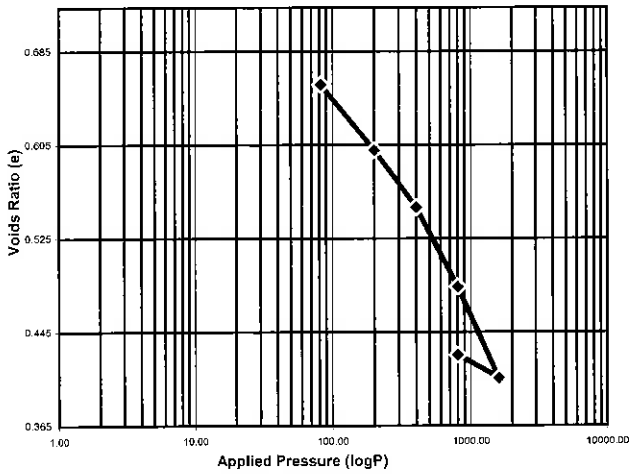
Test Details

Location:	BH1	
Sample Ref:	U1	
Sample Description:	Firm orange-brown grey slightly silty CLAY	
Particle Density (Mg/m^3):	2.74	Assumed
Mean Lab Temp. (°C):	22	
Variations from Standard:	None	
Lab Reference:	PL4654-1-3	
Depth (m):	2.00 m	

Specimen Details

	INITIAL	FINAL
Height (mm):	18.50	15.92
Bulk Density (Mg/m^3):	2.01	2.26
Moisture Content (%):	21	18
Dry Density (Mg/m^3):	1.65	1.92
Voids Ratio:	0.658	0.427
Degree of Saturation (%):	89.3	112.7
Diameter (mm):	75.00	N/A
Swelling Pressure (kPa):	82	N/A
Method of time fitting used:	Log Time	N/A

Voids Ratio against logarithm of Applied Pressure



Applied Pressure (kPa)	Coefficient of Compressibility m_v (m^2/MN)	Coefficient of Consolidation c_v ($m^2/year$)
82		
200	0.29	0.41
400	0.15	0.38
800	0.11	0.39
1600	0.07	0.51
800	0.02	---

Comments:

Approved Signatory: [x] M.Hartnup - Laboratory Manager
[ ] L.Petch - Team Leader

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 15/07/2014

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TEST CERTIFICATE

One-Dimensional Consolidation Properties

(Tested in accordance with BS1377 : Part 5 1990)

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Client:	Ground Engineering Ltd	Certificate Number:	PL4654-1-4/731
Client Address:	Newark Road	Client Reference Number:	C13269
	Peterborough	Date Sampled:	Unknown
	Cambridgeshire	Date Received:	27.06.2014
Postcode:	PE1 5UA	Date Tested:	02.07.2014
Contact:	Steve Fleming	Sampling Certificate No:	N/A
Site Name:	Hillcrest Estate	Certificate of Sampling:	N/A
Site Address:	London N6	Sampled By:	Client

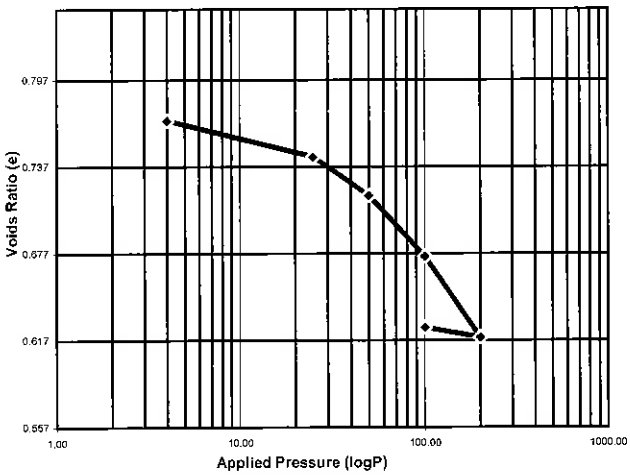
Test Details

Location:	BH1	
Sample Ref:	U2	
Sample Description:	Firm orange-brown grey sandy CLAY	
Particle Density (Mg/m^3):	2.7	Assumed
Mean Lab Temp. (^{o}C):	22	
Variations from Standard:	None	
Lab Reference:	PL4654-1-4	
Depth (m):	3.05 m	

Specimen Details

	INITIAL	FINAL
Height (mm):	18.93	17.40
Bulk Density (Mg/m^3):	1.89	2.07
Moisture Content (%):	24	24
Dry Density (Mg/m^3):	1.53	1.66
Voids Ratio:	0.769	0.626
Degree of Saturation (%):	82.9	105.7
Diameter (mm):	74.98	N/A
Swelling Pressure (kPa):	4	N/A
Method of time fitting used:	Log Time	N/A

Voids Ratio against logarithm of Applied Pressure



Applied Pressure (kPa)	Coefficient of Compressibility m_v (m^2/MN)	Coefficient of Consolidation c_v (m^2/year)
4		
25	0.67	12.27
50	0.63	14.35
100	0.48	10.91
200	0.33	8.31
100	0.04	---

Comments:

Approved Signatory: [x] M.Hartnup - Laboratory Manager
[ ] L.Petch - Team Leader

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 15/07/2014

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GROUND ENGINEERING

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TEST CERTIFICATE

Determination of Particle Size Distribution

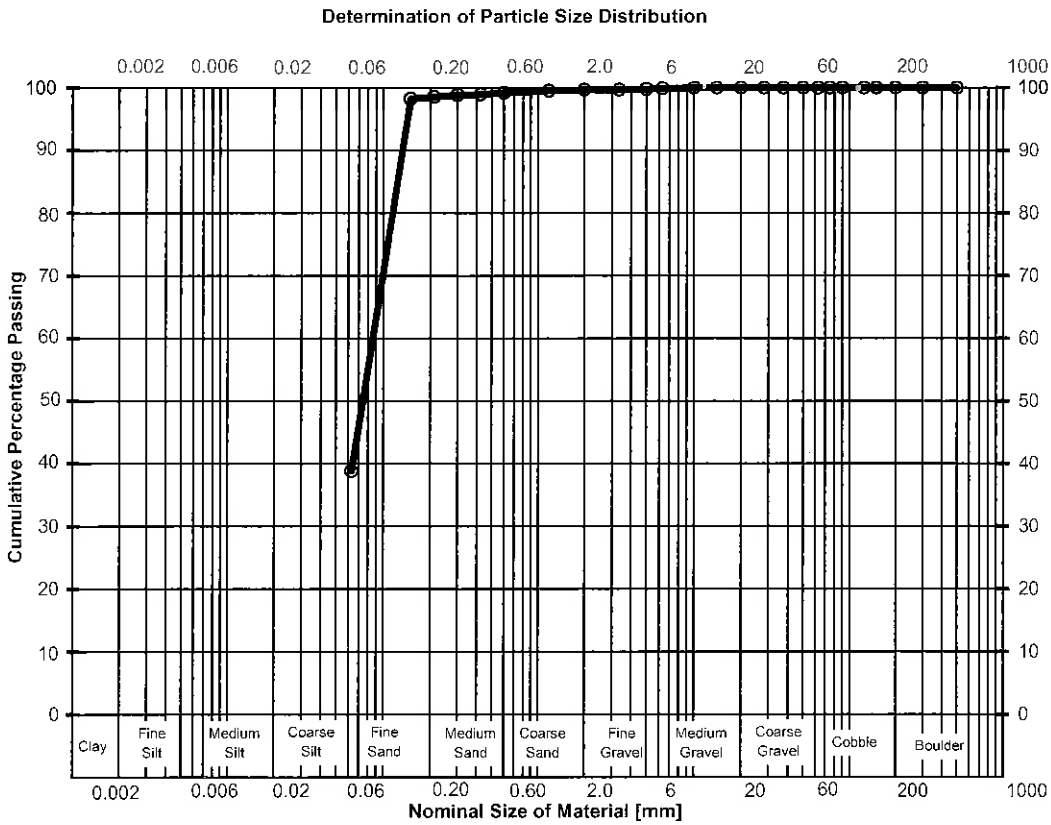
Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4
Sieved Grading and Sedimentation by Pipette

Client:	Ground Engineering Ltd	Certificate Number:	PL4654-1/6/710-2
Client Address:	Newark Road	Client Reference:	C13269
	Peterborough	Lab Job Number:	PL4654-1
	PE1 5UA	Date Sampled:	Unknown
		Date Received:	27.06.2014
Contact:	Steve Fleming	Date Tested:	02.07.2014
		Certificate of Sampling:	N/A
Site Name:	Hillcrest Estate	Sampling Certificate No.:	N/A
Site Address:	London N6	Sampled By:	lient

TEST RESULTS **Laboratory Reference:** PL4654-1/6 **Pre-treatment for organic material:** N/A
Client Reference: B3

Sample Description: Light brown SAND with occasional clay lumps

Material Specification: Not Required **Depth Top:** 4.50m
Location: BH1 **Depth Base:** 5.00m
Source: **Supplier:**



Sieve Analysis

Sieve mm	%Passing
125	100
90	100
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	100
6.3	100
5.0	100
3.35	100
2.00	100
1.18	100
0.600	99
0.425	99
0.300	99
0.212	99
0.150	98
0.063	39
0.020	
0.006	
0.002	

Comments: Data relevant to material below 63 microns is outside the current scope of UKAS accreditation

Approved Signatory: M. Hartnup - Laboratory Manager Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 14.07.2014 Page 1 of 1
Form Number: GELab/C/709-2 Version 39

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TEST CERTIFICATE

Determination of Particle Size Distribution

Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4
Sieved Grading and Sedimentation by Pipette

Client:	Ground Engineering Ltd	Certificate Number:	PL4654-1/9/710-2
Client Address:	Newark Road	Client Reference:	C13269
	Peterborough	Lab Job Number:	PL4654-1
	PE1 5UA	Date Sampled:	Unknown
		Date Received:	27.06.2014
Contact:	Steve Fleming	Date Tested:	02.07.2014
		Certificate of Sampling:	N/A
Site Name:	Hillcrest Estate	Sampling Certificate No.:	N/A
Site Address:	London N6	Sampled By:	lient

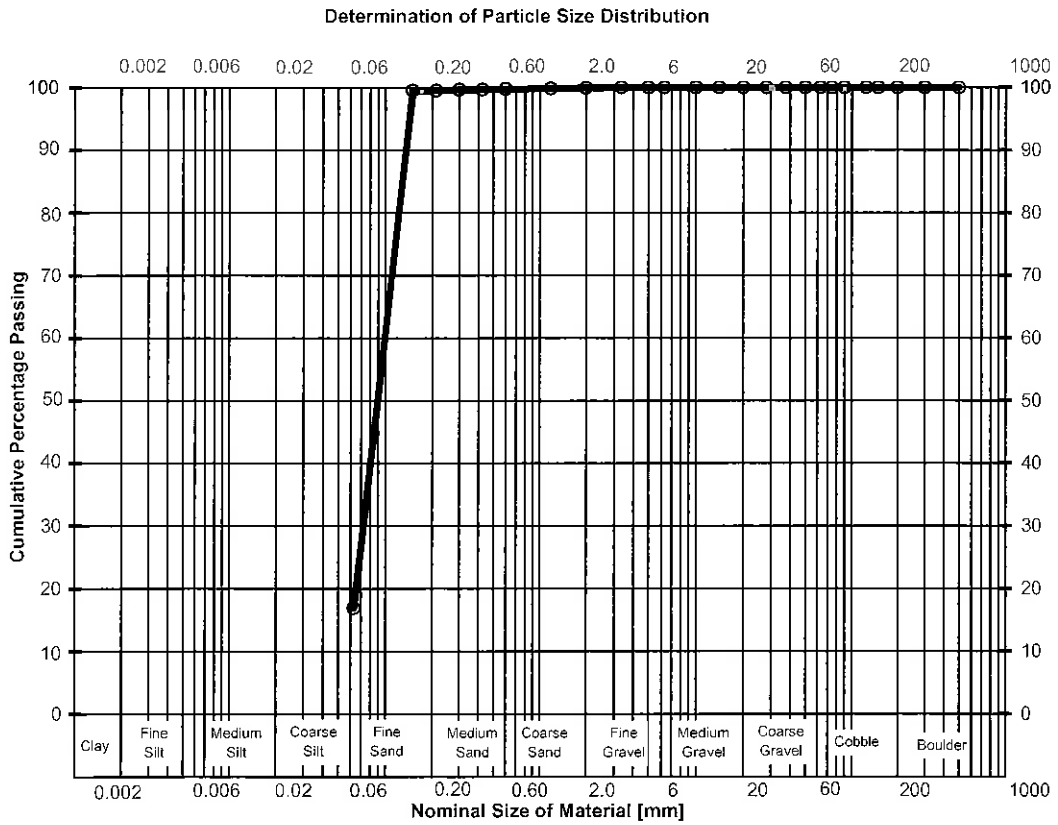
TEST RESULTS

Laboratory Reference: PL4654-1/9
Client Reference: B4
Pre-treatment for organic material: N/A

Sample Description: Light brown grey clayey SAND

Material Specification: Not Required
Location: BH1
Source:

Depth Top: 8.40m
Depth Base: 8.60m
Supplier:



Sieve Analysis

Sieve mm	%Passing
125	100
90	100
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	100
6.3	100
5.0	100
3.35	100
2.00	100
1.18	100
0.600	100
0.425	100
0.300	100
0.212	100
0.150	100
0.063	17
0.020	
0.006	
0.002	

Comments: Data relevant to material below 63 microns is outside the current scope of UKAS accreditation

Approved Signatory: M. Hartnup - Laboratory Manager

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 14.07.2014 Page 1 of 1
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TEST CERTIFICATE

Determination of Particle Size Distribution

Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4
Sieved Grading and Sedimentation by Pipette

Client:	Ground Engineering Ltd	Certificate Number:	PL4654-1/12/710-2
Client Address:	Newark Road	Client Reference:	C13269
	Peterborough	Lab Job Number:	PL4654-1
	PE1 5UA	Date Sampled:	Unknown
		Date Received:	27.06.2014
Contact:	Steve Fleming	Date Tested:	02.07.2014
		Certificate of Sampling:	N/A
Site Name:	Hillcrest Estate	Sampling Certificate No.:	N/A
Site Address:	London N6	Sampled By:	lient

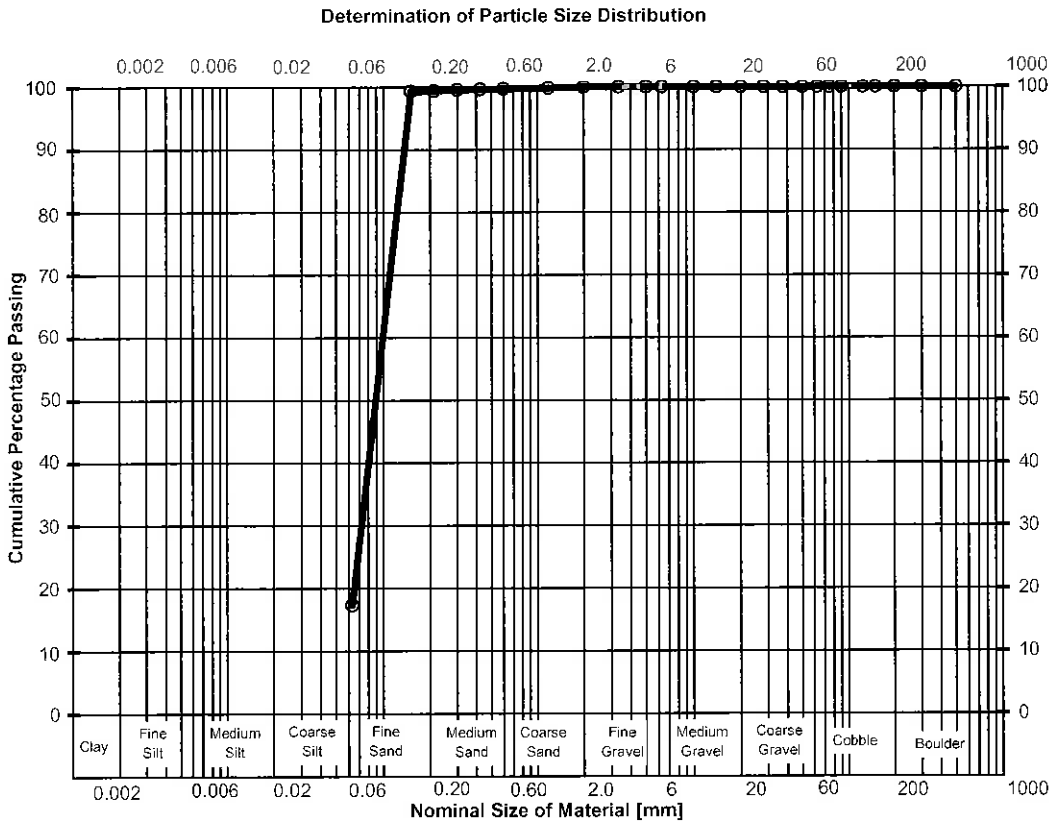
TEST RESULTS

Laboratory Reference: PL4654-1/12
Client Reference: B7
Pre-treatment for organic material: N/A

Sample Description: Light brown clayey SAND

Material Specification: Not Required
Location: BH1
Source:

Depth Top: 12.60m
Depth Base: 13.10m
Supplier:



Sieve Analysis

Sieve mm	%Passing
125	100
90	100
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	100
6.3	100
5.0	100
3.35	100
2.00	100
1.18	100
0.600	100
0.425	100
0.300	100
0.212	99
0.150	99
0.063	17
0.020	
0.006	
0.002	

Comments: Data relevant to material below 63 microns is outside the current scope of UKAS accreditation

Approved Signatory: M. Hartnup - Laboratory Manager

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 14.07.2014 Page 1 of 1
Form Number: GELab/C/709-2 Version 39

Registered in England & Wales
Registration Number: 6929574
Reg Office: Ground Engineering Ltd
Newark Rd, Peterbrough PE1 5UA

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8180

GROUND ENGINEERING

Newark Road Peterborough
t: 01733 566566 f: 01733 315280
e: admin@groundengineering.co.uk

TEST CERTIFICATE

Determination of Particle Size Distribution

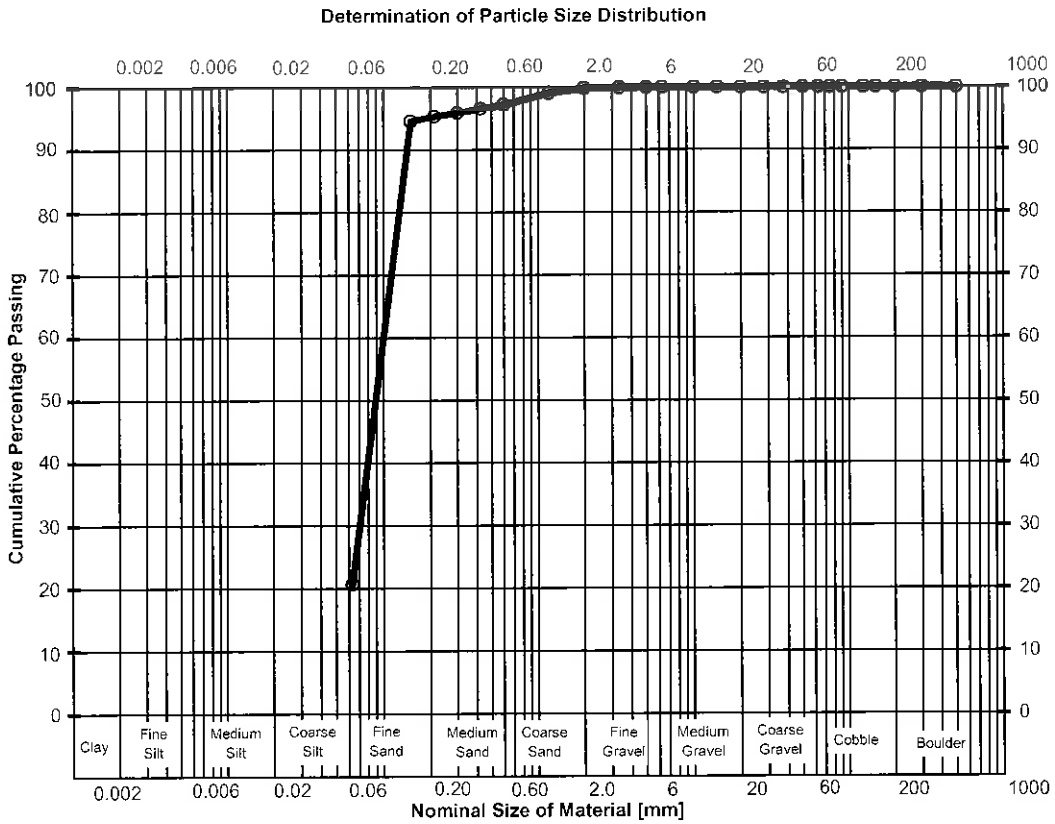
Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4
Sieved Grading and Sedimentation by Pipette

Client:	Ground Engineering Ltd	Certificate Number:	PL4654-1/14/710-2
Client Address:	Newark Road	Client Reference:	C13269
	Peterborough	Lab Job Number:	PL4654-1
	PE1 5UA	Date Sampled:	Unknown
		Date Received:	27.06.2014
Contact:	Steve Fleming	Date Tested:	02.07.2014
		Certificate of Sampling:	N/A
Site Name:	Hillcrest Estate	Sampling Certificate No.:	N/A
Site Address:	London N6	Sampled By:	lient

TEST RESULTS **Laboratory Reference:** PL4654-1/14 **Pre-treatment for organic material:** N/A
Client Reference: B9

Sample Description: Dark brown dark grey clayey SAND

Material Specification: Not Required **Depth Top:** 14.10m
Location: BH1 **Depth Base:** 14.60m
Source: **Supplier:**



Sieve Analysis

Sieve mm	%Passing
125	100
90	100
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	100
6.3	100
5.0	100
3.35	100
2.00	100
1.18	99
0.600	97
0.425	97
0.300	96
0.212	95
0.150	95
0.063	21
0.020	
0.006	
0.002	

Comments: Data relevant to material below 63 microns is outside the current scope of UKAS accreditation

Approved Signatory: M. Hartnup - Laboratory Manager Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 14.07.2014 Page 1 of 1
Form Number: GELab/C/709-2 Version 39

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GROUND ENGINEERING

Newark Road Peterborough
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e: admin@groundengineering.co.uk

TEST CERTIFICATE

Determination of Particle Size Distribution

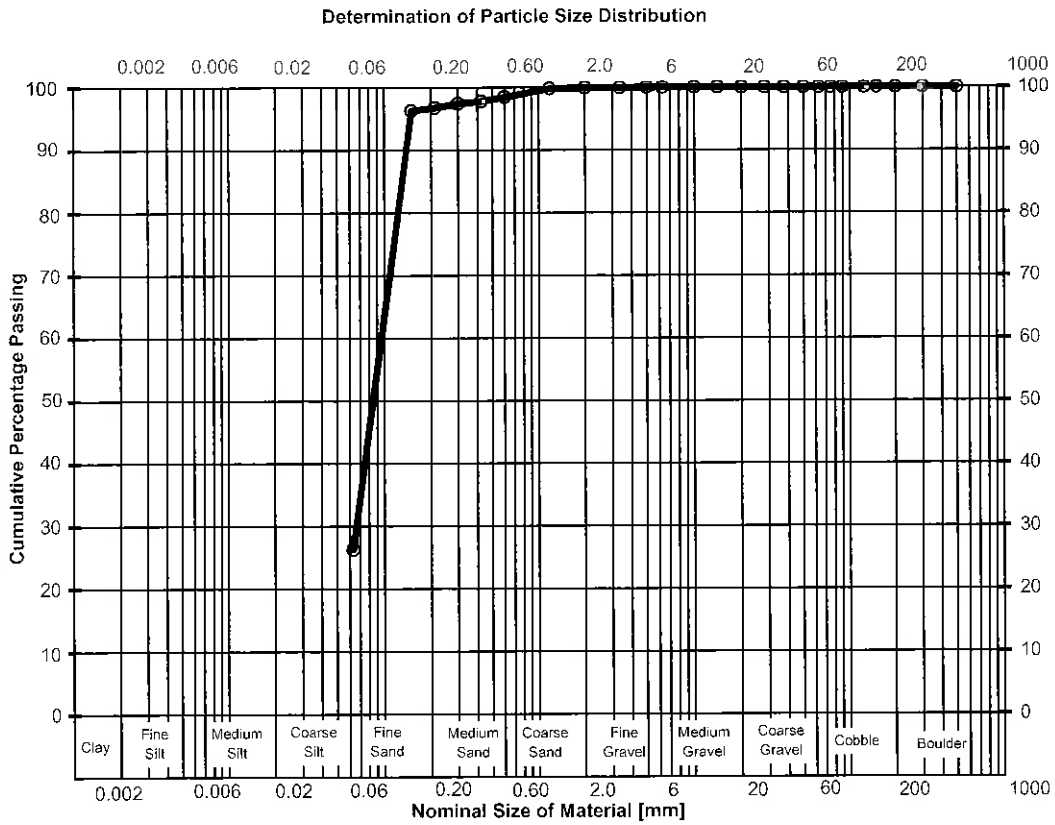
Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4
Sieved Grading and Sedimentation by Pipette

Client:	Ground Engineering Ltd	Certificate Number:	PL4654-1/16/710-2
Client Address:	Newark Road	Client Reference:	C13269
	Peterborough	Lab Job Number:	PL4654-1
	PE1 5UA	Date Sampled:	Unknown
		Date Received:	27.06.2014
Contact:	Steve Fleming	Date Tested:	02.07.2014
		Certificate of Sampling:	N/A
Site Name:	Hillcrest Estate	Sampling Certificate No.:	N/A
Site Address:	London N6	Sampled By:	lient

TEST RESULTS **Laboratory Reference:** PL4654-1/16 **Pre-treatment for organic material:** N/A
Client Reference: B11

Sample Description: Saturated brown orange brown grey clayey SAND

Material Specification: Not Required **Depth Top:** 16.10m
Location: BH1 **Depth Base:** 16.60m
Source: **Supplier:**



Sieve Analysis

Sieve mm	%Passing
125	100
90	100
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	100
6.3	100
5.0	100
3.35	100
2.00	100
1.18	100
0.600	98
0.425	98
0.300	97
0.212	97
0.150	96
0.063	26
0.020	
0.006	
0.002	

Comments: Data relevant to material below 63 microns is outside the current scope of UKAS accreditation

Approved Signatory: M. Hartnup - Laboratory Manager Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 14.07.2014 Page 1 of 1
Form Number: GELab/C/709-2 Version 39

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GROUND ENGINEERING

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e: admin@groundengineering.co.uk

TEST CERTIFICATE

Determination of Particle Size Distribution

Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4
Sieved Grading and Sedimentation by Pipette

Client:	Ground Engineering Ltd	Certificate Number:	PL4654-1/31/710-2
Client Address:	Newark Road	Client Reference:	C13269
	Peterborough	Lab Job Number:	PL4654-1
	PE1 5UA	Date Sampled:	Unknown
		Date Received:	27.06.2014
Contact:	Steve Fleming	Date Tested:	02.07.2014
		Certificate of Sampling:	N/A
Site Name:	Hillcrest Estate	Sampling Certificate No.:	N/A
Site Address:	London N6	Sampled By:	Client

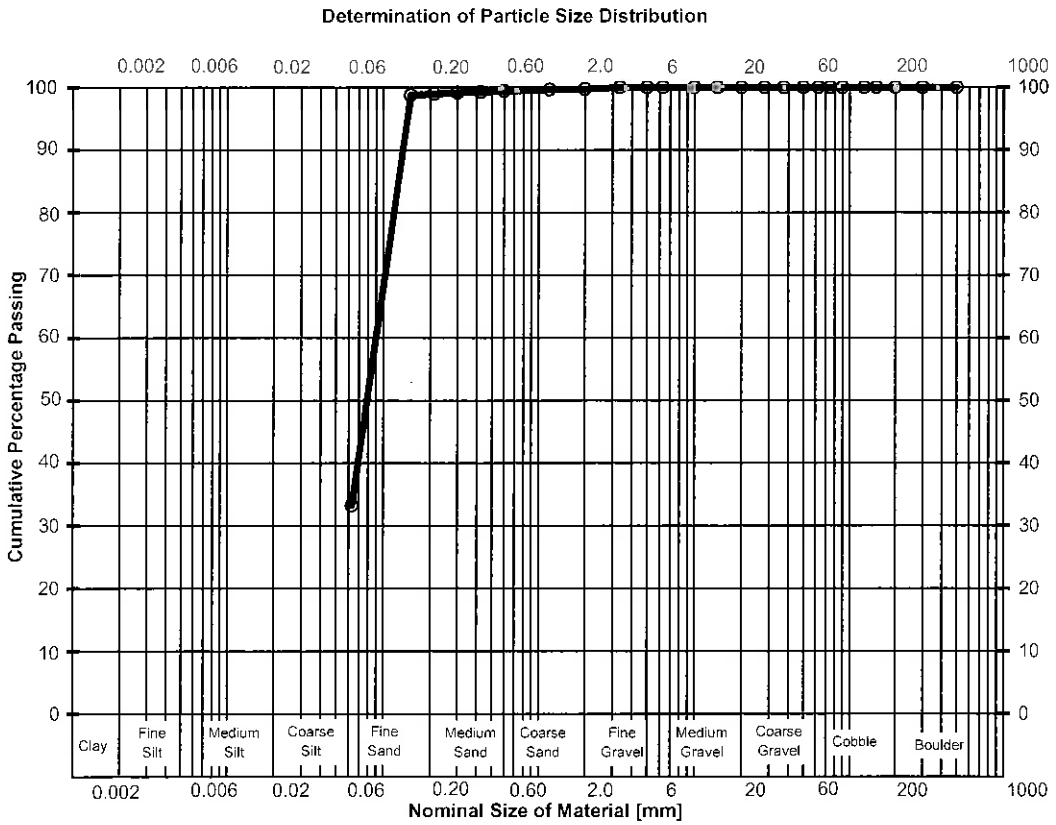
TEST RESULTS

Laboratory Reference: PL4654-1/31
Client Reference: U9
Pre-treatment for organic material: N/A

Sample Description: Light brown SAND with firm brown sand clay lumps

Material Specification: Not Required
Location: WS4
Source:

Depth Top: 9.50m
Depth Base: 10.00m
Supplier:



Sieve Analysis

Sieve mm	%Passing
125	100
90	100
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	100
6.3	100
5.0	100
3.35	100
2.00	100
1.18	100
0.600	99
0.425	99
0.300	99
0.212	99
0.150	99
0.063	33
0.020	
0.006	
0.002	

Comments: Data relevant to material below 63 microns is outside the current scope of UKAS accreditation

Approved Signatory: M. Hartnup - Laboratory Manager

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 14.07.2014 Page 1 of 1
Form Number: GELab/C/709-2 Version 39

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Registration Number: 6929574
Reg Office: Ground Engineering Ltd
Newark Rd, Peterbrough PE1 5UA

Groundwater/Gas Monitoring Record **GROUND ENGINEERING LIMITED**

Site: **Hillcrest Estate, Hillcrest, London N6**

Report Ref: C13269

Date	Borehole	Methane (% v/v)		Carbon Dioxide (% v/v)		Oxygen (% v/v)		Flow Rate (l/hr)	Atmosph. Pressure (mb)	Depth of Well (m)	Depth to Groundwater (m)
		Peak	Steady	Peak	Steady	Min.	Max.				
12/06/14	BH 1	<0.1	<0.1	3.1	3.1	17.5	17.5	<0.1	1027	10.00	8.10
	WS 4	<0.1	<0.1	2.5	2.5	18.6	18.6	<0.1	1027	10.00	Dry
19/06/14	BH 1	<0.1	<0.1	1.9	1.9	18.1	18.1	<0.1	1021	10.00	8.12
	WS 4	<0.1	<0.1	1.5	1.5	19.0	19.0	<0.1	1021	10.00	Dry
24/06/14	BH 1	<0.1	<0.1	3.2	3.2	17.0	17.0	<0.1	1004	10.00	8.07
	WS 4	<0.1	<0.1	2.1	2.1	18.3	18.3	<0.1	1004	10.00	Dry
16/07/14	BH 1	<0.1	<0.1	2.0	2.0	19.2	19.2	<0.1	1016	10.00	8.17
	WS 4	<0.1	<0.1	3.2	3.2	18.2	18.2	<0.1	1016	10.00	Dry

Equipment: GasLog GFM 430, 50m tape dipmeter.

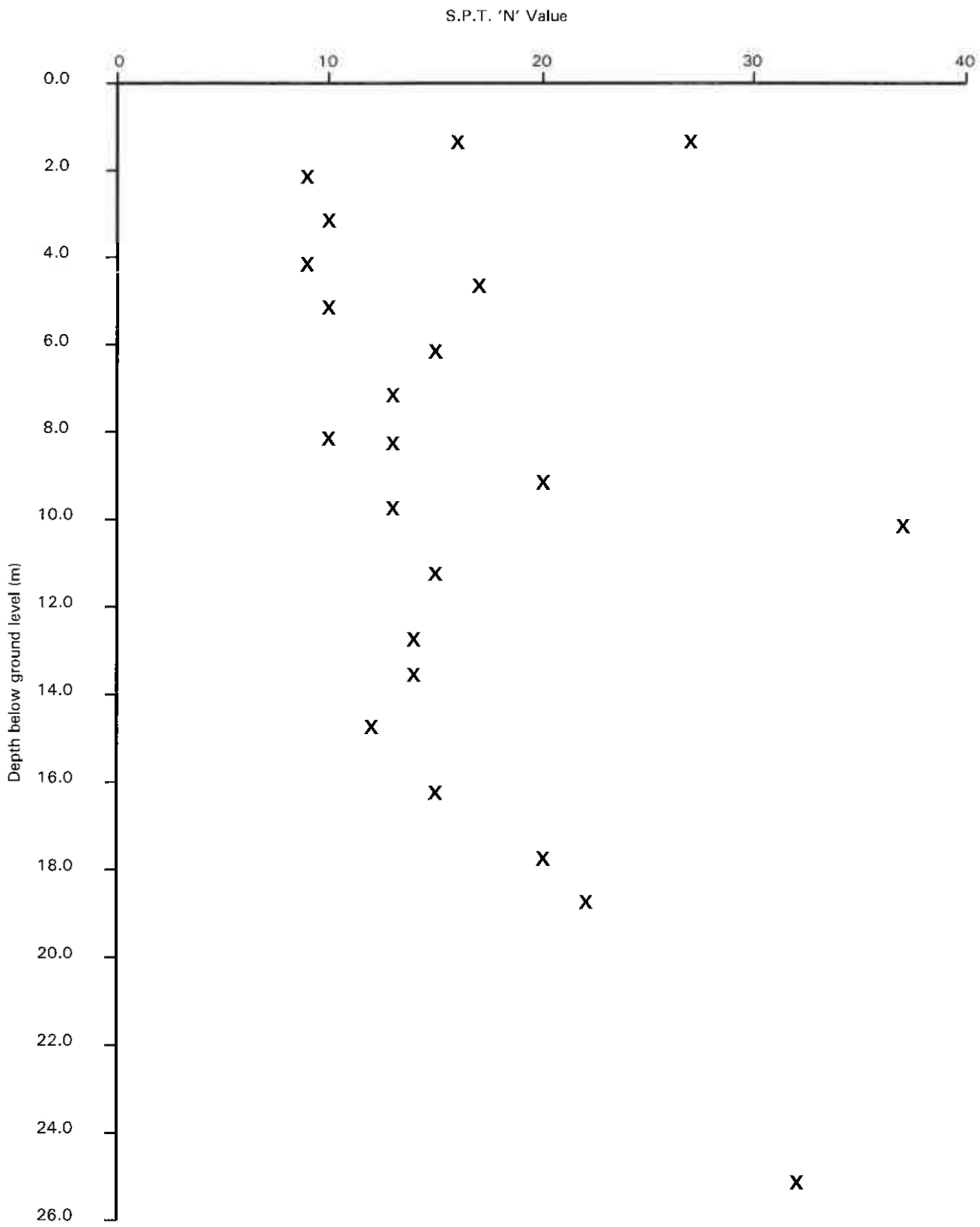
Groundwater/Gas Monitoring Record **GROUND ENGINEERING LIMITED**

Site: **Hillcrest Estate, Hillcrest, London N6**

Report Ref: C13269

Date	Borehole	Methane (% v/v)		Carbon Dioxide (% v/v)		Oxygen (% v/v)		Flow Rate (l/hr)	Atmosph. Pressure (mb)	Depth of Well (m)	Depth to Groundwater (m)
		Peak	Steady	Peak	Steady	Min.	Max.				
22/07/14	BH 1	<0.1	<0.1	1.7	1.7	18.9	18.9	<0.1	1022	10.00	8.21
	WS 4	<0.1	<0.1	1.3	1.3	19.2	19.2	<0.1	1022	10.00	Dry
06/08/14	BH 1	<0.1	<0.1	0.3	0.3	20.2	20.2	<0.1	1005	10.00	8.20
	WS 4	<0.1	<0.1	0.2	0.2	20.4	20.4	<0.1	1005	10.00	Dry

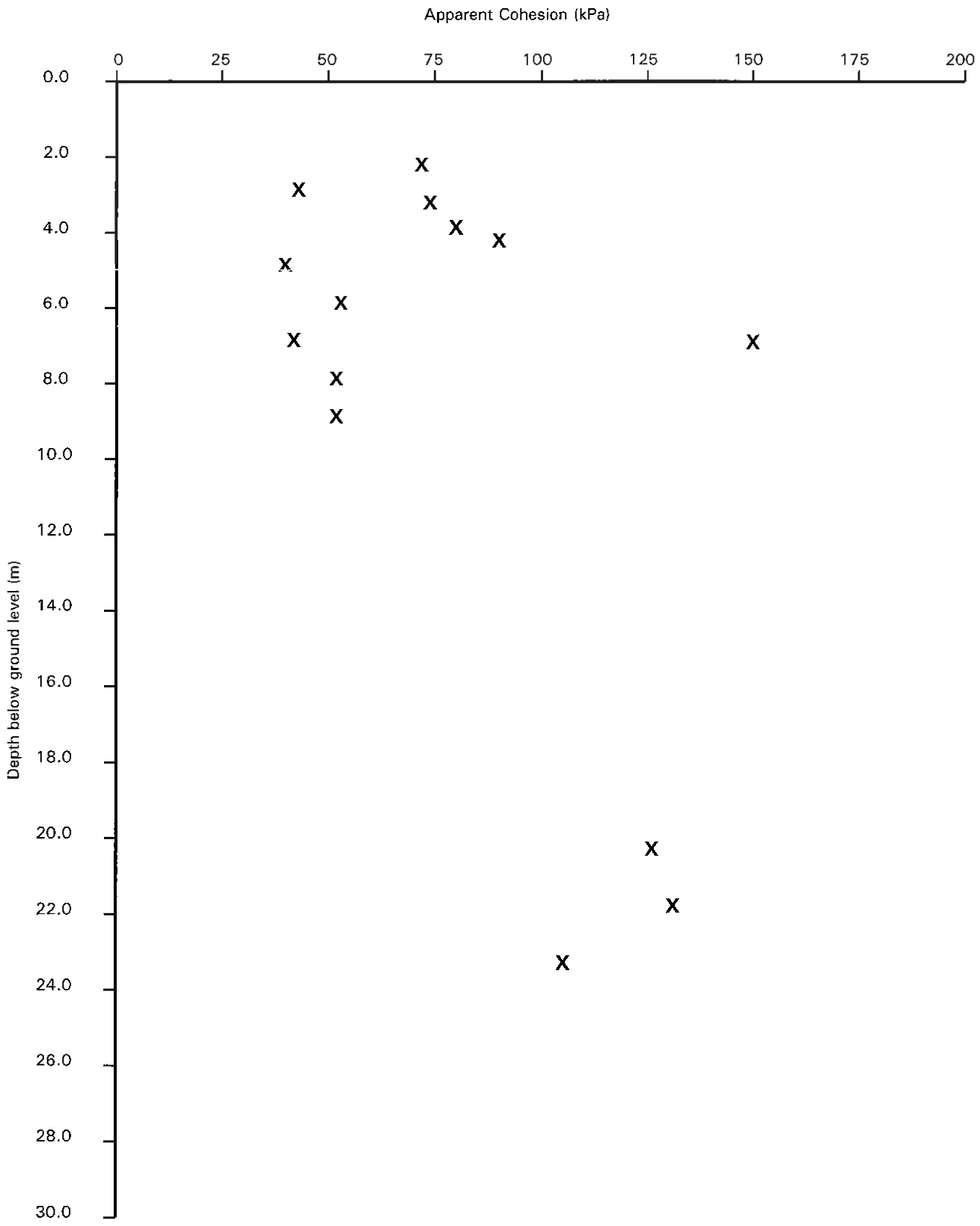
Equipment: GasLog GFM 430, 50m tape dipmeter.



KEY: X :-BH1 X :-WS4

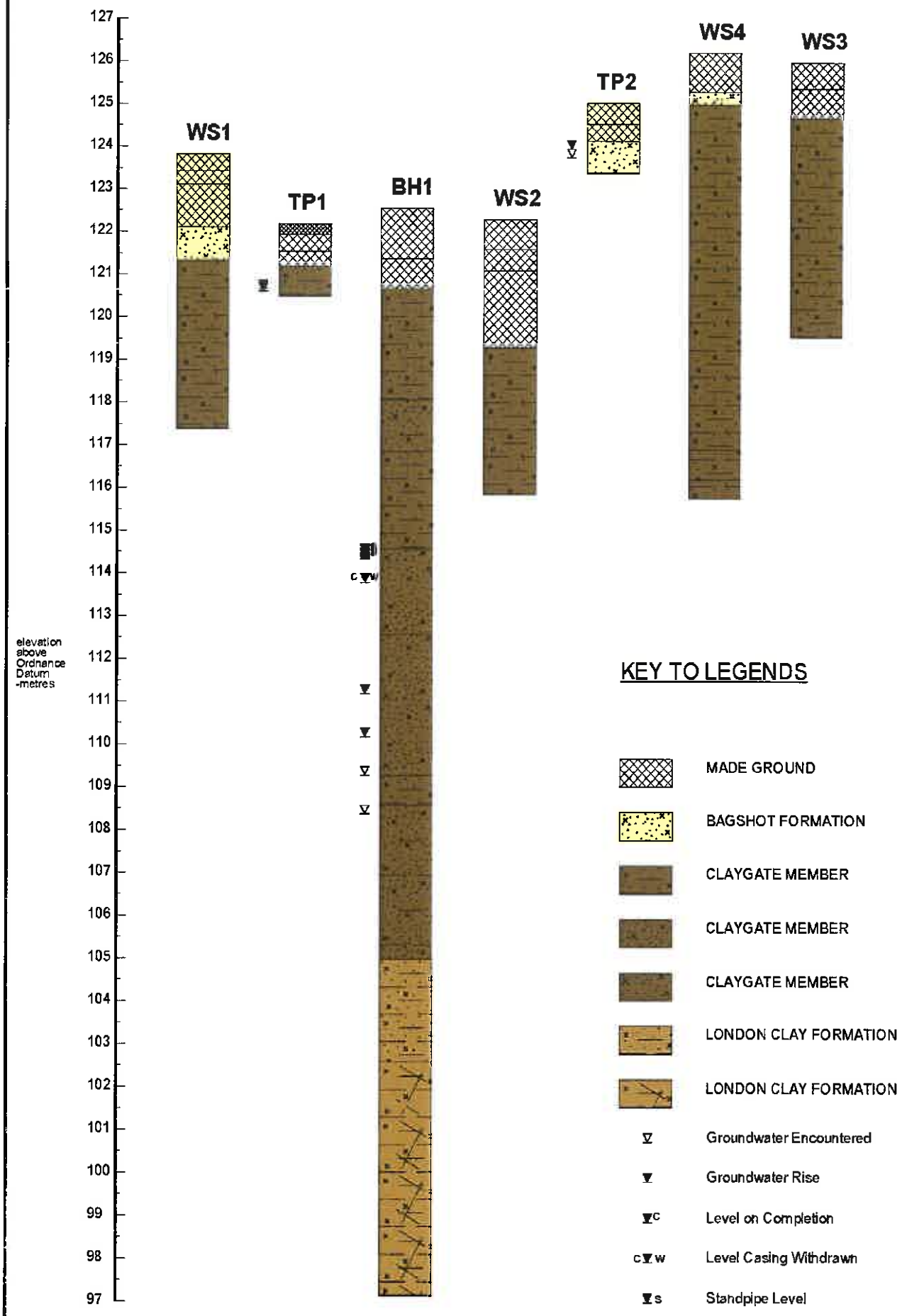
S.P.T. 'N' Value vs Depth below ground level (m).

SITE	HILLCREST ESTATE, HILLCREST, LONDON N6		
CLIENT	HARINGEY COUNCIL	Contract Number	13269
GROUND ENGINEERING LIMITED Tel: 01733-566566 www.groundengineering.co.uk	Date 11/08/14	Figure	1



Apparent Cohesion (kPa) vs Depth below ground level (m).

SITE	HILLCREST, HILLCREST, LONDON N6		
CLIENT	HARINGEY COUNCIL	Contract Number	13269
GROUND ENGINEERING LIMITED Tel: 01733-566566 www.groundengineering.co.uk	Date 11/08/14	Figure	2



SITE	HILLCREST ESTATE, HILLCREST, LONDON N6		Contract No. 13269
CLIENT	HARINGEY COUNCIL	Soil Profile	Vertical Scale 1:125
© GROUND ENGINEERING LIMITED, PETERBOROUGH. Tel (01733) 566566		Date 11/08/14	Fig. No 3

APPENDIX 1 – CHEMICAL TEST RESULTS

Chemtest
The right chemistry to deliver results

Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

Final Report

Test Report Number:	14-04855
Issue:	1
Initial Date of Issue:	07/07/2014
Contact:	Steve Fleming
Customer Details:	Ground Engineering Limited Newark Road Peterborough Cambridgeshire
Quotation No:	
Order No:	C13269
Customer Reference:	Hillcrest Estate, Hillcrest, London N6
Date Received:	01/07/2014
Date Approved:	07/07/2014
Details:	Hillcrest Estate, Hillcrest, London N6
Approved by:	Darrell Hall, Laboratory Director

Chemtest
The right chemistry to deliver results

Results Summary - Soil

Report No.: 14-04855_1

Project: Hillcrest Estate, Hillcrest, London N6

				Customer Sample ID	BH1	WS1	WS1	WS2	WS3	WS4	TP1	TP2
				Customer Sample Reference	D2	D1	D3	D3	D1	D2	D3	D2
				Chemtest Sample ID	25073	25074	25075	25076	25077	25078	25079	25080
				Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Sample Depth (m)	0.50	0.30	0.90	0.90	0.30	0.60	0.80	0.60
Determinand	Accred	SOP	Units	LOD								
pH	M	2010			7.6	7.3	7.3	7.6	7.7	7.5	7.8	7.8
Moisture	N	2030	%	0.02	9.3	12	10	16	6.2	14	18	18
Stones	N	2030	%	0.02	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
Boron (Hot Water Soluble)	M	2120	mg/kg	0.4	2.0	1.6	1.0	0.88	0.60	0.77	0.60	0.77
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/L	0.01	0.074	0.033	0.037	0.039	0.027	0.038	0.045	0.034
Cyanide (Free)	M	2300	mg/kg	0.5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Cyanide (Total)	M	2300	mg/kg	0.5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Sulphide (Easily Liberatable)	M	2325	mg/kg	0.5	12	2.1	4.2	2.1	1.7	1.7	1.6	1.7
Arsenic	M	2450	mg/kg	2	28	17	8.5	14	9.3	12	15	11
Cadmium	M	2450	mg/kg	0.1	0.81	0.23	< 0.10	0.16	< 0.10	0.19	< 0.10	0.10
Chromium	M	2450	mg/kg	5	26	26	21	20	23	19	24	21
Copper	M	2450	mg/kg	5	66	53	88	42	15	37	14	26
Mercury	M	2450	mg/kg	0.1	1.1	0.79	0.56	9.2	0.30	0.42	0.24	0.52
Nickel	M	2450	mg/kg	5	21	17	13	12	5.9	11	5.4	7.9
Lead	M	2450	mg/kg	5	950	410	230	370	70	290	57	180
Selenium	M	2450	mg/kg	0.2	1.1	0.51	0.73	0.84	0.50	0.57	0.55	0.54
Zinc	M	2450	mg/kg	5	400	140	49	96	41	78	30	64
Chromium (Hexavalent)	N	2490	mg/kg	0.5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Organic Matter	M	2625	%	0.4	10	7.8	8.3	6.0	1.3	2.8	0.95	3.6
Acenaphthene	M	2700	mg/kg	0.1	< 0.10	0.13	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	M	2700	mg/kg	0.1	< 0.10	0.18	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Anthracene	M	2700	mg/kg	0.1	0.36	0.31	< 0.10	0.31	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]anthracene	M	2700	mg/kg	0.1	< 0.10	0.89	< 0.10	1.5	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	M	2700	mg/kg	0.1	< 0.10	< 0.10	< 0.10	1.6	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	M	2700	mg/kg	0.1	< 0.10	< 0.10	< 0.10	1.6	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	M	2700	mg/kg	0.1	< 0.10	< 0.10	< 0.10	1.2	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	M	2700	mg/kg	0.1	< 0.10	< 0.10	< 0.10	0.64	< 0.10	< 0.10	< 0.10	< 0.10
Chrysene	M	2700	mg/kg	0.1	< 0.10	1.2	< 0.10	2.1	< 0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	M	2700	mg/kg	0.1	< 0.10	< 0.10	< 0.10	0.28	< 0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	M	2700	mg/kg	0.1	2.2	2.2	< 0.10	2.3	< 0.10	< 0.10	0.41	0.21
Fluorene	M	2700	mg/kg	0.1	< 0.10	0.28	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	M	2700	mg/kg	0.1	< 0.10	< 0.10	< 0.10	1.0	< 0.10	< 0.10	< 0.10	< 0.10
Naphthalene	M	2700	mg/kg	0.1	< 0.10	0.25	< 0.10	0.12	< 0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	M	2700	mg/kg	0.1	1.2	1.3	< 0.10	1.2	< 0.10	< 0.10	< 0.10	< 0.10
Pyrene	M	2700	mg/kg	0.1	2.0	2.1	< 0.10	2.3	< 0.10	< 0.10	0.51	0.41
Total Of 16 PAH's	N	2700	mg/kg	2	5.8	8.8	< 2.0	16	< 2.0	< 2.0	< 2.0	< 2.0
Total Phenols	M	2920	mg/kg	0.3	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30
Total TPH >C6-C40	N	2670	mg/kg	10	270	27	< 10			10	12	

Chemtest
The right chemistry to deliver results

Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

UKAS TESTING 2183

mCERTS

Final Report

Report Number:	14-04857 Issue-1		
Initial Date of Issue:	09-Jul-14	**Date of Re-Issue:**	09-Jul-14
Client:	Ground Engineering Limited		
Client Address:	Newark Road Peterborough Cambridgeshire PE1 5UA		
Contact(s):	Steve Fleming		
Client Reference:	Hillcrest Estate, Hillcrest, London N6		
Quotation No.:		**Date Received:**	01-Jul-14
Order No.:	C13269	**Date Instructed:**	30-Jun-14
No. of Samples:	2	**Results Due:**	09-Jul-14
Turnaround: (Weekdays)	8		
Date Approved:	09-Jul-14		
Approved By:			
Details:	Darrell Hall, Laboratory Director		

The results reported herein relate only to the material supplied to the laboratory.
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Chemtest
The right chemistry to deliver results

Results Summary - 2 Stage WAC

Report No.: 14-04857 Issue-1
Project: Hillcrest Estate, Hillcrest, London N6

Chemtest Sample ID: 25089 Sample Ref: D2 Sample ID: WS1 Top Depth(m): 0.60 Bottom Depth(m): Sampling Date:							Landfill Waste Acceptance Criteria Limits		
							Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous	Hazardous Waste Landfill
Determinand	**SOP**	**Accred.**	**Units**						
Total Organic Carbon	2625	M	%			1.8	3	5	6
Loss on Ignition	2610	M	%			5.0	--	--	10
Total BTEX	2761	M	mg/kg			< 0.001	6	--	--
Total PCBs (7 congeners)	2811	M	mg/kg			< 0.010	1	--	--
TPH Total WAC	2670	M	mg/kg			< 10	500	--	--
Total (of 17) PAHs	2700	N	mg/kg			< 2.0	100	--	--
pH	2010	M				7.7	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg			0.12	--	To evaluate	To evaluate
Eluate Analysis			**2:1 mg/l**	**8:1 mg/l**	**2:1 mg/kg**	**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
Arsenic	1450	U	0.025	0.013	< 0.050	0.14	0.5	2	25
Barium	1450	U	0.007	0.004	< 0.50	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.0001	< 0.010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70
Copper	1450	U	0.008	0.003	< 0.050	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.0005	< 0.010	< 0.010	0.01	0.2	2
Molybdenum	1450	U	0.009	< 0.001	< 0.050	< 0.050	0.5	10	30
Nickel	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	0.004	< 0.010	0.038	0.5	10	50
Antimony	1450	U	0.006	0.002	0.011	0.020	0.06	0.7	5
Selenium	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.1	0.5	7
Zinc	1450	U	0.010	0.001	< 0.50	< 0.50	4	50	200
Chloride	1220	U	1.9	< 1.0	< 10	< 10	800	15000	25000
Fluoride	1220	U	0.56	0.31	1.1	3.3	10	150	500
Sulphate	1220	U	3.3	< 1.0	< 10	< 10	1000	20000	50000
Total Dissolved Solids	1040	U	120	61	240	670	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-
Dissolved Organic Carbon	1610	U	4.1	< 2.5	< 50	< 50	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.175
Moisture (%)	14

Leachate Test Information	
Leachant volume 1st extract/l	0.321
Leachant volume 2nd extract/l	1.400
Eluant recovered from 1st extract/l	0.170

Chemtest
The right chemistry to deliver results

Results Summary - 2 Stage WAC

Report No.: 14-04857 Issue-1
Project: Hillcrest Estate, Hillcrest, London N6

Chemtest Sample ID: 25090 Sample Ref: D4 Sample ID: WS2 Top Depth(m): 1.10 Bottom Depth(m): Sampling Date:							Landfill Waste Acceptance Criteria Limits		
							Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous	Hazardous Waste Landfill
Determinand	**SOP**	**Accred.**	**Units**						
Total Organic Carbon	2625	M	%			2.2	3	5	6
Loss on Ignition	2610	M	%			5.1	--	--	10
Total BTEX	2761	M	mg/kg			< 0.001	6	--	--
Total PCBs (7 congeners)	2811	M	mg/kg			< 0.010	1	--	--
TPH Total WAC	2670	M	mg/kg			< 10	500	--	--
Total (of 17) PAHs	2700	N	mg/kg			71	100	--	--
pH	2010	M				7.9	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg			0.095	--	To evaluate	To evaluate
Eluate Analysis			**2:1 mg/l**	**8:1 mg/l**	**2:1 mg/kg**	**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
Arsenic	1450	U	0.007	0.009	< 0.050	0.086	0.5	2	25
Barium	1450	U	0.006	0.006	< 0.50	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.0001	< 0.010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70
Copper	1450	U	0.008	0.007	< 0.050	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.0005	< 0.010	< 0.010	0.01	0.2	2
Molybdenum	1450	U	0.012	0.003	< 0.050	< 0.050	0.5	10	30
Nickel	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.4	10	40
Lead	1450	U	0.004	0.019	< 0.010	0.18	0.5	10	50
Antimony	1450	U	0.016	0.010	0.032	0.10	0.06	0.7	5
Selenium	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.1	0.5	7
Zinc	1450	U	0.003	0.005	< 0.50	< 0.50	4	50	200
Chloride	1220	U	1.8	< 1.0	< 10	< 10	800	15000	25000
Fluoride	1220	U	0.65	0.45	1.3	4.7	10	150	500
Sulphate	1220	U	12	< 1.0	24	< 10	1000	20000	50000
Total Dissolved Solids	1040	U	110	74	220	770	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-
Dissolved Organic Carbon	1610	U	11	6.9	< 50	72	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.175
Moisture (%)	8.0

Leachate Test Information	
Leachant volume 1st extract/l	0.335
Leachant volume 2nd extract/l	1.400
Eluant recovered from 1st extract/l	0.144

APPENDIX 2

CLASSIFICATION OF AGGRESSIVE CHEMICAL ENVIRONMENT FOR BURIED CONCRETE

TABLE C2 – AGGRESSIVE CHEMICAL ENVIRONMENT FOR CONCRETE

(ACEC) CLASSIFICATION FOR BROWNFIELD LOCATIONS[a]

Table C2 Aggressive Chemical Environment for Concrete (ACEC) classification for brownfield locations[a]

Sulfate and magnesium						Groundwater		ACEC
Design Sulfate Class for location	2:1 water/soil extract[b]		Groundwater		Total potential sulfate[c]	Static water	Mobile water	Class for location
1	2 (SO_4 mg/l)	3 (Mg mg/l)	4 (SO_4 mg/l)	5 (Mg mg/l)	6 (SO_4 %)	7 (pH)[d]	8 (pH)[d]	9
DS-1	< 500		< 400		< 0.24	≥ 2.5		AC-1s
							> 6.5[d]	AC-1
							5.5–6.5	AC-2z
							4.5–5.5	AC-3z
							2.5–4.5	AC-4z
DS-2	500–1500		400–1400		0.24–0.6	> 5.5		AC-1s
							> 6.5	AC-2
						2.5–5.5		AC-2s
							5.5–6.5	AC-3z
							4.5–5.5	AC-4z
							2.5–5.5	AC-5z
DS-3	1600–3000		1500–3000		0.7–1.2	> 5.5		AC-2s
							> 6.5	AC-3
						2.5–5.5		AC-3s
							5.5–6.5	AC-4
							2.5–5.5	AC-5
DS-4	3100–6000	≤ 1200	3100–6000	≤ 1000	1.3–2.4	> 5.5		AC-3s
							> 6.5	AC-4
						2.5–5.5		AC-4s
							2.5–6.5	AC-5
DS-4m	3100–6000	> 1200[e]	3100–6000	> 1000[e]	1.3–2.4	> 5.5		AC-3s
							> 6.5	AC-4m
						2.5–5.5		AC-4ms
							2.5–6.5	AC-5m
DS-5	> 6000	≤ 1200	> 6000	≤ 1000	> 2.4	> 5.5		AC-4s
						2.5–5.5	≥ 2.5	AC-5
DS-5m	> 6000	> 1200[e]	> 6000	> 1000[e]	> 2.4	> 5.5		AC-4ms
						2.5–5.5	≥ 2.5	AC-5m

Notes

a Brownfield locations are those sites, or parts of sites, that might contain chemical residues produced by or associated with industrial production (Section C5.1.3).

b The limits of Design Sulfate Classes based on 2:1 water/soil extracts have been lowered from previous Digests (Box C7).

c Applies only to locations where concrete will be exposed to sulfate ions (SO_4), which may result from the oxidation of sulfides such as pyrite, following ground disturbance (Appendix A1 and Box C8).

d An additional account is taken of hydrochloric and nitric acids by adjustment to sulfate content (Section C5.1.3).

e The limit on water-soluble magnesium does not apply to brackish groundwater (chloride content between 12 000 mg/l and 17 000 mg/l). This allows 'm' to be omitted from the relevant ACEC classification. Seawater (chloride content about 18 000 mg/l) and stronger brines are not covered by this table.

Explanation of suffix symbols to ACEC Class

- Suffix 's' indicates that the water has been classified as static.
- Concrete placed in ACEC Classes that include the suffix 'z' have primarily to resist acid conditions and may be made with any of the cements in Table D2 on page 42.
- Suffix 'm' relates to the higher levels of magnesium in Design Sulfate Classes 4 and 5.

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