Appendix E: Ground and Water Site Investigation December 2016

GROUND INVESTIGATION REPORT

for the site at

59 CROFTDOWN ROAD, CAMDEN, LONDON NW5 1EL

on behalf of

FRANCOIS BAROU AND KATHARINE THEIL
C/O MOMENTUM STRUCTURAL ENGINEERS

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File Reference: Ground and Water/Project Files/ GWPR1860 59 Croftdown Road, Camden		

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1.0 INTRODUCTION

1.1 General

Ground and Water Limited were instructed by Francois Barou and Katharine Theil c/o Momentum Structural Engineers on the 6th October 2016 to conduct a Ground Investigation at 59 Croftdown Road, Camden, London NW5 1EL. The scope of the investigation was detailed within the Ground and Water Limited fee proposal ref: GWQ3073 dated 6th October 2016.

1.2 Aims of the Investigation

The aim of the investigation was understood to be to supply the client and their designers with information regarding the ground conditions underlying the site to assist them in preparing an appropriate scheme for development.

The investigation was to be undertaken to provide parameters for the design of foundations by means of in-situ and laboratory geotechnical testing undertaken on soil samples recovered from trial holes.

Included within the fee proposal was an allowance to undertake chemical laboratory testing on soil samples recovered from the site to enable recommendations for the safe redevelopment of the site and the protection of site workers, end-users and the public from any potential contamination identified.

A Desk Study and full scale contamination assessment were not part of the remit of this report.

The techniques adopted for the investigation were chosen considering the anticipated ground conditions and development proposals on-site, and bearing in mind the nature of the site, limitations to site access and other logistical limitations.

1.3 Conditions and Limitations

This report has been prepared based on the terms, conditions and limitations outlined within Appendix A.

2.0 SITE SETTING

2.1 Site Location

The site comprised 300m^2 rectangular shaped plot of land, orientated in a north-west to south-east direction, with Brookfield Park to the north-west and Croftdown Road to the south-east. The site was located in the Dartmouth Park area of north London, within the London Borough of Camden.

The national grid reference for the centre of the site was approximately TQ 28661 86305. A site location plan is given within Figure 1. A plan showing the boundary of the site is provided in Figure 2.

2.2 Site Description

The site comprised a three storey semi-detached brick built building in the south-west with single gated access off Brookfield Park. A rear garden was noted to the north-west with mature hedge to the north-east and trees to the north-west. A garage/shed was noted in the extreme north-west with double gated access off Brookfield Park.

An aerial view of the site is provided within Figure 3.

2.3 Proposed Development

At the time of reporting, December 2016, it was understood that the proposed development will comprise the deepening of the existing basement by 500mm to ~3.00m bgl and the extension of the basement to the north, underneath the existing timber deck. The development will also include the refurbishment of the single storey structure to the rear of the property.

A plan showing the proposed development can be seen in Figure 4.

2.4 Geology

The BGS Geological Map (Solid and Drift) for the North London area (Sheet No. 256) revealed that the site was underlain by the London Clay Formation.

No areas of Worked or Made Ground was noted within a 250m radius of the site.

London Clay Formation

The London Clay Formation comprises stiff grey fissured clay, weathering to brown near surface. Concretions of argillaceous limestone in nodular form (Claystones) occur throughout the formation. Crystals of Gypsum (Selenite) are often found within the weathered part of the London Clay Formation, and precautions against sulphate attack to concrete are sometimes required. The lowest part of the formation is a sandy bed with black rounded gravel and occasional layers of sandstone and is known as the Basement Bed.

A BGS borehole to 14.94m bgl ~300m north-east revealed 0.70m of Topsoil/Made Ground overlying firm to very stiff, brown, becoming grey with depth, silty clays.

2.5 Hydrogeology and Hydrology

A study of the aquifer maps on the Environment Agency website revealed the site to be located on **Unproductive Strata** comprising the bedrock deposits of the London Clay Formation. No designation was given to superficial deposits due to their likely absence.

Superficial (Drift) deposits are permeable unconsolidated (loose) deposits, for example, sands and gravels.The bedrock is described as solid permeable formations e.g. sandstone, chalk and limestone.

Unproductive strata are rock layers with low permeability that have negligible significance for water supply or river base flow. These were formerly classified as non-aquifers.

Examination of the Environment Agency records showed that the site did not fall within a Groundwater Source Protection (SPZ) as classified in the Policy and Practice for the Protection of Groundwater.

No surface water features were noted within close proximity to the site.

From analysis of hydrogeological and topographical maps groundwater was anticipated to be encountered at depth (>7m below existing ground level (bgl)). It was considered that the groundwater was flowing in a southerly direction in alignment with the local topography and towards the river Thames.

Examination of the Environment Agency records showed that the site was not located within a flood zone or flood warning area.

2.6 Radon

BRE 211 (2015) Map 5 of the London, Sussex and west Kent area revealed the site was located within an area where mandatory protection measures against the ingress of Radon were **unlikely to be** required. The site **was not** located within an area where a risk assessment was required.

3.0 FIELDWORK

3.1 Scope of Works

Fieldwork was undertaken on the 20th October 2016 and comprised the drilling of a one Windowless Sampler Borehole (BH1) to a depth of 8.00m bgl, at the rear of the property, and the hand excavation of three internal trial pit foundation exposures (TP/FE1 – TP/FE3) from basement level to determine the nature and extent of the existing property foundations. The proposed TP/FE4 could not be excavated due to the presence of surface obstructions and underground services. Standard penetration testing was undertaken at 1.00m intervals within BH1.

A small diameter combined bio-gas and groundwater monitoring well was installed within BH1 to 5.00m bgl. The construction of the well installed can be seen tabulated below.

Combined Bio-gas and Groundwater Monitoring Well Construction				
Trial Hole	**Depth of Installation (m bgl)**	**Thickness of slotted piping with gravel filter pack (m)**	**Depth of plain piping with bentonite seal (m bgl)**	**Piping external diameter (mm)**
BH1	5.00	4.00	1.00	63

The approximate locations of the trial holes can be seen within Figure 5.

Prior to commencing the ground investigation, a walkover survey was carried out to identify the presence of underground services and drainage. Where underground services/drainage were suspected and/or positively identified, exploratory positions were relocated away from these areas.

Upon completion of the site works, the trial holes were backfilled and made good/reinstated in relation to the surrounding area.

3.2 Sampling Procedures

Small disturbed samples were recovered from the trial holes at the depths shown on the trial hole record. Soil samples were generally retrieved from each change of strata and/or at specific areas of concern. Samples were also taken at approximately 0.5m intervals during broad homogenous soil horizons.

A selection of samples were despatched for geotechnical testing purposes. Samples were also sent off for analysis for a broad range of contaminants in accordance with DEFRA/CLEA methodologies to provide a general indication of potential contaminants within the near surface and for initial waste classification purposes.

4.0 ENCOUNTERED GROUND CONDITIONS

4.1 Soil Conditions

All exploratory holes were logged by Andrew Denton of Ground and Water Limited generally in accordance with BS EN 14688 'Geotechnical Investigation and Testing – Identification and Classification of Soil'.

The ground conditions encountered within the trial holes constructed on the site conformed to that anticipated from examination of the geology map. A capping of Made Ground was noted overlying the London Clay Formation.

The ground conditions encountered during the investigation are described in this section. For more complete information about the Made Ground and the London Clay Formation at particular points, reference must be made to the trial hole log within Appendix B and trial pit foundation exposures shown in Figures 6 - 8.

The trial hole location plan can be viewed in Figure 5.

For the purposes of discussion the succession of conditions encountered within the trial holes in descending order can be summarised as follows:

Made Ground
London Clay Formation

Made Ground
Made Ground was encountered underlying a 0.06 – 0.15m capping of concrete within all trial holes.

The Made Ground within the trial hole foundation exposures comprised a brick and clinker crush to a depth of 0.12 – 0.19m below basement level (m bbl).

Within BH1 the Made Ground was noted to comprise dark brown, with orange mottling from 0.70m bgl, silty sandy gravelly clay to 1.30m bgl. The sand was coarse grained. The gravel was occasional, fine to medium, sub-angular to sub-rounded brick, flint, glass, chalk and carbonaceous material (ash/clinker).

London Clay Formation
Soils described as representative of the London Clay Formation were noted underlying the Made Ground for the remaining depth of all trial pits, a maximum of 8.00m bgl within BH1, and 0.50 – 0.60m bbl within TP/FE1 – TP/FE3. The deposits were noted to comprise brown, locally with grey mottling, silty clay. Within BH1 selenite crystals were noted from 2.70m bgl and the strata became dark brown from 6.50m bgl.

For details of the composition of the soils encountered at particular points, reference must be made to the individual trial hole log within Appendix B and trial pit foundation exposures shown in Figures 6 - 8.

4.2 Foundation Exposures

A description of the foundation layout and ground conditions encountered within the hand dug trial pit foundation exposures are given within this section of the report.

TP/FE1

Trial pit foundation exposure TP/FE1 was hand excavated internally in the south-west corner of the existing basement. The exact location of the trial hole can be seen in Figure 5 with a section drawing of the foundations encountered in Figure 6.

The foundation layout encountered consisted of a brick wall to basement level. The brick wall continued from basement level to a depth of 0.20m bbl and was noted to rest upon three brick steps which stepped out by 0.05 – 0.10m and were 0.07 – 0.08m thick. The brick steps rested upon a crush concrete footing which stepped out by 0.05m and was 0.16m thick. The base of the foundation was at 0.59m bbl and was underlain by soils described as the London Clay Formation comprising a brown silty clay. The ground conditions encountered directly surrounding the foundation are shown in Figure 6 and described in Section 4.1.

TP/FE2

Trial pit foundation exposure TP/FE2 was hand excavated internally along the northern wall of the existing basement. The exact location of the trial hole can be seen in Figure 5 with a section drawing of the foundations encountered in Figure 7.

The foundation layout encountered consisted of a brick wall to 0.08m above basement level. The brick wall was noted to rest on three brick steps which stepped out by 0.04 – 0.07m and were 0.07 – 0.08m thick. The brick steps rested upon a crush concrete footing which was 0.23m thick. The base of the foundation was at 0.37m bbl and underlain by soils described as the London Clay Formation comprising a brown silty clay. A water seepage was encountered in the base of the pit. The ground conditions encountered directly surrounding the foundation are shown in Figure 7 and described in Section 4.1.

TP/FE3

Trial pit foundation exposure TP/FE3 was hand excavated internally in the south-east corner of the existing basement. The exact location of the trial hole can be seen in Figure 5 with a section drawing of the foundations encountered in Figure 8.

The foundation layout encountered consisted of a brick wall to basement level. The brick wall was noted to rest on two brick steps which stepped out by 0.07 – 0.10m and were 0.07m thick. The brick steps rested upon a crush concrete footing which stepped out by 0.02m and was 0.28m thick. The base of the foundation was at 0.42m bbl and underlain by soils described as the London Clay Formation comprising a brown silty clay. The ground conditions encountered directly surrounding the foundation are shown in Figure 8 and described in Section 4.1.

4.3 Roots Encountered

Roots were noted to 1.00m bgl within BH1. No roots were encountered within the trial pit foundation exposures.

It must be noted that the chance of determining actual depth of root penetration through a narrow diameter trial hole is low. Roots may be found to greater depths at other locations on the site, particularly close to trees and/or trees that have been removed both within the site and its close environs.

4.4 Groundwater Conditions

A water seepage was encountered in the base of TP/FE2 at ~0.37m bbl. No groundwater was encountered during the excavation of the remaining trial holes.

A standing water level of 4.28m bgl was recorded within the monitoring well installed in BH1 during a return visit to site on the 15th November 2016. This was considered likely to represent surface water or perched groundwater migrating through the Made Ground and/or silt lenses within the London Clay Formation and collecting within the installed standpipe.

Exact groundwater levels may only be determined through long term measurements from monitoring wells installed on-site. It should be noted that changes in groundwater level do occur for a number of reasons including seasonal effects and variations in drainage.

The site investigation was conducted in October and November 2016, when groundwater levels should be close to their annual maximum (i.e. highest). The long-term groundwater elevation might increase at some time in the future due to seasonal fluctuation in weather conditions. Isolated pockets of groundwater may be perched within any Made Ground found at other locations around the site.

4.5 Obstructions

It was not possible to excavate the planned TP/FE4 due to the presence of surface obstruction and underground services.

No other artificial or natural sub-surface obstructions were noted during excavation of the trial holes.

5.0 INSITU AND LABORATORY GEOTECHNICAL TESTING

5.1 In-Situ Geotechnical Testing

Standard penetration testing was undertaken at 1.00m intervals within BH1.

Windowless Sampler Boreholes provide samples of the ground for assessment but they do not give any engineering data.

The Standard Penetration test (SPT) is an in-situ dynamic penetration test designed to provide information on the geotechnical engineering properties of soil. The test uses a thick-walled sample tube, with an outside diameter of 50 mm and an inside diameter of 35 mm, and a length of around 650mm. This is driven into the ground at the bottom of a borehole by blows from a slide hammer with a weight of 63.5 kg falling through a distance of 760 mm. The sample tube is driven 150 mm into the ground and then the number of blows needed for the tube to penetrate each 150 mm up to a depth of 450 mm is recorded. The sum of the number of blows is termed the "standard penetration resistance" or the "N-value".

The cohesive soils of the London Clay Formation were classified based on the table below.

Undrained Shear Strength from Field Inspection/ SPT blow counts $(N_1)_{60}$. Cohesive Soils (EN ISO 14688-2:2004 & Stroud (1974))		
Classification	**Undrained Shear Strength (kPa)**	**Field Indications**
Extremely High	>300	-
Very High	150 – 300	Brittle or very tough
High	75 – 150	Cannot be moulded in the fingers
Medium	40 – 75	Can be moulded in the fingers by strong pressure
Low	20 – 40	Easily moulded in the fingers
Very Low	10 – 20	Exudes between fingers when squeezed in the fist
Extremely Low	<10	-

An interpretation of the in-situ geotechnical testing results is given in the table below.

In-Situ Geotechnical Testing Results Summary (SPT)					
Strata	**SPT "N" Blow Counts**	**Undrained Shear Strength kPa (based on Stroud, 1974)**	**Soil Type**		**Trial Hole/s**
			Cohesive	**Granular**	
London Clay Formation	11 - 27	55 - 135	Medium – High	-	BH1 (1.30 – 8.45m bgl)

It must be noted that field measurements of undrained shear strength are dependent on a number of variables including disturbance of sample, method of investigation and also the size of specimen or test zone etc.

The test results are presented on the trial hole log within Appendix B.

5.2 Laboratory Geotechnical Testing

A programme of geotechnical laboratory testing scheduled by Ground and Water Limited and carried out by K4 Soils Laboratory and QTS Environmental Limited was undertaken on samples recovered from the London Clay Formation. The results of the tests are presented in Appendix C.

The test procedures used were generally in accordance with the methods described in BS1377:1990.

Details of the specific tests used in each case are given below.

Standard Methodology for Laboratory Geotechnical Testing		
Test	**Standard**	**Number of Tests**
Atterberg Limit Tests	BS1377:1990:Part 2:Clauses 3.2, 4.3 & 5	4
One Dimensional Consolidation Test	BS1377:1990:Part 5:Clause 3 & 4	1
Water Soluble Sulphate & pH	BS1377:1990:Part 3:Clause 5	1
BRE Special Digest 1 (incl. Ph, Electrical Conductivity, Total Sulphate, W/S Sulphate, Total Chlorine, W/S Chlorine, Total Sulphur, Ammonium as NH4, W/S Nitrate, W/S Magnesium)	BRE Special Digest 1 "Concrete in Aggressive Ground" (BRE, 2005).	2

5.2.1 Atterberg Limit Tests

A summary of the results of Atterberg Limit Tests undertaken on four samples of the London Clay Formation encountered can be seen tabulated below.

The test results are presented within Appendix C.

Atterberg Limit Tests Results Summary							
Stratum	**Moisture Content (%)**	**Passing 425 µm sieve (%)**	**Modified PI (%)**	**Soil Class**	**Consistency Index (Ic)**	**Volume Change Potential**	
						BRE	**NHBC**
London Clay Formation	26 - 32	100	42 - 52	CH - CV	Stiff	High	High

NB: NP – Non-plastic
BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results)
Soil Classification based on British Soil Classification System.
Consistency Index (Ic) based on BS EN IS0 14688-2:2004.

5.2.2 Comparison of Soil's Moisture Content with Index Properties

5.2.2.1 Liquidity Index Analyses

The results of the Atterberg Limit tests undertaken on four samples of the London Clay Formation encountered was analysed to determine the Liquidity Index of the samples. This gives an indication as to whether the samples recovered showed a moisture deficit and their degree of consolidation. The results are tabulated overpage.

Liquidity Index Calculations Summary					
Stratum/Trial Hole/Depth (m bgl)	Moisture Content (%)	Plastic Limit (%)	Modified Plasticity Index (%)	Liquidity Index	Result
London Clay Formation **BH1/2.50** (Brown silty CLAY)	30	28	45.00	0.04	Heavily Overconsolidated
London Clay Formation **BH1/3.00** (Brown silty CLAY with orangish brown sand patches)	26	26	42.00	0.00	Heavily Overconsolidated
London Clay Formation **BH1/4.00** (Brown silty CLAY with scattered selenite crystals)	32	30	49.00	0.04	Heavily Overconsolidated
London Clay Formation **BH1/5.00** (Brown silty CLAY with scattered selenite crystals)	32	29	52.00	0.06	Heavily Overconsolidated

Liquidity Index testing did not reveal evidence for a potential moisture deficit within the heavily overconsolidated samples of the London Clay Formation.

5.2.2.2 Liquid Limit

A comparison of the soil moisture content and the liquid limit can be seen tabulated below.

Moisture Content vs. Liquid Limit				
Strata/Trial Hole/Depth (m bgl)/Soil Description	Moisture Content (MC) (%)	Liquid Limit (LL) (%)	40% Liquid Limit (LL)	Result
London Clay Formation **BH1/2.50** (Brown silty CLAY)	30	73	29.2	MC > 0.4 x LL (No Significant Moisture Deficit)
London Clay Formation **BH1/3.00** (Brown silty CLAY with orangish brown sand patches)	26	68	27.2	**MC < 0.4 x LL (Potential Significant Moisture Deficit)**
London Clay Formation **BH1/4.00** (Brown silty CLAY with scattered selenite crystals)	32	79	31.6	MC > 0.4 x LL (No Significant Moisture Deficit)
London Clay Formation **BH1/5.00** (Brown silty CLAY with scattered selenite crystals)	32	81	32.4	**MC < 0.4 x LL (Potential Significant Moisture Deficit)**

The results in the table above indicated that a potential significant moisture deficit was present within two samples of the London Clay Formation (BH1/3.00m bgl and BH1/5.00m bgl). The moisture content values were greater than 40% of the liquid limits.

The sample at BH1/3.00m bgl was described as a brown silty clay with orangish brown sand patches. Roots were noted to 1.00m bgl and therefore the apparent moisture deficit was likely to be associated with the presence of silt/sand patches and heavily overconsolidated nature of the soils rather than the moisture demand from roots/trees.

The sample at BH1/5.00m bgl was described as a brown silty clay with scattered selenite crystals. Roots were noted to 1.00m bgl and therefore the apparent moisture deficit was likely to be associated with the heavily overconsolidated nature of the soils rather than the moisture demand from roots/trees.

No significant moisture deficits were noted within the remaining samples of the London Clay Formation analysed.

5.2.3 One Dimensional Consolidation Test

A one dimensional consolidation test was undertaken on a disturbed sample obtained from BH1 at a depth of 3.50m bgl.

The results of the tests are tabulated below.

One Dimensional Consolidation Tests									
Stratum/Depth		Height (mm)	Moisture Content (%)	Bulk Density (Mg/m^3)	Dry Density (Mg/m^3)	Void Ratio	Degree of Saturation (%)	Particle Density (Mg/m^3)	Swelling Pressure (kpa)
The London Clay Formation BH1/3.50m bgl	Initial	18.80	33.0	1.73	1.30	1.081	82	2.70	80
	Final	19.93	39.7	1.71	1.22	1.205	89	-	-

It must be noted that the sample was remoulded and this must be taken into account in final design.

5.2.4 Sulphate and pH Tests

A sulphate and pH test was undertaken on one sample from the London Clay Formation (BH1/3.50m bgl). The sulphate concentration was 0.16g/l with a pH of 7.47.

5.2.5 BRE Special Digest 1

In accordance with BRE Special Digest 1 ‘Concrete in Aggressive Ground’ (BRE, 2005) two samples from the London Clay Formation (BH1/2.00m and BH1/4.50m bgl) were scheduled for laboratory analysis to determine parameters for concrete specification.

The results are given within Appendix D and a summary is tabulated overpage.

Summary of Results of BRE Special Digest Testing			
Determinand	**Unit**	**Minimum**	**Maximum**
pH	-	7.4	7.0
Ammonium as NH_4	mg/kg	15.9	28.7
Sulphur	%	<0.02	0.84
Chloride (water soluble)	mg/kg	22	87
Magnesium (water soluble)	mg/l	2.1	140
Nitrate (water soluble)	mg/kg	<3	<3
Sulphate (water soluble)	mg/l	23	3260
Sulphate (total)	%	0.03	2.86

5.3 Chemical Laboratory Testing – Human Health Risk Assessment

A programme of chemical laboratory testing, scheduled by Ground and Water Limited, and carried out by QTS Environmental Limited, was undertaken on one sample of Made Ground (BH1/0.30m bgl).

One soil sample was sent off for analysis for a broad range of contaminants in accordance with DEFRA/CLEA methodologies. The samples tested and the reason for testing can be seen tabulated below.

Methodology for Sampling Locations and Chemical Laboratory Testing		
Trial Hole	**Depth (m bgl)**	**Sampling Strategy**
BH1	0.30m	Representative sample of Made Ground

The area investigated as part of the proposed residential development totals ~0.03ha (300m^2) and with four sampling locations, given an unknown hotspot shape, the sampling density means that a hotspot with an area of approximately 112.5m^2 and a radius of approximately 6.0m would be encountered (CLR 4).

Soil sampling depths were chosen to reflect the receptors of concern, human health, and typically comprised a surface or near surface sample. The receptors relevant to the sampling depths can be seen below:

Near surface samples	Direct ingestion, dermal contact and dust inhalation. Protection of end-users and maintenance workers e.g. Landscape Gardeners. Protection of shallow rooted plants.

The depth of soil sampling can be seen within the trial hole logs presented in Appendix B.

The analysis suite is presented below and comprised:

- Semi Metals and Heavy Metals incl. Arsenic, Cadmium, Chromium (incl. Hexavalent Chromium), Copper, Lead, Mercury, Nickel, Selenium, Vanadium (BH1/0.30m bgl);
- Asbestos (BH1/0.30m bgl);
- Polycyclic Aromatic Hydrocarbons (PAHs) incl. Naphthalene, Acenaphthylene,

Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene, Benzo(ghi)perylene (BH1/0.30m bgl);

- Fuel Oils – Speciated TPH including full aliphatic/aromatic split (BH1/0.30m bgl);
- BTEX compounds (Benzene, Toluene, Ethylbenzene, Xylene) and MTBE – used as marker compounds for Volatile Organic Compounds (VOCs) (BH1/0.30m bgl).

The chemical laboratory results are presented in Appendix D.

5.3.1 Soil Assessment Criteria

The derivation of Soil Assessment Criteria used within this report can be seen within Appendix E.

5.3.2 Determination of Representative Contamination Concentration

At the time of reporting, December 2016, it was understood that the proposed development will comprise the deepening of the existing basement by 500mm to ~3.00m bgl and the extension of the basement to the north, underneath the existing timber deck. The development will also include the refurbishment of the single storey structure to the rear of the property. A plan showing the proposed development can be seen in Figure 4.

Therefore, the results of the chemical laboratory testing were compared to the LQM/CIEH Suitable 4 Use Levels (S4UL) for a ***'Residential with homegrown produce'*** land-use scenario, as this was considered the most appropriate land-use scenarios. The C4SL LLTC for Lead was compared to a ***'Residential with homegrown produce'*** land-use scenario.

Where no LQM/CIEH S4UL/C4SL LLTC was available for a particular determinant then preliminary reference was made to the laboratory detection limit of the determinant. If a positive concentration was noted then further risk assessment was undertaken.

For Cyanide, where no SGC/GAC or C4SL LLTC was available a Site Specific Assessment Criteria of 10mg/kg was adopted. This is based on ICRCL 59/83, TCL, ATRISK (SOIL) Screening Value and Dutch Intervention Value (ranging from 20 – 34mg/kg). Therefore, a SSAC of ~10mg/kg is considered conservative.

Where a contaminant of concern's LQM/CIEH S4UL/C4SL LLTC varies according to the Soil's Organic Matter (SOM), the SOM recorded for the soil sample was used to derive the appropriate SGV/GAC. The SOM of the sample analysed was 4.3%.

Polyaromatic Hydrocarbon (PAH) mixtures are commonly encountered in urban and peri-urban soils. These PAH's can be associated with a diverse range of contaminative sources, including petrogenic (e.g. oil spills and coal storage), pyrolytic (e.g. ash, clinker, soot and atmospheric deposition of smoke, coal tars, etc.) and phytogenic (e.g. plant-derived peat, etc.). Different sources may dominate the PAH contamination in different areas. Double ratio plots of the positive PAH concentrations identified at the site have been analysed with respect to literature to assess their likely source. The graphical comparison of PAHs in the sample of Made Ground analysed (BH1/0.30m bgl (1)) has been assessed and can be seen in Appendix F. The double plot analysis revealed the PAH's encountered within the samples are likely to be from a carbonisation source within the urban background. The LQM/CIEH Suitable 4 Use Levels (S4UL) of benzo(a)pyrene for a ***'Residential without homegrown***

produce' land-use scenario of was therefore considered to be applicable.

The results of the comparison of the representative contaminant concentrations are presented in the table below:

Soil Guideline Values and General Acceptance Criteria Results	
Substance	**Sample Location** **Where available LQM/CIEH S4UL and CSL4 LLTC were exceeded for relevant land-use scenario**
	"Residential with home-grown produce" **Land-Use Scenario**
Arsenic	None
Boron	None
Cadmium	None
Chromium (III)	None
Hexavalent Chromium (VI)	None
Copper	None
Lead	**BH1/0.30m bgl (584mg/kg)**
Mercury (Elemental)	None
Nickel	None
Selenium	None
Vanadium	None
Zinc	None
Cyanide (Total)	None
Total Phenol	None
Naphthalene	None
Acenapthylene	None
Acenapthene	None
Fluorene	None
Phenanthrene	None
Anthracene	None
Fluoranthene	None
Pyrene	None
Benzo(a)anthracene	None
Chrysene	None
Benzo(b)fluoranthene	None
Benzo(k)fluoranthene	None
Benzo(a)pyrene	None
Indeno(1,2,3-cd)pyrene	None
Dibenz(a,h)anthracene	None
Benzo(ghi)perylene	None
TPH C5 – C6 (aliphatic)	None
TPH C6 – C8 (aliphatic)	None
TPH C8 - C10 (aliphatic)	None
TPH C10 - C12 (aliphatic)	None
TPH C12 - C16 (aliphatic)	None
TPH C16 - C21 (aliphatic)	None
TPH C21 - C34 (aliphatic)	None
TPH C5 – C7 (aromatic)	None
TPH C7 – C8 (aromatic)	None
TPH C8 – C10 (aromatic)	None
TPH C10 – C12 (aromatic)	None
TPH C12 – C16 (aromatic)	None
TPH C16 - C21 (aromatic)	None
TPH C21 - C35 (aromatic)	None
Benzene	None
Toluene	None
Ethylbenzene	None
Xylene (o, m & p)	None
MTBE	None
Asbestos Screen	None

Chemical laboratory testing revealed an elevated level of lead in the sample of Made Ground analysed. A level of 584mg/kg was encountered within BH1/0.30m bgl, in excess of the C4SL LLTC of 210mg/kg for a ***'Residential with homegrown produce*** land-use scenario.

Chemical laboratory testing of the Made Ground revealed no other elevated levels of determinants above the guideline levels for a ***'Residential with homegrown produce'*** land-use scenario.

In addition, the intrusive investigation did not reveal any visual or olfactory evidence to suggest any hydrocarbon-type contamination in the trial holes excavated on the site. The chemical laboratory results have verified that no elevated concentrations of aliphatic/aromatic hydrocarbons (C5-C35) BTEX compounds are present in the soils underlying the site.

Further testing and sampling is recommended to further examine the distribution of lead within the Made Ground. This would allow for statistical analysis of the distribution of lead to be undertaken and possibly reduce any remediation required. Remediation would likely be required to protect end-users from the contamination identified in areas of soft landscaping.

5.4 Bio-Gas Risk Assessment

As part of the intrusive investigation a combined bio-gas and groundwater monitoring well was installed within BH1. The construction of the well installed can be seen tabulated below.

Combined Bio-gas and Groundwater Monitoring Well Construction				
Trial Hole	Depth of Installation (m bgl)	Thickness of slotted piping with gravel filter pack (m)	Depth of plain piping with bentonite seal (m bgl)	Piping external diameter (mm)
BH1	5.00	4.00	1.00	63

Bio-Gas Monitoring Results:

The results of the bio-gas monitoring undertaken on a return visit to site on the 15th November 2016 can be seen tabulated below.

Bio-Gas Monitoring from Wells										
Date	Trial Hole	O_2 (%)	LEL (%)	CH_4 (%)	CO_2 (%)	H2S (ppm)	CO (ppm)	Flow Rate (litre/hr)	Groundwater (m BGL)	VOC (ppm)
15th November 2016 Average to high atmospheric pressure (1025.17) Falling pressure over previous 48 hours. 70% Cloud Cover Wind speed = 5mph	Site	20.8	0	0	0	0	0	0	-	-
	BH1	18.5	0	0	1.9	0	0	0	4.28	-

CIRIA Report 665 gives tables of Characteristic Situations for protection from bio-gas for residential developments.

The oxygen concentration recorded within BH1 was 18.5%.

No methane was noted during the return visit.

A carbon dioxide concentration of 1.9% was noted in BH1.

The flow rate was below the limit of detection for the gas analyser.

A full scale bio-bas risk assessment was not part of the remit of this report. The potential for bio-gas sources to be present within the site's environs has not been assessed. The following is based on the data that has been obtained to date. For a finalised risk assessment, further monitoring and analysis of the area would be required.

Based on the documentation presented in "BS 8485:2007, Code of practice for the characterization and remediation from ground gas in affected developments", the *hazardous gas flow rate* (Q_{hg}) should be calculated using:

$Q_{hg}=C_{hg}/100 * q$

Where:

C_{hg} is the measured hazardous gas concentration (in percentage volume-by-volume);

q is the flow rate (in litres per hour) of combined gases found by direct measurement. If gas borehole flow was not detectable, it should be assumed to be at the detection limit of the equipment used.

No flow rate was recorded during the gas monitoring undertaken to date. Based on a flow rate of 0.1l/hr (detection limit of the gas analysers), the Q_{hg} for carbon dioxide was calculated to be:

Q_{hg} (l/hr) = 1.9/100 * 0.1 (gas analyser detection limit)

Q_{hg} for Carbon Dioxide = 0.0019 l/hr

This would indicate the site falls into a Characteristic Situation 1 (CS1) where no precautions against the ingress of bio-gas are necessary. Further monitoring is recommended to confirm this.

6.0 ENGINEERING CONSIDERATIONS

6.1 Soil Characteristics and Geotechnical Parameters

Based on the results of the intrusive investigation and geotechnical laboratory testing the following interpretations have been made with respect to engineering considerations.

- Made Ground was encountered underlying a 0.06 – 0.15m capping of concrete within all trial holes. The Made Ground within the trial hole foundation exposures was noted to a depth of 0.12 – 0.19m below basement level (m bbl). Within BH1 the Made Ground was encountered to 1.30m bgl.

  As a result of the inherent variability Made Ground, it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should, therefore, be taken through any Made Ground and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.

  Made Ground may be found to deeper depth at other locations on the site, especially close to former structures/foundations and service runs.

- Soils described as representative of the London Clay Formation were noted underlying the Made Ground for the remaining depth of all trial pits, a maximum of 8.00m bgl within BH1 and 0.50 – 0.60m bbl with TP/FE1 – TP/FE3.

  The deposits were noted to comprise brown, locally with grey mottling, silty clay. Within BH1 selenite crystals were noted from 2.70m bgl and the strata became dark brown from 6.50m bgl.

  The London Clay Formation was shown to have medium to high undrained shear strength (55 – 135kPa).

  Geotechnical testing revealed the soils of the London Clay Formation to have **high volume change potential** in accordance with both BRE240 and NHBC Standards Chapter 4.2. Consistency Index calculations indicated these soils to be stiff.

  Potential lithologically derived significant moisture deficits was identified within two samples of the London Clay Formation (BH1/3.00m bgl and BH1/5.00m bgl). No root exacerbated moisture deficits were noted.

  Soils of the London Clay Formation were considered a suitable bearing stratum for moderately loaded footings/foundations. Settlements on loading are likely to be moderate.

  The final design of foundations will need to take into account the volume change potential of the soil, the depth of root penetration and/or desiccation and the likely serviceability and settlement requirements of the proposed structure. These parameters for design are discussed in the next section of this report.

- A water seepage was encountered in the base of TP/FE2 at ~0.37m bbl. No groundwater was encountered during the excavation of the remaining trial holes.

  A standing water level of 4.28m bgl was recorded within the monitoring well installed in BH1 during a return visit to site on the 15th November 2016. This was considered likely to represent surface water or perched groundwater migrating through the Made Ground and/or silt lenses within the London Clay Formation and collecting within the installed standpipe.

- Roots were noted to 1.00m bgl within BH1. No roots were encountered within the trial pit foundation exposures.

6.2 Basement Foundations

At the time of reporting, December 2016, it was understood that the proposed development will comprise the deepening of the existing basement by 500mm to ~3.00m bgl and the extension of the basement to the north, underneath the existing timber deck. The development will also include the refurbishment of the single storey structure to the rear of the property.

A plan showing the proposed development can be seen in Figure 4.

The proposed development is likely to fall within Geotechnical Design Category 2 in accordance with Eurocode 7. The proposed foundation loads were not known to Ground and Water Limited at the time of reporting but are likely to range from 75 – 200kN/m^2.

Geotechnical testing revealed the London Clay Formation to have **high volume change potential** in accordance with both BRE240 and NHBC Standards Chapter 4.2. Consistency Index calculations indicated these soils to be stiff.

Given the potential for volume change potential, foundations must therefore not be placed within cohesive root penetrated and/or desiccated soils and the influence of the trees surrounding the site must be taken into account (NHBC Standards Chapter 4.2). It is recommended that foundations are taken at least 300mm into non-root penetrated strata. Roots were noted to a maximum depth of 1.00m bgl. The proposed foundation level for the basement is over 300mm below this depth.

Foundations must be taken through any Made Ground and be founded on the natural underlying strata of the London Clay Formation. Made Ground was noted to a maximum depth of 1.30m bgl.

Given the difference between overburden pressures for the development beneath the existing basement (deepening by 500mm) and the extension of the basement to the north (excavation from ground level to 3.00 – 3.50m bgl) bearing capacities have been calculated separately.

Where the development is to comprise the deepening of the basement by 500mm, the following bearing capacities could be adopted for 5.0m long by 0.75m and 1.00m wide footings or a 1.50m by 1.50m pad at depths of 3.00m and 3.50m within the London Clay Formation.

Limit State: Bearing Capacities Calculated (Based on BH1)		
Depth (m bgl)	**Foundation System**	**Limit Bearing Capacity (kN/m^2) (EC2)**
3.00m	5.00m by 0.75m Strip	133.46
	5.00m by 1.00m Strip	134.72
	1.50m by 1.50m Pad	143.41
3.50m	5.00m by 0.75m Strip	137.18
	5.00m by 1.00m Strip	138.44
	1.50m by 1.50m Pad	147.75

Serviceability State: Settlement Parameters Calculated (Based on BH1)			
Depth (m bgl)	**Foundation System**	**Limit Bearing Capacity (kN/m²)**	**Settlement (mm)**
3.00m	5.00m by 0.75m Strip	100	<23
	5.00m by 1.00m Strip	100	<24
	1.50m by 1.50m Pad	125	<23
3.50m	5.00m by 0.75m Strip	110	<22
	5.00m by 1.00m Strip	110	<23
	1.50m by 1.50m Pad	140	<22

Where the development is to comprise the excavation of the basement to the north of the existing property, the following bearing capacities could be adopted for 5.0m long by 0.75m and 1.00m wide footings or a 1.50m by 1.50m pad at depths of 3.00m and 3.50m within the London Clay Formation.

Limit State: Bearing Capacities Calculated (Based on BH1)		
Depth (m bgl)	**Foundation System**	**Limit Bearing Capacity (kN/m²) (EC2)**
3.00m	5.00m by 0.75m Strip	149.85
	5.00m by 1.00m Strip	151.11
	1.50m by 1.50m Pad	150.80
3.50m	5.00m by 0.75m Strip	153.58
	5.00m by 1.00m Strip	154.84
	1.50m by 1.50m Pad	164.77

Serviceability State: Settlement Parameters Calculated (Based on BH1)			
Depth (m bgl)	**Foundation System**	**Limit Bearing Capacity (kN/m²)**	**Settlement (mm)**
3.00m	5.00m by 0.75m Strip	140	<21
	5.00m by 1.00m Strip	150	<25
	1.50m by 1.50m Pad	150	<18
3.50m	5.00m by 0.75m Strip	150	<21
	5.00m by 1.00m Strip	150	<22
	1.50m by 1.50m Pad	160	<17

Where the development is to comprise the excavation of the basement to the north of the existing property it must be noted that a bearing capacity of less than 48kN/m^2 at 3.00m bgl, 56kN/m^2 at 3.50m bgl, could result in heave due to a reduction in effective stress at depth. This will need to be taken into account in final design. Geotechnical testing revealed a swelling pressure of 80kPa at 3.50m bgl.

Based on a 10m by 6m ground bearing basement raft with a self weight of 10kN/m^2, the immediate heave on removal of overburden pressure would be approximately 8.21mm at 3.00m bgl, 9.81mm at 3.50m bgl. This does not take into account the long term heave potential of the cohesive London Clay Formation.

General Recommendations for Spread Foundations:

- Foundation excavations must be carefully bottomed out and any loose soil or soft spots removed prior to the foundation concrete or blinding being placed. Failure to ensure that foundation excavations are suitably bottomed out could result in additional settlements.

- Inspection of foundation excavations, prior to concreting, must be made by a competent and suitably qualified person to check for any soft spots and to check for the presence of roots.

- The excavation must be kept dry as accumulation of water could result in increased settlements.

- Foundations must not be cast over foundations of former structures and/or other hard spots.

- Any groundwater or surface water ingress must be prevented from entering foundation trenches.

- Given the high volume change potential of the cohesive soils underlying the development, a suspended slab should be considered. The volume change potential of the shallow surface soils must be taken into account in final design (underfloor void diameter/compressible material/void formers etc.).

- Isolated Pad Foundations must be at least 1.5 times the width of the widest pad apart to keep to the anticipated settlements.

- Final designs for the foundations should be carried out by a suitably qualified Engineer based on the findings of this investigation and with reference to the anticipated loadings, serviceability requirements for the structure, volume change potential of the soils encountered and the developments proximity to former, present and proposed trees.

Excavations must be kept dry and either concreted or blinded as soon after excavation as possible. If water were allowed to accumulate on the formation level for even a short time not only would an increase in heave occur resulting from the soil increasing in volume by taking up water, but also the shear strength and hence the bearing capacity would also be reduced.

A water seepage was encountered in the base of TP/FE2 at ~0.37m bbl. No groundwater was encountered during the excavation of the remaining trial holes.

A standing water level of 4.28m bgl was recorded within the monitoring well installed in BH1 during a return visit to site on the 15th November 2016. This was considered likely to represent surface water or perched groundwater migrating through the Made Ground and/or silt lenses within the London Clay Formation and collecting within the installed standpipe.

Based on the groundwater readings taken during this investigation to date, it was considered likely that perched groundwater would be encountered during construction of the basement percolating through Made Ground and/or silt horizons within the London Clay Formation. The advice of a reputable dewatering contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the design of the excavation for the basement.

The basement must be suitably tanked to prevent ingress of groundwater and also surface water run-off. The basement must also be designed to take into account pressure exerted by the presence of groundwater in and around the basement.

6.3 Piled Foundations

Based on the results of the investigation it was considered unlikely that a piled foundations scheme would be required at this site.

6.4 Basement Excavations and Stability

Shallow excavations in the Made Ground and the London Clay Formation are likely to be marginally stable at best. Long, deep excavations, through these strata are likely to become unstable.

The excavation of the basement must not affect the integrity of the adjacent structures beyond the boundaries. The excavation must be supported by suitably designed retaining walls. It was considered unlikely that battering the sides of the excavation, casting the retaining walls and then backfilling to the rear of the walls would be suitable given the close proximity of the party walls.

The retaining walls for the basement will need to be constructed based on an appropriate angle of shear resistance (*Φ*') for the ground conditions encountered.

Based on the ground conditions encountered, the following parameters could be used in the design of retaining walls. These have been designed based the results of geotechnical classification tests and reference to literature.

Retaining Wall/Basement Design Parameters					
Strata	**Unit Volume Weight (kN/m³)**	**Cohesion Intercept (c') (kPa)**	**Angle of Shearing Resistance (Ø)**	**Ka**	**Kp**
Made Ground	~15	0	12	0.66	1.52
London Clay Formation	~20 - 22	0	24	0.42	2.37

Unsupported earth faces formed during excavation may be liable to collapse without warning and suitable safety precautions should therefore be taken to ensure that such earth faces are adequately supported before excavations are entered by personnel.

A water seepage was encountered in the base of TP/FE2 at ~0.37m bbl. No groundwater was encountered during the excavation of the remaining trial holes.

A standing water level of 4.28m bgl was recorded within the monitoring well installed in BH1 during a return visit to site on the 15th November 2016. This was considered likely to represent surface water or perched groundwater migrating through the Made Ground and/or silt lenses within the London Clay Formation and collecting within the installed standpipe.

Based on the groundwater readings taken during this investigation to date, it was considered likely that perched groundwater would be encountered during construction of the basement percolating through Made Ground and/or silt horizons within the London Clay Formation. The advice of a reputable dewatering contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the design of the excavation for the basement.

The basement must be suitably tanked to prevent ingress of groundwater and also surface water run-off. The basement must also be designed to take into account pressure exerted by the presence of groundwater in and around the basement.

6.5 Hydrogeological Effects

A study of the aquifer maps on the Environment Agency website revealed the site to be located on **Unproductive Strata** comprising the bedrock deposits of the London Clay Formation. No designation was given to superficial deposits due to their likely absence.

The ground conditions encountered within the trial holes constructed on the site conformed to that anticipated from examination of the geology map. A capping of Made Ground was noted overlying the London Clay Formation.

Based on a visual appraisal of the soils encountered, the permeability of the London Clay Formation was considered to be negligible.

A water seepage was encountered in the base of TP/FE2 at ~0.37m bbl. No groundwater was encountered during the excavation of the remaining trial holes.

A standing water level of 4.28m bgl was recorded within the monitoring well installed in BH1 during a return visit to site on the 15th November 2016. This was considered likely to represent surface water or perched groundwater migrating through the Made Ground and/or silt lenses within the London Clay Formation and collecting within the installed standpipe.

Based on the groundwater readings taken during this investigation to date, it was considered likely that perched groundwater would be encountered during construction of the basement percolating through Made Ground and/or silt horizons within the London Clay Formation. The advice of a reputable dewatering contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the design of the excavation for the basement.

The basement must be suitably tanked to prevent ingress of groundwater and also surface water run-off. The basement must also be designed to take into account pressure exerted by the presence of groundwater in and around the basement.

Once constructed, the cohesive soils of the London Clay Formation are unlikely to act as a porous medium for water to migrate through. Additional drainage to aid the migration of groundwater around the basement should be considered.

6.6 Ground Movement Analysis

At the time of reporting, December 2016, it was understood that the proposed development will comprise the deepening of the existing basement by 500mm to ~3.00m bgl and the extension of the basement to the north, underneath the existing timber deck.

A plan showing the proposed development can be seen in Figure 4.

An assessment of ground movements has been carried out as follows:

Movement has been assessed in alignment with CIRIA C580 for the surrounding properties due to the excavation of the basement.

The site was surrounded by two/three-storey brick built residential semi-detached properties to the north-west and south-west.

Based on a maximum depth of excavation of 3.50m bgl, structures within a 14m radius of the proposed basement were considered likely to be influenced by the development.

Parameters of Surrounding Properties			
Property	**Approximate Distance to Closest Wall (m)**	**Approximate Length (m)**	**Approximate Height (m)**
57 Croftdown Road	0.00	7.90	11.00
55 Croftdown Road	7.90	8.80	8.00
1 Brookfield Park	10.00	9.30	11.00

- The magnitude of ground movements has been assessed for the excavation in front of the traditional underpinned retaining wall structures.
- It is important to note that CIRIA Report C580 was written for embedded retaining walls. Therefore movement calculations for the excavation of soil and installation of the underpinnings does not strictly apply to C580.

The following parameters have been used to inform this assessment:

- The maximum excavation depth will be approximately 3.50m bgl;
- The method of basement construction will be traditional underpinning;
- A high wall stiffness has been assumed;
- In the permanent case the wall will always be propped at high level;
- Geotechnical testing revealed the London Clay Formation underlying the site to be stiff. This assumption was therefore considered reasonable.

Based on reference to C580 the following ground movements have been developed based on of the excavation of soils to form the basement.

Ground Movement Analysis							
Property	**Approx. Horizontal Ground Movement at Closest Wall (mm)**	**Approx. Horizontal Ground Movement at Furthest Wall (mm)**	**Horizontal Strain (%)**	**Approx. Vertical Ground Movement at Closest Wall (mm)**	**Approx. Vertical Ground Movement at Furthest Wall (mm)**	**Vertical Deflection Ratio (%)**	**Category of Damage**
57 Croftdown Road	5.25	2.29	0.038	1.40	1.24	0.020	Very Slight
55 Croftdown Road	2.29	0.00	0.026	1.24	0.00	0.007	Negligible
1 Brookfield Park	1.50	0.00	0.016	0.64	0.00	0.005	Negligible

In terms of building damage assessment and with reference to Table 2.5 of C580 (after Burland et al, 1977), the 'Description of typical damage' given the calculated movements it is likely that the neighbouring property of 57 Croftdown Road will fall within category of damage '1' Very Slight. All of the remaining surrounding properties are likely to fall within category of damage '0' Negligible.

Calculations for the potential damage at each property can be seen within Appendix G.

- There are a number of key points to note in using this assessment:
- Most ground movement will occur during excavation and construction so the adequacy of temporary support will be critical in limiting ground movements;
- The speed of propping and support is key to limiting ground movements;
- Good workmanship will contribute to minimising ground movements;
- The assessment assumes the wall is in competent clay, whereas ground conditions encountered were for low to high undrained shear strengths clays;
- Larger movements will be expected where soft soils are encountered at, above and below formation;

Ground movement can be minimised by adopting a number of measures, including;

- Ensuring that adequate propping is in place at all times during construction
- Installation of the first (stiff) support quickly and early in the construction sequence for each underpin panel.
- Movement monitoring is recommended. Should excessive movements be noted during construction then excavation should cease and a review of the construction process undertaken.

6.7 Sub-Surface Concrete

Sulphate concentrations were measured in 2:1 water/soil extracts taken from the London Clay Formation fell into class DS-5 of the BRE Special Digest 1, 2005, *'Concrete in Aggressive Ground'.*

Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1. For the classification given, the "mobile" and "natural" case was adopted given the presence of perched water and the residential use of the site. The sulphate concentration in the samples was <23 - 3260mg/l with a pH range of 7.00 – 7.70. The total potential sulphate concentrations was 0.03 – 2.86%.

Concrete to be placed in contact with soil or groundwater must be designed in accordance with the recommendations of Building Research Establishment Special Digest 1, 2005, *'Concrete in Aggressive Ground'* taking into account the pH of the soils.

It is prudent to note that pyrite nodules may be present within the London Clay Formation. Pyrite can oxidise to gypsum and this normally only occurs in the upper weathered layer, but excavation allows faster oxidation and water soluble sulphate values can rapidly increase during construction. Therefore rising sulphate values should be taken into account should ferruginous staining/pyrite nodules be encountered within the London Clay Formation.

6.8 Surface Water Disposal

Infiltration tests were beyond the scope of the investigation.

Soakaways constructed within the granular soils of the London Clay Formation are unlikely to prove satisfactory due to moderate anticipated infiltration rates. Testing to BRE365 would be necessary to confirm design criteria.

Consultation with the Environment Agency must be sought regarding any use that may have an impact on groundwater resources.

The principles of sustainable urban drainage system (SUDS) should be applied to reduce the risk of flooding from surface water ponding and collection associated with the construction of the basement.

6.9 Discovery Strategy

There may be areas of contamination that have not been identified during the course of the intrusive investigation. For example, there may have been underground storage tanks (UST's) not identified during the Ground Investigation for which there is no historical or contemporary evidence.

Such occurrences may be discovered during the demolition and construction phases for the redevelopment of the site.

Groundworkers should be instructed to report to the Site Manager any evidence for such contamination; this may comprise visual indicators, such as fibrous materials within the soil, discolouration, or odours and emission. Upon discovery advice must be taken from a suitably qualified person before proceeding, such that appropriate remedial measures and health and safety protection may be applied.

Should a new source of contamination be suspected or identified then the Local Authority will need to be informed.

6.10 Waste Classification

The excavation of foundations is likely to produce waste which will require classification and then recycling or removal from site.

Under the Landfill (England and Wales) Regulations 2002 (as amended), prior to disposal all waste must be classified as;

- Inert;
- Non-hazardous, or;

- Hazardous.

The Environment Agency's Hazardous Waste Technical Guidance (WM2) document outlines the methodology for classifying wastes. Once the classification was established the waste can be removed to the appropriately licensed facilities, with some waste requiring pre-treatments prior to disposal.

Based on a risk phrase analysis of the chemical laboratory test results, in accordance with EC Hazardous Waste Directive and undertaken by Ground and Water Limited, the sample of Made Ground taken on-site was classed as **NON-HAZARDOUS.** The results of the assessment are given within Appendix H.

INERT waste classification should be undertaken to determine if the proposed waste confirms to INERT or NON-HAZARDOUS Waste Acceptable Criteria (WAC).

It is important to note that whilst we consider our in-house assessment tool to be an accurate interpretation of the requirements of WM2, therefore producing an initial classification in accordance with the guidance, landfill operators have their own assessment tools and can often come to different conclusions. As a result, some landfill operators could refuse to take apparently suitable waste. It is recommended that the receiving landfill views the results of this assessment and the chemical laboratory results to determine their own classification.

Following this initial waste hazard assessment a Full WAC Solid Suite Test with single batch leachate was undertaken on a sample of the Made Ground taken from the site to determine which landfill category the waste conformed to. The results of the WAC test can be seen in Appendix D. All determinants, including cumulative 10:1 leachate concentrations, fell within the INERT waste category.

6.11 Imported Material

Any soil which is to be imported onto the site must undergo chemical analysis to prove that it is suitable for the purpose for which it is intended.

The Topsoil must be fit for purpose and must either be supplied with traceable chemical laboratory test certificates or be tested, either prior to placing (ideally) or after placing, to ensure that the human receptor cannot come into contact with compounds that could be detrimental to human health.

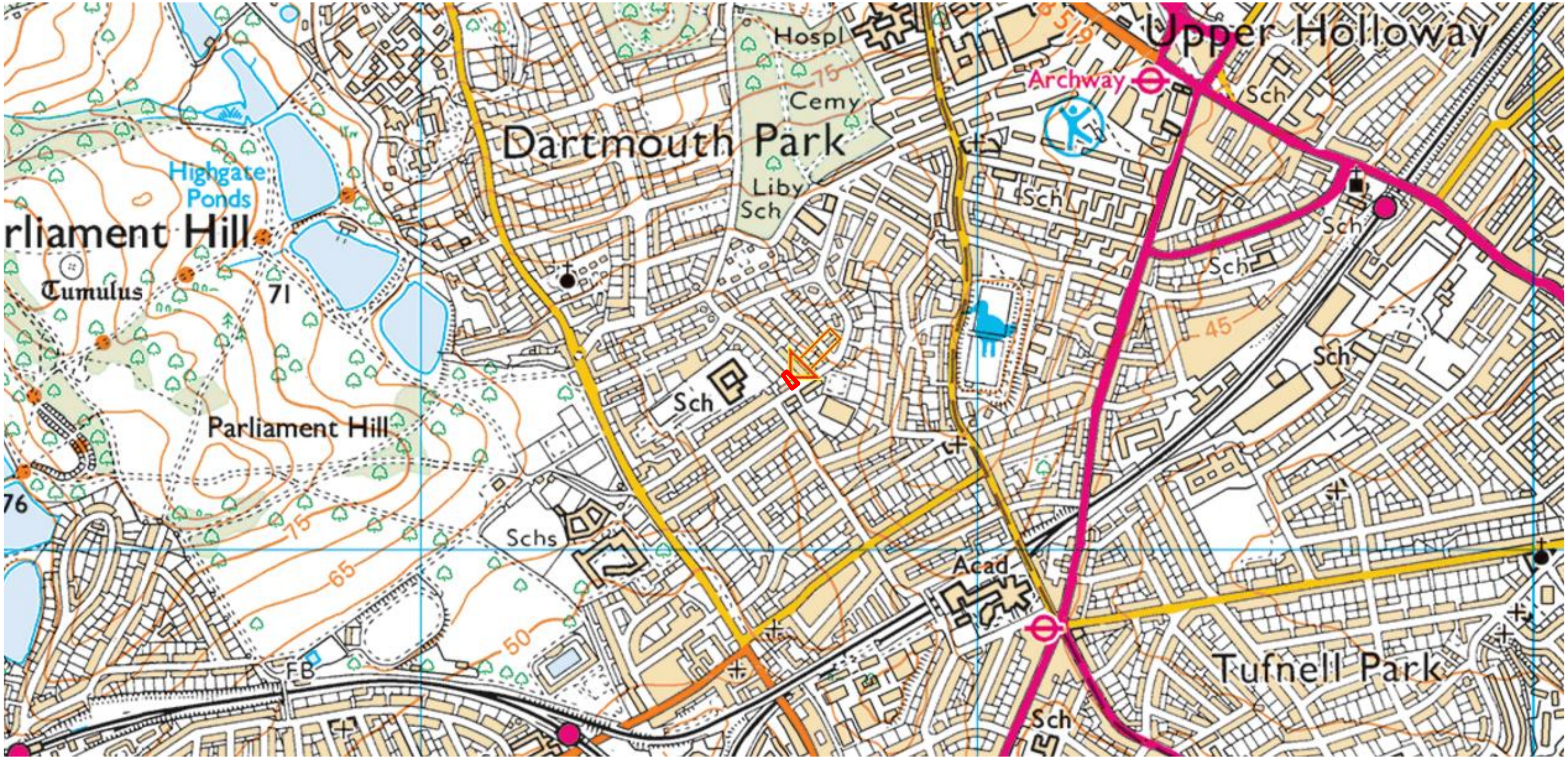
6.12 Duty of Care

Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

To prevent exposure to airborne dust by both the general public and construction personnel the site should be kept damp during dry weather and at other times when dust were generated as a result of construction activities.

The site should be securely fenced at all times to prevent unauthorised access. Washing facilities should be provided and eating restricted to mess huts.

N



APPROXIMATE SITE BOUNDARY

NOTE: NOT TO SCALE

Project: 59 Croftdown Road, Camden, London NW5 1EL		**Figure 1**
Client: Francois Barou and Katharine Theil c/o Momentum Structural Engineers	**Date:** December 2016	ground&water
Site Location Plan	**Ref:** GWPR1860	

APPROXIMATE SITE BOUNDARY

NOTE: NOT TO SCALE

Project: 59 Croftdown Road, Camden, London NW5 1EL		**Figure 2**
Client: Francois Barou and Katharine Theil c/o Momentum Structural Engineers	**Date:** December 2016	ground&water
Site Development Area	**Ref:** GWPR1860	

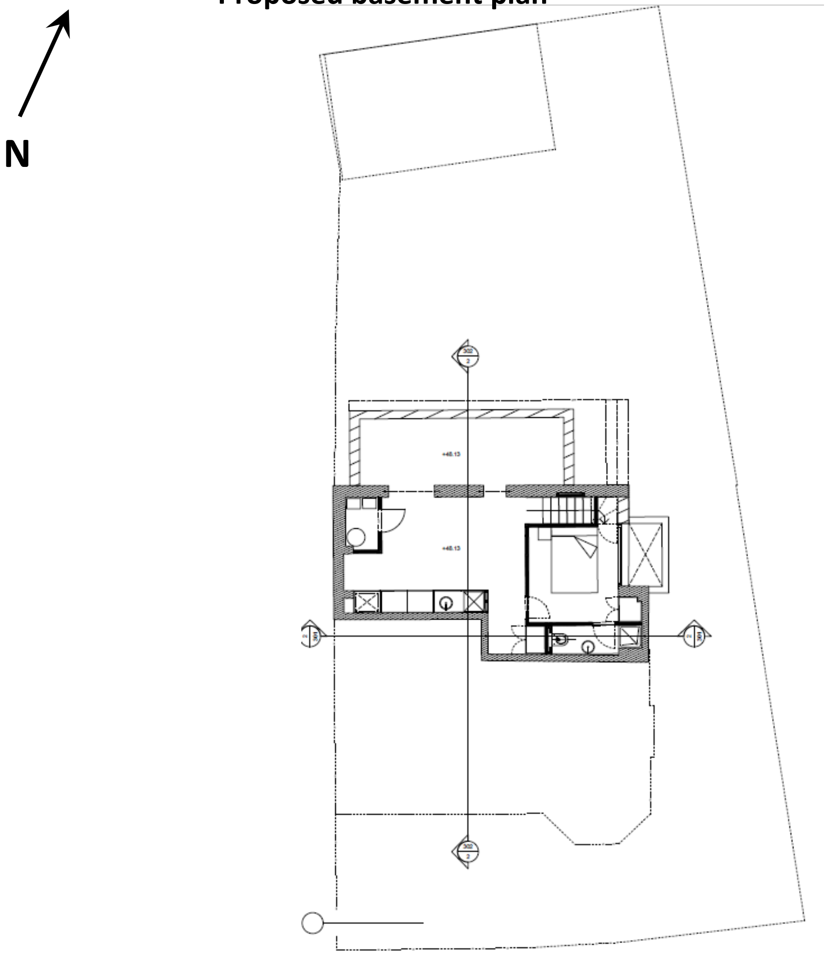
N

APPROXIMATE SITE BOUNDARY

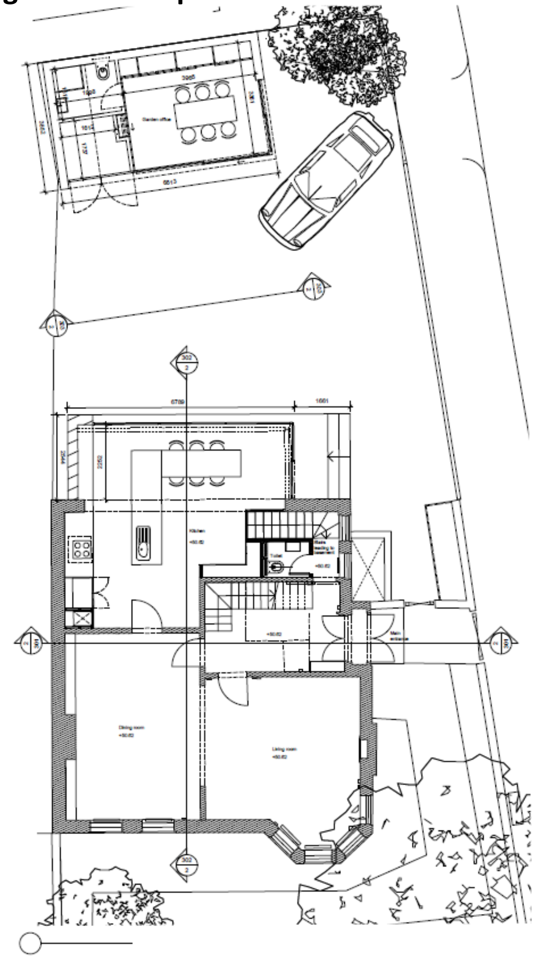
NOTE: NOT TO SCALE

Project: 59 Croftdown Road, Camden, London NW5 1EL		Figure 3
Client: Francois Barou and Katharine Theil c/o Momentum Structural Engineers	Date: December 2016	ground&water
Aerial View of Site	Ref: GWPR1860	

Proposed basement plan

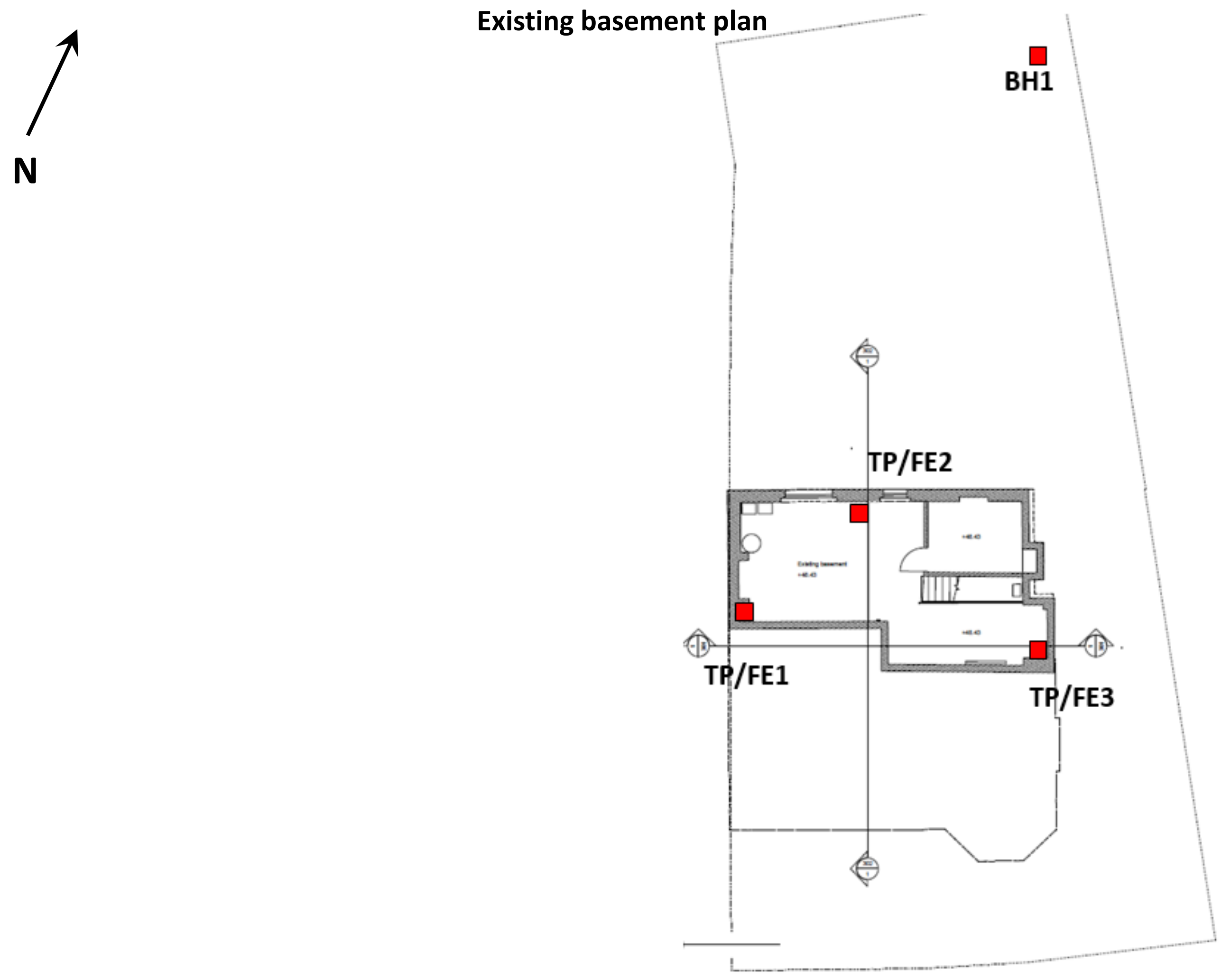


Proposed ground floor plan



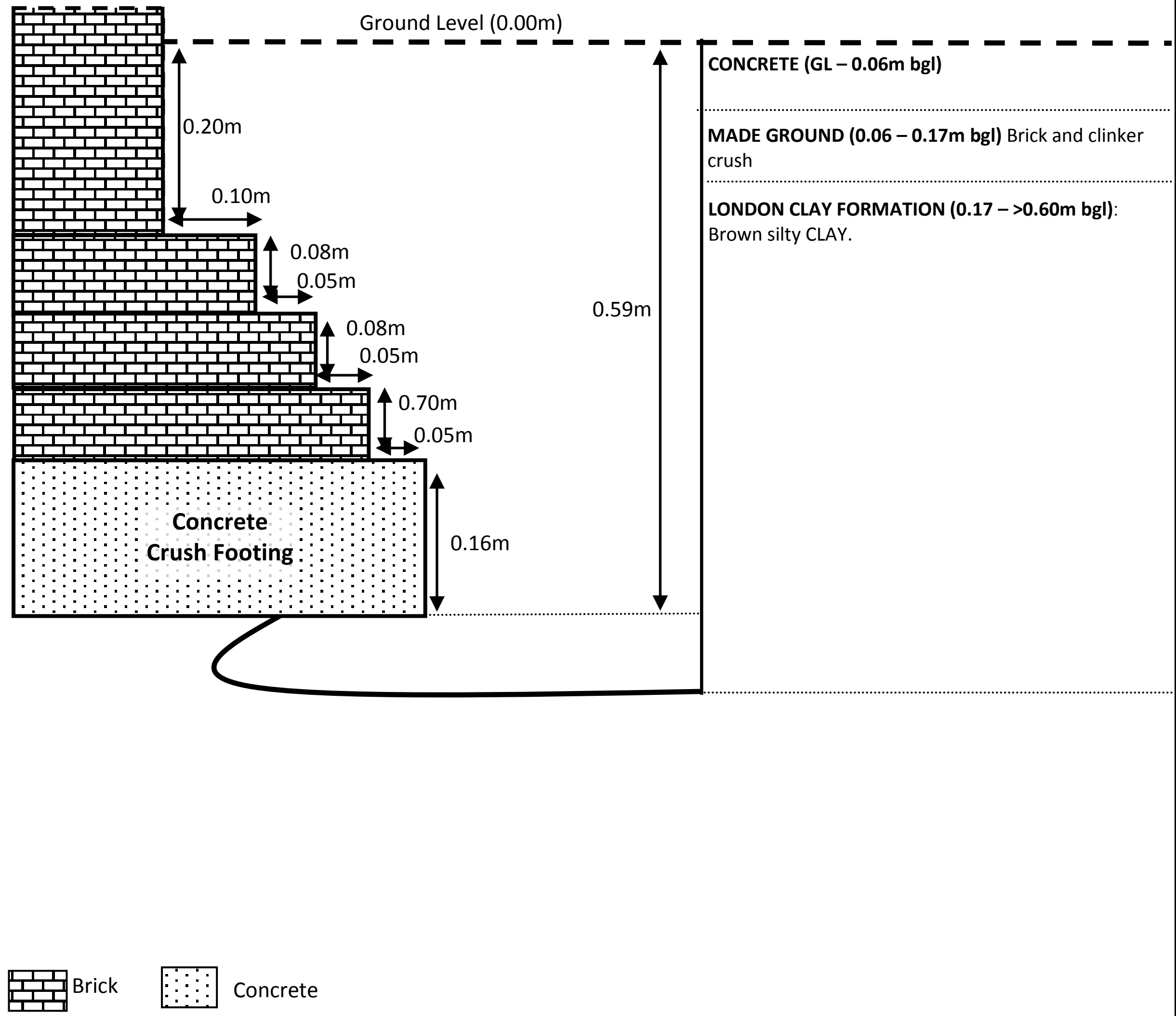
NOTE: NOT TO SCALE

Project: 59 Croftdown Road, Camden, London NW5 1EL		**Figure 4**
Client: Francois Barou and Katharine Theil c/o Momentum Structural Engineers	**Date:** December 2016	ground&water
Proposed Development Plan	**Ref:** GWPR1860	



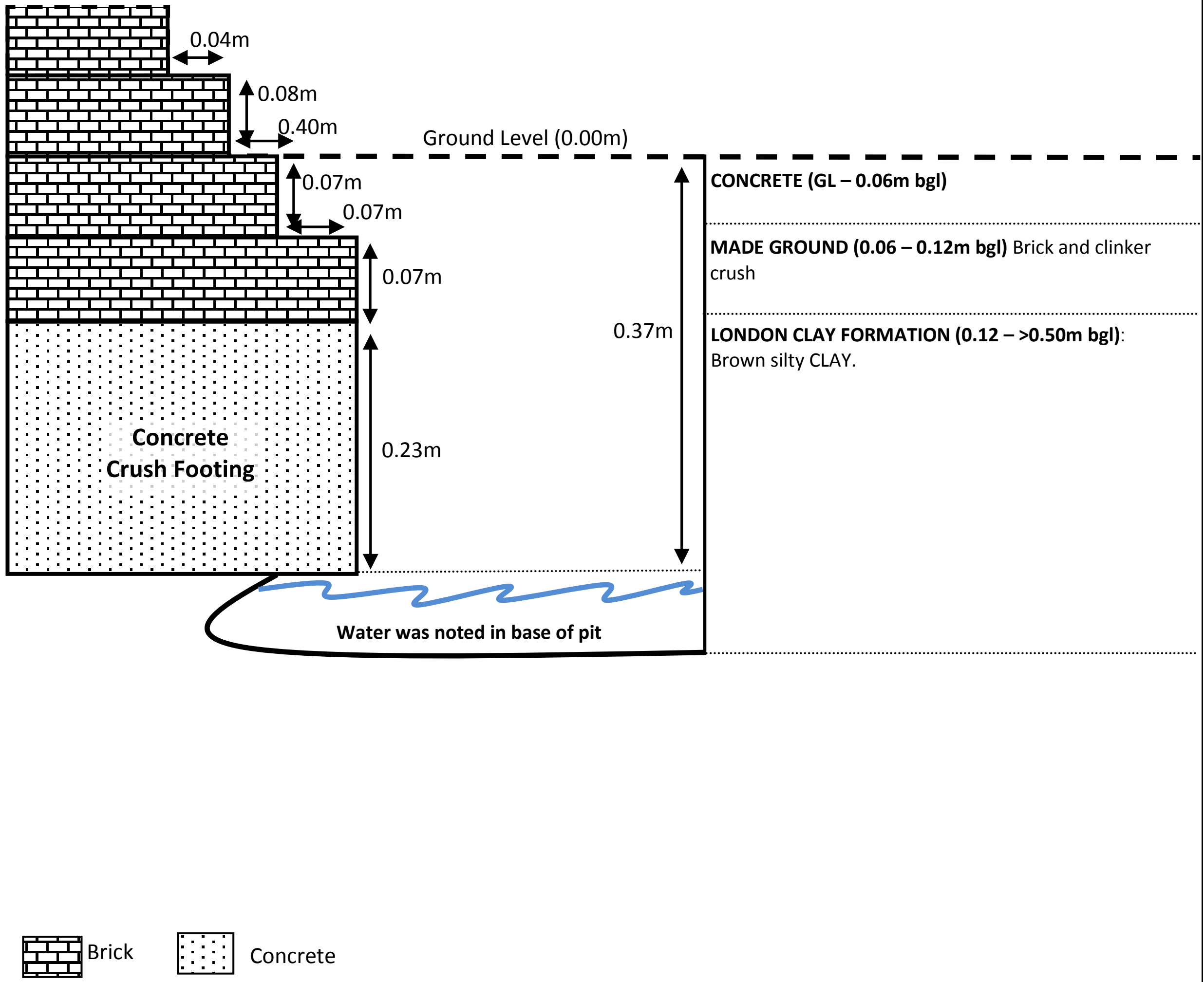
NOTE: NOT TO SCALE

Project: 59 Croftdown Road, Camden, London NW5 1EL		**Figure 5**
Client: Francois Barou and Katharine Theil c/o Momentum Structural Engineers	**Date:** December 2016	ground&water
Trial Hole Location Plan	**Ref:** GWPR1860	



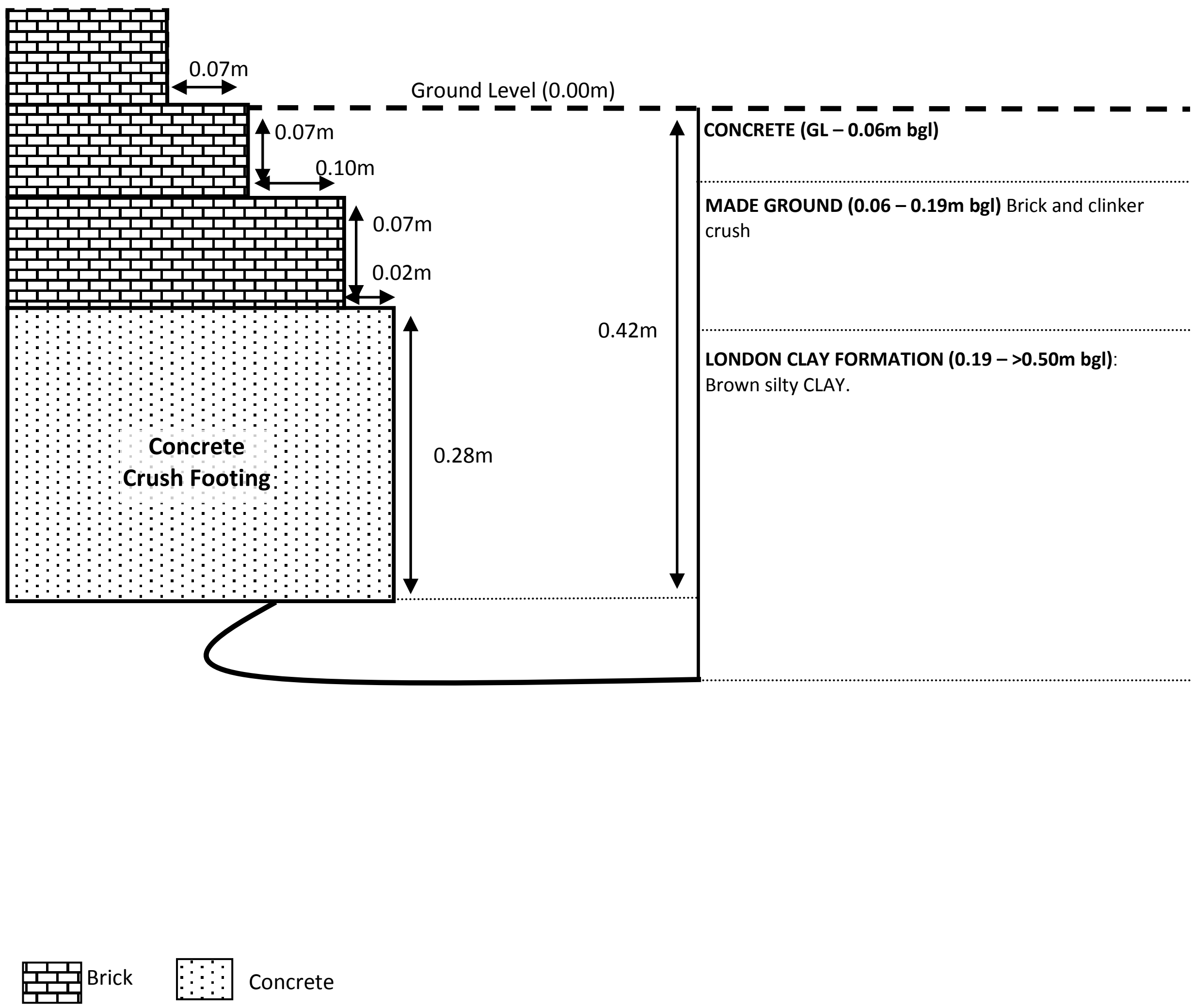
NOTE: NOT TO SCALE

Project: **59 Croftdown, London NW5 1EL**	**Figure 6**
Client: **Francois Barou and Katharine Theil c/o Momentum Structural Engineers** — **Date:** **December 2016**	ground&water
Section Drawing: Foundation Exposure TP/FE1 — **Ref:** **GWPR1860**	



NOTE: NOT TO SCALE

Project: 59 Croftdown, London NW5 1EL		**Figure 7**
Client: Francois Barou and Katharine Theil c/o Momentum Structural Engineers	**Date:** December 2016	ground&water
Section Drawing: Foundation Exposure TP/FE2	**Ref:** GWPR1876	



NOTE: NOT TO SCALE

Project:

59 Croftdown, London NW5 1EL

Client:
Francois Barou and Katharine Theil c/o Momentum Structural Engineers

Date:
December 2016

Section Drawing: Foundation Exposure TP/FE3

Ref:
GWPR1876

Figure 8

ground&water

APPENDIX A
Conditions and Limitations

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The report has been prepared on the basis of information, data and materials which were available at the time of writing. Accordingly any conclusions, opinions or judgements made in the report should not be regarded as definitive or relied upon to the exclusion of other information, opinions and judgements.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the client in accordance with their brief; as such these do not necessarily address all aspects of ground behaviour at the site. No liability is accepted for any reliance placed on it by others unless specifically agreed in writing.

Any decisions made by you, or by any organisation, agency or person who has read, received or been provided with information contained in the report ("you" or "the Recipient") are decisions of the Recipient and we will not make, or be deemed to make, any decisions on behalf of any Recipient. We will not be liable for the consequences of any such decisions.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

Any Recipient must take into account any other factors apart from the Report of which they and their experts and advisers are or should be aware. The information, data, conclusions, opinions and judgements set out in the report may relate to certain contexts and may not be suitable in other contexts. It is your responsibility to ensure that you do not use the information we provide in the wrong context.

This report is based on readily available geological records, the recorded physical investigation, the strata observed in the works, together with the results of completed site and laboratory tests. Whilst skill and care has been taken to interpret these conditions likely between or below investigation points, the possibility of other characteristics not revealed cannot be discounted, for which no liability can be accepted. The impact of our assessment on other aspects of the development required evaluation by other involved parties.

The opinions expressed cannot be absolute due to the limitations of time and resources within the context of the agreed brief and the possibility of unrecorded previous in ground activities. The ground conditions have been sampled or monitored in recorded locations and tests for some of the more common chemicals generally expected. Other concentrations of types of chemicals may exist. It was not part of the scope of this report to comment on environment/contaminated land considerations.

The conclusions and recommendations relate to 59 Croftdown Road, Camden, London NW5 1EL.

Trial hole is a generic term used to describe a method of direct investigation. The term trial pit, borehole or window sampler borehole implies the specific technique used to produce a trial hole.

The depth to roots and/or of desiccation may vary from that found during the investigation. The client is responsible for establishing the depth to roots and/or of desiccation on a plot-by-plot basis prior to the construction of foundations. Where trees are mentioned in the text this means existing trees, recently removed trees (approximately 15 years to full recovery on cohesive soils) and those planned as part of the site landscaping.

APPENDIX B
Fieldwork Logs

Ground and Water Ltd

Project Name 59 Croftdown Road	Project No. GWPR1860	Co-ords: -	Borehole No **BH1** Sheet 1 of 1
Location: Camden, London NW5 1EL		Level: -	Hole Type WLS Scale 1:50
Client: Momentum Structural Engineers		Dates: 20/11/2016	Logged By AD

Well	Water Strikes	Samples & In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
					0.15			CONCRETE
		0.30	D					MADE GROUND: Dark brown silty sandy gravelly clay. Sand is coarse grained. Gravel is occasional, fine to medium, sub-angular to sub-rounded brick, carbonaceous material (ash/clinker).
		0.50	D		0.70			
		0.80	D					MADE GROUND: Dark brown with orange mottling silty gravelly clay. Gravel is occasional, fine, sub-angular to sub-rounded brick, flint, glass, chalk and carbonaceous material (ash/clinker).
		1.00	SPT	N=6 (2,2/ 2,1,1,2)				
		1.00	D		1.30			
		1.50	D					LONDON CLAY FORMATION: Brown with grey mottling very silty CLAY.
		2.00	SPT	N=11 (1,2/ 2,3,3,3)				
		2.00	D					
		2.50	D		2.70			
		3.00	SPT	N=15 (2,2/ 2,4,4,5)				LONDON CLAY FORMATION: Brown silty CLAY with occasional selenite crystals. Becoming dark brown at 6.50m bgl.
		3.00	D					
		3.50	D					
		4.00	SPT	N=15 (3,4/ 4,3,4,4)				
		4.00	D					
		4.50	D					
		5.00	SPT	N=17 (3,4/ 4,4,4,5)				
		5.00	D					
		5.50	D					
		6.00	SPT	N=19 (4,5/ 5,5,4,5)				
		6.00	D					
		6.50	D					
		7.00	SPT	N=21 (5,6/ 6,5,5,5)				
		7.00	D					
		7.50	D					
		8.00	SPT	N=27 (6,6/ 7,7,6,7)				
		8.00	D		8.45			
								End of Borehole at 8.45 m

1 2 3 4 5 6 7 8 9

Type Results

Remarks: No groundwater encountered.
Roots noted to 1.00m bgl.

AGS

APPENDIX C
Geotechnical Laboratory Test Results

Summary of Natural Moisture Content, Liquid Limit and Plastic Limit Results

Job No.	Project Name	Programme	
21827	59 Croftdown Road, Camden, London	Samples received	24/10/2016
		Schedule received	25/10/2016
Project No.	Client	Project started	26/10/2016
GWPR1860	Ground and Water Ltd	Testing Started	10/11/2016

Hole No.	Sample				Soil Description	NMC	Passing 425μm	LL	PL	PI	Remarks
	Ref	Top	Base	Type		%	%	%	%	%	
BH1		2.50		D	Brown silty CLAY	30	100	73	28	45	
BH1		3.00		D	Brown silty CLAY with orangish brown sand patches	26	100	68	26	42	
BH1		4.00		D	Brown silty CLAY with scattered selenite crystals	32	100	79	30	49	
BH1		5.00		D	Brown silty CLAY with scattered selenite crystals	32	100	81	29	52	

UKAS TESTING 2519

Test Methods: BS1377: Part 2: 1990:
Natural Moisture Content : clause 3.2
Atterberg Limits: clause 4.3 and 5.0

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

Tel: 01923 711 288
Email: James@k4soils.com

Checked and Approved
Initials kp
Date: 03/11/2016

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

Sulphate Content (Gravimetric Method) for 2:1 Soil: Water Extract and pH Value - Summary of Results
Tested in accordance with BS1377 : Part 3 : 1990, clause 5.3 and clause 9

Job No.	Project Name	Programme	
21827	59 Croftdown Road, Camden, London	Samples received	24/10/2016
		Schedule received	24/10/2016
Project No.	Client	Project started	26/10/2016
GWPR1860	Ground and Water Ltd	Testing Started	08/11/2016

Hole No.	Sample				Soil description	Dry Mass passing 2mm	SO3 Content	SO4 Content	pH	Remarks
	Ref	Top	Base	Type		%	g/l	g/l		
BH1		3.50		D	Orangish brown mottled bluish grey silty CLAY	100	0.13	0.16	7.47	

Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU
Tel: 01923 711 288
Email: James@k4soils.com

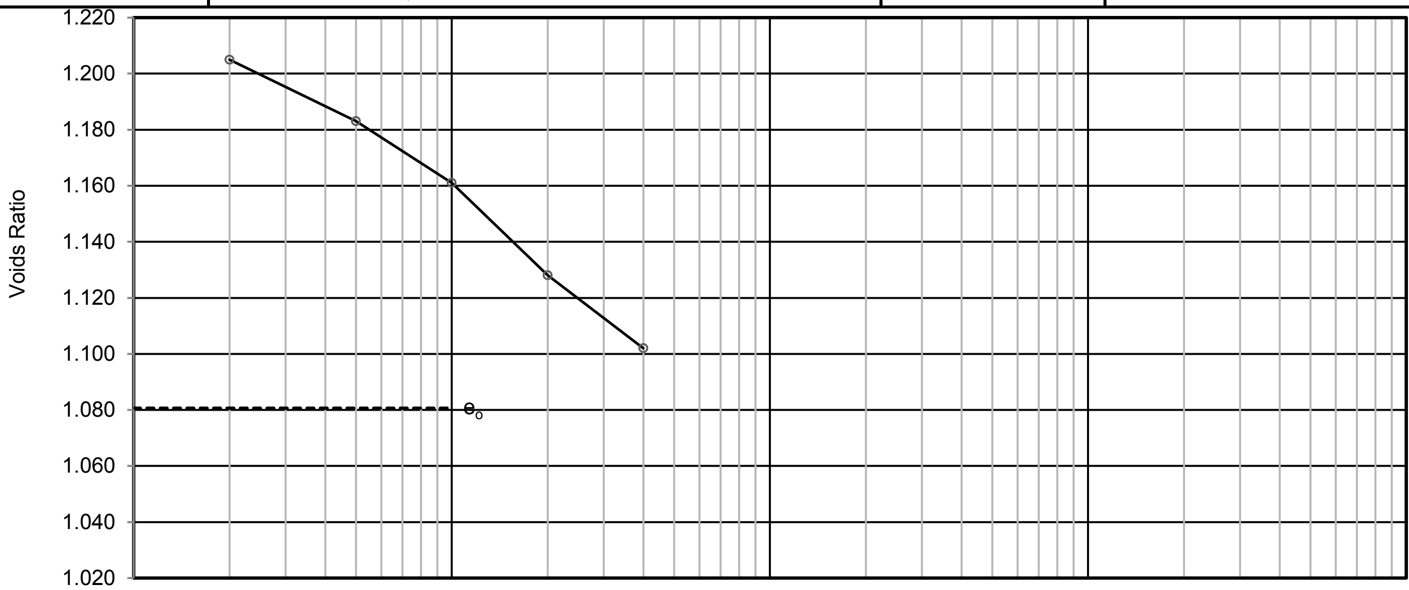
Checked and Approved
Initials **kp**
Date: 11/11/2016

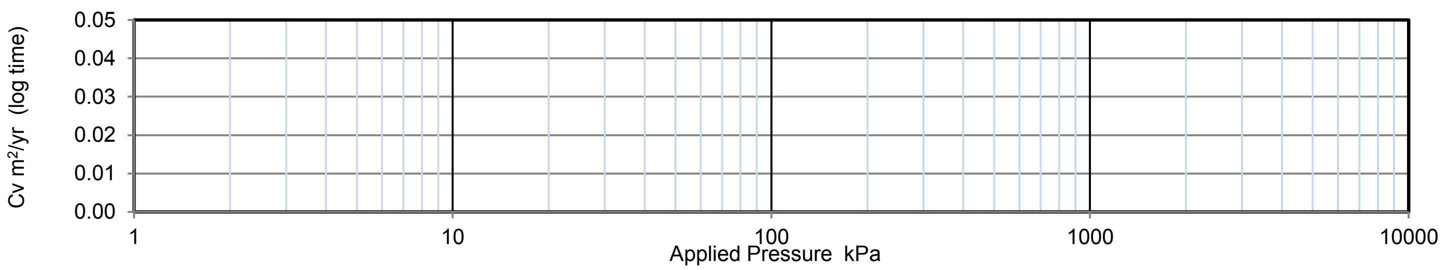
UKAS TESTING 2519

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

MSF-5-R29

K4 SOILS	ONE DIMENSIONAL CONSOLIDATION TEST			Job Ref	21827
				Borehole/Pit No.	BH1
Site Name	59 Croftdown Road, Camden, London			Sample No.	-
Project ID	GWPR1860	Client	Ground and Water Ltd	Depth	3.50
Soil Description	Orangish brown mottled bluish grey silty CLAY			Sample Type	D
				Sample Received	24/10/2016
				Schedule received	24/10/2016
				Project Started	26/10/2016
Test Method	BS1377:Part 5:1990, clause 3			Date Test started	02/11/2016





Applied Pressure kPa	Voids ratio	Mv m2/MN	Cv (t50, log) m2/yr	Cv (t90, root) m2/yr	Csec
80.0	1.081	-	-	-	-
40	1.102	0.25			
20	1.128	0.64			
10	1.161	1.5			
5	1.183	2			
2	1.205	3.5			

Preparation

Orientation wthin sample: Vertical

Particle density: assumed 2.70 Mg/m3

Specimen details	Initial	Final	
Diameter	74.85	-	mm
Height	18.80	19.93	mm
Moisture Content	33.0	39.7	%
Bulk density	1.73	1.71	Mg/m3
Dry density	1.30	1.22	Mg/m3
Voids Ratio	1.081	1.205	
Saturation	82	89	%
Average temperature for test	22.0		oC
Swelling Pressure	80		kPa
Settlement on saturation			%

Remarks

APPENDIX D
Chemical Laboratory Test Results

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GU34 3NB

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Lenham Heath
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t: 01622 850410
russell.jarvis@qtsenvironmental.com

QTS Environmental Report No: 16-51412

Site Reference: 59 Croftdown, London

Project / Job Ref: GWPR1860

Order No: None Supplied

Sample Receipt Date: 08/11/2016

Sample Scheduled Date: 08/11/2016

Report Issue Number: 1

Reporting Date: 14/11/2016

Authorised by:

Kevin Old
Associate Director of Laboratory

Authorised by:

Ela Mysiara
Inorganics & ICP Section Head

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Soil Analysis Certificate						
QTS Environmental Report No: 16-51412	**Date Sampled**	03/11/16	03/11/16	03/11/16		
Ground & Water Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied		
Site Reference: 59 Croftdown, London	**TP / BH No**	BH1	BH1	BH1		
Project / Job Ref: GWPR1860	**Additional Refs**	None Supplied	None Supplied	None Supplied		
Order No: None Supplied	**Depth (m)**	0.30	2.00	4.50		
Reporting Date: 14/11/2016	**QTSE Sample No**	237038	237040	237041		

Determinand	**Unit**	**RL**	**Accreditation**					
Asbestos Screen	N/a	N/a	**ISO17025**	Not Detected				
pH	pH Units	N/a	**MCERTS**	7.0	7.7	7.4		
Total Cyanide	mg/kg	< 2	NONE	< 2				
Total Sulphate as SO_4	mg/kg	< 200	NONE		285	28580		
Total Sulphate as SO_4	%	< 0.02	NONE		0.03	2.86		
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	**MCERTS**	29	23	3260		
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	**MCERTS**	0.03	0.02	3.26		
Total Sulphur	%	< 0.02	NONE		< 0.02	0.84		
Organic Matter	%	< 0.1	**MCERTS**	4.3				
Total Organic Carbon (TOC)	%	< 0.1	**MCERTS**	2.5				
Ammonium as NH_4	mg/kg	< 0.5	NONE		15.9	28.7		
Ammonium as NH_4	mg/l	< 0.05	NONE		1.59	2.87		
W/S Chloride (2:1)	mg/kg	< 1	**MCERTS**		22	87		
W/S Chloride (2:1)	mg/l	< 0.5	**MCERTS**		11.1	43.3		
Water Soluble Nitrate (2:1) as NO_3	mg/kg	< 3	**MCERTS**		< 3	< 3		
Water Soluble Nitrate (2:1) as NO_3	mg/l	< 1.5	**MCERTS**		< 1.5	< 1.5		
Arsenic (As)	mg/kg	< 2	**MCERTS**	22				
W/S Boron	mg/kg	< 1	NONE	< 1				
Cadmium (Cd)	mg/kg	< 0.2	**MCERTS**	0.3				
Chromium (Cr)	mg/kg	< 2	**MCERTS**	34				
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2				
Copper (Cu)	mg/kg	< 4	**MCERTS**	117				
Lead (Pb)	mg/kg	< 3	**MCERTS**	584				
W/S Magnesium	mg/l	< 0.1	NONE		2.1	140		
Mercury (Hg)	mg/kg	< 1	NONE	1				
Nickel (Ni)	mg/kg	< 3	**MCERTS**	31				
Selenium (Se)	mg/kg	< 3	NONE	< 3				
Vanadium (V)	mg/kg	< 2	NONE	64				
Zinc (Zn)	mg/kg	< 3	**MCERTS**	495				
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2				

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

Analysis carried out on the dried sample is corrected for the stone content

The samples have been examined to identify the presence of asbestiform minerals by polarising light microscopy and dispersion staining technique to In-House Procedures QTSE600 Determination of Asbestos in Bulk Materials; Asbestos in Soils/Sediments (fibre screening and identification)

This report refers to samples as received, and QTS Environmental Ltd, takes no responsibility for the accuracy or competence of sampling by others.

The material description shall be regarded as tentative and is not included in our scope of UKAS Accreditation.

Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation.

Asbestos Analyst: Graham Revell

RL: Reporting Limit

Pinch Test: Where pinch test is positive it is reported “Loose Fibres - PT” with type(s).

Subcontracted analysis (S)

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Soil Analysis Certificate - Speciated PAHs						
QTS Environmental Report No: 16-51412	**Date Sampled**	03/11/16				
Ground & Water Ltd	**Time Sampled**	None Supplied				
Site Reference: 59 Croftdown, London	**TP / BH No**	BH1				
Project / Job Ref: GWPR1860	**Additional Refs**	None Supplied				
Order No: None Supplied	**Depth (m)**	0.30				
Reporting Date: 14/11/2016	**QTSE Sample No**	237038				

Determinand	**Unit**	**RL**	**Accreditation**					
Naphthalene	mg/kg	< 0.1	**MCERTS**	< 0.1				
Acenaphthylene	mg/kg	< 0.1	**MCERTS**	< 0.1				
Acenaphthene	mg/kg	< 0.1	**MCERTS**	< 0.1				
Fluorene	mg/kg	< 0.1	**MCERTS**	< 0.1				
Phenanthrene	mg/kg	< 0.1	**MCERTS**	0.44				
Anthracene	mg/kg	< 0.1	**MCERTS**	< 0.1				
Fluoranthene	mg/kg	< 0.1	**MCERTS**	1.22				
Pyrene	mg/kg	< 0.1	**MCERTS**	1.06				
Benzo(a)anthracene	mg/kg	< 0.1	**MCERTS**	0.48				
Chrysene	mg/kg	< 0.1	**MCERTS**	0.56				
Benzo(b)fluoranthene	mg/kg	< 0.1	**MCERTS**	0.65				
Benzo(k)fluoranthene	mg/kg	< 0.1	**MCERTS**	0.26				
Benzo(a)pyrene	mg/kg	< 0.1	**MCERTS**	0.43				
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	**MCERTS**	0.24				
Dibenz(a,h)anthracene	mg/kg	< 0.1	**MCERTS**	< 0.1				
Benzo(ghi)perylene	mg/kg	< 0.1	**MCERTS**	0.20				
Total EPA-16 PAHs	mg/kg	< 1.6	**MCERTS**	5.5				

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

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Kent ME17 2JN
Tel : 01622 850410

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Soil Analysis Certificate - TPH CWG Banded						
QTS Environmental Report No: 16-51412	Date Sampled	03/11/16				
Ground & Water Ltd	Time Sampled	None Supplied				
Site Reference: 59 Croftdown, London	TP / BH No	BH1				
Project / Job Ref: GWPR1860	Additional Refs	None Supplied				
Order No: None Supplied	Depth (m)	0.30				
Reporting Date: 14/11/2016	QTSE Sample No	237038				

Determinand	Unit	RL	Accreditation					
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01				
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05				
Aliphatic >C8 - C10	mg/kg	< 2	MCERTS	< 2				
Aliphatic >C10 - C12	mg/kg	< 2	MCERTS	< 2				
Aliphatic >C12 - C16	mg/kg	< 3	MCERTS	< 3				
Aliphatic >C16 - C21	mg/kg	< 3	MCERTS	< 3				
Aliphatic >C21 - C34	mg/kg	< 10	MCERTS	< 10				
Aliphatic (C5 - C34)	mg/kg	< 21	NONE	< 21				
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01				
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05				
Aromatic >C8 - C10	mg/kg	< 2	MCERTS	< 2				
Aromatic >C10 - C12	mg/kg	< 2	MCERTS	< 2				
Aromatic >C12 - C16	mg/kg	< 2	MCERTS	< 2				
Aromatic >C16 - C21	mg/kg	< 3	MCERTS	< 3				
Aromatic >C21 - C35	mg/kg	< 10	MCERTS	< 10				
Aromatic (C5 - C35)	mg/kg	< 21	NONE	< 21				
Total >C5 - C35	mg/kg	< 42	NONE	< 42				

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

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Soil Analysis Certificate - BTEX / MTBE						
QTS Environmental Report No: 16-51412	**Date Sampled**	03/11/16				
Ground & Water Ltd	**Time Sampled**	None Supplied				
Site Reference: 59 Croftdown, London	**TP / BH No**	BH1				
Project / Job Ref: GWPR1860	**Additional Refs**	None Supplied				
Order No: None Supplied	**Depth (m)**	0.30				
Reporting Date: 14/11/2016	**QTSE Sample No**	237038				

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

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

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Waste Acceptance Criteria Analytical Certificate - BS EN 12457/2

						Landfill Waste Acceptance Criteria Limits		
QTS Environmental Report No: 16-51412		Date Sampled	03/11/16					
Ground & Water Ltd		Time Sampled	None Supplied			Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
Site Reference: 59 Croftdown, London		TP / BH No	BH1					
Project / Job Ref: GWPR1860		Additional Refs	None Supplied					
Order No: None Supplied		Depth (m)	0.80					
Reporting Date: 14/11/2016		QTSE Sample No	237039					
Determinand	**Unit**	**MDL**						
TOC^MU	%	< 0.1	1.6			3%	5%	6%
Loss on Ignition	%	< 0.01	5.50			--	--	10%
BTEX^MU	mg/kg	< 0.05	< 0.05			6	--	--
Sum of PCBs	mg/kg	< 0.1	< 0.1			1	--	--
Mineral Oil^MU	mg/kg	< 10	< 10			500	--	--
Total PAH^MU	mg/kg	< 1.7	< 1.7			100	--	--
pH^MU	pH Units	N/a	7.4			--	>6	--
Acid Neutralisation Capacity	mol/kg (+/-)	< 1	< 1			--	To be evaluated	To be evaluated
Eluate Analysis			**10:1 mg/l**		**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)**		
Arsenic^U			< 0.01		< 0.1	0.5	2	25
Barium^U			< 0.02		< 0.2	20	100	300
Cadmium^U			< 0.0005		< 0.005	0.04	1	5
Chromium^U			< 0.005		< 0.05	0.5	10	70
Copper^U			< 0.01		< 0.1	2	50	100
Mercury^U			< 0.0005		< 0.01	0.01	0.2	2
Molybdenum^U			0.005		0.05	0.5	10	30
Nickel^U			< 0.007		< 0.07	0.4	10	40
Lead^U			0.006		0.06	0.5	10	50
Antimony^U			< 0.005		< 0.05	0.06	0.7	5
Selenium^U			< 0.005		< 0.05	0.1	0.5	7
Zinc^U			0.008		0.08	4	50	200
Chloride^U			< 1		< 10	800	15000	25000
Fluoride^U			< 0.5		< 5	10	150	500
Sulphate^U			2		19	1000	20000	50000
TDS			48		480	4000	60000	100000
Phenol Index			< 0.01		< 0.1	1	-	-
DOC			4.4		43.6	500	800	1000
Leach Test Information								
Sample Mass (kg)			0.11					
Dry Matter (%)			81.9					
Moisture (%)			22.2					
Stage 1								
Volume Eluate L10 (litres)			0.88					

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

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Soil Analysis Certificate - Sample Descriptions	
QTS Environmental Report No: 16-51412	
Ground & Water Ltd	
Site Reference: 59 Croftdown, London	
Project / Job Ref: GWPR1860	
Order No: None Supplied	
Reporting Date: 14/11/2016	

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
237038	BH1	None Supplied	0.30	18.1	Brown sandy clay with stones and concrete
237039	BH1	None Supplied	0.80	18.1	Brown clayey sand with vegetation
237040	BH1	None Supplied	2.00	16.3	Brown clay
237041	BH1	None Supplied	4.50	20.2	Brown clay

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

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4480

Soil Analysis Certificate - Methodology & Miscellaneous Information
QTS Environmental Report No: 16-51412
Ground & Water Ltd
Site Reference: 59 Croftdown, London
Project / Job Ref: GWPR1860
Order No: None Supplied
Reporting Date: 14/11/2016

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D **Dried**
AR **As Received**

APPENDIX E
Soil Assessment Criteria

Appendix E
Soil Guideline Values and Genera Assessment Criteria

E1 Assessment Criteria

The Contaminated Land Regime reflects the UK Government's stated objectives of achieving sustainable development through the 'suitable for use approach'.

E1.1 Contaminated Land Exposure Assessment Model (CLEA)

Current United Kingdom risk assessment practice is based on the Contaminated Land Exposure Assessment Model (CLEA).

The CLEA Guidance comprises the following documents:

1) EA Science Report SC050021/SR2: *Human health toxicological assessment of contaminants in soil.*
2) EA Science Report SC050021/SR3: *Updated technical background to the CLEA model.*
3) EA CLEA Bulletin (2009).
4) CLEA software version 1.06 (2009)
5) Toxicological reports and SGV technical notes.

The CLEA guidance and tools:

- *do not cover other types of risk to humans, such as fire, suffocation or explosion, or short-term and acute exposures.*
- *do not cover risks to the environment, such as groundwater, ecosystems or buildings.*
- *do not provide a definitive test for telling when human health risks are significant.*
- *are not a legal requirement in assessing land contamination risks. They are not part of the legal regime for Part 2A of the Environmental Protection Act 1990.*

The CLEA guidance derives soil concentrations of contaminants above which (in the opinion of the EA) there may be a concern that warrants further investigation. It does not provide a definitive test for establishing that the risk is significant.

E1.2 Land-use Scenarios

The CLEA model uses a range of standard land-use scenarios to develop conceptual exposure models as follows:

1 Residential (with home grown produce) (RwHP)

Generic scenario assumes a typical two-storey house built on a ground bearing slab with a private garden having a lawn, flowerbeds and a small fruit and vegetable patch.

- Critical receptor is a young female child (zero to six years old)
- Exposure duration is six years.
- Exposure pathways include direct soil and indoor dust ingestion, consumption of homegrown produce and any adhering soil, skin contact with soils and indoor dust and inhalation of indoor and outdoor dust and vapours.
- Building type is a two-storey small terraced house.

A sub-set of this land-use is residential apartments with communal landscaped gardens where the consumption of home grown vegetables will not occur. (Residential without homegrown produce (RwoHP)).

2) Allotments

Provision of open space (about 250sq.m) commonly made available to tenants by the local authority to grow fruit and vegetable for their own consumption. Typically, there are a number of plots to a site which may have a total area of up to 1 hectare. The tenants are assumed to be adults and that young children make occasional accompanied visits.

Although some allotment holders may choose to keep animals including rabbits, hens, and ducks, potential exposure to contaminated meat and eggs is not considered.

- Critical receptor is a young female child (zero to six years old)
- Exposure duration is six years.
- Exposure pathways include direct soil ingestion, consumption of homegrown produce and any adhering soil, skin contact with soils and inhalation of outdoor dust and vapours.
- There is no building.

3) Commercial/Industrial

The generic scenario assumes a typical commercial or light industrial property comprising a three-storey building at which employees spend most time indoors and are involved in office-based or relatively light physical work.

- Critical receptor is a working female adult (aged 16 to 65 years old).
- Exposure duration is a working lifetime of 49 years.
- Exposure pathways include direct soil and indoor dust ingestion, skin contact with soils and dusts and inhalation of dust and vapours.
- Building type is a three-storey office (pre 1970).

E1.4 LQM/CIEH SUITABLE 4 USE LEVELS (S4UL)

For derivation of these S4UL reference must be made to:

Nathanial, P., McCaffrey, C., Gillet, A., Ogden, R., Nathanial, J.,. *The LQM/CIEH S4UL's for Human Health Risk Assessment*. **Land Quality Press**. 2015

The LQM/CIEH S4UL for a given land use is the concentration of the contaminant in soil at which the predicted daily exposure, as calculated by the CLEA software, equals the Health Criteria Value.

The final output for each contaminant represents a synthesis of new toxicological (and fate and transport) reviews published since the preparation of the 2nd edition LQM/CIEH GAC's (Nathanial et al., 2009).

In the derivation of LQM/CIEH S4UL's the principles of 'minimal' or 'tolerable' risk enshrined in SR2, which has not been withdrawn, has been maintained.

S4UL's have been derived for the basic CLEA land-uses, as described above, and for two new land uses:

- Public Open Spaces near Residential Housing (POSresi)
- Public Park (POSpark).

Public Open Spaces near Residential Housing (POSresi)
Includes the predominantly grassed areas adjacent to high density housing, the central green area on many 1930's – 1970's housing estates, and smaller areas commonly incorporated in newer developments as informal grassed areas or more formal landscaped areas with a mixture of open space and covered soils with planting. It is assumed that the close proximity to the place of residence will allow tracking back of soil to occur.

Public Park (POSpark)
An area of open space, usually owned and maintained by the local authority, provided for recreational uses including family visists and picnics, children's play area, informal sporting activities (not a dedicated sports pitch), and dog walking. It is assumed that tracking back of soils into places of residence will be negligible.

E1.5 Category 4 **Screening Levels (C4SLs)**
In the case of Lead, no SGV or GAC has been published to date. This is likely to be due to the toxicity review that is currently being undertaken by the Environment Agency. In the absence of updated toxicity information the SGV derived using CLEA 1.06 methodology and related toxicity will be used.

The overall objective of the C4SLs research project was to assist the provision of technical guidance in support of Defra's revised Statutory Guidance (SG) for Part 2A of the Environmental Protection Act 1990 (Part 2A) (Defra, 2012a). Specifically, the project aimed to deliver:

• A methodology for deriving C4SLs for four generic land-uses comprising residential, commercial, allotments and public open space; and
• A demonstration of the methodology, via the derivation of C4SLs for six substances – arsenic, benzene, benzo(a)pyrene, cadmium, chromium (VI) and lead.

To help achieve a more targeted approach to identifying and managing contaminated land in relation to the risk (or possibility) of harm to human health, the revised SG presented a new four category system for considering land under Part 2A, ranging from Category 4, where there is no risk that land poses a significant possibility of significant harm (SPOSH), or the level of risk is low, to Category 1, where the risk that land poses a significant possibility of significant harm (SPOSH) is unacceptably high. More specific guidance on what type of land should be considered as Category 4 (Human Health) is provided in Paragraphs 4.21 and 4.22 of the revised SG, as follows:

"4.21 The local authority should consider that the following types of land should be placed into Category 4: Human Health:

(a) Land where no relevant contaminant linkage has been established.

(b) Land where there are only normal levels of contaminants in soil, as explained in Section 3 of this Guidance.

(c) Land that has been excluded from the need for further inspection and assessment because contaminant levels do not exceed relevant generic assessment criteria in accordance with Section 3 of this Guidance, or relevant technical tools or advice that may be developed in accordance with paragraph 3.30 of this Guidance.

(d) Land where estimated levels of exposure to contaminants in soil are likely to form only a small proportion of what a receptor might be exposed to anyway through other sources of environmental exposure (e.g. in relation to average estimated national levels of exposure to substances commonly found in the environment, to which receptors are likely to be exposed in the normal course of their lives).

4.22 The local authority may consider that land other than the types described in paragraph 4.21 should be placed into Category 4: Human Health if following a detailed quantitative risk assessment it is satisfied that the level of risk posed is sufficiently low."

The C4SLs are intended as "relevant technical tools" (in relation to Paragraph 4.21(c)) to help local authorities and others when deciding to stop further assessment of a site, on the grounds that it falls within Category 4 (Human Health).

The Impact Assessment (IA), which accompanied the revised SG (Defra, 2012b) provides further information on the nature and potential role of the C4SLs. Paragraph 47(h) of the IA states that:

"The new statutory guidance will bring about a situation where the current SGVs/GACs are replaced with more pragmatic (but still strongly precautionary) Category 4 screening levels (C4SLs) which will provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land."

A key distinction between the Soil Guideline Values (SGVs) and the C4SLs is the level of risk that they describe. As described by the Environment Agency (2009a):
"SGVs are guidelines on the level of long-term human exposure to individual chemicals in soil that, unless stated otherwise, are tolerable or pose a minimal risk to human health."

The implication of Paragraph 47(h) of the IA is that minimal risk is well within Category 4 and that the C4SLs should describe a higher level of risk which, whilst not minimal, can still be considered low enough to allow a judgement to be made that land containing substances at, or below, the C4SLs would typically fall within Category 4. This reflects Paragraph 4.20 of the revised SG, which states:

"4.20 The local authority should not assume that land poses a significant possibility of significant harm if it considers that there is no risk or that the level of risk posed is low. For the purposes of this Guidance, such land is referred to as a "Category 4: Human Health" case. The authority may decide that the land is a Category 4: Human Health case as soon as it considers it has evidence to this effect, and this may happen at any stage during risk assessment including the early stages."

C4SLs, therefore, should not be viewed as "SPOSH levels" and they should not be used as a legal trigger for the determination of land under Part 2A.

The generic screening values referred to before usually take the form of risk-based Soil Guideline Values (SGVs) or other Generic Assessment Criteria (GACs) that are most typically derived using the Environment Agency's Contaminated Land Exposure Assessment (CLEA) model, as described in the Environment Agency's SR2, SR3 and SR7 reports (EA, 2009b & c; EA, 2008). It is anticipated that C4SLs will be used in a similar manner; as generic screening criteria that can be used within a GQRA, albeit describing a higher level of risk than the SGVs.

The suggested approach to the development of C4SLs consists of the retention and use of the CLEA framework, modified according to considerations of the underlying science within the context of Defra's policy objectives relating to the revised SG. Within this context, it is suggested that the development of C4SLs may be achieved in one of three ways, namely:

- By modifying the toxicological parameters used within CLEA (while maintaining current exposure parameters);
- By modifying the exposure parameters embedded within CLEA (while maintaining current toxicological "minimal risk" interpretations); and
- By modifying both toxicological and exposure parameters.

There is also a suggested check on "other considerations" (e.g., background levels, epidemiological data, sources of uncertainty) within the approach, applicable to all three options.

It is suggested that a new term is defined for the toxicological guidance values associated with the derivation of C4SLs – a Low Level of Toxicological Concern (LLTC). A LLTC should represent an intake of low concern that remains suitably protective of health, and definitely does not approach an intake level that could be defined as SPOSH.

E1.6 CL:AIRE Generic Assessment Criteria (GAC)

For derivation of the CL:AIRE Generic Assessment Criteria (GAC) reference should be made to the following report:

CL:AIRE, *The Soil Generic Assessment Criteria for Human Health Risk Assessment.* **Contaminated Land: Applications in the Real Environment**. 2009.

Within this report CL:AIRE provided Generic Assessment Criteria (GAC's) in accordance with the CLEA software and the principles outlined above for a further 35 contaminants sometime encountered on land affected by contamination.

E1.7 Detailed Quantitative Risk Assessments (DQRA)
Where the adoption of an S4UL/GAC/C4SL is not appropriate, for instance when the intended land-use is at variance the CLEA standard land-uses then a DQRA may be undertaking to develop site specific values for relevant soil contaminants.

⇒ Establishing the plausibility that generic exposure pathways exist in practice by measurement and observation.

⇒ Developing more accurate parameters using site data.

E1.8 Phytotoxicity
CLEA guidance only addresses human health toxicity; assessment of plant toxicity (phytotoxicity) is based on threshold trigger values obtained from the following source:

• ICRCL 70/90: *Notes on the restoration and aftercare of metalliferous mining sites for pasture and grazing*.

E1.8 Statistical Tests
DEFRA R&D Publication CLR 7 (DOE 1994) addressed the statistical treatment of test results and their comparison to Soil Guideline Values.

Consideration must be given to the appropriate area of land to be considered termed the critical averaging area.

For a communal open space or commercial land-use, the critical averaging area will depend on the proposed layout. For a residential use with private gardens the averaging area is the individual plot.

It may be appropriate to compare the upper 95th percentile concentration with the Soil Guideline Value, subject to applying a statistical test to establish that the range of concentrations are reasonably consistent and belonging to the same underlying distribution of data.

The DEFRA discussion paper Assessing risks from land contamination – a proportionate approach ('the way forward') (CLAN06/2006) aimed to increase understanding of the role that statistics can play in quantifying the uncertainty attached to the estimates of the mean concentration of contaminants in soil. In direct response CLAIRE/CIEH published a joint report, *Guidance in comparing soil contamination data with a critical concentration* (CLAIRE/CIEH 2008). A software implementation of the statistical techniques given in the report was published by ESI International (2008).

Treatment of Hot-Spots
⇒ A statistical test is applied to establish whether the data is a part of a single set, or whether data outliers are present.

⇒ Provided that the data is based on random sampling and no distinct contamination source was present at the sampling location, the hot-spot(s) may be excluded and the mean of the remaining data assessed.

E2 Ground and Water Limited Soil Assessment Criteria

The Soil Assessment Criteria used in the preparation of this report are tabulated in the following pages:

C4SL Low Level of Toxicological Concern

C4SL Low Level of Toxicological Concern						
Contaminant	**RwHP (mg/kg)**	**RwoHP (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**	**POSresi (mg/kg)**	**POSpark (mg/kg)**
Lead	<210	<330	<84	<6000	<760	<1400

Phytotoxicity Recommendations

ICRCL 70/90 *Restoration of metalliferous mining areas*

Phytotoxicity (Harmful to Plants) Threshold Trigger Values	
Copper	250mg/kg
Zinc	1000mg/kg
Notes: Many cultivars and specifically grasses have a high tolerance and there will be no ill-effect at the threshold trigger values given for neutral or near neutral pH. Site observation of plant vitality may give additional guidance.	

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LQM CIEH Suitable 4 Use Levels (S4UL's)

LQM/CIEH Suitable 4 Use Levels – Metals and Semi-metals						
Contaminant	**RwHP (mg/kg)**	**RwoHP (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**	**POSresi (mg/kg)**	**POSpark (mg/kg)**
Metals:						
Arsenic	37	40	43	640	79	170
Beryllium	1.7	1.7	35	12	2.2	63
Boron	290	11000	45	240000	21000	46000
Cadmium	11	85	1.9	190	120	532
Chromium (III)	910	910	18000	8600	1500	33000
Chromium (VI)	6	6	1.8	33	7.7	20
Copper	2400	7100	520	68000	12000	44000
Elemental Mercury	1.2	1.2	21	58	16	30
Inorganic Mercury	40	56	19	1100	120	240
Methylmercury	11	15	6	320	40	68
Nickel	180	180	230	980	230	3400
Selenium	250	430	88	12000	1100	1800
Vanadium	410	1200	91	9000	2000	5000
Zinc	3700	40000	620	730000	81000	170000

LQM/CIEH Suitable 4 Use Levels – BTEX Compounds							
Contaminant	**Soil Organic Matter**	**RwHP (mg/kg)**	**RwoHP (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**	**POSresi (mg/kg)**	**POSpark (mg/kg)**
Benzene	**1.0% SOM**	0.087	0.38	0.017	27	72	90
	2.5% SOM	0.170	0.70	0.034	47	72	100
	6.0% SOM	0.370	1.40	0.075	90	73	110
Toluene	**1.0% SOM**	130	880	22	56000	56000	87000
	2.5% SOM	290	1900	51	110000	56000	95000
	6.0% SOM	660	3900	120	180000	56000	100000
Ethylbenzene	**1.0% SOM**	47	83	16	5700	24000	17000
	2.5% SOM	110	190	39	13000	24000	22000
	6.0% SOM	260	440	91	27000	25000	27000
o-Xylene	**1.0% SOM**	60	88	**28**	6600	**41000**	**17000**
	2.5% SOM	140	210	**67**	15000	**42000**	24000
	6.0% SOM	330	480	**160**	33000	**43000**	33000
m-Xylene	**1.0% SOM**	59	82	31	6200	**41000**	17000
	2.5% SOM	140	190	74	**14000**	**42000**	24000
	6.0% SOM	320	450	170	31000	**43000**	33000
p-Xylene	**1.0% SOM**	**56**	**79**	29	**5900**	**41000**	**17000**
	2.5% SOM	**130**	**180**	69	**14000**	**42000**	**23000**
	6.0% SOM	**310**	**430**	**160**	**30000**	**43000**	**31000**
The most health protective value in each scenario for Xylene is highlighted in bold.							

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LQM/CIEH Suitable 4 Use Levels For TPH

Aliphatic		RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
EC 5-6	1.0% SOM	42	42	730	3,200 (304) [sol]	570,000 (304) [sol]	95,000 (304) [sol]
	2.5% SOM	78	78	1,700	5,900 (558) [sol]	590,000	130,000 (558) [sol]
	6.0% SOM	160	160	3,900	12,000 (1150) [sol]	600,000[l]	180,000 (1150) [sol]
EC >6-8	1.0% SOM	100	100	2,300	7,800 (144) [sol]	600,000	150,000 (144) [sol]
	2.5% SOM	230	230	5,600	17,000 (322) [sol]	610,000	220,000 (322) [sol]
	6.0% SOM	530	530	13,000	40,000 (736) [sol]	620,000	320,000 (736) [sol]
EC >8-10	1.0% SOM	27	27	320	2,000 (78) [sol]	13,000	14,000 (78) [sol]
	2.5% SOM	65	65	770	4,800 (118) [vap]	13,000	18,000 (118) [vap]
	6.0% SOM	150	150	1,700	11,000 (451) [vap]	13,000	21,000 (451) [vap]
EC >10-12	1.0% SOM	130 (48) [vap]	130 (48) [vap]	2,200	9,700 (48) [sol]	13,000	21,000 (48) [sol]
	2.5% SOM	330 (118) [vap]	330 (118) [vap]	4,400	23,000 (118) [vap]	13,000	23,000 (118) [vap]
	6.0% SOM	760 (283) [vap]	770 (283) [vap]	7,300	47,000 (283) [vap]	13,000	24,000 (283) [vap]
EC >12-16	1.0% SOM	1,100 (24) [sol]	1,100 (24) [sol]	11,000	59,000 (24) [sol]	13,000	25,000 (24) [sol]
	2.5% SOM	2,400 (59) [sol]	2,400 (59) [sol]	13,000	82,000 (59) [sol]	13,000	25,000 (59) [sol]
	6.0% SOM	4,300 (142) [sol]	4,400 (142) [sol]	13,000	90,000 (142) [sol]	13,000	26,000 (142) [sol]
EC >16-35	1.0% SOM	65,000 (8.48) [sol]	65,000 (8.48) [sol]	260,000	1,600,000	250,000	450,000
	2.5% SOM	92,000 (21) [sol]	92,000 (21) [sol]	270,000	1,700,000	250,000	480,000
	6.0% SOM	110,000	110,000	270,000	1,800,000	250,000	490,000
EC >35-44	1.0% SOM	65,000 (8.48) [sol]	65,000 (8.48) [sol]	260,000	1,600,000	250,000	450,000
	2.5% SOM	92,000 (21) [sol]	92,000 (21) [sol]	270,000	1,700,000	250,000	480,000
	6.0% SOM	110,000	110,000	270,000	1,800,000	250,000	490,000

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LQM/CIEH Suitable 4 Use Levels For TPH

Aromatic		RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
EC 5-7 (Benzene)	1.0% SOM	70	370	13	26,000 (1220) sol	56,000	76,000 (1220 sol
	2.5% SOM	140	690	27	46,000 (2260) sol	56,000	84,000 (2260) sol
	6.0% SOM	300	1,400	57	86,000 (4710) sol	56,000	92,000 (4710) sol
EC >7-8 (Toluene)	1.0% SOM	130	860	22	56,000 (869) vap	56,000	87,000 (869) sol
	2.5% SOM	290	1,800	51	110,000 (1920) sol	56,000	95,000 (1920) sol
	6.0% SOM	660	3,900	120	180,000 (4360) vap	56,000	100,000 (4360) vap
EC >8-10	1.0% SOM	34	47	8.6	3,500 (613) vap	5,000	7,200 (613) vap
	2.5% SOM	83	110	21	8,100 (1500) vap	5,000	8,500 (1500) vap
	6.0% SOM	190	270	51	17,000 (3850) vap	5,000	9,300 (3580) vap
EC >10-12	1.0% SOM	74	250	13	16,000 (364) sol	5,000	9,200 (364) sol
	2.5% SOM	180	590	31	28,000 (899) sol	5,000	9,700 (889) sol
	6.0% SOM	380	1,200	74	34,000 (2150) sol	5,000	10,000
EC >12-16	1.0% SOM	140	1,800	23	36,000 (169) sol	5,100	10,000
	2.5% SOM	330	2,300 (419) sol	57	37,000	5,100	10,000
	6.0% SOM	660	2,500	130	38,000	5,000	10,000
EC >16-21	1.0% SOM	260	1,900	46	28,000	3,800	7,600
	2.5% SOM	540	1,900	110	28,000	3,800	7,700
	6.0% SOM	930	1,900	260	28,000	3,800	7,800
EC >21-35	1.0% SOM	1,100	1,900	370	28,000	3,800	7,800
	2.5% SOM	1,500	1,900	820	28,000	3,800	7,800
	6.0% SOM	1,700	1,900	1,600	28,000	3,800	7,900
EC >35-44	1.0% SOM	1,100	1,900	370	28,000	3,800	7,800
	2.5% SOM	1,500	1,900	820	28,000	3,800	7,800
	6.0% SOM	1,700	1,900	1,600	28,000	3,800	7,900
EC >44-70	1.0% SOM	1,600	1,900	1,200	28,000	3,800	7,800
	2.5% SOM	1,800	1,900	2,100	28,000	3,800	7,800
	6.0% SOM	1,900	1,900	3,000	28,000	3,800	7,900

SOM = Soil Organic Matter Content (%)

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LQM/CIEH Suitable 4 Use Levels For Polycyclic Aromatic Hydrocarbons (PAH's)

Determinants		RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Acenapthene	1.0% SOM	210	3,000 (57.0) sol	34	84,000(57.0) sol	15,000	29,000
	2.5% SOM	510	4,700(141) sol	85	97,000(141) sol	15,000	30,000
	6.0% SOM	1100	6,000(336) sol	200	100,000	15,000	30,000
Acenapthylene	1.0% SOM	170	2,900(86.1) sol	28	83,000(86.1) sol	15,000	29,000
	2.5% SOM	420	4,600(212) sol	69	97,000(212) sol	15,000	30,000
	6.0% SOM	920	6,000(506) sol	160	100,000	15,000	30,000
Anthracene	1.0% SOM	2,400	31,000(1.17) vap	380	520,000	74,000	150,000
	2.5% SOM	5,400	35,000	950	540,000	74,000	150,000
	6.0% SOM	11,000	37,000	2,200	540,000	74,000	150,000
Benzo(a)anthracene	1.0% SOM	7.20	11	2.90	170	29	49
	2.5% SOM	11	14	6.50	170	29	56
	6.0% SOM	13	15	13	180	29	62
Benzo(a)pyrene	1.0% SOM	2.20	3.20	0.97	35	5.70	11
	2.5% SOM	2.70	3.20	2.00	35	5.70	12
	6.0% SOM	3.00	3.20	3.50	36	5.70	13
Benzo(b)flouranthene	1.0% SOM	2.60	3.90	0.99	44	7.10	13
	2.5% SOM	3.30	4.00	2.10	44	7.20	15
	6.0% SOM	3.70	4.00	3.90	45	7.20	16
Benzo(ghi)perylene	1.0% SOM	320	360	290	3,900	640	1,400
	2.5% SOM	340	360	470	4,000	640	1,500
	6.0% SOM	350	360	640	4,000	640	1,600
Benzo(k)flouranthene	1.0% SOM	77	110	37	1,200	190	370
	2.5% SOM	93	110	75	1,200	190	410
	6.0% SOM	100	110	130	1,200	190	440
Chrysene	1.0% SOM	15	30	4.10	350	57	93
	2.5% SOM	22	31	9.40	350	57	110
	6.0% SOM	27	32	19	350	57	120
Dibenzo(ah)anthracene	1.0% SOM	0.24	0.31	0.14	3.50	0.57	1.10
	2.5% SOM	0.28	0.32	0.27	3.60	0.57	1.30
	6.0% SOM	0.30	0.32	0.43	3.60	0.58	1.40

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LQM/CIEH Suitable 4 Use Levels For Polycyclic Aromatic Hydrocarbons (PAH's)

Determinants		RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Flouranthene	1.0% SOM	280	1,500	52	2,3000	3,100	6,300
	2.5% SOM	560	1,600	130	2,3000	3,100	6,300
	6.0% SOM	890	1,600	290	2,3000	3,100	6,300
Flourene	1.0% SOM	170	2,800 (30.9) sol	27	63,000(30.9) sol	9,900	20,000
	2.5% SOM	400	3,800(76.5) sol	67	68,000	9,900	20,000
	6.0% SOM	860	4,500(183) sol	160	71,000	9,900	20,000
Indeno(123-cd)pyrene	1.0% SOM	27	45	9.50	500	82	150
	2.5% SOM	36	46	21	510	82	170
	6.0% SOM	41	46	39	510	82	180
Napthalene	1.0% SOM	2.30	2.6	4.10	190 f (76.4) sol	4,900f	1,200f(76.4) sol
	2.5% SOM	5.60	5.6	10	460 f(183) sol	4,900f	1,900f(183) sol
	6.0% SOM	13	13	24	1,100f(432) sol	4,900f	3,000
Phenanthrene	1.0% SOM	95	1,300(183) sol	18	22,000	3,100	6,200
	2.5% SOM	220	1,500	38	22,000	3,100	6,200
	6.0% SOM	440	1,500	90	23,000	3,100	6,300
Pyrene	1.0% SOM	620	3,700	110	54,000	7,400	15,000
	2.5% SOM	1200	3,800	270	54,000	7,400	15,000
	6.0% SOM	2000	3,800	620	54,000	7,400	15,000
Coal Tar (Benzo(a)pyrene used as marker compound)	1.0% SOM	0.79	1.2	0.32	15	2.20	4.40
	2.5% SOM	0.98	1.2	0.67	15	2.20	4.70
	6.0% SOM	1.10	1.2	1.20	15	2.20	4.80

vap – GAC presented exceeds the vapour saturation limit, which is presented in brackets.
sol – GAC presented exceeds the soil saturation limit, which is presented in brackets.

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LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds						
Contaminant	**RwHP (mg/kg)**	**RwoHP (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**	**POSresi (mg/kg)**	**POSpark (mg/kg)**
Chloroalkanes & alkenes						
1,2 Dichloroethane						
1.0% SOM	0.0071	0.0092	0.0046	0.67	29	21
2.5% SOM	0.011	0.013	0.0083	0.97	29	24
6.0% SOM	0.019	0.023	0.016	1.70	29	28
1,1,2,2 Tetrachloroethane						
1.0% SOM	1.60	3.90	0.41	270	1,400	1,800
2.5% SOM	3.40	8.00	0.89	550	1,400	2,100
6.0% SOM	7.50	17	2.00	1,100	1,400	2,300
1,1,1,2 Tetrachloroethane						
1.0% SOM	1.20	1.50	0.79	110	1,400	1,500
2.5% SOM	2.80	3.50	1.90	250	1,400	1,800
6.0% SOM	6.40	8.20	4.40	560	1,400	2,100
Tetrachloroethene						
1.0% SOM	0.18	0.18	0.65	19	1,400	810 ^{sol}(424)
2.5% SOM	0.39	0.40	1.50	42	1,400	1,100 ^{sol}(951)
6.0% SOM	0.90	0.92	3.60	95	1,400	1,500
1,1,1 Trichloroethane						
1.0% SOM	8.80	9.00	48	660	140,000	57,000 ^{vap}(1425)
2.5% SOM	18	18	110	1,300	140,000	76,000 ^{vap}(2915)
6.0% SOM	39	40	240	3,000	140,000	100,000 ^{vap}(6392)
Tetrachloromethene						
1.0% SOM	0.026	0.026	0.45	2.90	890	190
2.5% SOM	0.056	0.056	1.00	6.30	920	270
6.0% SOM	0.130	0.130	2.40	14	950	400
Trichloroethene						
1.0% SOM	0.016	0.017	0.041	1.20	120	70
2.5% SOM	0.034	0.036	0.091	2.60	120	91
6.0% SOM	0.075	0.080	0.210	5.70	120	120
Trichloromethane						
1.0% SOM	0.91	1.20	0.42	99	2,500	2,600
2.5% SOM	1.70	2.10	0.83	170	2,500	2,800
6.0% SOM	3.40	4.20	1.70	350	2,500	3,100
Vinyl Chloride						
1.0% SOM	0.00064	0.00077	0.00055	0.059	3.50	4.80
2.5% SOM	0.00087	0.00100	0.00100	0.077	3.50	5.00
6.0% SOM	0.00014	0.00150	0.00180	0.120	3.50	5.40

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LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds

Contaminant	RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Explosives						
2,4,6 Trinitrotoluene						
1.0% SOM	1.60	65	0.24	1,000	130	260
2.5% SOM	3.70	66	0.58	1,000	130	270
6.0% SOM	8.10	66	1.40	1,000	130	270
RDX (Hexogen/Cyclonite/1,3,5-trinitro-1,3,5-triazacyclohexane)						
1.0% SOM	120	13,000	17	210,000	26,000	49,000(18.7)^{sol}
2.5% SOM	250	13,000	38	210,000	26,000	51,000
6.0% SOM	540	13,000	85	210,000	27,000	53,000
HMX (Octogen/1,3,5,7-tetrenitro-1,3,5,7-tetrazacyclo-octane)						
1.0% SOM	5.70	67,00	0.86	110,000	13,000	23,000(0.35)^{vap}
2.5% SOM	13	67,00	1.90	110,000	13,000	23,000(0.39)^{vap}
6.0% SOM	26	67,00	3.90	110,000	13,000	24,000(0.48)^{vap}
Atrazine						
1.0% SOM	3.30	610	0.50	9,300	1,200	2,300
2.5% SOM	7.60	620	1.20	9,400	1,200	2,400
6.0% SOM	17.40	620	2.70	9,400	1,200	2,400
Pesticides						
Aldrin						
1.0% SOM	5.70	7.30	3.20	170	18	30
2.5% SOM	6.60	7.40	6.10	170	18	31
6.0% SOM	7.10	7.50	9.60	170	18	31
Dieldrin						
1.0% SOM	0.97	7.00	0.17	170	18	30
2.5% SOM	2.00	7.30	0.41	170	18	30
6.0% SOM	3.50	7.40	0.96	170	18	31
Dichlorvos						
1.0% SOM	0.032	6.40	0.0049	140	16	26
2.5% SOM	0.066	6.50	0.0100	140	16	26
6.0% SOM	0.140	6.60	0.0220	140	16	27
Alpha - Endosulfan						
1.0% SOM	7.40	160(0.003)^{vap}	1.20	5,600(0.003)^{vap}	1,200	2,400
2.5% SOM	18	280(0.007)^{vap}	2.90	7,400(0.007)^{vap}	1,200	2,400
6.0% SOM	41	410(0.016)^{vap}	6.80	8,400(0.016)^{vap}	1,200	2,400

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LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds

Contaminant	RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Pesticides						
Beta - Endosulfan						
1.0% SOM	7.00	190(0.00007)[vap]	1.10	6,300(0.00007)[vap]	1,200	2,400
2.5% SOM	17	320(0.0002)[vap]	2.70	7,800(0.0002)[vap]	1,200	2,400
6.0% SOM	39	440(0.0004)[vap]	6.40	8700	1,200	2,500
Alpha - Hexachlorocyclohexanes						
1.0% SOM	0.23	6.90	0.035	170	24	47
2.5% SOM	0.55	9.20	0.087	180	24	48
6.0% SOM	1.20	11	0.210	180	24	48
Beta - Hexachlorocyclohexanes						
1.0% SOM	0.085	3.70	0.013	65	8.10	15
2.5% SOM	0.200	3.80	0.032	65	8.10	15
6.0% SOM	0.460	3.80	0.077	65	8.10	16
Gamma - Hexachlorocyclohexanes						
1.0% SOM	0.06	2.90	0.0092	67	8.2	14
2.5% SOM	0.14	3.30	0.0230	69	8.2	15
6.0% SOM	0.33	3.50	0.0540	70	8.2	15
Chlorobenzenes						
Chlorobenzene						
1.0% SOM	0.46	0.46	5.90	56	11,000	1,300(675)[sol]
2.5% SOM	1.00	1.00	14	130	13,000	2,000(1520)[sol]
6.0% SOM	2.40	2.40	32	290	14,000	2,900
1,2-Dichlorobenzene						
1.0% SOM	23	24	94	2,000 (571) [sol]	90,000	24,000(571)[sol]
2.5% SOM	55	57	230	4,800 (1370) [sol]	95,000	36,000(1370)[sol]
6.0% SOM	130	130	540	11,000 (3240) [sol]	98,000	51,000(3240)[sol]
1,3-Dichlorobenzene						
1.0% SOM	0.40	0.44	0.25	30	300	390
2.5% SOM	1.00	1.10	0.60	73	300	440
6.0% SOM	2.30	2.50	1.50	170	300	470
1,4-Dichlorobenzene						
1.0% SOM	61	61	15	4,400 (224)[vap]	17,000[g]	36,000 (224)[vap]
2.5% SOM	150	150	37	10,000 (540)[vap]	17,000[g]	36,000 (540)[vap]
6.0% SOM	350	350	88[g]	25,000 (1280)[vap]	17,000[g]	36,000 (1280)[vap]
1,2,3,-Trichlorobenzene						
1.0% SOM	1.50	1.50	4.70	102	1,800	770(134)[vap]
2.5% SOM	3.60	3.70	12	250	1,800	1,100(330)[vap]
6.0% SOM	8.60	8.80	28	590	1,800	1,600(789)[vap]

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LQM CIEH General Assessment Criteria:
Volatile and Semi-Volatile Organic Compounds

Contaminant	RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Chlorobenzenes						
1,2,3,- Trichlorobenzene						
1.0% SOM	1.50	1.50	4.70	102	1,800	770(134)^{vap}
2.5% SOM	3.60	3.70	12	250	1,800	1,100(330)^{vap}
6.0% SOM	8.60	8.80	28	590	1,800	1,600(789)^{vap}
1,2,4,- Trichlorobenzene						
1.0% SOM	2.60	2.60	55	220	15,000	1,700(318)^{vap}
2.5% SOM	6.40	6.40	140	530	17,000	2,600(786)^{vap}
6.0% SOM	15	15	320	1,300	19,000	4,000(1880)^{vap}
1,3,5,- Trichlorobenzene						
1.0% SOM	0.33	0.33	4.70	23	1,700	380(36.7)^{vap}
2.5% SOM	0.81	0.81	12	55	1,700	590(90.8)^{vap}
6.0% SOM	1.90	1.90	140	130	1,800	860(217)^{vap}
1,2,3,4,- Tetrachlorobenzene						
1.0% SOM	15	24	4.40	1,700(122)^{vap}	830	1,500(122)^{vap}
2.5% SOM	36	56	11	3,080(304)^{vap}	830	1,600
6.0% SOM	78	120	26	4,400(728)^{vap}	830	1,600
1,2,3,5,- Tetrachlobenzene						
1.0% SOM	0.66	0.75	0.38	49(39.4)^{vap}	78	110(39)^{vap}
2.5% SOM	1.60	1.90	0.90	120(98.1)^{vap}	79	120
6.0% SOM	3.70	4.30	2.20	240(235)^{vap}	79	130
1,2,4, 5,- Tetrachlobenzene						
1.0% SOM	0.33	0.73	0.06	42(19.7)^{sol}	13	25
2.5% SOM	0.77	1.70	0.16	72(49.1)^{sol}	13	26
6.0% SOM	1.60	3.50	0.37	96	13	26
Pentachlrobenzene						
1.0% SOM	5.80	19	1.20	640(43.0)^{sol}	100	190
2.5% SOM	12	30	3.10	770(107)^{sol}	100	190
6.0% SOM	22	38	7.00	830	100	190
Hexachlorobenzene						
1.0% SOM	1.80(0.20)^{vap}	4.10 (0.20)^{vap}	0.47	110(0.20)^{vap}	16	30
2.5% SOM	3.30(0.50)^{vap}	5.70 (0.50)^{vap}	1.10	120	16	30
6.0% SOM	4.90	6.70 (1.2)^{vap}	2.50	120	16	30

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LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds						
Contaminant	**RwHP (mg/kg)**	**RwoHP (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**	**POSresi (mg/kg)**	**POSpark (mg/kg)**
Phenols & Chlorophenols						
Phenols						
1.0% SOM	280	750	66	760[dir](31,000)	760[dir](11,000)	760[dir](8,600)
2.5% SOM	550	1,300	140	1,500[dir](35,000)	1,500[dir](11,000)	1,500[dir](9,700)
6.0% SOM	1100	2,300	280	3,200[dir](37,000)	3,200[dir](11,000)	3,200[dir](11,000)
Chlorophenols (4 Congeners)						
1.0% SOM	0.87	94	0.13	3,500	620	1,100
2.5% SOM	2.00	150	0.30	4,000	620	1,100
6.0% SOM	4.50	210	0.70	4,300	620	1,100
Pentachlorophenols						
1.0% SOM	0.22	27(16.4)[vap]	0.03	400	60	110
2.5% SOM	0.52	29	0.08	400	60	120
6.0% SOM	1.20	31	0.19	400	60	120
Others						
Carbon Disulphide						
1.0% SOM	0.14	0.14	4.80	11	11,000	1,300
2.5% SOM	0.29	0.29	10	22	11,000	1,900
6.0% SOM	0.62	0.62	23	47	12,000	2,700
Hexachloro-1,3-Butadiene						
1.0% SOM	0.29	0.32	0.25	31	25	48
2.5% SOM	0.70	0.78	0.61	68	25	50
6.0% SOM	1.60	1.80	1.40	120	25	51

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CL:AIRE Soil Generic Assessment Criteria				
Contaminant	**Residential (mg/kg)**	**Residential without plant uptake (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**
Metals:				
Antimony	ND	550	ND	7500
Barium	ND	1300	ND	22000
Molybdenum	ND	670	ND	17000

ND – Not Derived.
NA – Not Applicable

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CL:AIRE General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds				
Contaminant	**Residential (mg/kg)**	**Residential without plant uptake (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**
1,1,2 Trichloroethane				
1.0% SOM	0.60	0.88	0.28	94
2.5% SOM	1.20	1.8	0.61	190
6.0% SOM	2.70	3.9	1.40	400
1,1-Dichloroethane				
1.0% SOM	2.40	2.50	9.20	280
2.5% SOM	3.90	4.10	17	450
6.0% SOM	7.40	7.70	35	850
1,1-Dichloroethene				
1.0% SOM	0.23	0.23	2.80	26
2.5% SOM	0.40	0.41	5.60	46
6.0% SOM	0.82	0.82	12	92
1,2,4-Trimethylbenzene				
1.0% SOM	0.35	0.41	0.38	42
2.5% SOM	0.85	0.99	0.93	99
6.0% SOM	2.00	2.30	2.20	220
1,2-Dichloropropane				
1.0% SOM	0.024	0.024	0.62	3.3
2.5% SOM	0.042	0.042	1.20	5.9
6.0% SOM	0.084	0.085	2.60	12
2,4-Dimethylphenol				
1.0% SOM	19	210	3.10	16000*
2.5% SOM	43	410	7.20	24000*
6.0% SOM	97	730	17	30000*
2,4-Dinitrotoluene				
1.0% SOM	1.50	170*	0.22	3700*
2.5% SOM	3.20	170	0.49	3700*
6.0% SOM	7.20	170	1.10	3800*
2,6-Dinitrotoluene				
1.0% SOM	0.78	78	0.12	1900*
2.5% SOM	1.70	84	0.27	1900*
6.0% SOM	3.90	87	0.61	1900*
2-Chloronapthalene				
1.0% SOM	3.70	3.80	40	390*
2.5% SOM	9.20	9.30	98	960*
6.0% SOM	22	22	230	2200*

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CL:AIRE General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds				
Contaminant	**Residential (mg/kg)**	**Residential without plant uptake (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**
Biphenyl				
1.0% SOM	66*	220*	14	18000*
2.5% SOM	160	500*	35	33000*
6.0% SOM	360	980*	83	48000*
Bis (2-ethylhexyl) phthalate				
1.0% SOM	280*	2700*	47*	85000*
2.5% SOM	610*	2800*	120*	86000*
6.0% SOM	1100*	2800*	280*	86000*
Bromobenzene				
1.0% SOM	0.87	0.91	3.2	97
2.5% SOM	2.0	2.1	7.6	220
6.0% SOM	4.7	4.9	18	520
Bromodichloromethane				
1.0% SOM	0.016	0.019	0.016	2.1
2.5% SOM	0.030	0.034	0.032	3.7
6.0% SOM	0.061	0.070	0.068	7.6
Bromoform				
1.0% SOM	2.8	5.2	0.95	760
2.5% SOM	5.9	11	2.1	1500
6.0% SOM	13	23	4.6	3100
Butyl benzyl phthalate				
1.0% SOM	1400*	42000*	220*	940000*
2.5% SOM	3300*	44000*	550*	940000*
6.0% SOM	7200*	44000*	1300*	950000*
Chloroethane				
1.0% SOM	8.3	8.4	110	960
2.5% SOM	11	11	200	1300
6.0% SOM	18	18	380	2100
Chloromethane				
1.0% SOM	0.0083	0.0085	0.066	1.0
2.5% SOM	0.0098	0.0099	0.13	1.2
6.0% SOM	0.013	0.013	0.23	1.6
***Cis* 1,2 Dichloroethene**				
1.0% SOM	0.11	0.12	0.26	14
2.5% SOM	0.19	0.20	0.50	24
6.0% SOM	0.37	0.39	1.0	47

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CL:AIRE General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds				
Contaminant	**Residential (mg/kg)**	**Residential without plant uptake (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**
Dichloromethane				
1.0% SOM	0.58	2.10	0.10	270
2.5% SOM	0.98	2.80	0.19	360
6.0% SOM	1.70	4.50	0.34	560
Diethyl Phthalate				
1.0% SOM	120*	1800*	19*	150000*
2.5% SOM	260*	3500*	41*	220000*
6.0% SOM	570*	6300*	94*	290000*
Di-*n*-butyl phthalate				
1.0% SOM	13*	450*	2.00	15000*
2.5% SOM	31*	450*	5.00	15000*
6.0% SOM	67*	450*	12	15000*
Di-*n*-octyl phthalate				
1.0% SOM	2300*	3400*	940*	89000*
2.5% SOM	2800*	3400*	2100*	89000*
6.0% SOM	3100*	3400*	3900*	89000*
Hexachloroethane				
1.0% SOM	0.20	0.22	0.27	22*
2.5% SOM	0.48	0.54	0.67	53*
6.0% SOM	1.10	1.30	1.60	120*
Isopropylbenzene				
1.0% SOM	11	12	32	1400*
2.5% SOM	27	28	79	3300*
6.0% SOM	64	67	190	7700*
Methyl *tert*-butyl ether				
1.0% SOM	49	73	23	7900
2.5% SOM	84	120	44	13000
6.0% SOM	160	220	90	24000
Propylbenzene				
1.0% SOM	34	40	34	4100*
2.5% SOM	82	97	83	9700*
6.0% SOM	190	230	200	21000*
Styrene				
1.0% SOM	8.10	35	1.60	3300*
2.5% SOM	19	78	3.70	6500*
6.0% SOM	43	170	8.70	11000*

Cont'd Overleaf:

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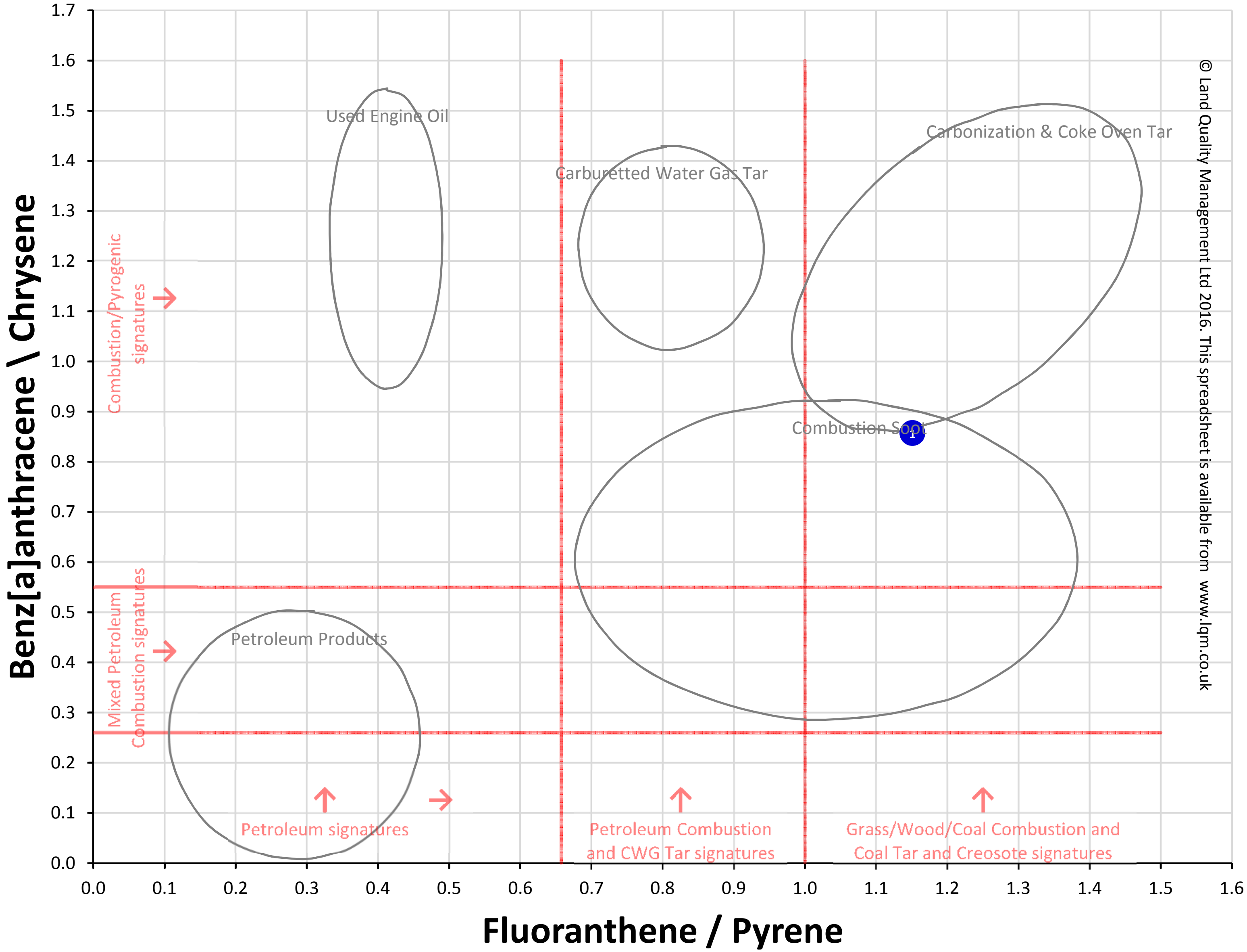
CL:AIRE General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds				
Contaminant	**Residential (mg/kg)**	**Residential without plant uptake (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**
Total Cresols (2-, 3-, and 4-methylphenol)				
1.0% SOM	80	3700	12	160000
2.5% SOM	180	5400	27	180000*
6.0% SOM	400	6900	63	180000*
***Trans* 1,2 Dichloroethene**				
1.0% SOM	0.19	0.19	0.93	22
2.5% SOM	0.34	0.35	1.90	40
6.0% SOM	0.70	0.71	0.24	81
Tributyl tin oxide				
1.0% SOM	0.25	1.40	0.042	130*
2.5% SOM	0.59	3.10	0.100	180*
6.0% SOM	1.30	5.70	0.240	200*

Notes: *Soil concentration above soil saturation limit

APPENDIX F
PAH Double Plot Analysis

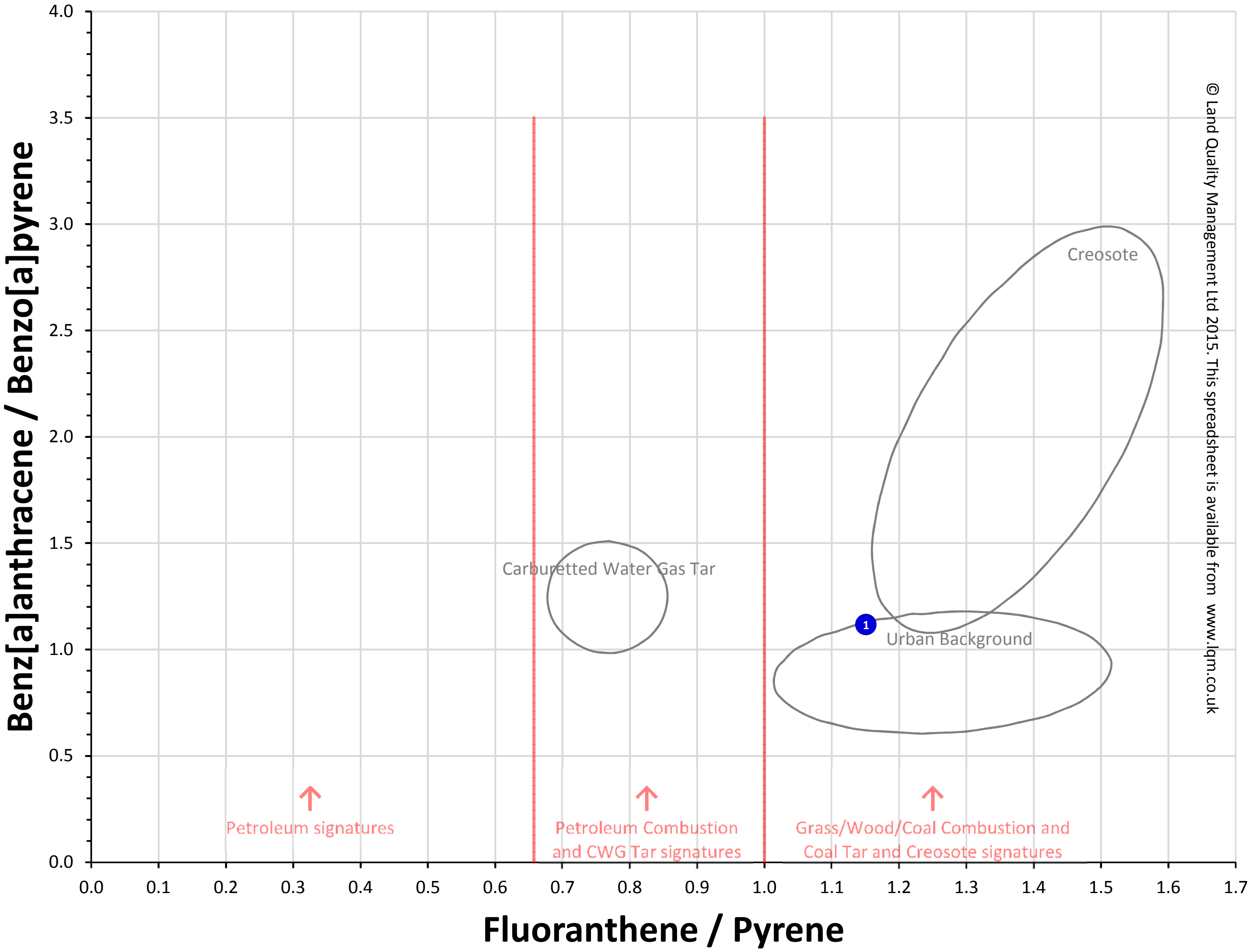


Key:

- Samples collected on site

Based on Figure 6 in Costa & Sauer (2005) with additional details based on a conference presentation by Costa (2005) in San Diego. The potential sources shown are indicative only.

ground &water

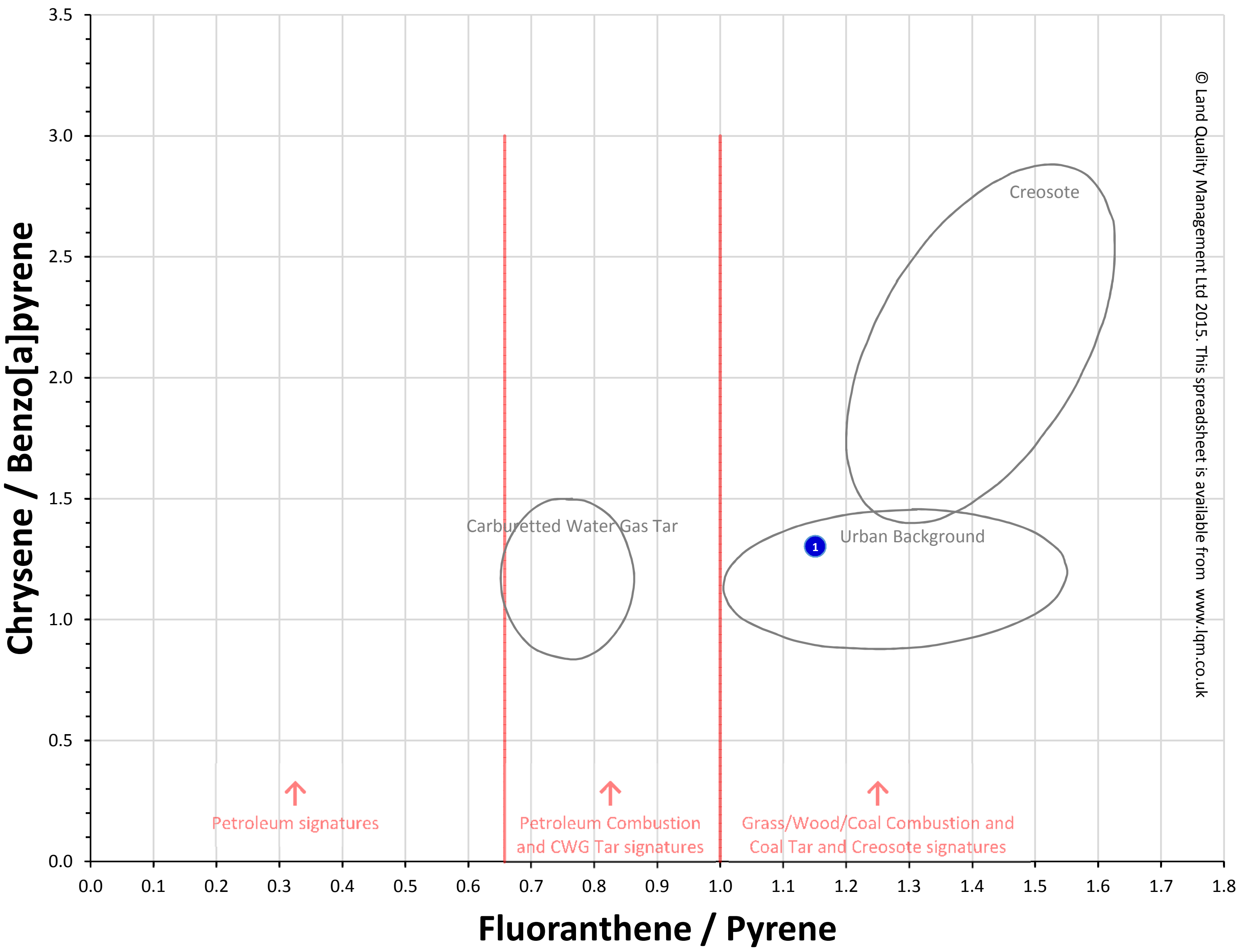


Key:

● Samples collected on site

Based on Figure 7 in Costa & Sauer (2005). The potential sources shown are indicative only.

ground &water



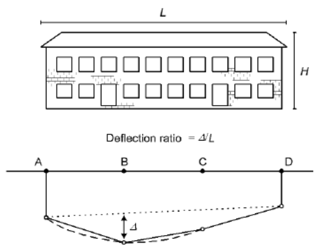
Key:
● Samples collected on site

Based on Figure 8 in Costa & Sauer (2005). The potential sources shown are indicative only.

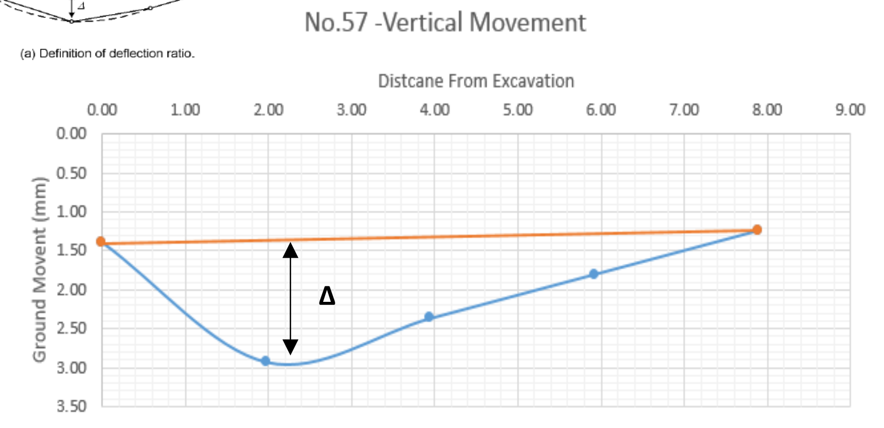
ground &water

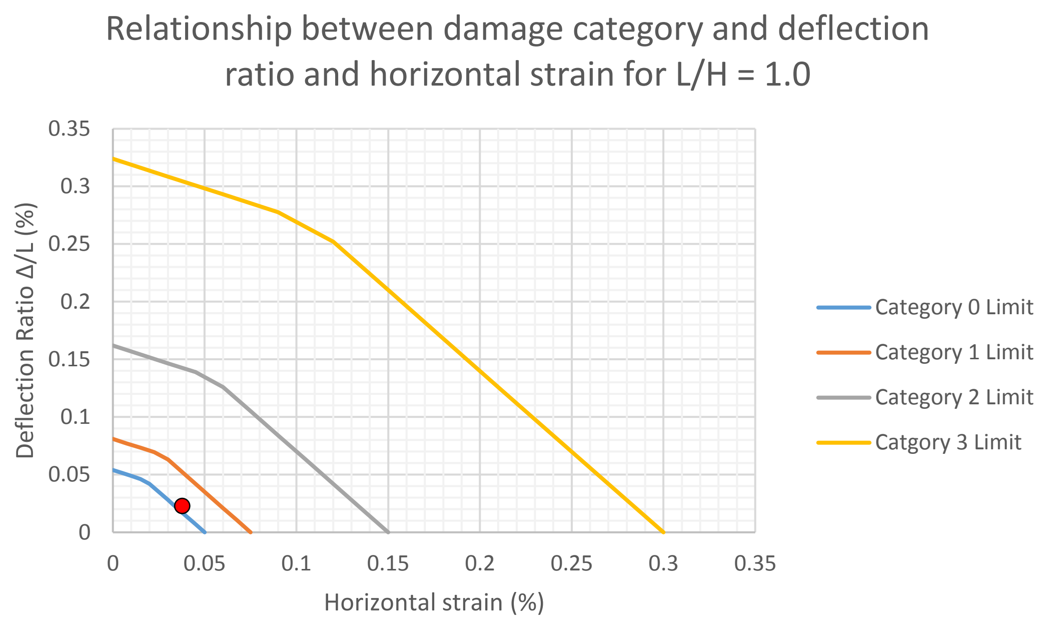
APPENDIX G
Potential Damage Calculations

No.57 Croftdown Road – Potential Damage Calculations in Stiff Clay

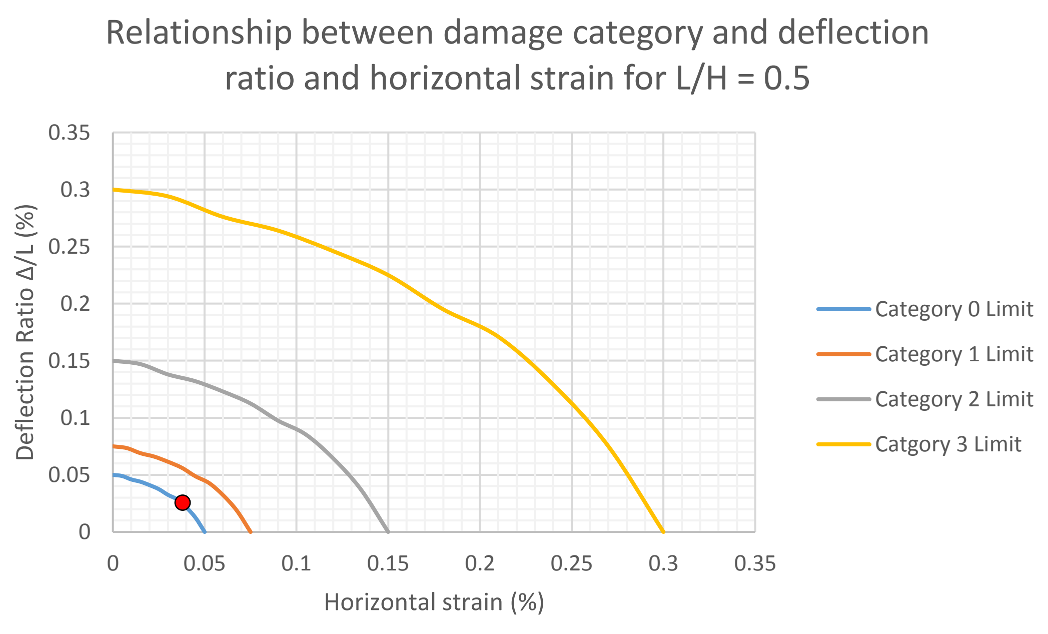


(a) Definition of deflection ratio.



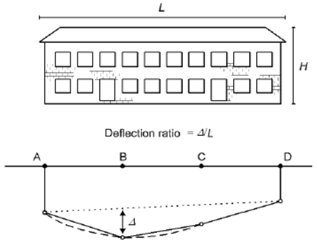


Neighbouring Property 1	No.	57	
	m	mm	
L	7.90	7900	
H	11.00	11000	
L/H	0.72		
Vertical Deflection (Δ)	1.6	mm	from graph (max difference between blue and orange line)
Defelction Ratio (Δ/L)	0.020253	%	
Horizontal Movement (δh)	2.96	mm	difference between horizontal movement at nearest and farthest walls
Horzontal Strain (Ɛh) = δh/L	0.03750	%	

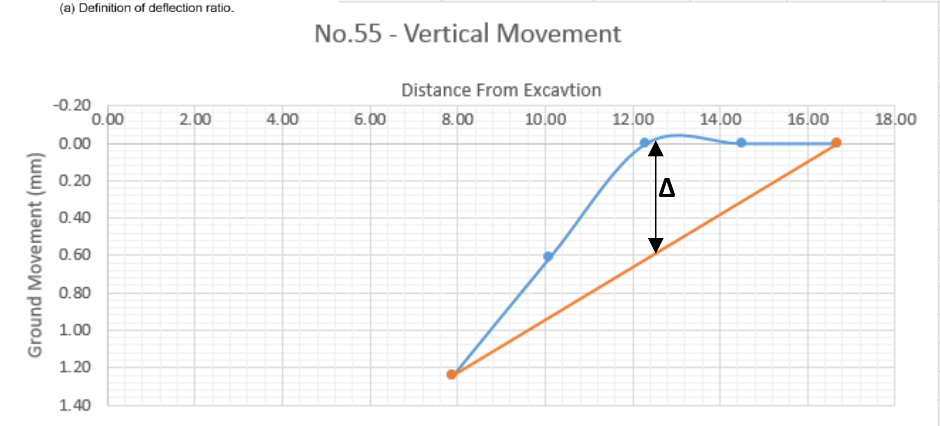


L/H for property is 0.72. The calculated vertical deflection and horizontal strain was therefore plotted on the relationship graphs for L/H=0.5 and L/H=1. The movement for the property plotted within or on the boundary line for Category 1 ‘Very Slight’. The potential damage for the property was therefore considered likely to be **‘Very Slight’.**

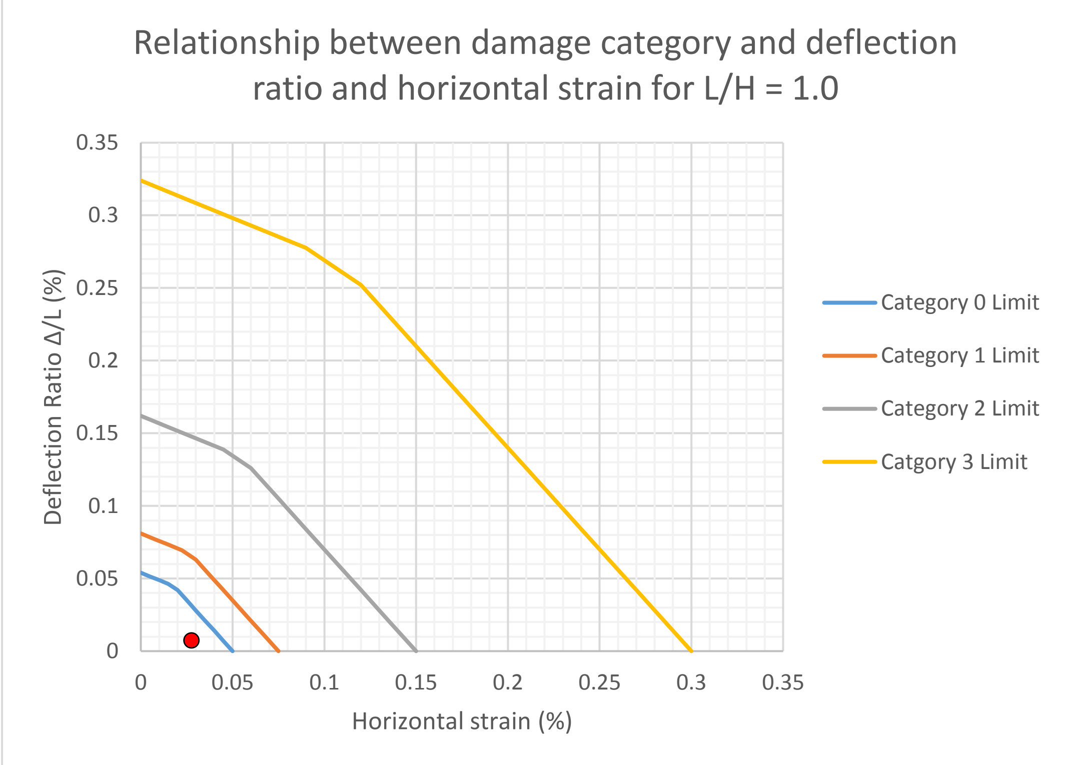
No.55 Croftdown Road – Potential Damage Calculations in Stiff Clay



(a) Definition of deflection ratio.

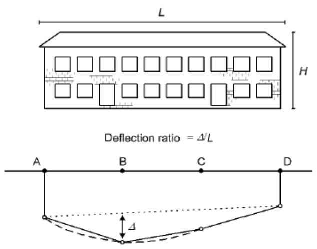


Neighbouring Property 2	No.	55	
	m	mm	
L	8.80	8800	
H	8.00	8000	
L/H	1.10		
Vertical Deflection (Δ)	0.6	mm	from graph (max difference between blue and orange line)
Defelction Ratio (Δ/L)	0.006818	%	
Horizontal Movement (δh)	2.29		difference between horizontal movement at nearest and farthest walls
Horzontal Strain (Ɛh) = δh/L	0.02599	%	

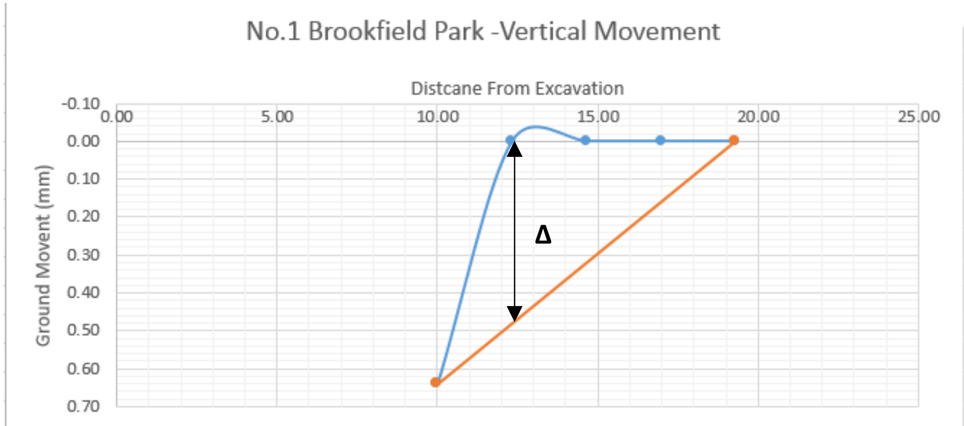


L/H for property is 1.10. The calculated vertical deflection and horizontal strain was therefore plotted on the relationship graph for L/H=1. The movement for the property plotted within the Category 0 'Negligible'. The potential damage for the property was therefore considered likely to be **'Negligible'.**

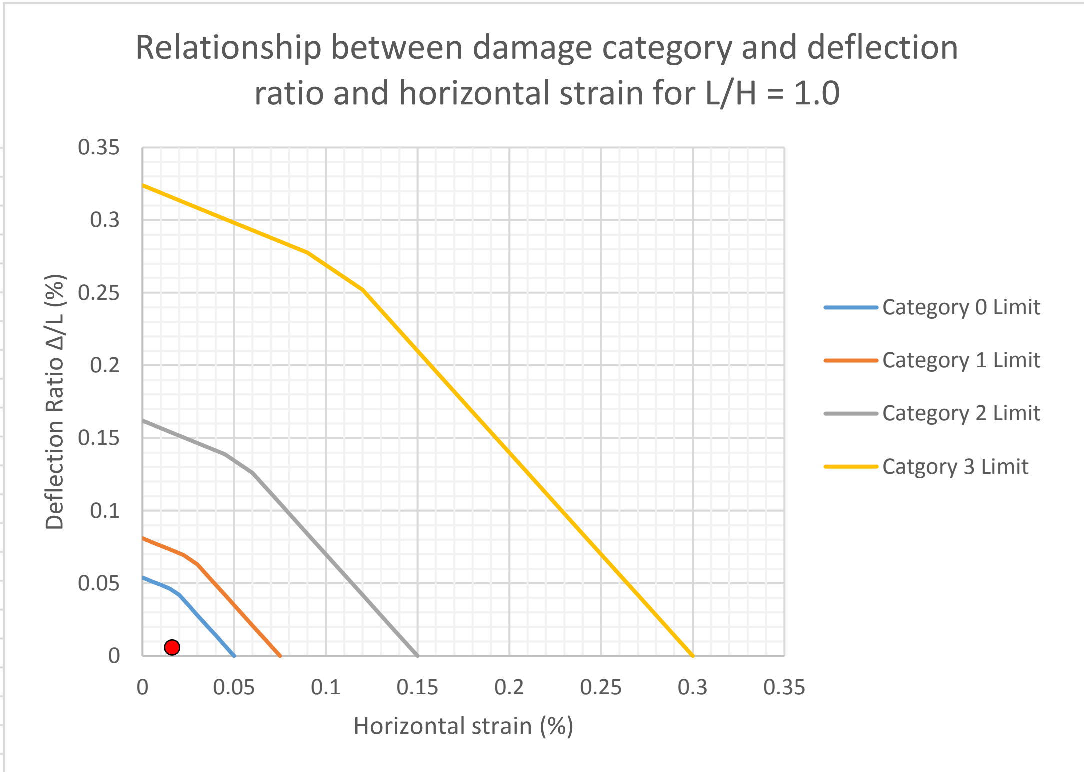
No.1 Brookfield Park – Potential Damage Calculations in Stiff Clay



(a) Definition of deflection ratio.



Neighbouring Property 1	No.	1	
	m	mm	
L	9.30	9300	
H	11.00	11000	
L/H	0.85		
Vertical Deflection (Δ)	0.5	mm	from graph (max difference between blue and orange line)
Defelction Ratio (Δ/L)	0.005376	%	
Horizontal Movement (δh)	1.50	mm	difference between horizontal movement at nearest and farthest walls
Horzontal Strain (Ɛh) = δh/L	0.01613	%	



L/H for property is 0.85. The calculated vertical deflection and horizontal strain was therefore plotted on the relationship graph for L/H=1. The movement for the property plotted within the Category 0 'Negligible'. The potential damage for the property was therefore considered likely to be **'Negligible'.**

APPENDIX H
Waste Hazard Assessment

Waste Classification Report

9BFAU-X6K79-JVWYU

Job name

GWPR1860

Waste Stream

Ground and Water V2 PA

Comments

Project

59 Croftdown Road, Camden, London W5 1EL

Site

Classified by

Name:
Dalziel, James
Date:
08/12/2016 14:38 UTC
Telephone:
0333 600 1221

Company:
Ground and Water
2 The Long Barn
Norton Farm, Selborne Road
Alton
GU34 3NB

Report

Created by: Dalziel, James
Created date: 08/12/2016 14:38 UTC

Job summary

#	Sample Name	Depth [m]	Classification Result	Hazardous properties	Page
1	BH1/0.30m		Non Hazardous		2

Classification of sample: BH1/0.30m

Non Hazardous Waste
Classified as **17 05 04**
in the List of Waste

Sample details

Sample Name:
BH1/0.30m
Sample Depth:
0 m
Moisture content: **0%**
(no correction)

LoW Code:
Chapter: 17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Entry: 17 05 04 (Soil and stones other than those mentioned in 17 05 03)

Hazard properties

None identified

Determinands (Moisture content: 0%, no correction)

pH: (Whole conc. entered as: 7 pH, converted to conc.:7 pH or 7 pH)
salts of hydrogen cyanide with the exception of complex cyanides such as ferrocyanides, ferricyanides and mercuric oxycyanide and those specified elsewhere in this Annex: (Cation conc. entered: <2 mg/kg, converted to compound conc.:<3.768 mg/kg or <0.000377%) IGNORED Because: "<LOD"
arsenic trioxide: (Cation conc. entered: 22 mg/kg, converted to compound conc.:29.047 mg/kg or 0.0029%)
boron tribromide/trichloride/trifluoride (combined): (Cation conc. entered: <1 mg/kg, converted to compound conc.:<13.43 mg/kg or <0.00134%) IGNORED Because: "<LOD"
cadmium sulfide: (Cation conc. entered: 0.3 mg/kg, converted to compound conc.:0.386 mg/kg or 0.0000386%, Note 1 conc.: 0.00003%)
Chromium (III) Sulphate: (Whole conc. entered as: 34 mg/kg or 0.0034%)
chromium(VI) oxide: (Cation conc. entered: <2 mg/kg, converted to compound conc.:<3.846 mg/kg or <0.000385%) IGNORED Because: "<LOD"
dicopper oxide; copper (I) oxide: (Cation conc. entered: 117 mg/kg, converted to compound conc.:131.729 mg/kg or 0.0132%)
lead chromate: (Cation conc. entered: 584 mg/kg, converted to compound conc.:910.932 mg/kg or 0.0911%, Note 1 conc.: 0.0584%)
mercury dichloride: (Cation conc. entered: 1 mg/kg, converted to compound conc.:1.353 mg/kg or 0.000135%)
nickel dihydroxide: (Cation conc. entered: 31 mg/kg, converted to compound conc.:48.964 mg/kg or 0.0049%)
selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex: (Cation conc. entered: <3 mg/kg, converted to compound conc.:<7.661 mg/kg or <0.000766%) IGNORED Because: "<LOD"
divanadium pentaoxide; vanadium pentoxide: (Cation conc. entered: 64 mg/kg, converted to compound conc.:114.252 mg/kg or 0.0114%)
zinc oxide: (Cation conc. entered: 495 mg/kg, converted to compound conc.:616.133 mg/kg or 0.0616%)
phenol: (Whole conc. entered as: <2 mg/kg or <0.0002%) IGNORED Because: "<LOD"
naphthalene: (Whole conc. entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
acenaphthylene: (Whole conc. entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
acenaphthene: (Whole conc. entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
fluorene: (Whole conc. entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
phenanthrene: (Whole conc. entered as: 0.44 mg/kg or 0.000044%)
anthracene: (Whole conc. entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
fluoranthene: (Whole conc. entered as: 1.22 mg/kg or 0.000122%)
pyrene: (Whole conc. entered as: 1.06 mg/kg or 0.000106%)
benzo[a]anthracene: (Whole conc. entered as: 0.48 mg/kg or 0.000048%)
chrysene: (Whole conc. entered as: 0.56 mg/kg or 0.000056%)
benzo[b]fluoranthene: (Whole conc. entered as: 0.65 mg/kg or 0.000065%)

benzo[k]fluoranthene: (Whole conc. entered as: 0.26 mg/kg or 0.000026%)
benzo[a]pyrene; benzo[def]chrysene: (Whole conc. entered as: 0.43 mg/kg or 0.000043%)
indeno[123-cd]pyrene: (Whole conc. entered as: 0.24 mg/kg or 0.000024%)
dibenz[a,h]anthracene: (Whole conc. entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
benzo[ghi]perylene: (Whole conc. entered as: 0.2 mg/kg or 0.00002%)
benzene: (Whole conc. entered as: <2 mg/kg or <0.0002%) IGNORED Because: "<LOD"
toluene: (Whole conc. entered as: <5 mg/kg or <0.0005%) IGNORED Because: "<LOD"
ethylbenzene: (Whole conc. entered as: <2 mg/kg or <0.0002%) IGNORED Because: "<LOD"
xylene: (Whole conc. entered as: <2 mg/kg or <0.0002%) IGNORED Because: "<LOD"
o-xylene; [1] p-xylene; [2] m-xylene; [3] xylene [4]: (Whole conc. entered as: <2 mg/kg or <0.0002%) IGNORED Because: "<LOD"
diesel petroleum group: (Whole conc. entered as: <35 mg/kg or <0.0035%) IGNORED Because: "<LOD"
TPH (C6 to C40) petroleum group: (Whole conc. entered as: <42 mg/kg or <0.0042%) IGNORED Because: "<LOD"

Legend

- This determinand has one or more of its Hazard Statements and Risk Phrases defined and maintained by the Classifier

Notes utilised in assessment

C14: Step 5

"identify whether any individual ecotoxic substance is present at or above a cut-off value ..." , used on:

Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "arsenic trioxide"
Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "dicopper oxide; copper (I) oxide"
Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "lead chromate"
Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "mercury dichloride"
Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "nickel dihydroxide"
Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "zinc oxide"
Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "phenanthrene"
Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "fluoranthene"
Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "pyrene"
Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "benzo[a]anthracene"
Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "chrysene"
Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "benzo[b]fluoranthene"
Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "benzo[k]fluoranthene"
Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "benzo[a]pyrene; benzo[def]chrysene"
Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "benzo[ghi]perylene"
Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "divanadium pentaoxide; vanadium pentoxide"
Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "cadmium sulfide"

Note 1 , used on:

Test: "HP 5 on STOT SE 1; H370, STOT RE 1; H372" for determinand: "cadmium sulfide"
Test: "HP 5 on STOT SE 2; H371, STOT RE 2; H373" for determinand: "cadmium sulfide"
Test: "HP 6 on Acute Tox. 4; H302" for determinand: "cadmium sulfide"
Test: "HP 7 on Carc. 1A; H350, Carc. 1B; H350, Carc. 1A; H350i, Carc. 1B; H350i" for determinand: "cadmium sulfide"
Test: "HP 10 on Repr. 1A; H360, Repr. 1A; H360D, Repr. 1A; H360Df, Repr. 1A; H360F, Repr. 1A; H360Fd, Repr. 1A; H360FD, Repr. 1B; H360, Repr. 1B; H360D, Repr. 1B; H360Df, Repr. 1B; H360F, Repr. 1B; H360Fd, Repr. 1B; H360FD " for determinand: "lead chromate"
Test: "HP 10 on Repr. 2; H361, Repr. 2; H361d, Repr. 2; H361f, Repr. 2; H361fd" for determinand: "cadmium sulfide"
Test: "HP 11 on Muta. 2; H341" for determinand: "cadmium sulfide"
Test: "HP 14 on R50, R50/53, R51/53, R52/53, R52, R53" for determinand: "lead chromate"

Determinand notes

Note 1 , used on:

determinand: "cadmium sulfide"
determinand: "lead chromate"

Appendix A: Classifier defined and non CLP determinands

pH (CAS Number: PH)

Comments: Appendix C4
Data source: WM3 1st Edition 2015
Data source date: 25/05/2015
Risk Phrases: None.
Hazard Statements: None.

salts of hydrogen cyanide with the exception of complex cyanides such as ferrocyanides, ferricyanides and mercuric oxycyanide and those specified elsewhere in this Annex

CLP index number: 006-007-00-5
Data source: Commission Regulation (EC) No 790/2009 - 1st Adaptation to Technical Progress for Regulation (EC) No 1272/2008. (ATP1)
Additional Risk Phrases: None.
Additional Hazard Statement(s): EUH032>= 0.2%
Reason:
14/12/2015 - EUH032>= 0.2% hazard statement sourced from: WM3, Table C12.2

boron tribromide/trichloride/trifluoride (combined) (CAS Number: 10294-33-4, 10294-34-5, 7637-07-2)

Conversion factor: 13.43
Comments: Combines the hazard statements and the average of the conversion factors for boron tribromide, boron trichloride and boron trifluoride
Data source: N/A
Data source date: 06/08/2015
Risk Phrases: R14, T+; R26/28, C; R34, C; R35
Hazard Statements: EUH014, Acute Tox. 2; H330, Acute Tox. 2; H300, Skin Corr. 1A; H314, Skin Corr. 1B; H314

Chromium (III) Sulphate (CAS Number: 10101-53-8)

Comments:
Data source: 10101-53-8
Data source date: 24/06/2015
Risk Phrases: None.
Hazard Statements: None.

dicopper oxide; copper (I) oxide (CAS Number: 1317-39-1)

CLP index number: 029-002-00-X
Data source: Regulation (EU) 2016/1179 of 19 July 2016 (ATP9)
Additional Risk Phrases: N; R50/53, N; R50/53>= 0.25%
Additional Hazard Statement(s): None.
Reason:
10/10/2016 - N; R50/53 hazard statement sourced from: WM3 v1 still uses ecotoxic risk phrases
10/10/2016 - N; R50/53>= 0.25% hazard statement sourced from: WM3 v1 still uses ecotoxic risk phrases

acenaphthylene (CAS Number: 208-96-8)

Comments: Data from C&L Inventory Database
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 17/07/2015
Risk Phrases: R22, R26, R27, R36, R37, R38
Hazard Statements: Acute Tox. 4; H302, Acute Tox. 1; H330, Acute Tox. 1; H310, Eye Irrit. 2; H319, STOT SE 3; H335, Skin Irrit. 2; H315

acenaphthene (CAS Number: 83-32-9)

Comments: Data from C&L Inventory Database
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 17/07/2015
Risk Phrases: R36, R37, R38, N; R50/53, N; R51/53
Hazard Statements: Eye Irrit. 2; H319, STOT SE 3; H335, Skin Irrit. 2; H315, Aquatic Acute 1; H400, Aquatic Chronic 1; H410, Aquatic Chronic 2; H411

fluorene (CAS Number: 86-73-7)

Comments: Data from C&L Inventory Database
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 06/08/2015
Risk Phrases: N; R50/53
Hazard Statements: Aquatic Acute 1; H400, Aquatic Chronic 1; H410

phenanthrene (CAS Number: 85-01-8)

Comments: Data from C&L Inventory Database
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 06/08/2015
Risk Phrases: R22, R36, R37, R38, R40, R43, N; R50/53
Hazard Statements: Acute Tox. 4; H302, Eye Irrit. 2; H319, STOT SE 3; H335, Carc. 2; H351, Skin Sens. 1; H317, Aquatic Acute 1; H400, Aquatic Chronic 1; H410, Skin Irrit. 2; H315

anthracene (CAS Number: 120-12-7)

Comments: Data from C&L Inventory Database
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 17/07/2015
Risk Phrases: R36, R37, R38, R43, N; R50/53
Hazard Statements: Eye Irrit. 2; H319, STOT SE 3; H335, Skin Irrit. 2; H315, Skin Sens. 1; H317, Aquatic Acute 1; H400, Aquatic Chronic 1; H410

fluoranthene (CAS Number: 206-44-0)

Comments: Data from C&L Inventory Database
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 21/08/2015
Risk Phrases: Xn; R22, N; R50/53
Hazard Statements: Acute Tox. 4; H302, Aquatic Acute 1; H400, Aquatic Chronic 1; H410

pyrene (CAS Number: 129-00-0)

Comments: Data from C&L Inventory Database; SDS Sigma Aldrich 2014
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 21/08/2015
Risk Phrases: Xi; R36/37/38, N; R50/53
Hazard Statements: Skin Irrit. 2; H315, Eye Irrit. 2; H319, STOT SE 3; H335, Aquatic Acute 1; H400, Aquatic Chronic 1; H410

indeno[123-cd]pyrene (CAS Number: 193-39-5)

Comments: Data from C&L Inventory Database
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 06/08/2015
Risk Phrases: R40
Hazard Statements: Carc. 2; H351

benzo[ghi]perylene (CAS Number: 191-24-2)

Comments: Data from C&L Inventory Database; SDS Sigma Aldrich 28/02/2015
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 23/07/2015
Risk Phrases: N; R50/53
Hazard Statements: Aquatic Acute 1; H400, Aquatic Chronic 1; H410

ethylbenzene (CAS Number: 100-41-4)

CLP index number: 601-023-00-4
Data source: Commission Regulation (EU) No 605/2014 – 6th Adaptation to Technical Progress for Regulation (EC) No 1272/2008. (ATP6)
Additional Risk Phrases: None.
Additional Hazard Statement(s): Carc. 2; H351
Reason:
03/06/2015 - Carc. 2; H351 hazard statement sourced from: IARC Group 2B (77) 2000

diesel petroleum group (CAS Number: 68334-30-5, 68476-34-6, 94114-59-7, 1159170-26-9)

Comments: Hazard statements taken from WM3 1st Edition 2015; Risk phrases: WM2 3rd Edition 2013
Data source: WM3 1st Edition 2015
Data source date: 25/05/2015
Risk Phrases: R40, R51/53, R65, R66
Hazard Statements: Flam. Liq. 3; H226, Skin Irrit. 2; H315, Acute Tox. 4; H332, Carc. 2; H351, Asp. Tox. 1; H304, STOT RE 2; H373, Aquatic Chronic 2; H411

TPH (C6 to C40) petroleum group (CAS Number: TPH)

Comments: Hazard statements taken from WM3 1st Edition 2015; Risk phrases: WM2 3rd Edition 2013
Data source: WM3 1st Edition 2015
Data source date: 25/05/2015
Risk Phrases: R10, R45, R46, R51/53, R63, R65
Hazard Statements: Flam. Liq. 3; H226, Asp. Tox. 1; H304, STOT RE 2; H373, Muta. 1B; H340, Carc. 1B; H350, Repr. 2; H361d, Aquatic Chronic 2; H411

Appendix B: Rationale for selection of metal species

C14: Step 5

from section: WM3: C14 in the document: "WM3 - Waste Classification"

"identify whether any individual ecotoxic substance is present at or above a cut-off value ..."

Note 1

from section: 1.1.3.2, Annex VI in the document: "CLP Regulation"

"The concentration stated or, in the absence of such concentrations, the generic concentrations of this Regulation (Table 3.1) or the generic concentrations of Directive 1999/45/EC (Table 3.2), are the percentages by weight of the metallic element calculated with reference to the total weight of the mixture."

Appendix C: Version

This classification utilises the following guidance and legislation:

- WM3 - Waste Classification - May 2015
- CLP Regulation - Regulation 1272/2008/EC of 16 December 2008
- 1st ATP - Regulation 790/2009/EC of 10 August 2009
- 2nd ATP - Regulation 286/2011/EC of 10 March 2011
- 3rd ATP - Regulation 618/2012/EU of 10 July 2012
- 4th ATP - Regulation 487/2013/EU of 8 May 2013
- Correction to 1st ATP - Regulation 758/2013/EU of 7 August 2013
- 5th ATP - Regulation 944/2013/EU of 2 October 2013
- 6th ATP - Regulation 605/2014/EU of 5 June 2014
- WFD Annex III replacement - Regulation 1357/2014/EU of 18 December 2014
- Revised List of Wastes 2014 - Decision 2014/955/EU of 18 December 2014
- 7th ATP - Regulation 2015/1221/EU of 24 July 2015
- 8th ATP - Regulation (EU) 2016/918 of 19 May 2016
- 9th ATP - Regulation (EU) 2016/1179 of 19 July 2016
- POPs Regulation 2004 - Regulation 850/2004/EC of 29 April 2004
- 1st ATP to POPs Regulation - Regulation 756/2010/EU of 24 August 2010
- 2nd ATP to POPs Regulation - Regulation 757/2010/EU of 24 August 2010

HazWasteOnline Classification Engine: WM3 1st Edition, May 2015
HazWasteOnline Classification Engine Version: 2016.317.3166.6295 (12 Nov 2016)
HazWasteOnline Database: 2016.315.3165.6292 (10 Nov 2016)