Charlie Ratchford Extra-Care Scheme, Crogsland Road, Camden

Phase 1 and Phase 2 Ground Condition Assessment

On behalf of: **London Borough of Camden**

Project Ref: 31103/3501 | Document: R001/rev0| October 2014

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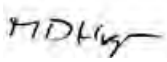
Approved and Reviewed by:	Martyn Higham	Senior Associate		14/10/2014
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Summary

This report presents a combined Phase 1 and Phase 2 Ground Condition Assessment for the second phase of a proposed extra care scheme to be constructed on the land at Crogsland Road, Camden. The report also presents comments on the ground conditions and characteristic values for use in the design of the geotechnical elements of the proposed development.

Site Location The Site is situated within the London Borough of Camden surrounded by residential properties and a school. The site was occupied by terraced housing until the 1970s when school buildings were constructed following the demolition of the housing. The school buildings were demolished in the mid-2000s. The site is currently used as an at-grade car park.

Ground Conditions The ground conditions revealed by the investigation typically comprise Made Ground to about 1 and 2 m depth underlain by the London Clay Formation to an investigated depth of 30 m below ground level. Groundwater was found to be between 2 and 4 m below ground level.

Geoenvironmental Conditions The measured concentrations of potential contaminants are generally below the selected assessment values appropriate for land uses as residential with plant uptake and allotments. The exceptions comprise slightly elevated concentrations of lead and individual Polynuclear Aromatic Hydrocarbons (PAHs). The measured concentrations of ground gases indicate predominantly near atmospheric conditions are present across the Site.

Ground Stability Risk Assessment A review of potential geological hazards has identified the risk for potentially adverse foundation conditions to be present, in general, to be **Very Low**. The exception relates to a **Moderate** potential risk for volume change owing to the presence of shrinking/swelling clays.

Geotechnical Considerations For the ground conditions encountered on the Site, piled foundations supported in the London Clay Formation are likely to be an appropriate option for founding the proposed building. Preliminary pile capacity estimates for bored and cast insitu piles are presented in the report. Based upon the ground conditions encountered at the Site, it is expected that the proposed buildings will require suspended floor slabs due to the thickness of the Made Ground. It is recommended that concrete in contact with the ground is designed for Class AC-4 as defined by BRE (2005).

Tier 2 Geoenvironmental Risk Assessment The findings of a qualitative risk assessment carried out to assess hazards and constraints posed by the existing site conditions to the proposed development are summarised in the following table.

Potential Receptor	Risk Assessment	Description
Site Workers	Low	The risk to site workers is expected to be Low provided appropriate protective clothing and equipment are worn, and good standards of hygiene are adopted to prevent prolonged skin contact, inhalation and ingestion of soils.
Future Site Users	Very Low	The proposed buildings and hard surfaces, together with the provision of a layer of topsoil/subsoil along with a geotextile grid in areas of soft landscaping will effectively mitigate the exposure of future site occupiers and users to any potential contaminants.
Ground Waters	Very Low	Given the nature of the proposed development, the potential for any mobile contaminants to adversely affect the quality of ground and surface waters is considered to remain as Very Low.
Surface Waters	Very Low	
Ecology and Wildlife	Very Low	Owing to the potential for contaminants to be present in the ground and the distance to the nearest ecological receptor the risk to ecology and wildlife is expected to remain as Very Low.

The geoenvironmental risk assessment indicates that any potential contaminants and hazardous ground gases do not by themselves represent an unacceptable risk to the human health, controlled waters or ecology and wildlife associated with the development of the Site as currently proposed. On this basis, specific mitigation or remediation works in advance of the construction works or beyond the limit of those works are not required. In addition, there is no reason that the site would be designated as Contaminated Land under Part IIa of the Environmental Protection Act 1990.

The summary contains an overview of the key findings and conclusions. However no reliance should be placed on any part of the summary until the whole of the report has been read.

1.0 Introduction

Peter Brett Associates LLP (PBA) has been commissioned by E C Harris LLP acting on behalf of the London Borough of Camden (the Client) to carry out a Phase 1 and Phase 2 Ground Condition Assessment for the proposed Charlie Ratchford Extra-Care Scheme at Crogsland Road, Camden.

An intrusive ground investigation has been carried out to provide information on the ground conditions and the potential for contamination to be present on the Site, together with information for the design and construction of foundations and infrastructure. The fieldwork and laboratory testing were carried out by Ground Technology Services Limited acting under the instruction and technical direction of Peter Brett Associates LLP. The factual results of the investigation are presented in a separate report prepared by Ground Technology Services Limited (GTSL, 2014).

This Phase 1 and Phase 2 Ground Condition Assessment presents an assessment of the ground conditions at the Site and immediate surrounding land and a Tier 2 qualitative geoenvironmental assessment of the risks and hazards associated with existing or potential future contamination in the ground. In accordance with the requirements of the National Planning Policy Framework(DCLoG, 2012), the Tier 2 assessment has been carried out in accordance with "established procedures" using current UK best practice and guidance as given in British Standard 10175 (2001), Contaminated Land Report 11 (EA, 2004) and NHBC Standards Chapter 4.1 (NHBC, 2014).

This report also presents a qualitative assessment of the geotechnical constraints to the development, comments on the ground conditions in relation to the design and construction of the proposed development, and characteristic values for use in the design of the geotechnical elements of the proposed development. These sections of the report have been prepared in accordance with the requirements of BS EN 1997-2 (2007).

Unless stated otherwise, detailed information from ground investigation has not been included in this report and, where referenced, the report presenting this information should be read in conjunction with this report.

Guidance on the context of this report and any general limitations or constraints on its content and usage are given in a guidance note included after the text of this report.

2.0 The Site

2.1 Site Location

The Site is centred on National Grid Reference TQ 282 845 about 0.9 km northwest of the historical centre of Camden Town as shown on **Figure 1**, Site Location Plan.

The ground level in the general vicinity of the Site is falling gently to the southeast towards the River Fleet (now culverted) that is situated about 0.2 km to the east of the Site. The ground level in the northwest corner of the site is about 33 m OD falling gently to the southeast where the ground level is about 31 m OD.

The Site is fronting Crogsland Road to the east, is bounded to the north with terraced housing and to the south and west by Haverstock School. The layout of the Site is shown on a Site Layout Plan presented as **Figure 2** of this report.

2.2 Site History

Information on the history of the Site and surrounding area has been determined by reference to a number of readily available historical and current Ordnance Survey (OS) maps supplemented where possible by reference to early maps and other historical records. Copies of the extracts from the OS maps are presented in **Appendix 1**; for ease of presentation the OS maps are presented at a reduced scale (from A3 to A4) with duplicate and blank maps omitted.

The earliest records available from the early 1830s show the site to be undeveloped farmland. By the mid 1860s residential premises are shown in the land surrounding the Site with the northern part of Crogsland Road shown in its current alignment. Camden Town Railway Depot and Chalk Farm Station are shown about 0.1 km to the south of the Site.

The earliest records of OS maps available date from the early 1870s and show the Site to be occupied by terraced housing fronting onto Crogsland Road with gardens at the rear of the properties. Crogsland Road is shown on about its present alignment with a small cul-de-sac denoted Kirkwood Road branching off Crogsland Road immediately to the south of the Site. Terraced housing is shown immediately to the north of the Site, and to the southwest of the southern part of the Site fronting Kirkwood Road. Large buildings and gardens later denoted School are shown immediately to the west of the Site.

By the mid 1890s a large school building denoted 'Boys & Girls School' was constructed in the former garden to the west of the Site. The Malden Factories manufacturing of oil and watercolour paints was constructed about 0.2 km to the northeast of the Site.

No significant changes are shown at or in the near vicinity of the Site until the early 1950s. The Bomb Damage Maps (LTS, 2005) indicate the site and its surroundings suffered from extensive damage owing to German air dropped bombing during World War II. By early 1950s four terraced properties at the Site were no longer recorded or recorded to be 'ruin'. The terraced housing and the large building immediately to the west of the Site were no longer recorded. The former school building to the west of the site was demolished and a new school building was constructed in the same area. One of the terraced propertied along the southern part of Kirkwood Place is denoted 'Works'.

By the mid 1960s the terraced housing at and to the south of the Site along Kirkwood Place were demolished and replaced with three large buildings as part of the Haverstock Secondary School. Subsequently, the terraced housing to the east of Crogsland Road were demolished and by early 1970s

were replaced by housing blocks. By the early 1980s the Charlie Ratchford Centre was constructed to the east of Crogsland Road comprising a single storey building.

By the mid 2000s, the school buildings that occupied the Site were demolished and a single building denoted Haverstock School was constructed with sports pitches immediately to the west and south of the Site. The site itself is shown to be vacant.

2.3 Current Site Use

The Site is accessed off a lockable metal gate off Crogsland Road. The site itself is used for at-grade car parking by the staff of Haverstock School on an area covered by asphalt. A large store used by the school is situated at the site by the gate. A cluster of semi mature trees surrounded by a metal fence are present at the southern part of the Site. The remained of the site is covered with scrubs with the remains of the former buildings and slabs locally visible.

The layout of the Site is shown on the Site Layout Plan presented as **Figure 2**.

2.4 Environmental and Industrial Setting

Information on the environmental and industrial setting of the Site is presented in a GroundSure EnviroInsight Report (Emap, 2014) prepared for the Site, a copy of this report is reproduced in **Appendix 2**.

The results of the database search are summarised on the following table and discussed in the following sections.

Summary of Environmental and Industrial Setting

Data Type	Number on Site [1]	Number within 250 m of Site [1]
Waste Regulation		
Landfill Sites	0 (0)	0 (0)
Licensed Waste Management Facilities	0 (0)	0 (0)
Statutory Permits/Authorisations		
Part A(1) and IPPC Permitted Activities[2]	0 (0)	0 (0)
Part A(2) and Part B Permitted Activities	0 (0)	1 (0)
Radioactive Substance Authorisations	0 (0)	0 (0)
Planning Hazardous Substances[3]	0 (0)	0 (0)
National Incidents Recording System, List 1	0 (0)	0 (0)
National Incidents Recording System, List 2	0 (0)	1 (0)
Potential Contaminative Uses		
Fuel Stations	0	2
Current Industrial Sites Data	0	22

Note: 1) Numbers in brackets denotes number of authorisations, licences or permits that are lapsed, revoked, cancelled, superseded, defunct, surrendered, not applicable, withdrawn or not yet started.
2) Includes historic Integrated Pollution Controls, Integrated Pollution Prevention and Control, Local Authority Integrated Pollution Prevention and Control and Local Authority Pollution Prevention and Control permits.
3) Includes COMAH (Control of Major Accident Hazards) and NIHHS (Notification of Installations Handling Hazardous Substances) sites.
4) Number corrected to omit directory entries incorrectly shown within the site boundaries.

Statutory Permits/Authorisations/Potential Contaminative Uses The statutory permits and authorisations together with the trade directory entries identified in the vicinity of the Site typically relate

to local light industrial and commercial activities, and local infrastructure facilities. The closest record relates to Fish, Meat and Poultry Products manufacturer located about 40 m to the southeast of the Site.

A single pollution incident is recorded about 120 m to the northeast of the Site. The pollution incident is related to Organic Chemicals/Products dated 30 May 2002. The impact to water, land and air was recorded to be Category 4 (No Impact).

Given their nature, size and/or distance from the Site and considering the regulatory regime under which potentially contaminative industries operate, none of the activities listed are considered to represent a particular risk of environmental hazard to the Site or the proposed development.

Areas of Environmental Sensitivity The closest statutory designated area of environmental sensitivity to the Site is Belsize Wood, a designated Local Nature Reserve (LNR), located approximately 1.0 km northwest of the Site. This LNR comprises a small woodland that has a broad diversity of insect species.

2.5 Proposed Development

The proposed development comprises the construction of six storey building to be used as care home with limited landscaping areas.

3.0 Geology, Hydrogeology and Hydrology

3.1 Geology

3.1.1 Published Geology

The 1:50 000 scale geological map of the area (BGS, 2006) and the geological memoir (BGS, 2004) indicate that the Site lies directly on the London Clay Formation underlain by the Lambeth Group (formerly denoted the Woolwich and Reading Beds) and Thanet Sand Formation with the Seaford and Newhaven Chalk Formations (formerly denoted the Upper Chalk) present at depth.

It is expected that the natural deposits are overlain by Made Ground associated with the former and current developments of the Site.

An historical borehole record held by the BGS archive situated about 0.3 km to the southeast indicates that the London Clay Formation is at least 31 m thick in the area of the Site.

3.2 Geological Hazards

Radon Radon is a naturally occurring radioactive gas and emanates from geological formations to varying degrees, depending on the type, porosity and permeability. The guidance notes (BRE, 2007) indicate (i) that the Site is situated within an area where less than 1 per cent of homes are affected by radon above the action level for either basic or full radon protection, and (ii) that the geological units underlying the Site are not known to produce significant quantities of radon. This assessment indicates that Site is situated in area where protection measures are currently not required for radon gas.

3.3 Hydrogeology

The published groundwater vulnerability map of the area (NRA, 1995) indicates the London Clay Formation is classified as an Unproductive Strata (formerly non-aquifer), these are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow. Although the groundwater flow in the London Clay Formation is imperceptible, groundwater flow through such formations may take place and needs to be considered in assessing the effects of any basement development on the hydrogeological regime and the risk associated with persistent pollutants.

The Seaford and Newhaven Chalk Formations, present at depth below the Site, represent a regionally important Principal (formerly Major) Aquifer. Principal Aquifers are defined as formations that may be highly productive and able to support large abstractions for public supply and other purposes.

The overlying Thanet Sand Formation and Lambeth Group are classified as Secondary (formerly Minor) Aquifers, which are formations of variable permeability that, although seldom producing large quantities of water for abstraction, may be important for local supplies and in supplying base flow to rivers.

The main hydrogeological significance of the London Clay Formation, and to a lesser extent the Lambeth Group, is to confine the aquifer in the Thanet Sand Formation and Seaford and Newhaven Chalk Formations. For the purposes of this report, the Thanet Sand Formation and Seaford and Newhaven Chalk Formations are considered to form the Chalk Aquifer, and the whole unit will be considered to be a Principal Aquifer for the purposes of the geoenvironmental risk assessment presented in this report.

The latest indicative maps included in the EnviroInsight Report (Emap, 2014) indicate that the Site is not located in any groundwater source protection zone. Groundwater source protection zones are defined as the groundwater catchment zones for significant public water supply and private wells or boreholes that supply water to potable or equivalent standards.

3.4 Hydrology

The nearest water course is the River Fleet flowing about 0.2 km to the east of the Site in general direction to the southeast towards the River Thames. The River Fleet was culverted in the 1870s during the residential development of the area around the river.

The Regent's Canal was constructed by the mid-1810s and is situated about 0.5 km to the southeast of the Site.

3.5 Groundwater and Surface Water Control

Information on ground and surface water controls is presented in the EnviroInsight Report (Emap, 2014) reproduced in **Appendix 2**. The results of the database search are summarised on the following table and indicate there are no licences related to groundwater or surface water in the vicinity of the Site..

Summary of Groundwater and Surface Water Control

Groundwater and Surface Water Controls	Number on Site [1]	Number within 0.5 km of Site [1]
Abstractions	0 (0)	0 (0)
Discharge Consents	0 (0)	0 (0)
Pollution Incidents to Controlled Waters	0	0
Prosecutions Relating to Controlled Waters	0	0

Notes: 1) Numbers in brackets denotes number of authorisations, licences or permits that are lapsed, revoked, cancelled, superseded, defunct, surrendered, not applicable or not yet started.

4.0 Ground Investigation

4.1 Ground Investigation

The ground conditions on the Site have been investigated by an intrusive ground investigation to provide information for the development of the Site. The scope of works is summarised in the following sections of this report. The factual results of the investigation are presented in a separate report prepared by Ground Technology Services Limited (GTSL, 2014) which should be read in conjunction with this report.

4.1.1 Fieldwork

The fieldwork for the ground investigation was carried out between the 18 and 21 August 2014 and comprised the sinking of two cable percussion boreholes, designated Boreholes 101 and 102, and the excavation of 8 trial pits, designated Trial Pits TP101, TP101A, and TP102 to 107.

The boreholes were sunk using cable percussion techniques to 20 and 30 m below existing ground level to provide information on ground conditions and to recover samples of the materials encountered for laboratory testing. The trial pits were excavated using a hydraulic excavator to depths between 1.55 and 3.7 m below existing ground level to obtain detailed information on the variation of near-surface ground conditions on the Site and .

In the boreholes, the ground conditions were investigated by the recovery of disturbed samples (small and bulk), recovery of soil samples with thin walled open tube sampler and standard penetration tests, and in the trial pits by the recovery of disturbed samples. On completion a groundwater and ground gas monitoring well was constructed in each borehole to allow groundwater levels and concentrations of ground gases to be monitored and samples of groundwater recovered for chemical analysis. The monitoring wells were constructed with 50 mm diameter well screen between 1 to 6 m depth.

The records of the exploratory holes are presented the factual report (GTSL, 2014) and their locations are shown on the Site Layout Plan, **Figure 2**.

4.1.2 Laboratory Testing

Geotechnical Laboratory Testing A programme of geotechnical laboratory soils testing was carried out to verify the visual identification and classification, and to determine the physical properties of selected samples of the materials encountered.

The testing was scheduled by PBA and carried out in accordance with BS 1377 (1990) by Geo Site & Testing Services Ltd, acting on behalf of Ground Technology Services Limited, who hold UKAS accreditation for geotechnical soil testing. The results of the geotechnical testing are presented in the factual report (GTSL, 2014).

Geochemical Laboratory Testing A programme of geochemical laboratory testing was carried out on 15 soil samples and 2 water samples to determine the concentrations of a range of commonly occurring potential contaminants. Samples of soil for geochemical testing were taken from the exploratory holes and the water samples were recovered from the monitoring wells.

The geochemical analyses were scheduled by PBA and carried out by Chemtest acting on behalf of Ground Technology Services Limited. The soil suites specified use methods that are accredited by MCERTS where available. The results of the chemical analyses are presented in the factual report (GTSL, 2014).

4.1.3 Monitoring

Each of the monitoring wells installed in the boreholes as part of the investigation have been monitored to determine the water level and the concentrations of methane, carbon monoxide, carbon dioxide, hydrogen sulphide and oxygen together with gas flow rates and differential and atmospheric pressure.

The monitoring was carried out on three visits between 28 August 2014 and 26 September 2014. The results of the monitoring are presented in the factual report (GTSL, 2014).

5.0 Ground Conditions

5.1 Stratigraphy

The ground conditions in the area of the Site, as revealed by the ground investigation, comprise the London Clay Formation. Made Ground was encountered above the London Clay in all the locations investigated.

Comments on the nature and extent of each stratum are presented in the following sections of this report taking into consideration the findings of the ground investigation. Where derived values of parameters for geotechnical design are recommended in the discussion on ground conditions below, reference should be made to the terminology and definitions given in BS EN 1997-1 (2004) and BS EN 1997-2 (2007) as appropriate. Characteristic values of geotechnical properties and design values for use in geotechnical design should be reviewed and selected by the Geotechnical Designer taking into consideration the limit states and design methods being used, and the process should be documented in the Geotechnical Design Report.

5.2 Made Ground

Description Made Ground was encountered at all the locations investigated and was found to be variable comprising SAND or CLAY with varying proportions of gravel. The gravel fraction comprised typically flint, brick, concrete, and mortar with locally wood, slate, glass, asphalt and other man-made materials. Locally the Made Ground contained cobble size fragments of concrete and whole bricks.

Floor slabs, asphalt layers, foundations and other sub surface structures were encountered within the Made Ground at various locations. These are likely to be the remains of the former buildings that occupied the Site. The foundations of the adjacent building at 11a Crogsland Road was investigated in two locations (TP101 and TP101A) situated along the northern boundary of the site. Details of the foundations and other sub surface structures are given in the exploratory hole records presented in the factual ground investigation report (GTSL, 2014).

Olfactory and visual signs of contamination were not noted during the investigation.

The Made Ground was encountered from the ground level to between 1.2 and 2.1 m depth.

Standard Penetration Test Values of measured penetration resistance determined by standard penetration testing are presented as a plot against reduced level on **Figure 3**. The values are between about 5 and 15.

5.3 London Clay Formation

The London Clay Formation was encountered below the Made Ground at all the locations investigated with the exception of Trial Pit TP101 where the Made Ground was not fully penetrated.

The London Clay Formation was found to comprise brown or grey CLAY. Locally the clay was found to be fissured and to contain occasional partings of silt and fine sand, and claystone nodules. The fissures were typically randomly orientated extremely closely to closely spaced. The claystone nodules were impersistent and were found locally in the formation.

The London Clay was encountered to the maximum depth investigated of 30.4 m below ground level, corresponding to a reduced level of 2.8 m OD.

Classification Results of classification testing are presented on a Casagrande Plasticity Chart on **Figure 4**. The results indicate the clay is generally of high plasticity with measured values of liquid and plastic limit typically between 50 and 70, and 20 and 35, respectively corresponding to plasticity index between about 30 and 35 per cent. Measured values of moisture content are between about 25 and 35 per cent.

Determined values of bulk unit weight are typically between about 18.9 and 20.6 kN/m^3. A characteristic value of 19.5 kN/m^3 is recommended for use in design analysis.

Undrained Shear Strength Manual examination of the material indicates the clay is typically firm increasing with depth to stiff and very stiff in consistency. Measured values of undrained shear strength, as determined by laboratory triaxial testing of 100 mm diameter specimens, are presented as a plot against reduced level on **Figure 5**. The measured values are typically in the range 60 to 300 kPa with a general trend of increasing strength with reducing elevation.

Derived values of undrained shear strength determined using the empirical correlation with SPT N values (Stroud, 1989) are also presented on **Figure 5**. The values as determined using a factor N_c of 4.5, indicating a similar trend of increasing strength with reducing elevation.

For design analysis, a characteristic shear strength profile increasing from 50 kPa at 30 m OD to 100 kPa at 25 m OD, and 220 kPa at 4 m OD as shown in **Figure 5** is recommended.

5.4 Groundwater

The groundwater entries and measured groundwater levels are presented in the ground investigation report (GTSL, 2014) and are discussed in this section of the report.

During the fieldwork, groundwater was encountered within the London Clay Formation at a depth of 26.4 m below ground level corresponding to a reduced level of about 4.7 m OD. Groundwater seepage was locally noted at the base of the Made Ground at 1.25 m below ground level.

On completion of the fieldwork for the investigation, groundwater levels between about 2.1 and 4.2 m below ground level, corresponding to reduced levels between about 29.5 and 31.1 m OD, were typically measured in the monitoring wells. It should be noted that the groundwater level in the monitoring wells installed within the London Clay Formation may have not reached equilibrium owing to the relatively low permeability of this stratum. For design purposes it is recommended that the groundwater level is assumed to be 1.5 m below existing ground level. It should be noted, however that locally higher water levels may be present following periods of prolonged rainfall.

For drainage design it should be assumed that the soils on the Site are, for practical purposes, impermeable.

6.0 Geoenvironmental Conditions

This section of the report discusses the measured concentrations of potential contaminants and assesses the geoenvironmental conditions on the site with respect to any hazards posed by the existing Site conditions to the proposed development and the environment.

6.1 Contamination

6.1.1 Geochemical Testing

Geochemical testing for a range of potential contaminants was carried out on 15 samples of soil recovered as part of the investigation for a range of general industrial contaminants; together with speciated determination of polynuclear aromatic hydrocarbons (PAH) and carbon banding of total petroleum hydrocarbons. The results of the testing of soil samples carried out are summarised on **Tables 1a** to **1c** and the water samples are summarised in **Table 2**. Full results of the chemical analysis carried out are presented in the factual report of the ground investigation (GTSL, 2014).

6.1.2 Contamination Assessment Regime

Soils The results of the geochemical testing on the soil samples have been compared to CLEA SGVs for land uses as residential with plant uptake and allotments (EA, 2009). Where a CLEA SGV is not available the concentrations were compared against the Land Quality Management Ltd (LQM) Generic Assessment Criteria (GACs) for a residential land use with plant uptake and an allotments land use (CIEH, 2009). Full details of the assessment criteria are given in the guidance note included after the text of this report.

Groundwater At present there is no guidance in the UK for assessing the quality of groundwater. Under the EC Groundwater Daughter Directive the quality of groundwater is related to the potential to adversely impact the quality of surface waters and the potential for use as a water resource. On this basis the quality of groundwater has been assessed in relation to the Water Framework Directive (DEFRA, 2010) and the UK drinking water quality standards (DETR, 2000).

Analysis of Data Guidance prepared under the auspices of DEFRA (CEIH, 2008) promotes the use of statistical analysis of the measured concentrations of potential contaminants. The outlier test identifies measurements that are large, or small, relative to the rest of the data and, therefore, suspected of misrepresenting the population from which they were collected. The one sample t-test provides an estimate of the upper bound concentration which the actual mean concentration will be below 19 times out of 20. Use of the outlier and one sample t-tests provides a robust statistical methodology for the assessment of concentration of potential contaminants.

6.1.3 Assessment of Contamination

Soils The measured concentrations of potential contaminants, as summarised on **Table 1a**, are generally below the selected assessment values appropriate for land uses as residential with plant uptake and allotments. The only exception is the elevated concentration of lead recorded in seven samples from the Made Ground. It is expected that these elevated lead concentrations are associated with the presence of man-made inclusions within the Made Ground.

Review of the carbon banded analysis (TPH), as summarised on **Table 1b**, indicates that the measured concentration of hydrocarbons is below the corresponding assessment values appropriate for land uses as residential with plant uptake.

The measured concentrations of PAH, as summarised on **Table 1c**, indicates the presence of slightly elevated concentration of a number of individual PAHs (Benzo(a)anthracene, Chrysene,

Benzo(b)fluoranthene, Benzo(a)pyrene, and Indeno(1,2,3-cd)pyrene) above the corresponding assessment values appropriate for land uses as residential with plant uptake and allotments. It is expected that these elevated concentrations are associated with the presence of man made materials and possible ash in the Made Ground.

Groundwaters The measured concentrations of potential contaminants, as summarised on **Table 2**, are below the selected assessment criteria for assessing potential groundwater impacts on surface waters and generally below the UK drinking water quality standards. The exceptions included elevated concentrations of sulphates and slightly elevated concentrations of selenium and ammoniacal nitrogen. It is expected that the elevated concentrations of sulphates result from the solution of natural minerals present within the soils on the Site. A specific reason for the marginally elevated concentrations of selenium and ammoniacal nitrogen is not known but it is just as likely to reflect the background quality of the groundwater in the vicinity of the Site owing to the general urban environment, as any contamination actually arising from the Site. As such the measured concentrations do not in themselves represent a particular concern for the proposed development,

6.1.4 Off Site Disposal

For the soil samples analysed, the measured concentrations of potential contaminants are generally below the assessment values appropriate for a residential land use. As such, the natural soils on the Site are not likely to contain significant concentrations of contaminants and in accordance with the criteria set in Part 3, of the Landfill (England and Wales) Amendment Regulations 2004, the natural soils at the Site are likely to be classified as inert waste.

With regard to the Made Ground, this material may contain slightly elevated concentrations of potential contaminants. If this material is to be disposed of or re-used off-site then discussions with the Landfill Operator and further testing, including Waste Acceptance Criteria (WAC) testing, may be required to determine the actual classification of the material to be disposed of off-site.

6.2 Ground Gases

The concentrations of ground gases have been measured in the gas monitoring wells installed in the boreholes sunk as part of the ground investigation and are summarised in the following table.

Measured Concentrations of Ground Gases

Gas	Concentration
Methane, %v/v	ND
Carbon Dioxide, %v/v	0.2 – 2.1
Oxygen, %v/v	16.1 – 19.2
Gas Flow, l/hr	0.01 – 0.11
Note ND denotes None Detected	

The measured concentrations of ground gases indicate predominantly near atmospheric conditions are present across the Site with slightly elevated concentration of carbon dioxide and corresponding slightly depleted oxygen concentrations. Assuming the measured concentrations of ground gases are representative of the long term equilibrium values, then the Site would, in general, be classified as Characteristic Situation 1 using the procedure for classifying gassing sites proposed by BS 8485 (2007). This Situation is representative of ground with a very low potential for gas generation. For Characteristic Situation 1, BS 8485 (2007) advise that gas protection measures are not required.

7.0 Ground Stability Risk Assessment

7.1 Introduction

In accordance with the requirements of the National Planning Policy Framework (DCLoG, 2012), the potential for the proposed development to contribute to or to be adversely affected by land instability has been assessed. Accordingly, consideration is given below to the potential risk of subsidence arising from Artificial Cavities; Natural Cavities; and Potential Adverse Foundation Conditions arising from existing ground conditions across the Site, as identified by the desk study and the ground investigation works.

7.2 Artificial and Natural Cavities

The Natural and National Mining Cavities Database maintained and updated by PBA has been searched for relevant natural and mining cavity records. No record was found of natural and mining cavities within a 1.0 km radius of the Site. Whilst the absence of existing records does not, in itself, demonstrate that natural or mining cavities are not present on the Site, the geology and geomorphological setting of the Site is such that the potential for such features to be present is considered to be **Very Low**.

7.3 Potential Adverse Foundation Conditions

An assessment of potential geological hazards that may give rise to adverse foundation or construction conditions as supplied by the British Geological Society from their National Geoscience Information Service are presented in an EnviroInsight Report (Emap, 2014) and reproduced in **Appendix 2**. The assessment is generated automatically based on digital geological maps and the scope and the accuracy is limited by the methods used to create the dataset and is therefore only indicative for the search area.

The information contained in the EnviroInsight Report has been reviewed and reassessed by PBA considering the specific information available for the Site. The modified assessment of the potential for geological hazards to be present on the Site is summarised below.

Summary of the Geological Hazards

Stability Hazard	Hazard Potential	Comment
Shrinking or Swelling Clay	Moderate	The London Clay Formation on the Site has a moderate volume change potential (NHBC, 2014). Due allowance will need to be made for the presence of trees and shrubs in the design of foundations, floor slabs and infrastructure founded on this strata.
Landslide	Very Low	The gradient of the Site is significantly flatter than the expected maximum safe gradient of the near surface soils on site.
Ground Dissolution	Very Low	The ground conditions are not considered to be susceptible to the development of natural cavities as a result of dissolution
Compressible Ground	Very Low	The ground conditions are such that layers of very soft compressible materials such as organic clay or peat are not expected to be present
Collapsible Ground	Very Low	The ground conditions are such that a rapid reduction in volume is not expected to occur when they are loaded and saturated with water.
Running Sand	Very Low	The ground conditions are such that no indicators for running sand have been identified. No special actions are required to avoid problems due to running sand.

8.0 Geotechnical Considerations

8.1 Foundations

Foundation Type The principal geotechnical consideration with regard to the proposed building is the strength and compressibility of the founding soils and, hence, the foundation requirements for the proposed building. The Made Ground is not likely to be suitable as a founding medium for spread foundations owing to their variability and potentially weak and compressible characteristics, which may result in excessive total and differential settlements.

For the ground conditions present on site and the estimated column loads from the proposed building it is anticipated that piled foundations are likely to provide a suitable solution to support the building.

It is anticipated that some form of rotary drilled or auger bored and cast in place piles including continuous flight auger systems will be appropriate although the presence of any existing foundations, below ground structures or mudstone/claystone layers in the London Clay may form obstructions to piling works. Temporary casing for the bored piling techniques may be required to support the soils in the Made Ground.

Axial Pile Resistance The axial capacity of piles should be determined from the characteristic design parameters recommended in **Section 4.0** of this report using the static design procedures recommended in BS EN 1997-1 (2004). In these procedures the axial capacity of the pile is taken to be the sum of the adhesion and friction on the pile shaft and the end bearing on the pile tip.

For the London Clay, the adhesion on the pile shaft is related to the undrained shear strength of the founding clay by an adhesion factor. The value of adhesion factor depends on the degree of softening and stress relief in the clay around the pile during boring and prior to concreting. The adhesion factor of 0.6 is considered appropriate for the design of cfa piles based on the results of triaxial compression tests on 100 mm diameter specimens. For the London Clay the end bearing on the pile toe may be taken as nine times the undrained shear strength of the clay immediately below the toe. Appropriate techniques will need to be adopted to clean the pile bore sufficiently to ensure that full end bearing can be realised.

The axial pile resistance should be determined using appropriate partial factors on soil properties, actions and resistances to determine the adequacy of the pile design (BS EN 1997-1, 2004a and 2004b).

To assist in the conceptual design of the development, preliminary estimates of the axial resistance for the GEO limit state of 450 and 600 mm uniform diameter bored and cast in-situ piles have been made using the static design procedures and the partial and model factors given in BS EN 1997-1 (2004a and 2004b). Preliminary estimates for axial resistance are presented in the table below.

Preliminary Estimates of Axial Resistance (GEO limit state) – Bored and Cast in place Piles

Pile Toe Level, m bgl	Axial Resistance, kN	
	450 mm diameter	600 mm diameter
15.0	550	775
20.0	875	1225
25.0	1250	1700

The values above are appropriate for single isolated piles and have been determined assuming that no bending or horizontal loads are applied to the pile. The actual resistance of a pile will be dependent on the method of installation and technique used. The actual pile capacity should therefore be established

with reference to specialist piling contractors. Pile integrity and load testing should be carried out to confirm the design and workmanship.

The preliminary estimates of axial load capacity presented above are given to inform the conceptual design of the proposed structures only. Design of the piles will need to be carried out by the appointed Geotechnical Designer taking into account the partial factors on soil properties, actions and resistances should be applied in accordance with the requirements of the National Annex to BS EN 1997-1 (2004).

8.2 Floor Slab and Pavement Design

8.2.1 Floor Slab

Given the thickness of Made Ground present on the Site, ground floor slabs will need to be designed and constructed to be suspended.

8.2.2 Pavement Design

Based upon the ground conditions encountered on the Site, it is expected that pavements supported on a suitable depth of sub-base will, in general, prove adequate provided the exposed formation is compacted by a heavy smooth wheeled roller and any soft or degradable materials removed and replaced with compacted granular fill. Similarly any remains of walls, foundations or exposed pieces of demolition material would need to be removed to prevent any development of concentrations of stress in the pavement. A CBR value of 2% for pavement supported on the Made Ground may be adopted for preliminary design.

8.3 Aggressiveness of the Ground

8.3.1 Design of Buried Concrete

The measured pH values and concentrations of water and acid soluble sulphate, and total sulphur measured on samples of soils recovered as part of the investigation and pH and sulphate measured on water samples are presented in the factual report on the investigation (GTSL, 2014) and are summarised on the following table.

	pH Value	Acid Soluble Sulphate (%)	Water Soluble Sulphate (g/l)	Total Sulphur (%)	Sulphate (mg/l)
Made Ground	8.1 – 10.3	-	0.17 – 1.50	-	-
London Clay	7.8 – 8.7	0.13 – 0.89	0.24 – 1.50	0.04 – 0.9	-
Groundwater	8.1	-	-	-	1800, 3600

For the mobile groundwater conditions the soil values correspond to design sulphate Class DS-2 as defined by BRE (2005), however, based on the sulphate concentrations in the groundwater a design sulphate class of DS-4 is required. On this basis, it is considered appropriate to design concrete in contact with the ground for Class AC-4 conditions as defined by BRE (2005). The recommendations of BRE (2005) should be followed in the design of mixes for buried concrete for the classifications given for concrete that is in contact with the Made Ground and/or the London Clay Formation.

It may be possible to use a less onerous design sulphate class subject to additional testing of groundwater samples.

8.3.2 Design of Water Supply Pipes

The concentrations of potential contaminants measured as part of the ground investigations indicate no significant potential contaminants are present on the Site with the exception of slightly elevated individual PAHs and lead. On this basis, it is possible that specific mitigation measures may need to be taken in the design and construction of the water supply pipes.

Under the Water Supply (Water Fittings) Regulations (DETR, 1999), the Water Supplier has a statutory duty to ensure that the design and material selection for water supply pipes are suitable and their advice and recommendations should be sought with regard to the water supply pipes for the proposed development. It should be noted that the Water Supplier may require additional testing to be carried out.

9.0 Tier 2 Geoenvironmental Risk Assessment

9.1 Risk Assessment Strategy

To assess the potential risk to the proposed development in relation to the quality of the ground and groundwaters, a Tier 2 generic risk assessment has been carried out utilising a Conceptual Site Model to identify 'source-pathway-receptor' linkages. This assessment has been made from considering both historic information and the findings of the ground investigation.

For the purposes of this study the potential for a significant source, pathway or receptor being present have been assessed in terms of their magnitude and extent as being very low, low, moderate, high or very high. The environmental risk is determined by the interrelationship between the potential for a source of contamination to be present, the potential for migration of the contaminant along a given pathway, and the significance of potential receptors for any identified source-pathway-receptor linkage. This approach allows the magnitude and probability of the possible consequences that may arise as a result of a hazard to be assessed and possible unacceptable risks to be identified. Details of the methodology used are given in the guidance notes included after the text of this report.

9.2 Potential Sources of Contamination

The site has previously was occupied by terraced housing. During World War II the site and its surrounding has suffered bomb damage. The remaining terraced housing was demolished and the site was subsequently occupied by a school. Since mid-2000s when the school buildings were demolished the site has remained vacant.

The ground investigation identified hat the majority of the contaminants tested were below the assessment criteria used with slightly elevated concentrations of individual PAHs and lead. In accordance with the guidance given in the Land Quality Management for contribution for the relevant pathways as calculated by CLEA (LQM, 2009) the vapour potential for the individual elevated PAHs is very low

Based on the known history of the Site and the ground investigation data the overall potential for significant contamination to be present is assessed to be **Low**. Based on the available information on ground conditions, the potential for any deleterious material producing hazardous ground gases to be present is considered to be **Very Low**. The presence of localised areas of significant contamination or hazardous ground gases associated with, for example, the disposal of debris during demolition of the previous development cannot at this time be discounted.

The potential for significant concentrations of potential contaminants to be present in the soils and groundwaters on the Site owing to the construction and use of the proposed development is considered to be very low. On this basis, the completed development will not adversely affect the potential for ground contamination to be present.

The area surrounding the Site typically comprises residential housing and a school. Overall the potential for significant contamination to be present in the area around the Site is considered to be **Low**.

9.3 Potential Exposure Pathways

Potential pathways for the uptake of contaminants by potential receptors include skin contact, inhalation and ingestion of soils and dust by site workers and future site users; absorption by vegetation; and indirectly associated with leaching of potential contaminants by infiltrating ground and surface waters.

Contact, Uptake and Leaching During the construction works, the clearance of the site and the excavation of the near-surface soils to facilitate excavation of the foundations will result in a significant potential for skin contact, inhalation and ingestion of any potential contaminants in the Made Ground and underlying natural soils. As such, the potential for skin contact, inhalation and ingestion by those workers involved in earthworks or ground works is considered to be **High**.

With regard to the proposed development, the presence of buildings and hard surfaces will limit the potential for skin contact, inhalation and ingestion of any potential contaminants in the Made Ground or underlying natural soils. The buildings and hard surfaces will also limit surface water infiltration and the potential for leaching of potential contaminants from the near-surface soils on the site. In the areas of the site covered by buildings or hard surfacing, the potential for significant contact, uptake or leaching of any potential contaminants in the near-surface soils is considered to be **Very Low**. With regard to areas of proposed soft landscaping, it is expected that the layer of topsoil/subsoil to be provided in these areas will be sufficient to limit the potential for significant contact, uptake or leaching of any potential contaminants in the near-surface soils to **Low**.

Site Drainage It is expected that disused drains associated with the historical development of the Site are likely to be present across the Site, whilst the existing drainage infrastructure on the Site is expected to be largely intact. On this basis, there is a plausible pathway for migration of potential contaminants through the pipe surround and trench backfill associated with leaks in the existing surface and foul water drainage system, however, given that there are expected to be limited number of discharge points the potential for significant migration of contaminants associated with site drainage is considered to be **Low**.

Groundwater Flow The site is underlain by a limited thickness of Made Ground overlying clays of the London Clay Formation. The ground conditions below the Site represent a plausible pathway for potential contaminants to enter or leave the Site, however, owing to the expected low permeability of the soils the potential for significant migration of contaminants associated with groundwater flow is considered to be **Very Low**.

9.4 Potential Receptors

Potential receptors include site workers and future site users, ground and surface waters, and ecology and wildlife. With regard to site workers and future site users, their potential significance is related directly to the cumulative length of time they will be on or in the immediate vicinity of the Site. With regard to ground and surface waters, and ecology and wildlife, their potential significance is based on the value of the attributes of the receptor and will be influenced by a number of factors such as the relative quality, scale, rarity and substitutability.

Site Workers The construction of the proposed development will require an increase in the number and length of time that workers are present on the Site. Considering the number and length of time they are likely to be on the Site, the potential significance of site workers involved in earthworks or ground works as a receptor is expected to be **Moderate**.

With regard to future site works, this is expected to be limited to maintenance work with little if any additional construction works. Considering the length of time they are likely to be on the Site and the nature of the required work, the potential significance of future site workers as a receptor is expected to be **Very Low**.

Future Site Users The proposed redevelopment of the Site for care home equivalent to residential use will result in unrestricted access to the Site by future site users such that they may be exposed to any potential contaminants present on the Site. The potential significance of future site users as a receptor is considered to be **High** given the cumulative length of time they are likely to be on the Site.

Ground and Surface Waters Given that the London Clay Formation is classified as Unproductive Strata and considering the number of and distance to the abstraction points from groundwater in the vicinity of the Site, the relative importance of the groundwaters as a receptor is considered to be **Very Low**.

With regard to the surface water resources, considering the distance to surface waters from the Site, the relative importance of the surface waters as a receptor is considered to be **Very Low**.

Ecology and Wildlife Considering the distance and the nature of the areas of environmental sensitivity, the relative importance of the local ecology and wildlife is considered to be **Very Low**.

9.5 Risk Assessment

Based on the Conceptual Ground Model the assessed environmental risks, associated with the Site and proposed development, are discussed in this section with respect to the identified potential receptors.

9.5.1 Site Workers

The impact on site workers relates to the risk of ingestion, inhalation or prolonged skin contact of contaminated material on the Site and inhalation of any potentially hazardous ground gases.

Considering that limited potential sources of contamination are expected to be present on Site, the potential risk to site workers is, assessed to be **Low** during construction works and **Very Low** during future maintenance works. With regard to potential sources of contamination in the areas surrounding the Site, given the distance to, the nature of and potential for migration from these sources, the associated potential risk to site workers is assessed to be **Very Low** both during construction and future maintenance works.

To mitigate the potential risk during construction works, appropriate protective clothing and equipment should be worn by site workers; and good standards of hygiene adopted to prevent prolonged skin contact, inhalation and ingestion of soils during construction. In addition, in line with current regulations and best practice, the methods of working will be selected to limit the potential for air-borne dust to arise associated with the excavation and disturbance of the soils present on the Site. Although the provision of appropriate protective clothing and adoption of good standards of hygiene and appropriate methods of working will mitigate many of the significant effects, the potential risk to site workers during the construction works will remain as **Low**.

With regard to the risk associated with the inhalation of potentially hazardous ground gases, given the limited potential for such gases to be present on the Site and surrounding areas, the potential risk to site workers is expected to be **Very Low**. Notwithstanding this assessment, appropriate ventilation should be provided to all confined spaces and appropriate procedures adopted to ensure they are checked for hazardous gases prior to man-entry to ensure any potential risk associated with ground gases does not occur.

9.5.2 Future Site Users

The impact on future site users relates to the risk of ingestion, inhalation or prolonged skin contact of contaminated material on the site and inhalation of any potentially hazardous ground gases.

In the areas of the buildings and hard surfaces of the proposed development, the potential risk to future site users associated with contaminated material is expected to be **Very Low** owing to the very low potential for skin contact, inhalation and ingestion of any potential contaminants. In areas of proposed landscaping, considering that only limited potential sources of contamination are likely to be present, it is expected that the layer of clean topsoil/subsoil to be provided in these areas will be sufficient to ensure the potential risk to future site users associated with contaminated material is **Very Low**. On this basis, no specific measures will be required to limit the risk of ingestion, inhalation or prolonged skin contact of the soils on the Site.

With regard to potential sources of contamination in the areas surrounding the Site, given the distance to, the nature of and potential for migration from these sources, the associated potential risk to future site users is assessed to be **Very Low**.

With regard to the risk associated with the inhalation of potentially hazardous ground gases, given the limited potential for such gases to be present on site, the potential risk to future site users associated with the build up of any such gases within confined spaces is expected to be **Very Low**.

9.5.3 Ground and Surface Water Resources

The impact on groundwater relates to the movement of potential contaminants by surface water infiltration and drainage and the leaching of any such contaminants from the near-surface soils on the Site. The impact on surface waters relates to the risk of movement of potential contaminants by groundwater flows and surface water drainage into adjacent watercourses.

Groundwaters Given the low potential for contaminants to be present and the very low relative importance of the groundwaters as a resource, the potential risk of any mobile contaminants present within the ground below the Site adversely affecting the quality of groundwater is currently assessed to be **Very Low** and is expected to remain at this level both during the construction works and on completion of the scheme.

Surface Waters Considering the distance to surface waters the potential risk to these waters is considered to be **Very Low** and is expected to remain at this level both during the construction works and on completion of the scheme.

9.5.4 Ecology and Wildlife

The impact on ecology and wildlife relates, primarily, to the risk of potentially mobile contaminants being present within the groundwaters on and adjacent to the Site. Considering the distance and low potential for mobile contaminants to be present and the expected low permeability of the soils on the Site, the risk to the ecology and wildlife in the vicinity of the Site is considered to be **Very Low** and is expected to remain at this level both during the construction works and on completion of the scheme.

9.6 Assessment Geoenvironmental Risk

The results of this Geoenvironmental Risk Assessment indicate that the potential risk to sensitive receptors is, in general, **Very Low**. The exception relates to the risk to site workers during the proposed construction works for which the potential risk is assessed to be **Low**. On this basis, any potential contaminants and hazardous ground gases do not by themselves represent an unacceptable risk to the human health, controlled waters or ecology and wildlife associated with the development of the Site as currently proposed.

On this basis, there is no reason that the Site would be designated as Contaminated Land under Part IIa of the Environmental Protection Act 1990.

10.0 Remediation Strategy

10.1 Required Remediation Measures

The geoenvironmental risk assessment presented in **Section 9.0** indicates that any potential contaminants in the ground or groundwater do not by themselves represent an unacceptable risk to human health, controlled waters or ecology and wildlife, associated with the development of the Site as currently proposed. On this basis, no specific remediation and/or mitigation measures will, in general, be required to limit the potential risks associated with land contamination.

The exception relates the potential risks to site workers associated with ingestion, inhalation or prolonged skin contact of any potentially contaminated material during the construction works. Measures to be adopted to mitigate the risk to site workers will include (i) informing the site workers of the potential risk through site induction and 'tool box talks'; (ii) the provision of appropriate protective clothing and equipment to be worn by site workers; and (iii) the adoption of good standards of hygiene to prevent prolonged skin contact, inhalation and ingestion of soils during construction. In addition, in line with current regulations and best practice, selection of appropriate methods of working to limit disturbance to the contaminated materials and the potential for air-borne dust to arise associated with the excavation and disturbance of the soils present on the site.

10.2 Management of Unidentified Sources of Contamination

There is a possibility that sources of contamination may be encountered during the site clearance or ground works that have not been identified by the ground investigation works.

Should visual and olfactory examination of any unusual solid materials or liquids encountered during the construction works identify areas of contamination, specific management procedures will need to be adopted. These procedures will allow for the short-term storage of the suspected material in stockpiles and/or storage tanks while verification testing for potential contamination is carried out. The storage area will be contained to ensure that contamination does not migrate and affect other areas of the site.

Once the nature, location and extent of the unexpected contamination have been identified appropriate remediation or mitigation measures will be adopted. Although these cannot be identified at this time the main emphasis will be on methods of isolating or treating the affected materials. If such measures are unlikely to be practical or effective in mitigating the risk from the identified contamination, consideration will be given to excavating and removing the contaminated material from site for disposal or treatment at a suitably licensed facility.

Where remediation of unexpected contaminants is required, an implementation and verification process will be established to identify the remediation activities required and to confirm that the remediation has been undertaken correctly. As part of this process, remediation objectives will be identified and remediation criteria selected for measuring compliance against these objectives in consultation with the Local Authority and other statutory consultees. Once any remediation of unexpected contaminants is complete, a verification report will be prepared demonstrating that the remediation objectives and criteria have been achieved. The report will provide a full record of all remediation activities carried out and data collected in accordance with the requirements of the verification plan and any monitoring and maintenance plan.

10.3 Verification Plan

A Verification Plan will need to be prepared by the contractor or his appointed consultant to demonstrate full compliance with the requirements of the remediation strategy. The Verification Plan shall include, but not be limited to provision of the following information:

i) Details of any unidentified sources of contamination encountered during the works, including details of (i) the location, nature and extent of the contamination; (ii) the methods of treatment and/or excavation and off-site disposal carried out; and (iii) verification and validation testing carried out. In the event that any unidentified source of contamination is not encountered, a statement to this effect by a suitably qualified and experienced individual shall be provided.

ii) Records demonstrating that all soil material transported off-site for treatment and/or disposal have been removed to an appropriately licensed facility approved by the Environment Agency in a safe and competent manner and in accordance with relevant Statutory Regulations. Such records to include but not be limited to (i) WAC (or other applicable) testing carried out to classify the material transported off-site and (ii) waste transfer notes counter-signed by the receiving party.

iii) Records demonstrating that all soil materials imported on-site or relocated on site do not represent a potential risk to the proposed development. Such records to include but not be limited to chemical analysis of (i) all soil material placed in areas of gardens, soft landscaping and hard landscaping with comparison of the results to appropriate criteria for a residential development with plant uptake end-use; and (ii) all soil material placed in areas of roads and buildings with comparison of the results to appropriate criteria for a residential without plant uptake/public open space end-use. Chemical analysis shall be carried out at a rate to be agreed with the Local Authority.

iv) Calculations to indicate the volume of material removed in comparison to the imported/relocated volume, including for each material the volume, type, date, source/disposal facility, location of excavation/placement on-site, details of any analyses, and all other pertinent information.

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Guidance on the Context of the Report

This report has been prepared within an agreed timeframe and to an agreed budget that will necessarily apply some constraints on its content and usage. The remarks below are presented to assist the reader in understanding the context of this report and any general limitations or constraints. If there are any specific limitations and constraints they are described in the report text.

1) The opinions and recommendations expressed in this report are based on statute, guidance, and appropriate practice current at the date of its preparation. Peter Brett Associates LLP (PBA) does not accept any liability whatsoever for the consequences of any future legislative changes or the release of subsequent guidance documentation, etc. Such changes may render some of the opinions and advice in this report inappropriate or incorrect and we will be pleased to advise if any report requires revision due to changing circumstances. Following delivery of the report PBA has no obligation to advise the Client or any other party of such changes or their repercussions.

2) Some of the conclusions in this report may be based on third party data. No guarantee can be given for the accuracy or completeness of any of the third party data used. Historical maps and aerial photographs provide a "snap shot" in time about conditions or activities at the site and cannot be relied upon as indicators of any events or activities that may have taken place at other times.

3) The conclusions and recommendations made in this report and the opinions expressed are based on the information reviewed and/or the ground conditions encountered in exploratory holes and the results of any field or laboratory testing undertaken. There may be ground conditions at the site that have not been disclosed by the information reviewed or by the investigative work undertaken. Such undisclosed conditions cannot be taken into account in any analysis and reporting.

4) It should be noted that groundwater levels, groundwater chemistry, surface water levels, surface water chemistry, soil gas concentrations and soil gas flow rates can vary due to seasonal, climatic, tidal and man made effects.

5) This report has been written for the sole use of the Client stated at the front of the report in relation to a specific development or scheme. The conclusions and recommendations presented herein are only relevant to the scheme or the phase of project under consideration. This report shall not be relied upon or transferred to any other party without the express written authorisation of PBA. Any such party relies upon the report at its own risk.

6) The interpretation carried out in this report is based on scientific and engineering appraisal carried out by suitably experienced and qualified technical consultants based on the scope of our engagement. We have not taken into account the perceptions of, for example, banks, insurers, other funders, lay people, etc, unless the report has been prepared specifically for that purpose. Advice from other specialists may be required such as the legal, planning and architecture professions, whether specifically recommended in our report or not.

7) Public or legal consultations or enquiries, or consultation with any Regulatory Bodies (such as the Environment Agency, Natural England or Local Authority) have taken place only as part of this work where specifically stated.

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1 Introduction

A Tier 2 Risk Assessment is a quantitative assessment using published generic criteria to "screen" the site-specific contamination testing data and identify potential hazards to specific receptors.

The aim of this document is to present an explanation for the selection of the assessment criteria routinely used by PBA when undertaking a Tier 2 risk assessment. This document is divided into general introductory text and sections on soils, waters and soil gases.

This document should be read in conjunction with another entitled "PBA "Methodology for Assessment of Potentially Contaminated Land" which summarises the legislative regime and our approach to ground contamination and risk assessment.

2 General Notes

Any deviation from the routine criteria and/or selection of criteria for parameters not covered in this document will be described in the report text. The report will also comment on the appropriateness of the routine criteria for project objectives or ground conditions.

Any PBA interpretation of contamination test results is based on a scientific and engineering appraisal. The perceptions of, for example, banks, insurers, lay people etc are not taken into account.

Any summary tables included in this Appendix are produced for ease of reference to the criteria, they do not in any way replace the documents of origin (which are fully referenced) and which should be read to ensure appropriate use and interpretation of the data.

3 Tier 2 Criteria for Assessing Soils

3.1 Potential Harm to Human Health

Defra has yet to produce a comprehensive list of assessment criteria that on its own, would be sufficient to enable the assessment of the potential risks posed by soil contaminants (to human health). A number of industry-driven initiatives have developed to generate contaminated land assessment criteria. This has led to the publication of a series of non-statutory non-Governmental contaminated land assessment criteria. It should be noted that the published DEFRA guidance is also non-statutory.

The criteria routinely used by PBA as Tier 2 soil screening values for the protection of human health are the Governmental Soil Guidance Values (SGVs) and various non-Governmental Generic Assessment Criteria (GAC), these criteria are presented in Table 1.

Both the Governmental and non Governmental sets of criteria have been generated using the Contaminated Land Exposure Assessment model (CLEA) and supporting technical guidance (EA, 2009a, 2009b, 2009c).

PBA has reviewed these publications and consider that the non-Governmental criteria are authoritative and robust, and therefore we will refer to such criteria until such time that DEFRA derive and publish Governmental SGVs to replace the non Governmental GACs.

It is important to note that because the GACs are not published by the UK Government, they may be subject to challenge by a regulatory body or their representative. If the use of the GACs is challenged, it may be necessary to carry out modelling to generate site-specific assessment criteria.

Soil Guideline Values (SGVs) - Governmental

The first series of SGVs were generated using a probabilistic version of the CLEA model. However, on 22 July 2008 DEFRA announced the withdrawal of these SGVs.

Revised SGVs have been calculated using the revised fully deterministic version of the CLEA model. The standard land use scenarios are residential with plant uptake, allotments and industrial/commercial.

Generic Assessment Criteria (GAC) - Non Governmental

SGVs generated for organic compounds are dependent on the amount of organic matter present in the soil (a lower SGV is generated for soils with lower organic matter contents since organic matter acts to immobilise organic contaminants). The SGVs for BTEX compounds and phenol assume that the 'host' soil has 6% organic matter.

UK soils often have organic matter concentrations below 6% and that it may therefore not be conservative to use the published SGVs for BTEX compounds when assessing the potential risks from these chemicals. The on-line Contaminated Land Strategies Digest (CLSD) formed a consortium of ten practitioners (including representatives from local authorities), to prepare generic assessment criteria for a number of contaminants at more conservative organic matter contents of 1% and 3% for the same end uses. The consortium also reproduced the SGVs using the EA's latest CLEA model and latest CLEA guidance and PBA independently verified the results published using CLEA v1.06. These criteria will be used by PBA where appropriate.

In addition the CLSD consortium derived GACs for selected substances for an additional end use, that being residential without plant uptake (CLSD, 2009).

In July 2009, GAC for 82 substances were published by the Chartered Institute of Environmental Health (CIEH) (LQM and CIEH, 2009) using the then current version of the CLEA software v1.04. These GAC replace those generated in 2006 using the original version of the model CLEA UK *beta*.

In January 2010, GAC for 35 substances were published by the Environmental Industries Commission (EIC), Association of Geotechnical and Geoenvironmental Specialists (AGS) and Contaminated Land: Applications in Real Environments (CL:AIRE), (CL:AIRE, 2010) using the then current version of the CLEA software v1.05. These substances are more rarely found to be contaminants of concern during contaminated land investigations and hence are not routinely tested for. The CL:AIRE GAC are not reproduced in Table 1 but may be utilised as required. .

Note on Appropriate Use of SGV/GAC The SGVs and GACs generated using the CLEA model are based on numerous and complex assumptions. The appropriateness of these assumptions in a site-specific context requires confirmation on a project by project basis.

In general, SGVs/GACs have been developed using highly conservative assumptions and exceedance does not indicate that a site is statutorily contaminated and/or necessarily unsuitable for use in the planning context (Defra 04/2012). The SGV/GAC provide an aid to decision-making, but they do not replace the need for sound professional judgement in risk assessment (EA, 2006b).

Note on Mercury and Arsenic Assessment The analytical testing routinely undertaken by PBA determines total concentration, however, the toxicity of Mercury and Arsenic differ depending on the form.

If a source of Mercury or Arsenic is identified or the total concentration exceeds the relevant worst case speciated criteria it will be desirable/necessary to undertake additional speciated testing.

3.2 Potential Harm to the Built Environment

PBA use the following primary guidance to assess the significance of soil chemistry with respect to its potential to harm the built environment.

i) Site Preparation and Resistance to Contaminants and Moisture. Approved Document C (DCLG 2010);

ii) Concrete in aggressive ground SD1 (BRE 2005); and

iii) Technical guidance on the assessment of soil chemistry with respect to its potential to corrode plastic service pipes published by the Water Regulations Advisory Scheme.

iv) Guidance for the selection of water supply pipes to be used in brownfield sites UKWIR 2011

3.3 Potential to Harm Ecosystems, Animals, Crops etc

The criteria routinely used by PBA as Tier 2 screening values to assess the potential of soil chemistry to harm ecosystems are taken from the following guidance and summarised in are given in Table 2.

i) Ecological Risk Assessment (ERA) Science Report Series SC070009, published by the Environment Agency, Bristol (EA, 2008);

ii) The Restoration and Aftercare of Metalliferous Mining Sites for Pasture and Grazing (ICRCL 70/90, 1990); and

iii) Code of Practice for Agricultural Use of Sewage Sludge (DOE, 1993).

4 Tier 2 Screening Values for Assessing Controlled Waters

4.1 Potential Harm to Human Health

The criteria routinely used by PBA as Tier 2 water screening values are taken from the Water Supply (Water Quality) Regulations 2010 Defra 2010 and are given in Table 3.

It should be noted that some of the prescribed concentrations listed in the Water Supply Regulations have been set for reasons other than their potential to cause harm to human health. The concentrations of iron and manganese are controlled because they may taint potable water with an undesirable taste, odour or colour or may potentially deposit precipitates in water supply pipes.

4.2 Potential to Harm Controlled Waters

Controlled Waters are rivers, estuaries, coastal waters, lakes and groundwaters, but not perched waters.

The criteria routinely used by PBA as Tier 2 screening values are taken from the directions to the Environment Agency in regard to the implementation of the Water Framework Directive (EA 2009d) and are given in Tables 3, 4 and 5.

Table 3 presents the criteria for assessing the chemistry of groundwater bodies and Tables 4 and 5 present the criteria for assessing the chemistry of surface water bodies.

The results from any eluted liquids will be compared to appropriate assessment criteria depending on the receptor of concern.

5 Tier 2 Screening Guidance for Assessing Soil Gases

Guidance on the assessment of risks specifically for sites located adjacent to Landfill Sites has been published by the Environment Agency (EA, 2004). A tiered approach to assessing risk is advocated by the guidance. This allows the level of detail in a risk assessment to be proportionate to the nature and complexity of the risk.

The Tier 1 Risk Screening methodology advocated by the Environment Agency (EA) guidance document (EA, 2004) should:

i) Identify complete source-pathway-receptor linkages;

ii) Screen out insignificant risks;

iii) Prioritise the risks and receptors; and

iv) Provide an initial assessment of the potential impacts at a receptor.

A Tier 2 assessment comprises the quantitative analysis of risk following the collection and analysis of soil gas monitoring data.

Guidance on suitable methodologies for the collection of gas monitoring data is provided in CIRIA Report C665 (CIRIA, 2007).

Guidance Available PBA use the following primary guidance to assess the significance of soil gas chemistry with respect to its potential to harm human health.

i) Assessing risks posed by hazardous gases to buildings C665 (CIRIA 2007);

ii) Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present. (NHBC 2007);

iii) Code of practice for the characterization and remediation from ground gas is affected developments (BSI, 2007); and

iv) Waste Management Paper No. 27 (DoE, 1991).

Waste Management Paper No. 27 (DoE, 1991) defines what constitutes a “significant quantity” of gas. WMP27 advises that a site producing (i) Methane concentrations in excess of 1% by volume and with a flow rate of greater than 15 litres per hour; or (ii) Carbon dioxide in excess of 1.5% by volume in air and with a flow rate of greater than 22 litres per hour would be considered as a significant source of soil gas.

Guidance on quantifying the risks from hazardous soil gases to properties and their occupiers is provided in CIRIA, 2007 (commercial developments), NHBC, 2007 (low rise residential developments) and British Standard BS 8485:2007. These documents provide guidance on gas monitoring methods and strategy, the assessment of risk posed by soil gases and mitigating the risks posed by soil gases during site development.

PBA use gas concentrations and borehole flow data in order to obtain the gas screening value (GSV) for methane and carbon dioxide at the site. The GSV can be used to establish the characteristic situation of the site as detailed in CIRIA C665 and in order to make recommendations for gas protection measures for buildings if required.

Radon In addition to the guidance listed above, PBA use the following primary guidance to assess the significance of the radon content of soil gas.

i) Radon: guidance on protective measures for new dwellings. Report BR211 (BRE, 1999); and

ii) Radon Atlas of England, R290 (NRPB, 1996).

6 References

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BSI (2007) BS 8485:2007 Code of practice for the characterization and remediation from ground gas is affected developments. British Standards Institute, London.

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Defra (2010) The Water Supply (Water Quality) Regulations, 2010. Statutory Instrument 2010 No 944, Department of the Environment, Transport and the Regions, London.

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DoE (1991) Landfill Gas, Waste Management Paper No. 27. Department of the Environment, London.

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EA (2008) Ecological Risk Assessment (ERA). Science Report Series SC070009, Environment Agency, Bristol.

EA (2009a) Using Soil Guideline Values. Science Report SC050021/SGV Introduction. Environment Agency, Bristol.

EA (2009b) Updated Technical Background to the CLEA model. Science Report SC050021/SR3 Introduction. Environment Agency, Bristol.

EA (2009c) Human health toxicological assessment of contaminants in soil. Science Report SC050021/SR2. Environment Agency, Bristol.

EA (2009d) River Basin Typology, Standards and Groundwater threshold values (Water Framework Directive) England and Wales) Direction 2009.

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LQM & CIEH (2006) Generic Assessment Criteria for Human Health Risk Assessment. Land Quality Management Limited and the Chartered Institute of Environmental Health, London.

LQM & CIEH (2009) The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd Edition). Land Quality Press, Nottingham. ISBN 0-9547474-7-X.

NRPB (1996) Radon Atlas of England. R290, National Radiological Protection Board, Didcot, Oxfordshire.

NHBC (2007) Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present. National House Building Council.

UKWIR (2011) Guidance for the selection of Water Pipes to be used in Brownfield Sites.

Table 1: Tier 2 Screening Criteria for the Assessment of Potential Contaminant Concentrations in Soil – Protection of Human Health

Determinand	Allotments	Residential with plant uptake	Residential without plant uptake	Commercial/ Industrial
Metals/Metalloids				
Arsenic (Inorganic)	43[a]	32[a]	35[f]	640[a]
Beryllium	55[c]	51[c]	-	420[c]
Boron	45[c]	291[c]	-	192,000[c]
Cadmium	1.8[a]	10[a]	117[f]	230[a]
Chromium (trivalent)	34,600[c]	3000[c]	-	30,400[c]
Chromium (hexavalent)	2.1[c]	4.3[c]	-	35[c]
Copper	524[c]	2330[c]	-	71,700[c]
Lead	-	450[b]	450[b]	750[b]
Mercury (elemental)	1[a]	26[a]	-	26[a]
Mercury (inorganic)	80[a]	170[a]	235[f]	3600[a]
Methyl Mercury	8[a]	11[a]	-	410[a]
Nickel	230[a]	130[a]	130[f]	1800[a]
Selenium	120[a]	350[a]	595[f]	13000[a]
Vanadium	18[c]	75[c]	-	3160[c]
Zinc	618[c]	3750[c]	-	665,000[c]
BTEX Compounds (1%, 3% and 6% SOM)[d]				
Benzene	0.02[f] / 0.04[f] / 0.07[a]	0.08[f] / 0.18[f] / 0.33[a]	0.27[f] / 0.56[f] / 1.0[f]	28[f] / 57[f] / 95[a]
Toluene	22[f] / 60[f] / 120[a]	120[f] / 320[f] / 610[a]	600[f] / 1500[f] / 2700[f]	870[f]/ 2200[f] / 4400[a]
Ethylbenzene	16[f] / 45[f] / 90[a]	65[f] / 180[f] / 350[a]	165[f] / 450[f] / 840[f]	520[f] / 1400[f] / 2800[a]
Xylenes #	28[f] / 80[f] / 160[a]	42[f] / 120[f] / 230[a]	53[f] / 145[f] / 285[f]	475[f] / 1300[f] / 2600[a]
Polycyclic Aromatic Hydrocarbons (1%, 2.5% and 6% SOM)[d]				
Acenaphthene	34[c] / 85[c] / 200[c]	210[c] / 480[c] / 1000[c]	-	85000[c] / 98000[c] / 100000[c]
Acenaphthylene	28[c] / 69[c] / 160[c]	170[c] / 400[c] / 850[c]	-	84000[c] / 97000[c] / 100000[c]
Anthracene	380[c] / 950[c] / 2200[c]	2300[c] / 4900[c] / 9200[c]	-	530000[c] / 540000[c] / 540000[c]
Benzo(a)anthracene	2.5[c] / 5.5[c] / 10[c]	3.1[c] / 4.7[c] / 5.9[c]	-	90[c] / 95[c] / 97[c]
Benzo(a)pyrene	0.60[c] / 1.2[c] / 2.1[c]	0.83[c] / 0.94[c] / 1.0[c]	-	14[c] / 14[c] / 14[c]
benzo(b)fluoranthene	3.5[c] / 7.4[c] / 13[c]	5.6[c] / 6.5[c] / 7.0[c]	-	100[c] / 100[c] / 100[c]
benzo(g,h,i)perylene	70[c] / 120[c] / 160[c]	44[c] / 46[c] / 47[c]	-	650[c] / 660[c] / 660[c]
benzo(k)fluoranthene	6.8[c] / 14[c] / 23[c]	8.5[c] / 9.6[c] / 10[c]	-	140[c] / 140[c] / 140[c]
Chrysene	2.6[c] / 5.8[c] / 12[c]	6.0[c] / 8.0[c] / 9.3[c]	-	140[c] / 140[c] / 140[c]
Dibenzo(a,h)anthracene	0.76[c] / 1.5[c] / 2.3[c]	0.76[c] / 0.86[c] / 0.90[c]	-	13[c] / 13[c] / 13[c]
Fluoranthene	52[c] / 130[c] / 290[c]	260[c] / 460[c] / 670[c]	-	23000[c] / 23000[c] / 23000[c]
Fluorene	27[c] / 67[c] / 160[c]	160[c] / 380[c] / 780[c]	-	64000[c] / 69000[c] / 71000[c]
Indeno(1,2,3-cd)pyrene	1.8[c] / 3.8[c] / 7.1[c]	3.2[c] / 3.9[c] / 4.2[c]	-	60[c] / 61[c] / 61[c]
Naphthalene	4.1[c] / 9.9[c] / 23[c]	1.5[c] / 3.7[c] / 8.7[c]	-	200[c] / 480[c] / 1100[c]
Phenanthrene	16[c] / 38[c] / 90[c]	92[c] / 200[c] / 380[c]	-	22000[c] / 22000[c] / 23000[c]
Pyrene	110[c] / 270[c] / 620[c]	560[c] / 1000[c] / 1600[c]	-	54000[c] / 54000[c] / 54000[c]
Aliphatic/Aromatic Hydrocarbons (1%, 2.5% and 6% SOM)[d]				
TPH Aliphatic >C5-6	740[c] / 1700[c] / 3900[c]	30[c] / 55[c] / 110[c]	-	3400[c] / 6200[c] / 13000[c]
TPH Aliphatic >C6-8	2300[c] / 5600[c] / 13000[c]	73[c] / 160[c] / 370[c]	-	8300[c] / 18000[c] / 42000[c]
TPH Aliphatic >C8-10	320[c] / 770[c] / 1700[c]	19[c] / 46[c] / 110[c]	-	2100[c] / 5100[c] / 12000[c]
TPH Aliphatic >C10-12	2200[c] / 4400[c] / 7300[c]	93[c] / 230[c] / 540[c]	-	10000[c] / 24000[c] / 49000[c]
TPH Aliphatic >C12-16	11000[c] / 13000[c] / 13000[c]	740[c] / 1700[c] / 3000[c]	-	61000[c] / 83000[c] / 91000[c]

Determinand	Allotments	Residential with plant uptake	Residential without plant uptake	Commercial/ Industrial
TPH Aliphatic >C16-35	260000[c] / 270000[c] / 270000[c]	45000[c] / 64000[c] / 76000[c]	-	1600000[c] / 1800000[c] / 1800000[c]
TPH Aliphatic >C35-44	260000[c] / 270000[c] / 270000[c]	45000[c] / 64000[c] / 76000[c]	-	1600000[c] / 1800000[c] / 1800000[c]
TPH Aromatic >C5-7 (benzene)	13[c] / 27[c] / 57[c]	65[c] / 130[c] / 280[c]	-	28000[c] / 49000[c] / 90000[c]
TPH Aromatic >C7-8 (toluene)	22[c] / 51[c] / 120[c]	120[c] / 270[c] / 611[c]	-	59000[c] / 110000[c] / 190000[c]
TPH Aromatic >C8-10	8.6[c] / 21[c] / 51[c]	27[c] / 65[c] / 151[c]	-	3700[c] / 8600[c] / 18000[c]
TPH Aromatic >C10-12	13[c] / 31[c] / 74[c]	69[c] / 160[c] / 346[c]	-	17000[c] / 29000[c] / 34500[c]
TPH Aromatic >C12-16	23[c] / 57[c] / 130[c]	140[c] / 310[c] / 593[c]	-	36000[c] / 37000 /[c] 37800[c]
TPH Aromatic >C16-21	46[c] / 110[c] / 260[c]	250[c] / 480[c] / 770[c]	-	28000[c] / 28000[c] / 28000[c]
TPH Aromatic >C21-35	370[c] / 820[c] / 1600[c]	890[c] / 1100[c] / 1230[c]	-	28000[c] / 28000[c] / 28000[c]
TPH Aromatic >C35-44	370[c] / 820[c] / 1600[c]	890[c] / 1100[c] / 1230[c]	-	28000[c] / 28000[c] / 28000[c]
TPH Aliphatic + Aromatic >C44-70	1200[c] / 2100[c] / 3000[c]	1200[c] / 1300[c] / 1300[c]	-	28000[c] / 28000[c] / 28000[c]
Chlorinated Hydrocarbons (1%, 2.5% and 6% SOM)[d]				
1,2-dichloroethane	0.0046[c] / 0.0083[c] / 0.016[c]	0.0054[c] / 0.0080[c] / 0.014[c]	-	0.71[c] / 1.0[c] / 1.8[c]
1,1,1 Trichloroethane (TCA)	48[c] / 110[c] / 240[c]	6.2[c] / 13[c] / 28[c]	-	700[c] / 1400[c] / 3100[c]
1,1,1,2 Tetrachloroethane	0.79[c] / 1.9[c] / 4.4[c]	0.90[c] / 2.1[c] / 4.8[c]	-	120[c] / 260[c] / 590[c]
1,1,2,2 Tetrachloroethane	0.41[c] / 0.89[c] / 2.0[c]	1.4[c] / 2.9[c] / 6.3[c]	-	290[c] / 580[c] / 1200[c]
Tetrachloroethene (PCE)	1.6[c] / 3.7[c] / 8.7[c]	0.94[c] / 2.1[c] / 4.8[c]	-	130[c] / 290 / 660[c]
Tetrachloromethane	0.16[c] / 0.37[c] / 0.85[c]	0.018[c] / 0.039[c] / 0.089[c]	-	3.0[c] / 6.6 / 15[c]
Trichloroethene (TCE)	0.43[c] / 0.95[c] / 2.2[c]	0.11[c] / 0.22[c] / 0.49[c]	-	12[c] / 25[c] / 55[c]
Trichloromethane/Chloroform	0.36[c] / 0.70[c] / 1.5[c]	0.75[c] / 1.3[c] / 2.7[c]	-	110[c] / 190[c] / 370[c]
Vinyl Chloride/Chloroethene	0.00055[c] / 0.0010[c] / 0.0018[c]	0.00047[c] / 0.00064[c] / 0.00099[c]	-	0.063[c] / 0.081[c] / 0.12[c]
Pesticides and Other Organic Compounds (1%, 2.5% and 6% SOM)[d]				
Aldrin	1.3[c] / 2.6[c] / 4.0[c]	1.7[c] / 2.0[c] / 2.1[c]	-	54[c] / 54[c] / 54[c]
Atrazine	0.037[c] / 0.085[c] / 0.2[c]	0.24[c] / 0.56[c] / 1.3[c]	-	870[c] / 880[c] / 880[c]
Dichlorvos	0.044[c] / 0.091[c] / 0.20[c]	0.29[c] / 0.6[c] / 1.3[c]	-	842[c] / 872[c] / 893[c]
Dieldrin	0.13[c] / 0.32[c] / 0.73[c]	0.69[c] / 1.4[c] / 2.2[c]	-	90[c] / 91[c] / 92[c]
Endosulfan	0.47[c] / 1.2[c] / 2.7[c]	2.9[c] / 7.0[c] / 16[c]	-	2310[c] / 2990[c] / 3390[c]
Carbon Disulphide	4.8[c] / 10[c] / 23[c]	0.10[c] / 0.20[c] / 0.44[c]	-	12[c] / 23[c] / 50[c]
Chlorobenzene	5.9[c] / 14[c] / 32[c]	0.33[c] / 0.73[c] / 1.7[c]	-	59[c] / 130[c] / 310[c]
Hexachloro-1,3-butadiene	0.25[c] / 0.61[c] / 1.4[c]	0.21[c] / 0.51[c] / 1.2[c]	-	32[c] / 69[c] / 120[c]
Hexachlorobenzene	0.18[c] / 0.42[c] / 0.92[c]	0.59[c] / 1.0[c] / 1.4[c]	-	48[c] / 53[c] / 55[c]
Pentachlorobenzene	1.2[c] / 3.1[c] / 7.1[c]	5.2[c] / 10[c] / 17[c]	-	650[c] / 770[c] / 830[c]
Pentachlorophenol	0.084[c] / 0.21[c] / 0.49[c]	0.55[c] / 1.3[c] / 2.96[c]	-	1200[c] / 1300[c] / 1400[c]
Phenol (1, 3, 6% SOM)	66[f] / 158[f] / 280[a]	184[f] / 316[f] / 420[a]	310[f] / 441[f] / 519[f]	3200[a]
Dioxins, Furans and dioxin-like PCBs[e]	0.008[a]	0.008[a]		0.24[a]

Notes
Units mg/kg
most conservative of the three isomers selected for each scenario
a Soil Guideline Value (2009) with SOM of 6%
b Soil Guideline Value (2002)
c Generic Assessment Criteria (LQM & CIEH 2009)
d Where three values are presented, SGV/GAC for soils with SOM of 1%, 2.5% and 6% or 1%, 3% and 6% are given as detailed in the table. SOM denotes Soil Organic Matter.
e Refer to Table 2 of the supporting guidance for suite
f Generic Assessment Criteria generated using CLEA v 1.04 by an independent contaminated land working group and independently verified by PBA (CLSD, 2009)

Table 2 Tier 2 Screening Criteria for the Assessment of Potential Contaminant Concentrations in Soil – Protection of Ecological Systems

Parameter	ICRCL 70/90 [a]			Proposed SSVs [b]	Code of Practice for Agricultural Use of Sewage Sludge [c]
	Threshold [d]	Maximum			
		Livestock	Crop Growth		
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Benzo(a)pyrene				0.15	
Arsenic	50	500	1000		50
Cadmium	3	30	50	1.15	3
Chromium				21.1	400
Copper	250	500	250	88.4	80/ 100/ 135/ 200 [e]
Fluoride	500	1000			500
Lead	300	1000		167.9	300
Mercury				0.06	1
Molybdenum					4
Nickel				25.1	50/ 60/ 75/ 110 [e]
Pentachlorobenzene				0.029	
Pentachlorophenol				0.6	
Selenium					3
Tetrachloroethene				0.01	
Toluene				0.3	
Zinc	1000	3000	1000	90.1	200/ 200/ 200/ 300 [e]

Notes

a. Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL) 70/90 Restoration and Aftercare of Metalliferous Mining Sites for Pasture and Grazing 1st edition 1990.

b. Proposed Soil Screening Values (SSVs) – Consultation, Environment Agency 2008. Threshold which if exceeded prompts further assessment.

c. Maximum permissible concentration of potentially toxic elements from the Code of Practice for Agricultural Use of Sewage Sludge. Second Edition. DOE 1993.

d. Concentrations are for contamination derived from mine spoil. In other situations the speciation may be more available. Factors include total concentration, speciation, particle size, pH, species of plant, type of animal/grazing habit.

e. Where four values are presented, concentrations are for soils with pH values 5.0-5.5/ 5.5-6.0/ 6.0-7.0/ >7.0

Table 3: Tier 2 Criteria for Screening Selected Contaminants in Groundwater

Parameter	Protection of Human Health	Protection of Controlled Waters			
	Water Supply (Water Quality) Regulations 2000	Test 2 Minimum	Test 2 Maximum	Test 4	Test 5
Metal/Semi Metal:					
Antimony (µg/l)	5				
Arsenic (µg/l)	10	51.6	199	7.5	
Boron (µg/l)	1000			750	
Cadmium (µg/l)	5	0.2	1.1	3.75	
Chromium (µg/l)	50	5	27.6	37.5	
Copper (µg/l)	2000	10.1	57.8	1500	
Iron (µg/l)	200				
Lead (µg/l)	25 (10 from 25/12/13)	7.3	39.8	18.8	
Manganese (µg/l)	50				
Mercury (µg/l)	1			0.75	
Nickel (µg/l)	20	20.2	116	15	
Selenium (µg/l)	10				
Zinc (µg/l)	-	75.8	414	3750	
Other:					
Ammonium NH4 (mg/l)	0.5				
Ammonia NH3 (mg/l)	-	0.3	1.73	0.29	0.29
Chloride (mg/l)	250			188	187.5
Cyanide (ug/l)	50				
Electrical Conductivity (µS/cm)	2500			1880	
pH (pH units)	6.5 to 10				
Nitrate NO3 (mg/l)	50			42	42
Sulphate (mg/l)	250			188	188
Organics:					
Anthracene		0.1	0.55		
Benzene (µg/l)	1	10.1	55.2	0.75	0.75
Benzo(a)pyrene (µg/l)	0.01			0.075	
Chloroform (µg/l)	100 a	2.53	13.8	75	75
1.2-Dichloroethane (µg/l)	3			2.25	2.25
Fluoranthene		0.1	0.6		
Naphthalene (µg/l)	-	2.4	13.2		
Phenol Total (mg/l)	0.5	15.2	82.8		
PAHs (µg/l)	0.1 b				
Pesticides (ug/l)	0.03c				
Toluene (µg/l)	-	50.5	276		
Trichloroethene TCE (µg/l)	10 d	10.1	55.2	7.5	7.5
Tetrachloroethene PCE (µg/l)	10 d	10.1	57.8	7.5	7.5
Tetrachoromethane (ug/l)	3				
Vinyl Chloride (µg/l)	0.5				
Xylene (µg/l)	-	30.3	166		

Notes

TV Threshold Values for each groundwater body are given in the River Basin Management Plans

Test 2 Groundwater Impacts on Surface Water

Test 4 Groundwater Drinking Water Protected Areas – designed to be equivalent to a 95% standard

Test 5 General Quality of Groundwater Body – designed to be equivalent to a 95% standard

a. Sum for Tri-halomethanes – chloroform, bromoform, dibromochloromethane, bromodichloromethane

b. Concentration for sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene

c. Sum for Aldrin, Dieldrin, Heptachor and Heptachor epoxide

d. Sum of TCE and PCE

Table 4: Surface Waters - Specific Pollutants – Standards for Ecological Status

Pollutant	Rivers and Freshwater Lakes	Transitional and Coastal Waters
2,4-Dichlorophenoxyacetic acid (2,4-D)	0.3 (1.3)*	0.3 (1.3)*
2,4-Dichlorophenol	20	20
Ammonia (Un-ionised) as Nitrogen	Not applicable	21
Arsenic #	50	25
Chlorine (total available)	2 (5)*	(10)*
Chromium VI	3.4	0.6 (32)*
Chromium III	4.7	(32)*
Copper – standard is hardness dependant for freshwater	1 (CaCO3 <50mg/l) 6 (CaCO3 50-<100mg/l) 10 (CaCO3 100-<250mg/l) 28 (CaCO3 >250mg/l)	5
Cyanide	1 (5)*	1 (5)*
Cypermethrin as ng/l	0.1 (0.4)*	0.1 (0.4)*
Diazinon	0.01 (0.02)*	0.01 (0.1)*
Dimethoate	0.48 (4)*	0.48 (4)*
Iron as mg/l	1	1
Linuron	0.5 (0.9)*	0.5 (0.9)*
Mecoprop	18 (187)*	18 (187)*
Permethrin	(0.01)	(0.01)
Phenol	7.7 (46)*	7.7 (46)*
Toluene	50 (380)*	40 (370)*
Zinc – standard is hardness dependant for freshwater	8 (CaCO3 <50mg/l) 50 (CaCO3 50-<100mg/l) 75 (CaCO3 100-<250mg/l) 125 (CaCO3 >250mg/l)	40

i. All units ug/l unless otherwise stated.
ii. The standard is the annual mean standard over a period of 12 consecutive months unless otherwise stated.
iii. ( ) indicates that this is the 95-percentile standard where the standard is failed if the measured concentration is above the standard for 5% or more of the time.
iv. * indicates that the standard is not to be used for the purpose of classifying the ecological status or potential of bodies of surface water.
v. # indicates that the standard is the dissolved fraction obtained by filtration through a 0.45um filter.

Reproduced from Part 4 of The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Direction 2009.

Table 5: Surface Waters - Priority Substances – Standards for Chemical Status

Pollutant	***Annual Average***		***Maximum Allowable Concentration***	
	Inland	***Other***	***Inland***	***Other***
Alachlor	0.3	0.3	0.7	0.7
Anthracene	0.1	0.1	0.4	0.4
Atrazine	0.6	0.6	2.0	2.0
Benzene	10	8	50	50
Brominated diphenylether	0.0005	0.0002	NA	NA

Pollutant	***Annual Average***		***Maximum Allowable Concentration***	
	Inland	***Other***	***Inland***	***Other***
Cadmium (and its compounds) # – hardness dependant – refer to Notes for definitions of C1 to C5	<0.08 C1 0.08 C2 0.09 C3 0.15 C4 0.25 C5	0.2	<0.45 C1 0.45 C2 0.6 C3 0.9 C4 1.5 C5	<0.45 C1 0.45 C2 0.6 C3 0.9 C4 1.5 C5
Carbon tetrachloride	12	12	NA	NA
C10-13 Chloroalkanes	0.4	0.4	1.4	1.4
Chlorfenvinphos	0.1	0.1	0.3	0.3
Chlorpyrifos	0.03	0.03	0.1	0.1
Aldrin, Dieldin, Endrin, Isodrin (Sum)	0.01	0.005	NA	NA
DDT Total	0.025	0.25	NA	NA
Para-para-DDT	0.01	0.01	NA	NA
1,2-Dichloroethane	10	10	NA	NA
Dichloromethane	20	20	NA	NA
Di(2-ethylhexyl)-phthalate (DEHP)	1.3	1.3	NA	NA
Diuron	0.2	0.2	1.8	1.8
Endosulfan	0.005	0.005	0.01	0.01
Fluoranthene	0.1	0.1	1	1
Hexachlorobenzene	0.01	0.01	0.05	0.05
Hexachlorobutadiene	0.1	0.1	0.6	0.6
Hexachlorocyclohexane	0.02	0.002	0.04	0.02
Isoproturon	0.3	0.3	1	1
Lead (and its compounds) #	7.2	7.2	NA	NA
Mercury (and its compounds) #	0.05	0.05	0.07	0.07
Naphthalene	2.4	1.2	NA	NA
Nickel (and its compounds) #	20	20	NA	NA
Nonylphenol	0.3	0.3	2	2
Octylphenol	0.1	0.01	NA	NA
Pentachlorobenzene	0.007	0.0007	NA	NA
Pentachlorophenol	0.4	0.4	1	1
Benzo(a)pyrene	0.05	0.05	0.1	0.1
Benzo(b)fluoranthene + Benzo(k)fluoranthene	0.03	0.03	NA	NA
Benzo(ghi)perylene + Indeno(1,2,3-cd)pyrene	0.002	0.002	NA	NA
Simazine	1	1	4	4
Tetrachloroethylene	10	10	NA	NA
Trichloroethylene	10	10	NA	NA
Tributyl tin compounds	0.0002	0.0002	0.0015	0.0015
Trichlorobenzenes	0.4	0.4	NA	NA
Trichloromethane	2.5	2.5	NA	NA
Tifluralin	0.03	0.03	NA	NA

i. The EQS are expressed as total concentrations in the whole water sample except for #.
ii. # indicates that the EQS is dissolved concentration obtained by filtration through 0.45um filter.
iii. Inland = surface waters encompassing rivers and lakes and related artificial or heavily modified water bodies.
iv. Hardness Classifications C1 <40 mg CaCO3/l, C2 40 to <50 mg CaCO3/l, C3 50 to <100 mg CaCO3/l, C4 100 to <200 mg CaCO3/l, C5 200 mg CaCO3/l.

Reproduced from Part 5 of The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Direction 2009.

Methodology for Ground Condition Assessments

1 Objective

The objective of the Phase 1 Preliminary Risk Assessment is to identify the existing ground conditions and environmental setting of a defined site using readily available published information. The aim is to identify the potential presence of ground contamination which might have associated environmental liabilities or which may affect the site redevelopment. A combined assessment including geotechnical information will also appraise the likely foundation requirements and geotechnical constraints at the site.

2 Introduction

The statutory definition of contaminated land is given in Part IIA of the Environmental Protection Act as "land which appears to the Local Authority in whose area it is situated to be in such as condition, by reason of substances in, on or under the land that (i) significant harm is being caused to people, ecosystems or infrastructure, or there is a significant possibility that such harm could be caused, or (ii) pollution of controlled waters is being, or likely to be, caused"

Situations where harm is to be regarded as significant are (i) chronic or acute toxic effect, serious injury or death to humans, (ii) irreversible or other adverse harm to the ecological system, (iii) substantial damage to, or failure of buildings, (iv) disease, other physical damage or death of livestock or crops, and (v) pollution of controlled waters

The definition of "pollution of controlled water" has been amended by the introduction of Section 86 of the Water Act 2003 and makes clear that, for the purposes of Part IIA only, groundwater does not include waters above the saturated zone.

3 Approach

UK policy and legislation promote the use of a risk based approach to the assessment of ground quality/conditions. Risk is defined the probability or frequency of exposure to a substance with the potential to cause harm, and the seriousness of the consequence.

The technical guidance supporting the legislation is presented in a series of documents known as the Contaminated Land Reports (CLRs 1 to 11). The guidance proposes a four-stage approach to the assessment of contamination and associated risks. The four stages are:-

i) Hazard Identification – identifying potential contaminant sources on and off site
ii) Hazard Assessment – analysing the potential for unacceptable risks by identifying what linkages could be present and what could be affected (Conceptual Model)
iii) Risk Estimation – establish the magnitude and probability of the possible consequences (what degree of harm might result to defined receptors and how likely)
iv) Risk Evaluation – deciding whether the risk is unacceptable.

The underlying principle is the evaluation of pollutant linkages for assessing whether the presence of a source of contamination could potentially lead to harmful consequences. A pollutant linkage consists of the following three elements:-

i) A Source/Hazard (chemical or geotechnical) which has the potential to cause harm or pollution;
ii) A Pathway for the hazard to move along / generate exposure; and
iii) A Receptor that is affected by the Source/Hazard.

The Source may be an identified leak of oil, an area of radioactive contamination or a former landfill for example. Pathways include transport by groundwater, surface water, windblown dust, vapours etc, and for humans will include the means by which contaminants enter the body, for example dermal contact, ingestion, inhalation etc. Receptors include people, other living organisms and the built environment. Groundwater and surface waters are receptors as well as being contaminant pathways.

4 Risk Assessment Strategy

To assess the potential risk related to the quality of the ground and groundwaters, a qualitative risk assessment is carried out utilising a Conceptual Site Model to identify 'source-pathway-receptor' linkages. This assessment is made from consideration of the information currently available and the findings of any ground investigations.

In the conceptual model the potential environmental risk is related to the potential for a source of contamination to be present, the potential for migration of the contaminant along a given pathway, and the significance of potential receptors. A significant environmental risk occurs only when there is significant migration along a pathway connecting a significant contamination source to a significant receptor. If either the potential for a source, pathway or receptor being present is not significant, then the risk is also not significant. For the purposes of the assessment, the potential for a significant source, pathway or receptor being present is assessed in terms of their magnitude and extent as being very low, low, moderate, high or

very high. The criteria used to assess the significance of the identified sources, pathways and receptors are given in the following sections.

4.1 Potential Sources

The significance of potential sources of contamination has been determined from consideration of the previous or ongoing activities on or near to the site and any available results of contamination analyses in general accordance with the criteria presented in the **Table 1**. In addition, specific consideration is given to the potential for "diffuse source" pollutants to be present.

4.2 Potential Pathways

The significance of potential pathways for the migration of contamination has been determined from consideration of the nature of the ground conditions on the site and the current use of the site in general accordance with the criteria presented in the **Table 2**. In addition, specific consideration is given to the effect of the distance and time of travel along a potential pathway on the environmental risks, for example the effect of dilution and dispersion of groundwater flow through an aquifer.

4.3 Potential Receptors

The significance of potential receptors is based on the value of the attributes of the receptor and will be influenced by a number of factors such as the relative quality, scale, rarity and substitutability of the receptor. The determination of the significance of the potential receptors is based mainly on existing designations but allows for professional judgement where receptors are found that do not have any formal national or local designation.

The significance of potential receptors has been determined in general accordance with the criteria presented in **Table 3**.

5 Risk Estimation and Evaluation

The environmental risk is related to the potential for a significant source of contamination to be present, the potential for significant migration of the contaminant along a given pathway, and the potential for significant harm to sensitive receptors. A significant environmental risk occurs only when there is significant migration along a pathway connecting a significant contamination source to a significant receptor. If either the potential for a source, pathway or receptor being present is not significant, then the environmental risk is also not significant.

The environmental risk is determined by the interrelationship between the potential for a source of contamination to be present, the potential for migration of the contaminant along a given pathway, and the significance of potential receptors for any identified source-pathway-receptor' linkage. This approach allows the magnitude and probability of the possible consequences that may arise as a result of a hazard to be assessed and possible unacceptable risks to be identified.

Table 1: Criteria for Determining the Significance of Potential Sources of Contamination

Potential Significance	Typical Land Use/ Sources of Gas Generation/ Concentrations of Potential Contaminants
Very Low	Land Use: Greenfield site. Gas Source: Soils with low organic content. Contamination: No significant contamination.
Low	Land Use: Residential, retail or office use. Gas Source: Soils with high organic content. Contamination: Locally slightly elevated concentrations of limited number of contaminants.
Moderate	Land Use: Railway land, collieries, scrap yards, light industry, inert landfills. Gas Source: Old landfills, inert waste. Contamination: Locally elevated concentrations of a number of contaminants.
High	Land Use: Gas works, chemical works, heavy industry, non-hazardous landfills. Gas Source: Shallow mine workings. Contamination: Widespread elevated concentrations of a number of contaminants.
Very High	Land Use: Hazardous landfills. Gas Source: Recent landfills. Contamination: Widespread highly elevated concentrations of a number of contaminants.

Table 2: Criteria for Determining the Significance of Potential Pathways

Significance	Typical Example
Very Low	Contact, uptake or leaching: Hard surfaces Absorption: Hard surfaces Infiltration: Hard surfaces Ground and surface water flow: Unproductive strata, strata with no significant groundwater flow
Low	Contact, uptake or leaching: Established surface vegetation, significant surface cover Absorption: Non-agricultural land, well established surface vegetation Infiltration: Soils of low leaching potential Ground and surface water flow: Secondary aquifers, materials with low mass permeability
Moderate	Contact, uptake or leaching: Limited surface vegetation or surface cover Absorption: Non-agricultural land, poorly established surface vegetation Infiltration: Soils of intermediate leaching potential Ground and surface water flow: Secondary aquifers, materials with moderate mass permeability
High	Contact, uptake or leaching: Exposed surface soils, areas with no significant surface cover Absorption: Cultivated arable land, grazing land Infiltration: Soils of high leaching potential Ground and surface water flow: Principle aquifer, materials with high mass permeability
Very High	Contact, uptake or leaching: Excavation or disturbance of surface soils Absorption: Land cultivated for fruit and vegetables Infiltration: Direct contact with mobile ground or surface waters Ground and surface water flow: Surface water flow

Table 3: Criteria for Determining the Significance of Potential Receptors

Potential Significance	Criteria	Typical Example
Very Low	Receptor of no significant importance.	Groundwater: Unproductive Strata Surface Water: CQA Grade F Ecology: No significant value Built Environment: No significant value
Low	Receptor of local or county importance with potential for replacement.	Groundwater: Secondary Aquifer Surface Water: CQA Grade D/E Ecology: Local habitat resources Built Environment: Sites of local value
Moderate	Receptor of local or county importance with limited potential for replacement.	Groundwater: Principle Aquifer Surface Water: CQA Grade B/C Ecology: County Wildlife Sites Built Environment: Areas of Historic Character
High	Receptor of county or regional importance with limited potential for replacement.	Groundwater: Source Protection Zone 2 Surface Water: CQA Grade A providing potable water to a small population Ecology: SSSI, NNR or MNR sites Built Environment: Conservation Area
Very High	Receptor of national or international importance with limited potential for replacement.	Groundwater: Source Protection Zone 1 Surface Water: CQA Grade A providing potable water to a large population Ecology: SPA, SAC or Ramsar sites Built Environment: World Heritage Sites

Note: The potential for significant harm to site workers, site users and site neighbours is related directly to the cumulative length of time people will be on or in the vicinity of the site.

To tie in with the established best practice used in environmental impact assessments, whereby the impact is determined from consideration of the magnitude of change and the sensitivity of the receptor, a two-stage assessment is adopted to determine the environmental risk associated with land contamination. Firstly the potential for a source of contamination to be present and the potential for migration of the contaminant along a given pathway are used to determine the potential for a contaminant to impact a sensitive receptor using the matrix presented in **Table 4**.

Secondly the potential for a contaminant to impact a sensitive receptor and the significance of potential receptors are used to determine the consequent environmental risk using the matrix presented in **Table 5**.

Risk classifications are then referenced to the following descriptions.

Very Low Risk – It is unlikely that harm will arise to a designated receptor and there is unlikely to be a liability/cost for the owner of the business/land.

Low Risk – It is possible that harm could arise to a designated receptor however, the consequences are likely to be limited and it is considered unlikely that the issue will represent a liability/cost for the owner of the business/land.

Moderate Risk – It is possible that harm could arise to a designated receptor but is unlikely that the harm will be significant or permanent. Remedial action may be necessary and therefore the issue could arise as a liability/cost for the owner/occupier whilst retained in the current use. Development/change of use will require further assessment and is likely to incur additional costs.

High Risk – It is likely that significant harm to a designated receptor will occur and therefore it is likely that the issue will represent a liability/cost for the owner of the business/land.

Very High Risk – It is likely that irreversible harm to or loss of a designated receptor will occur and therefore it is likely that the issue will represent a significant liability/cost for the owner of the business/land.

Table 4: Assessed Potential for a Contaminant to Impact a Sensitive Receptor

		Potential for Migration of the Contaminant along a given Pathway				
		Very Low	Low	Moderate	High	Very High
Potential for a Source of Contamination to be Present	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Low	Very Low	Low	Low	Low	Moderate
	Moderate	Very Low	Low	Moderate	Moderate	High
	High	Very Low	Low	Moderate	High	Very High
	Very High	Very Low	Moderate	High	Very High	Very High

Table 5: Assessed Environmental Risk

		Significance of Potential Receptors				
		Very Low	Low	Moderate	High	Very High
Potential for a Contaminant to Impact a Sensitive Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Low
	Low	Very Low	Low	Low	Low	Moderate
	Moderate	Very Low	Low	Moderate	Moderate	High
	High	Very Low	Low	Moderate	High	Very High
	Very High	Low	Moderate	High	Very High	Very High

TABLES

Potential Contaminant		Measured Values			Critical	Outlier Test		Assessment Values									
		Number of Tests	Minimum	Maximum	Concentration	Critical Value	Number Exceedng	Lower Value		Exceeding No	Exceeding Cc	Middle Value		Exceeding No	Exceeding Cc	Upper Value		Exceeding No	Exceeding Cc
Arsenic	mg/kg	15	4	31	23	66	0	32	(1a)	0	-	35	(1b)	0	-	640	(1c)	0	-
Cadmium	mg/kg	15	0.1	2.3	0.7	1.9	1	10	(1a)	0	-	117	(1b)	0	-	230	(1c)	0	-
Chromium	mg/kg	15	8	61	37	91	0	300	(1a)	0	-	300	(1b)	0	-	30400	(1c)	0	-
Lead	mg/kg	15	29	1700	666	5433	0	450	(1a)	7	**X**	450	(1b)	7	**X**	750	(1c)	3	-
Mercury	mg/kg	15	<0.1	1.2	0.6	2.6	0	8	(1a)	0	-	15	(1b)	0	-	480	(1c)	0	-
Selenium	mg/kg	15	<0.2	0.5	0.3	0.5	0	350	(1a)	0	-	595	(1b)	0	-	13000	(1c)	0	-
Copper	mg/kg	15	20	1000	225	474	1	2330	(2a)	0	-	-	(2b)	-	-	71700	(2c)	0	-
Nickel	mg/kg	15	<5	71	44	149	0	130	(1a)	0	-	130	(1b)	0	-	1800	(1c)	0	-
Zinc	mg/kg	15	43	2900	686	1863	1	3750	(2a)	0	-	3750	(2b)	0	-	665000	(2c)	0	-
Sulphate	g/l	15	0.2	1.5	1.0	4.0	0	-		-	-	-		-	-	-		-	-
TPH	mg/kg	15	9	425	150	787	0	500	(3a)	0	-	-		-	-	-		-	-
Total (of 16) PAHs	mg/kg	15	<2	310	86	733	0	-		-	-	-		-	-	-		-	-
Phenols	mg/kg	15	0.3	0.5	0.3	0.4	1	184	(1a)	0	-	310	(1b)	0	-	3200	(1c)	0	-
Organic matter	%	15	0.4	6.6	3.6	15.3	0	-		-	-	-		-	-	-		-	-
pH Value	pH Units	15	8.1	10.3	9.3	10.9	0	-		-	-	-		-	-	-		-	-

Notes

(1) Denotes EA Soil Guideline Values for residential with plant uptake (1a) for residential without plant uptake (1b) and for commercial and industrial development (1c)

(2) Denotes CIEH Generic Assesment Criteria for residential with plant uptake (2a) for residential without plant uptake (2b) and for commercial and industrial development (2c)

(3) Denotes EA Waste Acceptance Criteria for inert (3a) non-hazardous (3b) and hazardous waste (3c)

TPH Denotes Total Petroleum Hydrocarbons (Aliphatics & Aromatics >C5-C44)

PAH Denotes Polynuclear Aromatic Hydrocarbons (US EPA-16)

X Denotes Critical Concentration (Cc) exceeding assessment value

Critical Concentration is the concentration which the actual mean concentration will be below 19 times out of 20

Crtical Value is the concentration above which values may be outliers of the data set.

Critical Concentrations are determined including values exceeding Outlier Test

Values below the Method Detection Limit taken to be equal to the Method Detection Limit

Critical Values and Critical Concentrations have been determined assuming the data forms a normally distributed dataset.

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Client

Camden

SUMMARY OF CHEMICAL ANALYSIS OF SOIL SAMPLES
GENERAL INDUSTRIAL CONTAMINANTS [All Samples]

CHARLIE RATCHFORD EXTRA-CARE SCHEME, CROGSLAND ROAD, CAMDEN

Date	October 2014
A4 Scale	nts
Drawn	az
Checked	az
Table	**1a**