ground&water

GROUND INVESTIGATION REPORT

for

4 BELLINGHAM ROAD, CATFORD, LONDON SE6 2PT

on behalf of

SMART ENVIRONMENT FREEHOLDS LIMITED

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Proposed Development	At the time of reporting, May 2020, the proposed development was understood to comprise the partial demolition and conversion of the former gas valve distribution building (Sui Generis Use Class) at 4 Bellingham Road, SE6 and the construction of a 3-storey, L-shaped building comprising 5x one bedroom, and 4x two bedroom dwellings, together with associated landscaping works and refuse and cycle storage.
Geology	The BGS Geological Map (Solid and Drift) for the Catford area (South London Sheet No. 270) revealed the majority of the site was located on the superficial deposits of the Kempton Park gravel Member overlying the bedrock deposits of the London Clay Formation.
Hydrogeology	The site was located on a **Secondary A Aquifer** relating to the superficial deposits of the Kempton Park Gravel Member overlying **Unproductive Strata** relating to the bedrock deposits of the London Clay Formation.
Radon	The site was not located in an area where Radon protection measures were likely to be required.
Soils Encountered	The ground conditions encountered within the trial holes was generally as anticipated from examination of the geology map. A capping of Topsoil was noted from ground level overlying the soils of Kempton Park Gravel Member which in turn rest upon the soils of the London Clay Formation for the remaining depth of the boreholes.
Foundation Design	Minimum foundation depths are likely to range between 2.00 – 2.50m bgl See section 6.2 for bearing capacities and anticipated settlements for spread foundations at depths of 1.50m, 2.00m, 2.50m and 3.40m bgl. Given the depth of excavation and amount of waste produced, a piled foundation may be more economical for the project and an indicative pile design is given in Section 6.3.
Infiltration Rates	Soakaways constructed within the shallow Kempton Park Gravel Member and the underlying cohesive soils of the London Clay Formation were unlikely to be successful.
Sub-Surface Concrete	According to BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground' a Sulphate Design Classes of DS-1, DS-3 and DS-4 is appropriate for sub-surface concrete in contact with the soils encountered on site. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1, AC-3 and AC-4. **A DS-4 class with an ACEC of AC-4 will be required for design.**
Contamination Analyses	Chemical laboratory testing of the Topsoil revealed elevated levels of metals and PAHs above the guideline levels for a *'Residential with homegrown produce'* land-use scenario. Chrysotile asbestos was also detected. Remediation requires removal of the shallow thickness of Topsoil from the soft landscaped areas to expose the underlying soils of the Kempton Park Gravel Member The voids created should then be independently inspected, sample and verified and backfilled with certified clean Topsoil. No remediation of groundwater was considered to be necessary.
Waste Acceptance Protocols	Based on a risk phase analysis of the chemical laboratory test results, in accordance with EC Hazardous Waste Directive (WM3), undertaken by Ground and Water Limited, the three samples of the Topsoil tested were NON HAZARDOUS. A full WAC Solid Suite Test with single batch leachate was undertaken on one sample of the Topsoil (WS3/0.30m bgl) and indicated the sample conformed to the INERT Waste classification.

The above information must be read in conjunction with the full report.

1.0 INTRODUCTION

1.1 General

Ground and Water Limited were instructed by Smart Environment Freeholds Limited, on the 26th February 2020 to conduct a Ground Investigation on 4 Bellingham Road, Catford, London SE6 2PT. The scope of the investigation was detailed within the Ground and Water Limited fee proposal ref.: GWQ5356, dated 25th February 2020.

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.

A programme of chemical laboratory testing, scheduled by Ground and Water Limited and carried out by DETS Environmental Limited, was undertaken on samples recovered from the trial holes. The testing schedule and suite was based on the Conceptual Site Model developed within Section 2.7 of this report and relies totally upon the following reports:

- *Symonds Group Factual Desk Study Report, ref: 46947/0002.doc, dated March 1998;*
- *Atkins Limited Factual Desk Study Report, ref: 2000078/NGP/Catford/R002v1, dated May 2014*;
- *Atkins Limited Factual Desk Study Report - Final, ref: 5159414/R001v1, dated August 2017*.

Total reliance has been placed on these reports and no liability can be taken for their short comings.

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 a 0.07ha (700m^2) rectangular plot of land, orientated in a north-west to south-east direction, and was located on the southern side of Bellingham Road in Catford, south-east London.

The approximate O.S. National Grid reference for the site is TQ 37969 72325. A site location plan is given within Figure 1. A plan showing the site development area is given within Figure 2.

2.2 Site Description

The northern half of the site comprises a detached two-storey house, with basement. The rear garden was understood to be partially overgrown with areas of soft landscaping and hardstanding. Access to the rear garden was via a ~800mm wide gate at the side of the house and a wider 2.70m wide gate off the access road along the western boundary of the site.

An aerial view of the site showing an approximate site boundary is given within Figure 3.

2.3 Proposed Development

At the time of reporting, May 2020, the proposed development was understood to comprise the partial demolition and conversion of the former gas valve distribution building (Sui Generis Use Class) at 4 Bellingham Road, SE6 and the construction of a 3-storey, L-shaped building comprising 5x one bedroom, and 4x two bedroom dwellings, together with associated landscaping works and refuse and cycle storage. A plan view of the proposed development is given in Figure 4.

2.4 Geology

The BGS Geological Map (Solid and Drift) for the Catford area (South London Sheet No. 270) revealed the site was located on the superficial deposits of the Kempton Park Gravel Member overlying the bedrock deposits of the London Clay Formation. There were no areas of Made Ground or Worked Ground in a close proximity to the site.

Kempton Park Gravel Member.

The Kempton Park Gravel Member is part of a complex series of River Terrace Deposits formed by the River Thames and its tributaries. These terraces represent ancient floodplain deposits that became isolated as the river cut downwards to lower levels. The Kempton Park Gravel Member is found at an elevation below the current river. The composition of the River Terrace Gravel varies greatly, depending on the source material available in the river's catchment. Deposits generally consist of sands and gravels of roughly bedded flint or chert commonly in a matrix of silts and clays.

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 record from 1943 ~35m to the west of the site revealed ~1.00m of Made Ground overlying sand and gravel to 3m bgl. The London Clay Formation was then encountered for the remaining depth of the borehole at 10m bgl.

2.5 Hydrogeology and Hydrology

An examination of the DEFRA website revealed the site was located on a **Secondary A Aquifer** relating to the superficial deposits of the Kempton Park Gravel Member overlying **Unproductive** Strata relating to the bedrock deposits of the London Clay Formation.

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

Secondary aquifers include a wide range of drift deposits with an equally wide range of water permeability and storage capacities. Secondary (A) Aquifers consist of deposits with permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as Minor Aquifers.

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 DEFRA records showed that the site within an Outer Zone (Zone II) Groundwater Source Protection Zone (SPZ) as classified in the Policy and Practice for the Protection of Groundwater. An Outer Zone (Zone II) Groundwater source Protection Zone is defined by a 400 day travel time from a point below the water table. The previous methodology gave an option to define SPZ2 as the minimum recharge area required to support 25 per cent of the protected yield. This option is no longer available in defining new SPZs and instead this zone has a minimum radius of 250 or 500 metres around the source, depending on the size of the abstraction.

The nearest surface water feature was the northerly flowing Ravensbourne River located ~150m to the west of the site.

From analysis of hydrogeological and topographical maps groundwater was anticipated to be encountered at moderate depth (2 - 4m below existing ground level (bgl)) and it was considered that the groundwater was flowing in a northerly/north-westerly direction in alignment with local topography and the flow of local rivers.

Examination of the Environment Agency records showed that the site fell within a Flood Zone 1 (an area with a low probability of river or sea flooding).

2.6 Radon

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

2.7 Review of Previous Desk Studies

2.7.1 Symonds Group Factual Desk Study Report, ref: 46947/0002.doc, dated March 1998.

Symonds Group produced a Factual Desk Study Report on the site in March 1998 and a précis of the report can be found below.

A Site Walkover undertaken in February 1998 revealed a detached two storey building with a basement in the northern portion of the site with hardstanding to the north and a rear garden to the south. The building was a former District Pressure Regulating Station (Valve House and Governor) Stores and Office Depot. The basement was believed to have formerly been used for regulating supply but had been out of use for 15 – 20 years. At the time of the Site Walkover, it was flooded by 0.15m of standing water. The ground floor was used as office space and general storage. The upper floor of the building was let as a residential flat.

The site was used as a distribution point run by BG St Mary Cray maintenance depot with medium pressure gas flow in and low pressure gas flow out. The gas control facility was carried out in a small extension at the front of the main building on the north-west corner.

During the Site Walkover, residential properties were noted to the north, south and east. A maintenance and repair garage was noted to the immediate west.

The geology of the site comprised River Terrace Deposits over the London Clay which in turn rest upon the Woolwich and Reading Beds at depth. The superficial deposits were classified as a Minor Aquifer with the London Clay being classed as a Non Aquifer.

A summary of the review of historical Ordnance Survey maps (1:10,560 and 1:10,000 maps only) from 1874 revealed the site was open undeveloped land until the 1930s when the buildings currently occupying the western portion of the site was erected and associated garden area was shown in the western portion. The area in which the site was located was also undeveloped until the 1891 historic map, when residential properties were shown to the east and west of the site and on the northern side of Bellingham Road. By 1938, the buildings to the west had been extended further south. By 1968, residential development to the south was noted.

Enquiries made to the London Borough of Lewisham Environmental Services and Planning Department revealed no evidence of any remediation measures having been undertaken at the site and that there were no pollution incidents in the vicinity of the site. The nearest licenced landfill site was 1.38km to the west at the Sydenham Gas Works which was an authorised waste disposal site operated by British Gas (South Eastern) plc.

Enquires made to the Health and Safety Executive (HSE) revealed that the site was not subject to the Control of Industrial Major Accident Hazards Regulations 1984 as amended and that there were no hazardous installations within 1km of the site.

Enquires made to the Environment Agency revealed no significant pollution incidents have affected the site or its environs.

2.7.2 Atkins Limited Factual Desk Study Report, ref: 2000078/NGP/Catford/R002v1, dated May 2014.

Atkins Limited produced a factual Desk Study Report on the site in May 2014 and a précis of any significant additions relevant to the site and contained within the report can be found below.

A Site Walkover in February 2014 revealed no significant changes to the site. The only change to the within the site’s environs was a garage and printers to the north on the northern side of Bellingham Road.

A summary of the review of historical Ordnance Survey maps (1:10,560, 1:10,000 and 1:2,500 maps) from 1863 added that by 1949 the structure on-site was labelled as a gas valve house. No significant changes were noted to the site from study of the subsequent maps.

Within the site's environs a north to south railway and Bellingham station was noted 180m to the west on the 1895 historic map. A garage was noted 168m to the north-west on the 1916 historic map. A building later identified as being a garage was noted ~70-80m to the south-west of the site from 1938. A works was noted ~10m to the north on the northern side of Bellingham Road on the 1981 historic map.

The report also references another Desk Study Report produced by Parsons Brinckerhoff Ref. BEN45513B-Catford, September 2003 (Ref.11) that added no new information.

2.7.3 Atkins Limited Factual Desk Study Report - Final, ref: 5159414/R001v1, dated August 2017.

Atkins Limited produced an updated Factual Desk Study Report on the site in August 2017 and this revealed no significant changes to the site or its environs since the production of the previous report.

The review of the Desk Study Reports has revealed the following potential on-site sources of contamination.

- The review of the maps has shown that the building on site has been used as a as a gas valve house/gas governor station. These buildings control the pressure of gas throughout the mains gas network and therefore were not considered likely to pose a contaminative risk.

  However, construction activities are likely to have created a capping of Made Ground containing demolition debris where the original residential property was removed. Building materials used in the early 20th Century may have included asbestos for partitions and insulative lagging. Lead, cadmium and other heavy metal based paints may also have been used. During the demolition process, it is likely that removal of any harmful building materials would have been uncontrolled and quantities of asbestos and traces of heavy metals from paints and dyes may be present in the near surface soils around the footprints of the old building. Fires may have taken place on the site as part of the demolition process to remove waste. Potential pollutants such as carcinogenic PAHs in the tars produced by combustion of timber and other materials may be present in the near surface soils. Oil spills may have also occurred over time. However, given the size of the buildings demolished, the potential contamination is likely to be limited.

  Given the age of the structure, an **Asbestos Management Strategy** should be put in place to ensure that any potentially asbestos containing materials are identified and removed from site in a suitable manner to prevent cross-contamination.

The review of the Desk Study Reports has revealed the following potential off-site sources of contamination.

- Within the site's environs a north to south railway and Bellingham station was noted 180m to the west on the 1895 historic map.

  Potential contaminants associated with railway land include metals such as cadmium, chromium, nickel and lead, asbestos, Polycyclic Aromatic Hydrocarbons (PAHs), Total

Petroleum Hydrocarbons (TPH) and ethylene glycol, which is a common component in anti-freeze.

Given the limited changes in the buildings occupying the site it was considered that the risk of fill being sourced from the railway land to change ground levels, was considered to be very low. Additionally, given the anticipated groundwater flow direction to the north/north-west, these potential sources of contamination were dismissed.

- A garage was noted 168m to the north-west on the 1916 historic map. A building later identified as being a garage was noted ~70-80m to the south-west of the site from 1938. A works was noted ~10m to the north on the northern side of Bellingham Road on the 1981 historic map.

  Potential sources of contamination associated with a garage could include: lubricant oils; brake fluids (constitute mainly of polymerised glycols and ethers. Waste fluid is generated during repair work on brake systems); solvents (chlorinated hydrocarbons, carbon tetrachloride, paraffin and proprietary degreasing compounds); paints (lead-based paints, zinc-rich epoxy primers, polyurethanes as decorative finishes); gasoline, diesel, paraffin *(Department of the Environment Industry Profile, Road vehicle fuelling, service and repair: garages and filling stations 1996).*

  Potential sources of contamination associated with a works could include: Metals and semi-metals; asbestos; oil/fuel hydrocarbons, PAHs, solvents and inorganic chemicals *(R&D Publication CLR 8, 2002).*

  Given the limited changes in the buildings occupying the site it was considered that the risk of fill being sourced from the garages/works to change ground levels, was considered to be very low. Additionally, given the anticipated groundwater flow direction to the north/north-west, these potential sources of contamination were dismissed.

A tabulated Conceptual Site Model based upon the results of the previously reviewed Desk Study Reports can be seen overpage.

Tabulated Conceptual Site Model – Plausible Pollutant Linkages Only

Potential on-site Sources	Potential Absorption Pathways	Potential Receptors
Contaminants introduced by previous site usage and construction activities. • Heavy metals & semi-metals (Lead etc); • Combustion products (PAH's, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene); • Organic compounds (fuel oils, ash, tar); • Volatile and Semi-volatile Organic Compounds (VOC/SVOC's); • Asbestos (building material, pipe lagging).	Direct ingestion of soil and soil derived dust; Dermal contact of soil and soil derived dust; Ingestion of soil with elevated concentration of determinants; Dermal contact with impacted soils; Inhalation of impacted dust (indoors and outdoors) with elevated concentration of determinants. Inhalation of volatiles (indoors and outdoors) with elevated concentration of determinants. Inhalation of volatile vapours (indoors and outdoors) with elevated concentration of determinants.	Construction workers Service and Maintenance Operatives. Site Occupiers.
	Via anthropogenic pathways; Via underlying geology; (Made Ground and Kempton Park Gravel Member) Via surface water.	Secondary A Aquifer (Kempton Park Gravel Member) Ravensbourne River ~150m to the west
Aggressive ground conditions with Made Ground and natural ground; • Sulphates • Acidic pH • PAHs	Direct contact with aggressive ground conditions	Building Materials and Services

3.0 FIELDWORK

3.1 Scope of Works

Site works were undertaken on the 5th March 2020 and comprised the drilling of 4No. Windowless Sampler Boreholes (WS1 – WS4) to depths of between 5.45 – 10.45m bgl. Standard Penetration Tests (SPTs) were carried out at 1.00m intervals in the boreholes.

The approximate locations of the trial holes are given on 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.

As a further precautionary measure, the positions were hand scanned with a Cable Avoidance Tool (CAT scanner) to minimise the risk to services.

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 records. 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. A programme of chemical laboratory testing, scheduled by Ground and Water Limited and carried out by DETS Environmental Limited, was undertaken on soils samples recovered from the trial holes. The testing schedule and suite was based on the Conceptual Site Model developed in section 2.7 above or the revised CSM within this report.

4.0 ENCOUNTERED GROUND CONDITIONS

4.1 Soil Conditions

All exploratory holes were logged by Roger Foord 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 conformed to what was anticipated from examination of the geology map. A capping of Topsoil was noted from ground level overlying the soils of the Kempton Park Gravel Member overlying the soils of the London Clay Formation for the remaining depth of the boreholes.

The ground conditions encountered during the investigation are described in this section. All trial hole logs can be seen in Appendix B and the trial hole location plan can be viewed in Figure 5.

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

Topsoil
Kempton Park Gravel Member
London Clay Formation

Topsoil

Topsoil was encountered from ground level in each of the boreholes to a depth of between 0.35 – 0.45m bgl. The Topsoil generally comprised a dark brown slightly gravelly sandy clay. The sand was fine to coarse grained and the gravel was fine to coarse, sub-angular to sub-rounded flint.

Kempton Park Gravel Member

Soils of the Kempton Park Gravel Member were encountered underlying the Topsoil to a depth of between 0.90 – 1.10m bgl. The soils comprised an orange brown to brown clayey sandy gravel. The sand was fine to coarse grained and the gravel was fine to coarse, sub-angular to sub-rounded flint.

London Clay Formation

Soils described as the London Clay Formation were encountered underlying the Kempton Park Gravel Member comprising a grey brown silty clay for the remaining depth of WS1 – WS3 at a depth of 5.45m bgl and to a depth of 7.50m bgl in WS4. A grey silty clay with fine selenite crystals from 7.50m bgl for the remaining depth of 10.45m bgl in WS4.

For more complete information about the soils encountered during the investigation, reference should be made to the detailed trial hole records given within Appendix C.

4.2 Roots Encountered

The depth of roots encountered in the trial holes can be seen tabulated overpage

Trial Hole	Depth of Fresh Root Penetration (m bgl)	Depth of Dark Brown/Black Friable Rootlets (m bgl)
WS1	2.00m bgl	2.00m bgl
WS2	0.40m bgl	2.50m bgl
WS3	1.10m bgl	2.50m bgl
WS4	1.50m bgl	2.50 – 5.00m bgl

It must be noted that the chance of determining actual depth of fresh root penetration through a narrow diameter borehole 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.

4.3 Groundwater Conditions

Groundwater was not encountered in WS1 – WS4 during the intrusive investigation. However, any seepages may have been obscured by the speed of the drilling process. Perched water may be recorded, however, within the shallow granular deposits of the Kempton Park Gravel Member, especially after a prolonged period of rainfall.

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

The site investigation was conducted in March 2020, when groundwater levels should be falling from their annual maximum (highest elevation). 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.

4.4 Obstructions

No artificial or natural sub-surface obstructions were noted during drilling of the boreholes.

5.0 INSITU AND LABORATORY GEOTECHNICAL TESTING

5.1 In-Situ Geotechnical Testing

5.1.1 Standard Penetrations Tests (SPTs)

Standard Penetration Tests (SPTs) were carried out within WS1 – WS4 at 1.00m intervals. The results of the SPT's have not been amended to take into account hammer efficiency, rod lengths and overburden pressure in accordance with Eurocode 7. The test results are presented on the borehole logs within Appendix B.

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 75 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 results
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

Strata	SPT results	Equivalent Undrained Shear Strength (kPa) Cohesive Soils	Soil Type		Trial Hole/s
			Cohesive	Granular	
London Clay Formation	8 – 22 9 – 23 8 – 18 8 – 40	40 – 110 45 – 115 40 – 90 40 – 200	Medium – High Medium – High Medium – High Medium – High	-	WS1 (0.90 – 5.45m bgl) WS2 (1.00 – 5.45m bgl) WS3 (1.10 – 5.45m bgl) WS4 (1.00 – 10.45m 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.

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 Kempton Park Gravel Member and the London Clay Formation. The results of the tests are presented in Appendix C and D. The test procedures used were generally in accordance with the methods described in BS1377:2016/2018. 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	BS1377:2016:Part 2:Clauses 3.2, 4.3 & 5	4
Moisture Content	BS1377:2016:Part 2:Clause 3.2	15
Particle Size Distribution	BS1377:2016:Part 2:Clause 9	3
Water Soluble Sulphate & pH	BS1377:2018: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 précis of Atterberg Limit Tests undertaken on four samples of the London Clay Formation can be seen tabulated below.

Atterberg Limit Tests Results Summary

Stratum/Depth	Moisture Content (%)	Passing 425 µm sieve (%)	Modified PI (%)	Soil Class	Consistency Index (Ic)	Volume Change Potential	
						BRE	NHBC
London Clay Formation	25 – 33	94 – 100	34.8 – 41.6	CH – CV	Stiff – Very Stiff	Medium – High	Medium - 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 were 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. The test results are presented within Appendix C.

Liquidity Index Calculations Summary					
Stratum/Trial Hole/Depth	Moisture Content (%)	Plastic Limit (%)	Modified Plasticity Index (%)	Liquidity Index	Result
London Clay Formation WS1/2.50m bgl Brown slightly mottled bluish grey silty CLAY with rare fine to medium mudstone fragments.	31	31	39.6	0.00	Heavily Overconsolidated (boundary)
London Clay Formation WS2/3.00m bgl Brown slightly mottled bluish grey silty CLAY with rare fine to medium mudstone fragments.	33	27	41.6	0.14	Heavily Overconsolidated
London Clay Formation WS3/1.50m bgl Brown slightly mottled bluish grey slightly gravelly silty CLAY (gravel is fine to medium and rounded).	25	26	34.8	-0.03	**Potential Moisture Deficit**
London Clay Formation WS4/3.00m bgl Brown slightly mottled bluish grey silty CLAY.	30	29	36.0	0.03	Heavily Overconsolidated

The results in the table above indicated that a potential significant moisture deficit was present within one of the samples of the London Clay Formation tested (WS3/1.50m bgl). The sample was described as a brown slightly mottled bluish grey slightly gravelly silty clay. The gravel was fine to medium and rounded. Roots were noted to 1.10m bgl in WS3. Dead roots were also noted at a depth of 2.50m bgl in WS3. Consequently the potential moisture deficit was likely to be related to the lithology of the soil (heavily overconsolidated soils with 6% coarse fraction) rather than the water demand of roots from nearby trees.

Liquidity Index testing revealed no evidence for a potential moisture deficit within the remaining heavily overconsolidated samples of the London Clay Formation tested.

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/Soil Description	**Moisture Content (MC) (%)**	**Liquid Limit (LL) (%)**	**40% Liquid Limit (LL)**	**Result**
London Clay Formation WS1/2.50m bgl Brown slightly mottled bluish grey silty CLAY with rare fine to medium mudstone fragments.	31	71	28.4	MC > 0.4 x LL (Not Significantly Desiccated)
London Clay Formation WS2/3.00m bgl Brown slightly mottled bluish grey silty CLAY with rare fine to medium mudstone fragments.	33	69	27.6	MC > 0.4 x LL (Not Significantly Desiccated)
London Clay Formation WS3/1.50m bgl Brown slightly mottled bluish grey slightly gravelly silty CLAY (gravel is fine to medium and rounded).	25	63	25.2	**MC < 0.4 x LL (Potential Significant Moisture Deficit)**
London Clay Formation WS4/3.00m bgl Brown slightly mottled bluish grey silty CLAY.	30	65	26	MC > 0.4 x LL (Not Significantly Desiccated)

The results in the table above indicated that a potential significant moisture deficit was present within one of the samples of the London Clay Formation tested

(WS3/1.50m bgl). The sample was described as a brown slightly mottled bluish grey slightly gravelly silty clay. The gravel was fine to medium and rounded. Roots were noted to 1.10m bgl in WS3. Dead roots were also noted at a depth of 2.50m bgl in WS3. Consequently the potential moisture deficit was likely to be related to the lithology of the soil (heavily overconsolidated soils with 6% coarse fraction) rather than the water demand of roots from nearby trees.

The results in the table above indicate that the remaining three samples of the London Clay Formation tested showed no evidence of a significant moisture deficit.

5.2.3 Moisture Content Profiling

The moisture content versus depth plots for WS1, WS2, WS3 and WS4 can be seen within Figures 6 - 8 respectively.

The results for the shallow samples tested at 0.80m bgl in WS1 and WS2 with the exceptionally low moisture contents will be disregarded as these were samples of gravel tested from the Kempton Park Gravel Member and the results were typical for those types of soil.

The moisture content profiles for boreholes WS2, WS3 and WS4 (Figures 7, 8 and 9) showed potential moisture content deficits to a depth of ~1.50 – 2.00m bgl where moisture contents generally increase, showing signs of recovery (with a slight exception of WS3/2.50m bgl) and then the profiles show a natural gradual decrease in moisture content with depth, with subtle variations in moisture content due to minor changes in lithology, showing a typical behaviour of soils of the London Clay Formation.

The moisture content profile for WS1 (Figure 6) showed no evidence for possible significant moisture deficits. In general, there is a natural gradual decrease in moisture content with depth, with subtle variations in moisture content due to minor changes in lithology.

5.2.4 Particle Size Distribution (PSD) Tests

The results of PSD testing undertaken on two samples of the Kempton Park Gravel Member and one sample of the London Clay Formation encountered are tabulated below.

PSD Test Results Summary

Trial Hole/Depth/Soil Description	Volume Change Potential Range		Passing 63µm sieve Range (%)
	BRE	NHBC	
Kempton Park Gravel Member **WS1/0.80m bgl** (Brown clayey very sandy GRAVEL. (Gravel is fine to coarse and sub-angular to sub-rounded)	No	No	8
Kempton Park Gravel Member **WS2/0.80m bgl** (Brown clayey very sandy GRAVEL. (Gravel is fine to coarse and sub-angular to sub-rounded)	No	No	6
London Clay Formation **WS4/1.50m bgl** (Brown clayey very slightly sandy gravelly silty CLAY (Gravel is fine to coarse and sub-angular to sub-rounded)	**Yes**	**Yes**	48

NB Volume Change Potential refers to BRE Digest 240 (based on Grading test results).
Shrinkability refers to NHBC Standards Chapter 4.2 (based on Grading test results).

Volume Change Potential – BRE 240 states that a soil has a volume change potential when the clay fraction exceeds 15%. Only the silt and clay combined fraction are determined by sieving therefore the volume change potential is estimated from the percentage passing the 63µm sieve.

NHBC Standards Chapter 4.2 states that a soil is shrinkable if the percentage of silt and clay passing the 63µm sieve is greater than 35% and the Plasticity Index is greater than 10%.

5.2.5 Water Sulphate and pH Tests

Water soluble Sulphate and pH tests were undertaken on one sample from the London Clay Formation (WS2/2.50m bgl). The water soluble sulphate concentration was 2440g/l with a pH of 7.6.

5.2.6 BRE Special Digest 1

In accordance with BRE Special Digest 1 'Concrete in Aggressive Ground' (BRE, 2005) one sample of the Kempton Park Gravel Member (WS3/1.00m bgl) and one sample of the London Clay Formation (WS4/5.50m bgl) were scheduled for laboratory analysis to determine parameters for concrete specification.

The results of the chemical analysis undertaken are given within Appendix D and a summary is tabulated below.

Summary of Results of BRE Special Digest Testing

Determinand	Unit	Kempton Park Gravel Member	London Clay Formation
pH	-	8.1	7.7
Ammonium as NH_4	mg/kg	0.13	0.65
Sulphur	%	<0.02	0.77
Chloride (water soluble)	mg/l	3.2	10.4
Magnesium (water soluble)	mg/l	1.2	96
Nitrate (water soluble)	mg/l	<1.5	<1.5
Sulphate (water soluble)	mg/l	20	2490
Sulphate (total)	%	<0.02	2.12

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.

- Topsoil was encountered from ground level in each of the boreholes to a depth of between 0.35 – 0.45m bgl.

  As a result of the inherent variability of Topsoil or Made Ground it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should, therefore, be taken through any Topsoil or 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.

- Soils of the Kempton Park Gravel Member were encountered underlying the Topsoil to a depth of between 0.90 – 1.10m bgl. The soils comprised an orange brown to brown clayey sandy gravel. The sand was fine to coarse grained and the gravel was fine to coarse, sub-angular to sub-rounded flint.

  The granular soils were shown to have **no volume change potential** in accordance with both NHBC Standards Chapter 4.2 and BRE240.

  Given that the granular soils of the Kempton Park Gravel Member were of limited thickness and that roots generally extended into the underlying cohesive soils, they were considered to be an unsuitable bearing stratum for the proposed development and should be bypassed in favour of the underlying London Clay Formation.

- Soils described as the London Clay Formation were encountered underlying the Kempton Park Gravel Member comprising a grey brown silty clay for the remaining depth of WS1 – WS3 at a depth of 5.45m bgl and to a depth of 7.50m bgl in WS4. A grey silty clay with fine selenite crystals from 7.50m bgl for the remaining depth of 10.45m bgl in WS4.

  In-situ testing revealed the cohesive soils of the London Clay Formation were shown to have a medium to high undrained shear strength (SPT "N" blow counts of 8 - 40, 40 – 200kPa).

  Geotechnical testing revealed the cohesive soils of the London Clay Formation to have a **medium to high volume change potential** in accordance with both BRE240 and NHBC Standards Chapter 4.2. Geotechnical analyses indicated these soils to be stiff to very stiff and with a potential moisture deficit resulting from the lithology of the soil (heavily overconsolidated soils with 6% coarse fraction) rather than the water demand of roots from nearby trees in one of the samples tested (WS3/1.50m bgl).

  The moisture content versus depth plots for WS1, WS2, WS3 and WS4 can be seen within Figures 6 - 8 respectively. The moisture content profiles for boreholes WS2, WS3 and WS4 (Figures 7, 8 and 9) showed potential moisture content deficits to a depth of ~1.50 – 2.00m bgl where moisture contents increase and then the profiles show a natural gradual decrease in moisture content with depth, with subtle variations in moisture content due to minor changes in lithology. The moisture content profiles for WS1 (Figures 6) showed no evidence for possible significant moisture deficits. In general, there is a natural gradual decrease in moisture content with depth, with subtle variations in moisture content due to minor changes in lithology.

The soils of the London Clay Formation comprised heavily overconsolidated cohesive soils and were therefore likely to be a suitable stratum for lightly to moderately loaded spread foundations. The settlements induced on loading are likely to be moderate to high.

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.

- Roots were noted to a depth of 2.00m bgl in WS1, 0.40m bgl in WS2, 1.10m bgl in WS3 and 1.50m bgl in WS4. Dead/decayed roots were noted at 2.00m bgl in WS1, 1.50m bgl in WS2, 2.50m bgl in WS3 and between 2.50 – 5.00m bgl in WS4. These dead roots were considered to be relict and therefore unlikely to affect the serviceability of the foundations of the proposed development.

- Groundwater was not encountered in WS1 – WS4 during the intrusive investigation. However, any seepages may have been obscured by the speed of the drilling process. Perched water may be recorded, however, within the shallow granular deposits of the Kempton Park Gravel Member, especially after a prolonged period of rainfall.

6.2 Spread Foundations

At the time of reporting, May 2020, the proposed development was understood to comprise the partial demolition and conversion of the former gas valve distribution building (Sui Generis Use Class) at 4 Bellingham Road, SE6 and the construction of a 3-storey, L-shaped building comprising 5x one bedroom, and 4x two bedroom dwellings, together with associated landscaping works and refuse and cycle storage. A plan view of the proposed development is given 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 between 75 – 150kN/m^2.

Geotechnical testing revealed the cohesive soils of the London Clay Formation to have a **medium to high volume change potential** in accordance with both BRE240 and NHBC Standards Chapter 4.2. Geotechnical analyses indicated these soils to be stiff to very stiff and with a potential moisture deficit resulting from the lithology of the soil (heavily overconsolidated soils with 6% coarse fraction) rather than the water demand of roots from nearby trees in one of the samples tested (WS3/1.50m bgl).

Foundations constructed within the soils of London Clay Formation should be designed therefore in accordance with soils of **high volume change potential** in accordance with BRE Digest 240 and with NHBC Chapter 4.2.

Due to the soils at shallow depth having the potential for volume change, foundations must 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. The base of foundation excavations must extend at least 300mm into non-root penetrated soils. Foundations must also be designed in accordance with NHBC Standards Chapter 4.2 and the proximity of nearby trees or recently removed trees (moisture recovery can take up to 15yrs to complete). Should a tree be removed from the footprint of the proposed structures then a piled foundation scheme should be considered.

Roots were noted to a depth of 2.00m bgl in WS1, 0.40m bgl in WS2, 1.10m bgl in WS3 and 1.50m bgl in WS4. Dead/decayed roots were noted at 2.00m bgl in WS1, 1.50m bgl in WS2, 2.50m bgl in WS3 and between 2.50 – 5.00m bgl in WS4. These dead roots were considered to be relict and therefore unlikely to affect the serviceability of the foundations of the proposed development.

It must be noted that the chance of determining actual depth of fresh root penetration through a narrow diameter borehole is low. The excavation of trial trenches could be considered to potentially more accurately determine the depth of roots.

The moisture content versus depth plots for WS1, WS2, WS3 and WS4 can be seen within Figures 6 - 8 respectively. The moisture content profiles for boreholes WS2, WS3 and WS4 (Figures 7, 8 and 9) showed potential moisture content deficits to a depth of ~1.50 – 2.00m bgl where moisture contents increase and then the profiles show a natural gradual decrease in moisture content with depth, with subtle variations in moisture content due to minor changes in lithology. The moisture content profiles for WS1 (Figures 6) showed no evidence for possible significant moisture deficits. In general, there is a natural gradual decrease in moisture content with depth, with subtle variations in moisture content due to minor changes in lithology.

Groundwater was not encountered in WS1 – WS4 during the intrusive investigation. However, any seepages may have been obscured by the speed of the drilling process. Perched water may be recorded, however, within the shallow granular deposits of the Kempton Park Gravel Member, especially after a prolonged period of rainfall.

Consequently, in order to by-pass soils with a potential moisture deficit and the live roots noted in the boreholes, minimum foundation depths of 2.00 – 2.50m bgl are likely to be required.

The following bearing capacities could be adopted for 5.0m long by 0.75m and 1.00m wide strip footings and 1.50m square pads at depths of 2.00m and 2.50m bgl in the soils of the London Clay Formation. The bearing capacities and settlements were determined based on data available from WS4. The bearing capacities are tabulated below and overpage.

Limit State: Bearing Capacities Calculated (Based on WS4)

Depth (m BGL)	Foundation System	Limit Bearing Capacity (kN/m^2)
2.00m	5.00m by 0.75m Strip	125.69
	5.00m by 1.00m Strip	126.78
	1.50m by 1.50m Pad	145.49
2.50m	5.00m by 0.75m Strip	160.50
	5.00m by 1.00m Strip	161.89
	1.50m by 1.50m Pad	175.86

Serviceability State: Settlement Parameters Calculated (Based on WS4)			
Depth (m BGL)	**Foundation System**	**Load (kN/m²)**	**Settlement (mm)**
2.00m	5.00m by 0.75m Strip	125	<15
	5.00m by 1.00m Strip	125	<18
	1.50m by 1.50m Pad	125	<18
2.50m	5.00m by 0.75m Strip	150	<15
	5.00m by 1.00m Strip	150	<20
	1.50m by 1.50m Pad	170	<20

The settlements include the elastic (short term) and the long-term part, using the oedometric modulus, based on Geostru 'dynamic probe' software. It should be noted, that the calculation of the total settlement, based on the oedometric modulus was considered to be a conservative approach and settlements are likely to be less. Further analysis using elastic short term and long-term Young modulus, based on literature can be carried out for less conservative results.

Note should be made that differential settlement may also occur between strip and isolated pad foundations.

It must be mentioned that it was assumed that excavations will be kept dry and either concreted or blinded as soon after excavation as possible. If water were allowed to accumulate on the formation 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.

Based upon the groundwater readings undertaken to date, it was considered unlikely that significant amounts of groundwater would be encountered during the foundation excavation. Perched water is likely to be encountered within the granular soils of the Made Ground after periods of prolonged rainfall.

Given the potential presence of cohesive soils at shallow depth, special foundation precautions may be required to prevent possible future shrinkage/swelling within clay strata affecting the integrity of the outside faces of ground beams. A void, void former or compressible layer must be provided to accommodate potential movement. Minimum void dimensions are given in Tables 9 and 10 of NHBC Chapter 4.2, Building near trees.

General Recommendations for Spread Foundations:

- 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.

- 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.

- Any groundwater or surface water ingress must be prevented from entering foundation trenches. 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 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 and this could result in increased settlements.

- 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.

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

- Given the presence of cohesive natural soils with a high volume change potential at shallow depth, 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 and the developments proximity to former, present and proposed trees.

6.3 Piled Foundations

Given the increased costs of excavating foundations to depth of 2.00 - 2.50m bgl, the amount of waste produced, the amount of concrete required and impracticality of forming traditional strip footings at this depth a piled foundation may prove to be the more economical foundation solution with piles taken through the Topsoil, Kempton Park Gravel Member and into the underlying London Clay Formation.

The construction and design of a piled foundation is a specialist job, and the advice of a reputable contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the foundation design, as the actual pile working load will depend on the particular type of pile and method of installation adopted.

The foundation would comprise a piled foundation with reinforced ground beams. For the cumulative pile capacity calculations, shaft friction over the desiccated levels should be ignored and piles should not be terminated within desiccated soils where moisture recovery following tree removal could occur.

Indicative limit loads and settlements for a bored pile have been given within the table below have been based on WS4. An allowance for negative skin friction to occur within the top 3.0m of the soil has been included within the calculations where it could pass through any Made Ground, root penetrated soils and soils showing a possible moisture deficit. An adhesion factor of 0.45m has been applied.

The bearing values may be limited by the maximum permissible stress allowable on a concrete pile. To achieve the full bearing value a pile should penetrate the bearing stratum by at least five times the pile diameter.

Bored Pile – Limit Loads and Settlement Parameters (Based on WS4)						
Depth (m bgl)	Diameter (m)	Limit States (kN)			Settlement (Poulos Davis (1968))	
		Tip	Lateral	Total	Load (kN)	Total (Elastic + Rigid) (cm)
6.00	0.30	23.53	83.35	96.68	95	0.18
	0.45	53.85	125.02	155.02	150	0.20
	0.60	95.74	166.70	220.02	200	0.20
8.00	0.30	30.95	137.39	149.40	145	0.14
	0.45	69.63	198.89	236.71	225	0.24
	0.60	123.79	265.19	332.43	300	0.24

The bearing values given in the table above are applicable to single piles. Where piles are to be constructed in groups the bearing value of each individual pile should be reduced by a factor of approximately 0.8 and a calculation made to check the factor of safety against block failure.

The piles will need to be designed in accordance with the volume change potential of the soils encountered, depth of desiccation, root penetration, etc. Temporary casing may be required where the upper portion of the pile passes through the Made Ground, particularly where perched water is encountered, to prevent necking of the concrete.

6.4 Excavations and Stability

Shallow excavations in the Topsoil, Kempton Park Gravel Member and London Clay Formation are likely to be marginally stable at best. Long, deep excavations, through these strata are likely to become unstable, especially where groundwater strikes are noted.

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.

6.5 Sub-Surface Concrete

For the classification given below, the “mobile” and “brownfield” case was adopted given the geology encountered and the history of the site.

Topsoil

The water-soluble sulphates in the Topsoil tested (from the chemical laboratory testing) were found to be <10 - 11mg/l with a pH of 7.7 – 7.8.

Natural Ground – Kempton Park Gravel Member

The water-soluble sulphates were found to be 20mg/l (from the chemical laboratory tests). The total potential sulphate concentration (3x Sulphur) was found to be <0.06%. The pH was 8.1.

Natural Ground – London Clay Formation

The water-soluble sulphates were found to range between 2440 and 2490mg/kg (from the chemical laboratory tests). The total potential sulphate concentration (3x Sulphur) was found to be 2.31%. The pH was 7.6 – 7.7.

Therefore, sulphate concentrations measured in 2:1 water/soil extracts taken from the natural ground and total potential sulphate concentrations, fell into Classes **DS-1, DS-3 and DS-4** 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, AC-3 and AC-4. A DS4 class**

with an ACEC of AC-4 will be required for design.

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.

6.6 Road and Hardstanding

Equilibrium CBR Assessment

Roads and hardstanding constructed on the granular soils of the Kempton Park Gravel Member should be designed based on a CBR value of 40%. This is based on reference to Table C1 of TRL1132 and average construction conditions. Based on wet conditions a CBR of 20% should be adopted, with dry conditions a CBR of 60% being applicable.

Roads and hardstanding constructed on the cohesive soils London Clay Formation encountered at shallow depth in BH3 should be designed based on a CBR value of 4.0%. This is based on reference to Table C1 of TRL1132 and average construction conditions. Based on wet conditions a CBR of 2.5% should be adopted, with dry conditions a CBR of 4.5% being applicable.

Frost Susceptibility

Given that the granular soils of the Kempton Park Gravel Member encountered beneath the site were shown to have a fines content of <10% **these deposits are likely to be non-frost susceptible.**

The cohesive soils of the London Clay Formation encountered beneath the site are cohesive soils with a modified plasticity index ranging between 34.8 – 41.6%. Therefore, these deposits are **likely to be frost susceptible.**

All formation levels for roads and hardstanding should be proof rolled to highlight any soft areas which should then be dug out and replaced with selected granular material compacted in thin layers to a suitable specification.

6.7 Surface Water Disposal

Infiltration tests were beyond the scope of the investigation.

Soakaways constructed within the the limited thickness of the granular soils of the Kempton Park Gravel Member or the cohesive soils of the London Clay Formation are unlikely to perform to a satisfactory standard.

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) and the requirements of the London Plan Policy 5.13 Sustainable Drainage should be applied to reduce the risk of flooding from surface water ponding and collection associated with the existing basement.

In accordance with the London Plan Policy 5.13 Sustainable Drainage the surface water run-off should be managed as close to its source as possible in line with the following drainage hierarchy:

- store rainwater for later use;
- use infiltration techniques, such as porous surfaces in non-clay areas;
- attenuate rainwater in ponds or open water features for gradual release;
- attenuate rainwater by storing in tanks or sealed water features for gradual release;
- discharge rainwater direct to a watercourse;
- discharge rainwater to a surface water sewer/drain;
- discharge rainwater to the combined sewer.

Drainage should be designed and implemented in ways that deliver other policy objectives of this Plan, including water use efficiency and quality, biodiversity, amenity and recreation.

7.0 PHASE 2 CONTAMINATION RISK ASSESSMENT

7.1 Results of the Phase 1 Risk Assessment (Conceptual Site Model)

The tabulated Conceptual Site Model based upon the review of the previous Desk Study Reports produced for the site and reviewed in section 2.7 of this report is reproduced in this section and can be seen below.

Tabulated Conceptual Site Model – Plausible Pollutant Linkages Only		
Potential on-site Sources	**Potential Absorption Pathways**	**Potential Receptors**
Contaminants introduced by previous site usage and construction activities. • Heavy metals & semi-metals (Lead etc); • Combustion products (PAH's, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene); • Organic compounds (fuel oils, ash, tar); • Volatile and Semi-volatile Organic Compounds (VOC/SVOC's); • Asbestos (building material, pipe lagging).	Direct ingestion of soil and soil derived dust; Dermal contact of soil and soil derived dust; Ingestion of soil with elevated concentration of determinants; Dermal contact with impacted soils; Inhalation of impacted dust (indoors and outdoors) with elevated concentration of determinants. Inhalation of volatiles (indoors and outdoors) with elevated concentration of determinants. Inhalation of volatile vapours (indoors and outdoors) with elevated concentration of determinants. Via anthropogenic pathways; Via underlying geology; (Made Ground and Kempton Park Gravel Member) Via surface water.	Construction workers Service and Maintenance Operatives. Site Occupiers. Secondary A Aquifer (Kempton Park Gravel Member) Ravensbourne River ~150m to the west Building Materials and Services
Aggressive ground conditions with Made Ground and natural ground; • Sulphates • Acidic pH • PAHs	Direct contact with aggressive ground conditions	

No Made Ground was encountered in the boreholes drilled. Topsoil was encountered from ground level in each of the boreholes to a depth of between 0.35 – 0.45m bgl. The Topsoil generally comprised a dark brown slightly gravelly sandy clay. The sand was fine to coarse grained and the gravel was fine to coarse, sub-angular to sub-rounded flint.

Consequently, there was no need to modify the tabulated Conceptual Site Model developed in section 2.7 of this report.

7.2 Sampling Locations

The methodology for sampling locations can be seen tabulated overpage. A trial hole location plan is given within Figure 5 and the proposed development plan is shown within Figure 4.

Methodology for Sampling Locations and Chemical Laboratory Testing		
Trial Hole	**Sampling Strategy**	**Anticipated Proposed End-use**
WS1	Random Sampling Locations	Under Proposed Structure
WS2		Communal Garden Area
WS3		Under Proposed Structure
WS4		Private Garden Area

The area investigated as part of the proposed residential development totals 0.07ha (700m^2) and with four sampling locations, given an unknown hotspot shape, the sampling density means that a hotspot with an area of approximately 262.5m^2 and a radius of approximately 9.1m 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 Perched Water/Surface Water Run-off
>0.5m below ground level	Protection of deep rooted plants Perched Water/Surface Water Run-off

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

7.3 Chemical Laboratory Testing – Human Health Risk Assessment

A programme of chemical laboratory testing, scheduled by Ground and Water Limited and carried out by DETS Limited, was undertaken on four samples samples of Topsoil (WS1/0.30m, WS2/0.30m, WS3/0.30m and WS4/0.30m bgl).

The samples tested and the reasons for testing can be seen tabulated below.

Methodology for Sampling Locations and Chemical Laboratory Testing			
Trial Hole	**Depth (m bgl)**	**Sampling Strategy**	**Anticipated Proposed End-use**
WS1	0.30m	Representative samples of Topsoil	Under Proposed Structure
WS2	0.30m		Communal Garden Area
WS3	0.30m		Under Proposed Structure
WS4	0.30m		Private Garden Area

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

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, Zinc: (WS1/0.30m, WS2/0.30m and WS4/0.30m bgl);

- Asbestos Screen: (WS1/0.30m, WS2/0.30m and WS4/0.30m 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: (WS1/0.30m, WS2/0.30m and WS4/0.30m bgl);
- Fuel Oils – Speciated TPH including full aliphatic/aromatic split: (WS2/0.30m and WS4/0.30m bgl);
- BTEX compounds (Benzene, Toluene, Ethylbenzene, Xylene) and MTBE – used as marker compounds for Volatile Organic Compounds (VOCs): (WS2/0.30m and WS4/0.30m bgl);
- Full WAC Solid Suite Test with single batch leachate: Ground and Water Limited (WS3/0.30m bgl)

The chemical laboratory results are presented in Appendix E.

7.3.1 Soil Assessment Criteria

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

7.3.2 Determination of Representative Contamination Concentrations

At the time of reporting, May 2020, the proposed development was understood to comprise the partial demolition and conversion of the former gas valve distribution building (Sui Generis Use Class) at 4 Bellingham Road, SE6 and the construction of a 3-storey, L-shaped building comprising 5x one bedroom, and 4x two bedroom dwellings, together with associated landscaping works and refuse and cycle storage. A plan view of the proposed development is given in Figure 4.

Therefore, the results of the chemical laboratory testing were compared to the LQM/CIEH Suitable 4 Use Levels (S4UL) and General Assessment Criteria (GAC) for a ***'Residential with homegrown produce'*** land-use scenario, as this was considered the most appropriate land-use scenario. 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 each soil sample was used to derive the appropriate SGV/GAC. The average SOM of the samples analysed was 2.9% (SOM ranged between 1.3 – 4.2%).

Double plot analysis indicated that the majority PAH's encountered were from a combustion source, within the urban background source and may be associated fragments of coal. None of the PAH's appeared to be from a Coal Tar source and therefore the benzo(a)pyrene S4UL was considered suitable for use. The PAH double ratio analysis can be seen in Appendix F.

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/, CSL4 LLTC or GAC were exceeded for relevant land-use scenario**
	“Residential with Homegrown Produce” Land-Use Scenario
Arsenic	None
Boron	None
Cadmium	None
Chromium (III)	None
Hexavalent Chromium (VI)	None
Lead	**WS1/0.30m (333 mg/kg)** **WS4/0.30m (433 mg/kg);**
Mercury (Elemnetal)	None
Nickel	None
Selenium	None
Vanadium	None
Copper	None
Zinc	None
Boron	None
Cyanide (Total)	None
Phenol	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
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	**WS4/0.30m (4.97 mg/kg)**
Benzo(k)fluoranthene	None
Indeno(1,2,3-cd)pyrene	None
Benzo(ghi)perylene	None
Benzo(a)pyrene	**WS4/0.30m (3.24 mg/kg)**
Dibenz(a,h)anthracene	**WS4/0.30m (0.35 mg/kg)**
Benzene	None
Toluene	None
Ethylbenzene	None
Xylene (o, m & p)	None
MTBE	None
Asbestos Screen	**WS4/0.30m (chrysotile – small bundle 0.001%);**

Chemical laboratory testing revealed elevated levels of lead in excess of the C4SL LLTC of 210mg/kg for a ***'Residential with homegrown produce'*** land-use scenario within two samples of Topsoil (WS1/0.30m (333 mg/kg) and WS4/0.30m (433 mg/kg)).

Elevated levels of PAHs were detected in one of the samples of Topsoil tested (WS4/0.30m bgl) above the respective guideline values for a ***'Residential with homegrown produce'*** land use scenario. Chemical laboratory testing revealed elevated levels of: benzo(b)fluoranthene (4.97 mg/kg) above the guideline value of 3.30mg/kg (2.5% SOM); benzo(a)pyrene (3.24mg/kg), above the guideline value of 2.70mg/kg (2.5% SOM); and dibenz a,h)anthracene (0.35 mg/kg), above the guideline value of 0.28mg/kg (2.5% SOM).

Chemical laboratory testing of the Topsoil 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.

Asbestos was identified in one of the samples tested as shown in the table below.

Type and Quantity of Asbestos detected in Trial Holes			
Trial Hole/ Sample	**Asbestos Matrix**	**Asbestos Type**	**Asbestos Quantification (%)**
WS4/0.30m	Small bundle	Chrysotile	0.001%

A quantification risk assessment was carried out for the highest concentration of chrysotile recorded (0.001%), in accordance with the guidance within CIRIA 733. The background, considerations taken and the calculations can be seen in Appendix G. A cumulative value of fibres/ml.year of 0.00091 for mesothelioma and 0.00065 for lung cancer were calculated.

Regarding the risk for mesothelioma, based on Table 14.1, the risk fell within the insignificant category.

Regarding the risk for lung cancer, based on Table 14.3, the risk was also regarded as insignificant.

An **Asbestos Management Strategy** should be put in place so that any potentially asbestos containing materials are identified and removed from site in a suitable manner to prevent cross-contamination.

An **asbestos survey** of the buildings currently on site is also recommended prior to any demolition and conversion.

7.4 Groundwater Risk Assessment

An examination of the DEFRA website revealed the site was located on a **Secondary A Aquifer** relating to the superficial deposits of the Kempton Park Gravel Member overlying **Unproductive** Strata relating to the bedrock deposits of the London Clay Formation.

Examination of the DEFRA records showed that the site within an Outer Zone (Zone II) Groundwater Source Protection Zone (SPZ) as classified in the Policy and Practice for the Protection of Groundwater. An Outer Zone (Zone II) Groundwater source Protection Zone is defined by a 400 day travel time from a point below the water table. The previous methodology gave an option to define SPZ2 as the minimum recharge area required to support 25 per cent of the protected yield. This option is no longer available in defining new SPZs and instead this zone has a minimum radius of 250 or 500 metres around the source, depending on the size of the abstraction.

The nearest surface water feature was the northerly flowing Ravensbourne River located ~150m to the west of the site.

From analysis of hydrogeological and topographical maps groundwater was anticipated to be encountered at moderate depth (2 - 4m below existing ground level (bgl)) and it was considered that the groundwater was flowing in a northerly/north-westerly direction in alignment with local topography and the flow of local rivers.

Examination of the Environment Agency records showed that the site fell within a Flood Zone 1 (an area with a low probability of river or sea flooding).

The potential receptors are presented below and comprise:

- Secondary A Aquifer underlying the site;
- Northerly flowing Ravensbourne River ~150m to the west of the site.

Given the hydrogeological setting of the site, the groundwater directly underlying the site and the Ravensbourne River ~150m to the west **were** considered to be sensitive receptors. **However, given the likely limited mobility of determinants noted during the investigation no risk is posed to groundwater from the Made Ground encountered on-site.**

7.5 Re-Evaluated Phase 2 Conceptual Site Model

Following completion of the Phase 2 Site Investigation, the CSM within Section 7.1 of this report was re-evaluated and can be seen overpage.

The plausible pollutant linkages remaining after risk assessment are shown and where risk assessment has indicated no unacceptable risk to sensitive receptors, the pollutant linkages have been crossed out.

Tabulated Conceptual Site Model – Plausible Pollutant Linkages Only

Potential on-site Sources	Potential Absorption Pathways	Potential Receptors
Contaminants introduced by previous site usage and construction/demolition activities. - Heavy metals & semi-metals (Lead); - Combustion products (PAH's, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene); - Organic compounds (fuel oils, ash, tar); - Volatile and Semi-volatile Organic Compounds (VOC/SVOC's); - Asbestos (building material, pipe lagging). Elevated concentration of metals and PAHs were deemed to pose a risk to end-users. The presence of asbestos in soil poses a risk to construction works, service and maintenance workers. An Asbestos Management Strategy should be put in place so that any potentially asbestos containing materials are identified and removed from site in a suitable manner to prevent cross-contamination. An asbestos survey of the buildings should be undertaken prior to any demolition/conversion.	Direct ingestion of soil and soil derived dust; Dermal contact of soil and soil derived dust; Ingestion of soil with elevated concentration of determinants; Dermal contact with impacted soils; Inhalation of impacted dust (indoors and outdoors) with elevated concentration of determinants. Inhalation of volatiles (indoors and outdoors) with elevated concentration of determinants. Inhalation of volatile vapours (indoors and outdoors) with elevated concentration of determinants. Via anthropogenic pathways; Via underlying geology; (Made Ground and Kempton Park Gravel Member) Via surface water.	Construction workers Service and Maintenance Operatives. Site Occupiers. Secondary A Aquifer (Kempton Park Gravel Member) Ravensbourne River ~150m to the west Building Materials and Services
Aggressive ground conditions with Made Ground and natural ground; - Sulphates - Acidic pH - PAHs Fell into Classes DS-4 and AC-4. Elevated concentration of PAHs	Direct contact with aggressive ground conditions	

8.0 DEVELOPMENT OF A REMEDIATION STRATEGY

8.1 Option Appraisal

This section of the report will discuss the options available following completion of the Site Investigation and Risk Assessment with respect to soil and groundwater contamination.

Risk Assessment to date has revealed the following contaminants of concern:

We have assessed that the contamination noted does not pose a risk to groundwater and therefore remediation is solely necessary with respect to human health.

Risk Assessment has indicated that the determinants noted pose no unacceptable risk to groundwater and therefore the Made Ground can remain under areas of permanent hardstanding. However given the risks posed to end-users remediation is necessary for areas of soft landscaping.

Complete removal of Made Ground from the site has not been considered given the cost implications and that a simple capping system could be adopted. This would prevent needless lorry movements and prevent waste unnecessarily being sent to landfills with only a finite capacity.

All works associated with construction/remediation will need to take into account the presence of elevated metals, PAHs and asbestos fibres within the Made Ground at the concentrations noted within the report. The Method Statements must ensure that not only site operative/workers are protected from any potential release of asbestos fibres but also that local residents are not affected.

All future maintenance workers/service operatives, working within areas of hardstanding (including beneath the footprint of building), will need to take into account the presence of Made Ground potentially containing fibrous asbestos and elevated metals and PAHs within their work Method Statements.

In relation to end-users the presence of permanent hardstanding (i.e. a building, car parking area or roads) will sever any plausible pollutant linkages present. In areas of soft landscaping then a risk may exist and remediation will be required.

8.2 Remediation Strategy

Based on the results of the contamination testing to date the following remediation options are available.

Complete removal of Topsoil from the site has not been considered given the cost implications and that a simple capping system could be adopted. This would prevent needless lorry movements and prevent waste unnecessarily being sent to landfills with only a finite capacity.

All works associated with construction/remediation will need to take into account the presence of asbestos cement and fibres within the Topsoil at the concentrations noted within the report. The Method Statements must ensure that not only site operative/workers are protected from any potential release of asbestos fibres but also that local residents are not affected.

All future maintenance workers/service operatives, working within areas of hardstanding (including beneath the footprint of buildings), will need to take into account the presence of Topsoil potentially containing cement bound and fibrous asbestos within their work Method Statements.

In relation to end-users the presence of permanent hardstanding (i.e. a building, car parking area or roads) will sever any plausible pollutant linkages present. In areas of soft landscaping a risk may exist and remediation will be required.

The levels of metals and PAH's within the Topsoil were considered likely to pose a risk to end-users. No risks to groundwater were considered likely to be present. Given the limited thickness of Topsoil encountered (0.35 – 0.45m in thickness, the Topsoil should be removed from the soft landscaped areas to expose the underlying soils of the Kempton Park Gravel Member. The voids created should then be independently inspected, sample and verified and backfilled with certified clean Topsoil.

Any imported soils would need to be verified as suitable for use, from a human health/contamination perspective, prior to importation.

8.3 Remediation Method Statement

At the time of reporting, May 2020, the proposed development was understood to comprise the partial demolition and conversion of the former gas valve distribution building (Sui Generis Use Class) at 4 Bellingham Road, SE6 and the construction of a 3-storey, L-shaped building comprising 5x one bedroom, and 4x two bedroom dwellings, together with associated landscaping works and refuse and cycle storage. A plan view of the proposed development is given in Figure 4.

The following remedial methodology should be undertaken based on the elevated levels of determinants noted:

- It is recommended that Topsoil (0.35 – 0.45m in thickness) is removed from the private garden areas and the private amenity areas to expose the natural soils of the Kempton Park Gravel Member with samples of the formation taken to verify it is suitable for use.

- Should validation sampling identify further contamination then remedial excavation should continue until validation sampling reveals all contaminants to have been removed. Repeat points above till sampling proves contaminants have been removed.

- Where a satisfactory capping is present or has been formed then the voids created may be backfilled with certified clean Subsoil/Topsoil.

- It is recommended that all remedial works are supervised by a Ground and Water Limited Engineer. This will allow for supervision and segregation of the waste produced whilst remedial works are ongoing. This may reduce overall disposal costs.

- Following the reduced dig the voids created must be visually inspected by an independent and suitably qualified person to verify the removal of the Topsoil. Validation samples from the sides and, where applicable, the base of the excavations should be taken and analysed for the presence of asbestos and/or elevated levels of contaminants. Validation of any anti-capillarity barriers installed at the base of the voids will also be undertaken.

- The voids created should be measured and photographed.

- The voids should be backfilled with certified clean Subsoil/Topsoil.

- Stockpiled contaminated Topsoil, destined for removal from site, must be placed on an impermeable liner with raised edge and must be covered at all times.

- Materials to be removed off-site must be classified by carrying out Waste Acceptance Produce (WAP) testing. A registered contractor must undertake the removal of waste. Full liaison must be made with the Environment Agency prior to the removal of any material and must be conducted to meet their full approval.

- Additional verification of any imported soil will also need to occur onsite, once received, to validate the accompanying lab certificate. Any samples taken from a stockpile of imported soil or placed soil should be at a rate of one sample per 50m^3 of material and be tested for semi-metals, heavy metals, speciated PAH's and speciated TPH.

Validation;

- Following completion of all the remediation and validation works, outlined above, a report should be submitted to the local authority for approval.

Full liaison must be made with the statutory authority, prior to the implementation of this method statement and/or the removal of any material from site. All works must be undertaken to meet their full approval.

8.4 Validation Strategy

Any remedial works undertaken on the site will need to be inspected and independently validated by a Ground and Water Limited Engineer. All remedial excavations will need to be inspected, documented and photographed.

8.5 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 Desk Study and/or 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.

8.6 Waste Disposal

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 classified the waste can be removed to the appropriately licensed facilities, with some waste requiring pre-treatments prior to disposal.

Asbestos was detected in one of the three samples of the Made Ground tested. No asbestos was found in the remaining two samples analysed.

Asbestos is the name given to a group of naturally occurring minerals which consist of flexible fibres. The most common types of asbestos are Chrysotile (white), Amosite (brown) and Crocidolite (blue). The properties of asbestos, in particular its strength, high thermal and electrical insulation, chemical resistance and fire resistance made it a very useful building material. However, breathing in asbestos fibres can cause diseases of the respiratory system. Whilst its use has now been banned, there are still many buildings which have asbestos containing materials which were installed before the ban came into effect.

Asbestos is both carcinogenic and toxic. The threshold limit for carcinogenic materials (0.1%) is lower than the threshold for toxic materials (3%). In practice this means that any material containing more than 0.1% asbestos is classed as hazardous waste.

Chrysotile asbestos (0.001%) was identified in one of the three samples of the Topsoil tested. This was below the hazardous waste threshold; therefore, the levels of asbestos noted were **NON-HAZARDOUS.**

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 three samples of Topsoil tested were **NON-HAZARDOUS**. The results of the assessment are given within Appendix G.

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 WM3, 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, 1No. Full WAC Solid Suite Test with single batch leachate was undertaken on one sample of Topsoil (WS3/0.30m bgl) to determine which landfill category the waste conformed to. The results of the WAC tests can be seen summarised overpage and the full results in Appendix D.

Summary of WAC Tests	
Trial Hole	**Classification**
WS3/0.30m	INERT Waste Landfill

8.7 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. The compounds that are to be tested for are those given in the LQM CIEH Generic Assessment Criteria, which can be viewed in Appendix E of this report.

8.8 Duty of Care

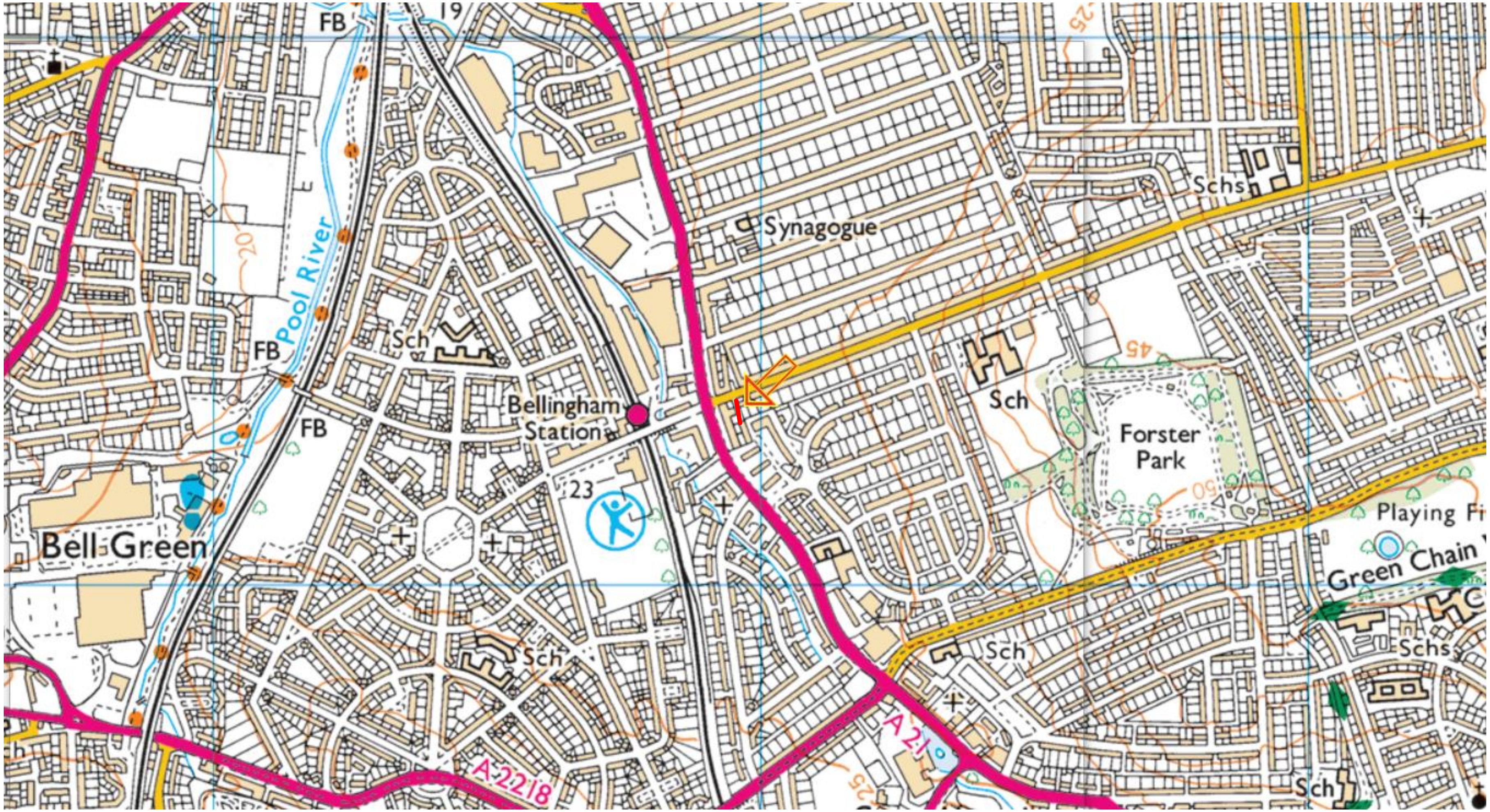
Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

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.

The presence of Asbestos fibres within the Made Ground will need to be take into account when producing Method Statement for construction and remedial works. Dampening down of excavation is likely to be required along with PP3 marks, gloves and overalls for all site operatives. Perimeter dust monitoring may be required.

N



APPROXIMATE SITE BOUNDARY

NOT TO SCALE

Project:

4 Bellingham Road, Catford, London SE6 2PT

Client:

Smart Environmental Freeholds Limited

Date:

May 2020

Site Location Plan

Ref:

GWPR3599

Figure 1

ground&water

🟥 APPROXIMATE SITE BOUNDARY

NOT TO SCALE

Project: 4 Bellingham Road, Catford, London SE6 2PT

Client: Smart Environmental Freeholds Limited

Date: May 2020

Site Development Area

Ref: GWPR3599

Figure 2

ground&water

🟥 APPROXIMATE SITE BOUNDARY

NOT TO SCALE

Project:

4 Bellingham Road, Catford, London SE6 2PT

Client:

Smart Environmental Freeholds Limited

Date:

May 2020

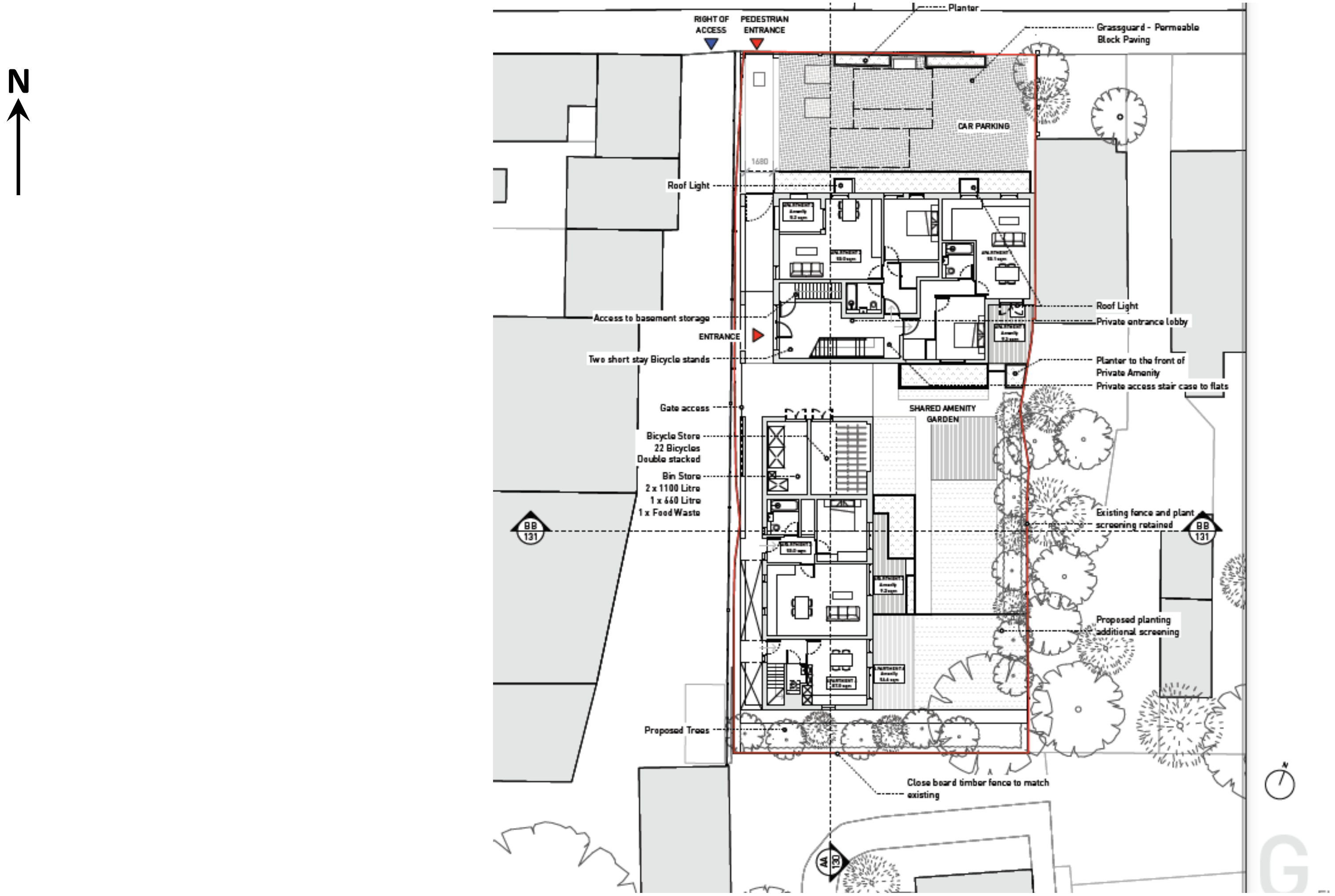
Aerial View of the Site

Ref:

GWPR3599

Figure 3

ground&water

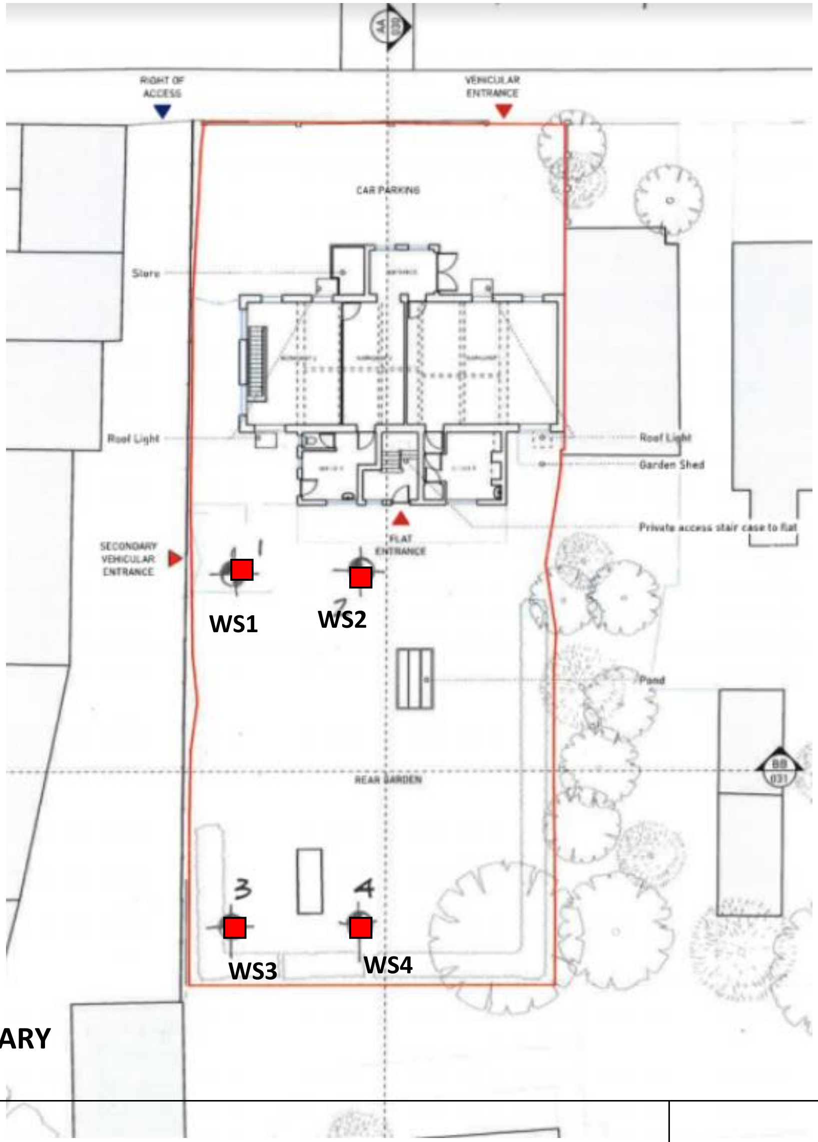


APPROXIMATE SITE BOUNDARY

NOT TO SCALE

Project: **4 Bellingham Road, Catford, London SE6 2PT**		**Figure 4** ground&water
Client: **Smart Environmental Freeholds Limited**	**Date:** **May 2020**	
Proposed Development Plan	**Ref:** **GWPR3599**	

N



APPROXIMATE SITE BOUNDARY

NOT TO SCALE

Project:

4 Bellingham Road, Catford, London SE6 2PT

Client:

Smart Environmental Freeholds Limited

Date:

May 2020

Trial Hole Location Plan

Ref:

GWPR3599

Figure 5

ground&water

Figure 6: Change in Moisture Content With Depth Within WS1

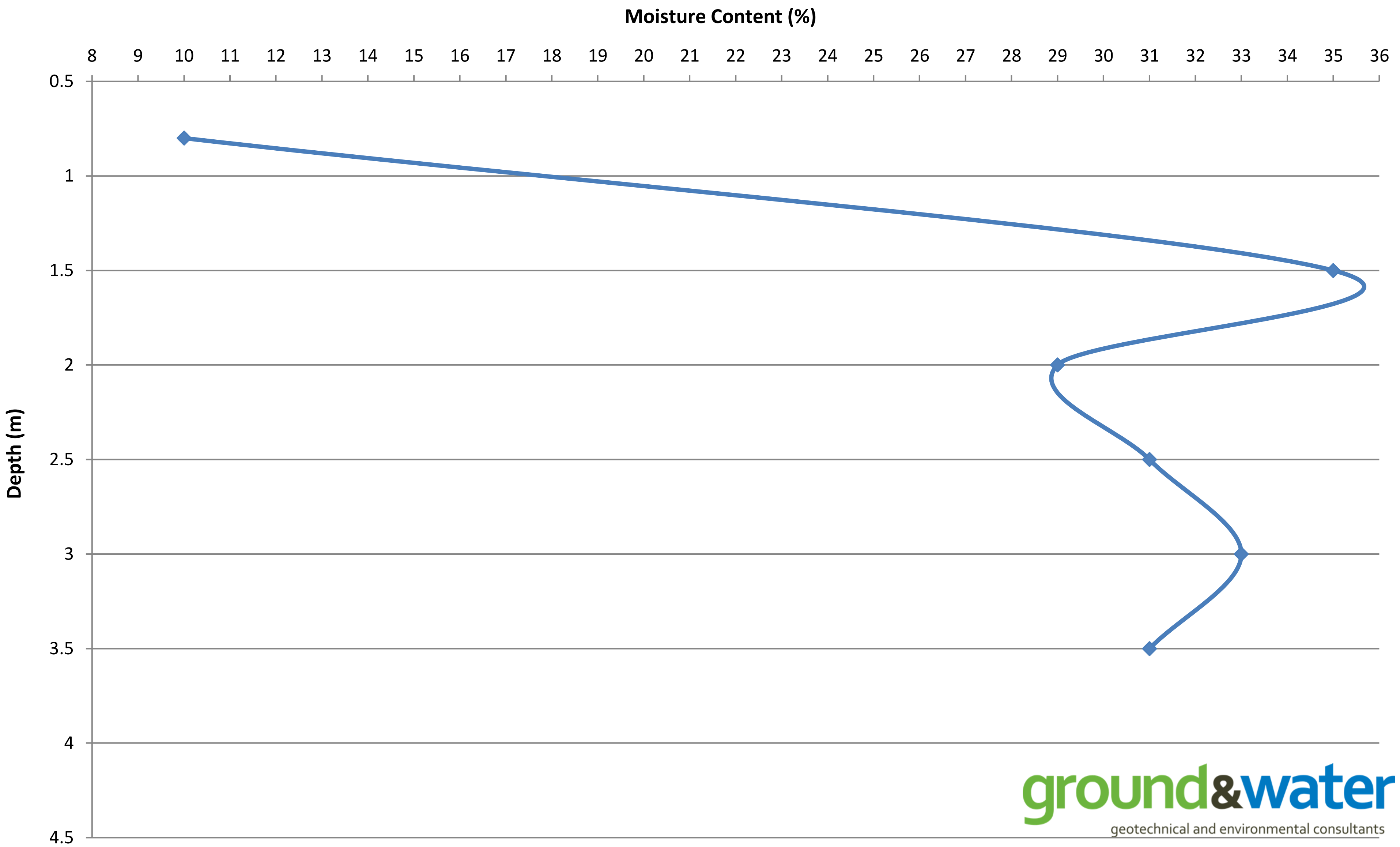


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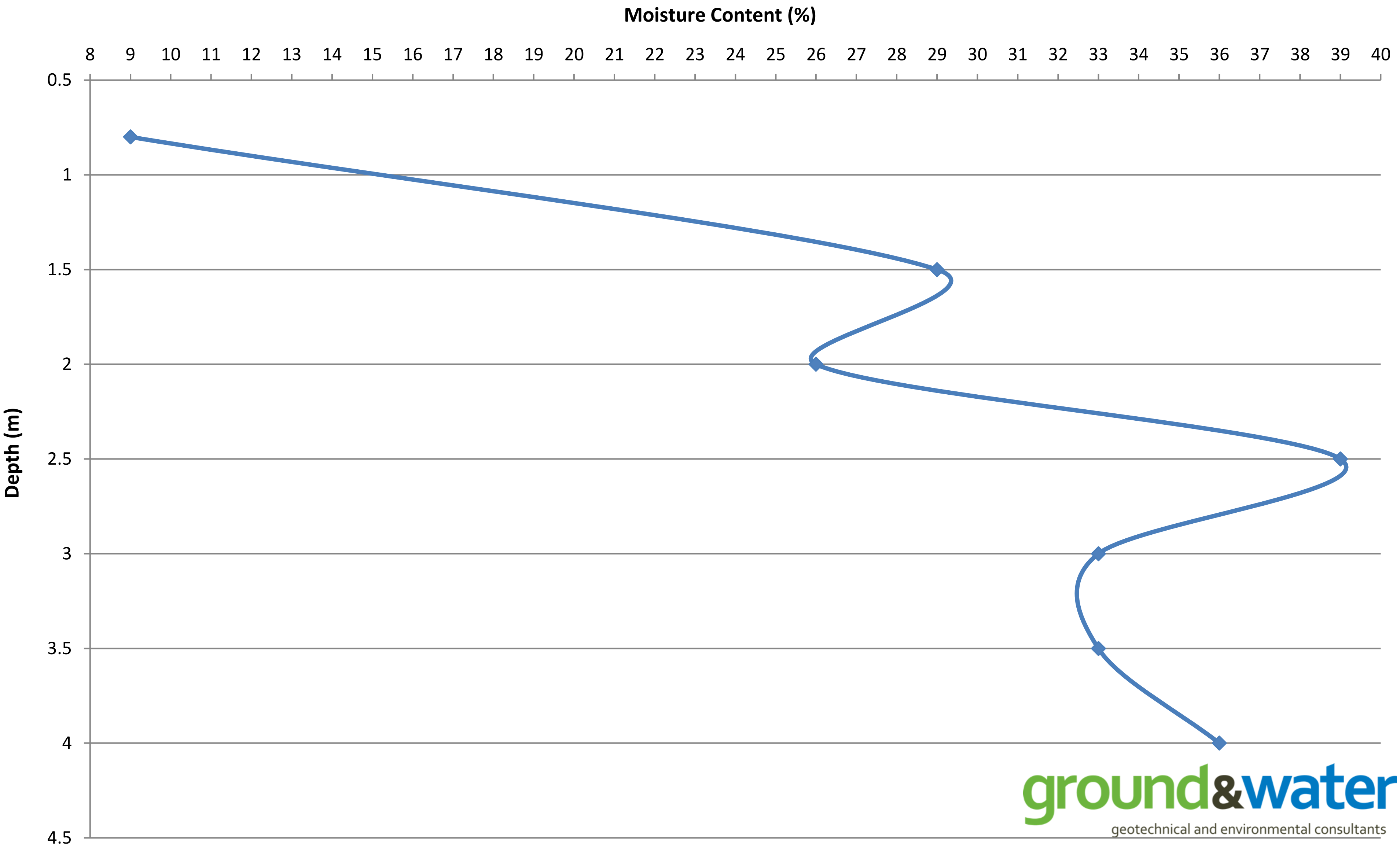
Figure 7: Change in Moisture Content With Depth Within WS2



ground&water

geotechnical and environmental consultants

Figure 8: Change in Moisture Content With Depth Within WS3

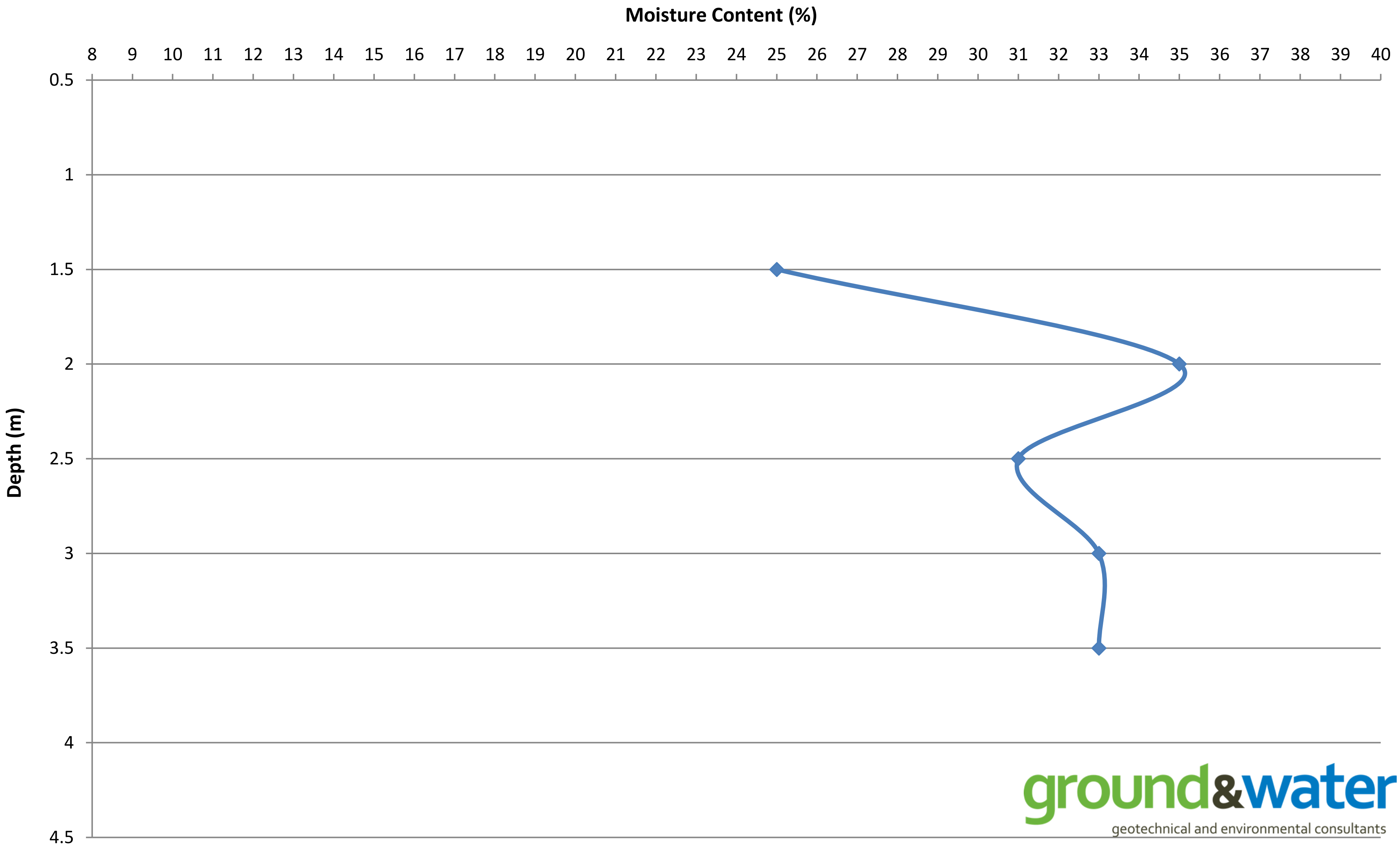


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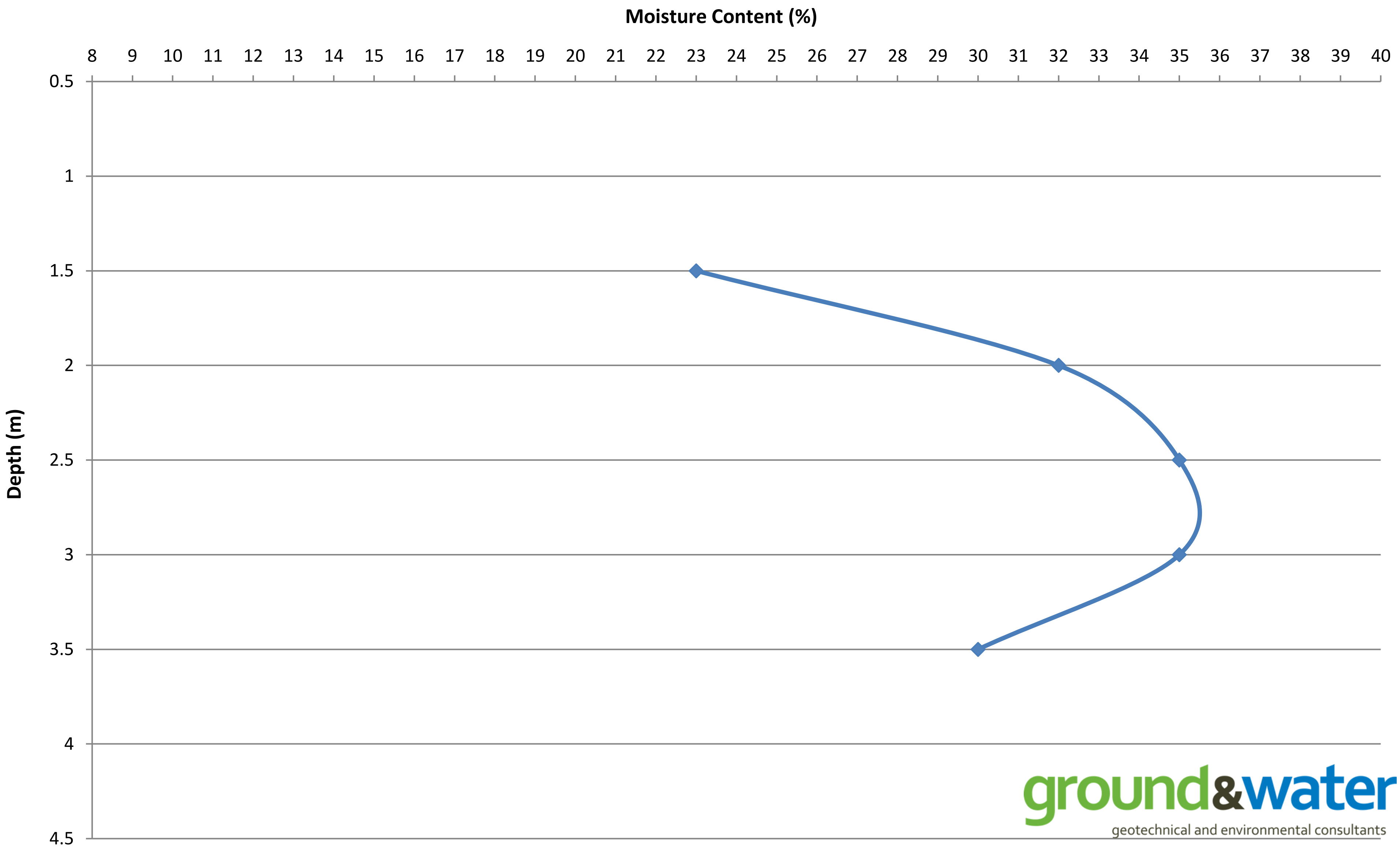
Figure 9: Change in Moisture Content With Depth Within WS4



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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 4 Bellingham Road, Catford, London SE6 2PT.

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.

Ownership of copyright of all printed material including reports, laboratory test results, trial pit and borehole log sheets, including drillers log sheets, remain with Ground and Water Limited. Licence is for the sole use of the client and may not be assigned, transferred or given to a third party.

Only our client may rely on this report and should this report or any information contained in it be provided to any third party we accept no responsibility to the third party for the contents of this report save to the extent expressly outlined by us in writing in a reliance letter addressed from us to the third party.

Recipients are not permitted to publish this report outside of their organisation without our express written consent.

APPENDIX B

Fieldwork Logs

Percussion Drilling Log

Project Name: 4 Bellingham Road	Client: Smart Environment Freeholds Limited	Date: 05/03/2020
Location: Catford, London SE6 2PT	Contractor:	
Project No. : GWPR3599	Crew Name:	Drilling Equipment:

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS1	WLS		RF	1:50	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
▨		0.30 0.50	D D		0.35		▨	TOPSOIL: Dark brown slightly gravelly sandy clay. The sand was fine to coarse grained and the gravel was fine to coarse, sub-angular to sub-rounded flint.
▨		0.80	D		0.90		▨	KEMPTON PARK GRAVEL MEMBER: Orange brown to brown clayey sandy GRAVEL. The sand was fine to coarse grained and the gravel was fine to coarse, sub-angular to sub-rounded flint.
▨		1.00 1.00 1.50 2.00 2.00 2.50 3.00 3.00 3.50 4.00 4.00 4.50 5.00 5.00	D SPT D D SPT D D SPT D D SPT D D SPT	 N=8 (2,2/2,2,2,2) N=10 (3,3/3,2,2,3) N=16 (3,4/4,4,4,4) N=17 (5,5/4,4,4,5) N=22 (6,6/5,5,6,6)	5.45		▨	LONDON CLAY FORMATION: Grey brown silty CLAY with fine selenite crystals from 2.50m bgl.
								End of Borehole at 5.450m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

No groundwater encountered. Roots noted to 2.00m bgl.

Percussion Drilling Log

Project Name: 4 Bellingham Road	Client: Smart Environment Freeholds Limited	Date: 05/03/2020
Location: Catford, London SE6 2PT	Contractor:	
Project No. : GWPR3599	Crew Name:	Drilling Equipment:

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS2	WLS		RF	1:50	Sheet 1 of 1

Sample and In Situ Testing

Depth (m)	Type	Results
0.30	D	
0.50	D	
0.80	D	
1.00	D	
1.00	SPT	N=9 (2,2/2,2,2,3)
1.50	D	
2.00	D	
2.00	SPT	N=9 (3,3/2,2,2,3)
2.50	D	
3.00	D	
3.00	SPT	N=16 (3,3/4,4,4,4)
3.50	D	
4.00	D	
4.00	SPT	N=20 (4,4/5,5,5,5)
4.50	D	
5.00	D	
5.00	SPT	N=23 (5,5/6,6,5,6)

Depth (m)	Level (m)	Stratum Description
0.40		TOPSOIL: Dark brown slightly gravelly sandy clay. The sand was fine to coarse grained and the gravel was fine to coarse, sub-angular to sub-rounded flint.
1.00		KEMPTON PARK GRAVEL MEMBER: Orange brown to brown clayey sandy GRAVEL. The sand was fine to coarse grained and the gravel was fine to coarse, sub-angular to sub-rounded flint.
5.45		LONDON CLAY FORMATION: Grey brown silty CLAY with fine selenite crystals from 1.50m bgl.

End of Borehole at 5.450m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

No groundwater encountered. Roots noted to 0.40m bgl. Dead roots noted at 1.50m bgl.

Percussion Drilling Log

Project Name: 4 Bellingham Road	Client: Smart Environment Freeholds Limited	Date: 05/03/2020
Location: Catford, London SE6 2PT	Contractor:	
Project No. : GWPR3599	Crew Name:	Drilling Equipment:

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS3	WLS		RF	1:50	Sheet 1 of 1

Well	Water Strikes	**Sample and In Situ Testing**			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.20	D					TOPSOIL: Dark brown slightly gravelly sandy clay. The sand was fine to medium grained and the gravel was fine, sub-angular to sub-rounded flint.
					0.35			
		0.50	D					KEMPTON PARK GRAVEL MEMBER: Orange brown to brown clayey sandy GRAVEL. The sand was fine to coarse grained and the gravel was fine to coarse, sub-angular to sub-rounded flint.
		0.80	D					
		1.00	D					
		1.00	SPT	N=8 (2,2/2,2,2,2)	1.10			LONDON CLAY FORMATION: Grey brown silty CLAY with fine selenite crystals from 3.00m bgl.
		1.50	D					
		2.00	D					
		2.00	SPT	N=10 (2,2/2,3,2,3)				
		2.50	D					
		3.00	D					
		3.00	SPT	N=16 (3,3/4,4,4,4)				
		3.50	D					
		4.00	D					
		4.00	SPT	N=18 (5,5/4,4,5,5)				
		5.00	SPT	N=18 (5,5/4,4,5,5)				
					5.45			End of Borehole at 5.450m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

No groundwater encountered. Roots noted to 1.10m bgl. Dead roots noted at 2.50mbgl.

Percussion Drilling Log

Project Name: 4 Bellingham Road	Client: Smart Environment Freeholds Limited	Date: 05/03/2020
Location: Catford, London SE6 2PT	Contractor:	
Project No. : GWPR3599	Crew Name:	Drilling Equipment:

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS4	WLS		RF	1:50	Sheet 1 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	D					TOPSOIL: Dark brown slightly gravelly sandy silty clay. The sand was fine to medium grained and the gravel was fine, sub-angular to sub-rounded flint.	
		0.50	D		0.45			KEMPTON PARK GRAVEL MEMBER:: Orange brown to brown clayey sandy GRAVEL. The sand was fine to coarse grained and the gravel was fine to coarse, sub-angular to sub-rounded flint.	
		0.80	D						
		1.00	D		1.00			LONDON CLAY FORMATION: Grey brown silty CLAY with fine selenite crystals from 1.50m bgl.	1
		1.00	SPT	N=8 (1,1/2,2,2,2)					
		1.50	D						
		2.00	D						2
		2.00	SPT	N=12 (3,3/3,3,3,3)					
		2.50	D						
		3.00	D						3
		3.00	SPT	N=17 (5,5/5,4,4,4)					
		3.50	D						
		4.00	D						4
		4.00	SPT	N=20 (5,5/5,5,5,5)					
		4.50	D						
		5.00	D						5
		5.00	SPT	N=20 (5,5/4,5,5,6)					
		5.50	D						
		6.00	D						6
		6.00	SPT	N=24 (5,6/6,6,6,6)					
		6.50	D						
		7.00	D						7
		7.00	SPT	N=27 (6,6/6,7,7,7)					
		7.50	D		7.50			LONDON CLAY FORMATION: Grey silty CLAY with fine selenite crystals.	
		8.00	D						8
		8.00	SPT	N=28 (7,7/7,7,7,7)					
		8.50	D						
		9.00	D						9
		9.00	SPT	N=36 (8,8/9,9,9,9)					
		9.50	D						
		10.00	D						10

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

No groundwater encountered. Roots noted to 1.50m bgl. Dead roots noted between 2.50 -5.00m bgl.

Percussion Drilling Log

Project Name: 4 Bellingham Road	Client: Smart Environment Freeholds Limited	Date: 05/03/2020
Location: Catford, London SE6 2PT	Contractor:	
Project No. : GWPR3599	Crew Name:	Drilling Equipment:

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS4	WLS		RF	1:50	Sheet 2 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
▨		10.00	SPT	N=40 (9,9/10,10,10,10)	10.45		⊠	
								End of Borehole at 10.450m

11
12
13
14
15
16
17
18
19
20

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

No groundwater encountered. Roots noted to 1.50m bgl. Dead roots noted between 2.50 -5.00m bgl.

APPENDIX C
Geotechnical Laboratory Test Results

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

Job No.	Project Name	Programme	
28043	4 Bellingham Road, Catford, London SE6 2PT	Samples received	17/03/2020
		Schedule received	12/03/2020
Project No.	**Client**	Project started	18/03/2020
GWPR3599	Ground & Water Ltd	Testing Started	04/05/2020

Hole No.	Sample				Soil Description	NMC	Passing 425µm	LL	PL	PI	Remarks
	Ref	Top m	Base m	Type		%	%	%	%	%	
WS1	-	0.80	1.00	D	Brown clayey very sandy GRAVEL (gravel is fmc and sub-angular to sub-rounded)	10					
WS1	-	1.50	-	D	Brown silty CLAY	35					
WS1	-	2.00	-	D	Brown mottled bluish grey silty CLAY with traces of decayed rootlets	29					
WS1	-	2.50	-	D	Brown slightly mottled bluish grey silty CLAY with rare fm mudstone fragments	31	99	71	31	40	
WS1	-	3.00	-	D	Brown slightly mottled bluish grey silty CLAY with orangish brown fine sand pockets and scattered traces of selenite	33					
WS1	-	3.50	-	D	Brown slightly mottled bluish grey silty CLAY with orangish brown fine sand pockets and scattered traces of selenite	31					
WS2	-	0.80	1.00	D	Brown clayey very sandy GRAVEL (gravel is fmc and sub-angular to sub-rounded)	9.0					
WS2	-	1.50	-	D	Brown mottled bluish grey silty CLAY with traces of decayed rootlets	29					
WS2	-	2.00	-	D	Brown slightly mottled bluish grey slightly sandy slightly gravelly silty CLAY with rare cobbles (gravel is fmc and sub-angular)	26					
WS2	-	2.50	-	D	Brown slightly mottled bluish grey silty CLAY with scattered traces of selenite and decomposed roots	39					
WS2	-	3.00	-	D	Brown slightly mottled bluish grey silty CLAY with rare fm mudstone fragments	33	99	69	27	42	
WS2	-	3.50	-	D	Brown slightly mottled bluish grey silty CLAY with orangish brown fine sand pockets and scattered traces of selenite	33					

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 **J.P**
Date: 12/05/2020

UKAS TESTING 2519

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

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

Job No.	Project Name	Programme	
28043	4 Bellingham Road, Catford, London SE6 2PT	Samples received	17/03/2020
		Schedule received	12/03/2020
Project No.	**Client**	Project started	18/03/2020
GWPR3599	Ground & Water Ltd	Testing Started	04/05/2020

Hole No.	Sample				Soil Description	NMC %	Passing 425µm %	LL %	PL %	PI %	Remarks
	Ref	Top m	Base m	Type							
WS2	-	4.00	-	D	Brown mottled bluish grey silty CLAY with scattered traces of selenite	36					
WS3	-	1.50	-	D	Brown slightly mottled bluish grey slightly gravelly silty CLAY (gravel is fm and rounded)	25	94	63	26	37	
WS3	-	2.00	-	D	Brown mottled bluish grey silty CLAY with scattered traces of selenite	35					
WS3	-	2.50	-	D	Brown slightly mottled bluish grey silty CLAY with orangish brown fine sand pockets and scattered traces of selenite	31					
WS3	-	3.00	-	D	Brown slightly mottled bluish grey silty CLAY with orangish brown fine sand pockets and scattered traces of selenite	33					
WS3	-	3.50	-	D	Brown slightly mottled bluish grey silty CLAY	33					
WS4	-	1.50	-	D	Brown slightly sandy gravelly silty CLAY (gravel is fmc and sub-angular to sub-rounded)	23					
WS4	-	2.00	-	D	Brown slightly mottled bluish grey silty CLAY with orangish brown fine sand pockets	32					
WS4	-	2.50	-	D	Brown mottled bluish grey silty CLAY with traces of decayed rootlets	35					
WS4	-	3.00	-	D	Brown slightly mottled bluish grey slightly fine sandy silty CLAY with scattered traces of selenite	35					
WS4	-	3.50	-	D	Brown slightly mottled bluish grey silty CLAY	30	100	65	29	36	

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
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Date: 12/05/2020

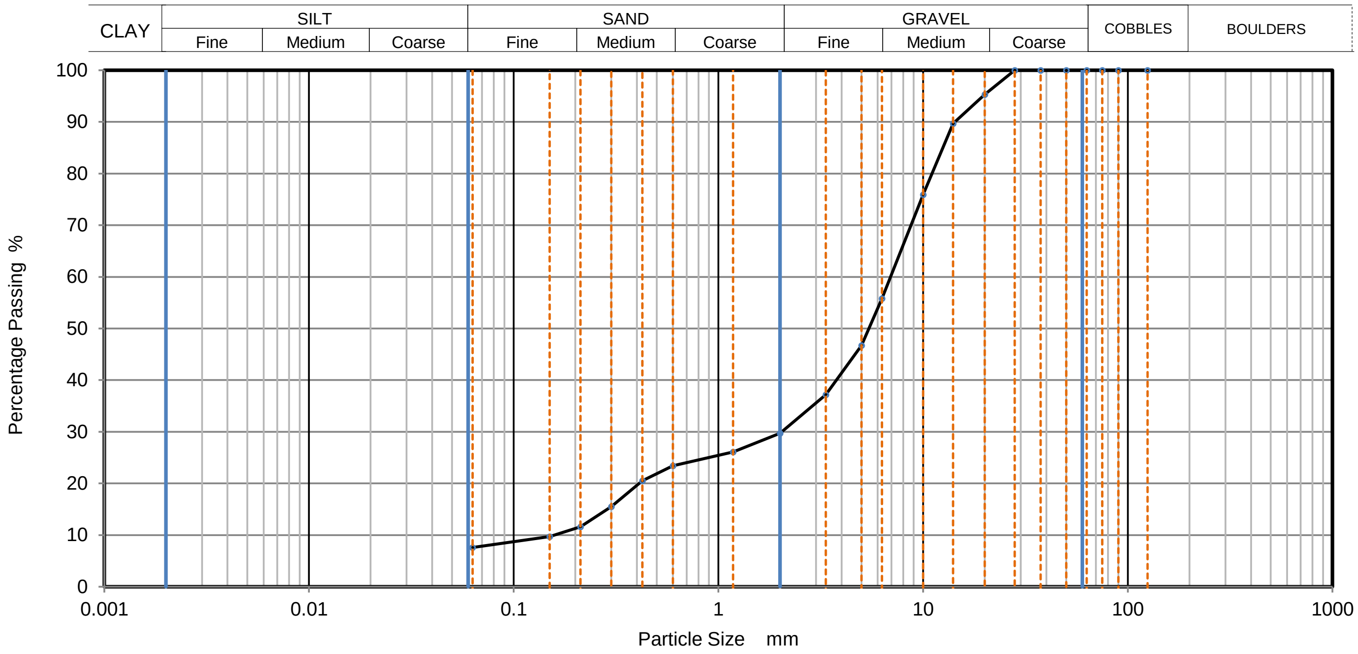
UKAS TESTING
2519

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

MSF-5-R1(b)

PARTICLE SIZE DISTRIBUTION

Job Ref	28043		
Borehole/Pit No.	WS1		
Site Name	4 Bellingham Road, Catford, London SE6 2PT	Sample No.	-
Project No.	GWPR3599	Client	Ground & Water Ltd
Depth Top	0.80 m	Depth Base	2.00 m
Soil Description	Brown clayey very sandy GRAVEL (gravel is fmc and sub-angular to sub-rounded)	Sample Type	D
Samples received	17/03/2020	Schedules received	12/03/2020
Test Method	BS1377:Part 2: 1990, clause 9.0	Project started	18/03/2020
Date tested	04/05/2020		



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	95		
14	90		
10	76		
6.3	56		
5	47		
3.35	37		
2	30		
1.18	26		
0.6	23		
0.425	21		
0.3	16		
0.212	12		
0.15	10		
0.063	8		

Sample Proportions	% dry mass
Very coarse	0.0
Gravel	70.3
Sand	22.1
Fines <0.063mm	7.6

Grading Analysis	
D100 mm	
D60 mm	6.94
D30 mm	2.05
D10 mm	0.159
Uniformity Coefficient	44
Curvature Coefficient	3.8

Remarks

Preparation and testing in accordance with BS1377 unless noted below

K4 Soils Laboratory

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UKAS TESTING 2519

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Checked and Approved

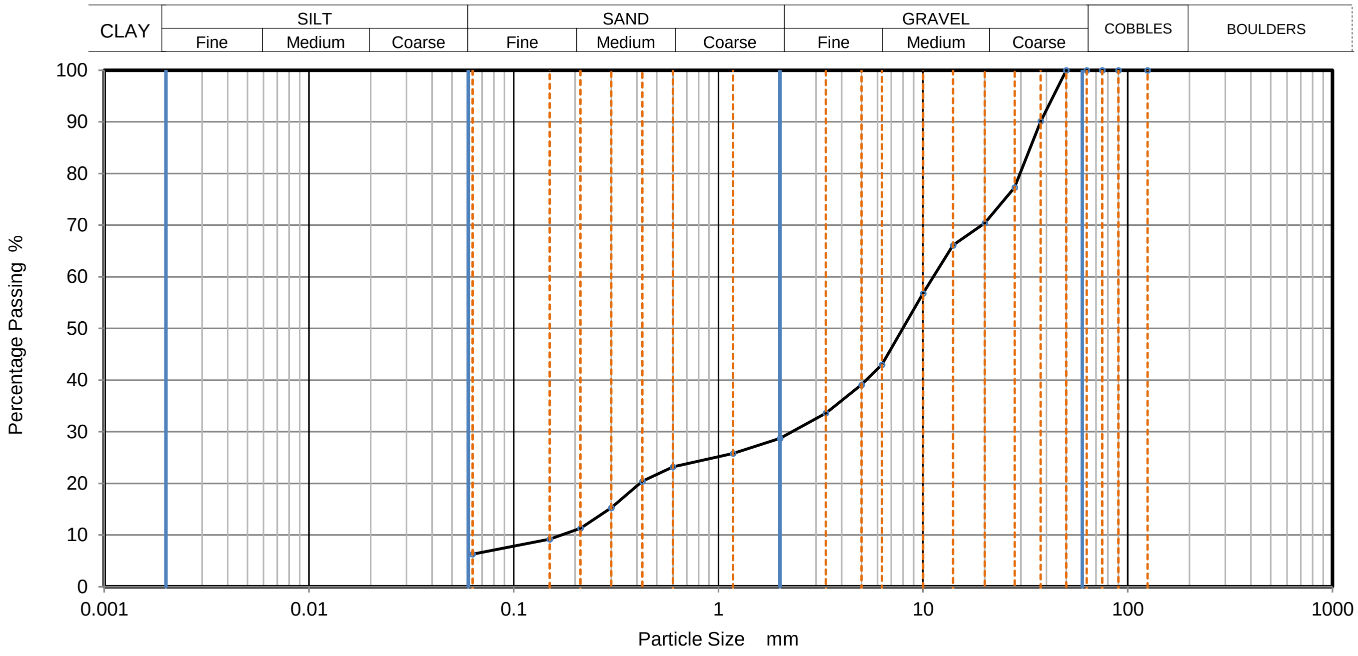
Initials: **J.P**

Date: 05/05/2020

MSF-5-R3

PARTICLE SIZE DISTRIBUTION

Site Name	4 Bellingham Road, Catford, London SE6 2PT			Job Ref	28043
				Borehole/Pit No.	WS2
				Sample No.	-
Project No.	GWPR3599	Client	Ground & Water Ltd	Depth Top	0.80 m
Soil Description	Brown clayey very sandy GRAVEL (gravel is fmc and sub-angular to sub-rounded)			Depth Base	2.00 m
				Sample Type	D
				Samples received	17/03/2020
				Schedules received	12/03/2020
Test Method	BS1377:Part 2: 1990, clause 9.0			Project started	18/03/2020
				Date tested	04/05/2020



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	90		
28	77		
20	70		
14	66		
10	57		
6.3	43		
5	39		
3.35	34		
2	29		
1.18	26		
0.6	23		
0.425	20		
0.3	15		
0.212	11		
0.15	9		
0.063	6		

Sample Proportions	% dry mass
Very coarse	0.0
Gravel	71.3
Sand	22.4
Fines <0.063mm	6.3

Grading Analysis		
D100	mm	
D60	mm	11.2
D30	mm	2.29
D10	mm	0.171
Uniformity Coefficient		66
Curvature Coefficient		2.7

Remarks

Preparation and testing in accordance with BS1377 unless noted below

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2519

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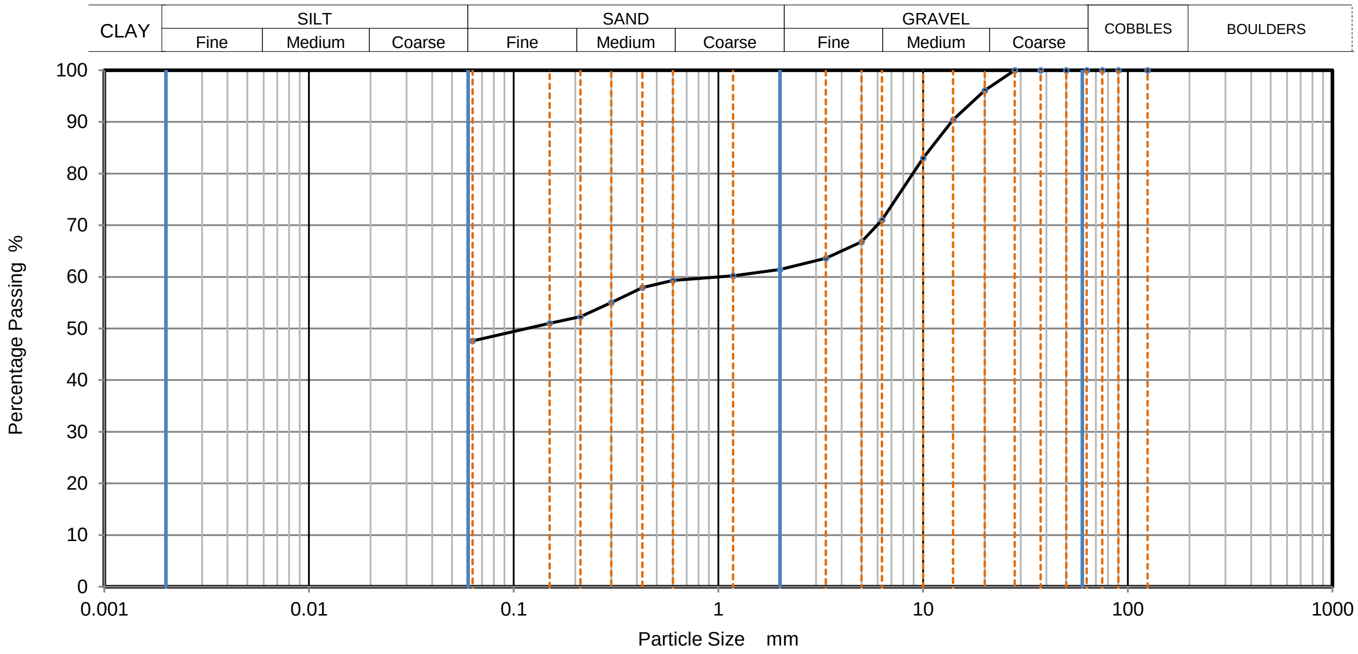
Checked and Approved

Initials: **J.P**

Date: 05/05/2020

K4 SOILS	**PARTICLE SIZE DISTRIBUTION**			Job Ref	28043
				Borehole/Pit No.	WS4
Site Name	4 Bellingham Road, Catford, London SE6 2PT			Sample No.	-
Project No.	GWPR3599	Client	Ground & Water Ltd	Depth Top	1.50 m
Soil Description	Brown slightly sandy gravelly silty CLAY (gravel is fmc and sub-angular to sub-rounded)			Depth Base	- m
				Sample Type	D
				Samples received	17/03/2020
				Schedules received	12/03/2020
Test Method	BS1377:Part 2: 1990, clause 9.0			Project started	18/03/2020
				Date tested	04/05/2020



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	96		
14	90		
10	83		
6.3	71		
5	67		
3.35	64		
2	61		
1.18	60		
0.6	59		
0.425	58		
0.3	55		
0.212	52		
0.15	51		
0.063	48		

Sample Proportions	% dry mass
Very coarse	0.0
Gravel	38.6
Sand	13.8
Fines <0.063mm	47.6

Grading Analysis	
D100 mm	
D60 mm	0.998
D30 mm	
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

UKAS TESTING
2519

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Checked and Approved

Initials: **J.P**

Date: 05/05/2020

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 : 2018, Clause 7.6 & Clause 12

Job No. 28043	Project Name 4 Bellingham Road, Catford, London SE6 2PT	Programme	
		Samples received	17/03/2020
		Schedule received	12/03/2020
Project No. GWPR3599	Client Ground & Water Ltd	Project started	18/03/2020
		Testing Started	28/04/2020

Hole No.	Sample				Soil description	Dry Mass passing 2mm	SO4 Content	pH	Remarks
	Ref	Top m	Base m	Type		%	mg/l		
WS2	-	2.50	-	D	Brown slightly mottled bluish grey silty CLAY with scattered traces of selenite and decomposed roots	100	2440	7.59	

UKAS TESTING
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Test Report by K4 SOILS LABORATORY
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Checked and Approved
Initials **J.P**
Date: **05/05/2020**

MSF-5-R29

APPENDIX D
Chemical Laboratory Test Results

Roger Foord
Ground & Water Ltd
2 The Long Barn
Norton Farm
Selborne Road
Alton
Hampshire
GU34 3NB

DETS Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410

UKAS TESTING
4480

DETS Report No: 20-03296

Site Reference:	4 Bellingham Road, Catford, London SE6 2PT
Project / Job Ref:	GWPR3599
Order No:	None Supplied
Sample Receipt Date:	13/03/2020
Sample Scheduled Date:	13/03/2020
Report Issue Number:	1
Reporting Date:	19/03/2020

Authorised by:

Dave Ashworth
Technical Manager

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

Soil Analysis Certificate						
DETS Report No: 20-03296	**Date Sampled**	05/03/20	05/03/20	05/03/20	05/03/20	05/03/20
Ground & Water Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: 4 Bellingham Road, Catford, London SE6 2PT	**TP / BH No**	WS1	WS2	WS4	WS3	WS4
Project / Job Ref: GWPR3599	**Additional Refs**	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	**Depth (m)**	0.30	0.30	0.30	1.00	5.50
Reporting Date: 19/03/2020	**DETS Sample No**	468412	468413	468415	468416	468417

Determinand	**Unit**	**RL**	**Accreditation**					
Asbestos Screen (S)	N/a	N/a	**ISO17025**	Not Detected	Not Detected	Detected		
Sample Matrix (S)	Material Type	N/a	NONE			Bundle of Chrysotile		
Asbestos Type (S)	PLM Result	N/a	**ISO17025**			Chrysotile		
pH	pH Units	N/a	**MCERTS**	7.8	7.8	7.7	8.1	7.7
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2		
Total Sulphate as SO_4	mg/kg	< 200	NONE				< 200	21200
Total Sulphate as SO_4	%	< 0.02	NONE				< 0.02	2.12
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	**MCERTS**	11	< 10	< 10	20	2490
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	**MCERTS**	0.01	< 0.01	< 0.01	0.02	2.49
Total Sulphur	%	< 0.02	NONE				< 0.02	0.77
Organic Matter	%	< 0.1	**MCERTS**	3.3	1.3	4.2		
Total Organic Carbon (TOC)	%	< 0.1	**MCERTS**	1.9	0.8	2.4		
Ammonium as NH_4	mg/kg	< 0.5	NONE				1.3	6.5
Ammonium as NH_4	mg/l	< 0.05	NONE				0.13	0.65
W/S Chloride (2:1)	mg/kg	< 1	**MCERTS**				6	21
W/S Chloride (2:1)	mg/l	< 0.5	**MCERTS**				3.2	10.4
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**	14	7	16		
W/S Boron	mg/kg	< 1	NONE	< 1	< 1	< 1		
Cadmium (Cd)	mg/kg	< 0.2	**MCERTS**	0.4	< 0.2	0.7		
Chromium (Cr)	mg/kg	< 2	**MCERTS**	19	20	21		
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2		
Copper (Cu)	mg/kg	< 4	**MCERTS**	39	28	102		
Lead (Pb)	mg/kg	< 3	**MCERTS**	333	135	433		
W/S Magnesium	mg/l	< 0.1	NONE				1.2	94
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1	< 1		
Nickel (Ni)	mg/kg	< 3	**MCERTS**	18	13	19		
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3		
Vanadium (V)	mg/kg	< 2	NONE	39	20	43		
Zinc (Zn)	mg/kg	< 3	**MCERTS**	258	60	363		
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2	< 2	< 2		

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

Subcontracted analysis (S)

Soil Analysis Certificate - Speciated PAHs						
DETS Report No: 20-03296	**Date Sampled**	05/03/20	05/03/20	05/03/20		
Ground & Water Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied		
Site Reference: 4 Bellingham Road, Catford, London SE6 2PT	**TP / BH No**	WS1	WS2	WS4		
Project / Job Ref: GWPR3599	**Additional Refs**	None Supplied	None Supplied	None Supplied		
Order No: None Supplied	**Depth (m)**	0.30	0.30	0.30		
Reporting Date: 19/03/2020	**DETS Sample No**	468412	468413	468415		

Determinand	**Unit**	**RL**	**Accreditation**					
Naphthalene	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	0.76		
Acenaphthylene	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	< 0.1		
Acenaphthene	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	0.65		
Fluorene	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	0.55		
Phenanthrene	mg/kg	< 0.1	**MCERTS**	1.81	0.52	5.08		
Anthracene	mg/kg	< 0.1	**MCERTS**	0.75	< 0.1	0.49		
Fluoranthene	mg/kg	< 0.1	**MCERTS**	5.56	1.37	9.65		
Pyrene	mg/kg	< 0.1	**MCERTS**	4.85	1.18	7.83		
Benzo(a)anthracene	mg/kg	< 0.1	**MCERTS**	2.29	0.53	3.58		
Chrysene	mg/kg	< 0.1	**MCERTS**	2.01	0.67	3.90		
Benzo(b)fluoranthene	mg/kg	< 0.1	**MCERTS**	2.33	0.91	4.97		
Benzo(k)fluoranthene	mg/kg	< 0.1	**MCERTS**	0.94	0.37	1.86		
Benzo(a)pyrene	mg/kg	< 0.1	**MCERTS**	1.89	0.72	3.24		
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	**MCERTS**	1.32	0.62	2.22		
Dibenz(a,h)anthracene	mg/kg	< 0.1	**MCERTS**	< 0.1	< 0.1	0.35		
Benzo(ghi)perylene	mg/kg	< 0.1	**MCERTS**	0.88	0.38	1.68		
Total EPA-16 PAHs	mg/kg	< 1.6	**MCERTS**	24.6	7.3	46.8		

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

Soil Analysis Certificate - TPH CWG Banded						
DETS Report No: 20-03296	**Date Sampled**	05/03/20	05/03/20			
Ground & Water Ltd	**Time Sampled**	None Supplied	None Supplied			
Site Reference: 4 Bellingham Road, Catford, London SE6 2PT	**TP / BH No**	WS2	WS4			
Project / Job Ref: GWPR3599	**Additional Refs**	None Supplied	None Supplied			
Order No: None Supplied	**Depth (m)**	0.30	0.30			
Reporting Date: 19/03/2020	**DETS Sample No**	468413	468415			

Determinand	**Unit**	**RL**	**Accreditation**					
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01	< 0.01			
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05			
Aliphatic >C8 - C10	mg/kg	< 2	**MCERTS**	< 2	< 2			
Aliphatic >C10 - C12	mg/kg	< 2	**MCERTS**	< 2	< 2			
Aliphatic >C12 - C16	mg/kg	< 3	**MCERTS**	< 3	< 3			
Aliphatic >C16 - C21	mg/kg	< 3	**MCERTS**	< 3	< 3			
Aliphatic >C21 - C34	mg/kg	< 10	**MCERTS**	< 10	< 10			
Aliphatic (C5 - C34)	mg/kg	< 21	NONE	< 21	< 21			
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01	< 0.01			
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05			
Aromatic >C8 - C10	mg/kg	< 2	**MCERTS**	< 2	< 2			
Aromatic >C10 - C12	mg/kg	< 2	**MCERTS**	< 2	< 2			
Aromatic >C12 - C16	mg/kg	< 2	**MCERTS**	< 2	7			
Aromatic >C16 - C21	mg/kg	< 3	**MCERTS**	< 3	28			
Aromatic >C21 - C35	mg/kg	< 10	**MCERTS**	< 10	50			
Aromatic (C5 - C35)	mg/kg	< 21	NONE	< 21	86			
Total >C5 - C35	mg/kg	< 42	NONE	< 42	86			

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

Soil Analysis Certificate - BTEX / MTBE

DETS Report No: 20-03296	**Date Sampled**	05/03/20	05/03/20			
Ground & Water Ltd	**Time Sampled**	None Supplied	None Supplied			
Site Reference: 4 Bellingham Road, Catford, London SE6 2PT	**TP / BH No**	WS2	WS4			
Project / Job Ref: GWPR3599	**Additional Refs**	None Supplied	None Supplied			
Order No: None Supplied	**Depth (m)**	0.30	0.30			
Reporting Date: 19/03/2020	**DETS Sample No**	468413	468415			

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

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

Waste Acceptance Criteria Analytical Certificate - BS EN 12457/2

DETS Report No: 20-03296	**Date Sampled**	05/03/20
Ground & Water Ltd	**Time Sampled**	None Supplied
Site Reference: 4 Bellingham Road, Catford, London SE6 2PT	**TP / BH No**	WS3
Project / Job Ref: GWPR3599	**Additional Refs**	None Supplied
Order No: None Supplied	**Depth (m)**	0.30
Reporting Date: 19/03/2020	**DETS Sample No**	468414

				Landfill Waste Acceptance Criteria Limits		
				Inert Waste Landfill	**Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Determinand	**Unit**	**MDL**				
TOC^{MU}	%	< 0.1	2.2	3%	5%	6%
Loss on Ignition	%	< 0.01	4.80	--	--	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	21.7	100	--	--
pH^{MU}	pH Units	N/a	6.3	--	>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			< 0.005	0.01	0.2	2
Molybdenum^{U}	< 0.001			< 0.01	0.5	10	30
Nickel^{U}	< 0.007			< 0.07	0.4	10	40
Lead^{U}	< 0.005			< 0.05	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}	0.018			0.18	4	50	200
Chloride^{U}	1.5			15	800	15000	25000
Fluoride^{U}	< 0.5			< 5	10	150	500
Sulphate^{U}	3.3			33	1000	20000	50000
TDS	58			580	4000	60000	100000
Phenol Index	< 0.01			< 0.1	1	-	-
DOC	9.7			97.1	500	800	1000

Leach Test Information				
Sample Mass (kg)	0.11			
Dry Matter (%)	80.6			
Moisture (%)	24			
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 DETS Ltd cannot be held responsible for any discrepencies with current legislation
M Denotes MCERTS accredited test
U Denotes ISO17025 accredited test

DETS Ltd
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Tel : 01622 850410

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Soil Analysis Certificate - Sample Descriptions

DETS Report No: 20-03296
Ground & Water Ltd
Site Reference: 4 Bellingham Road, Catford, London SE6 2PT
Project / Job Ref: GWPR3599
Order No: None Supplied
Reporting Date: 19/03/2020

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
468412	WS1	None Supplied	0.30	18.4	Brown loamy sand with vegetation
468413	WS2	None Supplied	0.30	8	Brown loamy sand with stones
468414	WS3	None Supplied	0.30	19.3	Brown loamy sand with stones and vegetation
468415	WS4	None Supplied	0.30	22	Black loamy sand with stones and vegetation
468416	WS3	None Supplied	1.00	46.1	Brown sandy gravel with stones
468417	WS4	None Supplied	5.50	22.1	Brown loamy clay

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample $^{I/S}$

Unsuitable Sample $^{U/S}$

Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 20-03296
Ground & Water Ltd
Site Reference: 4 Bellingham Road, Catford, London SE6 2PT
Project / Job Ref: GWPR3599
Order No: None Supplied
Reporting Date: 19/03/2020

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

Parameter	Matrix Type	Suite Reference	Uncertainity Measurement	Unit
TOC	Soil	BS EN 12457	7	%
Loss on Ignition	Soil	BS EN 12457	17	%
BTEX	Soil	BS EN 12457	14	%
Sum of PCBs	Soil	BS EN 12457	23	%
Mineral Oil	Soil	BS EN 12457	9	%
Total PAH	Soil	BS EN 12457	20	%
pH	Soil	BS EN 12457	0.23	Units
Acid Neutralisation Capacity	Soil	BS EN 12457	18	%
Arsenic	Leachate	BS EN 12457	10	%
Barium	Leachate	BS EN 12457	10	%
Cadmium	Leachate	BS EN 12457	7	%
Chromium	Leachate	BS EN 12457	7	%
Copper	Leachate	BS EN 12457	12	%
Mercury	Leachate	BS EN 12457	12	%
Molybdenum	Leachate	BS EN 12457	9	%
Nickel	Leachate	BS EN 12457	10	%
Lead	Leachate	BS EN 12457	5	%
Antimony	Leachate	BS EN 12457	9	%
Selenium	Leachate	BS EN 12457	10	%
Zinc	Leachate	BS EN 12457	7	%
Chloride	Leachate	BS EN 12457	8	%
Fluoride	Leachate	BS EN 12457	9	%
Sulphate	Leachate	BS EN 12457	9	%
TDS	Leachate	BS EN 12457	12	%
Phenol Index	Leachate	BS EN 12457	14	%
DOC	Leachate	BS EN 12457	10	%
Clay Content	Soil	BS 3882: 2015	15	%
Silt Content	Soil	BS 3882: 2015	14	%
Sand Content	Soil	BS 3882: 2015	13	%
Loss on Ignition	Soil	BS 3882: 2015	17	%
pH	Soil	BS 3882: 2015	0.23	Units
Carbonate	Soil	BS 3882: 2015	16	%
Total Nitrogen	Soil	BS 3882: 2015	12	%
Phosphorus (Extractable)	Soil	BS 3882: 2015	24	%
Potassium (Extractable)	Soil	BS 3882: 2015	20	%
Magnesium (Extractable)	Soil	BS 3882: 2015	26	%
Zinc	Soil	BS 3882: 2015	7	%
Copper	Soil	BS 3882: 2015	12	%
Nickel	Soil	BS 3882: 2015	10	%
Available Sodium	Soil	BS 3882: 2015	23	%
Available Calcium	Soil	BS 3882: 2015	23	%
Electrical Conductivity	Soil	BS 3882: 2015	10	%

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DETS Report No: 20-04632

Site Reference:	4 Bellingham Road, Catford, London SE6 2PT
Project / Job Ref:	GWPR3599
Order No:	None Supplied
Sample Receipt Date:	13/03/2020
Sample Scheduled Date:	24/04/2020
Report Issue Number:	1
Reporting Date:	29/04/2020

Authorised by:

Dave Ashworth
Technical Manager

Dates of laboratory activities for each tested analyte are available upon request.

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

Soil Analysis Certificate						
DETS Report No: 20-04632	**Date Sampled**	05/03/20				
Ground & Water Ltd	**Time Sampled**	None Supplied				
Site Reference: 4 Bellingham Road, Catford, London SE6 2PT	**TP / BH No**	WS4				
Project / Job Ref: GWPR3599	**Additional Refs**	None Supplied				
Order No: None Supplied	**Depth (m)**	0.30				
Reporting Date: 29/04/2020	**DETS Sample No**	474345				

Determinand	**Unit**	**RL**	**Accreditation**					
Asbestos Quantification $^{(S)}$	%	< 0.001	**ISO17025**	0.001				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Samples Descriptions page describes if the test is performed on the dried or as-received portion

Subcontracted analysis (S)

DETS Ltd
Unit 1, Rose Lane Industrial Estate
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Maidstone
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Tel : 01622 850410

Soil Analysis Certificate - Methodology & Miscellaneous Information
DETS Report No: 20-04632
Ground & Water Ltd
Site Reference: 4 Bellingham Road, Catford, London SE6 2PT
Project / Job Ref: GWPR3599
Order No: None Supplied
Reporting Date: 29/04/2020

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.

The following LQM/CIEH S4Uls (Copyright Land Quality Management Limited) have been reproduced with permission, to the publication number S4UL3072

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	130	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]	4,900[f]	1,200[f](76.4) [sol]
	2.5% SOM	5.60	5.6	10	460 [f](183) [sol]	4,900[f]	1,900[f](183) [sol]
	6.0% SOM	13	13	24	1,100[f](432) [sol]	4,900[f]	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*

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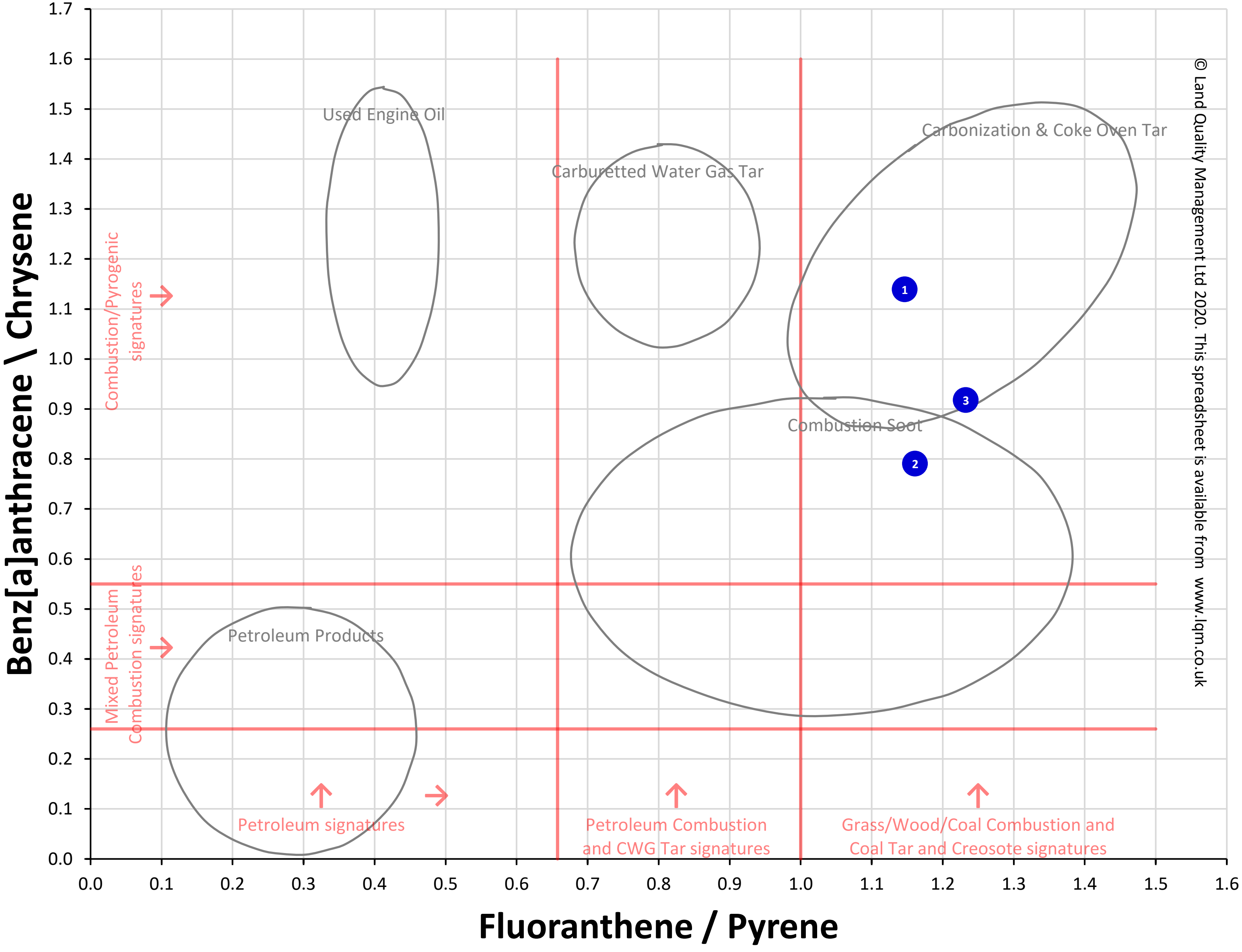
CL:AIRE General Assessment Criteria:
Volatile and Semi-Volatile Organic Compounds

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

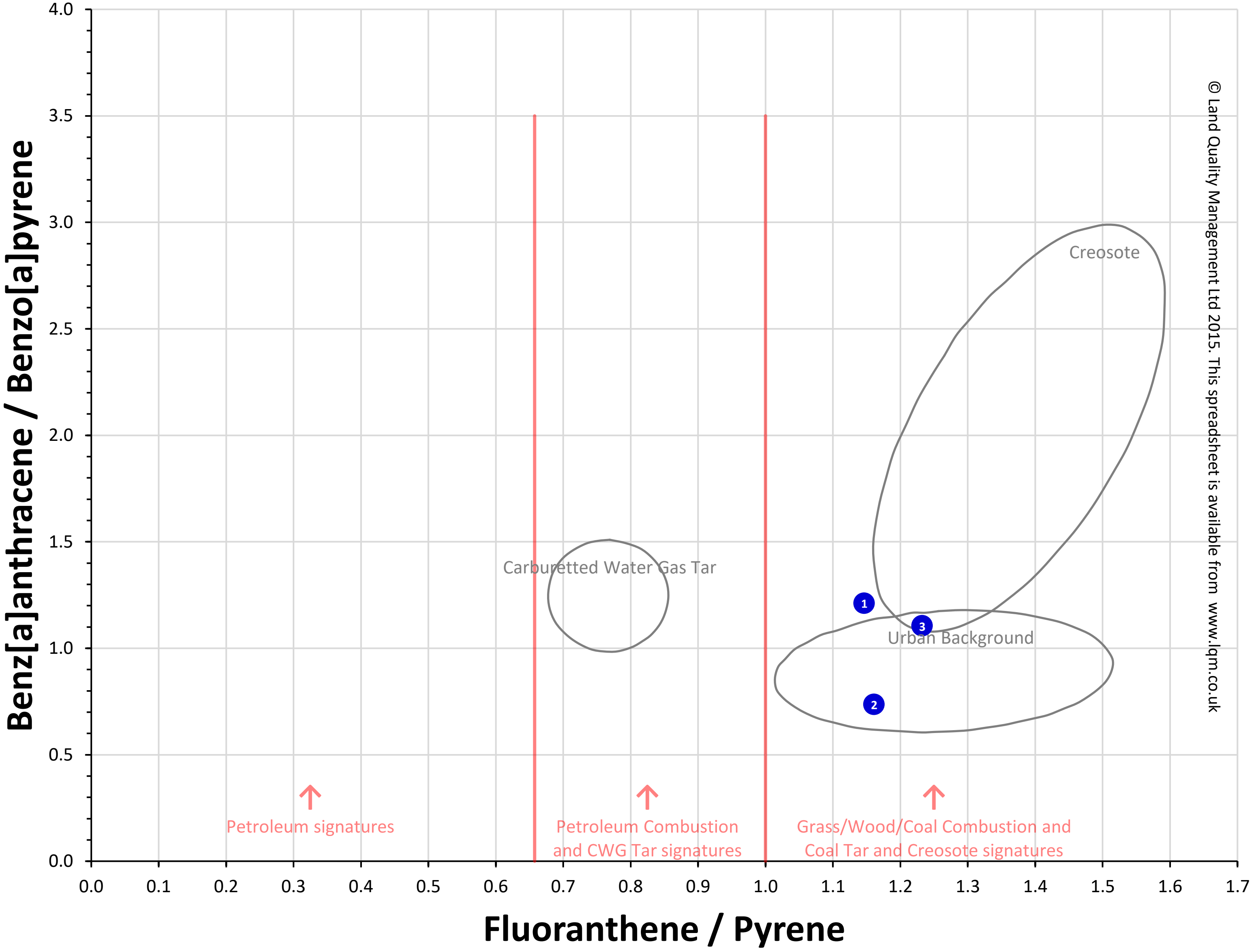
APPENDIX F
PAH Double Ratio Spreadsheets



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.

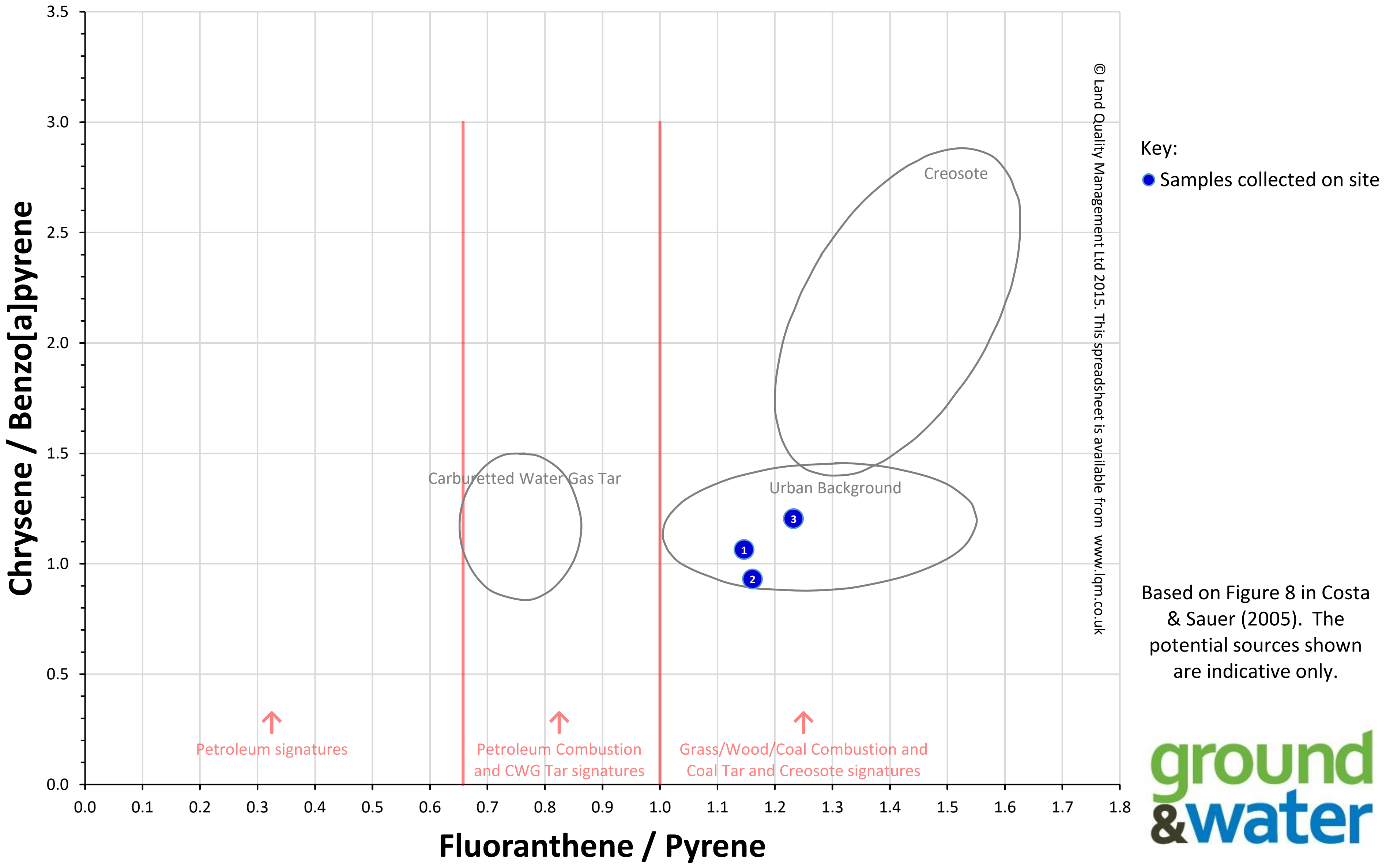


Key:

● Samples collected on site

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

ground &water



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

ground
&water

APPENDIX G
Asbestos Risk Assessment

ground&water

CIRIA733 Asbestos Risk Assessment

Site information	Trial Hole	WS3								
	Depth (m bgl)	0.3								
Asbestos Type Considerations	Abestos type	Chrysotile			Amosite			Crocidolite		
	Kasbestos	1.3			1.7			2.0		
	Soil Concentration (Quantification Result in %)	0.001								
Soil Type Considerations	Soil Type	Sand	Sandy Clay	Clay	Sand	Sandy Clay	Clay	Sand	Sandy Clay	Clay
	Ksoil	2.9	1.7	0.93	2.9	1.7	0.93	2.9	1.7	0.93
	Enter the relevant from the above	1.7								
Constants	Koverall	1.6			1.6			1.6		
	Dust Concentration (mg/m3)	0.1			0.1			0.1		
	Dry Conditions Exposure (hrs)	750			750			750		
	Occupation hours in a year	1920			1920			1920		
Calculation Results	fibre/ml per mg/m3	0.00138								
	fibre/ml	0.000138								
	fibre/ml.hr	0.104								
	fibre/ml.year	0.000054								
Mesothelioma Accumulated Risk	Age (exposure commences)	0			0			0		
	Risk persists for (Years)	60			60			60		
	Cummulative Age Adjustment Factor	16.8			16.8			16.8		
	fibre/ml.year (cumulative)	0.00091								
Lung Cancer Accumulated Risk	Risk persists for (Years)	60			60			60		
	fibre/ml.year (cumulative)	0.00065								

BACKGROUND

This asbestos risk assessment has been undertaken in accordance with the guidance within CIRIA733.

The fibre concentration within the airborne soil dust (in fibres/ml per mg/m3) was calculated based on the results of Addison et al 1988.

The airborne concentration of soil dust (0.1mg/m3) was based on ambient urban dust levels and ART modelling.

The dry conditions exposure (750hrs) was based upon regional meteorological data suggesting 150hrs of dry conditions per year, when applied over a 5-year segment this equates to 750hours.

The occupational hours per year (1920hrs) is based on a 40-hour working week and 48 working weeks in a year.

A worst-case exposure scenario has been considered for residents, groundworkers or generally end-users. This was based on the risk persisting for a period of 60 years, accumulated in 5-year increments. As the risk of mesothelioma is age dependent, this considered the exposure commencing at age 0 with the relevant age adjustment factor applied for each 5-year increment.

Based on the above considerations, the following equations have been used:

((Kasbestostype x Ksoil) ÷ Koverall) x Soil Concentration = fibre/ml per mg/m3

Fibre/ml per mg/m3 x Dust Concentration = fibre/ml

(f/ml x Dry Conditions Exposure (hrs)) = fibre/ml.hr

Fibre/ml.hr ÷ occupational hours per year = fibre/ml.year

Mesothelioma: fibre/ml.year x 16.8 (cumulative age adjustment factor for 60 years)

Lung Cancer: fibre/ml.year x 12 (60 years in 5-year increments)

APPENDIX H
Waste Hazard Assessment

Waste Classification Report

A4Y9R-BTTJQ-KA38F

Job name

GWPR3599

Description/Comments

Project

GWPR3599

Site

Related Documents

#	Name	Description
None		

Waste Stream Template

Ground and Water V2 PA

Classified by

Name:
Roger Foord
Date:
12 May 2020 15:58 GMT
Telephone:
07979 754715

Company:
Ground and Water
15 Bow Street
Alton
GU34 1NY

HazWasteOnline™ Training Record:

Course	**Date**
Hazardous Waste Classification	-
Advanced Hazardous Waste Classification	-

Report

Created by: Roger Foord
Created date: 12 May 2020 15:58 GMT

Job summary

#	Sample Name	Depth [m]	Classification Result	Hazard properties	Page
1	GWPR3599 WS1@0.30	0.3	Non Hazardous		2
2	GWPR3599 WS2@0.30m	0.3	Non Hazardous		4
3	GWPR3599 WS4@0.30m	0.3	Non Hazardous		7

Classification of sample: GWPR3599 WS1@0.30

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

Sample details

Sample Name:		LoW Code:	
GWPR3599 WS1@0.30		Chapter:	17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Sample Depth:			
0.3 m		Entry:	17 05 04 (Soil and stones other than those mentioned in 17 05 03)
Moisture content:			
18.4% (no correction)			

Hazard properties

None identified

Determinands

Moisture content: 18.4% No Moisture Correction applied (MC)

#		Determinand			CLP Note	**User entered data**		Conv. Factor	Compound conc.		**Classification value**	MC Applied	Conc. Not Used
		CLP index number	EC Number	CAS Number									
1		pH				7.8	pH		7.8	pH	7.8 pH		
				PH									
2		cyanides { salts of hydrogen cyanide with the exception of complex cyanides such as ferrocyanides, ferricyanides and mercuric oxycyanide and those specified elsewhere in this Annex }				<2	mg/kg	1.884	<3.768	mg/kg	<0.000377 %		**<LOD**
		006-007-00-5											
3		arsenic { arsenic trioxide }				14	mg/kg	1.32	18.485	mg/kg	0.00185 %		
		033-003-00-0	215-481-4	1327-53-3									
4		boron { boron tribromide/trichloride/trifluoride (combined) }				<1	mg/kg	13.43	<13.43	mg/kg	<0.00134 %		**<LOD**
				10294-33-4, 10294-34-5, 7637-07-2									
5		cadmium { cadmium sulfide }			1	0.4	mg/kg	1.285	0.514	mg/kg	0.00004 %		
		048-010-00-4	215-147-8	1306-23-6									
6		Chromium (III) Sulphate				19	mg/kg		19	mg/kg	0.0019 %		
				10101-53-8									
7		chromium { chromium(VI) oxide }				<2	mg/kg	1.923	<3.846	mg/kg	<0.000385 %		**<LOD**
		024-001-00-0	215-607-8	1333-82-0									
8		copper { dicopper oxide; copper (I) oxide }				39	mg/kg	1.126	43.91	mg/kg	0.00439 %		
		029-002-00-X	215-270-7	1317-39-1									
9		lead { lead chromate }			1	333	mg/kg	1.56	519.418	mg/kg	0.0333 %		
		082-004-00-2	231-846-0	7758-97-6									
10		mercury { mercury dichloride }				<1	mg/kg	1.353	<1.353	mg/kg	<0.000135 %		**<LOD**
		080-010-00-X	231-299-8	7487-94-7									
11		nickel { nickel dihydroxide }				18	mg/kg	1.579	28.431	mg/kg	0.00284 %		
		028-008-00-X	235-008-5 [1] 234-348-1 [2]	12054-48-7 [1] 11113-74-9 [2]									
12		selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }				<3	mg/kg	2.554	<7.661	mg/kg	<0.000766 %		**<LOD**
		034-002-00-8											

#		Determinand			CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
		CLP index number	EC Number	CAS Number									
13	⚛	vanadium { divanadium pentaoxide; vanadium pentoxide }											
		023-001-00-8	215-239-8	1314-62-1		39	mg/kg	1.785	69.622	mg/kg	0.00696 %		
14	⚛	zinc { zinc chloride }											
		030-003-00-2	231-592-0	7646-85-7		258	mg/kg	2.085	537.806	mg/kg	0.0538 %		
15		phenol											
		604-001-00-2	203-632-7	108-95-2		<2	mg/kg		<2	mg/kg	<0.0002 %		**<LOD**
16		naphthalene											
		601-052-00-2	202-049-5	91-20-3		<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		**<LOD**
17	●	acenaphthylene											
			205-917-1	208-96-8		<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		**<LOD**
18	●	acenaphthene											
			201-469-6	83-32-9		<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		**<LOD**
19	●	fluorene											
			201-695-5	86-73-7		<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		**<LOD**
20	●	phenanthrene											
			201-581-5	85-01-8		1.81	mg/kg		1.81	mg/kg	0.000181 %		
21	●	anthracene											
			204-371-1	120-12-7		0.75	mg/kg		0.75	mg/kg	0.000075 %		
22	●	fluoranthene											
			205-912-4	206-44-0		5.56	mg/kg		5.56	mg/kg	0.000556 %		
23	●	pyrene											
			204-927-3	129-00-0		4.85	mg/kg		4.85	mg/kg	0.000485 %		
24		benzo[a]anthracene											
		601-033-00-9	200-280-6	56-55-3		2.29	mg/kg		2.29	mg/kg	0.000229 %		
25		chrysene											
		601-048-00-0	205-923-4	218-01-9		2.01	mg/kg		2.01	mg/kg	0.000201 %		
26		benzo[b]fluoranthene											
		601-034-00-4	205-911-9	205-99-2		2.33	mg/kg		2.33	mg/kg	0.000233 %		
27		benzo[k]fluoranthene											
		601-036-00-5	205-916-6	207-08-9		0.94	mg/kg		0.94	mg/kg	0.000094 %		
28		benzo[a]pyrene; benzo[def]chrysene											
		601-032-00-3	200-028-5	50-32-8		1.89	mg/kg		1.89	mg/kg	0.000189 %		
29	●	indeno[123-cd]pyrene											
			205-893-2	193-39-5		1.32	mg/kg		1.32	mg/kg	0.000132 %		
30		dibenz[a,h]anthracene											
		601-041-00-2	200-181-8	53-70-3		<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		**<LOD**
31	●	benzo[ghi]perylene											
			205-883-8	191-24-2		0.88	mg/kg		0.88	mg/kg	0.000088 %		
										Total:	0.111 %		

Key

🟨	User supplied data
▨	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
●	Determinand defined or amended by HazWasteOnline (see Appendix A)
👤	Determinand defined by classifier (see Appendix A)
⚛	Speciated Deteminand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
ND	Not detected
CLP: Note 1	Only the metal concentration has been used for classification

Classification of sample: GWPR3599 WS2@0.30m

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

Sample details

Sample Name:		LoW Code:	
GWPR3599 WS2@0.30m		Chapter:	17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Sample Depth:			
0.3 m		Entry:	17 05 04 (Soil and stones other than those mentioned in 17 05 03)
Moisture content:			
8% (no correction)			

Hazard properties

None identified

Determinands

Moisture content: 8% No Moisture Correction applied (MC)

#		Determinand	CLP index number	EC Number	CAS Number	CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
1		pH			PH		7.8	pH		7.8	pH	7.8 pH		
2		cyanides { salts of hydrogen cyanide with the exception of complex cyanides such as ferrocyanides, ferricyanides and mercuric oxycyanide and those specified elsewhere in this Annex }	006-007-00-5				<2	mg/kg	1.884	<3.768	mg/kg	<0.000377 %		<**LOD**
3		arsenic { arsenic trioxide }	033-003-00-0	215-481-4	1327-53-3		7	mg/kg	1.32	9.242	mg/kg	0.000924 %		
4		boron { boron tribromide/trichloride/trifluoride (combined) }			10294-33-4, 10294-34-5, 7637-07-2		<1	mg/kg	13.43	<13.43	mg/kg	<0.00134 %		<**LOD**
5		cadmium { cadmium sulfide }	048-010-00-4	215-147-8	1306-23-6	1	<0.2	mg/kg	1.285	<0.257	mg/kg	<0.00002 %		<**LOD**
6		Chromium (III) Sulphate			10101-53-8		20	mg/kg		20	mg/kg	0.002 %		
7		chromium { chromium(VI) oxide }	024-001-00-0	215-607-8	1333-82-0		<2	mg/kg	1.923	<3.846	mg/kg	<0.000385 %		<**LOD**
8		copper { dicopper oxide; copper (I) oxide }	029-002-00-X	215-270-7	1317-39-1		28	mg/kg	1.126	31.525	mg/kg	0.00315 %		
9		lead { lead chromate }	082-004-00-2	231-846-0	7758-97-6	1	135	mg/kg	1.56	210.575	mg/kg	0.0135 %		
10		mercury { mercury dichloride }	080-010-00-X	231-299-8	7487-94-7		<1	mg/kg	1.353	<1.353	mg/kg	<0.000135 %		<**LOD**
11		nickel { nickel dihydroxide }	028-008-00-X	235-008-5 [1] 234-348-1 [2]	12054-48-7 [1] 11113-74-9 [2]		13	mg/kg	1.579	20.533	mg/kg	0.00205 %		
12		selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }	034-002-00-8				<3	mg/kg	2.554	<7.661	mg/kg	<0.000766 %		<**LOD**

#		Determinand			CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
		CLP index number	EC Number	CAS Number									
13		vanadium { divanadium pentaoxide; vanadium pentoxide }				20	mg/kg	1.785	35.704	mg/kg	0.00357 %		
		023-001-00-8	215-239-8	1314-62-1									
14		zinc { zinc chloride }				60	mg/kg	2.085	125.071	mg/kg	0.0125 %		
		030-003-00-2	231-592-0	7646-85-7									
15		phenol				<2	mg/kg		<2	mg/kg	<0.0002 %		<LOD
		604-001-00-2	203-632-7	108-95-2									
16		naphthalene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
		601-052-00-2	202-049-5	91-20-3									
17	●	acenaphthylene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
			205-917-1	208-96-8									
18	●	acenaphthene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
			201-469-6	83-32-9									
19	●	fluorene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
			201-695-5	86-73-7									
20	●	phenanthrene				0.52	mg/kg		0.52	mg/kg	0.000052 %		
			201-581-5	85-01-8									
21	●	anthracene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
			204-371-1	120-12-7									
22	●	fluoranthene				1.37	mg/kg		1.37	mg/kg	0.000137 %		
			205-912-4	206-44-0									
23	●	pyrene				1.18	mg/kg		1.18	mg/kg	0.000118 %		
			204-927-3	129-00-0									
24		benzo[a]anthracene				0.53	mg/kg		0.53	mg/kg	0.000053 %		
		601-033-00-9	200-280-6	56-55-3									
25		chrysene				0.67	mg/kg		0.67	mg/kg	0.000067 %		
		601-048-00-0	205-923-4	218-01-9									
26		benzo[b]fluoranthene				0.91	mg/kg		0.91	mg/kg	0.000091 %		
		601-034-00-4	205-911-9	205-99-2									
27		benzo[k]fluoranthene				0.37	mg/kg		0.37	mg/kg	0.000037 %		
		601-036-00-5	205-916-6	207-08-9									
28		benzo[a]pyrene; benzo[def]chrysene				0.72	mg/kg		0.72	mg/kg	0.000072 %		
		601-032-00-3	200-028-5	50-32-8									
29	●	indeno[123-cd]pyrene				0.62	mg/kg		0.62	mg/kg	0.000062 %		
			205-893-2	193-39-5									
30		dibenz[a,h]anthracene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
		601-041-00-2	200-181-8	53-70-3									
31	●	benzo[ghi]perylene				0.38	mg/kg		0.38	mg/kg	0.000038 %		
			205-883-8	191-24-2									
32		benzene				<0.002	mg/kg		<0.002	mg/kg	<0.0000002 %		<LOD
		601-020-00-8	200-753-7	71-43-2									
33		toluene				<0.005	mg/kg		<0.005	mg/kg	<0.0000005 %		<LOD
		601-021-00-3	203-625-9	108-88-3									
34	●	ethylbenzene				<0.002	mg/kg		<0.002	mg/kg	<0.0000002 %		<LOD
		601-023-00-4	202-849-4	100-41-4									
35		xylene				<0.002	mg/kg		<0.002	mg/kg	<0.0000002 %		<LOD
		601-022-00-9	202-422-2 [1] 203-396-5 [2] 203-576-3 [3] 215-535-7 [4]	95-47-6 [1] 106-42-3 [2] 108-38-3 [3] 1330-20-7 [4]									
36		o-xylene; [1] p-xylene; [2] m-xylene; [3] xylene [4]				<0.002	mg/kg		<0.002	mg/kg	<0.0000002 %		<LOD
		601-022-00-9	202-422-2 [1] 203-396-5 [2] 203-576-3 [3] 215-535-7 [4]	95-47-6 [1] 106-42-3 [2] 108-38-3 [3] 1330-20-7 [4]									
37	●	diesel petroleum group				<3	mg/kg		<3	mg/kg	<0.0003 %		<LOD
				68334-30-5, 68476-34-6, 94114-59-7, 1159170-26-9									
38	●	TPH (C6 to C40) petroleum group				<42	mg/kg		<42	mg/kg	<0.0042 %		<LOD
				TPH									
										Total:	0.0462 %		

Key

🟨	User supplied data
▨	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
●	Determinand defined or amended by HazWasteOnline (see Appendix A)
👤	Determinand defined by classifier (see Appendix A)
⚗	Speciated Deteminand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
ND	Not detected
CLP: Note 1	Only the metal concentration has been used for classification

Classification of sample: GWPR3599 WS4@0.30m

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

Sample details

Sample Name:		LoW Code:	
GWPR3599 WS4@0.30m		Chapter:	17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Sample Depth:			
0.3 m		Entry:	17 05 04 (Soil and stones other than those mentioned in 17 05 03)
Moisture content:			
22% (no correction)			

Hazard properties

None identified

Determinands

Moisture content: 22% No Moisture Correction applied (MC)

#		Determinand			CLP Note	**User entered data**		Conv. Factor	Compound conc.		**Classification value**	MC Applied	Conc. Not Used
		CLP index number	EC Number	CAS Number									
1	●	pH				7.7	pH		7.7	pH	7.7 pH		
				PH									
2		cyanides { ● salts of hydrogen cyanide with the exception of complex cyanides such as ferrocyanides, ferricyanides and mercuric oxycyanide and those specified elsewhere in this Annex }				<2	mg/kg	1.884	<3.768	mg/kg	<0.000377 %		<**LOD**
		006-007-00-5											
3		arsenic { arsenic trioxide }				16	mg/kg	1.32	21.125	mg/kg	0.00211 %		
		033-003-00-0	215-481-4	1327-53-3									
4		boron { ● boron tribromide/trichloride/trifluoride (combined) }				<1	mg/kg	13.43	<13.43	mg/kg	<0.00134 %		<**LOD**
				10294-33-4, 10294-34-5, 7637-07-2									
5		cadmium { cadmium sulfide }			1	0.7	mg/kg	1.285	0.9	mg/kg	0.00007 %		
		048-010-00-4	215-147-8	1306-23-6									
6		Chromium (III) Sulphate				21	mg/kg		21	mg/kg	0.0021 %		
				10101-53-8									
7		chromium { chromium(VI) oxide }				<2	mg/kg	1.923	<3.846	mg/kg	<0.000385 %		<**LOD**
		024-001-00-0	215-607-8	1333-82-0									
8		copper { ● dicopper oxide; copper (I) oxide }				102	mg/kg	1.126	114.841	mg/kg	0.0115 %		
		029-002-00-X	215-270-7	1317-39-1									
9		lead { lead chromate }			1	433	mg/kg	1.56	675.4	mg/kg	0.0433 %		
		082-004-00-2	231-846-0	7758-97-6									
10		mercury { mercury dichloride }				<1	mg/kg	1.353	<1.353	mg/kg	<0.000135 %		<**LOD**
		080-010-00-X	231-299-8	7487-94-7									
11		nickel { nickel dihydroxide }				19	mg/kg	1.579	30.01	mg/kg	0.003 %		
		028-008-00-X	235-008-5 [1] 234-348-1 [2]	12054-48-7 [1] 11113-74-9 [2]									
12		selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }				<3	mg/kg	2.554	<7.661	mg/kg	<0.000766 %		<**LOD**
		034-002-00-8											

#		Determinand	CLP index number	EC Number	CAS Number	CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
13		vanadium { divanadium pentaoxide; vanadium pentoxide }	023-001-00-8	215-239-8	1314-62-1		43	mg/kg	1.785	76.763	mg/kg	0.00768 %		
14		zinc { zinc chloride }	030-003-00-2	231-592-0	7646-85-7		363	mg/kg	2.085	756.681	mg/kg	0.0757 %		
15		phenol	604-001-00-2	203-632-7	108-95-2		<2	mg/kg		<2	mg/kg	<0.0002 %		<LOD
16		naphthalene	601-052-00-2	202-049-5	91-20-3		0.76	mg/kg		0.76	mg/kg	0.000076 %		
17	●	acenaphthylene		205-917-1	208-96-8		<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
18	●	acenaphthene		201-469-6	83-32-9		0.65	mg/kg		0.65	mg/kg	0.000065 %		
19	●	fluorene		201-695-5	86-73-7		0.55	mg/kg		0.55	mg/kg	0.000055 %		
20	●	phenanthrene		201-581-5	85-01-8		5.08	mg/kg		5.08	mg/kg	0.000508 %		
21	●	anthracene		204-371-1	120-12-7		0.49	mg/kg		0.49	mg/kg	0.000049 %		
22	●	fluoranthene		205-912-4	206-44-0		9.65	mg/kg		9.65	mg/kg	0.000965 %		
23	●	pyrene		204-927-3	129-00-0		7.83	mg/kg		7.83	mg/kg	0.000783 %		
24		benzo[a]anthracene	601-033-00-9	200-280-6	56-55-3		3.58	mg/kg		3.58	mg/kg	0.000358 %		
25		chrysene	601-048-00-0	205-923-4	218-01-9		3.9	mg/kg		3.9	mg/kg	0.00039 %		
26		benzo[b]fluoranthene	601-034-00-4	205-911-9	205-99-2		4.97	mg/kg		4.97	mg/kg	0.000497 %		
27		benzo[k]fluoranthene	601-036-00-5	205-916-6	207-08-9		1.86	mg/kg		1.86	mg/kg	0.000186 %		
28		benzo[a]pyrene; benzo[def]chrysene	601-032-00-3	200-028-5	50-32-8		3.24	mg/kg		3.24	mg/kg	0.000324 %		
29	●	indeno[123-cd]pyrene		205-893-2	193-39-5		2.22	mg/kg		2.22	mg/kg	0.000222 %		
30		dibenz[a,h]anthracene	601-041-00-2	200-181-8	53-70-3		0.35	mg/kg		0.35	mg/kg	0.000035 %		
31	●	benzo[ghi]perylene		205-883-8	191-24-2		1.68	mg/kg		1.68	mg/kg	0.000168 %		
32		benzene	601-020-00-8	200-753-7	71-43-2		<0.002	mg/kg		<0.002	mg/kg	<0.0000002 %		<LOD
33		toluene	601-021-00-3	203-625-9	108-88-3		<0.005	mg/kg		<0.005	mg/kg	<0.0000005 %		<LOD
34	●	ethylbenzene	601-023-00-4	202-849-4	100-41-4		<0.002	mg/kg		<0.002	mg/kg	<0.0000002 %		<LOD
35		xylene	601-022-00-9	202-422-2 [1] 203-396-5 [2] 203-576-3 [3] 215-535-7 [4]	95-47-6 [1] 106-42-3 [2] 108-38-3 [3] 1330-20-7 [4]		<0.002	mg/kg		<0.002	mg/kg	<0.0000002 %		<LOD
36		o-xylene; [1] p-xylene; [2] m-xylene; [3] xylene [4]	601-022-00-9	202-422-2 [1] 203-396-5 [2] 203-576-3 [3] 215-535-7 [4]	95-47-6 [1] 106-42-3 [2] 108-38-3 [3] 1330-20-7 [4]		<0.002	mg/kg		<0.002	mg/kg	<0.0000002 %		<LOD
37	●	diesel petroleum group			68334-30-5, 68476-34-6, 94114-59-7, 1159170-26-9		35	mg/kg		35	mg/kg	0.0035 %		
38	●	TPH (C6 to C40) petroleum group			TPH		86	mg/kg		86	mg/kg	0.0086 %		
											Total:	0.165 %		

Key

🟨	User supplied data
▨	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
●	Determinand defined or amended by HazWasteOnline (see Appendix A)
👤	Determinand defined by classifier (see Appendix A)
⚛	Speciated Deteminand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
ND	Not detected
CLP: Note 1	Only the metal concentration has been used for classification

Supplementary Hazardous Property Information

HP 3(i): Flammable "flammable liquid waste: liquid waste having a flash point below 60°C or waste gas oil, diesel and light heating oils having a flash point > 55°C and <= 75°C"

Force this Hazardous property to non hazardous because Heavy end hydrocarbons unlikely to flammable at the concentrations noted

Hazard Statements hit:

Flam. Liq. 3; H226 "Flammable liquid and vapour."

Because of determinands:

diesel petroleum group: (conc.: 0.0035%)
TPH (C6 to C40) petroleum group: (conc.: 0.0086%)

Appendix A: Classifier defined and non CLP determinands

● **pH** (CAS Number: PH)

Description/Comments: Appendix C4
Data source: WM3 1st Edition 2015
Data source date: 25 May 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
Description/Comments: Conversion factor based on a worst case compound: sodium cyanide
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 for additional Hazards Statement(s):
14 Dec 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
Description/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 Aug 2015
Risk Phrases: C R35 , C R34 , T+ R26/28 , R14
Hazard Statements: Skin Corr. 1B H314 , Skin Corr. 1A H314 , Acute Tox. 2 H300 , Acute Tox. 2 H330 , EUH014

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

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

● **dicopper oxide; copper (I) oxide** (EC Number: 215-270-7, CAS Number: 1317-39-1)

CLP index number: 029-002-00-X
Description/Comments: M-factor for long-term aquatic hazard not included as per paragraph (5), ATP9
Data source: Regulation (EU) 2016/1179 of 19 July 2016 (ATP9)
Additional Risk Phrases: N R50/53 >= 0.25 %, N R50/53
Additional Hazard Statement(s): None.
Reason for additional Hazards Statement(s):
10 Oct 2016 - N R50/53 >= 0.25 % risk phrase sourced from: WM3 v1 still uses ecotoxic risk phrases
10 Oct 2016 - N R50/53 risk phrase sourced from: WM3 v1 still uses ecotoxic risk phrases

● **acenaphthylene** (EC Number: 205-917-1, CAS Number: 208-96-8)

Description/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 Jul 2015
Risk Phrases: R38 , R37 , R36 , R27 , R26 , R22
Hazard Statements: Skin Irrit. 2 H315 , STOT SE 3 H335 , Eye Irrit. 2 H319 , Acute Tox. 1 H310 , Acute Tox. 1 H330 , Acute Tox. 4 H302

● **acenaphthene** (EC Number: 201-469-6, CAS Number: 83-32-9)

Description/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 Jul 2015
Risk Phrases: N R51/53 , N R50/53 , R38 , R37 , R36
Hazard Statements: Aquatic Chronic 2 H411 , Aquatic Chronic 1 H410 , Aquatic Acute 1 H400 , Skin Irrit. 2 H315 , STOT SE 3 H335 , Eye Irrit. 2 H319

- **fluorene** (EC Number: 201-695-5, CAS Number: 86-73-7)

Description/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 Aug 2015
Risk Phrases: N R50/53
Hazard Statements: Aquatic Chronic 1 H410 , Aquatic Acute 1 H400

- **phenanthrene** (EC Number: 201-581-5, CAS Number: 85-01-8)

Description/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 Aug 2015
Risk Phrases: N R50/53 , R43 , R40 , R38 , R37 , R36 , R22
Hazard Statements: Skin Irrit. 2 H315 , Aquatic Chronic 1 H410 , Aquatic Acute 1 H400 , Skin Sens. 1 H317 , Carc. 2 H351 , STOT SE 3 H335 , Eye Irrit. 2 H319 , Acute Tox. 4 H302

- **anthracene** (EC Number: 204-371-1, CAS Number: 120-12-7)

Description/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 Jul 2015
Risk Phrases: N R50/53 , R43 , R38 , R37 , R36
Hazard Statements: Aquatic Chronic 1 H410 , Aquatic Acute 1 H400 , Skin Sens. 1 H317 , Skin Irrit. 2 H315 , STOT SE 3 H335 , Eye Irrit. 2 H319

- **fluoranthene** (EC Number: 205-912-4, CAS Number: 206-44-0)

Description/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 Aug 2015
Risk Phrases: N R50/53 , Xn R22
Hazard Statements: Aquatic Chronic 1 H410 , Aquatic Acute 1 H400 , Acute Tox. 4 H302

- **pyrene** (EC Number: 204-927-3, CAS Number: 129-00-0)

Description/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 Aug 2015
Risk Phrases: N R50/53 , Xi R36/37/38
Hazard Statements: Aquatic Chronic 1 H410 , Aquatic Acute 1 H400 , STOT SE 3 H335 , Eye Irrit. 2 H319 , Skin Irrit. 2 H315

- **indeno[123-cd]pyrene** (EC Number: 205-893-2, CAS Number: 193-39-5)

Description/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 Aug 2015
Risk Phrases: R40
Hazard Statements: Carc. 2 H351

- **benzo[ghi]perylene** (EC Number: 205-883-8, CAS Number: 191-24-2)

Description/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 Jul 2015
Risk Phrases: N R50/53
Hazard Statements: Aquatic Chronic 1 H410 , Aquatic Acute 1 H400

- **ethylbenzene** (EC Number: 202-849-4, CAS Number: 100-41-4)

CLP index number: 601-023-00-4
Description/Comments:
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 for additional Hazards Statement(s):
03 Jun 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)

Description/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 May 2015
Risk Phrases: R66 , R65 , R51/53 , R40
Hazard Statements: Aquatic Chronic 2 H411 , STOT RE 2 H373 , Asp. Tox. 1 H304 , Carc. 2 H351 , Acute Tox. 4 H332 , Skin Irrit. 2 H315 , Flam. Liq. 3 H226

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

Description/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 May 2015
Risk Phrases: R65 , R63 , R51/53 , R46 , R45 , R10
Hazard Statements: Aquatic Chronic 2 H411 , Repr. 2 H361d , Carc. 1B H350 , Muta. 1B H340 , STOT RE 2 H373 , Asp. Tox. 1 H304 , Flam. Liq. 3 H226

Appendix B: Rationale for selection of metal species

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

Worst case species

arsenic {arsenic trioxide}

Worst case species based on risk phrases

boron {boron tribromide/trichloride/trifluoride (combined)}

Worst case species based on risk phrases

cadmium {cadmium sulfide}

Worst case species based on risk phrases

chromium {chromium(VI) oxide}

Worst case species based on risk phrases

copper {dicopper oxide; copper (I) oxide}

Most likely common species

lead {lead chromate}

Worst case species based on risk phrases

mercury {mercury dichloride}

Worst case species based on risk phrases

nickel {nickel dihydroxide}

Worst case species based on risk phrases

selenium {selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex}

Worst case species based on risk phrases

vanadium {divanadium pentaoxide; vanadium pentoxide}

most common form

zinc {zinc chloride}

Zinc chromate unlikely to be found on-site

Appendix C: Version

HazWasteOnline Classification Engine: WM3 1st Edition, May 2015
HazWasteOnline Classification Engine Version: 2020.128.4292.8469 (09 May 2020)
HazWasteOnline Database: 2020.128.4292.8469 (09 May 2020)

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
10th ATP - Regulation (EU) 2017/776 of 4 May 2017
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