

Phase 2 land quality assessment: land at junction of Bryn Road and Harwd Road, Brymbo, Wrexham, LL11 5BW

Prepared for: Tony Lambert
C Lambert Builders
High Street
Brymbo
Wrexham
Clwyd
LL11 5BL

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Prepared by
Ground First Ltd

26 Victoria Street, Castlefields, Shrewsbury, SY1 2HS

Tel: 07484 542827

email: info@groundfirst.com

Registered in England and Wales, number 10418394

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Glossary and Abbreviations

This glossary includes definition of key technical terms and abbreviations that may be used within the report text.

ACM	Asbestos containing material
aOD	Above Ordnance Datum
bgl	Below ground level
BGS	British Geological Survey
BOD	Biological oxygen demand
BTEX	Benzene, toluene, ethylbenzene, xylene
C4SL	Category 4 Screening Level
DRO	Diesel range organics
EA	Environment Agency
EPH	Extractable petroleum hydrocarbons
GRO	Gasoline range organics
GAC	Generic assessment criterion
LOD	Limit of detection
MTBE	Methyl tertiary butyl ether
NGR	National Grid Reference
PAH	Polycyclic aromatic hydrocarbons
S4UL	Suitable for Use Level
SGV	Soil Guideline Value
SOM	Soil organic matter
SVOC	Semi-volatile organic compound
TPH	Total petroleum hydrocarbons
VOC	Volatile organic compound

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1 INTRODUCTION

1.1 Background

Planning approval has been granted by Wrexham County Borough Council (planning application ref: P/2015/0204) for the construction of three detached properties and new vehicular and pedestrian access at a c. 0.11 ha brownfield site at the junction of Bryn Road and Harwd Road in Brymbo, Wrexham (the Site). The Site location is shown on Figure 1.1.

The approved development plans are presented on Figure 1.2 and Figure 1.3; these plans allow for separate vehicle driveways leading off Harwd Road along with front and rear gardens to each dwelling. In order to create the approved development platform, selected in situ soils / Made Ground will require excavation and removal off-Site. A schematic showing the two main areas of the Site where bulk earth movements will be required is shown on Figure 1.4.

The planning approval includes conditions relating to the phased assessment of contaminated land risks (Planning Conditions 4 and 5):

4. *No part of the development shall commence until a scheme to deal with potential contamination at the site has been submitted to and approved in writing by the Local Planning Authority. This scheme shall include a phased investigation approach to identify the extent of contamination and any measures required to remediate the site, including post-development monitoring.*
5. *No part of the development shall occupied until a Verification Report which demonstrates that the remedial works approved as part of condition 4 have been satisfactorily carried out, has been submitted to and approved in writing by the Local Planning Authority.*

In response to Condition 4, GeoSmart Information Ltd. produced a Phase 1 contaminated land desk study for the Site in March 2020. The Phase 1 report concluded that, *'Given the various phases of redevelopment activity that have taken place at the Site over the last 100+ years including the demolition of assorted buildings and the presence of a car park, there is the potential for localised contamination to be present at the Site, including contamination associated with miscellaneous Made Ground. It is therefore recommended that a proportionate programme of site investigation works be undertaken in order to establish the presence or absence of contamination and to enable a quantitative assessment of the associated environmental risks'*.

Following the review of the Phase 1 report Stacey Inglis (Contaminated Land Officer for Wrexham County Borough Council) provided the following comment to the Council's planning department (letter dated 16th April 2020):

I can confirm that I am in agreement with the conclusions and recommendations within the report: a proportionate programme of site investigation works to be undertaken in order to establish the presence or absence of contamination and to enable a quantitative assessment of the associated environmental risks.

It is a requirement of Condition 4 that the above works are undertaken and that the subsequent site investigation report is submitted to the Council for written approval. Please note that I cannot recommend to the Planning Department to discharge Condition 4 until this report has been submitted and approved in writing and if deemed necessary agreed to any remedial proposals.

In response to the Phase 1 report findings and also the requirements of Planning Condition 4 Ground First has been commissioned to undertake a proportionate intrusive site investigation in order to quantify potential environmental risks associated with the prevailing land quality at the Site.

1.2 Instruction

Ground First was instructed by the Client (C Lambert Builders) on 28th May 2020 to undertake a Phase 2 land quality assessment as outlined in proposal reference 4145P1.

1.3 Objectives

The objective of the work was to undertake a proportionate programme of site investigation and environmental risk assessment in order to satisfy the requirements of Planning Condition 4.

1.4 Scope of works

In order to ascertain the risks posed by any in situ ground contamination, a programme of investigative works was designed to address the following key uncertainties:

- The extent, thickness and composition of Made Ground present across the Site.
- The chemical composition of the Made Ground.
- The presence of any asbestos containing materials at surface and within the underlying Made Ground.
- The likely ground gas potential of any Made Ground.
- The nature of the underlying natural geology and the presence of any shallow groundwater.

1.5 This report

This report provides factual records of all relevant fieldwork observations and analytical test results; it also presents a conceptual site model as well as the findings of appropriate risk assessments relating to relevant contaminant linkages.

1.6 Exclusions

It is noted that the findings presented in this report are in part based on information supplied by third parties. Whilst we assume that all information is representative of past and present conditions we can offer no guarantee as to its validity. This report excludes consideration of potential hazards arising from any activities at the Site other than normal use of the proposed development. Hazards associated with any other activities have not been assessed and must be subject to a specific risk assessment by the parties responsible for those activities.

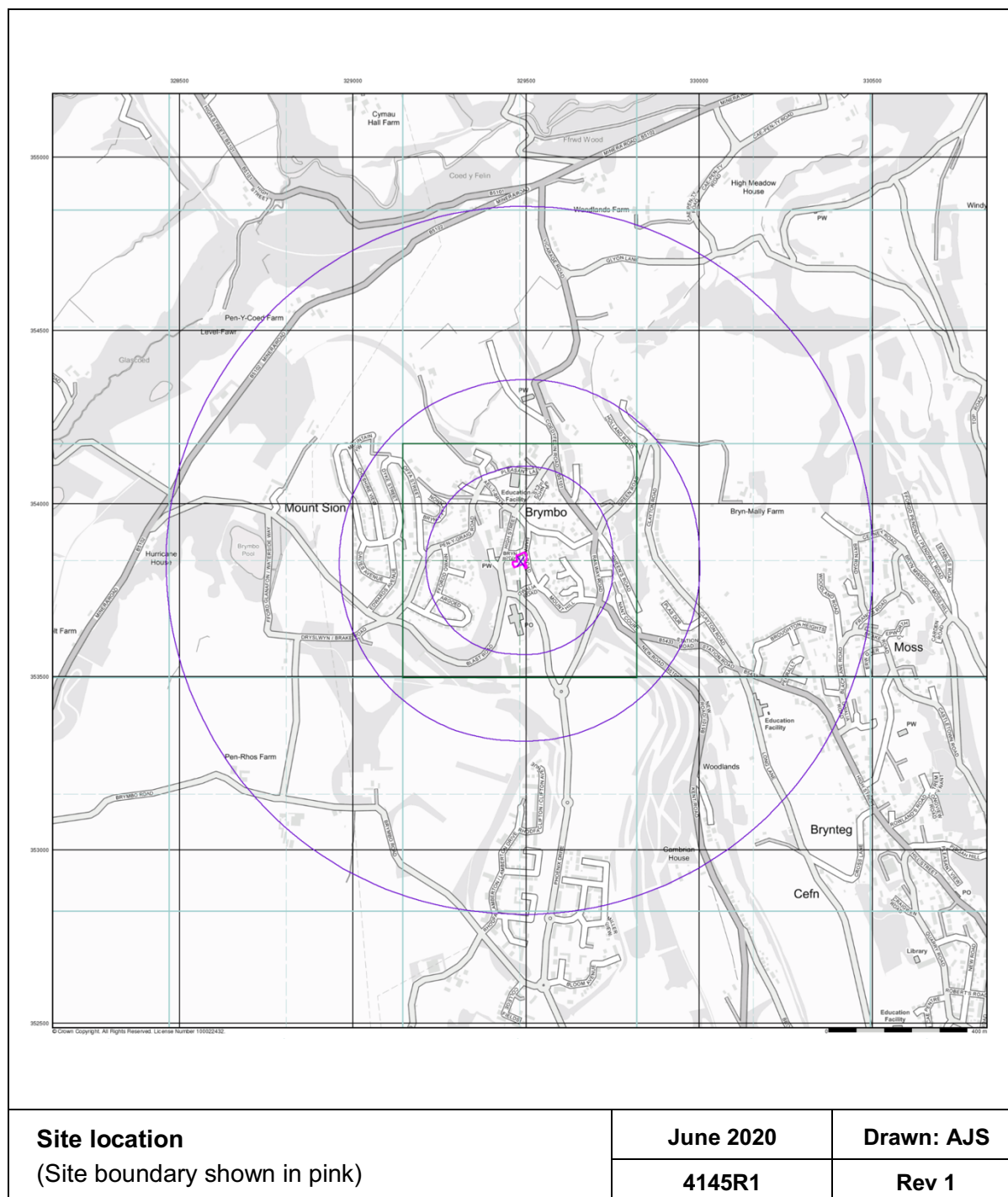
Figure 1.1 Site location

Figure 1.2 Proposed development plan

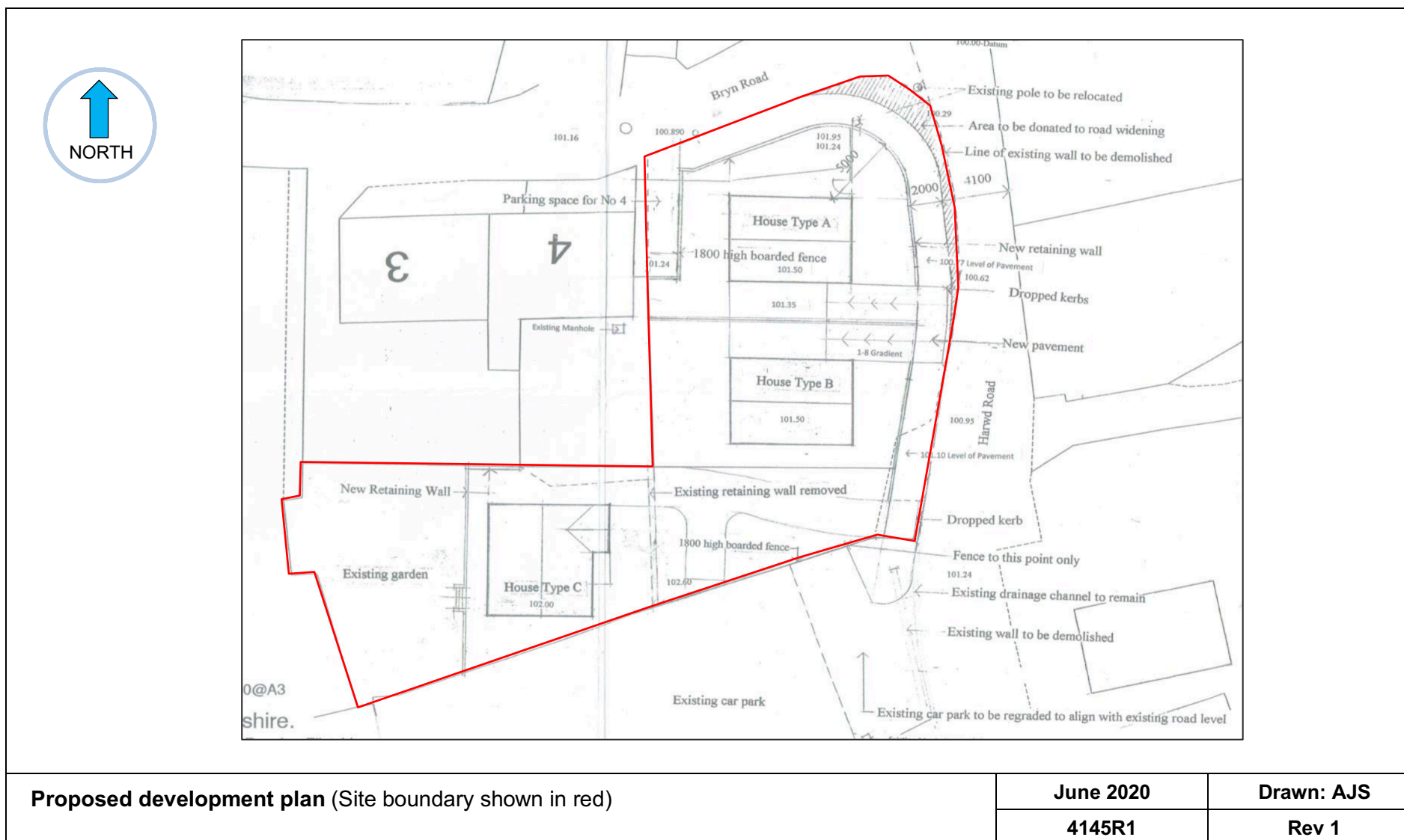
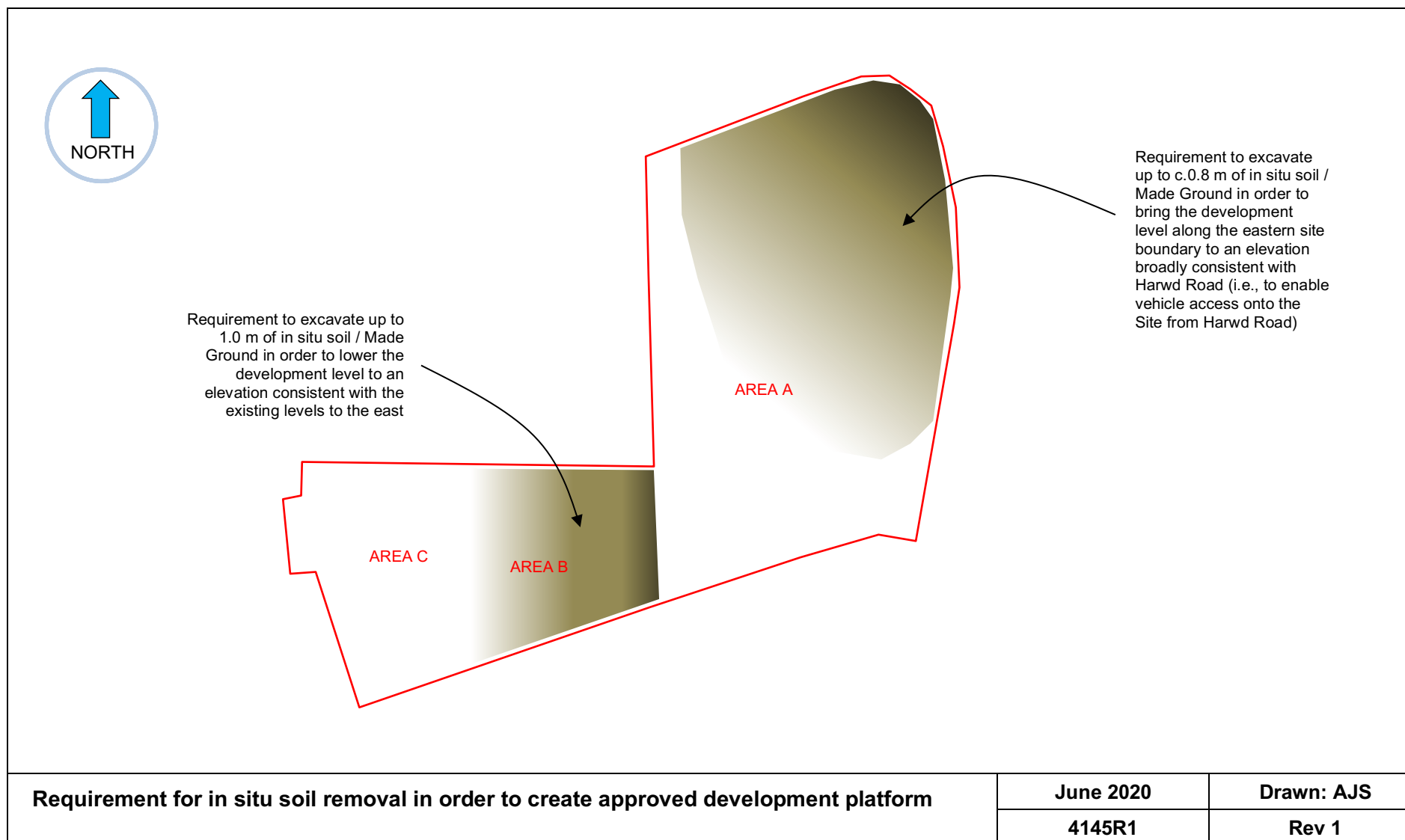


Figure 1.3 Proposed development plan – building front elevations**Proposed development plan – view from Harwd Road****June 2020****Drawn: AJS****4145R1****Rev 1**

Figure 1.4 Indicative extents of required bulk earth movements

2 SITE SETTING AND HISTORY

The following section provides a summary of the Site setting and land use history.

2.1 Basic site information

Information relating to the Site location is summarised in Table 2.1.

Table 2.1 Site details

Site Address	Land adjacent at the junction of Bryn Road and Harwd Road, Brymbo, Wrexham, LL11 5BW.
Site area	The application Site occupies a land area of c. 0.11 ha.
Topography	The current Site topography is characterised by the following three areas: - Area A: A relatively flat and level area which extends across the eastern half of the Site (see Figure 1.4). - Area B: A raised garden terrace in the central-south-western part of the Site (see Figure 1.4); this land is c. 1.1 m higher than the neighbouring Area A. - Area C: A further raised garden terrace in the south-western part of the Site (see Figure 1.4); this land is c. 0.3 m higher than the neighbouring Area B. The ground elevation along the northern and north-eastern Site boundaries is c. 1.4 m higher than the adjacent road levels; this suggests that the Site has previously been subject to infilling in order to create the current landform across Area A. Areas B and C have been terraced but appear generally to follow the local topographic controls.
General setting and Ground coverage	The Site is located within a predominantly residential land use area. The main Site area (Area A) is covered by weathered tarmac and compacted sand and gravel / hardcore. The south-western part of the application area (Areas B and C) is currently occupied by residential garden space. The Site is bound to the east by Harwd Road and the north by Bryn Road. The long standing residential properties, 3 and 4 Bryn Road, are positioned directly to the north-west of the Site. The land to the south is occupied by tarmac hard standing / parking associated with the social club located directly to the south-west of the Site. Photographs of the current Site condition are included in Appendix B.

2.2 Site history

Salient aspects of the Site's past land use are shown in Table 2.2 below (as derived from the existing Phase 1 report and associated historical land use mapping).

Table 2.2 Site land use history

Date	Land use
1873	The Site is developed including an irregular shaped structure in the north of the Site, two small adjoining rectangular structures (possible sheds/garages) in the south-east and a further modest rectangular building along the western Site boundary. The surrounding land area is occupied by assorted residential-scale structures; the existing properties at 3 and 4 Bryn Road are evident directly to the north-west of the Site. There is a mineral railway c. 75 m to the east, orientated north to south; a suspected spoil heap c. 90 m to the south; and a gasometer c. 230 m to the south, associated with Brymbo Iron Works. Various rail lines / siding are mapped from c. 150 m to the south of the Site; these features are also associated with the Iron Works.
1899	The former adjoining rectangular structures in the south-east of the Site are no longer mapped; two small detached square structures are however shown in the south of the Site. A post office appears to have been constructed to the north of the Site. There has been development over the spoil heap area c. 90 m to the south. There is an old quarry pit c. 110 m to the west.
1912	Two further small structures are shown in the south-west corner of the Site.
1963	All former on-Site structures appear to have been removed. The boundary line between the lower Site area and the garden of 4 Bryn Road (in the south-west of the Site) is evident. The Miner's Arms public house is shown c. 5 m to the west. There is a club c. 15 m to the west. Brymbo Steel and Iron Works is now labelled as a works (steel works). Two areas of water (suspected reservoirs) are labelled c. 140 m to the south associated with the works; the gasometer c. 230 m to the south is no longer shown.
1967	Two domestic-scale buildings have been erected within the central area of the Site.
1980 - 1984	The two buildings in the central area are no longer shown. By 1984 the club to the south-west has been expanded to occupy its current footprint.
1987 - 1996	No obvious land use changes are evident on-Site or within the immediate vicinity. The former Brymbo Steel and Iron Works is no longer labelled on the 1993 land use mapping.
2006 - 2012 Aerial imagery	Aerial imagery indicates that the main Site area in the east remains undeveloped with some vegetation along the northern Site boundary. Potential aggregate stockpiles appear to be intermittently present on-Site. In 2006 the garden area to the rear of 3 Bryn Road appears to have been used for possible material storage (potentially associated with the neighbouring social club). No such storage activity is evident from 2012.
2018 Aerial imagery	Aerial imagery shows the main Site area to be used for the storage of building materials (including small aggregate stockpiles and various pallets of miscellaneous construction materials). The garden area to the rear of 3 Bryn Road appears vegetated.

In summary, the study Site was developed prior to 1873 for assumed residential use (note: the Client has indicated that residential cottages were historically present on-Site). The Site has been redeveloped on several occasions during the late 1800s and 1900s. All former on-Site structures appear to have been cleared by the early 1980s.

More recently the central and eastern parts of the Site appear to have been used for the

storage of building materials, including bricks and aggregate stockpiles (i.e., sand and gravel, criggion stone, and grano dust mix). The Client has also stated that the Site was previously used as a car park in conjunction with The Miners Arms public house and the neighbouring social club.

2.3 Environmental setting

Information relating to the environmental Site setting is summarised in Table 2.3, as obtained from the existing Phase 1 report plus publicly available environmental data sets.

Table 2.3 Environmental Site setting

Topic	Description
Geology and groundwater	British Geological Survey (BGS) mapping indicates the absence of any superficial deposits beneath the Site. The bedrock geology consists of the Pennine Lower Coal Measures Formation and Pennine Middle Coal Measures Formation, which comprise of mudstone, siltstone and sandstone and are classified as a Secondary A Aquifer. Localised Made Ground is anticipated on-Site, possibly including demolition materials associated with former built structures. The following BGS borehole records are present within a 250 m radius of the Site: - A series of seven boreholes were drilled c. 80 m to the north-west of the Site (in relation to the 'Long Row site') - BGS borehole refs: SJ25SE1313 to SJ25SE1319. The borehole logs revealed between 0.9 m and 2.1 m of Made Ground (comprised largely of 'brick, ash and stone fill') overlying weathered sandstone (including 'hard and soft bands'). - BGS borehole ref: SJ25SE948 was drilled c. 160 m to the east of the Site. The encountered geological sequence included: 0.9 m of ash fill; 1.3 m of clay and sandstone fill; 5.8 m of weathered sandstone; and 4 m+ of mudstone. According to the Phase 1 report (see Appendix A) the Site does not lie within a groundwater Source Protection Zone (SPZ) and there are no groundwater abstraction licences within 1 km of the Site. According to the Coal Authority the Site is located within a 'Development Low Risk Area' (with regard to residual coal mining risks). A Consultants Coal Mining Report is included within the Phase 1 report; the Coal Mining report includes the following salient information: - There are two underground mining records local to the Site; (1) a wall and bench coal seam (3V5K) to a depth of 102 m was worked at 11.3 degrees east at an extraction thickness of 70 cm beneath the property - last mined in 1906; (2) a quaker coal seam (ref: 7OLK) to a depth of 115 m was worked at 8 degrees east at an extraction thickness of 100 cm south of the Site - last mined in 1800. - There has been no probable unrecorded shallow coal workings. - There are no recorded mine entries within 100 m of the Site. - There is a geological fault recorded close to the Site. - No opencast mines are recorded within 500 m of the Site. - No Coal Authority managed tips are recorded within 500 m of the Site. - The Coal Authority has not received a damage notice or claim for the Site or any property within 50 m of the enquiry boundary since 31st October 1994. - No mine gas has been recorded within 500 m of the Site. - There are no coal mining licences recorded within 200 m of the Site. - No notices have been given under section 46 of the Coal Mining Subsidence Act 1991, stating that the land is at risk of subsidence.

Topic	Description
Surface water and flooding	There are no significant surface water features within 250 m of the Site. The Phase 1 report (see Appendix A) indicates that there are no surface water abstraction licences within 1 km of the Site. According to the Phase 1 report the Site lies within fluvial Flood Zone 1.
Landfill	According to the Phase 1 report (see Appendix A) the Works Bank landfill is located c. 60 m south of the Site; the landfill is reported to have received inert and industrial waste from 1899. However, no corresponding evidence of landfilling is shown on the historical OS maps. Any infill materials are therefore likely to be of an appreciable age and thus of significantly reduced gas potential. There are no other known historical or operational landfill sites within a 250 m radius of the Site. The Phase 1 report cites correspondence from the Council confirming that no tips associated with the former Brymbo Steel Works are located within 250 m of the Site, and that ground gas has not been identified as a risk to the application Site.
Pollution incidents	According to the Phase 1 report (see Appendix A) there are no Environment Agency records of known pollution incidents within 200 m of the Site. There are no records of any sites determined as Contaminated Land under the Environmental Protection Act 1990, within 250 m of the Site.
Radon	Public Health England mapping (https://www.ukradon.org/information/ukmaps) indicates that the application Site is located within a Radon Affected area; the Site is positioned within a 1 km grid square where 5% to 10% of homes are estimated to be at or above the Action Level (200 Bq/m³).
Environmental designations	According to the Phase 1 report (see Appendix A) the Site is not located within 250 m of any environmental designations.

2.4 Client consultations

The Client has provided the following information regarding the Site history and current condition:

- The Site developer has owned the Site for the last 20 years.
- During the last 20 years the Site has largely been used for the storage of clean aggregate. There has been no storage of demolition materials, bulk fuels or chemicals.
- Previous excavations relating to the laying of a water supply pipe at the Site (in the south-eastern corner) encountered a c. 1 m thickness of clay over bedrock.
- There is no drainage infrastructure on-Site.

The Client has provided the following information regarding the development plans:

- A detailed foundation specification is yet to be produced. However, the property constructions are likely to comprise traditional strip foundations.
- Areas of soft standing (including front and rear gardens) will be associated with each of the proposed properties.
- Bulk earth movements are proposed in order to construct the development platform (as illustrated on Figure 1.4). As such, in situ soils / Made Ground present in the north, east and south-west of the Site will require removal from Site prior to the commencement of building works.

3 SITE INVESTIGATION WORKS

3.1 Site investigation programme

A programme of intrusive site investigations was coordinated by Ground First on 3rd June 2020. A summary of the site investigation activities undertaken is presented in Table 3.1. Trial pit locations are shown on Figure 3.1 with trial pit soil descriptions provided in Appendix C. A photographic record of the Site works is provided in Appendix B (note: due to camera water damage, no photographs taken of the trial pits were recoverable).

Table 3.1 Site investigation activities

Element of investigation	Details	Rationale
Trial pitting	Nine trial pit locations (TP01 to TP09) were excavated at the study site using a tracked 3-tonne excavator. The pits were distributed across accessible areas of the Site; all locations were focussed on areas of proposed soft standing (post development). The trial pit locations are shown on Figure 3.1. The pits were excavated to depths of between 0.7 m and 1.55 m bgl. All pits were backfilled on completion. The excavated spoil was replaced in broadly the same order as it was excavated. All excavated materials were logged by an experienced site supervisor.	To characterise existing ground conditions across accessible areas of the Site. To assess the extent, thickness and composition of any Made Ground. To make a visual assessment of any ground contamination. To facilitate environmental soil sampling. To assess the chemical composition of any Made Ground. To clarify the nature of the natural geology including the presence of any shallow groundwater.
Soil sampling	Nine soil samples were taken from the trial pits (one from each excavation) at depths of between 0.05 m and 0.8 m bgl. <i>Note: given the requirement for the excavation of selected in situ soils / Made Ground in order to create the required development platform (as illustrated on Figure 1.4) soil samples were targeted on those materials that will be left in place following the earth work activities.</i>	To provide appropriate samples for chemical laboratory analysis (analytical suite described below) in order to inform the environmental risk assessment.
Laboratory analysis	All samples collected on-Site were submitted to the UKAS and MCERTS accredited i2 Analytical laboratories for analysis.	To allow assessment of potential land quality risks to identified receptors.

3.2 Chemical laboratory testing

Representative samples of soil / Made Ground were obtained from each of the trial pits excavated at the Site.

A total of eight soil samples were scheduled for chemical analysis performed by i2 Analytical (i2 Analytical is an approved Ground First supplier) – the sample taken from TP08 (where no Made Ground was observed) was placed on hold. Where possible UKAS and MCERTS certified tests were used. The samples were analysed for a range of the following soil determinands:

- Metals and metalloids (As, Be, B, Cd, Cr (III and VI), Cu, Ni, Pb, Se, Zn, V and Hg)
- Water soluble sulphate
- Free cyanide
- Fraction of organic carbon (foc)
- pH
- Moisture content
- Banded TPH
- Speciated TPH
- Speciated PAHs
- MTBE
- BTEX
- Total phenol
- Asbestos in soil screen

4 SITE INVESTIGATION RESULTS

4.1 Encountered ground conditions

The sequence of strata encountered within each of the trial pits is described in full in Appendix C and summarised below.

- Made Ground was encountered within all of the trial pits excavated across the open land area in the eastern part of the Site (i.e., TP01 to TP07). The Made Ground is described as follows:
 - A layer of compacted hardcore, comprising brown-grey sand and gravel plus grey to grey-pink sandy gravel was encountered in trial pits TP01 to TP06. This material was observed at thicknesses of between 0.1 m (TP06) and 0.25 m (TP01 and TP05).
 - A weathered tarmac layer (typical of the surface covering across the centre of the open land area) was encountered at TP07, to a depth of 0.05 m.
 - A c. 0.1 m thickness of dark brown gravelly sand with frequent roots and rootlets was observed beneath the hardcore layer in TP01 and TP05; this may relate to a relic topsoil layer.
 - The main mass of Made Ground appears to comprise of two broad horizons:
 - An 'upper' layer of dark brown-grey to black sand and gravel with cobbles plus assorted man made material including variable amounts of brick, slate, clay tile, metal, glass, ceramics, plastic and tarmac remains. This layer was encountered in each of the trial pits TP01 to TP07; the observed thicknesses were between 0.25 m and >0.85 m (TP01).
 - A 'lower' layer of grey-brown to black-brown silty sand and gravel and silty gravelly sand including only limited amounts of brick, slate and metal, was observed at TP02, TP03 and TP05. The observed thicknesses were between 0.55 m and 0.95 m (TP02).
 - A 0.75 m thickness of orange-red sandy gravel with some brick remains was recorded beneath the upper Made Ground in TP04.
 - The full thickness of Made Ground varied between 0.35 m in the south of the Site (TP06 and TP07) and 1.35 m in the north-east of the Site (TP02). The trend for increasing thicknesses of infilled ground towards the north of the Site is consistent with the observed differential between Site levels and the surrounding natural ground elevations (i.e., the north-eastern part of the Site appears to have been built up to a level c 1.4 m above the neighbouring road level).
- The natural superficial deposits / weathered bedrock largely comprised soft to firm mid-brown gravelly clay.
- The observed ground conditions within the garden area to the rear of 3 Bryn Road (as encountered in trial pits TP08 and TP09) included a brown to dark brown gravelly sand topsoil to depths of between 0.05 m and 0.35 m. The soil layer was underlain by friable grey mudstone and clayey (weathered) mudstone.

4.2 Groundwater

Shallow groundwater was only encountered in one of the nine trial pits; water entered TP09 at a depth of c. 0.6 m bgl; the water level rose to 0.5 m bgl after 30 mins.

4.3 Visual and olfactory evidence of contamination

The following site observations were recorded in relation to potential ground contamination:

- As above, Made Ground was identified across the open land area in the eastern half of the Site, including variable amounts of man-made material, albeit these materials appeared largely inert in nature.
- No significant staining or odours were recorded in any of the trial pits.
- No obvious evidence of any asbestos containing materials was observed either at ground surface or within the excavated Made Ground.

4.4 Chemical testing results

Full laboratory certificates of the soil test results are presented in Appendix D.1. A summary of all analytical data is also shown in Appendix D.2.

4.5 Other site observations

Salient observations made during the site investigation works included:

- The open area in the eastern part of the Site is partially surfaced with weathered tarmac; the surfacing around the edges of the open area comprises of compacted hardcore. The existing garden area to the rear of 4 Bryn Road is laid to grass with some paving and planted borders. The garden area to the rear of 3 Bryn Road is covered by assorted grasses and shrubs.
- Modest quantities of building materials including some small aggregate / mineral stockpiles and several pallets of bricks and tiles were observed in the north-east of the Site (see Photographs 4 and 5 in Appendix B).
- No evidence of any drainage infrastructure was observed on-Site.
- The Site topography across the open area across the north-east of the Site is relatively flat and level (see Photograph 1 in Appendix B). The ground elevation along the northern and north-eastern Site boundaries is c. 1.4 m higher than the adjacent road levels (see also annotations included on Figure 3.1). This suggests that the Site has previously been subject to infilling in order to create a level platform.
- The ground surface along the southern Site boundary steps up (facilitated by a stone retaining wall – see Photograph 6 in Appendix B) from the open land area in the south-east to the rear garden of 4 Bryn Road (the level change is c. 1.1 m). Ground levels also step up from the rear garden of 4 Bryn Road to the adjacent garden area to the rear of 3 Bryn Road (see Photograph 3 in Appendix B).
- There was no evidence of any past or present bulk fuel or chemical storage on the Site.

5 CONTAMINATION ASSESSMENT

The following section identifies potential contaminants of concern (COC) associated with encountered ground conditions beneath the Site. The outputs of this process will be used to refine the conceptual site model which will in turn provide the technical basis for an assessment of contamination risks in Section 6.

5.1 Planning context

The planning system adopts a risk-based approach to the management of soil contamination in which the Local Authority acts as the primary regulator. The requirements of the planning system, including those associated with the management of contaminated land, are described within Planning Policy Wales, Edition 10 (WAG, 2018). Relevant components of the Planning Policy Wales document include:

- **Section 3.51. Previously Developed Land:**

‘Previously developed (also referred to as brown field) land should, wherever possible, be used in preference to green field sites where it is suitable for development’.

- **Sections 6.9.16 to 6.9.21. Land Contamination:**

(Section 6.9.17). *‘The onus will remain with the developer to ensure that the development of the site will remove any unacceptable risks and the planning authority in making development management decisions will need to ensure that the land is suitable for its proposed use and would not meet the legal definition of contaminated land under Part IIA’.*

(Section 6.9.18). *‘Planning authorities should take into account the nature, scale and extent of land contamination which may pose risks to health and the environment so as to ensure the site is capable of effective remediation and is suitable for its intended use. In doing so, development management decisions need to take into account:*

- *the potential hazard that contamination presents to the development itself, its occupants and the local environment; and*
- *the results of a specialist investigation and assessment by the developer to determine the contamination of the ground and to identify any remedial measures required to deal with any contamination’.*

(Section 6.9.19). *‘Where land contamination issues arise, the planning authority will require evidence of a detailed investigation and risk assessment prior to the determination of the application to enable beneficial use of land.’*

5.2 Assessment of soil data (human health)

5.2.1 Contaminant screen (soil quality)

An initial soil screening exercise involved comparing observed soil quality data with a set of generic human health screening values (commonly referred to as Generic Assessment Criteria (GAC)). GACs have been compiled from various published sources, based on the following hierarchy:

- Suitable for Use Levels (S4ULs) derived by a consortia of industry professionals and published by LQM and CIEH.
- Category 4 Screening Levels (C4SL) published by Defra.

The available soil quality data have been assessed against GACs representative of a typical residential land use, with a sandy loam soil type and a soil organic matter content of 6% (note: the average observed SOM was 7.3%). The adopted GACs are listed in Appendix E.

Table 5.1 below presents a summary of soil quality determinands for which exceedances have been observed against the GACs together with corresponding locations and sample depths. GAC exceedances are highlighted in bold.

Table 5.1 Soil quality screen

Analyte	No. Samples	Minimum (mg/kg)	Average (mg/kg)	Maximum (mg/kg)	GAC (mg/kg)	Number of Samples exceeding GAC	Samples exceeding GAC (depth)
Beryllium	8	1.0	2.5	4.4	1.7 (S4UL)	7 (88%)	All samples locations other than TP01
Lead	8	57	332	650	200 (C4SL)	7 (88%)	All samples locations other than TP01
Benzo(b) fluoranthene	8	1.2	5.0	17.0	3.7 (S4UL)	3 (38%)	HP04 (0.4m) TP05 (0.3m) TP06 (0.25m)
Benzo(a) pyrene	8	0.95	4.4	14.0	3.0 (S4UL)	3 (38%)	HP04 (0.4m) TP05 (0.3m) TP06 (0.25m)
Dibenz(a,h) anthracene	8	<0.05	0.5	1.7	0.3 (S4UL)	3 (38%)	HP04 (0.4m) TP05 (0.3m) TP06 (0.25m)

Key observations taken from the soil screening exercise, include the following:

- The majority of analytes, including all phenols, free cyanide, BTEX and TPH species, were measured at concentrations below the adopted screening values indicating that these substances are unlikely to pose any future health risks under the proposed residential development scenario.
- However, the majority of beryllium and lead concentrations plus several PAH results exceeded the adopted GACs and may therefore pose a potential human health risk, subject to more detailed consideration of likely contaminant exposures.
- Seven of the eight measured beryllium and lead concentrations were in excess of their respective GACs. The average concentrations of both metals also exceeded the adopted screening values.
- It is noted that the beryllium and lead concentrations were relatively consistent across all of the sample results, with the exception of the sample collected from TP01 (which was taken from a distinct surficial 'soil' layer).
- Selected PAH species were in excess of the adopted screening values in three of the eight samples. In addition, the average PAH concentrations for benzo(b)fluoranthene, benzo(a)pyrene and dibenz(a,h)anthracene were also in excess of the adopted screening values.

The risks posed by the soil quality data are discussed further in Section 6.

5.2.2 Normal Background Concentrations

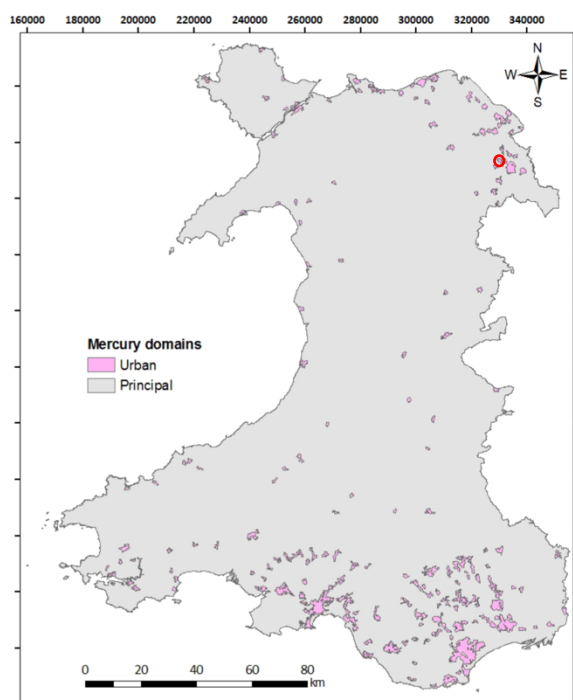
BGS (2013) developed normal background concentrations (NBCs) for a limited number of potential contaminants with each having separate spatial 'domains' to distinguish between the variation in background concentrations in different areas of England and Wales.

The NBC values are deemed to represent 'typical and widespread' topsoil quality (i.e. chemical quality at depths from 0 to 15 cm below ground surface) including contributions from both natural and diffuse anthropogenic sources.

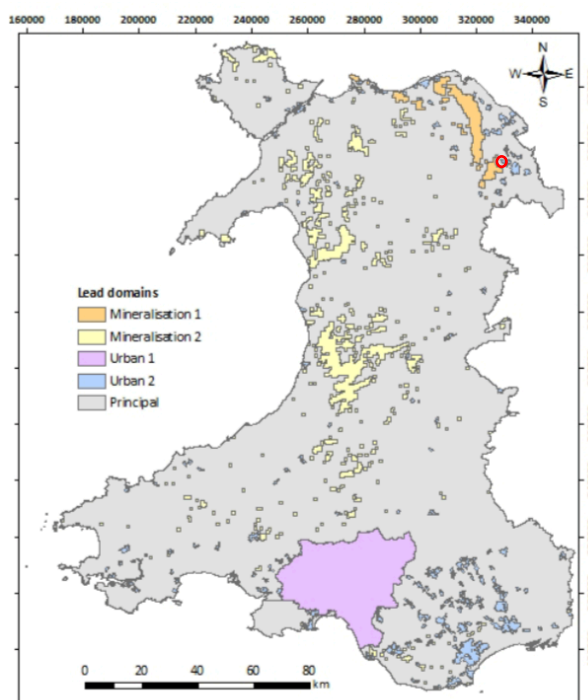
Report Reference: 4145R1

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Of the contaminants identified for further consideration in Table 5.1, NBCs have only been established for lead and benzo(a)pyrene (BaP). The Welsh NBC domain maps for lead and BaP are shown below (note: the Welsh BaP domains are based on those identified for mercury); these indicate that the study Site is located within the 'Urban' and 'Urban 2' domains (which are entirely equivalent). A summary of the published lead and BaP NBCs (each equivalent to the upper 95% confidence limit of the 95th percentile analyte concentration within topsoil) are summarised in Table 5.2.



BaP / Mercury domain map (Defra, 2013)



Lead domain map (Defra, 2013)

Table 5.2 Normal background concentrations

Domain	Lead NBC: mg/kg	BaP NBC: mg/kg
Urban 1	1300	/
Urban / Urban 2	890	3.6
Mineralisation 1	/	/
Mineralisation 2	280	/
Principal	230	0.5

Notes: Wales has far fewer, and significantly less densely sampled, soil sites compared to England; as such the contaminant NBCs for Wales are associated with a much greater level of uncertainty than the NBCs calculated for England.

Table 5.2 indicates that the lead NBC is relatively elevated for the Urban / Urban 2 domain, not least when compared to the lead GAC (200 mg/kg) presented in Table 5.1. The BaP NBC for the Urban / Urban 2 domain is broadly equivalent to the residential GAC (3 mg/kg) presented in Table 5.1. It is acknowledged that the NBCs summarised in Table 5.2 have been derived from relatively modest data sets and are therefore considered to be only indicative of likely background soil chemistry in and around the Site.

With regard to the application of NBCs within the contaminated land risk assessment process, Welsh Government guidance (2014) provides the following example, 'A pragmatic approach

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for lead would be to recommend the use of the 'normal' background concentration when the land use and domain permit (for example, providing other site and contaminant specific characteristics such as chemical form, bioavailability, soil depth, site use, etc. are comparable between the background and the site under investigation) so as not to disproportionately target land where there is widespread diffuse pollution of lead'.

5.2.3 Contaminant screen (asbestos)

Eight soil samples were screened by i2 Analytical for the presence of asbestos containing materials (ACM). ACMs were identified within one of the eight samples; 'chrysotile – loose fibres' was recorded within a sample taken from TP04 at a depth of 0.4 m. No ACMs were identified within any of the other soil samples.

CIRIA C733 (2014) provides guidance concerning the investigation, assessment and remediation of soils containing, or suspected of containing, free asbestos fibres or asbestos containing material (ACM).

C733 indicates that there are negligible health risks from the ingestion of ACMs; potentially significant health risks are constrained to the inhalation of airborne asbestos. As such, asbestos only poses a distinct health risk when it is airborne.

The number of fibres released into the air from asbestos containing soils is influenced by a range of site-specific factors (CIRIA, 2014); these factors are evaluated for the study Site in Table 5.3.

Table 5.3 Appraisal of asbestos fibre release factors (CIRIA, 2014)

Factor	Description / context	Site-specific conditions
Characteristics of the asbestos or ACM		
Concentration of asbestos in soil	The risk of exposure to ACMs is proportional to the concentration of any free fibres within the near surface soils.	One of the eight samples recently screened for ACMs contained 'chrysotile – loose fibres'.
Depth to asbestos in relation to (final) ground level	In the absence of significant physical disturbance, exposure to airborne asbestos fibres from soil will be from friable materials or asbestos fibres present at, or very close to, the soil surface (i.e., the soil-air interface). Consequently, soil risk assessments for buried asbestos primarily need to consider the likelihood that such materials may reach the surface due to the action of burrowing animals or human activities.	Only a single asbestos detection was recorded from the eight soil samples which were screened. The identified asbestos related to 'chrysotile – loose fibres'. The sample was taken from a depth of 0.4 m bgl within Made Ground. The Made Ground comprised, black to dark brown sand and gravel including frequent brick, some slate tile remains and occasional pottery.
Volume or surface area of asbestos containing soils (ACS)	The larger the area of soil which could give rise to asbestos releases, the greater the associated exposure risks.	It is noted that no visible suspected asbestos cement fragments or other ACMs were observed either at ground surface or within any of the trial excavations during the recent site investigations. Seven of the eight soil samples collected from the Site related to the in situ Made Ground; the absence of any identifiable asbestos within six of these samples suggests that widespread asbestos contamination may be unlikely. However, the presence of demolition type wastes within the Made Ground indicates that asbestos may be present elsewhere on Site.

Factor	Description / context	Site-specific conditions
Type(s) of asbestos present / degree of heterogeneity	Chrysotile asbestos is less potent than amosite, which in turn is less potent than crocidolite. Chrysotile asbestos is largely considered to be both less toxic and to generate lower airborne concentrations than either amosite or crocidolite.	Only a single asbestos detection was recorded from the eight soil samples which were screened. The identified asbestos related to 'chrysotile – loose fibres'. No amosite or crocidolite asbestos were identified within the screened soil samples.
Type(s) and condition of ACMs	Asbestos cement (AC) typically contains less than 10 per cent asbestos bound in a cohesive matrix; AC materials are also associated with far lower levels of fibre generation when compared with other forms of ACM (such as textiles, insulation board, etc.).	The identified asbestos related to 'chrysotile – loose fibres'. Free asbestos fibres are therefore locally present within the in situ Made Ground.
Extent of bonding/friability	Chrysotile is typically less friable than other forms of asbestos.	Only chrysotile asbestos was detected on-Site, including loose fibres.
Weathering, degradation or physical deterioration	Increasing amounts of fibres are likely to be released over time as ACMs deteriorate. Friable ACMs (e.g., lagging and asbestos insulating board) release fibres much more easily, and are likely to deteriorate faster, than firmly bound materials (e.g., asbestos cement), which may take a very long time to degrade, if undisturbed.	No evidence of any ACMs was visually recorded during the Site works.
Fraction of free respirable fibres	Significant health risks are constrained to the inhalation of airborne asbestos fibres.	The identified asbestos related to 'chrysotile – loose fibres'. Free asbestos fibres are therefore locally present within the in situ Made Ground. The quantity and distribution of asbestos fibres is somewhat uncertain, although the absence of any identifiable asbestos within six of the seven Made Ground samples suggests that widespread asbestos contamination is unlikely.
Characteristics of the soil		
Soil type including particle size distribution	Empirical experimentation has shown that the rate of release of airborne asbestos fibres is proportional to the soil particle size (i.e., lower rates of fibre release can be expected from clayey soils, as compared to more granular, sandy soils).	The Made Ground deposits encountered across the Site area were typified by granular material (which may give rise to fibre release under certain conditions), including sand and gravel, silty sand and gravel and silty gravelly sand.
Soil moisture content	The moisture content of the soil is one of the most important factors dictating the emission of airborne asbestos fibres from soil. Minor increases in moisture content significantly reduce the release of fibres. The addition of five per cent moisture to dry soil reduced airborne fibre release (in laboratory tests) by 80 to 95 per cent, and no airborne fibre were detected above 40 per cent soil moisture content.	The average Moisture Content Ratio (% of as received sample) for the soil samples taken during the recent site investigations was 17.4%.

Factor	Description / context	Site-specific conditions
	In the UK, most soils, even after long dry periods, are likely to have about five per cent moisture apart from extreme or very localised situations.	
Presence of surface vegetation / (Micro) relief of soil surface	CIRIA C733 indicates that ‘airborne fibres will predominantly be released only from exposed soil’ and ‘release will be strongly inhibited by vegetative cover’	The proposed development plans allow for both areas of hard standing (including driveway and paving) and soft standing gardens. The future gardens are anticipated to be in part covered by lawn but may well include flower / vegetable beds or other areas of exposed soil.
Presence of hard landscaping or cover	Hard standing offers a pathway break to the release of any sub surface asbestos fibres.	
Weather influences		
Precipitation	Number of dry days can be used as an indicator of potential fibre release.	Rainfall data have not been collected as part of this assessment although rates of rainfall are assumed to be broadly consistent with the national average.
Temperature and ground freezing	Frozen ground conditions can inhibit the release of asbestos fibres from the near surface soils.	Frozen ground conditions are not commonly anticipated at the Site.
Wind speed and direction	Wind conditions will influence the potential for dust/fibre release from any exposed soils.	No site-specific data is available regarding wind conditions.
Land use/soil-disturbing activities		
Distance of receptor(s) from the source of asbestos	The distance separation between receptors and impacted soils will influence the exposure to any airborne asbestos.	Future residential occupants will be located on-Site and will have regular access to the proposed garden areas, potentially including areas of exposed soil.
Type(s) of activities	The level of disturbance of the surficial and sub surface soils is an important factor in controlling asbestos exposure.	Routine gardening and recreational activities are likely to be performed within the proposed garden areas – these activities have the potential to disturb in situ soils and possibly give rise to airborne fibres.
Duration and frequency of activities	The degree of asbestos exposure is proportional to the duration and frequency of any activities which may disturb in situ ground.	
May dust mitigation measures employed	Targeted control measures can reduce the extent of dust/fibre release and associated asbestos exposure.	No specific mitigation measures are anticipated as part of the routine occupation of the Site once developed.

The risks posed by potential ACMs are discussed further in Section 6.

5.3 Preliminary assessment of ground gases

In general, hazardous ground gases may pose a variety of risks to human health and built structures including acute effects such as asphyxiation and explosion, as well as on-going physiological effects (CIRIA, 2007).

The most common hazardous ground gases in the context of risks to built structures and Site occupants are methane and carbon dioxide, radon and hydrocarbon vapours.

Available soil quality data suggest an absence of any appreciable vapour source within the on-Site Made Ground. This is broadly consistent with the known land use history of the Site and also the length of time that the Made Ground appears to have been in situ (over 40 years).

Public Health England mapping indicates that the Site is located within an area where between 5% and 10 % of homes may be at or above the radon action level (200 Bq/m³). As such the on-Site structures are likely to require basic radon protection measures.

Methane and carbon dioxide are common gases generated through the degradation of organic material that can be contained in both natural soils and Made Ground. In relation to the application Site, there is a modest potential for bulk gases to be generated on-Site. The risks posed by any such gases can be evaluated using a lines of evidence approach.

Key evidence relating to the ground gas potential of on-Site soils / Made Ground includes the following:

- The recent site investigation has demonstrated the widespread presence of Made Ground beneath the eastern half of the Site. The observed thickness of Made Ground varied between 0.35 m in the south-east of the Site and 1.35 m in the north-east.
- Given the relatively modest Site area, the volume of Made Ground present on-Site (and thus the potential for gas generation) is somewhat limited. It is noted that the approved development plans allow for a component of the in situ Made Ground to be excavated and removed off-Site in order to enable the final development platform (see Figure 1.4). This activity will further reduce the potential gas source.
- Following the proposed ground works, minimal Made Ground is anticipated to remain beneath the proposed property in the south-west of the Site.
- No appreciable component of putrescible material was observed within the Made Ground during the recent site works.
- The Made Ground is anticipated to have been in situ for over 40 years (and as such, any associated gases are likely to have been significantly diminished over this period).

Any risks posed by on-Site ground gases are also a function of the proposed building design and construction. It is noted that standard radon protection will be installed within the three properties. The use of appropriate radon protection measures (including suitable gas membranes and/or sumps/passive ventilation) will provide a further degree of protection from any low level bulk gases.

Hence, based on both the low likelihood of an on-Site gas source and the inherent protection offered by the proposed building constructions, no significant gas risks have been identified in relation to future Site occupants.

6 CONCEPTUAL SITE MODEL AND RISK ASSESSMENT

6.1 Conceptual model

The recent site investigation was designed to inform the conceptual site understanding by providing reliable information relating to the physical ground model and associated plausible contaminant linkages. The prevailing conceptual model is described below.

6.1.1 Sources

The identified potential contaminant sources are summarised as follows:

- Near surface Made Ground containing potentially elevated metal and PAH concentrations.
- Localised asbestos containing materials present within the near surface Made Ground.
- Naturally occurring radon gas.

Note: the recent site investigation has not identified the likely presence of any appreciable gaseous or vapour phase contamination at the Site (i.e., the observed soil PAHs are not considered to constitute a viable vapour source).

6.1.2 Pathways

The relevant potential contaminant pathways are summarised as follows:

Pathways relevant to human health

It is possible that future construction workers, Site occupants and neighbouring land users may be exposed to on-Site contaminants via one or more of the following exposure pathways:

- Dermal contact with in situ soils.
- Accidental ingestion of in situ soils.
- Inhalation/ingestion of soil dust.
- Consumption of home grown produce and any attached soil.
- Ingress of any organic contamination into water supply pipework and subsequent ingestion.
- Inhalation of any airborne asbestos fibres.
- Inhalation of any radon gases which may enter the proposed residential structures.

Pathways relevant to controlled waters

Potential contaminant migration pathways associated with local controlled waters receptors include the following:

- Dissolution of any contaminants present within the Made Ground and vertical migration of dissolved phase compounds towards the underlying bedrock aquifer.

6.1.3 Receptors

Based on the prevailing conceptual model, the following receptors have been identified for further consideration:

- Future construction workers.
- Future Site occupants.
- Neighbouring residents.
- Pennine Lower Coal Measures and Pennine Middle Coal Measures Formations (Secondary A Aquifer).

6.2 Risk assessment

A summary of the revised potential contaminant linkages associated with the Site is presented in **Error! Reference source not found.**, alongside a judgement of the risks posed by each linkage.

The contaminant linkages have been assessed using the risk assessment methodology described in CIRIA C552 (2001). As such, risk is considered to be a function of both the probability (likelihood) of contamination occurring at the study site and also the potential severity (consequence) of the environmental impacts associated with any such contamination. The classification system used to define contaminant probability, consequence and risk is described in Appendix F.

Table 6.1 Risk assessment

	Sources	Pathways	Receptors	Consequence	Probability	Risk classification	Comment / risk mitigation
1	Made Ground containing potentially elevated metal and PAH concentrations	Dermal contact, soil ingestion and dust ingestion/inhalation	Construction workers	Minor	Likely	Low Risk	Risk rating reflects the presence of moderately elevated lead, beryllium and selected PAH concentrations within the in situ Made Ground (albeit based on published GACs for a residential land use) but also the limited anticipated exposure durations and frequencies associated with construction personnel. <i>Suitable PPE and working methods should still be adopted to minimise soil exposure during all future development activities.</i>
2		Dermal contact, soil ingestion, dust ingestion/inhalation and consumption of home grown produce and any attached soil	Future residential occupants	Medium	Likely	Moderate Risk	Risk rating reflects the presence of moderately elevated lead, beryllium and selected PAH concentrations (benzo(b)fluoranthene, benzo(a)pyrene and dibenz(a,h)anthracene) within the in situ Made Ground (all average soil concentrations were in excess of published health screening values). Whilst the observed lead concentrations were below the equivalent Normal Background Concentration (NBC), benzo(a)pyrene concentrations were in excess of the relevant NBC. The presence of Made Ground across the proposed garden areas in the east of the Site (following the proposed groundworks – see Figure 1.4) offers viable contaminant linkages which could pose a health risk to future occupants. No significant Made Ground or associated health risks have been identified within the long standing garden areas in the south-west of the Site. <i>A suitable remediation strategy will be required in order to manage the risks posed by observed soil quality, most notably across areas of proposed soft standing in the east of the Site.</i>
3		Ingress of organic contamination into water supply pipework and subsequent human ingestion	Future residential occupants	Medium	Low likelihood	Moderate / Low Risk	Risk rating reflects the presence of locally elevated PAH concentrations which could penetrate conventional water supply pipework, subject to the depth of future pipework and the nature of the surrounding soils. <i>Consideration should be given to the use of barrier pipework, laid in clean service trenches, for all future water supplies.</i>

	Sources	Pathways	Receptors	Consequence	Probability	Risk classification	Comment / risk mitigation
4	Potential soluble contaminant sources associated with the on-Site Made Ground	Vertical and lateral migration of any leachable contaminants towards the bedrock aquifer	Coal Measures Formation (Secondary A Aquifer)	Medium	Unlikely	Low Risk	Risk rating reflects the likely absence of a significant dissolved phase contaminant source at the Site; the relatively modest Site area; and the likely modest resource potential of the Coal Measures Formation (reflected by the absence of any local SPZs or licensed groundwater abstractions within 1 km of the Site). As such, the potential loading of any dissolved phase contaminants to the bedrock aquifer is anticipated to be very low.
5	Localised asbestos containing materials (ACM) present within Made Ground, including chrysotile free fibres	Potential disturbance of asbestos containing materials during the proposed construction works and subsequent inhalation of any airborne fibres	Construction workers	Medium	Low likelihood	Moderate / Low Risk	Risk ratings reflect the prevailing conceptual exposure model discussed in Table 5.3 including the following points: - One of the eight samples recently screened for ACMs contained 'chrysotile – loose fibres'. Asbestos fibres are therefore locally present within the in situ Made Ground. - The absence of any identifiable asbestos within six of the seven Made Ground samples suggests that widespread asbestos contamination is however unlikely, albeit demolition type wastes were routinely recorded within the Made Ground (including frequent brick, slate tile remains and occasional pottery). - The Made Ground was typified by granular material which could give rise to fibre release under certain conditions. - No visible suspected asbestos cement fragments or other ACMs were observed either at ground surface or within any of the trial excavations during the recent site investigations. - The construction works will be of relatively limited duration (thus constraining possible asbestos exposures), although the proposed groundworks (including assorted excavation and soil disposal activities) could give rise to airborne asbestos fibres and subsequent inhalation. Based on the above information it is considered unlikely that in situ ACMs will pose a significant health risk to neighbouring residents. Construction worker exposure to any asbestos fibres, especially during the groundworks phase, must be appropriately managed in order to constrain the overall risk levels.
6			Neighbouring residents	Medium	Unlikely	Low Risk	

	Sources	Pathways	Receptors	Consequence	Probability	Risk classification	Comment / risk mitigation
							<i>Suitable PPE and working methods must be adopted to minimise dust / fibre generation and any associated exposure to asbestos fibres which could be generated during the proposed development works.</i>
7	Localised asbestos containing materials (ACM) present within Made Ground, including chrysotile free fibres	Potential disturbance of asbestos containing materials during any future gardening / recreational / development activities giving rise to possible inhalation of any airborne fibres	Future residential occupants	Medium	Low likelihood	Moderate / Low Risk	Risk ratings reflect the prevailing conceptual exposure model discussed in Table 5.3 including the following points: - One of the eight samples recently screened for ACMs contained 'chrysotile – loose fibres'. Asbestos fibres are therefore locally present within the in situ Made Ground. - The absence of any identifiable asbestos within six of the seven Made Ground samples suggests that widespread asbestos contamination is however unlikely, albeit demolition type wastes were routinely recorded within the Made Ground (including frequent brick, slate tile remains and occasional pottery). - The Made Ground was typified by granular material which could give rise to fibre release under certain conditions. - No visible suspected asbestos cement fragments or other ACMs were observed either at ground surface or within any of the trial excavations during the recent site investigations. - Routine gardening and recreational activities are likely to be performed within the proposed garden areas – these activities have the potential to disturb in situ soils and possibly give rise to airborne fibres. Based on field observations and laboratory analyses it is considered somewhat unlikely that there is widespread asbestos contamination at the Site although given the sensitive Site end-use a moderate to low health risk remains. <i>The proposed excavation of soils from within future garden areas (in response to contaminant linkage 2 – see above) will adequately address the risks posed by asbestos.</i>

	Sources	Pathways	Receptors	Consequence	Probability	Risk classification	Comment / <i>risk mitigation</i>
8	Radon gas (naturally occurring)	Migration of any radon gases into the proposed dwellings and subsequent inhalation	Construction workers	Mild	Unlikely	Very Low Risk	Risk rating reflects the limited exposure frequencies and exposure durations associated with construction workers.
9			Future Site occupants	Medium	Likely	Moderate Risk	Risk rating reflects the assessment that 5% to 10% of local properties may be at or above the radon action level (200 Bq/m³). <i>Suitable radon protection measures will be required within the proposed dwelling.</i>
	OVERALL RISK RATING					Moderate Risk	

7 RISK ASSESSMENT CONCLUSIONS AND RECOMMENDATIONS

7.1 Environmental conclusions

The approved development allows for the construction of three detached properties plus new vehicular and pedestrian access at a c. 0.11 ha brownfield site in Brymbo.

The current landform comprises a relatively flat and level area which extends across the eastern half of the Site; there are no built structures on this land, which is covered by weathered tarmac and compacted sand and gravel. The ground elevation along the northern and north-eastern Site boundaries is c. 1.4 m higher than the adjacent road levels; this suggests that the Site has previously been subject to infilling in order to create a level platform. The south-western part of the Site is occupied by two long standing residential gardens which are raised up in terraces above the main Site area to the east.

In order to create the approved development platform, in situ soils will need to be removed from the north-eastern and south-western parts of the Site.

The Site was developed prior to 1873 for assumed residential use and appears to have been redeveloped on several occasions. All former on-Site structures were cleared by 1984. During the last 20 years the eastern half of the Site has largely been used for the storage of clean aggregate and general building materials, plus informal use as a car park.

Geological mapping indicates the absence of any superficial deposits beneath the Site. The bedrock geology consists of the Pennine Lower Coal Measures Formation and Pennine Middle Coal Measures Formation, which comprise of mudstone, siltstone and sandstone and are classified as a Secondary A Aquifer. Local BGS borehole records confirm the absence of any significant superficial deposits, with laminated sandstone and mudstone evident close to ground surface. According to the Coal Authority the Site is located within a 'Development Low Risk Area' (with regard to residual coal mining risks).

The recent ground investigations have shown the presence of Made Ground across the eastern half of the Site to depths of between 0.35 m and 1.35 m (the thicknesses of Made Ground increases towards the north, consistent with the observed differential between Site levels and the surrounding natural ground elevations).

The Made Ground was characterised by a layer of compacted hardcore (c. 0.1 m to 0.25 m thick) underlain by an 'upper' sand and gravel layer including variable amounts of brick, slate, clay tile, metal, glass, ceramics, plastic and tarmac remains (c. 0.25 m to >0.85 m thick), and a 'lower' layer of silty sand and gravel and silty gravelly sand including only limited amounts of brick, slate and metal (c. 0.55 m and 0.95 m thick).

No appreciable Made Ground was observed in the south-west of the Site.

The natural superficial deposits / weathered bedrock largely comprised soft to firm gravelly clay. Friable grey mudstone and clayey mudstone was also identified close to ground surface in the south-west of the Site.

The Site does not lie within a groundwater Source Protection Zone and there are no groundwater abstraction licences within 1 km of the Site.

The recent ground investigations have indicated the general absence of shallow groundwater within 1.5 m of ground surface.

There are no significant surface water features within 250 m of the Site. Furthermore, the Site is not located within 250 m of any relevant environmental designations.

Laboratory chemical testing of the in situ Made Ground has identified some potentially elevated metal and PAH concentrations associated with the in situ Made Ground. One of the eight samples scheduled for testing revealed the presence of asbestos containing materials (chrysotile – loose fibres).

No appreciable source of ground gases or soil vapours has been identified in relation to the Site.

Public Health England mapping indicates that the application Site is in an area where 5% to 10% of homes are estimated to be at or above the radon Action Level.

7.1.1 Risks to construction workers

The health risks posed to future construction workers by the chemical quality of the in situ soils are considered to be low, based on both the observed ground conditions and the limited duration of any soil exposure during the proposed construction works.

The risks posed by asbestos containing soils are considered to be moderate to low given the presence of localised free fibres and the requirement for bulk earth movements. Any such risks can however be managed through the adoption of appropriate working methods.

7.1.2 Risks to future Site occupants

The health risks posed to future Site occupants by the observed soil quality (including lead, beryllium and selected PAH concentrations) are considered to be moderate. These risks relate to the potential for routine human exposure to impacted soils within the proposed garden areas.

The risk posed by the possible ingress of organic contamination (including selected PAH compounds) to drinking water supply pipework is considered to be moderate to low (where pipework is routed through in situ Made Ground).

The risks posed to future occupants from asbestos containing soils are considered to be moderate to low given the presence of localised free fibres within the Made Ground.

A suitable remediation strategy will be required in order to manage the risks posed by the presence of metals, PAHs and localised asbestos within the in situ Made Ground.

The risks posed to future Site occupants by any residual soil gases and/or soil vapours are considered to be low. However, the risks posed by natural radon gas are considered to be moderate and will require suitable mitigation.

7.1.3 Risks to neighbouring residents

The health risks posed to neighbouring residents from current ground conditions are considered to be low.

7.1.4 Risks to the water environment

The pollution risks posed to the underlying Secondary A Aquifer are considered to be low based on the level of anticipated contaminant loading from the Site post development.

7.2 Recommendations

Based on observed ground conditions and the prevailing environmental risk assessments described in this report the following recommendations are made:

Management of risks posed by observed soil metals and PAHs

- The potential risks posed by in situ metal and PAH concentrations should be managed through the following measures:
 - o Suitable PPE and working methods should be adopted by all construction workers to minimise soil exposure during all future development activities.
 - o It is recommended that in situ Made Ground present across the areas of proposed soft standing (post development) are removed as per the schematic shown on Figure 7.1 and described below:

- All Made Ground to be removed from the south-eastern part of the Site (Zone 1 – see Figure 7.1). The anticipated depth of Made Ground across this area is of the order 0.2 m to 0.4 m.
- Residual Made Ground to be removed from the front gardens of the two properties planned for the north-eastern part of the Site to a depth of 0.4 m below the finished ground level (Zone 2 – see Figure 7.1).
- Residual Made Ground to be removed from the side and rear gardens of the two properties planned for the north-eastern part of the Site to a depth of 0.6 m below the finished ground level (Zone 3 – see Figure 7.1).
- The excavated Made Ground must be removed off-Site under appropriate Duty of Care and in line with prevailing waste management regulations.
- A suitable anti-dig/geotextile membrane should be fitted prior to the placement of any imported soils (where any Made Ground remains below the remedial excavations).
- All imported material used to reinstate the remedial excavations must be 'clean' and 'inert' and free from contamination.
- It is recommended that clean imported topsoil is spread across the proposed garden in the south-west corner of the Site (as per Zone 4 on Figure 7.1) in order to improve the chemical and physical quality of the in situ soils.
- Where future water supplies may come into contact with in situ Made Ground, these should be constructed using barrier pipework, with clean imported backfill materials placed within associated service trenches.

Management of risks posed by asbestos containing soils

- The potential risks posed by potential asbestos in soil should be managed through the following measures:
 - Suitable PPE and working methods should be adopted by all construction workers to minimise soil exposure during future development activities. In particular, the development Contractor must carefully consider the manner in which all excavation / ground works are carried out, such that any dust generation / possible fibre release is minimised and associated inhalation exposures are reduced to the lowest levels reasonably practicable. Suitable working methods must therefore be identified and implemented including the specification of appropriate PPE. Working methods should include careful consideration of the sequencing of future ground works; the choice of excavation techniques; Site security and access; appropriate material management (including the avoidance of any stockpiling of excavated Made Ground); plus suitable dust/fibre control measures (such as regular wetting down or covering over of exposed Made Ground).
 - All future service corridors should be backfilled with clean and inert imported materials (should these require excavation into the Made Ground).
 - Excavation and replacement of in situ Made Ground should be undertaken as described above (in relation to the management of metal and PAH risks).

Management of risks posed by radon gas

- Appropriate radon protection measures should be incorporated within each of the proposed properties, such as:
 - The construction of appropriate radon sumps (in line with prevailing UK guidance, such as: https://www.ukradon.org/information/reducelevels_sump).

- Use of a radon protection membrane within the building foundations, fitted by an experienced installer in line with prevailing industry guidance.

In addition, the following general recommendations are made:

- All excess Made Ground resulting from the proposed ground works (including the lowering of current ground levels in the north-east and south-west of the Site – see Figure 1.4) will require appropriate waste classification (as per EA, 2018) prior to being removed off-Site for appropriate treatment, re-use or disposal. All waste management activities will be carried out in compliance with current waste management legislation including Duty of Care for waste handling.
- Access to the Site during all proposed ground works / remedial activities should be appropriately controlled.
- A watching brief should be maintained during all future ground works activities in order to identify any further signs of ground contamination. If any further unexpected contamination is identified, development must be halted on the impacted part of the Site and advice sought from a suitably qualified contaminated land specialist. The Local Planning Authority should also be kept informed of any notable Site observations.

8 REFERENCES

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WAG, 2018. Planning Policy Wales, Edition 10.

<https://gov.wales/sites/default/files/publications/2019-02/planning-policy-wales-edition-10.pdf>

Welsh Government, 2014. Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination. Policy Companion Document.

APPENDICES

APPENDIX A

Phase 1 report (GeoSmart Ltd)

The Phase 1 report can be accessed via the following link:
https://storage.googleapis.com/client_reports/72909R1.pdf

APPENDIX B

Site photographs

Note: due to water damage sustained to Ground First's site camera all photographs taken of the trial excavations were unfortunately lost



Photograph 1

Description: Main development area (eastern part of the Site)

Date: 03/06/2020

Location: View from mid-point on southern Site boundary – looking north



Photograph 2

Description: Current rear garden of 4 Bryn Road (proposed development plot)

Date: 03/06/2020

Location: South-western part of the Site – looking to the north-east



Photograph 3

Description: Current rear gardens of 3 and 4 Bryn Road (proposed development plot)

Date: 03/06/2020

Location: South-western part of the Site – looking to the west



Photograph 4

Description: Northern edge of the Site (showing localised storage of building materials and neighbouring properties - 3 and 4 Bryn Road)

Date: 03/06/2020

Location: Northern Site boundary – looking to the west



Photograph 5

Description: Localised storage of building aggregate plus neighbouring properties (3 and 4 Bryn Road)

Date: 03/06/2020

Location: North-west corner of the Site – looking to the north-west



Photograph 6

Description: Current retaining wall along boundary of 4 Bryn Road

Date: 03/06/2020

Location: Central area of the Site – looking to the north-west



Photograph 7

Description: Harwd Road and neighbouring property

Date: 03/06/2020

Location: View from current Site entrance – looking to the south-east



Photograph 8

Description: Neighbouring property to the east of Harwd Road

Date: 03/06/2020

Location: View from the north-east of the Site – looking to the east



Photograph 9

Description: Retaining wall at edge of Site, maintaining Site elevation above adjacent Harwd Road

Date: 03/06/2020

Location: View from north-eastern Site corner – looking to the north

APPENDIX C

Trial pit soil descriptions

Depth: m bgl	Soil description	Comments
TP01		
0.0 - 0.25	Brown-grey sand and gravel. Sand is fine. Gravel is fine to coarse and sub angular to angular. MADE GROUND	No hard standing present A vertical concrete slab was encountered across the southern face of the excavation (from 0.2 m to > 1.0 m bgl) No significant odours recorded No appreciable putrescible material identified No groundwater encountered Soil sample taken at 0.15 m bgl
0.25 - 0.35	Dark brown gravelly sand with frequent roots and rootlets. Sand is fine to medium. Gravel is fine to coarse, angular to sub rounded. MADE GROUND	
0.35 - 1.2+	Dark brown-grey sand and gravel. Sand is fine. Gravel is fine to coarse, angular to sub rounded including brick, slate and clay tile remains plus occasional metal and glass. Frequent whole bricks and angular to sub rounded cobbles. MADE GROUND	
TP02		
0.0 - 0.1	Grey sandy gravel. Sand is fine. Gravel is fine to medium and sub angular to angular. MADE GROUND / HARDCORE	No hard standing present Minimal man made material below 0.4 m No significant odours recorded No appreciable putrescible material identified No groundwater encountered Soil sample taken at 0.8 m bgl <i>(note: ground level to be reduced by c. 0.6 m during the development ground works)</i>
0.1 - 0.15	Light grey sandy gravel. Sand is fine. Gravel is fine to medium and sub angular to angular. MADE GROUND / HARDCORE	
0.15 - 0.4	Dark brown to black sand and gravel. Sand is fine. Gravel is fine to coarse, angular to sub rounded including frequent brick, some clay tile remains and occasional metal and slate. Sub angular to sub rounded cobbles. MADE GROUND	
0.4 - 1.35	Black to dark brown silty gravelly sand. Sand is fine. Gravel is fine to coarse, angular to sub rounded including occasional slate. Occasional sub angular to sub rounded cobbles. MADE GROUND	
1.35 - 1.55+	Soft to firm mid-brown gravelly clay. Gravel is fine to coarse, rounded to sub rounded.	
TP03		
0.0 - 0.2	Grey-pink sandy gravel. Sand is fine. Gravel is fine to medium and sub angular to angular. MADE GROUND / HARDCORE	No hard standing present Minimal man made material below 0.6 m No significant odours recorded No appreciable putrescible material identified No groundwater encountered Soil sample taken at 0.7 m bgl <i>(note: ground level to be reduced by c. 0.4 m during the development ground works)</i>
0.2 - 0.6	Black to dark brown sand and gravel. Sand is fine. Gravel is fine to coarse, angular to sub rounded including frequent brick, some clay tile remains and occasional slate. Sub angular to sub rounded cobbles. MADE GROUND	
0.6 - 1.2	Black to dark brown silty gravelly sand. Sand is fine. Gravel is fine to coarse, angular to sub rounded including occasional brick and slate. Occasional sub angular to sub rounded cobbles. MADE GROUND	
1.2+	Soft to firm mid-brown gravelly clay. Gravel is fine to coarse, rounded to sub rounded.	

Depth: m bgl	Soil description	Comments
TP04		
0.0 - 0.15	Grey sandy gravel. Sand is fine. Gravel is fine to medium and sub angular to angular. MADE GROUND / HARDCORE	No hard standing present Limited man made material below 0.65 m No significant odours recorded No appreciable putrescible material identified No groundwater encountered Soil sample taken at 0.4 m bgl <i>(note: ground level to be reduced by c. 0.1 m during the development ground works)</i>
0.15 - 0.65	Black to dark brown sand and gravel. Sand is fine. Gravel is fine to coarse, angular to sub rounded including frequent brick, some slate tile remains and occasional pottery. Sub angular to sub rounded cobbles. MADE GROUND	
0.65 - 1.4	Orange-red sandy gravel. Sand is fine to medium. Gravel is fine to coarse, angular to sub angular including some brick remains. Sub angular to angular cobbles. MADE GROUND	
1.4 - 1.5+	Soft to firm light-grey clay.	
TP05		
0.0 - 0.25	Grey-pink sandy gravel. Sand is fine. Gravel is fine to medium and sub angular to angular. MADE GROUND / HARDCORE	No hard standing present No significant odours recorded No appreciable putrescible material identified No groundwater encountered Soil sample taken at 0.3 m bgl
0.25 - 0.35	Dark brown sand and gravel with frequent roots and rootlets. Sand is fine to medium. Gravel is fine to coarse, angular to sub rounded. MADE GROUND	
0.35 - 0.8	Black to dark brown sand and gravel. Sand is fine. Gravel is fine to coarse, angular to sub rounded including brick plus occasional slate, metal and glass. Some whole bricks and sub angular to sub rounded cobbles. MADE GROUND	
0.8 - 1.35	Grey brown silty sand and gravel. Sand is fine. Gravel is fine to coarse, angular to sub rounded including brick, slate and occasional metal. MADE GROUND	
1.35 - 1.45+	Soft to firm grey gravelly clay. Gravel is fine to coarse, rounded to sub rounded including mudstone.	

TP06		
0.0 - 0.1	Grey sand and gravel. Sand is fine. Gravel is fine to medium and sub angular to angular. MADE GROUND / HARDCORE	No hard standing present No significant odours recorded No appreciable putrescible material identified No groundwater encountered Soil sample taken at 0.25 m bgl
0.1 - 0.35	Dark brown to black-grey silty sand and gravel. Sand is fine. Gravel is fine to coarse, angular to sub rounded including brick, glass, tile, ceramic and tarmac remains. Occasional plastic fragments. MADE GROUND	
0.35 - 0.6	Mid-brown silty sand and gravel. Sand is fine. Gravel is fine to coarse, angular to sub rounded. Some angular to sub angular cobbles	
0.6 - 0.75+	Mid-brown friable mudstone.	
TP07		
0.0 - 0.05	Weathered tarmac layer. MADE GROUND / HARDCORE	Limited man made material No significant odours recorded No appreciable putrescible material identified No groundwater encountered Soil sample taken at 0.2 m bgl
0.05 - 0.35	Black to dark brown sand and gravel. Sand is fine. Gravel is fine to coarse, angular to sub rounded including occasional brick, metal and ceramic. Some possible fine coal remains. Occasional sub rounded cobbles. MADE GROUND	
0.35 - 0.55	Soft to firm grey silty clay.	
0.55 - 0.8+	Firm orange-brown clay with some fine black inclusions.	
TP08		
0.0 - 0.05	Dark brown gravelly sand with abundant roots and rootlets. Sand is fine. Gravel is fine to coarse, sub angular to sub rounded. TOPSOIL	Grassed garden area No significant odours recorded No appreciable putrescible material identified Water entered the excavation at c. 0.6 m bgl; rose to 0.5 m bgl in 30 mins Soil sample taken at 0.05 m bgl
0.05 - 0.65	Friable grey mudstone.	
0.65 - 0.7+	Brown-grey clayey mudstone.	
TP09		
0.0 - 0.35	Brown gravelly sand with roots and rootlets. Sand is fine. Gravel is fine to coarse, sub angular to sub rounded. TOPSOIL	Grassed garden area No significant odours recorded No appreciable putrescible material identified Water entered the excavation at c. 0.6 m bgl; rose to 0.5 m bgl in 30 mins Soil sample taken at 0.2 m bgl
0.35 - 0.75+	Friable grey-brown mudstone.	

APPENDIX D

Laboratory results

Appendix D.1: Laboratory test certificates

**Andy Singleton**

Ground first
26 Victoria Street
Castlefields
Shrewsbury
Shropshire
SY1 2HS

e: andy@groundfirst.com

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

t: 01923 225404

f: 01923 237404

e: reception@i2analytical.com

Analytical Report Number : 20-12850

Project / Site name:	Brymbo 4145	Samples received on:	05/06/2020
Your job number:		Sample instructed/ Analysis started on:	08/06/2020
Your order number:		Analysis completed by:	12/06/2020
Report Issue Number:	1	Report issued on:	15/06/2020
Samples Analysed:	8 soil samples		

Signed: *A. Czerwińska*

Agnieszka Czerwińska

Technical Reviewer (Reporting Team)
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :	soils	- 4 weeks from reporting
	leachates	- 2 weeks from reporting
	waters	- 2 weeks from reporting
	asbestos	- 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement uncertainty can be provided on request.

Iss No 20-12850-1 Brymbo 4145.XLS

This certificate should not be reproduced, except in full, without the express permission of the laboratory.

The results included within the report relate only to the sample(s) submitted for testing.

Page 1 of 8

Analytical Report Number: 20-12850

Project / Site name: Brymbo 4145

Lab Sample Number				1527251	1527252	1527253	1527254	1527255
Sample Reference				TP01	TP02	TP05	TP07	TP09
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.15	0.80	0.30	0.20	0.20
Date Sampled				03/06/2020	03/06/2020	03/06/2020	03/06/2020	03/06/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	8.5	24	16	16	14
Total mass of sample received	kg	0.001	NONE	1.0	1.0	1.0	1.0	1.0

Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	-	-	-	-
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.4	7.9	8.9	8.3	7.6
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.020	0.023	0.095	0.074	0.017
Fraction Organic Carbon (FOC)	N/A	0.001	MCERTS	0.0093	0.053	0.051	0.059	0.048

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
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Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.41	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.61	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	1.4	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	0.29	1.0	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	2.1	2.6	19	1.2	2.0
Anthracene	mg/kg	0.05	MCERTS	0.18	0.62	3.5	0.48	0.51
Fluoranthene	mg/kg	0.05	MCERTS	2.2	4.1	30	2.2	3.1
Pyrene	mg/kg	0.05	MCERTS	1.9	3.4	26	2.1	2.7
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.95	2.2	13	1.5	1.6
Chrysene	mg/kg	0.05	MCERTS	1.1	2.2	12	1.5	1.6
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	1.2	1.7	17	1.6	1.6
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.45	1.5	6.5	0.91	0.64
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.95	1.9	14	1.4	1.3
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.43	0.89	6.7	0.60	0.56
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	0.26	1.7	0.25	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.50	1.2	7.6	0.73	0.64

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	11.9	22.8	160	14.5	16.2
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Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	6.0	24	34	35	26
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	1.0	2.7	2.3	4.4	2.8
Boron (water soluble)	mg/kg	0.2	MCERTS	0.6	1.5	2.7	0.4	0.9
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	0.4	3.3	4.2	3.8	1.3
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (III)	mg/kg	1	NONE	32	51	100	61	37
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	32	54	100	63	37
Copper (aqua regia extractable)	mg/kg	1	MCERTS	25	83	160	150	100
Lead (aqua regia extractable)	mg/kg	1	MCERTS	57	280	650	380	300
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	0.7	0.8	1.6	0.6
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	25	43	80	58	57
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	3.1	3.9	3.5	3.4
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	22	49	63	55	42
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	110	720	1900	970	680

Analytical Report Number: 20-12850

Project / Site name: Brymbo 4145

Lab Sample Number	1527251	1527252	1527253	1527254	1527255
Sample Reference	TP01	TP02	TP05	TP07	TP09
Sample Number	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)	0.15	0.80	0.30	0.20	0.20
Date Sampled	03/06/2020	03/06/2020	03/06/2020	03/06/2020	03/06/2020
Time Taken	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status		

Monoaromatics & Oxygenates

Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

Petroleum Hydrocarbons

Petroleum Range Organics (C6 - C10)	mg/kg	0.1	MCERTS	-	-	-	-	-
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TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	1.7	< 1.0	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	2.8	< 2.0	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	< 8.0	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	< 8.0	71	< 8.0	< 8.0
TPH-CWG - Aliphatic > EC35 - EC44	mg/kg	8.4	NONE	< 8.4	< 8.4	19	< 8.4	< 8.4
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	< 10	80	< 10	< 10
TPH-CWG - Aliphatic (EC5 - EC44)	mg/kg	10	NONE	< 10	< 10	99	< 10	< 10

TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	7.8	6.7	10	1.8	8.8
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	9.2	7.7	22	3.6	9.6
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	22	24	110	22	22
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	33	47	230	64	36
TPH-CWG - Aromatic > EC35 - EC44	mg/kg	8.4	NONE	62	18	41	21	21
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	71	86	370	92	76
TPH-CWG - Aromatic (EC5 - EC44)	mg/kg	10	NONE	130	100	410	110	97

TPH (C10 - C25)	mg/kg	10	MCERTS	-	-	-	-	-
TPH (C25 - C40)	mg/kg	10	MCERTS	-	-	-	-	-



Analytical Report Number: 20-12850

Project / Site name: Brymbo 4145

Lab Sample Number				1527256	1527257	1527258		
Sample Reference				TP03	TP04	TP06		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				0.70	0.40	0.25		
Date Sampled				03/06/2020	03/06/2020	03/06/2020		
Time Taken				None Supplied	None Supplied	None Supplied		
Analytical Parameter (Soil Analysis)				Units	Limit of detection	Accreditation Status		
Stone Content				%	0.1	NONE	< 0.1	< 0.1
Moisture Content				%	N/A	NONE	28	22
Total mass of sample received				kg	0.001	NONE	1.0	1.0

Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	Chrysotile - Loose Fibres	-		
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Detected	Not-detected		

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.1	7.9	8.0		
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1		
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	-	-	-		
Fraction Organic Carbon (FOC)	N/A	0.001	MCERTS	0.047	0.035	0.036		

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0		
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Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.43		
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	0.68	0.62		
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	0.48	1.2		
Fluorene	mg/kg	0.05	MCERTS	< 0.05	1.0	1.3		
Phenanthrene	mg/kg	0.05	MCERTS	1.6	8.2	8.4		
Anthracene	mg/kg	0.05	MCERTS	0.44	1.7	3.3		
Fluoranthene	mg/kg	0.05	MCERTS	2.2	14	16		
Pyrene	mg/kg	0.05	MCERTS	2.0	13	15		
Benzo(a)anthracene	mg/kg	0.05	MCERTS	1.3	8.1	11		
Chrysene	mg/kg	0.05	MCERTS	1.1	5.3	6.3		
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	1.2	7.2	8.8		
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	1.0	3.1	3.4		
Benzo(a)pyrene	mg/kg	0.05	MCERTS	1.3	6.9	7.7		
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.68	3.1	3.3		
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	0.20	0.81	0.94		
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	1.0	3.5	3.8		

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	14.0	77.5	91.6		
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Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	23	23	18		
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	2.5	2.0	2.1		
Boron (water soluble)	mg/kg	0.2	MCERTS	1.2	0.5	1.5		
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	2.0	2.6	1.7		
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0		
Chromium (III)	mg/kg	1	NONE	26	31	37		
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	29	32	40		
Copper (aqua regia extractable)	mg/kg	1	MCERTS	79	95	83		
Lead (aqua regia extractable)	mg/kg	1	MCERTS	230	370	390		
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	1.1	0.7	0.3		
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	39	37	54		
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	2.9	2.5	2.9		
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	42	35	38		
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	510	730	640		

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Lab Sample Number				1527256	1527257	1527258		
Sample Reference				TP03	TP04	TP06		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				0.70	0.40	0.25		
Date Sampled				03/06/2020	03/06/2020	03/06/2020		
Time Taken				None Supplied	None Supplied	None Supplied		
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Monoaromatics & Oxygenates								
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0		
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0		
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0		
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0		
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0		
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0		

Petroleum Hydrocarbons

Petroleum Range Organics (C6 - C10)	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1		
TPH-CWG - Aliphatic >EC5 - EC6								
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-	-	-		
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-		
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-		
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-		
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-	-	-		
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-	-	-		
TPH-CWG - Aliphatic > EC35 - EC44	mg/kg	8.4	NONE	-	-	-		
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-		
TPH-CWG - Aliphatic (EC5 - EC44)	mg/kg	10	NONE	-	-	-		
TPH-CWG - Aromatic >EC5 - EC7								
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-	-	-		
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-		
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-		
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-		
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-	-	-		
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-	-	-		
TPH-CWG - Aromatic > EC35 - EC44	mg/kg	8.4	NONE	-	-	-		
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-		
TPH-CWG - Aromatic (EC5 - EC44)	mg/kg	10	NONE	-	-	-		
TPH (C10 - C25)								
TPH (C10 - C25)	mg/kg	10	MCERTS	130	250	190		
TPH (C25 - C40)								
TPH (C25 - C40)	mg/kg	10	MCERTS	180	250	240		



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* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1527251	TP01	None Supplied	0.15	Brown clay and sand with gravel.
1527252	TP02	None Supplied	0.80	Brown clay and sand with gravel.
1527253	TP05	None Supplied	0.30	Brown clay and sand with gravel.
1527254	TP07	None Supplied	0.20	Brown clay and sand.
1527255	TP09	None Supplied	0.20	Brown loam and clay with vegetation and gravel
1527256	TP03	None Supplied	0.70	Brown clay and sand with gravel.
1527257	TP04	None Supplied	0.40	Brown clay and sand with gravel.
1527258	TP06	None Supplied	0.25	Brown loam and clay with gravel.

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Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Cr (III) in soil	In-house method by calculation from total Cr and Cr VI.	In-house method by calculation	L080-PL	W	NONE
Fraction of Organic Carbon in soil	Determination of fraction of organic carbon in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In house method.	L009-PL	D	MCERTS
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 dphenylcarbazine followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
PRO (Soil)	Determination of hydrocarbons C6-C10 by headspace GC-MS.	In-house method based on USEPA8260	L088-PL	W	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS
TPH in (Soil)	Determination of TPH bands by HS-GC-MS/GC-FID	In-house method, TPH with carbon banding and silica gel split/cleanup.	L076-PL	D	NONE
TPH Oils (Soils)	Determination of extractable hydrocarbons in soil by GC-MS/FID.	In-house method with silica gel split/clean up.	L076-PL	D	MCERTS

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The results included within the report relate only to the sample(s) submitted for testing.

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Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L088/76-PL	W	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Appendix D.2: Summary of laboratory test results

Lab Sample Number				1527251	1527252	1527253	1527254	1527255	1527256	1527257	1527258
Sample Reference				TP01	TP02	TP05	TP07	TP09	TP03	TP04	TP06
Depth (m)				0.15	0.80	0.30	0.20	0.20	0.70	0.40	0.25
Date Sampled				03/06/2020	03/06/2020	03/06/2020	03/06/2020	03/06/2020	03/06/2020	03/06/2020	03/06/2020
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Acceleration Status								
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	8.5	24	16	16	14	28	22	11
Total mass of sample received	kg	0.001	NONE	1	1	1	1	1	1	1	1

Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	-	-	-	-	-	Chrysotile - Loose Fibres	-
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected	Detected	Not-detected

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.4	7.9	8.9	8.3	7.6	8.1	7.9	8
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.02	0.023	0.095	0.074	0.017	-	-	-
Fraction Organic Carbon (FOC)	N/A	0.001	MCERTS	0.0093	0.053	0.051	0.059	0.048	0.047	0.035	0.036

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
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Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.41	< 0.05	< 0.05	< 0.05	< 0.05	0.43
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.61	< 0.05	< 0.05	< 0.05	< 0.05	0.62
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	1.4	< 0.05	< 0.05	< 0.05	< 0.05	1.2
Fluorene	mg/kg	0.05	MCERTS	< 0.05	0.29	1	< 0.05	< 0.05	< 0.05	< 0.05	1.3
Phenanthrene	mg/kg	0.05	MCERTS	2.1	2.6	19	1.2	2	1.6	8.2	8.4
Anthracene	mg/kg	0.05	MCERTS	0.18	0.62	3.5	0.48	0.51	0.44	1.7	3.3
Fluoranthene	mg/kg	0.05	MCERTS	2.2	4.1	30	2.2	3.1	2.2	14	16
Pyrene	mg/kg	0.05	MCERTS	1.9	3.4	26	2.1	2.7	2	13	15
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.95	2.2	13	1.5	1.6	1.3	8.1	11
Chrysene	mg/kg	0.05	MCERTS	1.1	2.2	12	1.5	1.6	1.1	5.3	6.3
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	1.2	1.7	17	1.6	1.6	1.2	7.2	8.8
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.45	1.5	6.5	0.91	0.64	1	3.1	3.4
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.95	1.9	14	1.4	1.3	1.3	6.9	7.7
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.43	0.89	6.7	0.6	0.56	0.68	3.1	3.3
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	0.26	1.7	0.25	< 0.05	0.2	0.81	0.94
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.5	1.2	7.6	0.73	0.64	1	3.5	3.8

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	11.9	22.8	160	14.5	16.2	14	77.5	91.6
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Heavy Metals / Metalloids

Arsenic (aquia regia extractable)	mg/kg	1	MCERTS	6	24	34	35	26	23	23	18
Beryllium (aquia regia extractable)	mg/kg	0.06	MCERTS	1	2.7	2.3	4.4	2.8	2.5	2	2.1
Boron (water soluble)	mg/kg	0.2	MCERTS	0.6	1.5	2.7	0.4	0.9	1.2	0.5	1.5
Cadmium (aquia regia extractable)	mg/kg	0.2	MCERTS	0.4	3.3	4.2	3.8	1.3	2	2.6	1.7
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (III)	mg/kg	1	NONE	32	51	100	61	37	26	31	37
Chromium (aquia regia extractable)	mg/kg	1	MCERTS	32	54	100	63	37	29	32	40
Copper (aquia regia extractable)	mg/kg	1	MCERTS	25	83	160	150	100	79	95	83
Lead (aquia regia extractable)	mg/kg	1	MCERTS	57	280	650	380	300	230	370	390
Mercury (aquia regia extractable)	mg/kg	0.3	MCERTS	< 0.3	0.7	0.8	1.6	0.6	1.1	0.7	0.3
Nickel (aquia regia extractable)	mg/kg	1	MCERTS	25	43	80	58	57	39	37	54
Selenium (aquia regia extractable)	mg/kg	1	MCERTS	< 1.0	3.1	3.9	3.5	3.4	2.9	2.5	2.9
Vanadium (aquia regia extractable)	mg/kg	1	MCERTS	22	49	63	55	42	42	35	38
Zinc (aquia regia extractable)	mg/kg	1	MCERTS	110	720	1900	970	680	510	730	640

Monoaromatics & Oxygenates

Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

Petroleum Hydrocarbons

Petroleum Range Organics (C6 - C10)	mg/kg	0.1	MCERTS	-	-	-	-	-	< 0.1	< 0.1	< 0.1
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	-	-	-
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	-	-	-
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	-	-	-
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	1.7	< 1.0	< 1.0	-	-	-
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	2.8	< 2.0	< 2.0	-	-	-
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	< 8.0	< 8.0	-	-	-
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	< 8.0	71	< 8.0	< 8.0	-	-	-
TPH-CWG - Aliphatic > EC35 - EC44	mg/kg	8.4	NONE	< 8.4	< 8.4	19	< 8.4	< 8.4	-	-	-
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	< 10	80	< 10	< 10	-	-	-
TPH-CWG - Aliphatic (EC5 - EC44)	mg/kg	10	NONE	< 10	< 10	99	< 10	< 10	-	-	-
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	-	-	-
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	-	-	-
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	-	-	-
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	7.8	6.7	10	1.8	8.8	-	-	-
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	9.2	7.7	22	3.6	9.6	-	-	-
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	22	24	110	22	22	-	-	-
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	33	47	230	64	36	-	-	-
TPH-CWG - Aromatic > EC35 - EC44	mg/kg	8.4	NONE	18	18	41	21	21	-	-	-
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	71	86	370	92	76	-	-	-
TPH-CWG - Aromatic (EC5 - EC44)	mg/kg	10	NONE	130	100	410	110	97	-	-	-

TPH (C10 - C25)	mg/kg	10	MCERTS	-	-	-	-	-	130	250	190
TPH (C25 - C40)	mg/kg	10	MCERTS	-	-	-	-	-	180	250	240

APPENDIX E

Soil screening values

Screening values adopted for the human health risk assessment

Parameter	Units	Screening value/GAC	Comment
Metals			
Arsenic	mg/kg	37	LQM (2015)
Beryllium	mg/kg	1.7	LQM (2015)
Boron	mg/kg	290	LQM (2015)
Cadmium	mg/kg	11	LQM (2015)
Chromium VI	mg/kg	6	LQM (2015)
Chromium III	mg/kg	910	LQM (2015)
Copper	mg/kg	2400	LQM (2015)
Lead	mg/kg	200	Category 4 Screening Level incorporating vegetable consumption (DEFRA, 2014)
Mercury	mg/kg	11	LQM (2015) - Methylmercury
Nickel	mg/kg	130	LQM (2015)
Selenium	mg/kg	250	LQM (2015)
Vanadium	mg/kg	410	LQM (2015)
Zinc	mg/kg	3700	LQM (2015)
Miscellaneous			
Phenols	mg/kg	380	LQM (2015)
Cyanide (free)	mg/kg	16.8	RIVM derived value ¹ for free cyanide
PAHs			
Acenaphthene	mg/kg	1100	LQM (2015)
Acenaphthylene	mg/kg	920	LQM (2015)
Anthracene	mg/kg	11000	LQM (2015)
Benzo[a]anthracene	mg/kg	13	LQM (2015)
Benzo[a]pyrene	mg/kg	3	LQM (2015)
	mg/kg	5	Category 4 Screening Level incorporating vegetable consumption (DEFRA, 2014)
Benzo[b]fluoranthene	mg/kg	3.7	LQM (2015)
Benzo[g,h,i]perylene	mg/kg	350	LQM (2015)
Benzo[k]fluoranthene	mg/kg	100	LQM (2015)
Chrysene	mg/kg	27	LQM (2015)
Dibenzo[a,h]anthracene	mg/kg	0.3	LQM (2015)
Fluoranthene	mg/kg	890	LQM (2015)
Fluorene	mg/kg	860	LQM (2015)
Indeno[1,2,3-cd]pyrene	mg/kg	41	LQM (2015)
Naphthalene	mg/kg	13	LQM (2015)
Phenanthrene	mg/kg	440	LQM (2015)
Pyrene	mg/kg	2000	LQM (2015)
BTEX and speciated TPH			
Benzene	mg/kg	0.37	LQM (2015)
Toluene	mg/kg	660	LQM (2015)
Ethylbenzene	mg/kg	260	LQM (2015)
m Xylene	mg/kg	320	LQM (2015)
p Xylene	mg/kg	310	LQM (2015)
o Xylene	mg/kg	330	LQM (2015)
Aliphatics C5-C6	mg/kg	160	LQM (2015)
Aliphatics >C6-C8	mg/kg	530	LQM (2015)
Aliphatics >C8-C10	mg/kg	150	LQM (2015)
Aliphatics >C10-C12	mg/kg	760 (283) ^{vap}	LQM (2015). GAC exceeds theoretical soil saturation limit

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Parameter	Units	Screening value/GAC	Comment
Aliphatics >C12-C16	mg/kg	4300 (142) ^{sol}	LQM (2015). GAC exceeds theoretical soil saturation limit
Aliphatics >C16-C21	mg/kg	110,000	LQM (2015). Based on GAC for C16-C35 fraction
Aliphatics >C21-C35	mg/kg	110,000	LQM (2015). Based on GAC for C16-C35 fraction
Aromatics C6-C7	mg/kg	300	LQM (2015). Based on GAC for C5-C7 fraction
Aromatics >C7-C8	mg/kg	660	LQM (2015)
Aromatics >EC8-EC10	mg/kg	190	LQM (2015)
Aromatics >EC10-EC12	mg/kg	380	LQM (2015)
Aromatics >EC12-EC16	mg/kg	660	LQM (2015)
Aromatics >EC16-EC21	mg/kg	930	LQM (2015)
Aromatics >EC21-EC35	mg/kg	1700	LQM (2015)
Aromatics >EC35-EC44	mg/kg	1700	LQM (2015)

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APPENDIX F

Risk classification methodology

Risk classification methodology

The method of risk evaluation adopted in this document is consistent with CIRIA C552 (2001). Hence, risk is considered to be a function of both the probability (likelihood) of contamination occurring at the study site and also the potential severity (consequence) of the environmental impacts associated with this contamination.

The classification system used to define contaminant probability, consequence and risk is described in the following tables.

Table A: Classification of probability

Classification	Definition
High Likelihood	There is a contaminant linkage and an event that appears either very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	There is a contaminant linkage and all the elements are present and in the right place, which means that it is probably that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term, and likely over the long term.
Low Likelihood	There is a contaminant linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term.
Unlikely	There is contaminant linkage but circumstances are such that it is improbable that an event would occur even in the long term.

Table B: Classification of consequence

Classification	Receptor	Definition	Examples
Severe <i>(acute risks)</i>	Humans	Short-term (acute) risk to human health likely to result in "significant harm" as defined in the CTL Statutory Guidance	High concentrations of cyanide on the surface of an informal recreation area
	Controlled waters	Short-term risk of pollution (note: Water Resources Act contains no scope for considering significance of pollution) of sensitive water resource	Major spillage of contaminants from site into controlled water
	Property	Catastrophic damage to buildings/property	Explosion resulting from methane accumulation, causing building collapse (can also equate to an acute human health risk if buildings are occupied)
	Ecology	A short-term risk to a particular ecosystem, or organism forming part of such eco-system	Potentially significant derogation of a designated site or protected species
Medium <i>(long-term)</i>	Humans	Chronic damage to human health ("significant harm" as defined in the Contaminated Land Statutory Guidance)	Concentrations of a contaminant from site exceed the GAC or SSAC
	Controlled waters	Pollution of sensitive water resources (note: Water Resources Act contains no scope for considering significance of pollution)	Leaching of contaminants from a site to a Principal or Secondary Aquifer

Classification	Receptor	Definition	Examples
	Property	Significant damage to sensitive crops, buildings, structures and services	Damage to building rendering it unsafe to occupy (e.g. foundation damage resulting in instability)
	Ecology	A significant change in a particular ecosystem, or organism forming part of such ecosystem	Death of a species within a designated nature reserve
Mild (long-term; less sensitive receptors)	Humans	Contamination present although unlikely to constitute a significant chronic health risk to sensitive receptors	Concentrations of chemical species that exceed the GAC or SSAC for a low sensitive land-use e.g. public open space
	Controlled waters	Pollution of non-sensitive water resources	Pollution of non-classified groundwater
	Property	Damage to sensitive buildings/structures/services	Aggressive ground conditions leading to potential for long term degradation of buried concrete
	Ecology	Damage to the environment	Localised damage to aquatic habitat causing temporary relocation of certain species
Minor (long-term; less significant receptors)	Humans	Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc.)	The presence of contaminants at such concentrations that protective equipment is required during site works.
	Controlled waters	Potential minor release of contamination to local water features	Short term or low volume release of potentially polluting material to a secondary surface water course of low existing quality
	Property	Easily reparable effects of damage to buildings, structures and services. Harm which may result in a financial loss, or expenditure to resolve.	The loss of plants in a landscaping scheme. Discolouration of concrete
	Ecology	Short term, localised damage may occur; consequences are spatially and temporally limited	Short term or localised disruption to in situ flora or fauna; no lasting effects

Table C: Risk classification (comparison of consequence and probability)

Probability (likelihood)		Consequence (severity)			
		Severe	Medium	Mild	Minor
	High likelihood	Very high risk	High risk	Moderate risk	Low risk
	Likely	High risk	Moderate risk	Moderate/low risk	Low risk
	Low likelihood	Moderate risk	Moderate/low risk	Low risk	Very low risk
	Unlikely	Moderate/low risk	Low risk	Very low risk	Very low risk