MABEY HOUSE,
NEW HOUSE PARK, CHEPSTOW

ALUK (UK)

PHASE 1 DESK STUDY REPORT

Prepared for:
ALUK (UK)
c/o Bradley Associates
31 Cardiff Road
Taffs Well
CF15 7RB

Prepared by:
Earth Science Partnership
33 Cardiff Road
Taff's Well
Cardiff CF15 7RB
Tel: 029 2081 3385
Fax: 029 2081 3386
e-mail: enquiries@earthsciencepartnership.com
Website: www.earthsciencepartnership.com

Document Ref. 6283b/2258
Date: May 2016
Status: Draft Report
Revision: 0

MABEY HOUSE,
NEW HOUSE PARK, CHEPSTOW

ALUK (UK)

PHASE 1 DESK STUDY REPORT

Date	Status	Written By	Checked By	Approved By
May 2016	Draft Report	Danilo Bettosi	Danilo Bettosi	Giles Sommerwill
		BSc (Hons) Msc FGS	BSc (Hons) MSc FGS	BSc (Hons) MSc CGeol FGS UK Registered Ground Engineering Specialist
Signature				

SUMMARY

The Client is proposing to purchase the subject site for refurbishment/redevelopment. We further understand that no significant construction is to be undertaken and minor changes to site and access road layouts are proposed alongside the construction of a wind turbine construction/maintenance pit. ESP were instructed to undertake a geo-environmental and geotechnical desk study assessment in order to identify and evaluate ground related hazards which could impact on the proposed development. The salient findings are summarised below:

	Potential Hazard	Anticipated Risk	Discussion
Site Setting	**Current Site Status.**	-	*The site is currently occupied by an existing manufacturing facility and associated areas of hardstanding and landscaping.*
	Probable Ground Conditions.	-	*Identified from geological maps, and previous investigations the site is likely to be underlain by limited or absent River Terrace Deposits and the Mercia Mudstone Bedrock.*
	Probable Groundwater Conditions.	-	*The site is underlain by a Secondary B Aquifer.*
	Historical Land Use and Potential Contamination Sources	- Low/Medium	*Prior to the construction of the existing building, no significantly contaminative former use has been identified. The most plausible pollutant source is likely to be the existing manufacturing plant constructed between 2002 and 2010.*
Geo-environmental	**Chronic Risks to Human Health**	Low	*Limited Made Ground is anticipated at the site, due to the construction of the existing building, however no sources of extraordinary contamination identified. Chemical analysis of soils at the site would be required to fully assess the contamination levels present.*
	Risks to Controlled Waters	Low	*The nearest major surface water feature to the site is a small stream located to the east. A small pond are also indicated in the south portion.*
	Hazardous Ground Gas	Low/ medium	*A stream/drain once present in the east portion has been rerouted as part of the development works. Depending on the backfill status of the stream, there is a potential ground gas risk. A reen is also identified at the west boundary on the historical mapping from 2002.*
Geotechnical	**Abandoned Mine Workings and Old Mine Entries**	Negligible	*Site is not located overlying Coal Measures Bedrock.*
	Shrinkage or Swelling	Moderate	*Weathered Mercia Mudstone is anticipated beneath the site, which can potentially have a high plasticity index and, hence, be classified as of potential high volume change potential with changes in moisture content (shrinkage and swelling). Variable results have been identified in previous ground investigations.*
	Sulphate Attack on Buried Concrete	Low	*Extensive Made Ground is not anticipated and Mercia Mudstone is unlikely to have high levels of sulphates.*
Others	**UXO**	-	*No assessment undertaken.*
	Flooding	Medium	*Low risk of flooding from rivers or seas identified, however, a risk of flooding from groundwater sources has been identified within the Sitecheck report.*
	Invasive Plants	Low	*Unable to assess - no walkover undertaken - to be assessed during SI.*
	Further Work Required	**Yes**	***Full intrusive ground investigation to fully assess the geo-environmental and geotechnical hazards as outlined in the body of this text.***

Note: The above is intended to provide a brief summary of the assessment at the site. It does not provide a definitive assessment and reference should be made to the main body of the report for details of our findings.

MABEY HOUSE,
NEW HOUSE PARK, CHEPSTOW

CONTENTS

ENCLOSURES

GENERAL NOTES

1.0 INTRODUCTION AND OBJECTIVES

1.1 Background

ALUK UK (hereafter known as the Client) are proposing to purchase the subject site for refurbishment/redevelopment. We further understand that no significant construction is to be undertaken and minor changes to site and access road layouts are proposed alongside the construction of a wind turbine construction/maintenance pit.

The Earth Science Partnership Ltd (ESP), Consulting Engineers, Geologists and Environmental Scientists, were instructed by the Client to undertake a geotechnical and geo-environmental Phase 1 desk study assessment to identify and evaluate potential ground hazards which could impact on the proposed development. The site location is shown on Figure 1.

1.2 Objective and Scope of Works

The scope of works for the investigation was designed by the Client and comprised a desk study review of available historical Ordnance Survey maps, geological maps, memoirs, and further desk study information.

The contract was awarded on the basis of a competitive tender quotation. The terms of reference for the assessment are as laid down in the Earth Science Partnership email proposal of 19th May 2016.

1.3 Risk Assessment Methodology

The assessment was partly conducted to formulate an opinion as to the potential for hazardous substances (contamination) or conditions to exist on, at or near the site at levels or in a situation likely to warrant mitigation or consideration appropriate to the proposed end use. The risk assessment methodology used to achieve this is discussed in Section 3.0.

The assessment of the potential risk is phased with the Phase One desk study and Preliminary Risk Assessment (PRA) presented in Section 2.0 of this report.

1.4 Limitations of Report

This report represents the findings of the brief relating to the proposed end use as detailed in the text. The brief did not require an assessment of the implications for any other end use, nor is the report a comprehensive site characterisation and should not be construed as such. Should an alternative end use be considered, the findings of the assessment should be re-examined relating to this use.

Where preventative, ameliorative or remediation works are required, professional judgement will be used to make recommendations that satisfy the site specific requirements in accordance with good practice guidance.

Consultation with regulatory authorities will be required with respect to proposed works as there may be overriding regional or policy requirements which demand additional work to be undertaken. It should be noted that both regulations and their interpretation by statutory authorities are continually changing.

This report represents the findings and opinions of experienced geo-environmental and geotechnical specialists. Earth Science Partnership does not provide legal advice and the advice of lawyers may also be required.

1.5 Digital Copy of Report

A digital copy of this report (in pdf format) is included on a CD in Appendix E.

2.0 DESK STUDY AND PRELIMINARY RISK ASSESSMENT

The information presented in this section comprises a Preliminary Risk Assessment (PRA) which presents information obtained from desk based research that was used to inform decisions made in scoping the physical works. Desk study information has been obtained from various sources as described in the text, including historical maps and a Sitecheck Report which are presented in Appendices A and B respectively. The site description is largely based on available aerial photography and historical maps. No walkover has been undertaken at the site.

2.1 Site Location and Description

The site is located at the existing Mabey House, in the north portion of New House Park Estate, Chepstow. The National Grid Reference of the centre of the site is (ST) 353011, 191255 and a Site Location Plan is presented as Figure 1.

The site comprises a roughly rectangular shaped parcel of land of around 500m length (south west to north east) and 100m width (north west to south east) occupying an area of around 7.6 hectares.

It is presently occupied by an existing manufacturing facility and external areas occupied by Mabey Bridge an electrical production facility.

The site is bordered by:

- To the north: by open ground followed by the M48 motorway;
- To the east: by a stream, open ground an access road associated with New House Park Estate;
- To the south: by New House Park Estate followed by, Caldicot Levels;
- To the west: by open ground followed by the village of Mathern.

Vehicular access to the site is currently gained via the access road to the wider New House Park Estate. The general topography in the area slopes south toward the Caldicot Level. Whilst no topographic survey is available, spot levels on Ordnance Survey records indicate the site to be situated between 10mAOD and 14mAOD.

Service plans have been ordered for the site and are awaited from the provider.

The west and north boundaries are indicated to be surrounded by an embankment and heavily vegetated. Two ponds are noted in the south portion of the site. A general layout of the site is presented on Inset 1 below.

Inset 1: Current Site Layout

2.2 Site History

The site history has been assessed from a review of available historical Ordnance Survey County Series and National Grid maps obtained from the Landmark Information Group. The full set of historical maps is presented in Appendix A. Relevant information from other sources, such as the Local Authority and the Sitecheck report (Appendix B), has also been incorporated, where appropriate.

Table 1: Review of Historical Maps

Date	On-Site	In Vicinity of Site
1880 – 1901	The site is indicated to be primarily vacant fields. A footpath trends east to south west across the site. A stream arising from "issues" trends north/south through the east portion. This stream is also marked as a County Borough Boundary (centre of stream) and a drain is also noted to join this stream. A small area of waterlogged ground with a number of trees present in the south portion.	The site is generally surrounded by open farmland. A network of reens/streams are indicated across the area. New House Farm is indicated approximately 250m to the east. The Great Western Railway is indicated 500m to the south. The village of Mathern is present approximately 450m to the west and the town of Chepstow approximately 1km to the north. The River Wye is present approximately 1km to the north, east and south. A small pond is indicated approximately 100m to south. A well is indicated approximately 750m to the east.
1920 – 1955	No significant changes indicated.	Old quarries and limekilns are indicated approximately 500m to the north. .An engine shed is indicated approximately 700m to the north east.

Cont.

Table 1 Cont: Review of Historical Maps

1967 – 1969	No significant changes indicated.	A major highway (now the M48) is indicated approximately 20m to the north. Residential areas of Chepstow are now indicated approximately 500m to the north. A gasholder is indicated approximately 700m to the east.
1982 – 2002	A reen is indicated at the west boundary, trending north to south. No other significant changes indicated.	A series of warehouses (New House Farm Industrial Estate) are immediately to the south of the site. An access road constructed on an embankment and associated with the warehouses is indicated at the south boundary, leading from the M48, with a roundabout at the site south boundary. A tank associated with one of the warehouses is indicated approximately 30m to the south.
2010 - 2015	The stream/drain on site is indicated to have been rerouted outside the site boundary to the east and re-enters the site boundary in the south east corner. The stream is not visible on site and may be culverted. Two ponds are indicated in the south portion. A building is indicated to have been constructed in the west portion.	No significant changes indicated.
Present Day	We understand that the building on site has been extended to occupy much of the north and central portions.	No significant changes indicated.

2.3 Previous Investigations and Assessments

The Client has provided ESP with a copies of a geo-environmental assessment reports undertaken for plots 1-3 New House Park Estate, with plot 2 predominantly covering the current study site. These works were undertaken by WS Atkins (2002) and Environ (2006). For ease of reference, copies of the previous exploratory data are presented in Appendix D. The salient findings from these assessments are incorporated into the following sections.

2.4 Geology, Hydrology and Hydrogeology

2.4.1 Published Geology

The published 1:50,000 scale geological map for the area of the site (Sheet 250, available on the website of the British Geological Survey) indicates the site to be underlain by Mercia Mudstone bedrock. The Mercia Mudstone Formation lies unconformably over the Hunts Bay Oolite (Limestone) which is shown to outcrop to the north of the site. The bedrock is recorded to be overlain by River Terrace Deposits

The exploratory hole records from the 2002 Atkins report indicate the ground conditions at the site to comprise, a cover of topsoil followed by a horizon of completely weathered Mercia Mudstone. Competent bedrock was identified at depths of between 1m and 6m below ground level, however, weak mudstone bands, consistent with highly weathered rock were recorded in a number of exploratory holes. River Terrace Deposits were not encountered.

The works undertaken by Environ identified similar ground conditions to those identified by WS Atkins. Whilst the ground model identified at the site is consistent, the structure and weathering grade of the identified bedrock varies considerably across the site.

2.4.2 Available BGS Borehole Records

There are no available BGS borehole records available for the site, however, a number of borehole records are available for the M48 highway and the wider New House Park Estate. Pertinent records are presented in Appendix C, however the boreholes generally indicate a cover of Made Ground, limited River Terrace Deposits followed by Mudstone bedrock. The bedrock is generally encountered at depths of between 2m and 3.5m.

2.4.3 Hydrology

The nearest major surface water feature to the site is the River Wye present to the west and south of the site. A number of other surface water features such as ponds, streams and a large reen network are present across the wider area. A stream/drain is present at the east boundary of the site and enters the site boundary at the south east corner. The stream flows into two ponds that are indicated on site.

The Sitecheck Report indicates that there are no surface water abstractions within 250m of the site.

From a review of topographical plans and flooding maps presented on the Environment Agency (EA) website (EA, 2015), the site is not indicated to be at risk from flooding.

Inset 2: Flood Risk Mapping (EA - May 2016)

2.4.4 Hydrogeology

Reference to the aquifer maps published in the environmental data report indicates that the Mercia Mudstone is a classified as a Secondary B Aquifer.

Secondary B Aquifers generally correspond with the previously classified water bearing parts of non-aquifers and comprise strata of generally lower permeability, but which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. In some circumstances, Secondary B Aquifers can be sensitive to pollution.

2.5 Environmental Setting

The site exists in a historically rural, and now a urban setting. Environmental data for the vicinity of the site has been obtained via a Sitecheck Report, which is presented in Appendix B. The salient data is summarised in Table 2 below.

Table 2: Summary of Sitecheck Data

Item	On the Site	In the Immediate Vicinity
Potentially contaminative historical land uses	None identified.	14no. identified within 250m of the site comprising, warehouses, cuttings and industrial estates. .
Historical Tanks/Energy facilities	None identified.	15no. records within 250m of the site, comprising, unspecified tank storage. 6no. electricity substations recorded within 250m, 3no. recorded between 250m and 500m of the site and one gas governor located approximately 411m to the east.
Potentially Infilled Land	None identified.	12no. recorded within 250m comprising ponds and cuttings.
Discharge Consents	None identified.	2no. identified within comprising expired consents for unspecified effluent discharge.
Pollution Incidents	None identified.	None identified in the immediate vicinity.
Waste/Landfill Sites	None identified.	None identified within 250m of the site. One identified within 500m of the site.
Industrial/Commercial Sites	1no. identified on site comprising the current site use as electrical production facilities registered to Mabey Bridge.	7no. recorded within 250m comprising tanks and electrical features
Petrol and Fuel Sites	None identified.	None identified within 250m.
Sensitive Land Uses (SSSI, Nature Reserves, SAC etc.)	None identified.	None identified within 250m.

2.6 Contact with Regulatory Bodies & Local Information Sources

ESP have made enquiries to various departments of the Local Authority (Monmouthshire Council) to obtain local information on the environmental and geotechnical setting of the site. A response has not yet been received. Any pertinent information will be forwarded on receipt.

2.7 Anticipated Geotechnical Hazards

2.7.1 Summary of Potential Hazards

The potential for various geotechnical hazards at the site is provided in the environmental data report. The potential hazards as reported in the environmental data report are listed in Table 3 below, along with any salient further information on the potential hazard identified by ESP in the preparation of this report.

Where a potential hazard has been identified, it is discussed further in subsequent sections.

Table 3: Geotechnical Hazards

Ground Stability Hazard	Potential[1]	ESP Comment
Coal Mining	No hazard	Site is not within an area of coal mining.
Mining (non-coal)	No hazard	No further information identified to contradict environmental data report, however, quarries noted in the local area.
Shrinking or Swelling Clay	Very Low	ESP do not concur with this assessment See Section 2.7.2.
Landslide	Moderate	No further information identified to contradict environmental data report.
Ground Dissolution	No hazard	No further information identified to contradict environmental data report.
Compressible Ground	No hazard	ESP do not concur with this assessment See Section 2.7.3.
Collapsible Rocks	Very Low	No further information identified to contradict environmental data report.
Running Sand	Very Low	No further information identified to contradict environmental data report.
Radon	Moderate	3-5% of properties affected with basic radon protection measures required.
Groundwater Flooding	Moderate	Groundwater flooding is noted as a potential at the site and associated with superficial deposits.

Note to Table 3:

1. Potential as reported in environmental data report.

2.7.2 Shrinkable and Swelling Soils

Fine grained weathered Mudstone bedrock is anticipated beneath the site, which can potentially have a high plasticity index and, hence, be classified as of high volume change potential with changes in moisture content (shrinkage and swelling).

Initial review of plasticity testing provided within the WS Atkins report indicates the near srufce weathered bedrock to vary from low plasticity to high plasticity.

Therefore, we consider that the potential for shrinkable and swelling clays at the site should be increased from that reported in the environmental data report (Table 3, very low) to **Moderate.**

2.7.3 Compressibility

Fine grained soils are anticipated at shallow depths underlying the topsoil at the site which can be susceptible to compression. Therefore, we consider that the potential for compressibility at the site should be increased from that reported in the environmental data report (Table 3, No hazard) to **Moderate.**

2.7.4 Pyritic Ground

The environmental data report does not consider the potential risk from sulphate rich or pyritic ground which may oxidise to sulphates and lead to aggressive attack on buried concrete.

Given the above, at this stage (without laboratory analysis) we consider that the potential for sulphate/pyrite attack on buried concrete placed within Mercia Mudstone Bedrock would be **Moderate/Low.**

3.0 PRELIMINARY GEO-ENVIRONMENTAL RISK ASSESSMENT

3.1 Phase One Conceptual Site Model

3.1.1 Background

The Phase One Conceptual Site Model lists the potential sources of geo-environmental risk, the receptors at risk and the pathways between the two. These are discussed in the following sections.

3.1.2 Potential Sources of Contamination

The desk study review has not established the presence of any significant potential sources of contamination on site with the main potential contaminant source likely to be the current electrical manufacturing facility on site.

3.1.3 Potential Sources of Hazardous Ground Gas

The site is not located within 250m of an existing or former recorded landfill. The closest record of any potentially infilled land is approximately 400m from the site. A former stream has been rerouted to the east of the site and depending on the backfill materials, this feature may pose a potential risk of ground gas.

3.1.4 Potential Sources of Radon

Radon is a colourless, odourless, radioactive gas, which can pose a risk to human health. It originates where uranium and radium are naturally present in the bedrock and can move through fractures in the bedrock and overlying superficial deposits to collect in spaces in structures.

The Sitecheck report identifies that the site lies in an area where less than 3-5% of homes are above the action level for radon, with basic radon protection measures required.

3.1.5 Potential Receptors

As discussed in Section 1.0, the development is to comprise residential housing with associated hardstanding and landscaped areas. The most sensitive potential receptors would therefore be:

- Site workers/operatives.
- Construction and maintenance workers.
- Small stream located adjacent to the site.
- Foundation and other buried concrete could be at risk of attack if Made Ground is identified across the site and shown to containing high levels of sulphate/sulphide at shallow depth.

3.1.6 Potential Migration Pathways

The following are considered the most likely migration pathways with regard to any contamination or hazardous ground gas present beneath the site.

Site Users:

- Ingestion of soils and inhalation of dust in landscaped areas;
- Ingestion of edible plants and dust associated with such plants;
- Dermal contact with contaminated soils.

Construction and Maintenance Workers:

- Ingestion of soils and inhalation of dust across site;
- Dermal contact with contaminated soils.

Buildings:

- Sulphate attack on buried concrete;
- Potential explosive risk from flammable ground gas;
- Potential exposure to toxic ground gas.

Surface Water Channels:

- Migration of water to the adjacent stream/drain and associated ponds.

3.1.7 Previous Geoenvironmental Data

Geoenvironmental testing undertaken by Environ in 2006 indicate generally low levels of contaminants for a wide range of organic and inorganic contaminants. This would not be unexpected for a site that was predominantly greenfield. The currently occupying manufacturing plant is likely to pose the greatest contaminative risk and intrusive works would be required to confirm the contaminative risk in its current state.

3.2 Preliminary Risk Evaluation & Plausible Pollutant Linkages

The land use history of the site and surrounding area, as established from the desk study and walkover, has identified a number of potential contamination linkages due to ground conditions or former operations either on, adjacent to, or in the vicinity of the site. Note that these potential linkages will need to be later assessed and re-established using actual site data obtained from an exploratory investigation.

3.2.1 Introduction to Risk Evaluation Methodology

The methodology set out in CIRIA C552 (2001), *Contaminated Land Risk Assessment – A Guide to Good Practice*, has been used to assess whether or not risks are acceptable, and to determine the need for collating further information or remedial action. Whilst at a later stage, this methodology may be informed by quantitative data (such as laboratory test results) the assessment is a qualitative method of interpreting findings to date and evaluating risk. The methodology requires the classification of:

- The magnitude of the potential consequence (severity) of risk occurring (Table 4):
- The magnitude of the probability (likelihood) of risk occurring (Table 5).

Table 4 - *Classification of Consequence*

Classification	Definition	Examples
Severe	• Short-term (acute) risk to human health likely to result in *Significant Harm*. • Short-term risk of pollution to a sensitive water resource. • Catastrophic damage to buildings/property. • Short-term risk to ecosystem, or organism forming part of that ecosystem.	• High concentrations of Cyanide at surface of informal recreation area. • Major spillage of contaminants from site into controlled water. • Explosion causing building collapse.
Medium	• Chronic damage to human health. • Pollution of sensitive water resource. • A significant change to ecosystem, or organism forming part of that ecosystem.	• Contaminant concentrations exceed assessment criteria. • Leaching of contaminants to Secondary A aquifer. • Death of species within nature reserve.
Mild	• Pollution of non-sensitive water resources. • Significant damage to crops, buildings, structures. • Damage to sensitive buildings, structures or the environment.	• Pollution of Secondary groundwater sources. • Damage to building rendering it unsafe to occupy.
Minor	• Harm, although not necessarily significant harm, which may result in financial loss, or expenditure to resolve. • Non-permanent risks to human health (easily prevented by means of PPE). • Easily repairable effects of damage to buildings and structures.	• The presence of contaminants at such concentrations that PPE is required during site works. • The loss of plants in a landscaping scheme. • Discoloration of concrete.

Table 5: *Classification of Probability*

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

The classifications defined above are then compared to indicate the risk presented by each pollutant linkage, allowing evaluation of a risk category (see Tables 6 and 7).

Table 6*: Risk Categories – Comparison of consequence against probability*

		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Probability	**High Likelihood**	Very High Risk	High Risk	Moderate Risk	Moderate / 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

Table 7: *Description of Risk Categories*

Classification	Description
Very High Risk	• There is a probability that severe harm could arise to a designated receptor from an identified hazard. Or, there is evidence that severe harm to a designated receptor is currently happening. • The risk, if realised, is likely to result in a substantial liability. • Urgent investigation (if not already undertaken) and remedial action are likely to be required.
High Risk	• Harm is likely to arise to a designated receptor from an identified hazard. • Realisation of the risk is likely to present a substantial liability. • Urgent investigation (if not already undertaken) is required, and remedial action may be necessary in the short term and are likely over the longer term.
Moderate Risk	• It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur, it is more likely that the harm would be mild. • Investigation (if not already undertaken) is normally required to clarify the risk and to determine potential liability. Some remedial action may be required in the longer term.
Low Risk	• It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low Risk	• There is a very low possibility that harm could arise at a receptor. In the event of such harm being realised, it is not likely to be severe.

The methodology described above has been used to establish Plausible Pollutant Linkages (PPL) based on the Conceptual Site Model generated for the site and proposed development, and to evaluate the risks posed by those linkages, using information known about the site, at this desk study stage. This is presented as Table 8 in Section 3.2.2.

3.2.2 Tabulated Preliminary Risk Evaluation & Plausible Pollutant Linkages

Table 8: Preliminary Risk Evaluation & Plausible Pollutant Linkages (PPL).

Source	Pathway	Receptor	Classification of Consequence	Classification of Probability	Risk Category	Further Investigation or Remedial Action to be Taken
Potential contaminants in shallow soils.	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Site Users (workers/visitors)	Medium – potential for chronic levels.	Likley[2]	Moderate/Low Risk	Walkover survey to undertake visual inspection of potential contaminant sources. Sampling of near-surface soils to confirm levels of total contamination present.
	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Construction/ Maintenance Workers	Minor – standard PPE likely to be sufficient	Unlikely[2]	Low Risk	
	Leaching of soil contaminants	Impact on Groundwater	Medium - the site lies on a Secondary B Aquifer	Unlikely[2]	Low Risk	
	Leaching of soil contaminants	Impact on Surface Water	Medium – the site lies adjacent to a small stream.	Unlikely[2]	Low Risk	
Asbestos in shallow soils	Ingestion of fibres	Construction/ Maintenance Workers	Medium – potential for chronic levels	Unlikely[3]	Low Risk	Sampling of shallow soils for asbestos.
Soil sulphate and pyrite	Aggressive groundwater	Buried Concrete	Mild – damage to structures	High Likelihood[4]	Moderate Risk	Sampling of soils to confirm levels of sulphate, pH.
Hazardous ground gas/vapours from infilled stream/drain and landfill to the east.	Asphyxiation/poisoning. Injury due to explosion.	Site Users (residents)	Severe – acute risk.	Low Likelihood[5]	Moderate Risk	Investigation of near surface soils to identify if any potential for ground gas (i.e. decaying organic materials). If identified, gas monitoring wells may be required.
	Damage through explosion.	Building/Property	Severe – acute risk.		Moderate Risk	
	Asphyxiation/poisoning. Injury due to explosion.	Construction and Maintenance Workers.	Severe – acute risk.		Moderate Risk	
Radon gas	Migration into Buildings	Site Users (residents)	Medium – potential for chronic levels	Unlikely[6]	Low Risk	See Section 3.1.4.

Notes:

1. Methodology and details of risk consequence, probability and category based on CIRIA C552 (2001) and presented in Section 3.2.1.
2. No significant Made Ground is anticipated on site. The most potentially contaminative former land uses has been identified as the current production facility on site.
3. No asbestos materials are anticipated on site.
4. The Mercia Mudstone bedrock anticipated at shallow depth beneath the site can potentially contain high levels of pyrite.
5. Low likelihood of potential ground gas sources from historical woodland at the site, cleared sometime between 1939 and 1960.
6. Radon risk identified in environmental data report. No radon protection measures are required. (Section 3.1.4).
7. The above risk evaluation will need to be updated following an intrusive investigation and laboratory testing of samples collected.

4.0 PRELIMINARY GEOTECHNICAL RISK ASSESSMENT

4.1 Anticipated Geotechnical Hazards

4.1.1 Past Mining

The site is not underlain by Coal Measures bedrock.

4.1.2 Site Stability

The site is not in an area where it will be affected by post-glacial landslips or limestone solution, however Limestone is indicated to the north of the site and identified as the Hunts Bay Oolite.

4.1.3 Shrinkable and Swelling Soils

Fine grained weathered Mercia Mudstone is anticipated beneath the site, which can potentially have a high plasticity index and, hence, be classified as of potential high volume change potential with changes in moisture content (shrinkage and swelling). Therefore, we consider that the potential for shrinkable and swelling clays at the site is moderate.

4.1.4 Compressible Ground

Fine grained soils are anticipated at shallow depths underlying the topsoil at the site which can be susceptible to compression.

Based on the limited information available, the weathered Mercia Mudstone beneath the site is likely to be of medium compressibility.

4.1.5 Geomorphology

The existing topography and geomorphology at the site has evolved over a period of many, perhaps sixty to seventy millions of years under a number of different erosional regimes. However, the original geomorphology of the area has been altered by man's activities, in particular the construction of the existing electrical manufacturing facility on site and construction of the adjacent industrial estate and associated infrastructure.

5.0 RECOMMENDED FURTHER WORK

As the site is under consideration for purchase and possible refurbishment, we understand that no significant construction is to be undertaken and minor changes to site and access road layouts are proposed alongside the construction of a wind turbine construction/maintenance pit.

Further understanding or assessment of the ground conditions would require a detailed site walkover, followed by an intrusive site investigation to determine the ground conditions and allow an assessment of the identified geotechnical and geoenvironmental hazards.

ESP have previously provided a proposal for an intrusive investigation, however, based on the Phase 1 Desk Study the previously issue proposal should be revised to comprise:

- Trial pits across the site to determine the shallow ground conditions. Dependant on the detail required by the client, the trial pitting should be extended to two days to allow suitable coverage;
- Based on the type of ground conditions identified, a rotary percussive in place of the previously recommended light cable percussion borehole to determine the ground conditions at depth within the proposed pit area;
- Groundwater level monitoring;
- Dynamic cone penetrometer testing along the route of proposed access roads/hardstanding;
- Geoenvironmental and geotechnical laboratory testing;
- Quantitative risk assessment may be required, should potential contaminant sources be identified during walkover and/or site works;
- Incorporation of a detailed assessment of previous geoenvironmental and geotechnical testing undertaken by Environ and WS Atkins respectively;
- Interpretive assessment and reporting.

It would be prudent to undertake the trial pits in advance of the borehole in order to determine the depth to rockhead and the need for deeper exploratory works.

6.0 REFERENCES

ALLEN D J, BREWERTON L J, COLEBY L M, GIBBS B R, LEWIS M A, MacDONALD A M, WAGSTAFF S J and WILLIAMS A T. 1997. The Physical Properties of Major Aquifers in England & Wales. BGS Technical Report WD/97/34 - EA R&D Publication 8. BGS and Environment Agency.

BRITISH GEOLOGICAL SURVEY (BGS). 2015/2016. Website accessed December 2015 and January 2016.

BUILDING RESEARCH ESTABLISHMENT (BRE). 1987. The influence of trees on house foundations in clay soils. BRE Digest 298. BRE, Garston.

BUILDING RESEARCH ESTABLISHMENT (BRE). 1996. Desiccation in Clay Soils. BRE Digest 412. BRE, Garston.

BUILDING RESEARCH ESTABLISHMENT (BRE). 2007. Radon: Guidance on Protective Measures for New Dwellings. BR211. BRE, Garston.

DEPARTMENT FOR ENVIRONMENT, FOOD AND RURAL AFFAIRS (DEFRA) AND THE ENVIRONMENT AGENCY. 2002b. Potential Contaminants for the Assessment of Land. R&D Publication CLR8.

TOMLINSON, MJ. 2001. Foundation Design and Construction (7th edition). Prentice Hall.

WILSON S, OLIVER S, MALLETT H, HUTCHINGS H and CARD G. 2007. Assessing Risks Posed by Hazardous Ground Gases to Buildings. CIRIA C665.

WILSON S, CARD G and HAINES S. 2009. Ground Gas Handbook. Whittles Publishing.