

Earth Science Partnership

Consulting Engineers | Geologists | Environmental Scientists

Safe Gas Cylinders
Proposed Commercial Development
Phase 1 Desk Study
Report Reference: ESP.7500b.3400

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Safe Gas Cylinders Proposed Commercial Development Phase 1 Desk Study

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Report Reference: **ESP.7500b.3400**

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General Notes

Executive Summary

Safe Gas Cylinders (hereafter known as the Client) are proposing to redevelop the subject site with a proposed commercial unit to expand the services already present on site. ESP have undertaken a geo-environmental and geotechnical assessment and the key potential land quality issues identified by the assessment are summarised below:

	Potential Hazard	Anticipated Risk	Discussion
Site Setting	Current Site Status.	-	The site is currently occupied by an existing Safe Gas Facility and contains a number of on site storage tanks and also stored (empty) LPG tanks.
	Identified Ground Conditions.	-	The published geology for the area indicates the site to be underlain by Wind Blown Sands and peat horizons, followed by Alluvial Sands, Clays and Silts and Gravels overlying Glacial Till followed by both Middle and Upper Coal Measures Bedrock at depths of around 60m to 70m.
	Groundwater Conditions.	-	The site is underlain by Secondary A aquifers in both the superficial deposits and bedrock.
	Historical Land Use.	-	Historical land uses identified include use as a tin plate works, railway sidings, works with the potential for infilled features such as a pond, swimming pool and ditches to be present.
Geo-environmental	Potential Contamination Sources	High/ Moderate/	Based on available Desk Study information.
	Chronic Risks to Human Health)	Moderate	Based on available information and proposed end use – requires further consideration.
	Risks to Controlled Waters	High/ Moderate	Based on available information and underlying Secondary Aquifers – requires further consideration.
	Hazardous Ground Gas	High	Based on available information and proposed end use – requires further consideration. Risk from Radon is anticipated to be low.
	Weak/Compressible Ground, requiring non-traditional foundations	High/ Moderate	Potential risks from low insitu soil strengths that could extend for significant depth before becoming competent – further consideration required.
	Shrinkage or Swelling)	Moderate	Potential for shrink/swell in near surface fine soils are identified.
	Sulphate Attack on Buried Concrete	Moderate	Based on available Desk Study information.
	Soakaway Feasibility	-	May be suitable for use but design and assessment will need to take into account shallow groundwater and contamination mobilisation.
Others	UXO	-	To be confirmed before investigation works.
	Flooding	High/	North portion of the site is indicated to be at risk of flooding.
	Further Investigation Required?	Yes	See Section 5.0.

Note: The above is intended to provide a brief summary of the conclusions of the assessment. It does not provide a definitive assessment and must not be referenced as a separate document. Refer to the main body of the report for details

1 Introduction

1.1 Background

Safe Gas Cylinders (hereafter known as the Client) are proposing to redevelop the subject site with a proposed commercial unit to expand the services already present on site. The Earth Science Partnership Ltd (ESP), Consulting Engineers, Geologists and Environmental Scientists, were instructed by the Client to undertake an integrated geotechnical and geo-environmental assessment to identify and evaluate potential ground hazards which could impact on the proposed development. The site location is shown on Insert 1 in Section 2.1 and our understanding of the site boundary is presented on Insert 2.

We understand that the development will comprise the construction of one commercial warehouse building in the north portion. We have been provided with two drawings (Appendix D) that do not match the advised layout. As such our assessment is based on the google earth boundary provided by the Client for Plots 1 & 3 shown in Appendix D and also on Insert 2. We have referred to the site throughout this assessment as Safe Gas Cylinders, however, we understand it has also been known as the former “Linermar Site”.

Based on the above, we understand that the proposed structures would be classified as Geotechnical Category 2 (BS5930:2015).

1.2 Objective and Scope of Works

The objective of the investigation was to obtain information on the geotechnical character and properties of the ground beneath the site, potential risks posed by contamination and ground gas, and to allow an assessment of these ground conditions with particular reference to the potential impact on the proposed development.

We are not aware of any ground hazard related planning conditions relating to the development at present.

The scope of works for the investigation was designed by mutually developed with the Client by ESP within an agreed budget, and comprised a desk study review of available historical Ordnance Survey maps, environmental data, geological maps, memoirs and data, and further desk study information and preliminary assessments of geo-environmental and geotechnical risks posed to the site.

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 proposal of 16th March 2020 (ref: db/7500b.It1 proposal). The assessment was undertaken in August 2020.

1.3 Report Format

This report includes the desk study (Section 2), along with the Preliminary Risk Assessment (Section 3). A preliminary evaluation of the risks from contamination and hazardous ground gas is included in Sections 3 and 5. It should be appreciated that this is a preliminary evaluation only, and will not generally meet the requirements of the Options Appraisal report of CLR11.

A preliminary risk register, identifying potential geotechnical hazards from the desk study review, is presented as Section 2.10. The report concludes with a summary of any further surveys/ investigations/ assessments recommended (Section 6).

The assessment of 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 has been undertaken using the guidance published by CIRIA (2001). This is discussed in more detail in Section 3.2.1 and in Appendix A.

This report is issued as a digital version only.

1.4 Limitations of Report

This report represents the findings of the brief relating to the proposed end use and geotechnical category of structure(s) as detailed in Section 1.1 above. The brief did not require an assessment of the implications for any other end use or structures, nor is the report a comprehensive site characterisation and should not be construed as such. It should be appreciated that no intrusive investigation has been undertaken to date. Should an alternative end use or structure be considered, the findings of the assessment should be re-examined relating to the new proposals.

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.

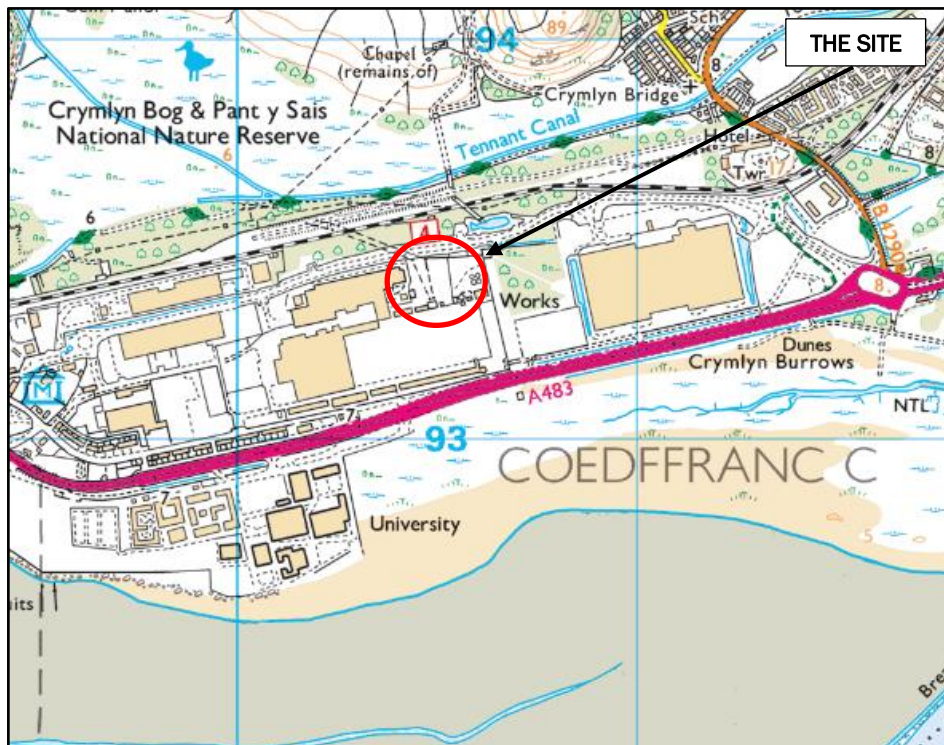
This report represents the findings and opinions of experienced geo-environmental and geotechnical specialists. Earth Science Partnership does not provide legal advice and the advice of lawyers may also be required.

2 Desk Study and Field Reconnaissance Visit

The information presented in this section was obtained from desk-based research of sources detailed in the text, including historical maps and an environmental and geological data report. Further desk study reports/data/records are included as subsequent appendices as referenced in the text.

2.1 Site Location and Description

The site is located to the east off Ffordd Amazon, Crymlyn Burrows. The National Grid Reference of the centre of the site is (SS) 270449E, 193363N and the postcode is SA1 8QJ. A Site Location Plan is presented as Insert 1 below.



Insert 1 - Site Location Plan from Ordnance Survey 1:25,000 scale map.
Reproduced with permission (OS License No.: AL100015788).

The site comprises an inverted “L” shaped parcel of land, of around 130m length (north to south) and 75m width (west to east), at its longest axis, occupying an area of around 0.81ha and it is bound by:

- To the north: immediately by Ffordd Amazon, followed by a railway (95m) and the Tenant Canal (175m).
- To the east: by further land area owned and operated by Safe Gas Cylinders, but not subject to this assessment (see Insert 2).
- To the south: by buildings of industrial and commercial use associated with Crymlyn Burrows with Fabian Way present around 200m to the south.
- To the west: by buildings and industrial and commercial areas associate with Crymlyn Burrows.

We understand that only a portion of the site is to be developed and our understanding of the layout is based on the drawings provided by the Client (see Appendix D). Our understanding of the project location is shown on Insert 2 below.



Insert 2: Site Location (Google Earth August 2020)

The general topography in the area is slopes towards the toward Baglan Bay. We are not aware of a topographic survey for the site at this time, however, available Ordnance Survey Datum suggests the site is relatively level and located at an elevation of around 8mAOD.

A brief site walkover was undertaken on 14th August 2020 and whilst the main features of the site were viewed, full access was not possible as the visiting engineer was advised a full induction and “shadowing” of visitors was required .

The site layout is generally as identified from the available Desk Study information, with a number of LPG storage tanks in the west portion and a substation present at the south boundary, with overhead power cables crossing the site in a north west to south east direction.

The main site area is generally hard surfaced and at the time of the walkover, the yard area was full of empty LPG tanks which we understand are empty and being stored until sold. A general layout of the site is presented on Insert 3 below.



Insert 3: General View of Site Looking South West (14.08.20)

2.2 Site History

2.2.1 Published Historical Maps

The site history has been assessed from a review of available historical Ordnance Survey County Series and National Grid maps. Extracts from the historical maps are presented in Appendix B and the salient features since the First Edition of the County Series maps are summarised in Table 1 below.

Table 1: Review of Historical Plans

Date	On-Site	In Vicinity of Site
1881	The site is vacant and undeveloped, shown as soft/marshy ground associated with Crymlyn Burrows.	Two railway lines travelling in a general south west to north east direction are indicated approximately 100m to the north.
1899	No significant changes shown.	Three new railway lines have been constructed approximately 20m to the north of the site orientated in a general south west to north east direction.
1917	A drain/reen is indicated to cross the central portion in a south west – north east direction. A single railway siding is also indicated adjacent to the drain.	The railway land located to the north has developed considerably with numerous new tracks and sidings now shown within approximately 20m to the north. A new railway line is also shown to terminate adjacent to the eastern site boundary.

1946	Railway sidings and a small rectangular structure are present in the north portion. A swimming pool, pond and bowling green are indicated to occupy the south west portion. A sports ground to the east encroaches upon the east portion of the site.	The railway land located to the north has again developed considerably with numerous new tracks and sidings now shown, meeting the northern site boundary. A new Tin Plate Works has been constructed adjacent to the west site boundary. Numerous tanks are indicated in the vicinity. A sports ground is present at the eastern boundary of the site.
1963	An electric pylon is indicated to cross the site north west to south east, with another overhead cable terminating at the north east boundary of the site. The pool, pond and bowling green in the south west portion are no longer indicated and are shown to have been replaced with a series of buildings roughly reflecting the current site layout. A series of tanks are indicated in the central portion.	A works is indicated approximately 10m from the south boundary.
1993 to present day	A series of tanks are indicated in the south west portion. A substation is present at the south boundary.	A series of buildings and tanks are shown to the south east (wider land area within client ownership).

2.3 Previous Investigations and Assessments

We are not aware of any previous geotechnical or geo-environmental investigations or assessments at the site, however, ESP have undertaken an investigation immediately to the west of the site (Ref: 3991s.02.1404), and the information where appropriate have been discussed in the following sections.

2.4 Contact with Regulatory Bodies & Local Information Sources

The following departments of the Local Authority have been contacted as part of this assessment:

- Environmental Services/Health/Pollution Control
- Building Control
- Trading Standards (Petroleum Officer)

At the time of issue of this report, we have not yet received a response from the consultees. Once received, any response will be forwarded under separate cover. It should be appreciated that their responses may contain salient information on the site which could not be taken into account during the preparation of this report.

2.5 Hydrology

2.5.1 Surface Water Features

The nearest major surface water feature to the site is Baglan Bay approximately to the south. Tidally influenced fluctuations in groundwater level are expected in the area (see Section 2.6.3). The Tenant Canal is identified around 125m to the north.

2.5.2 Surface Water Abstractions

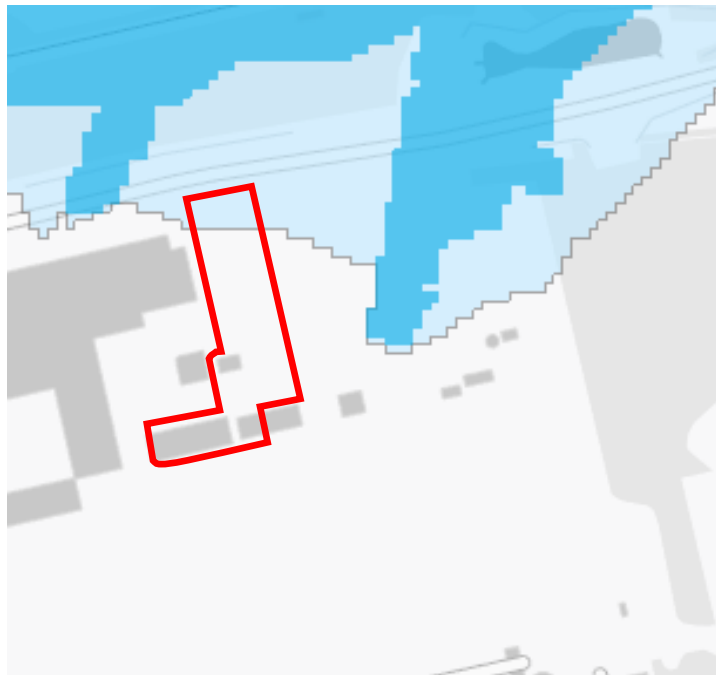
The environmental data report (Appendix C) indicates that there are no surface water abstractions within 250m of the site.

2.6 Flooding

2.6.1 Rivers and Seas

From a review of flooding maps presented in the environmental and geological data report and on the Natural Resources Wales (NRW, 2020), indicates that the north portion is located within Zone 2, defined as:

- The extent of a flood from rivers or from the sea with up to a 0.1% (1 in 1000) chance of happening in any given year.
- Contains areas recorded to have flooded in the past.
- Flood Zone 2 is important from a planning context as it forms the basis of Zone C in the Welsh Government Development Advice Map (DAM).



Insert 4: Extract of Flood Map Presented on NRW Website (August 2020)

The potential for flooding from rivers or seas has not been addressed further in this report and ESP are able to offer further advice and/or implement an appropriate Flood Consequences Assessment when required.

2.6.2 Surface Water

Surface water flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground but lies on or flows over the ground instead. This type of flooding can be difficult to predict, much more so than river or sea flooding as it is hard to forecast exactly where or how much rain will fall in any storm. The information available depends on available records including ground levels and drainage.

From a review of flooding maps presented in the environmental and geological data report and on the Natural Resources Wales (NRW, 2020), the highest risk on site, in the southern extent, is indicated to be in an area of Low risk from surface water flooding.

2.6.3 Groundwater

Groundwater flooding is defined as the emergence of groundwater at the ground surface away from river valleys or the rising of groundwater into man-made ground under conditions where the 'normal' range of groundwater levels and groundwater flows is exceeded and predicted risk from groundwater flooding aims to identify locations where this form of groundwater flooding could happen.

It does not incorporate anomalous discharge from springs leading to groundwater flooding down the topographic slope or flooding associated with urban groundwater rebound, mine water discharge, urban drainage, or any other flooding associated with changes in the engineered environment.

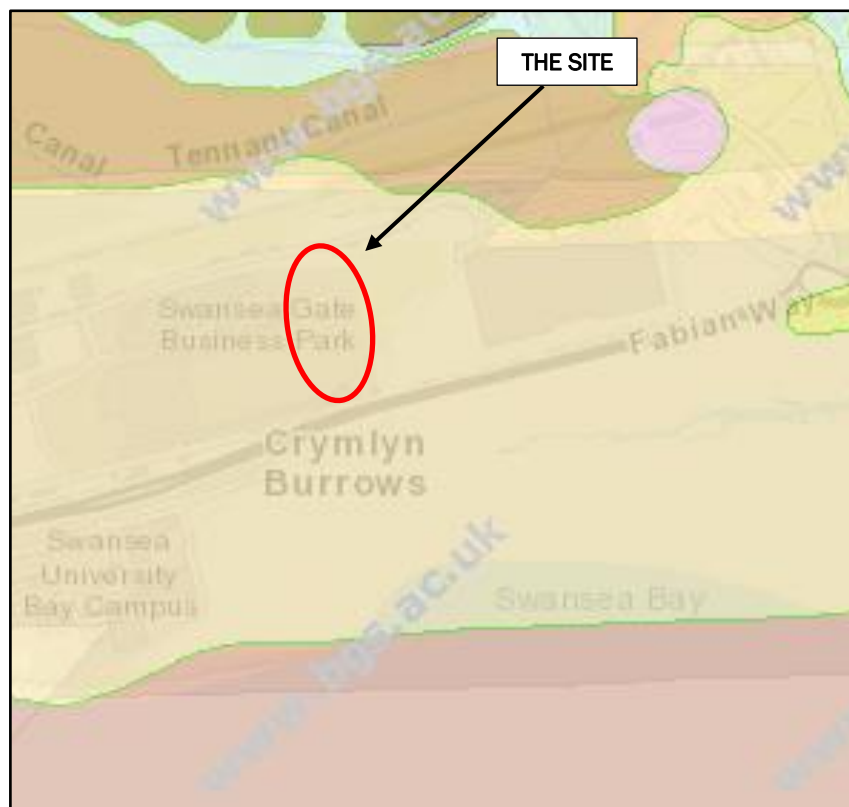
The environmental and geological data report in Appendix C indicates that the site is at a potential low risk at surface from groundwater flooding.

2.7 Geology

2.7.1 Published Geology

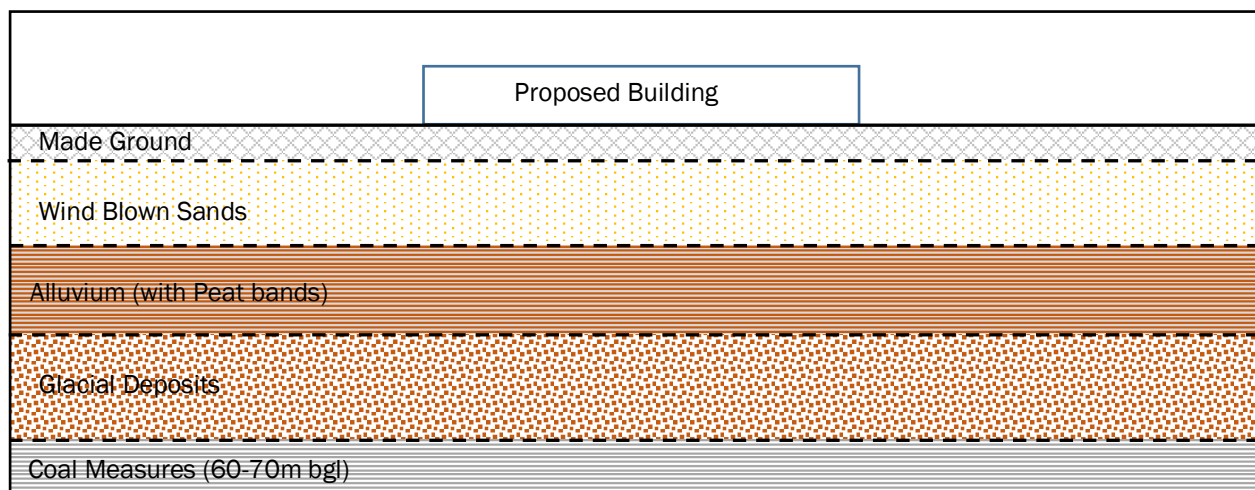
The published geological map for the area of the site (1:10,560 scale, SS69SE) indicates the site to be underlain by Wind Blown Sands and peat horizons, followed by Alluvial Sands, Clays and Silts and Gravels overlying Glacial Till followed by both Middle and Upper Coal Measures Bedrock at depths of around 60m to 70m (1:10,560 scale, SS 69SE).. Owing to the sites repeated re-development, and the industrialisation of the surrounding area a covering of Made Ground can be anticipated.

Reference to the up-to-date mapping available on the website of the British Geological Survey (BGS, 2020) indicates a similar succession and is shown as Insert 5 below.



Insert 5 - Extract from online BGS Geological Map
Reproduced with permission (BGS licence number: C15/05 CSL)

As part of the ESP investigation around 200m to the west of the site (Ref: 3991s.02.1404), a ground-model was identified comprising around 1-2m of Made Ground, overlying wind blown sands and alluvium, with impersistent peat bands, to a depth of around 14m where glacial deposits were encountered. Bedrock was not proven in the investigation but noted to likely to be present at depths of around 60m to 70m. The likely ground model that will be present at the site, based on available information is presented on Insert 6 below.



Insert 6 – Conceptual Ground Model

2.7.2 Available BGS Borehole Records

Reference to the website of the British Geological Survey (BGS, 2020) indicates a number of boreholes in the vicinity of the site, however, many are recorded as confidential. One borehole approximately 200m to the west indicates a ground model comprising, drift deposits (differentiation between Blown Sand, Alluvium and Glacial Deposits is not made) to at least 117 feet (~36m) possibly extending to 152 feet (46m).

2.8 Hydrogeology

2.8.1 Aquifer Classification

Reference to the aquifer maps published in the environmental and geological data report (Appendix C) indicates that both the superficial deposits and underlying bedrock are classified as Secondary A Aquifers.

Secondary A Aquifers generally correspond with the previously classified minor aquifers, and comprise permeable layers capable of supporting water at a local, rather than strategic, scale and in some cases form an important base flow to rivers. Secondary A Aquifers are sensitive to pollution.

2.8.2 Anticipated Groundwater Bodies

Based on the available information, we consider that due to the substantial thickness of superficial deposits (Wind Blown Sands, Alluvium and Glacial Deposits) groundwater is likely to be present in the superficial strata and also present at depth in the bedrock. Perched water is likely to be present within Made Ground.

The previous works to the west of the site undertaken by ESP (Ref: 3991s.02.1404) identified separate groundwater bodies at depths of between 2-3m and around 10-11m within the Wind Blown Sands/Alluvium.

2.8.3 Abstractions and Groundwater Vulnerability

The environmental and geological data report (Appendix C) indicates no groundwater abstractions or source protection zones within 500m of the site.

2.8.4 Groundwater Movement

Groundwater movement within the superficial deposits will likely be controlled by intergranular flow, whilst within the deeper coal measures bedrock, groundwater movement will likely be dominated by fracture flow.

2.9 Environmental Setting

2.9.1 Summary of Environmental Data

The site exists in a historically rural, and now an urban setting. An environmental and geological data report has been obtained for the site and is presented in Appendix C, and the relevant data therein is summarised below. The report should be consulted for further detail.

Historical Land Use

Historical land uses have been identified on the site including Tin Plate Works, Dock Works, Unspecified Works and Railway Sidings. A number of tanks have also been identified as being historically present on site. Investigation works undertaken to the west of the site have identified the potential for contaminants, including hydrocarbons, to be present in the soils and groundwaters.

Current Land Use

A number of current potentially contaminative land uses are identified including tanks and sub-stations. These are understood to be associated with the current site use, however, the contents of any tanks are unknown at present.

Artificial and Made Ground

The site is recorded to be underlain by extensive “Disturbed Ground” with areas of “Worked Ground” noted to the north and south. Historical mapping has indicated the potential for infilled land in the south west portion, formerly an area that contained a pond and swimming pool, with a former ditch/reen likely to have been infilled in the central portion.

2.10 Preliminary Geotechnical Risk Register

The potential for various geotechnical and geomorphological hazards at the site is provided in the environmental and geological data report (Appendix C). The potential hazards, as defined by the British Geological Survey (BGS) and reported in the above report, along with any salient further information has been considered in the preparation of this report.

2.10.1 Shrinkable and Swelling Soils

A significant thickness of Wind Blown Sands are anticipated at the site and therefore the near surface soils are not likely to present a hazard with regards to shrink/swell. However, any fine soils present (naturally or as a result of reworking) and as such we consider that the potential for shrinkable/swelling soils at the site should be advanced from that reported in the environmental data report (Negligible) to Low until further ground information is gained.

2.10.2 Running Sands

The Wind Blown Deposits can contain loosely-packed sandy layers that can become fluidised by water flowing through them. Such sands can 'run', removing support from overlying buildings and causing potential damage. The environmental report outlines a negligible risk based on anticipated groundwater, however, previous works by ESP have identified groundwater and/or perched water at depths of between 1-2m local to the site. As such we consider that the potential for running sands at the site should be advanced from that reported in the environmental data report (Negligible) to Moderate until further ground information is gained.

2.10.3 Compressible Deposits

Any Made Ground (dependant on the make up) may be compressible and as such we consider that the potential for compressible ground at the site should be advanced from that reported in the environmental data report (Negligible) to Moderate until further ground information is gained.

2.10.4 Ground Workings

A number of historic ground workings are recorded in the vicinity, including former ponds in the south west portion. As such we consider that the potential for historic ground workings at the site should be considered as a potential hazard until discounted as part of the compilation of further ground information.

2.10.5 Pyritic Ground

The environmental data report does not consider the potential risk from sulphate rich or pyritic ground.

Ground conditions, if containing elevated levels of pyrite, can oxidise to sulphates and lead to aggressive attack on buried concrete.

Depending on its origin, the near surface superficial deposits and any Made Ground beneath the site may contain elevated levels of pyrite. Given the above, we consider that the potential for sulphate/pyrite attack on buried concrete would be Moderate/High.

2.11 Radon Hazard

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

The environmental data report (Appendix C) indicates that the site lies in a radon affected area as defined by the Health Protection Agency, with between 1-3% of properties above the action level no radon protection measures required in dwellings.

These maps indicate the worst level of radon potential, based on existing information gathered mainly from residential properties within the 1km square in which the site is located. It is designed as a preliminary evaluation only.

Given the currently available information, the risk from radon is considered Moderate.

3 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 (both contamination and hazardous gas), the receptors at risk (both human and non-human), and any feasible pathways between the two. These are discussed in the following sections.

3.1.2 Potential Soil Contamination Sources

A review of available historical, geological and environmental information indicates that the site is likely underlain by a cover of Made Ground with previous land uses include uses associated with a tin plate works, tank storage and ground workings. Previous investigation works undertaken by ESP to the west of the site have identified the potential for contaminants, particularly hydrocarbons to be present in the soil and groundwater phases.

Historical mapping has indicated the potential for infilled land in the south west portion, formerly an area that contained a pond and swimming pool, with a former ditch/reen likely to have been infilled in the central portion.

3.1.3 Potential Contaminants Present

The potential contaminants associated with the above potential sources have been identified from various guidelines published by DEFRA, the Environment Agency and others.

Based on this guidance and our experience, we consider that the following contaminants could be present on the site:

- heavy metals and semi-metals (arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, vanadium, zinc, tin);
- organolead compounds;
- cyanide, sulphate, sulphide;
- polyaromatic hydrocarbon (PAH) compounds;
- petroleum hydrocarbons (TH);
- phenols;
- asbestos.

No evidence has been identified from the desk study to suggest that radioactive substances may be present on the site. The potential presence of radon is discussed in Section 2.11.

3.1.4 Potential Sources of Hazardous Ground Gas

This section considers the potential sources of hazardous gases such as methane, carbon dioxide and hydrocarbon vapours. The potential for radon was discussed in Section 2.11.

From the desk study information, there is no evidence to suggest that any Made Ground that is present may provide an on-site source of hazardous ground gas. Historical mapping has indicated the potential for infilled land in the south west portion, formerly an area that contained a pond and swimming pool, with a former ditch/reen likely to have been infilled in the central portion. Deeper peat horizons also have the potential to be a gassing source.

Based on the guidelines presented by O’Riordan and Milloy (1995) and revised by Wilson et al (2009), the above potential gas sources would generally be classified as of low to moderate gas generation potential, but will need confirming as part of detailed design.

3.1.5 Potential Receptors

We consider that the most vulnerable receptors with regards to any contamination or hazardous ground gas present are likely to be as follows.

- Future site users
- Construction and maintenance workers.
- Buried concrete (foundations, drainage etc.).
- The groundwater within the underlying Secondary A Aquifers (Superficial and Bedrock).

3.1.6 Potential Migration Pathways

Based on the Conceptual Site Model discussed in the previous sections, 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 landscaping areas.
- Dermal contact with contaminated soils.
- Exposure to asbestos containing materials within the shallow soils.
- Potential explosive risk from flammable ground gas/vapours from on-site sources.
- Potential risk from toxic ground gas/vapours from on-site sources.

Construction and Maintenance Workers:

- Exposure to asbestos containing materials within the shallow soils.
- Ingestion of soils and inhalation of dust across site.
- Dermal contact with contaminated soils.
- Potential explosive risk from flammable or toxic ground gas/vapours from on-site sources.

Groundwater:

- Leaching of mobile contaminants into the water-bearing strata within the superficial deposits and bedrock.

Buildings:

- Sulphate attack on buried concrete infrastructure (foundations not anticipated).
- Potential explosive risk from flammable ground gas/vapours from on-site sources.

If a SABs application is to be made to allow the use of soakaway drainage (>100m² development footprint), it should be noted that have the potential to leach contaminants from the infiltration strata, which could then impact on the groundwater beneath the site.

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 general methodology set out in CIRIA C552 *Contaminated Land Risk Assessment – A Guide to Good Practice* (Rudland et al, 2001), 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 A1 in Appendix A):
- The magnitude of the probability (likelihood) of risk occurring (Table A2 in Appendix A).

The classifications defined above are then compared to indicate the risk presented by each pollutant linkage, allowing evaluation of a risk category (Tables A3 and A4 in Appendix A). These tables have been revised slightly by ESP from those presented in CIRIA C552, to allow for the circumstances where no plausible linkage has been identified and, therefore, no risk would exist.

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 1 in Section 3.2.2 below.

3.2.2 Tabulated Preliminary Risk Evaluation & Plausible Pollutant Linkages

Table 1: 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 associated with historical land use and positively identified during ESP investigation to the west of the site.	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Site Users	Medium – potential for chronic levels.	Likely ²	Moderate Risk	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	Likely ²	Low Risk	
	Leaching of soil contaminants	Impact on Groundwater	Medium – site lies on Secondary A Aquifer	Likely ²	Moderate Risk	
	Leaching of soil contaminants	Impact on Surface Waters	Minor – no surface waters in immediate vicinity.	Low Likelihood ²	Moderate/Low Risk	
Asbestos in shallow soils	Inhalation of fibres	Construction/ Maintenance Workers	Medium – potential for chronic levels	High Likelihood	High Risk	Sampling of shallow soils for asbestos.
Soil sulphate and pyrite	Aggressive groundwater	Buried Concrete	Mild – damage to structures	High likelihood ³	Moderate Risk	Sampling of soils to confirm levels of sulphate, pH, and groundwater.
Hazardous ground gas/vapours from Made Ground Peat Bands and infilled ponds.	Asphyxiation/poisoning. Injury due to explosion.	Site Users/Visitors.	Severe – acute risk.	Likely	Moderate/High Risk	To be reviewed depending on ground conditions – potentially install and monitor gas wells.
	Damage through explosion.	Building/Property	Severe – acute risk.		Moderate/High Risk	
	Asphyxiation/poisoning. Injury due to explosion.	Construction and Maintenance Workers.	Severe – acute risk.		Moderate/High Risk	
Radon gas	Migration into Buildings	Site Users (residents)	Medium – potential for chronic levels	Low Likelihood ⁴	Low Risk	See Section 2.11.
Notes: - Methodology and details of risk consequence, probability and category based on CIRIA C552 (2001) and presented in Section 3.2.1. - The presence of Made Ground or contamination has not yet been confirmed on site. See Section 3.1. - The underlying strata can potentially contain sulphates/pyrite. See Section 2.10.5. - Radon risk identified in environmental data report. See Section 2.11.						

4 Preliminary Geotechnical Comments

4.1 Preliminary Conceptual Ground Model

Based on the desk study information obtained to date, we anticipate that parts of the site may be underlain by Made Ground, followed by a significant depth of Superficial Deposits that will include Wind Blown Sands, Alluvium (including Peat Bands) and Glacial Deposits. Coal Measures bedrock is likely to be at significant depth.

The insitu strengths of each of these strata will vary significantly and the presence of groundwater may lead to “softening” and a reduction in ground strengths, particularly within the Wind Blown Sands.

A number of potential geotechnical hazards have been identified that will require further consideration, these comprise:

- Shrink/Swell;
- Running Sands;
- Compressible Ground;
- Ground Workings;
- Pyritic Ground Conditions;

Prior to the development of the site, the Conceptual Ground Model should be confirmed via an appropriate intrusive site investigation for the development proposals.

4.2 Preliminary Foundation Comments

At present no detailed design drawings of design or construction technique have been provided and we understand the development will comprise a single warehouse style commercial building. An appropriate foundation type is likely to comprise piles or possible ground improvement, dependant on proposed loadings and tolerance of the building. This will need to be assessed further following an appropriate ground investigation.

If a SABs application is required for the development to allow the use of soakaway drainage (>100m² development footprint), then the undertaking of soakaway infiltration testing will be required in strict accordance with BRE 365. As Made Ground and/or Wind Blown Sands are likely to be present at the site, the use of stone infill would likely be required to keep the pits open. In addition to this, soakaway design would likely need to accommodate the potential for shallow groundwater.

5 Preliminary Geo-environmental Comments

5.1 Soil Contamination

As discussed in Section 3.1, the site is noted to have operated as part of a former tin works, with tanks, substations and likely infilled ponds, ditches and a pool identified. These are potentially significant contaminative former uses. In addition to this, the site and surrounding area are noted to have been extensively affected by ground workings and reworked ground.

As part of the recommended further investigation, we recommend that samples of the near surface soils are collected and analysed for a range of contaminants present on brownfield sites in the UK. Dependant on the findings of the investigation, this may need to be supplemented with detailed geoenvironmental testing, including leachate and groundwater testing.

As discussed in Section 3.1.5, there is a potential risk of contaminants within the Made Ground leaching into the underlying aquifers. Investigation works undertaken by ESP to the west of the site have identified the potential for contamination within the soil and groundwater and as the site shares the same historical development, these conditions could be realised beneath the site.

Further assessment may be required where soakaways are being considered for the site, this may the collection of samples for leachate testing and a subsequent Level One assessment of risks to groundwater.

5.2 Hazardous Ground Gas

As discussed in Section 3.1.4, there is a potential for hazardous ground gas generation within the anticipated Made Ground, infilled features such as ponds, ditches, a pool and any peat bands contained within the underlying alluvium. The potential for hazardous ground gas poses a risk to the development however, such risks can be mitigated provided that levels of ground gas and flow rates are known. This should be assessed further based on the arising conditions identified as part of the ground investigation.

6 Recommendations

We consider that the following further investigation and assessment would be required or prudent prior to development:

Required Further Actions:

- Layout and Planning Requirements to be confirmed.
- Intrusive investigation across the site to identify the underlying ground conditions and further develop the ground conceptual model. We consider at this stage that a site investigation comprising trial pitting and or windowless sampling would be required at this stage to determine the shallow ground conditions.
- Deep light cable percussion boreholes to a depth to be confirmed once the design is finalised.
- Sampling and analysis for contaminants within shallow soils.
- Detailed assessment of potential foundation options (this will require a preferred design with loadings, tolerances etc.).
- Infiltration testing if a SABs application is required.
- Installation of ground gas monitoring wells and monitoring visits dependant on arising conditions.
- Dependant on arising conditions and contamination status identified, planning may require a formal Controlled Waters Risk Assessment.
- Any investigation will require services plans and an Unexploded Ordnance report prior to commencement. The area and surrounds is generally identified as of higher risk with regards to UXO and detailed assessment may be required dependant on the findings of the preliminary risk assessment.

Recommended Further Actions:

- Further consideration of flooding aspects in the north portion. This may impact on the location of the building and local regulators may require a formal Flood Consequences Assessment.
- Verification testing of any soils imported to site.
- Materials management plan for re-use of soils on site and WM3 assessment of soils to be disposed of/re-used off-site, followed by WAC testing if disposal to landfill (Section 4.4).

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